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ASSESSING THE SPATIAL PATTERN OF CRIME IN BOMADI AND PATANI LOCAL GOVERNMENT AREAS OF DELTA STATE, NIGERIA

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Abstract

Criminal activity is frequently unevenly distributed throughout space, with concentrations in specific neighbourhoods, and is linked to several socioeconomic and criminal opportunity factors. This study assessed the spatial pattern of property and violent crime in Bomadi and Patani Local Government Areas of Delta State, Nigeria. Data on the experience of crime victimisation by residents were collected using a crime victimisation questionnaire survey. A total of 399 respondents were selected using a systematic random sampling method. An administrative map of the study area was acquired from the Ministry of Land and Survey, Delta State which was used as the base map. These data were analysed using Nearest Neighbour Analysis (NNA) and Kernel Density Estimation (KDE), to derive the pattern and density of hotspots of crime in the area. Descriptive statistics such as line graphs were used to analyse the crime types and temporal variation of crime incidence. Hypotheses were tested with Analysis of Variance (ANOVA), and regression analytical tools. Findings revealed that property crime had the highest incidence rate of 61.68% while violent crime had the least with 38.32%. Findings revealed property and violent crime are concentrated in the towns of Bomadi, Patani and Akugbene which are more economically developed and have a larger population than the surrounding communities. Furthermore, the study reveals that there has been a substantial decline in recorded property and violent crimes over the years. To ensure the safety and protection of citizens, it is recommended that the police should conduct frequent patrols in the towns of Bomadi, Akugbeni, and Patani, which have been identified as hotspots.

Keywords: Property and violent crimes, **N**earest neighbour analysis, Kernel density estimation, Hotspots, Spatial pattern

Introduction

Crime is a major problem that has generated great concern in Nigeria and other developing nations. The differences in political and economic structure, physical structure, national tradition and cultural background present varied patterns of crime in different countries. Many cities around the world are experiencing spatial growth with increased population. The alterations in the social structures and increased population of many societies over time have resulted in a rise in crime rates due to the absence of adequate environmental and/or social policies and programmes.

The role of the spatial and the social structure as the generator and inhibitor of both property and violent

crime has been a subject of research and debate in the past 30 years. Nominally, property crimes are offences against human belongings such as theft, burglary, housebreaking, among others while violent crimes are those offences against human beings such as murder, manslaughter, infanticide, concealment of birth, rape and other physical abuse, among others. (National Bureau of Statistics, [NBS], 2017). The uneven distribution of crime events across space is shaped by both spatial (built-up or non-built-up, industrial/retail, agriculture, bare soil, vegetation and water) and social (family, religion, law, economy, and class) structures. Many socioeconomic characteristics such as household income, educational attainments, employment status and poverty of neighbourhoods shape the pattern of both

property and violent crime within cities of the world (Malik, 2016 and Mitchell, 2011).

In the past 30 years, the literature on environmental criminology has supported the influence of the structure of both the physical and social environment on crime. Bomadi and Patani Local Government Areas (LGAs) in Delta State, Nigeria are experiencing uncontrolled urbanization, changes in occupation mostly due to loss of fishing grounds and an increase in economic activities despite the space constraints (UNDP, 2006; Onyepuemu, 2015). With the presence and growth of the oil and gas industry, the area has experienced a social change that is weakening traditional institutions. It has been suggested that the social and economic impact of the oil and gas industry has contributed to various social problems such as crime in the area (Kayinwaye, 2014; Osuagwu and Olaifa, 2018). This has severely weakened the social fabric of the region and has the potential to raise crime rates in the area's waterways and villages. This necessitated the need to assess the spatial pattern of property and violent crimes in Bomadi and Patani Local Government Areas of Delta State, Nigeria. The objectives are to identify and map the major property and violent crime types, determine the spatial patterns and hotspots of property and violent crime types and examine the temporal variation of both crime types between 2014 and 2018 in the study area.

Literature Review

The past three decades have seen a major expansion into the analysis of the spatial distribution and hotspots of property and violent crimes (Newton and Felson, 2015). Emerging at the forefront of place-based research on crime; the emphasis has been on small scale or at a micro-level analysis of crime (Weisburd 2015). Weisburd (2015) introduced the concept of the law of crime concentration at places otherwise known as the hotspot. The author, for instance, reported in this study that about 1.4% of street segments accounted for 25% of all crime incidents in New York City with a population of 8.3 million people. The concentration of both crime types is influenced by the characteristics of the neighbourhood population and the surrounding physical environment (Malleson and Andresen, 2016). The study of property and violent crime at the micro-level was driven by both advancements in geospatial techniques such as GIS and the increased availability of spatially referenced crime data (Newton and Felson, 2015). This advancement has

promoted the analysis of the spatial clustering of crime, or hot-spot analysis.

As noted above, the relationship between property and violent crime and neighbourhood have looked primarily to routine activity theory as an explanation for why crime events vary at places (Weisburd, Bushway, Lum and Yang, 2004; Weisburd, 2015). These authors have observed that many criminological studies have focused primarily on the identification of crime at micro places known as hotspots. This has formed the basis for constructing practical crime hindrance methods (Weisburd et al., 2004). Furthermore, Eck et al. (2005) believe that to understand why particular settings are more susceptible to criminal incidents than others, the hotspots detection method should map the locations of crimes rather than specifying their addresses. This contributes to a better understanding of the underlying spatial and social processes that influence the presence or absence of criminal activity in a given environment. The level of analysis can be hotspot street, hotspot neighbourhood, or hotspot city. Therefore, the concept of a hotspot does not always refer to a single point feature, but sometimes it also refers to a polygon feature. And that is crucial to GIS analysis tools.

