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ORIGINAL RESEARCH ARTICLE

A Geospatial Analysis of Crimes Patterns in Niger Republic Using Hotspots and K-Means Cluster

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ABSTRACT

This study is an investigation of some crimes in the Niger Republic. The methods consist of determining the crime patterns using crime maps and cluster analysis (k-means). It was observed from the hotspot analysis that 61.53% of the crimes like violence or assault, narcotics, rebellion, murder, counterfeit money, scam, stealing, and abuse of confidence are observed in the western part of the country that has a border with Mali Republic, Burkina Faso, Benin republic. 33.33% of the hotspots are observed in the southern part of the country with a border with Nigeria and concern crimes like recels, rebellion, counterfeit money, and criminal association. 15.38% of the hotspots are observed in the north that have borders with Libya, Chad, and Algeria and are concerned with crimes like Illegal arms possession and corruption. For the k-means cluster, the optimum clusters were determined first using the elbow method. It was observed that most clusters have optimum numbers of four and five except the embezzlement crime type, which has three clusters. Based on the above, there is a need to strengthen cross-border security collaboration, optimize resource allocation in high-risk regions, and enhance law enforcement efforts.

ARTICLE HISTORY

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INTRODUCTION

A security crisis is a situation that poses a significant threat to the safety, well-being, or stability of a nation, region, or the global community. Currently, the Sahel region is facing critical security issues, such as armed gang revolts, jihadist uprisings, coups d'état, and the illegal trafficking of drugs, weapons, and migrants. The fall of Libyan leader Muammar Gaddafi in 2011 weakened border security and led to a substantial increase in the flow of weapons, which contributed to the collapse of the Malian state and intensified an existing security crisis (Global Initiative Against Transnational Organized Crime, 2021).

The crime rate is the most frequently used metric for assessing the incidence of crime (Volasik, 2018). Generally, crime rates tend to be higher in more developed and densely populated areas, such as large cities or urban regions. This phenomenon is influenced by various factors, including environmental, economic, social, political, and demographic aspects. A study conducted by (Gyamfi, 2002) supports this observation, as Southern Ghana, a more developed and densely populated area, exhibits the highest crime rate, even if this assertion is relative and depends on the type of crimes in the case of Niger. Furthermore, (Motcho, 2004) identifies demographic variables, such as population trends and district density, as significant contributors to the rise of insecurity.

Crime lacks a universal definition due to the differences in legal systems across countries. Changes influence these social, political, psychological, and economic variations. What one society deems a crime may be viewed differently by another (Danbazau, 2007). Furthermore, many scholars have defined crime from various perspectives, often influenced by their ethical and ideological viewpoints, as noted by the United Nations Research Institute (United Nations, 1995).

In Niger, as in many other developing African nations, the crime index has remained high over the years, standing at 72.61. The crime rate has risen over the past three years, reaching an index of 81.25 (Numbeo, 2015). According to the Global Initiative Against Transnational Organized Crime (2021), Niger has a criminality score of 6.02, ranking 41st out of 193 countries, 14th out of 54 countries in Africa, and 3rd out of 15 West African countries.

Geostatistics is a statistical branch that analyzes spatial and spatiotemporal data, originating in the mining and petroleum industries in the 1950s. Its foundational work by Danie Krige aimed to predict ore grade distributions, later developed further by Georges Matheron.

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Geostatistics relies on prior research from various fields, making its development slower than other empirical methods. It is primarily applied in geology to predict outcomes based on point observations.

A key aspect of spatial analysis is examining the relationships between geographical entities and their neighbors. Tobler's First Law of Geography emphasizes that closer objects have stronger relationships than those farther apart. In criminology, crime clusters, or hotspots, refer to areas with high criminal incidents. Hotspot analysis is commonly used to identify these clusters by detecting statistically significant rates of crime occurrence. In the geospatial context, clustering refers to a group of similar data points (Nath, 2006). Clustering data mining techniques are particularly effective for describing new patterns or detecting unknown patterns within data (Borg & Boldt, 2016).

The K-Means algorithm has several weaknesses, including the challenge of determining the optimal number of clusters based on assumptions and its dependence on the initial selection of centroids. To address these issues, optimization is essential. One widely used method for cluster optimization is the Elbow method. This visual technique assesses the appropriateness of the number of clusters by comparing the differences in the Sum of Squared Errors (SSE) across clusters. The optimal number of clusters is indicated by the most pronounced difference, which forms the angle of the elbow on the resulting graph (Kodinariya & Makwana, 2013); (López-Rubio *et al.,* 2018).

Much research has been conducted on crime in different regions worldwide, encompassing regional studies and specific inquiries into crime-related issues. However, to my knowledge, there have been no studies that analyze crime rates in the Republic of Niger using hotspot and cluster analysis. Consequently, this paper aims to examine crime patterns through the use of maps and spatial cluster analysis.

Crime can target individuals, organizations, or the state and may also involve property destruction. When crime data is integrated with Geographic Information Systems (GIS), it maps and visualizes patterns, identifies clusters, and explores relationships or underlying causes. As Brown et al. (1998) highlights, understanding the connection between crime and location and the role of crime mapping and analysis is essential.

Spatial features such as roads, bus stops, banks, unfinished buildings, and street segment lines often delineate crime hotspots (Laukkanan *et al.,* 2008), (Van Patten *et al.,* 2009).

Volasik (2018) examined the use of Risk Terrain Modeling to predict gang violence, specifically gang assaults and homicides. The study found that locations prone to gang assaults are typically near areas where gang members are observed loitering, metro rail stops, and neighborhoods with a high residential concentration of local gang members. United Nations. (1995) applied Risk Terrain Modeling to identify high-risk areas for violent crime victimization in Bogotá, Colombia, focusing on homicide, assault, and theft. the city's poorest areas are most at risk for homicide and assault, while thefts are more prevalent near the city center, where economic activity is concentrated. Usman *et al.* (2012) analyzed crime rates in Sokoto State using Principal Component Analysis (PCA). The analysis retained three principal components based on the Scree plot and Loading plot, revealing a correlation between crimes against persons and crimes against property. Almanie et al. (2015) investigated spatial and temporal crime hotspots by analyzing two real-world crime datasets and comparing them through statistical analysis supported by visualizations. The results of their study can be used to increase public awareness of high-risk areas and assist agencies in predicting future crimes at specific locations and times.

