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Full Length Research

Geospatial analysis of crime in Akinyele Local Government Area, Oyo State, Nigeria

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ABSTRACT: This study identified and mapped the crime hotspots; determined crime cases and types; and assessed the spatio-temporal dimensions of crimes in Akinyele LGA of Oyo State. This study used primary and secondary data. The primary data were obtained from the structured questionnaire, which was used to sample the opinions of the residents about crime activities and the policing system in the area. The secondary data emanated from the crime records of the Nigeria Police Force (NPF), Oyo State Headquarters, Iyaganku, and Moniya Divisional office. The Police records were used to determine crime hotspots, crime types, and spatio-temporal dimensions of crimes in the study area. The spatial statistical tools (Autocorrelation, Average Nearest Neighbour Analysis and Hotspot Analysis (Getis-Ord Gi*) in ArcGIS 10.8 were used for the analysis of the data. The results showed a total number of 4,501 offences recorded by Nigerian Police over the period of 10 years (2014 – 2023), which were classified into crimes against persons, crimes against property and other offences. The crime hotspots in the study revealed a high concentration in the Moniya and Ojoo axis. The study further revealed that stealing as a crime against property was the highest with (35.84%) in the study area and dominant in the low-density and high-income areas, while assaults as a crime against the person were highest with (39.35%) in the high-density area, such as Moniya and Ojoo and low-income areas such as Olorisaoko, Aroromakinde, Iwokoto, Ikereku Onidundu, Iroko and Olanla. The study concluded that GIS technology was efficient in providing relevant information to the security actors on the effective policing system to combat criminal activities in the study area.

Keywords: Dominant, hotspots, policing system, spatial autocorrelation, spatio-temporal.

INTRODUCTION

Crime happens in a physical location, not in space (Ige, 2015). Crime incidence has been going on in all parts of the world and among all segments of society, and its occurrence today makes it a major public issue. The recent growth rate of crime has not only been unprecedented but also has been accelerating. However, the archaic systems for data collection, analysis, and storage exacerbate the problem. Reliance on manual forms and outdated filing systems not only hampers data accuracy but also impedes trend prediction and strategic planning. New forms of crime are emerging, and old forms are assuming new dimensions. Although traditional crime analysis methods have been extensively studied in prior research (Oguntunde *et al*., 2018; Butt *et al*., 2021), there is a notable gap in incorporating recent advancements in geospatial techniques. Many researchers have used Geographic Information Systems (GIS) to map criminal incidents and perform hotspot analysis (Han *et al*., 2023; Mokhtar *et al*., 2023), which has produced insightful findings on crime patterns that will influence future research approaches.

Bako *et al*. (2020) demonstrates the application of Participatory Geographic Information System (PGIS) in crime mapping. This study used a Web-based PGIS map collection to collect spatial information on crime occurrences in the study area. The results of the study shows that, Mokola experiences more crime than other areas and further revealed crime hotspots in area such as Roundabout junction, Dandaru hill, Darlington Street of the study area. The study concluded best use of GIS in crime hotspot analysis, predictive policing, spatio-temporal trend mapping, and environmental criminology. However, Lawal (2021) in a study conducted on geospatial analysis of crime in urban neighbourhoods of Ibadan, Nigeria. The

study used crime data between 2011 and 2015 and explored the characteristics and travel patterns of criminals across the different neighbourhood densities. The study further employed ArcGIS 10.8 and Geoda 1.18 software to analyse the pattern and spatial autocorrelation of crime in the study area. The analysis revealed a high clustered pattern of property and violent crimes in the city's traditional core and surrounding high density neighbourhoods with Moran's I value of 0.69 and 0.79 respectively. The rate and frequency of crime decreased outward from the city centre to the medium and low-density neighbourhoods in the periphery of the city.

Maps and analyses of crime in Nigeria's Kaduna metropolitan were carried out by Ayuba *et al*. (2016) in a study conducted on Geo-Spatial Analysis of Crime in Kaduna Metropolis, *Nigeria*. The study used a geospatial methodology, and attribute data sourced from the Kaduna Police Division Headquarters. The divisional police headquarters jurisdiction in Kaduna Metropolis was taken into account when drawing the boundaries of the police districts on an administrative map of the study region. Eleven different types of crimes were found and plotted in the research region. The research also showed that Tudun Wada has the greatest crime occurrence (15.05%), followed by Sabon Tasha and Rigachikun (10.24% and 10.16%). Theft/stealing and hurting/fight rank highest (19.29% and 16.82%, respectively. The study also revealed that Tudunwada, Sabon Tasha, Rigachikun and Rigasa were the major crime hotspots in the metropolis. The study recommends that more effort should be put towards fighting crime, especially in December and January, as these two months have the highest number of crimes committed.

Ahmad *et al*. (2024) used full crime data from the Royal Malaysia Police and Geographic Information Systems (GIS) and looked at property crime trends in Selangor, Kuala Lumpur, and Putrajaya between 2015 and 2020 to examined the correlation between property crime rates and the boundaries of police station jurisdictions in the federal territories of Putrajaya (PFT), Kuala Lumpur (KLFT), and Selangor State. A thorough examination of secondary data from the Royal Malaysia Police Headquarters's Intelligence, Operations, and Records Division was made possible by the analysis of their study, which allowed for a detailed exploration of the geographical features of property crime in these areas.

Therefore, many studies largely overlook the vulnerability of critical infrastructures near crime hotspots and the perception of the victims regarding curbing crime incidents in the environment. In the year 2025, three self-claimed Islamic clerics were arrested by the police for allegedly beheading a survey technician in the Moniya Area of Akinyele Local Government Area, Oyo State (Nwaoko and Ajibola, 2023). Also, seven people were reportedly murdered for ritual purposes in Balogun village, near Moniya, the headquarters of Akinyele LGA, and three weeks later, another one was killed at Akinyele area (https://tribuneonlineng.com/the-killings-in-akinyele). All these crime incidents necessitated the need to assess crime activities in Akinyele Local Government Area, Oyo State, Nigeria, by assessing the dimensions of crime cases across various settlements.

MATERIALS AND METHODS

The study area

Akinyele, a Local Government Area in Oyo State, Nigeria, with its headquarters at Moniya, is one of the eleven Local Governments that make up Ibadan Metropolis. Akinyele Local Government Area was created in 1976. The Local Government Area shares boundaries with Afijio Local Government Area to the North, Lagelu Local Government Area to the East, Ido Local Government Area to the West, and Ibadan North Local Government Area to the South. It lies at approximately Longitudes 3˚54'30"E to 3˚55'03"E and Latitudes 7˚26'26"N to 7˚34'52"N. It occupies a land area of 464.892 square kilometres with a population density of 516 persons per square kilometre. Using 2.41% annual growth rate, the 2023 estimated population for the Local Government is 362,693 (Tokede *et al*., 2020). Akinleye Local Government Area is subdivided into 12 wards: Ikereku, Olanla/Oboda/Labode, Arulogun/Eniosa/Aroro, Olode/Amosun/Onidundu, Ojo-Emo/Moniya, Akinyele/Isabiyi/Irepodun, Iwokoto/Talontan/Idi-oro, Ojoo/Ajibode/Laniba, Ijaye/Ojedeji, Ajibade/Alabata/Elekuru, Olorisa-Oko/Okegbemi/Mele, and Iroko. The economy of the LG is predominantly agricultural, with farming being the major occupation of the residents. The region is a significant contributor to Oyo State's agricultural output, producing crops like cocoa, palm products, plantain, banana, cassava, yam, maize, citrus, and various other cash crops. Poultry and animal husbandry are also prevalent. The LGA is a major gateway to Ibadan city, making transportation a significant contributor to the region's economy. Notable Institutions and Infrastructure, such as the prestigious International Institute of Tropical Agriculture (IITA) is located in Akinyele LGA. The LG also hosts a central butchery/abattoir centre, supplying meat to most places in the South-West. The LGA has a connected road network, including Trunk A Roads (Ibadan – Oyo - Ilorin Road), Trunk B Road (Ibadan – Iseyin Road), and Trunk C Road. The new construction of the Lagos-Kano/Sokoto railway passes through a large area in Akinyele LGA, promising buoyant economic activity around the port. Figure 1 describes the study area.