Many scholars have provided a strong empirical basis for the assumption that crime is strongly clustered at specific places known as hotspots. Weisburd et al. (2004) examined crime at street segments in Seattle, Washington, over 14 years. They found that 50% of crime events over the 14 years occurred at only 4.5% of the street segments. They also found out that the concentration of crime at micro-units of geography is relatively stable over time. For instance, the study revealed that between 4% and 5% of the street segments account for about 50% of the crime incidents in each of the years examined. More importantly, they also found that there were distinct developmental trends at street segments, which suggested significant variability in crime trends over time at micro levels of geography. Another study conducted by Weisburd (2015) again replicated the more general assumption that crime concentrates at specific hotspots. For example, the author's findings revealed that 0.8% of street segments accounted for 25% of all crime incidents in Sacramento (a city with a population of 476,577 people). The author further concluded that crime rates vary greatly across the eight cities of Cincinnati, Seattle, Tel Aviv-Yafo, New York, Sacramento, Brooklyn, Redlands and Ventura, as do social characteristics.

Gill, Wooditch and Weisburd (2016) also assessed

whether the concentration of crime at specific places known as hotspot applies in a non-urban context. The author acquired crime data from Brooklyn Park Police Department (BPPD). The authors used group-based trajectory analysis to examine trends in recorded crime incidents on street segments in Brooklyn Park, a suburban city outside Minneapolis, Minnesota, over 15 years from 2000 to 2014. The study revealed that 2% of the street segments fashioned 50 % of the crime events over the 15 years and 0.4% of segments produced 25 % of the crime. They also observed that the spatial patterns of crime concentration were highly stable over time.

Mafumbabete et al. (2019) used geospatial analysis to determine crime densities and hotspots in rural Zimbabwe using data collected from mobile Global Positioning Systems and interviews. The authors applied Moran's I to determine crime clustering and Gertis~Ord statistic to determine the hotspots of crime in the Chivi district. The results of the study revealed that crime densities of 4.6 were located at Chivi growth point and low crime densities (1.15) were found as the distance from the growth point increased. The study revealed that hotspots of crime at 99% confidence level were located in wards 11, 12, 15 and 30. The authors concluded that geospatial techniques will help the law enforcement agents in establishing beat patrols in the problematic areas to curb crime and safeguard life and property.

In summary, it can be deduced that much of the research on the spatial pattern of property and violent crime has not come to a consensus on the spatiotemporal trends of various crime types. This provides strong support for the need for additional comparisons of neighbourhoods. Based on the above literature, there is still a need for further research on crime patterns, particularly from the oil-rich area of Delta State, Nigeria. As such, this study seeks to assess both property and violent crime using both police records and residents' victimisation surveys from different political wards of Bomadi and Patani LGAs of Delta State, Nigeria.

Study area

Bomadi and Patani LGAs are in Delta State, Nigeria. The study area is located between Latitudes 5°5'58''N and 5°20'54''N of the equator and Longitudes 5°43'53''E to 6°16'58''E of the Greenwich meridian with a total landmass area of 346sg.km (National Population Commission, 2009). It is bounded by Ughelli South, Ughelli North and Isoko South LGAs on the North, on the West by Burutu LGA and Ekeremor and Sagbama LGAs of Bayelsa State on the South. Many of the communities are almost (and in some cases) surrounded by water (see Figure 1). The climate of the area is characterized by a tropical monsoon climate marked by two distinct seasons, the dry and rainy seasons. Rainfall occurs generally every month of the year. The area is characterized by heavy rainfall with an average mean of 2,550 - 2,755 mm per annum and rain falls every month of the year with heavy downpours (UNDP, 2006; Egbuchua and Ojobor, 2011). The mean minimum annual temperature ranged from 23° - 34°C with high relative humidity of about 78-82% (Mesike, Ugwa and Esekhade, 2015).
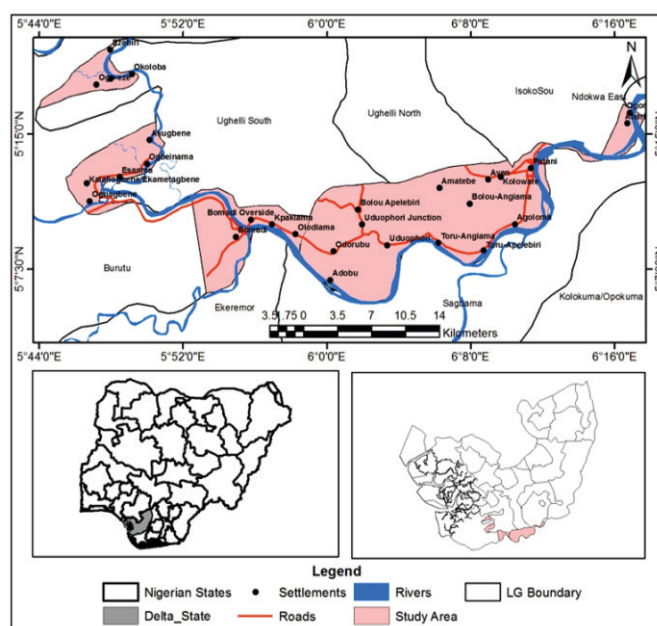

Figure 1: Bomadi and Patani LGAs
Source: Adapted from the Administrative Map of Delta State

The projected population of the study area in 2019 was 130,744 and 102,434 people for Bomadi and Patani LGAs respectively. The majority of the study area's dwellers are members of the Ijaw ethnic group. The study area is one of the areas with oil mineral and natural gas deposits in Delta State and as a result, petroleum production is one of the important economic activities in the area. The area also has other mineral resources such as fine sand and clay (used in pottery and porcelain production). Other forms of economic activities include small-scale businesses (trading) and artisanship. Due to the immersed availability of water, the inhabitants mostly engage in fishing on subsistence and commercial level. Agriculture or farming is another mainstay of the study area economy. Crops largely cultivated are yam, cassava, plantain, palm oil, banana and cocoyam. However, oil exploration in the area has the potential to increase criminal activities such as theft and stealing, piracy, bunkering, breaking, and kidnapping due to the loss of fishing grounds, disappearance of basic means of income, occupational changes, land scarcities, and unregulated urban expansion. The Delta State Police Command's operatives recently increased their security patrol operations on the creeks of the State due to an increase in crime, according to the Command's Commissioner of Police, CP Ari Mohammed Ali (Ogunyemi, 2021). There are also residents in public service mostly in the major towns in the study area. The secondary occupations include trading, dressmaking, carpentry, gold smiting, and food vending and auto repairs (Mesike et al., 2015).