Niger Republic demographic structure, with a fast-growing population that is both highly dispersed and partially nomadic have an impact on service delivery and exacerbates insecurity in underserved regions. The persistence of organized crime, particularly in areas such as Tillabéri, Maradi, and Tahoua, poses direct threats to national cohesion, economic activity, and public safety. Yet, while the threat is clear, analytical tools to understand crime's spatial and structural patterns remain underutilized. This paper aimed to conduct a geospatial analysis of crime patterns in Niger Republic through hotspot and k-means clustering,

METHODOLOGY

Niger, a landlocked country in West Africa, covers 1,267,000 km² and is located between 11°37' and 23°33' North latitude and 0°06' and 16° East longitude. It shares borders with Algeria and Libya to the north, Chad to the east, Nigeria and Benin to the south, and Burkina Faso and Mali to the west, totaling 5,697 km of borders (Figure 1). The border lengths are: Chad (1,175 km), Nigeria (1,497 km), Algeria (956 km), Mali (821 km), Burkina Faso (628 km), Benin (266 km), and Libya (354 km). According to Law No. 2008-42, enacted on July 31, 2008, Niger is divided into eight regions, which include 66 departments and 265 municipalities.

The data for this paper is secondary and was sourced from the Statistics Directorate of the Ministry of Justice criminal records. The dataset includes variables such as age, gender, and the origin of the crimes, covering the period from 2015 to 2022. Due to data limitations, the dataset consists of the following crime categories: cases of abuse of confidence, cases of criminal associations, cases of corruption, cases of illegal arms possession, cases of embezzlement, cases of fraud (419), cases of counterfeit money, cases of murder, cases of rebellion, cases of receiving stolen goods, cases of narcotics, cases of violence or assault, and cases of theft. Additionally, the dataset includes variables such as the unemployment rate, literacy rate, school attendance rate, educational level, and population size. The geographical coordinates of the District and High Courts, where each crime was adjudicated, were used as the locations for the crime analysis. R-studio, ArcGIS, and Excel software were used for analysis purposes.

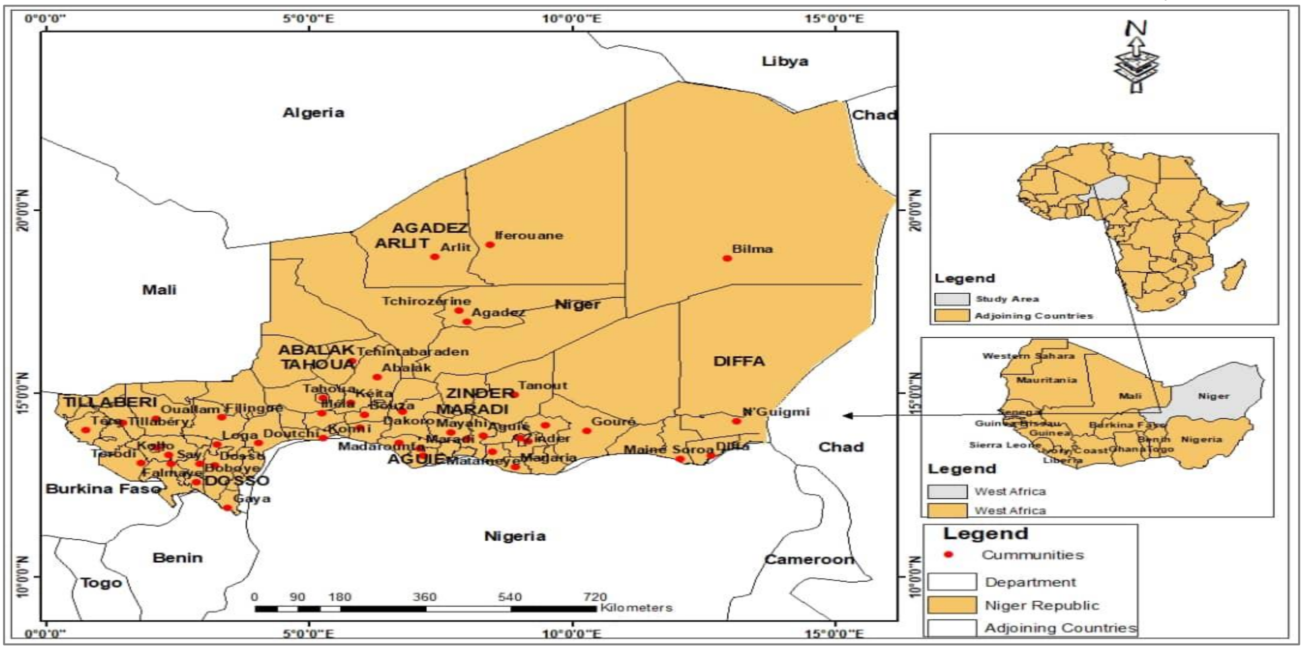

Figure 1: Map of Niger Republic

2.1 Cluster analysis

Crime clustering is primarily used to identify patterns that can be leveraged to predict crime locations (Jain & Jain, 2014). In this study, k-means clustering, one of the most widely used non-hierarchical algorithms, was applied. It partitions the observations into *k* clusters, where points within the same cluster are similar, and points in different clusters are dissimilar (Volasik, 2018).