Method of data acquisition

The study utilised both primary and secondary source data. The primary data were the Geographic data of crime location and police stations obtained with the aid of a hand-

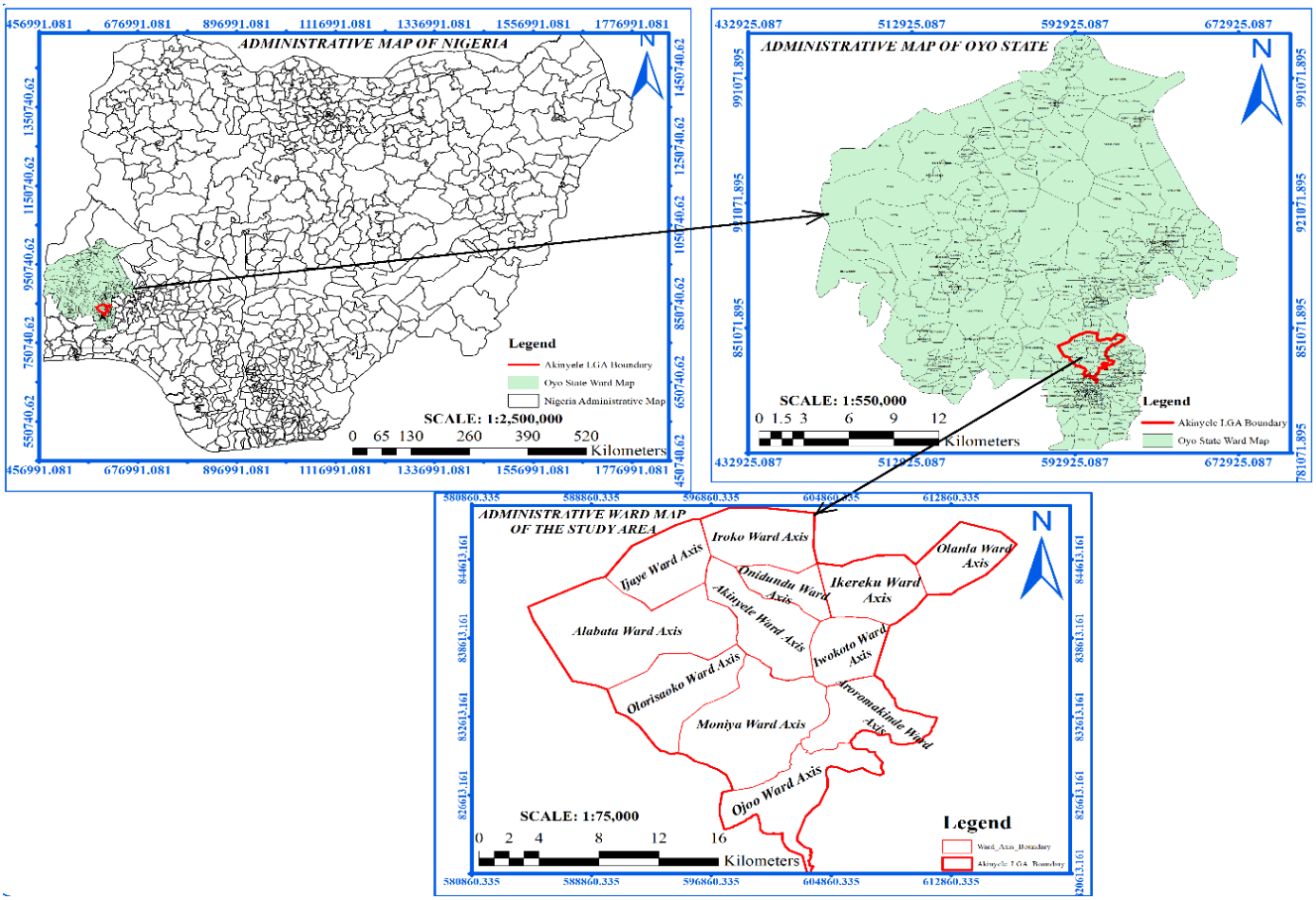

Figure 1. Study area map.

held Global Positioning System (GPS) device (GARMIN 78s model), and a structured questionnaire was also administered to sample the opinions of residents on crime activities and the policing system of Akinyele Local Government Area. The crime location/hot spot was based on police crime data from the records of reported crime cases. The geographic coordinates (x, y) obtained from crime location points, as well as records obtained from police stations, were used to assess the spatial distribution of crime incidence in the study area. The secondary data used for this study include: Police data on crime obtained from the Moniya Divisional Police station and the Nigeria Police Force (NPF) Oyo State headquarters in Iyaganku. Crime data collected includes: the type of crime committed, month and year crime was committed, Locations, dates, days, and time the crime was committed and the reported number per crime committed, with each crime assigned a geographic coordinate (x, y) projected in WGS84 datum (Minna zone 31). Spatial statistical tools such as spatial autocorrelation (Moran 1), average nearest neighbour (ANN) and Hotspot analysis (Getis and Ord GI*) were used to analyse the data.

This study used descriptive and spatial analysis. Records of crime cases were acquired from the Nigeria Police stations, and their respective geographic coordinate points from the year 2014 to 2023 were imported from the Excel spreadsheet and stored as point features in the ArcGIS 10.8 personal geo-database. With the help of the spatial statistics toolbox, patterns such as Average Nearest Neighbour (ANN), High/Low Clustering (Getis-Ord General G) and Spatial Autocorrelation (Moran's I) were analysed. The crime cases' clusters were mapped with respect to Cluster and Outlier Analysis (Anselin Local Moran's I).

RESULTS AND DISCUSSION

The findings from this study are presented in this paper. With a focus on identifying hotspots in the study area, figuring out the spatial patterns of dominant crime types in Akinyele Local Government between 2014 and 2023, and evaluating the temporal variations of crime cases over the study area.

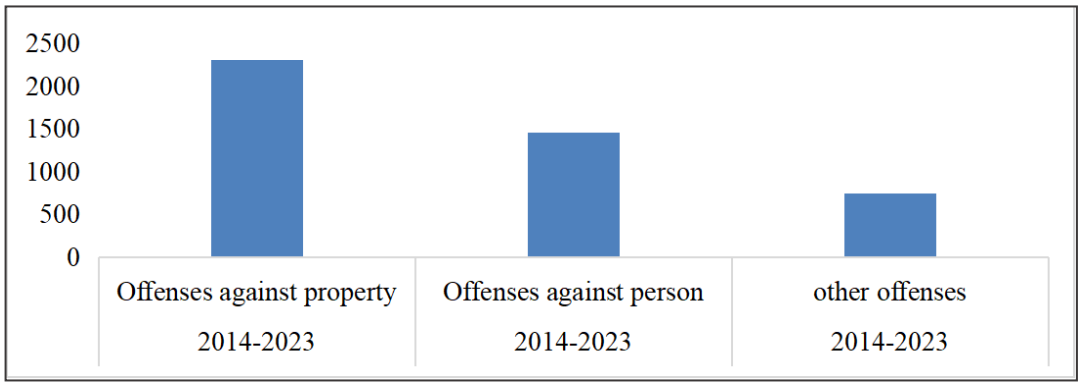

Figure 2. Offences Committed from 2014-2023.