Material and Methods

A reconnaissance survey was carried out to have adequate knowledge of the study area. The property and violent crime experienced by respondents was collected through a Crime Victimisation Questionnaire Survey. The respondents were asked if they or a family member had been a victim of property or violent crimes in their neighbourhood in the previous five years. If they said yes, the next question was how many times each of the property and violent crime types had happened to them. Members of the households were asked to fill out the questionnaire. All of the settlements in the study region, which was defined as 20 political (electoral) wards, make up the population (see Table 1). As a result, the study was divided into strata based on the existing political wards. Their geographic coordinates were obtained by fieldwork (ground survey) with the use of the Global Positioning

Table 1: Projected Population and Sample Size by Wards

S/N	Ward	Population 1991	Projection 2018	Sample Size
1	Bomadi	9,976	20,750	37
2	Kpakiama	4,680	97,34	17
3	Esanma	6,635	13,801	24
4	Ogriagbene	9,736	20,251	36
5	Kalafiogbene/Ekametagbene	5,051	10,506	19
6	Ogbeinama/Okoloba	7,803	16,230	29
7	Akugbene 1	4,617	9,603	17
8	Akugbene 2	3,463	7,203	13
9	Akugbene 3	3,127	6,504	11
10	Ogo-eze	4,317	8,979	16
11	Abari I	4,043	8,409	15
12	Patani I	6,493	13,505	24
13	Patani II	4,749	9,878	17
14	Patani III	4,516	9,393	17
15	Taware/Koloware/Aven	2,721	5,660	10
16	Agoloma	2,743	5,705	10
17	Toru-Angiama	4,059	8,443	15
18	Toru-Apelebiri/Bolou-Angiama/Amatebe	5,763	11,987	21
19	Uduophori	6,521	13,564	24
20	Odorobu	7,481	15,560	28
	Total	**108,494**	**225,668**	**399**

Source: NPC, Delta State (2019)/Authors' Compilation, (2019)

System (Garmin eTrex 20x GPS Receiver). The administrative maps of the study area at a scale of 1:50,000 were sourced from the Ministry of Lands and Surveys, Delta State, satellite imagery was obtained from Google Earth which was used to validate the location, features and digitized roads, rivers and boundary of political wards, among others.

A total of twenty wards in Bomadi and Patani LGAs were used to map and analyse the spatial variation of both property and violent crimes in the study area. They include: Bomadi, Kpakiama, Esanma, Ogriagbene, Kalafiogbene/Ekametagbene, Ogbeinama/Okoloba, Akugbene I, Akugbene II, Akugbene III. Ogo-eze. Others include Abari I, Patani I, Patani II, Patani III, Taware/Koloware/Aven, Agoloma, Toru-Angiama, ToruApelebiri/Bolou/Angiama/Amatebe, Uduophori, Odorobu (see Table 1).

The population of Bomadi and Patani LGAs was estimated according to the 2006 census as 153,407 people (National Bureau of Statistics, 2011). However, the 2006 population figures of the study area were not disaggregated into the 20 wards. Therefore, the 1991 National population and housing census results which were disaggregated into localities were used to find the proportion of people in the respective wards. The projection was based on the average population growth rate of Delta State that is 3%, using Newman's (2001) formula:

$$P_n = Po + (\frac{1 + R}{100} \times Po) \, n$$

Where: P_n = population in the recent year, Po = population in the base, year (108,494), R = Annual growth rate (3%), n = number of intermediary years (2018-1991= 27). The projected population is, therefore, 225,668 people. Having determined the sampling frame, the Yamane (1967) formula was used to determine the sample size thus

$$\text{Sample Size} = \frac{N}{1 + N \, (e)^2}.$$

Where: N = total population of the study area, e = as error margin (0.05 or 5 per cent). The sample size is therefore 399. In each of the wards, the sample size was based on the projected population of the ward.

A Systematic sampling technique was used to select the respondents in the various wards of the study area. This method was chosen because it ensures that the entire population is sampled uniformly. The researcher and the field assistants, therefore, select a respondent randomly followed by every fourth house in the area. Where the respondent declined access or is absent, the researcher and his field assistants will move to the next house until the target population sample is reached.

The identification of the property and violent crimes in the research area was accomplished by the use of police-reported crime data collected from the Criminal Investigation and Intelligence Department (CIID) of the Delta State Police Command. These police reports span the years 2014 to 2018 but have no geographical coordinates and/or addresses for each recorded occurrence. Therefore, it was not possible to map the incident using the police crime records. Data from the crime victimization survey were analysed and used to map the victimization rate of the respondents in the region.

The Delta State Police Command crime data included yearly crime data for 35 crime types for the period 2014 to 2018. Crime data types collected were first reduced to ten, five each for property and violent crime types. These offences were selected because they were the most common types committed in the study area as recorded in the police report. For this research, the researchers focused on the following offences: theft/stealing, burglary, housebreaking, store breaking, false pretence and cheating, murder/homicide, assault, rape, armed robbery, and kidnapping. These crime types were categorized as either property or violent crimes and combined to form the two crime groups: total property crime and total violent crime. Property crimes (theft/stealing, burglary, housebreaking, store breaking, false pretence and cheating) are illegal acts committed to getting money, property, or some other benefit, and may involve the use or threat of force, whereas violent crimes (murder/homicide, assault, rape, armed robbery, and kidnapping) are horrible crimes against humanity (National Bureau of Statistics, 2017; Yin, 2017)