K-means clustering is a popular unsupervised machine learning algorithm used for partitioning a dataset into a set of distinct, non-overlapping subgroups called clusters. In geostatistics**,** K-means clustering can be applied to spatial data to group observations based on their attributes or spatial characteristics. The basic principle was to partition a set of I individuals into k classes, where the value $k$was unknown and defined by the user or the software. Here are the detailed steps for applying the K-means clustering algorithm in the context of geostatistics:

Summary of k-means clustering in algebraic form:

Given:

$X = \{x_1, x_2, \dots, x_n\};$

$$initialcentroids C^{(0)} = \left\{C_1^{(0)}, C_2^{(0)}, \dots, C_k^{(0)}\right\}$$

Assignement

$$R_{ij}^{(t)} = \begin{cases} 1 if j = argmin_k \left\| x_i - C_k^{(t)} \right\|^2 \\ 0, Otherwise \end{cases}$$

Centroid update:

$$C_k^{(t+1)} = \frac{\sum_{i=1}^{n} R_{ij}^{(t)} x_i}{\sum_{i=1}^{n} R_{ij}^{(t)}}$$

RESULTS AND DISCUSSION

The results and discussion begin with the descriptive statistics, then the crime mapping hotspot which is an area, sometimes small and well-defined, where crime incidents are significantly more regular compared to other locations. They are presented as follows:

Table 1 and Figure 2 below show high skewness (skewness > 2) for all types of crimes, signifying strong right-skewed distributions. This means that many towns show low crime counts while a few towns report exceptionally high numbers. It also shows that stealing (603.82) and narcotics (199.50) are the most prevalent crimes, extremely variable across towns, and concentrated in a few urban areas. Crimes like corruption (0.70), murder (0.43), and embezzlement (0.95) are very infrequent and highly limited. In general, all crimes show strong spatial clustering tendencies, suggesting the utility of spatial analysis techniques.

Figure 3(a) above illustrates the hotspots for violence or assault crime. These crime hotspots vary across different regions. The highest concentration was found in the western part of the country, which borders Mali and Burkina Faso, areas that, along with Niger, continue to combat banditry and terrorism in the tri-border zone (zone des trois Frontières). The highest number of violence or assault cases (373) was recorded in Niamey, followed by Gaya (80) and Téra (79). In contrast, the least number of cases were observed in the north-east, with areas such as Damagaram Takaya and Iférouane reporting no incidents, and Falmaye (1), Torodi (2), and Tchirozérine (9) recording only a few cases. For narcotic cases, as shown in Figure 3(b), the hotspots are concentrated in the western part of the country, particularly around Niamey.

Table1: Descriptive statistics of crime types

Crime type	Mean	SD	Skewness
Abuse of confidence	76.64	165.10	5.59
Association of criminal	5.70	12.52	3.91
Corruption	0.70	2.25	4.01
Counterfeit	8.11	16.23	4.00
Embezzlement	0.95	1.84	2.64
Illegal arm possession	8.95	13.80	3.26
Murder	0.43	2.86	6.19
Narcotic	199.50	345.45	4.73
Rebellion	4.95	9.80	3.70
Recels	28.23	32.49	3.33
Scam	44.66	116.50	5.49
Steal	603.82	784.22	4.92
Violance or assault	42.02	55.07	4.90