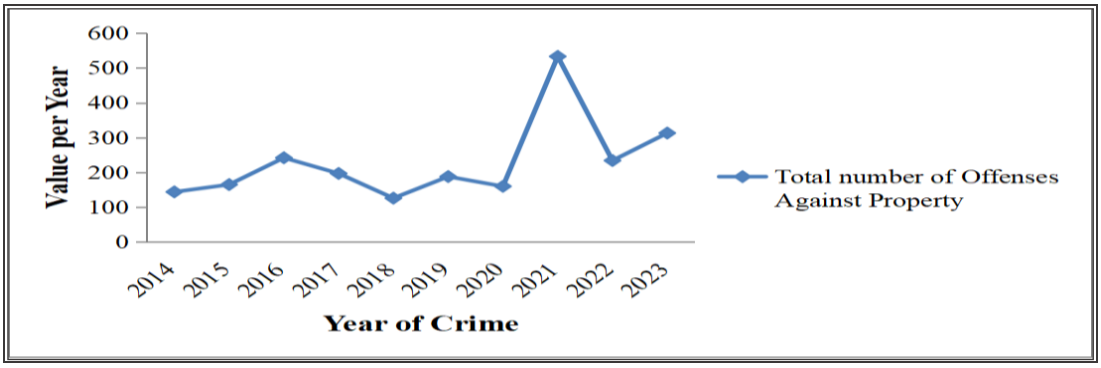

Figure 3. Trend in offences against property by years.

Analysis of crime cases

Based on the crime data obtained from police records at the Police Headquarters, Iyaganku, Ibadan, Oyo State, there were a total of 4,501 crime cases between January 2014 and December 2023. People in developing nations like Nigeria, according to Badiora *et al*. (2016), did not want to report crime cases to the police. The total number of crimes as revealed in this study may not reflect the actual number of crimes committed during the study period, but only the formally reported cases.

Crime cases and types

Dominant crime types

In accordance with the crime data gathered for this study, offences are categorised into three, namely: offences against property, offences against people, and other offences.

A total of 4501 crime cases were obtained in this study from the police records from 2014 to 2023, with 2,302 offences against property, 1,456 offences against persons, and 743 other offences (Figure 2).

Crime against property

The data shown in Table 1 and Figure 3 indicate that there are sixteen (16) offences related to property crimes, out of 2,302 reported criminal events. Stealing has the highest crime cases with 825 (35.84%) cases, followed by burglary with 320 (13.90%) cases, and housebreaking with 230 (9.99%) cases. The least of the offences against property is arson, with 13 (0.56%) cases, which means stealing is the major crime mostly committed against property in the study area. Having clearly seen from Table 1 that stealing has the highest percentage amongst the types of crime committed in the study area means that stealing is the major crime mostly committed against property in the study area. This shows that the cases of stealing and burglary have been very predominant in the study.

Offences against persons

There are 14 offences classified as crimes against persons, and there are 1,456 total crime incidents. Yet, there are more cases of assault than any other—573 (39.35%), harm (231 (15.87%), cheating (157 (13.78%), prostitution (137 (9.41%), and suicide (smallest)—than

Table 1. Offenses against property.

Types of Crime	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total	%
Bribery	1	3	4	0	1	4	6	14	5	6	44	1.91
Extortion	2	1	0	3	1	2	14	18	8	11	60	2.61
Pick Pocketing	1	3	0	1	0	0	7	18	2	6	38	1.65
Vehicle Theft	3	0	5	1	9	2	21	38	11	8	98	4.26
Malicious Damage	2	3	1	0	2	4	9	22	3	5	51	2.22
Forceful Entry	2	0	1	1	0	1	7	13	4	4	33	1.43
Unlawful Possession	8	0	0	1	0	3	2	12	0	2	28	1.22
Arson	1	1	1	1	1	0	1	0	3	4	13	0.56
Robbery	5	4	6	1	2	1	3	22	2	7	53	2.30
Office Broken	7	11	10	9	8	7	7	9	10	9	87	3.78
Stealing	39	41	117	96	43	68	28	155	102	136	825	35.84
Shop breaking	18	22	18	25	0	27	0	40	16	23	189	8.21
Store breaking	13	11	15	9	8	11	6	23	18	15	129	5.60
Burglary	22	34	21	17	24	35	16	73	29	49	320	13.90
House Broken	15	23	35	26	24	19	24	34	9	21	230	9.99
Vandalism	5	8	8	6	3	4	9	42	12	7	104	4.52
Total	144	165	242	197	126	188	160	533	234	313	2302	100

Source: Author's analysis 2024.

Table 2. Offenses against persons.

Types of crime	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total	%
Attempted Suicide	2	0	1	0	2	1	0	5	2	2	15	1.03
Suicide	0	0	1	0	0	2	1	0	3	0	7	0.48
Murder	1	2	1	0	3	2	10	25	6	4	54	3.71
Threat to Life	0	1	0	2	0	1	2	1	2	2	11	0.76
Child Abuse	1	0	0	1	2	0	1	4	0	2	11	0.76
Abortion	1	2	5	1	0	2	4	2	3	4	24	1.65
Cheating	31	12	7	11	4	10	17	20	19	26	157	10.78
Prostitution	28	11	3	5	2	4	6	19	26	33	137	9.41
Kidnapping	0	1	0	1	2	4	6	8	6	8	36	2.47
Harm	22	26	18	23	21	15	21	32	29	24	231	15.87
Attempted Rape	5	2	3	6	4	3	5	12	9	7	56	3.85
Rape	2	3	8	4	6	2	9	14	4	9	61	4.19
False Pretense	4	7	8	5	7	4	11	19	11	7	83	5.70
Assault	66	28	23	32	12	22	47	96	90	62	573	39.35
Total	163	95	78	91	65	72	140	257	210	190	1456	100.00

any other category. Assault is the most common offence against people in the study area (Table 2) (Figure 4). However, with Table 2, assault having the highest number of cases, it can be seen that, assault is the major offence against persons in the study area. This outcome indicates that the types of crimes found here are comparable to those found in Katsina State by Bala *et al*. (2015) and Benin City by Balogun *et al*. (2014).