ArcGIS 10.5 was used to create a series of maps displaying the victimisation patterns of property and violent crime and the administrative wards characteristics in Bomadi and Patani LGAs of Delta State, Nigeria. The study area's communities have not been spatially demarcated into the various administrative wards with well-defined and recognized boundaries. To overcome this challenge, the study area was delineated into 20 neighbourhoods representing the various political wards. At the same time, this was done to ensure that every part of Bomadi and Patani LGAs were captured in the survey (see Figure 2). The
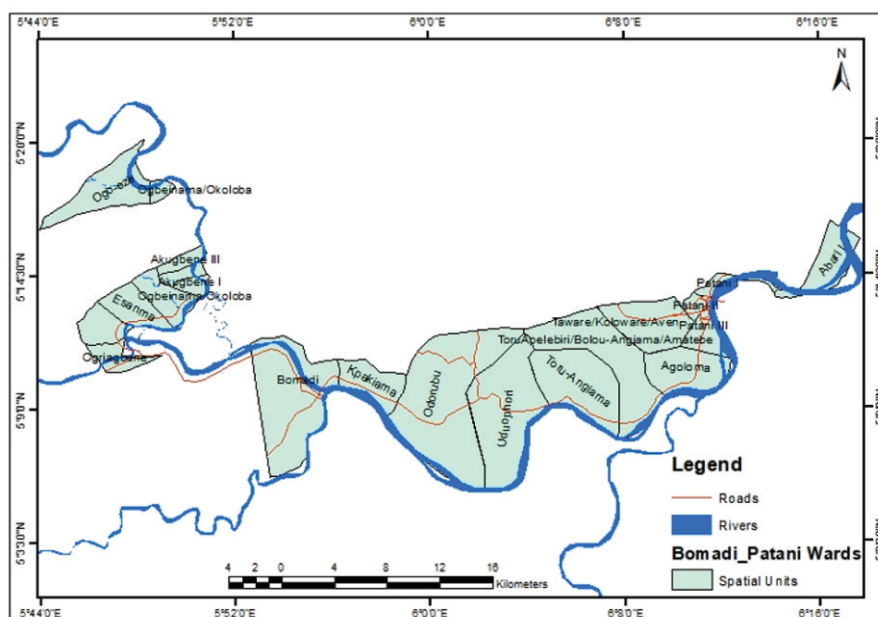
Figure 2: Bomadi and Patani LGAs showing the Subdivision of Administrative Wards
Source: Field Survey (2019)

administrative wards were demarcated based on the boundaries of the communities in each ward which served as the unit of data collection.

The geographic coordinates of the respondents' experience of crime were overlaid on the Geo-referenced and digitized map of the study area to map the distribution and determine the hotspots of the two categories of crime in the area. The spatial pattern of property and violent crimes was determined by the Nearest Neighbour Analysis (NNA) inferential statistical tool in ArcGIS10.5 was used. The method was used to determine if property and violent crimes were clustered or dispersed. The NNA uses a statistical technique in which it measures the distance between each feature in the dataset and its single nearest feature neighbour, then calculates the average distance of all measurements (Bajjali, 2018). This was also used to examine the degree of confidence in a dataset with a confidence level of less than 0.001%. And a z-score was calculated, which was crucial in deciding whether to accept or reject the null hypothesis, which is that property and violent crime types are randomly distributed rather than clustered or dispersed. Badru et al. (2019) employed this method to determine the spatial pattern of crime at the University of Lagos, Nigeria. A crime hotspot map was produced using the Kernel Density Estimation (KDE).in ArcGIS10.5 to show the area with high to low susceptibility to both property and violent crime. KDE was used because it is the most suitable spatial analysis technique for picturing crime data (Chainey et al., 2008; Bajjali, 2018).

Results and Discussion

Property and violent crimes in Bomadi and Patani Local Government Areas

Table 2 shows the crime types for each of the two categories and the portion of the total crimes that the variables contribute to their respective categories. It shows the overall distribution of incident reports in the five observation years. Property crime accounts for 61.68% followed by violent crime with 38.32%. This finding is similar to the one identified by Weisburd et al. (2004) in the city of Seattle in the United States where the authors reported that property crime accounted for over 49% while violent crime recorded less than 12%. The high rate of property crime in the study area may be tied to the high percentage of the residents living below the national minimum wage and the high percentage of respondents with no tertiary education in the study area.

Victims of crime survey of property and violent crimes

Figure 3 depicts the property and violent crime experienced by respondents in the LGAs of Bomadi and Patani. The findings in this Figure revealed that property crime had the highest percentage with 81% while violent crime had 48.4%. This result is consistent with crime statistics gathered by the Delta State Police Command's Criminal Investigation and

Intelligence Department (CIID), which recorded 61.7% of property crime, the most common type of crime, as seen in Table 2. The findings of this study are likewise similar to those reported by Weisburd et al. (2004) in the city of Seattle, Washington, where the findings revealed that property crime accounted for almost 49% of all crimes committed. However, this finding contrasts with that of Wang et al. (2019), who found that violent crime was more common than property crime in Toronto neighbourhoods.

Spatial Distribution of Property and Violent Crimes Victimization in the Study Area

The spatial distribution of the victimisation rate of property crime is shown in Figure 4. This Figure shows the victimisation patterns of property crime rate by administrative wards in Bomadi and Patani LGAs of Delta State. The finding revealed that the administrative wards of Bomadi and Patani I had a high victimisation rate of property crime with 131.17

and 90.64 rates per 1,000 populations respectively. However, the rate of victimisation decreases as one moves away from the centre of these wards. There are four wards of medium victimisation rates of property crime with a range from 39.80 - 53.06 and four other wards having a low rate between 0-25.79.

The spatial distribution of the victimisation rate of violent crime is shown in Figure 5. This Figure shows the victimisation patterns of violent crime rate by administrative wards in Bomadi and Patani LGAs of Delta State. For violent crime, the highest victimisation rates are also located in the administrative wards of Bomadi (167.9) and Patani I (97.8). This is followed by Akugbene 1 with 86.7 rates per 1,000 populations. There are three medium victimisation rates with a range from 36.91 - 46.13 of violent crime in the administrative wards. Also, four of the twenty administrative wards had low rates ranging between 0 and 18.45 rates per 1,000 populations.