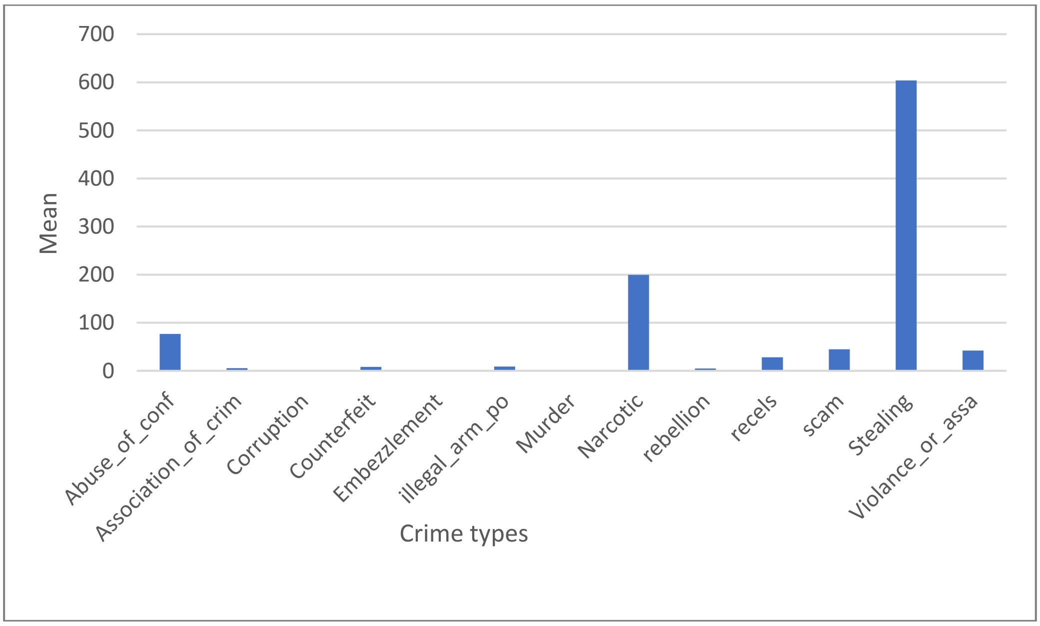

Figure 2: Bar chart of crime types

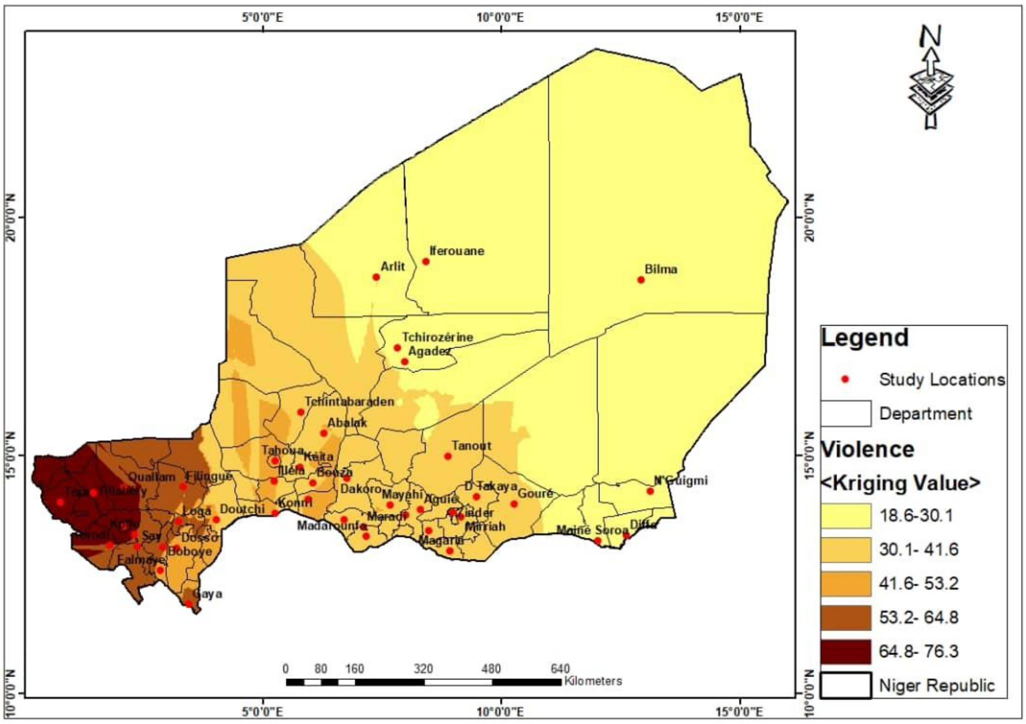

Figure 3a: Spatial Distribution and Hotspot of Crimes Associated with Violence or assault