Other Offenses

Other offences show a total of five (5) offences and seven hundred and forty-three (743) crime incidents as presented in Table 3 and Figure 5. However, other offences revealed breach of public peace having the highest cases with 311 (41.86%) cases followed by cybercrime/internet fraud with 165 (22.21%) cases followed by drug abuse with 128 (17.23%) cases and impersonation with 114 (15.34%) cases with forgery being the least of other offences committed in the study area. The analysis shows that compared to other crime categories, property crimes occur more frequently. This result is in line with Tengbeh (2006) investigation on crime analysis and the location of police stations in Swaziland, which also showed that property crime was common in

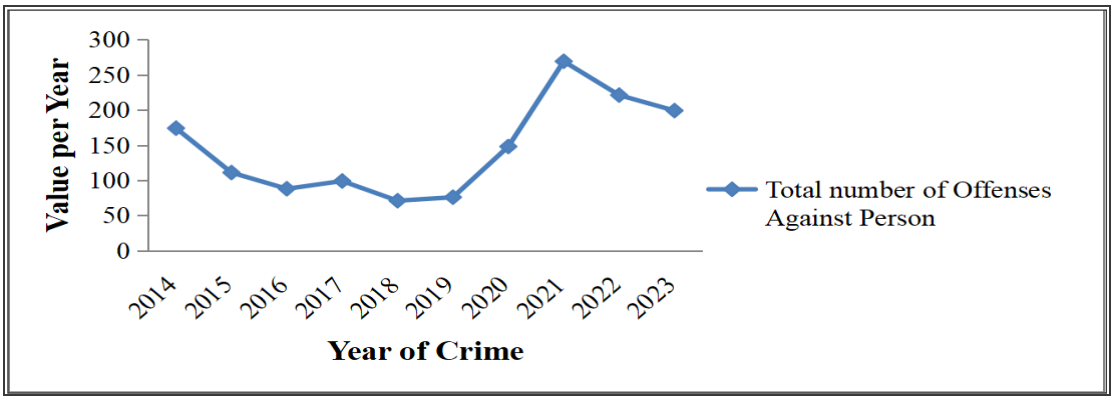

Figure 4. Trend in offences against persons by years.

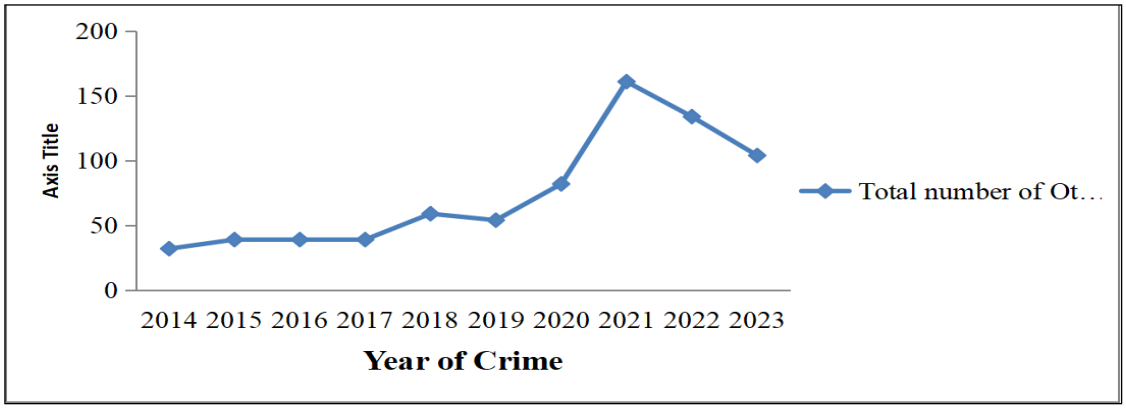

Figure 5. Trend in offences against others by years.

Table 3. Other offenses.

Types of crime	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total	%
Drug Abuse	5	7	4	7	15	9	13	26	18	24	128	17.23
Impersonation	6	9	12	7	10	9	11	16	21	13	114	15.34
Forgery	3	5	2	3	0	1	5	3	2	1	25	3.36
Breach of Public Peace	12	7	10	8	21	19	32	98	63	41	311	41.86
Cybercrime/Internet fraud	6	11	11	14	13	16	21	18	30	25	165	22.21
Total	32	39	39	39	59	54	82	161	134	104	743	100

Manzi, Swaziland. Furthermore, the results of this study are in agreement with the National Bureau of Statistics' 2017 report and a study conducted by Badiora *et al*. (2016). According to the study, crimes against property occur more frequently than other types of crimes. The present discovery aligns with Tengbeh (2006) investigation on crime analysis and the location of police stations in Swaziland.

Spatial analysis pattern of crime types

Three spatial statistical analyses, including hotspots analysis and kernel density estimation, were used to assess the spatial patterns of crime cases in the Akinyele Local Government Area: average nearest neighbour (ANN), high-low clustering (Getis Ord general G), and spatial autocorrelation (Moran's I). Conversely, the Spatial Autocorrelation (Global Moran's 1) tool employs a simultaneous measurement of the spatial autocorrelation based on feature locations and feature values by a given set of features and an associated attribute to determine whether the expressed pattern is clustered, dispersed, or random (Hasim *et al*, 2018). By calculating the average of all the distances between each feature's centroid and the centroid of its closest neighbour, the Average Nearest

Neighbour (ANN) tool determines. When the average distance is less than the average for a hypothetical random distribution, the distribution is said to be clustered. The features that are being analysed fall under this. If the average distance exceeds the theoretical random distribution, it is considered that the features are distributed (Hasim *et al*., 2018).

High Low Clustering Getis-Ord General G tools use the Getis-Ord General G to calculate the degree of clustering for either high or low values. Additionally, because kernel density estimation can interpolate the point locations of individual targets in addition to correctly identifying the locations, spatial extent, and distribution of crime hotspots, it has been widely employed. Unlike cluster analysis, this method can also help determine the point feature density surrounding output raster cells, which allows for a more precise detection of hotspots (Levine, 2004). By applying the kernel density estimation interpolation method, the hotspots of the different towns in the research area were examined.

Hotspots analysis

A total of 2,302 offences against property, 1,456 offences against the person and 743 other offences were obtained with known location. Locations with major crime hot spots were situated in the southern part of the study area. The result, as depicted in Figure 6 (a-c), showed that all the hot spots detected were situated in a residential area. The map revealed more cluster spots than all other locations. The brighter colour area from Figure 6 (a-c) is the most significant area where crime occurred most, and the green colour area is the least significant.

Cold and hotspot analysis was done based on crime against property, crime against person and other crime types from 2014 to 2023. Proper statistical analysis was performed using spatial statistics tools in ArcGIS. When criminogenic features are dispersed throughout the landscape, a location becomes more susceptible to crime risk (Caplan and Kennedy 2011). By utilising the Getis-Ord Gi* (hot spot analysis) spatial statistics tool in ArcGIS 10.8, it is possible to determine the primary crime hot spot zones at 95% and 99% confidence levels: the Moniya and Ojoo axis. Figure 6 (a-c) shows the crime hotspot map. This demonstrates that insufficient security measures have been seen, and inadequacies in the efficient prevention and management of crime have been found in certain crime hotspots within Akinyele Local Government. But as Figure 6 (a-c) illustrates, clusters call for effective and efficient security intervention, constant police and other security agency patrols, and the use of enhanced crime-prevention tactics.

The cold spot at 99% and 95% falls within the middle and Eastern parts of the study area, namely, Alabata, Akinyele, Onidundu, Iwokoto, Ikereku, Olanla and part of the Aroromakinde axis and at 90% confidence level, it falls within the North-Western and South-Eastern parts of the study area (Figure 6 (a-c)). However, the hot spot at 99% confidence level (deep red colour) falls in the Southern parts of the study area, mainly Moniya and Ojoo and part of Aroromakinde wards. At 95% (red colour) and 90% (lighter red colour) confidence falls majorly in Moniya and Ojoo, and part of Aroromakinde and Olorisaoko, while other cold and spot areas are not significant (Figure 6 (a-c)). From Table 4, negative values indicate the joint occurrence of high and low crime types/cases in the nearby localities/settlements within the study area. The GiZ score with high values and high p-values (+) is a statistically significant hotspot zone and a spatial clustering of high value while the GiZ score with low values (-) and small p-values indicates a significant cold spot and a spatial clustering of low values.