Table 2: Bomadi and Patani LGAs Crime Incidents Report

	Total Offences	Percentage	Overall Proportion (%)
Criminal Offences	**1357**		**100**
Property crime - Total	**837**	**100**	**61.68**
Theft/Stealing	454	54.24	
Burglary	77	9.2	
Housebreaking	91	10.87	
Store breaking	44	5.26	
False Pretense and Cheating	171	20.43	
Violent Crimes - Total	**520**	**100**	**38.32**
Murder/Homicide	7	1.35	
Assault	456	87.69	
Rape	19	3.65	
Armed Robbery	21	4.04	
Kidnapping	17	3.27	

Source: Delta State Police Command (2019)/Authors' Compilation 2019
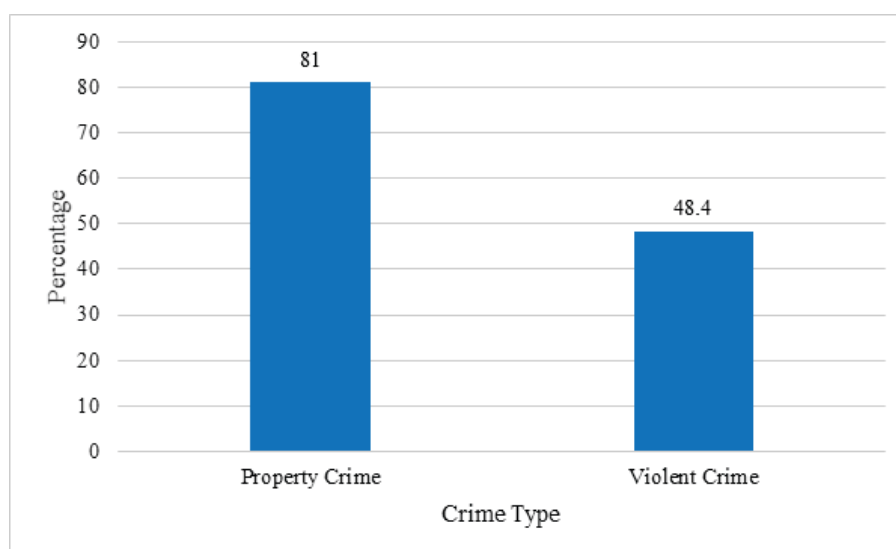

Figure 3: Property and Violent Crime Experienced by Respondents
Source: Field Survey (2019)
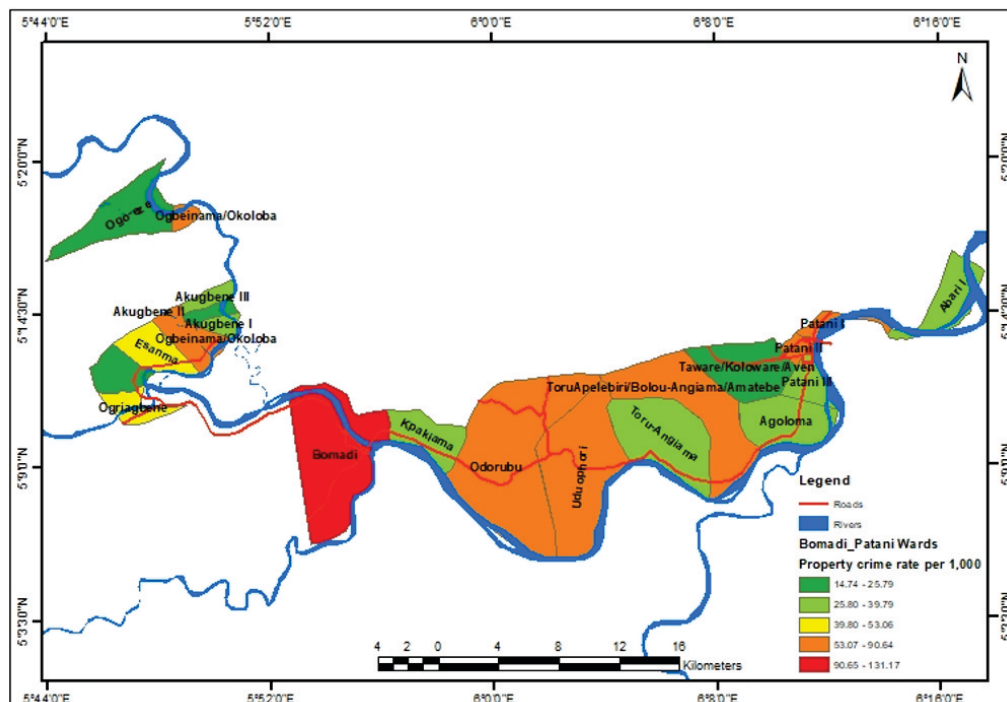
Figure 4: Victimization of Property Crime Rate per 1,000 Population by Administrative Wards
Source: Authors' Analysis (2019)
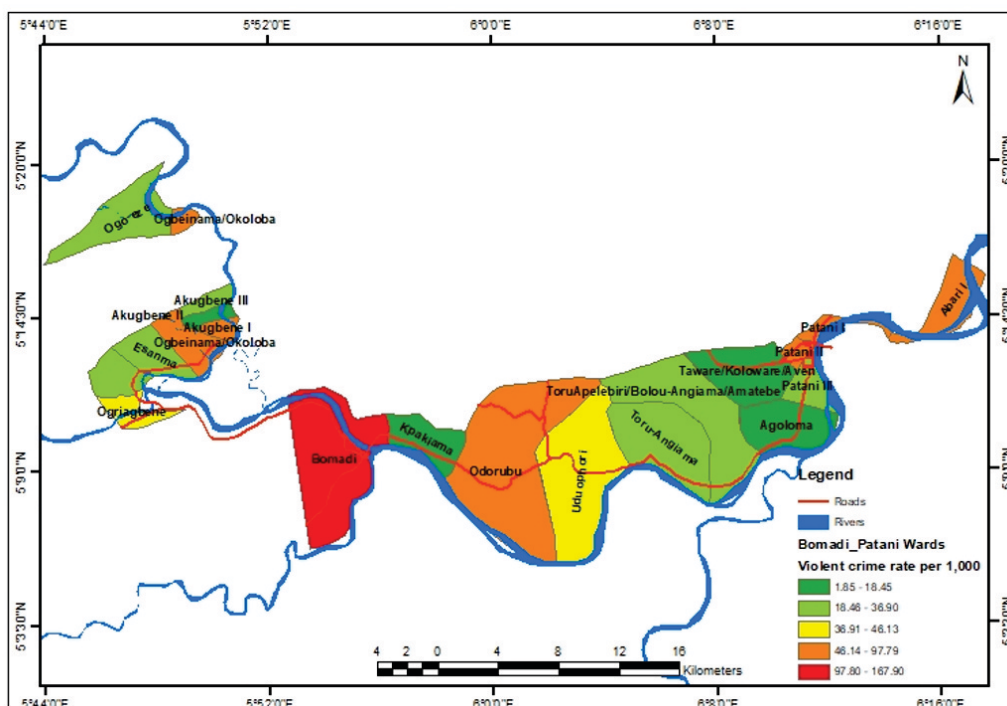
Figure 5: Victimization of Violent Crime Rate per 1,000 Population by Administrative Wards
Source: Authors' Analysis (2019)