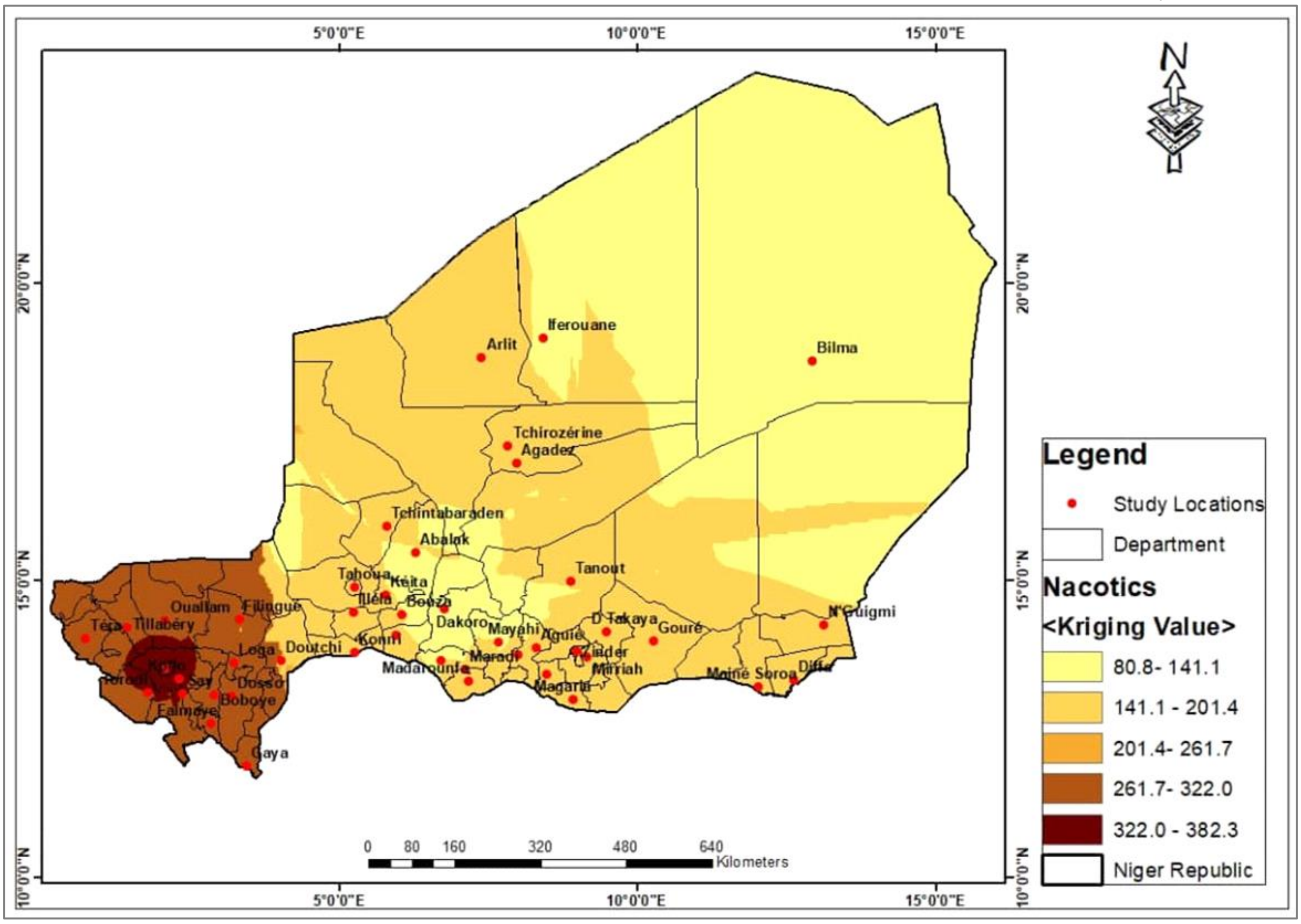

Figure 3b: Spatial Distribution and Hotspot of Crimes Associated with Narcotics

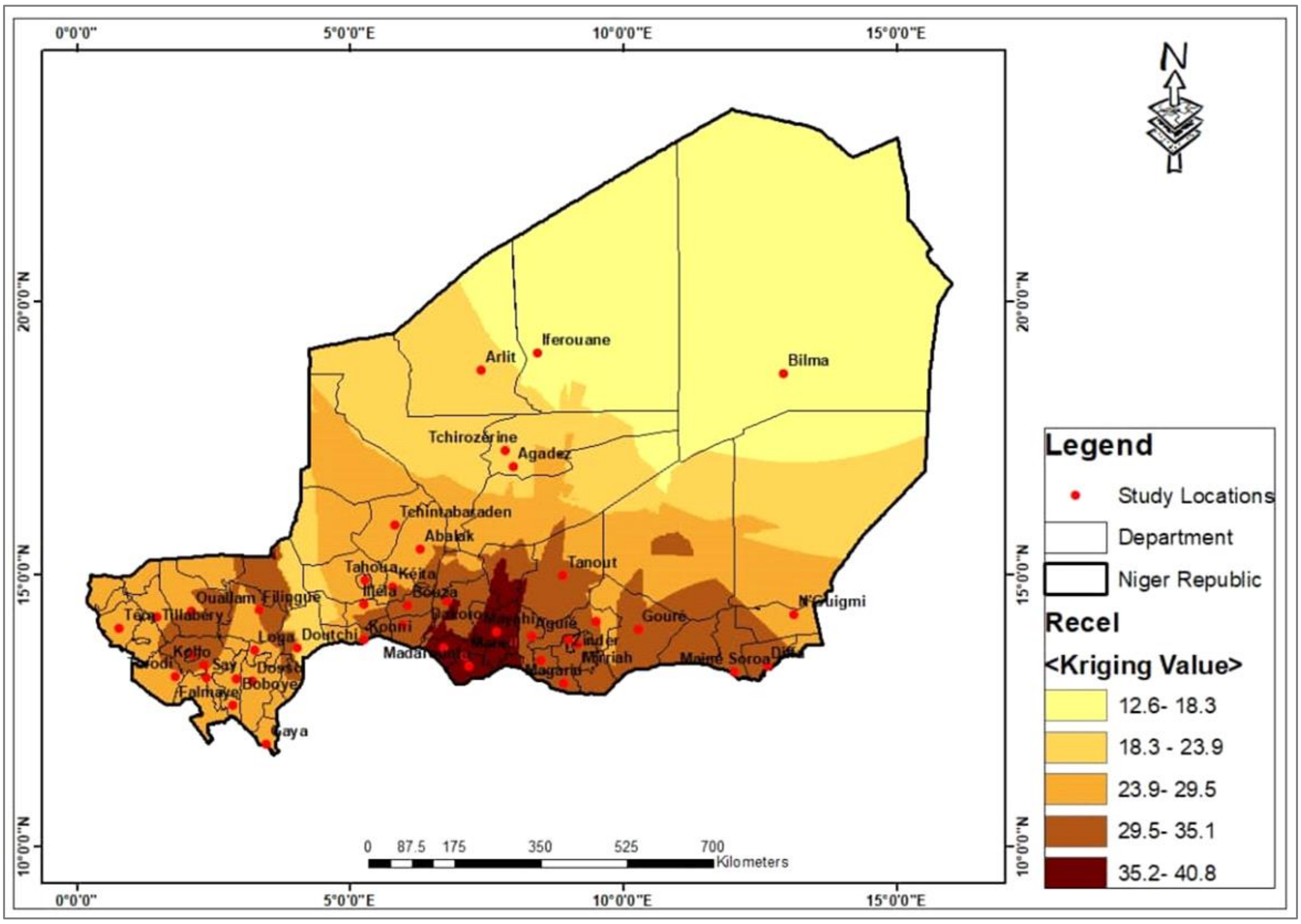

Figure 3c: Spatial Distribution and Hotspot