Since the primary focus of this study is the analysis of crime patterns in space, the results clearly show that the red areas with clusters are the most vulnerable and can be considered areas of criminal activity (Figure 6(a-c)) which indicates that, in order to effectively prevent and control crime in these crime hotspots, adequate security formation is require, and it is necessary to apply improved crime prevention strategies, conduct intensive patrols, and provide efficient and effective security intervention in the affected areas. However, as the most vulnerable and vulnerable areas are within the same jurisdiction, the results are similar to those obtained by Hasim *et al*. (2018).

Kernel density estimation

Figure 7 (a-c) shows how the intensity of crime cases and crime hotspots were mapped using kernel density estimation. This information is crucial for helping the local security authorities and other security agencies in the study area reduce the number of crime cases. From the estimation and map produced, the lighter colour showed a high crime area, and the orange and brown colour areas showed high medium crime area (Moniya and Ojoo), and the blue area is the least vulnerable. The reason for the high intensity in Moniya and Ojoo may be due to the fact that the locality is the most populated of all localities in the study area, and other areas, such as Akinyele, Alabata, Ijaye, Iroko, Onidundu, and Ikereku wards, are between the medium and least vulnerable areas. From Figure 7(a-c), eight (8) police stations are within the study area, with 4 stations within Ojoo wards, 2 in Moniya wards, and 1 each from Iroko and Akinyele wards. The kernel density estimation for the offences against property, person and other offences revealed prediction coverage area values of 13.54 km^2, 4.59 km^2 and 1.81 km^2 as the most vulnerable areas and 0.00 as the least vulnerable areas. Despite four (4) police stations within the Ojoo wards of the study area, crime still persists.

From the kernel density surface map, it shows that the crime rate is in the range of medium to low medium at Ojoo

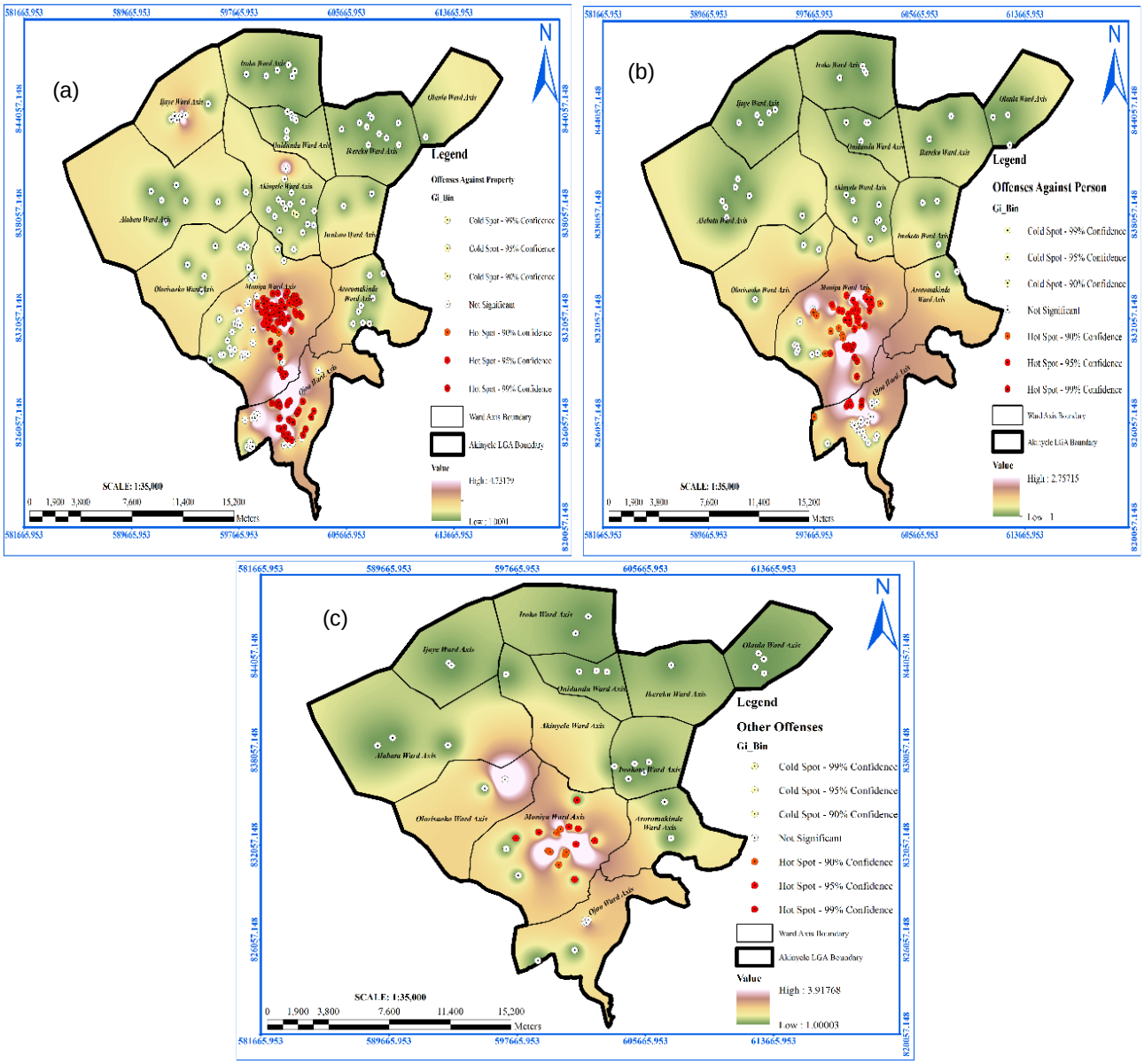

Figure 6(a-c). Cold Spot and hot spot map from Hot Spot Getis-Ord Gi* for offenses to property and Persons and others (2014-2023).

Table 4. Sample of cold spot and hot spot (Z-score and P-score).

GiZScore Fixed			GiPValue Fixed		
Property	**Person**	**Others**	**Property**	**Person**	**Others**
-0.91	3.40	-0.13	0.36	0.00	0.90
-0.81	3.40	-0.13	0.42	0.00	0.90
0.21	3.40	-0.13	0.84	0.00	0.90
0.21	3.33	0.15	0.84	0.00	0.88
-0.81	2.96	-0.25	0.42	0.00	0.80
0.21	2.82	0.34	0.84	0.00	0.74
0.21	2.80	0.34	0.84	0.01	0.74