In general, the victimisation patterns for the rates of each crime type show that crime tends to be highest in the administrative wards of Bomadi and Patani I, which are the core wards with higher economic activities. Inequalities in population distribution, inequalities in the presence of influential people and politicians, variations in industrial development, and the presence of liquor stores and markets in these two political wards than in others may all contribute to these higher rate of victimization. These two wards are the core or the most developed wards with increasing economic activities. The rate of

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victimisation decreases as one moves away from the centre of Bomadi and Patani towns. This research corroborates the suggestion of Bala et al. (2015), who found that five of the thirteen zones, namely Kangiwa, Shinkafi II, Wakilin Gabas I, Wakilin Gabas II, and Wakilin Kudu III, have a high rate of crime due to the high population and economic activity in these wards.

The spatial patterns of property and violent crimes in Bomadi and Patani Local Government Areas

The spatial dependence of property and violent crime events were analysed in the study area. Property and violent crime victimisation data were collected on the frequency of victimization experienced by respondents in the communities of the study area. A victimization survey was used

because the crime data from the police records were not recorded with their geographic coordinates and/or their addresses. This makes it impossible to establish the concept of the concentration of property and violent crime known as a hotspot. The summary of this nearest neighbourhood analysis is shown in Figures 6 and 7.

The results in Figures 6 and 7 show the spatial pattern of property and violent crime. The result in Figure 6 revealed that the observed mean distance between the victimisation of property crime events is 21.21 meters as opposed to the expected mean distance of 492.59 meters. The result also revealed that the spatial pattern of the property crime events in the study area is clustered with z-scores of -64.2. Also, the result in Figure 7 revealed that the observed mean distance between the victimisation of violent crime events is 68.96 meters as opposed to the expected

Figure 6: Spatial Pattern of Victimisation of Property Crime Scene. Source: Authors' Analysis (2019)

Summary of Nearest Neighbour Result of the Spatial Pattern of Property Crime in Bomadi and Patani LGAs	
Observed Mean Distance:	21.2112 Meters
Expected Mean Distance:	492.5888 Meters
Nearest Neighbour Ratio:	0.043061
Z-score:	-64.204848
P-value:	0.000000

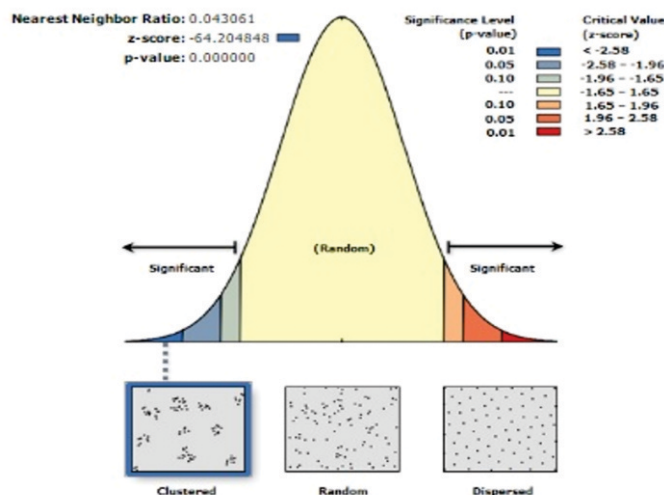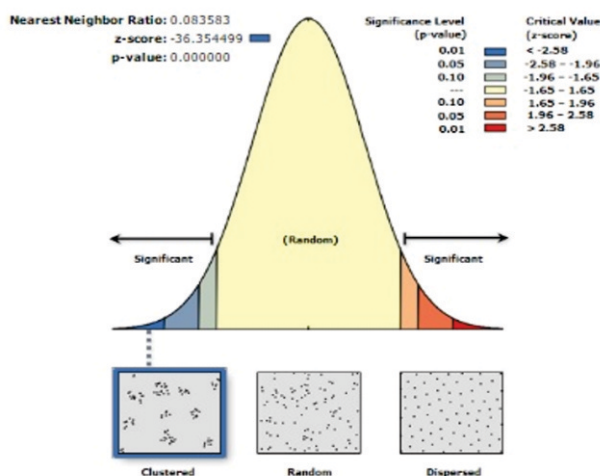Figure 7: Spatial Pattern of Victimisation of Violent Crime Scene. Source: Authors' Analysis (2019)

Summary of Nearest Neighbour Result of the Spatial Pattern of Property Crime in Bomadi and Patani LGAs	
Observed Mean Distance:	68.9589 Meters
Expected Mean Distance:	825.0330 Meters
Nearest Neighbour Ratio:	0.083583
Z-score:	-36.354499
P-value:	0.000000

mean distance of 825.03 meters. The result also revealed that the spatial pattern of the violent crime events in the study area is clustered with z-scores of -36.35.

Given the Z-scores of -64.2 and -36.35 for property and violent crime, respectively, there is a less than 1% chance that these crimes are the result of random chance. We reject the null hypothesis and accept that the distributions of both crime categories are clustered because the nearest neighbour index (I) ratios for property and violent crimes are also 0.04 and 0.08, respectively, which are less than 1. In terms of clustering, the study indicated that property crime, with a Z-score of -64.2, is more clustered than violent crime. This may be because the majority of the population work in the informal sector, which is fraught with risk because some of the benefits accrued to traders, peasant farmers, and artisans are seasonal. This may predispose people to criminal behaviour, particularly property crime when their livelihoods are threatened. As a result, providing some level of social support (in the form of assisting people who require higher education with welfare to affect their principal source of income) in the study area, which could be a powerful factor of crime prevention, is necessary to reduce crime. The findings of this study agree with the study of Badru et al. (2019), within the University of Lagos, Nigeria where crimes are clustered in specific areas.