of Crimes Associated with Recels

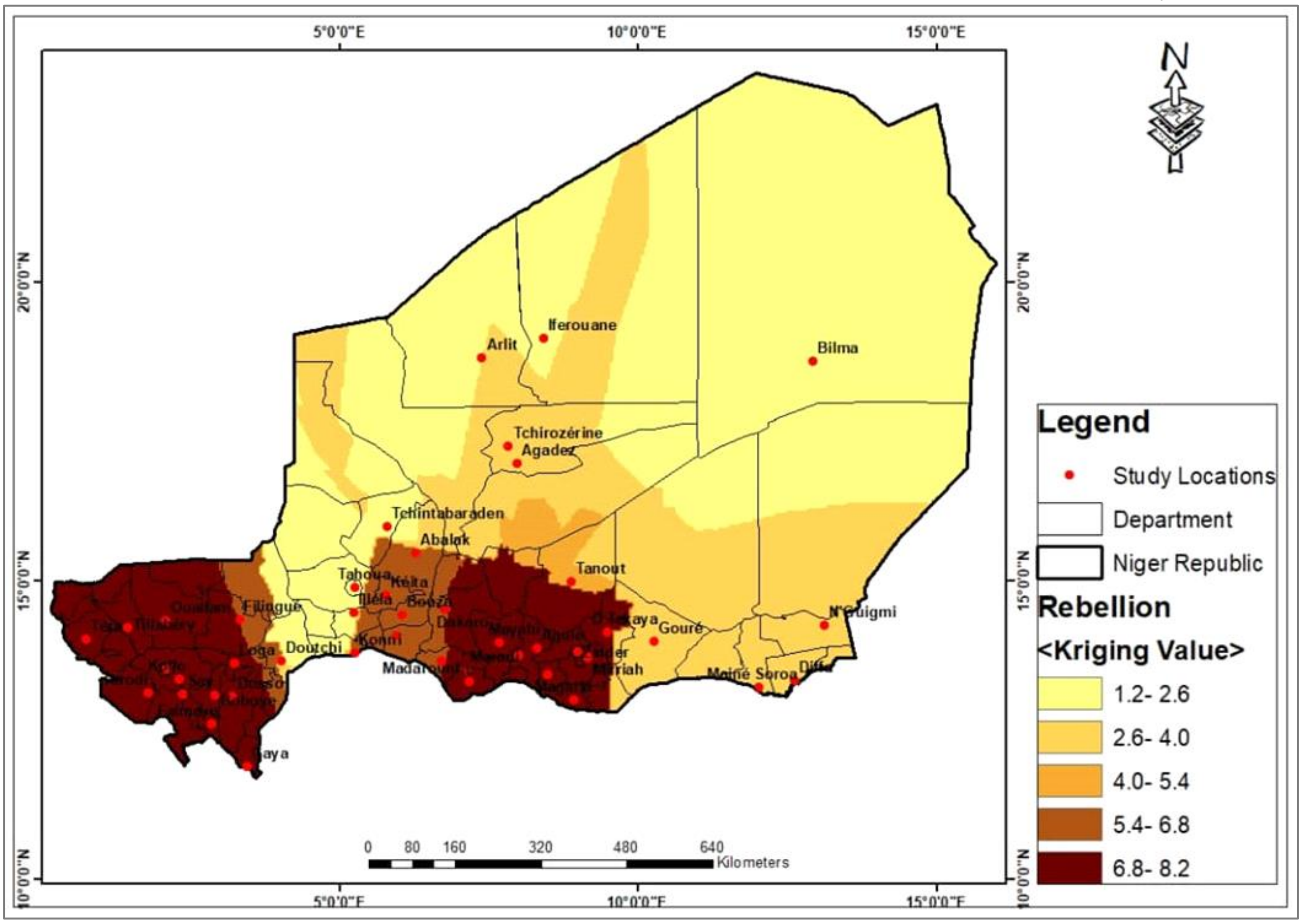

Figure 3d: Spatial Distribution and Hotspot of Crimes Associated with Rebellion

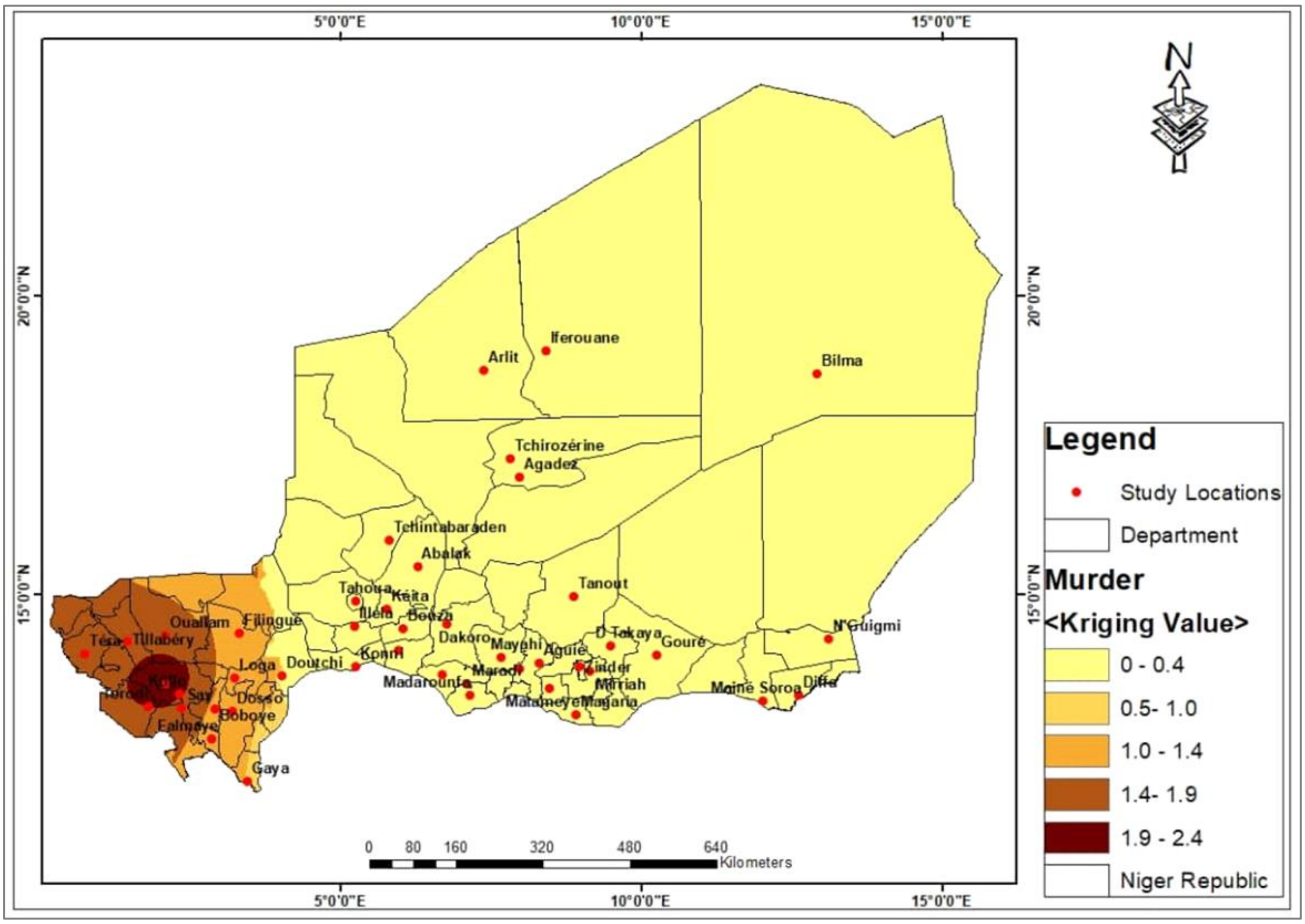