***Source:** Study attribute table from ArcGIS.

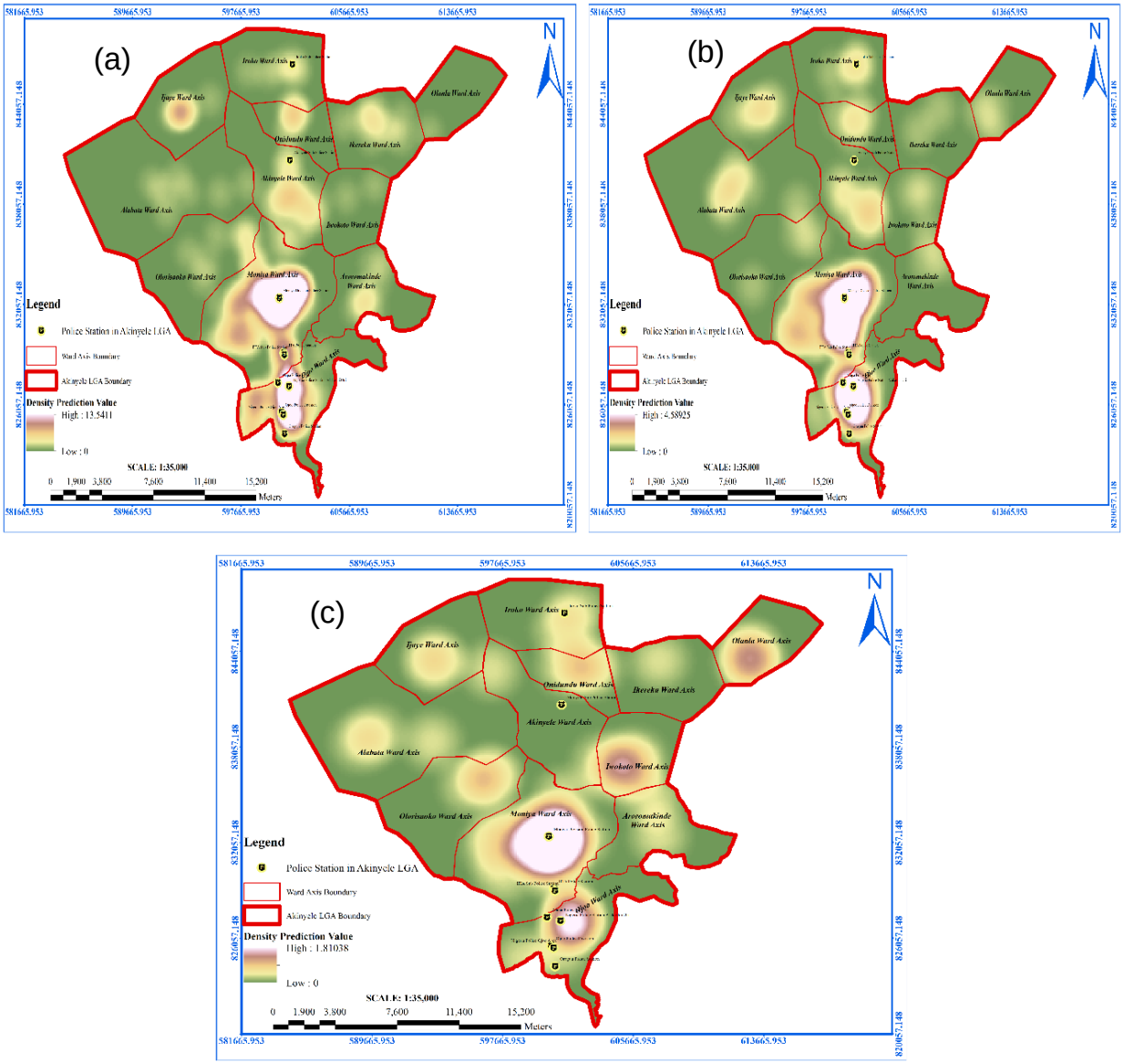

Figure 7(a-c). Kernel density hotspot for offences against property, person and others (2014-2023).

wards, and this is due to four (4) Police stations within the axes where more police officers will be patrolling the locality (Figure 7 (a-c)). However, in Moniya wards, crime rate ranges from high to high medium, and this is due to two (2) Police stations that are serving the location and other locations like Akinyele, Alabata, Olorisaoko, Ikereku, Ijaye, Onidundu, Iwokoto and Olanla wards. More criminal cases coming from those locations will affect the proper monitoring of crime in Moniya wards (Figure 7(a-c)). Table 5 presents the police stations and their spatial location in the study area.

Moreover, with the use of Kernel density estimation (Figure 7 (a-c)) used to map the density of crime cases throughout the study area and for hotspot identification for the offenses against property, person, and others, it will help both community and government security agents locate crime occurrence area(s) and strategize on the way to minimize and eradicate the occurrence of crime in the affected areas. Consequently, the areas with lighter colours represent the identified hotspot localities, which are characterised as both developed and vulnerable areas. According to an average nearest neighbour analysis, there was a high degree of clustering among the crime cases in the study area and the potential explanations for this could include the nearly inevitable spatial clustering of crime cases that result from human populations generally living in spatial clusters as opposed to a randomly distributed manner (Hasim *et al*., 2018).

Figure 8 (a-c) presents the average distance from the Average Nearest Neighbour analysis for the crime cases

Table 5. Name of police station and their geographic coordinates.

Name of police station	Easting	Northing
Moniya Police Station	600412.91	832560.72
Ojoo Poilce Division	600651.653	825581.239
IITA Police Station	600809.209	829152.751
Alapa Police Station	600390.843	827367.838
Nigeria Police Station Alaka/Idi Ori	601219.461	827146.664
Nigeria Police Ojoo Area	600801.008	825450.973
Orogun Police Station	600884.0611	824299.411
Nigeria Police Station Orogun Area	600151.052	824155.826