In addition, the environment has a major effect on both of the two forms of crimes in the field of study. In particular, the socio-economic features and physical layout of the different administrative wards will also make it easier or harder for crime to occur at specific locations. Generally, the highly populated areas with increased economic development, such as Akugbene, Bomadi and Patani towns were among the wards with a high number of residents that experience victimization. These areas appear to be dominated by high influential people and politicians, non-indigenous people, business activities and offices of both government and private establishment.

The hotspots of property and violent crimes in Bomadi and Patani Local Government Areas

Figures showing the distribution of the two categories of property and violent crime hotspots were produced from the geocoded crime data collected from the victimisation questionnaire survey conducted in the study area. A count of reported incidents of victimisation by respondents within the

study area was taken for each of the ten crime types categorised into property and violent crime (see Table 2). The Kernel Density Estimation in ArcGIS 10.5 was used in mapping the property and violent crime hotspots in the study area. The geographic coordinates of the residents' who experienced victimisation of the two categories of property and violent crimes were imported into ArcGIS 10.5 environment and overlaid as a point data. The spatial analysis tool in the Arc toolbox was used to generate the crime hotspots (as shown in Figures 8 and 9).

A visual analysis of Figures 4.6 and 4.7 show three distinct crime hotspots, two of which falls in Bomadi LGA and one in Patani LGA. The hotspots in Bomadi LGA have their nuclei in Bomadi and Akugbene town. While the only hotspot in Patani LGA has its nucleus in Patani town with three administrative wards of Patani I, II and III. The spatial concentration of the high victimisation rates in these three towns may be attributed to the fact that the area is more developed economically with a higher population than its surrounding communities. The first concentric region which is yellow in colour covers mostly forest areas and the administrative ward of Ogo-eze with little or no victimisation of any of the two categories of crime types. However, apart from these three hotspots, there is also a mild concentration of victimisation of property and violent crime incidents or flashpoints at Odorubu and Toru-Angiama, which are yet to develop into hotspots but have the potential to be one in nearest future if not tackled. Therefore, these findings suggest that both property and violent crime tend to concentrate in specific locations with the two categories of crime showing similar spatial patterns. These findings concurred with the general existing knowledge about the spatial patterns of crime in an urban setting (Umar et al., 2015; Kyegh et al., 2017 and Anumba et al., 2018).

Temporal variation of crime in Bomadi and Patani Local Government Areas

Descriptive statistics were used to represent the yearly variation of property and violent crime incidences in Bomadi and Patani LGAs of Delta State, Nigeria. Figure 10 displays the yearly reported crime incidents in the study area. Both property and violent crimes showed a significant decrease over the years. For example, the year 2014 (27.84%) had the highest reported incidents of property crime which dropped drastically to 20.07% in 2015. A significant reduction of property crime was also recorded from
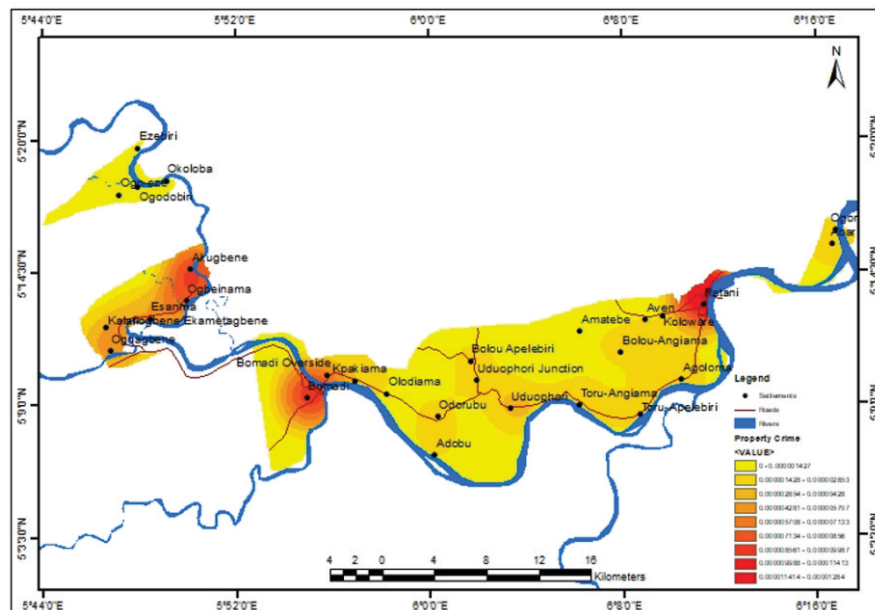
Figure 8: Hotspot of Victimisation rate of Property Crime in Bomadi and Patani LGAs
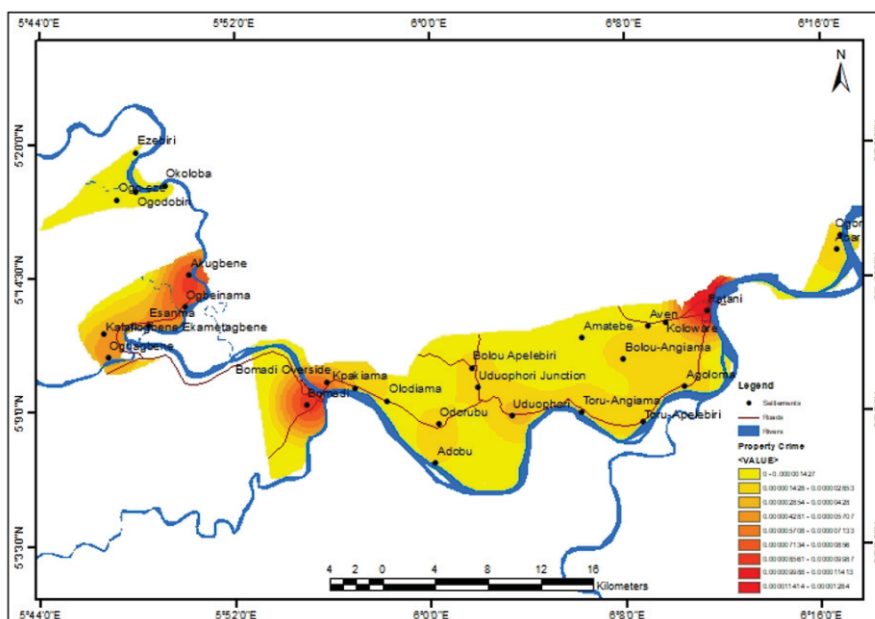Source: Authors' Analysis (2019)