Figure 3e: Spatial Distribution and Hotspot of Crimes Associated with Rebellion

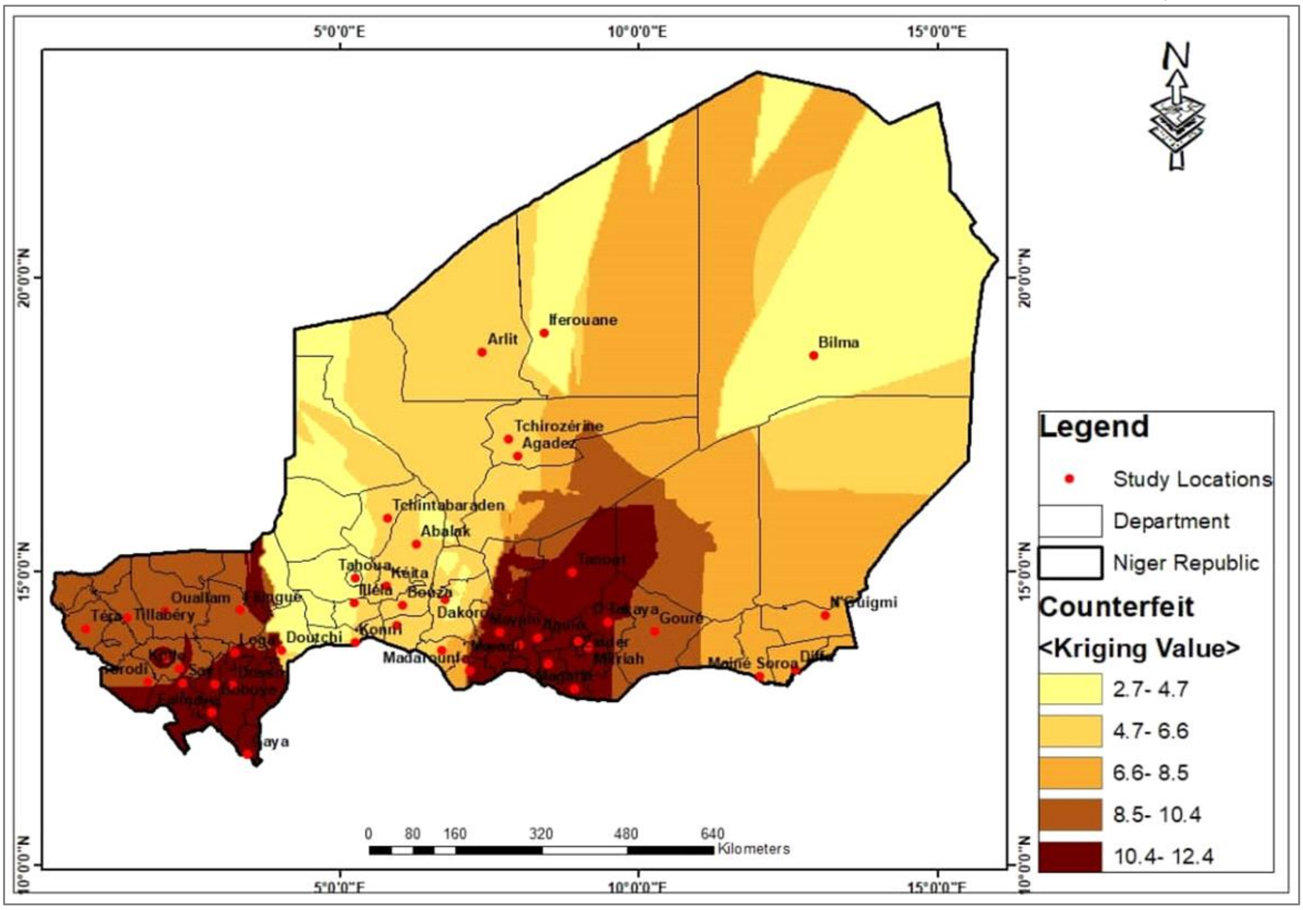

Figure 3f: Spatial Distribution and Hotspot of Crimes Associated with counterfeit money