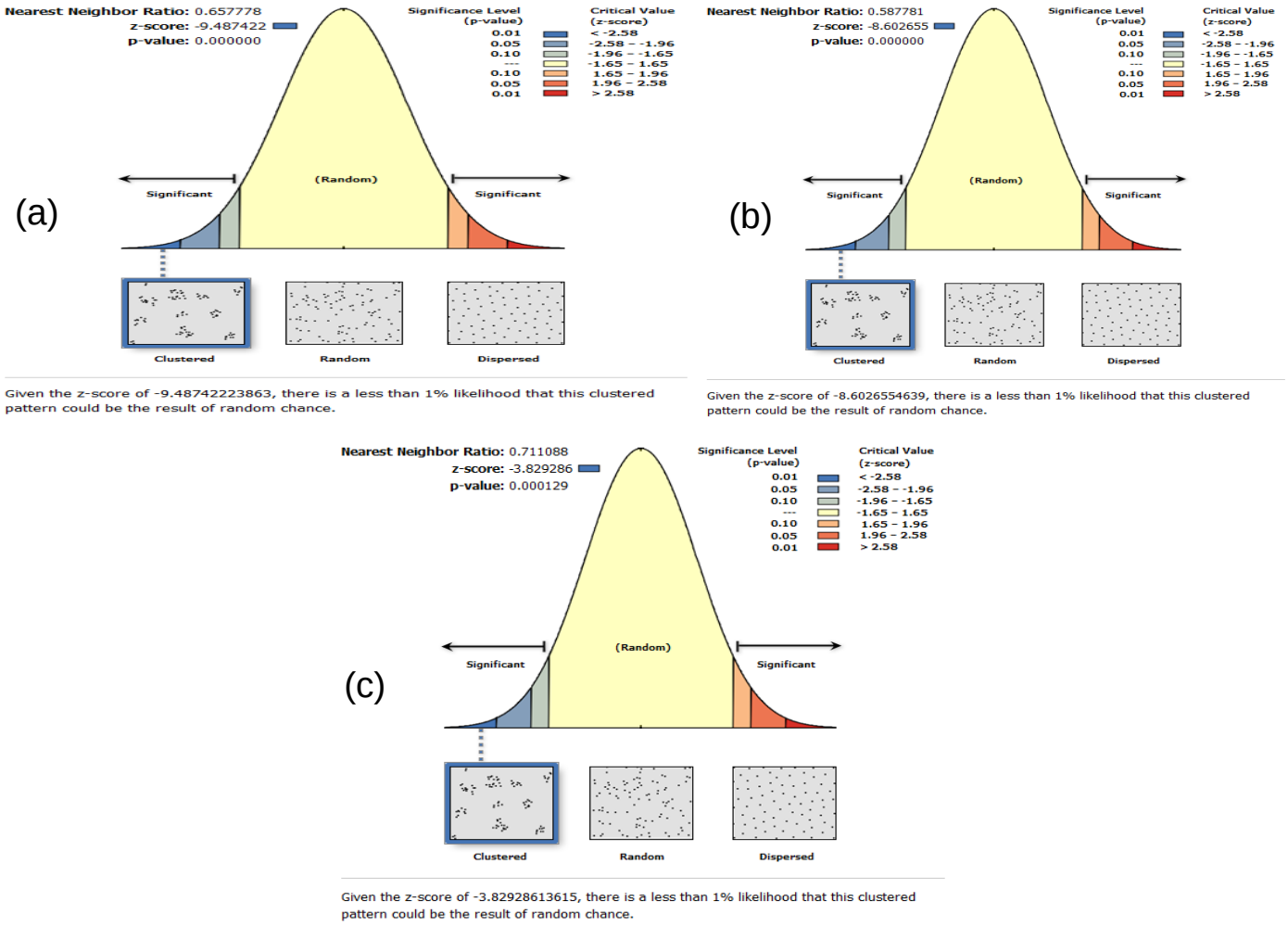

Figure 8(a-c). Average Nearest Neighbor significant value for offenses against property, persons and others (2014-2023).

between 2014 and 2023 by offences against property, offences against the person and other offences. The property, person, and other offences displayed a clustered pattern, according to the results of the Average Nearest Neighbour (ANN) analysis. The clustered pattern is 0.66, 0.59, 0.71 ($p<0.01$) with z-score G statistics -9.49, -8.60, and -3.83, which is <-2.58 ($p<0.01$), indicating that z is least significant at 0.01 significance level (99% confidence) with p-value ($p<0.00$) (Figure 8 (a-c)). This suggests that the clustered pattern is less likely than 1% chance. Additionally, the nearest neighbour ratio is determined by dividing the observed mean distance by the

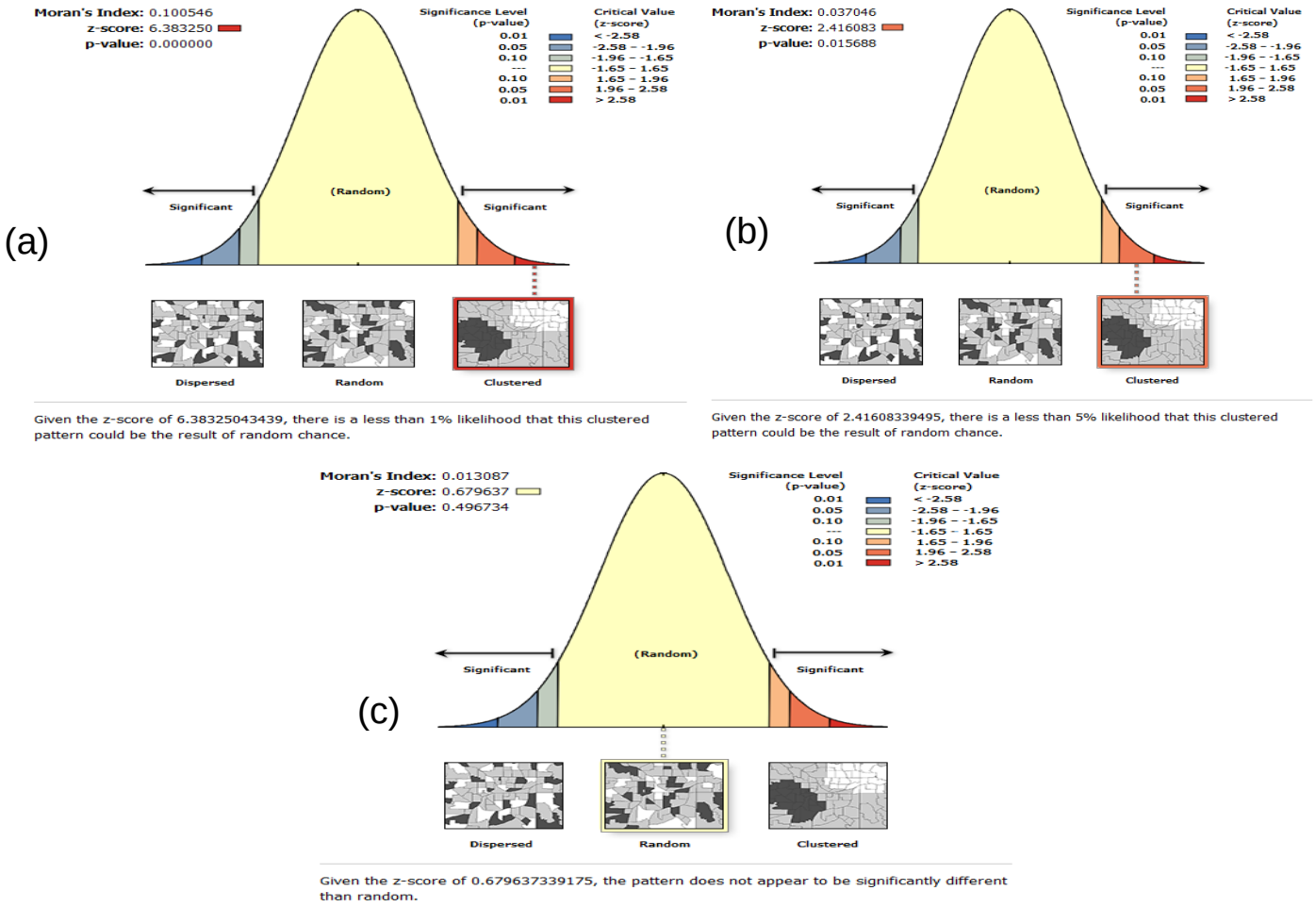

Figure 9 (a-c). Spatial Autocorrelation Moran 1 significant value for offenses against property, persons and others (2014-2023).

expected distance, and this led to a clustered pattern of crime cases in the study area.

Spatial autocorrelation values less than zero are considered negative (NIJ, 2005). According to the Global Moran I estimation, which had values greater than 0 (positive) for crime cases from 2014 to 2023, global spatial cluster analysis and spatial correlations of crime cases between the settlements in the study area were established. The result revealed the offenses against property and person exhibit a clustered pattern with Moran index is 0.10, and 0.04 ($p<0.01$) with z-score G statistics 6.38 >2.58 and p value 0.00 most significant at 99% and 2.42 <2.58 ($p<0.01$) significant at 95% at 0.01 and 0.05 significant level (99% and 95% confidence level) with p-value ($p<0.02$) and with z-score 6.38 indicates that there is less than 1% and 2.42 less than 5% likelihood that the clustered pattern could be the result of a random chance (Figure 9 (a-b)).

Furthermore, with a p-value of 0.50, a Moran's index of 0.001, a G statistics (z-score) of 0.68, and an outcome of the spatial autocorrelation (Global Moran's I) analysis for the other offences as shown in Figure 9c, the crime incidence rate in the study area is random in pattern. Given a corresponding z-score of 0.68, which is higher than <2.58, indicating no significant result, the pattern does not seem to differ significantly from random. The Z-score and Moran's I indicate the occurrence of crime was positively and spatially correlated between the settlements in the study area.