Figure 9: Hotspot of Victimisation rate of Violent Crime in Bomadi and Patani LGAs
Source: Authors' Analysis (2019)

2016 (19.12%) to 2017 (15.17%) with a slight increase in 2018 (17.8%). Also, there was a drastic drop in violent crime from 2014 (26.15%) to 2015 (20.38%). The year 2017 also saw a drastic reduction of reported cases of violent crime to about 13% while again the figures skyrocketed to 19.04% in 2018. These high incidence rates of property and violent crime in 2014 may be attributed to the increase in youth restiveness and the tension related to the lead up to the 2015 Presidential as well as the Governorship race in Nigeria and Delta State.

Hypothesis I

The null hypothesis was stated thus: There is no significant increase in each of the crime types from 2014 to 2018. The total property and violent crime cases reported in the study were subjected to the ANOVA tool as shown in Table 3. The test was based on the linearly independent pairwise comparisons among the estimated marginal means of crime events and the temporal variation in events of both

categories of crime for the years considered (2014-2018).

The result in Table 3 indicates that there is no significant temporal variation of the reported property and violent crime events for the year 2014 to 2018 in the study area, F (4, 5) = 0.94, p< 0.51. In relation to annual seasonal variations in temperature or other weather variables such as rainfall, and the differences in routine activities and social interactions during different times of the year (or week), or due to holidays, the workweek, and weekends are not significant. These findings are not in agreement with that of Ajayi and Ajayi (2014) in Ibadan Metropolis which outcome revealed that there was a significant temporal variation in the incidence of each crime type over time.

Conclusion

This study was inspired by an attempt to examine the variation of hotspots (known as areas of crime concentration) at the select places for both property and violent crimes within Bomadi and Patani LGAs in Delta State. Property crime was the most common crime type experienced by respondents in the area, according to the findings. In terms of geographic pattern, the respondents' experiences with property and violent crimes reveal a clustered pattern, with localities such as Bomadi, Patani, and Akugbene serving as hotspots for both types of crime. This was mostly due to the towns' increasing populations and economic development with no corresponding job opportunities for the youth. The results also demonstrated that there were no temporal dimensions in the pattern of property and violent crimes occurrence.

Recommendations

The following recommendations were made based on the findings:

1. The study shows that parts of Bomadi, Patani and
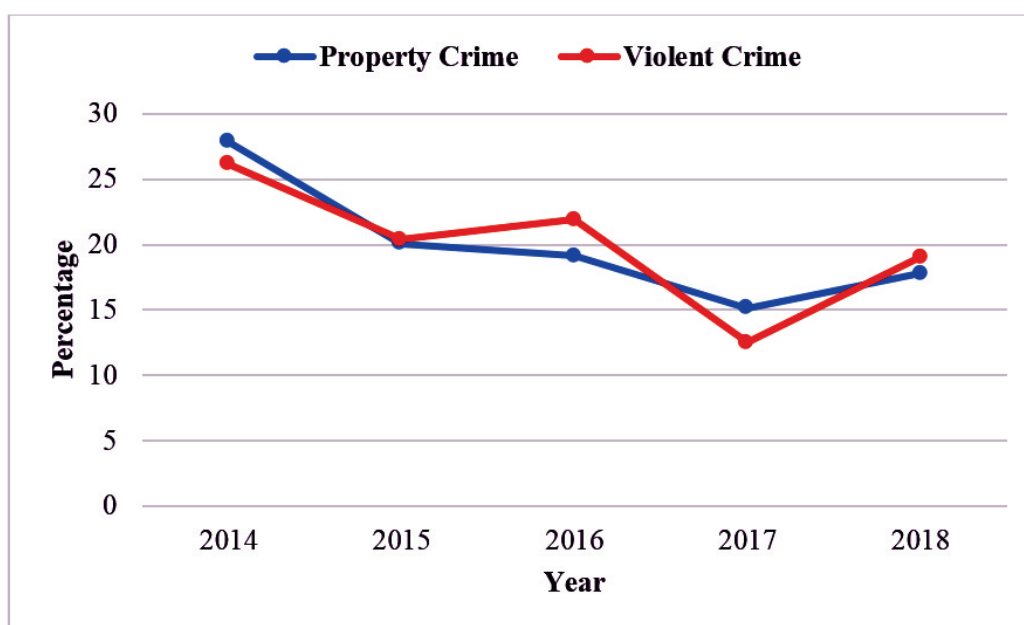
Figure 10: Bomadi and Patani LGAs Crime Incident Report
Source: Delta State Police Command (2019)/Authors' Analysis (2019)

Table 3: Analysis of Variance Result

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8195.60	4	2048.90	0.94	0.51
Within Groups	10856.50	5	2171.30		
Total	19052.10	9			

*Dependent Variable: Crime Incidents
Source: Authors' Analysis (2019)

Akugbene are hotspots of property and violent crime. To ensure the safety and protection of people of these affected areas, the police should intensify regular patrol of these areas. The police authorities should support patrol teams with the required logistics: vehicle, fuelling and personnel to respond quickly in the event of reported incidents.

2. According to the findings, Bomadi, Patani, and Akugbene are hotspots for property and violent crime. Residents or stakeholders should be involved in the security of these towns by being given a role to play in monitoring their

neighbourhoods to report, prevent or track criminals. To accomplish this, the Inspector General of Police (IGP) should order the Commissioner of Police Delta State Command to create community police committees in the affected towns. Divisional Police Officers (DPOs), traditional rulers, stakeholders, and other security forces operating in the area, such as the Vigilantes, should all be represented in the committees. This will ensure useful and appropriate knowledge and feedback on the prevention plan for the crime.

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