Interpreting the analysis's findings in light of the null hypothesis, which holds that there is no global presence of spatial autocorrelation for the study area, crime cases in the Akinyele Local Government Area from 2014 to 2023 are distributed in a cluster pattern for offences against people, property, and other offences at high and low clustering that is random within the study area. The null hypothesis is thus rejected, and it is possible that random spatial processes are what caused the total crime cases' spatial distribution to occur. This is because the data for the research area's Global Moran's 1 values show that they are significant.

The spatial autocorrelation (Global Moran's 1) analysis for the offense against property and person (Figure 9a & b) which showed that, the cluster is as a result of different

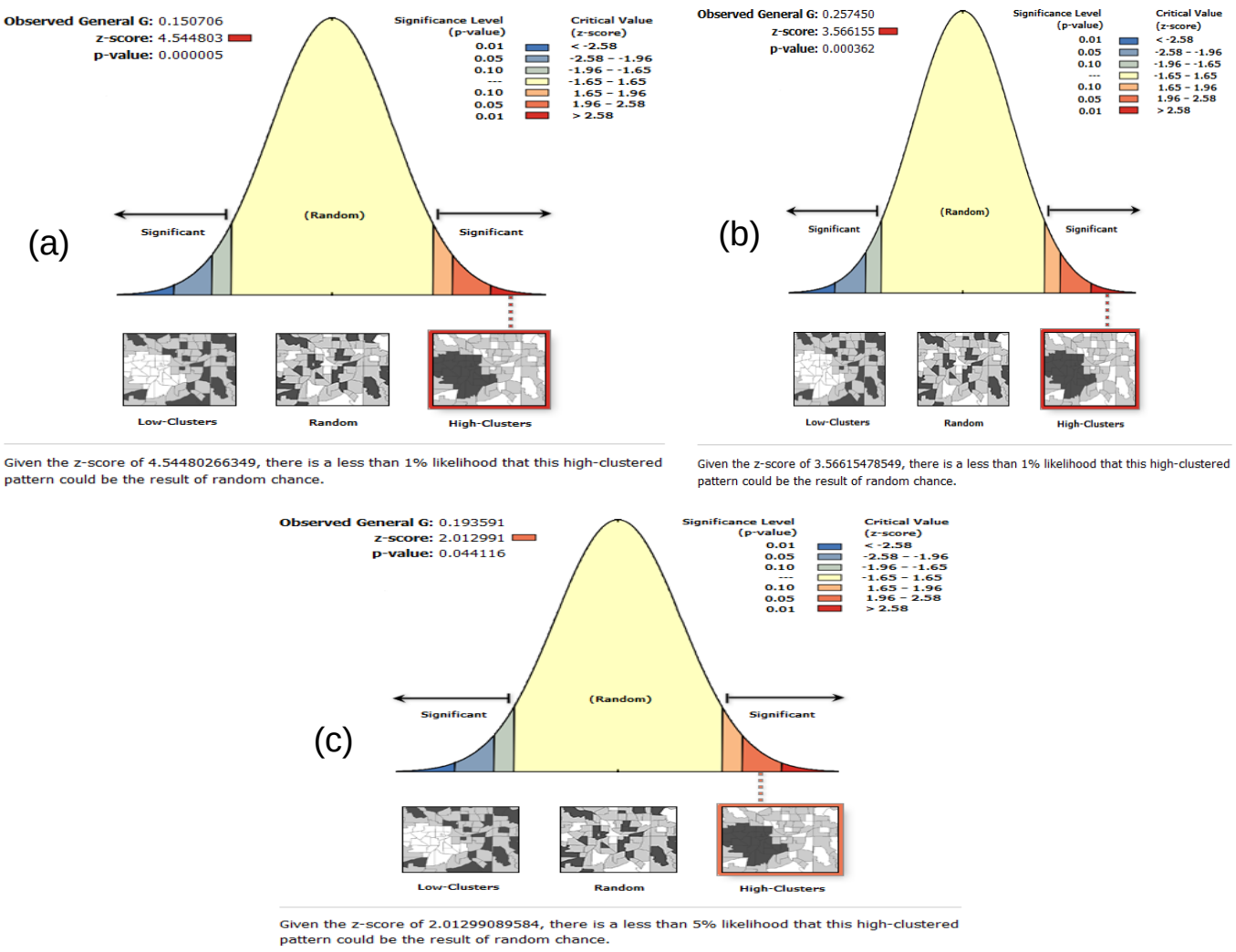

Figure 10(a-c). High/low clustering Getis-Ord General G significant value for offenses against property, persons and others (2014-2023).

crime types that exist at proximity and revealed statistically significant result indicates that, the different cases in offenses is correlated with one and other in the study area and occurrence of all these crime in these areas can be attributed to low or few security formation and the result is similar to the result obtained from the research conducted by (Ocholi *et al*., 2023) on spatio-temporal change on other offenses as depicted in Figure 9c which shows no significant result as the pattern is random which indicates no relationship between different cases in offenses and the result is similar to the result obtained by (Hasim *et al*., 2018).

Getis-Ord general G statistics are used here to calculate the degree of clustering for both high and low values. Figure 10 (a-c) shows how crime hotspots were identified using the Getis-Ord Gi* statistic. The outcome showed high cluster patterns in the observed General G of 0.151, 0.26, and 0.19 for the offences against people, property, and others. Getis z-scores are created by combining the z-score and the Getis-Ord's Gi statistic, which is calculated using ArcGIS software, into a single index (Mitchel, 2005).

With z-score 4.54 >2.58, 3.57 >2.58 and <2.58 2.01 and z-score of the offenses against property and person are most significant at 0.01 (99% confidence level) and other offenses significant at 95% confidence level which implies that the z-scored is less than 1% likelihood (Figure 10 (a-b)) for the offenses against property and person and 5% likelihood (Figure 10c) for other offenses as the high cluster pattern could be the result of a random chance.

The findings of the analysis are interpreted using the null hypothesis, which states that there is no global existence for the study area and that the distribution of crime cases against people and property from 2014 to 2023 is clustered at high and low clustering (Getis-Ord Gi*), with a high cluster occurring within the study area. Thus, the p-values in Figure 7(a and b) at 99% confidence level and the p-

value 0.044 in Figure 10c are less than 0.05 (95% confidence level), both reject the null hypothesis and suggest that random spatial processes could be the cause of the overall crime case distribution for crimes against people, property, and other crimes. Highly clustered regions are revealed in the results of the high and low clustering Getis-Ord Gi* shows no significant relationship, which indicates no correlation among the crime cases.

Conclusion

This study illustrated the critical need for further investigation into the ways in which various crimes can impact the lives of individuals residing in Akinyele Local Government Area, Oyo State. The results of the investigation demonstrated that, from 2014 to 2023, crime cases were concentrated in Ojoo, Moniya, Aroromakinde, Ijaye, Alabata, Akinyele, Onidundu, Iroko, Iwokoto, Ikereku, and Olanla of Akinyele Local Government Area, with a heterogeneous but random spatial distribution of cases. Nevertheless, this study demonstrates the importance of temporal and geographic analyses in crime data records. The least vulnerable and most vulnerable areas are identified throughout the study area based on the Global Moran's 1 values that were obtained in this study. This study found many high-risk cluster crime points in Moniya wards and Ojoo wards of the study area, which may adversely affect the security of life and properties of the inhabitants. It is concluded from the analysis of this study that the risk intensity between the settlements in the study area is associated with the significant spatial aspect of the distribution of crime types. Therefore, this study recommends the need for an adequate geographic database of crime activities so as to tackle crime incidence at various locations of the study area

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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