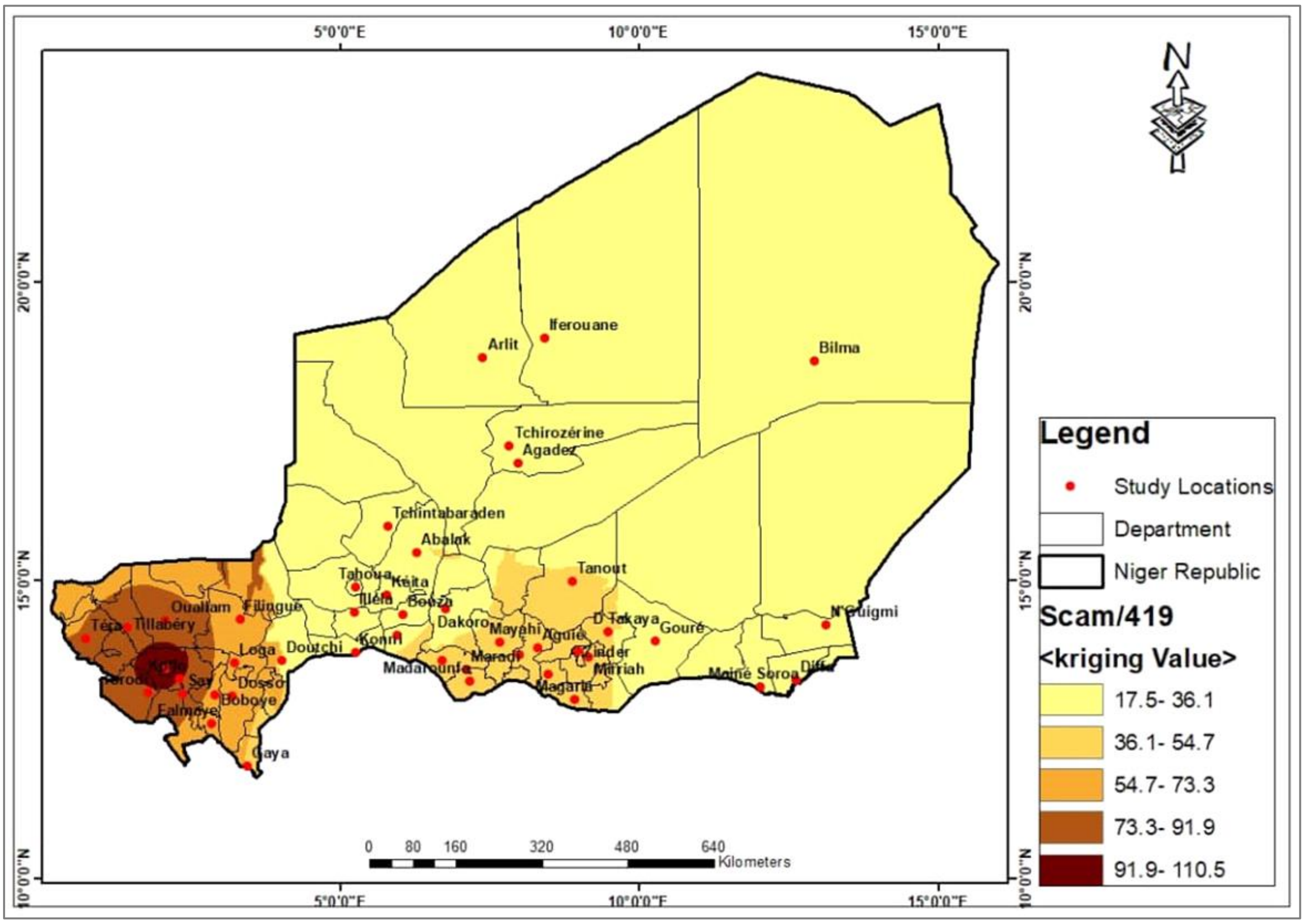

Figure 3g: Spatial Distribution and Hotspot of Crimes Associated with Scam (419)

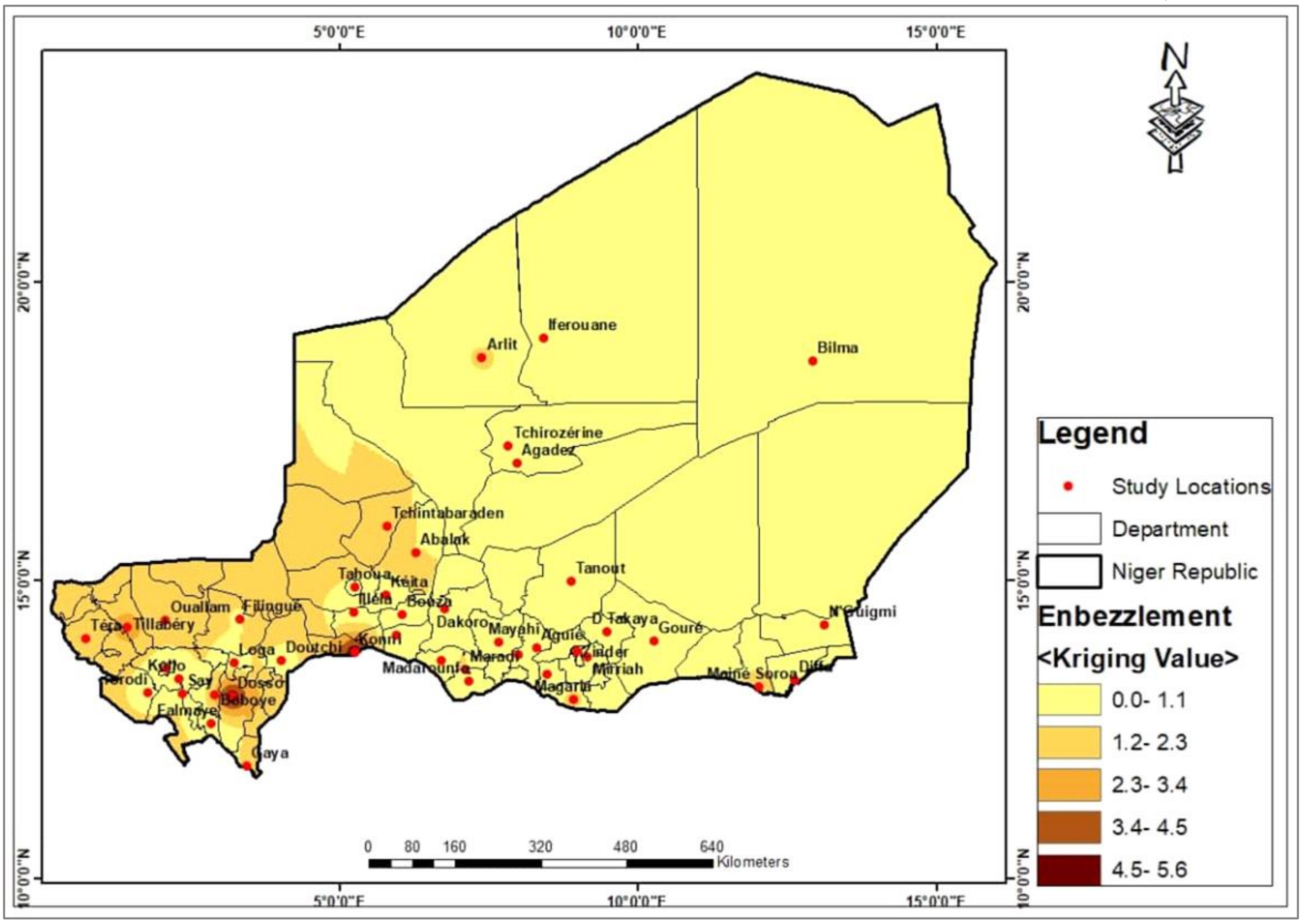

Figure 3h: Spatial Distribution and Hotspot of Crimes Associated with Embezzlement

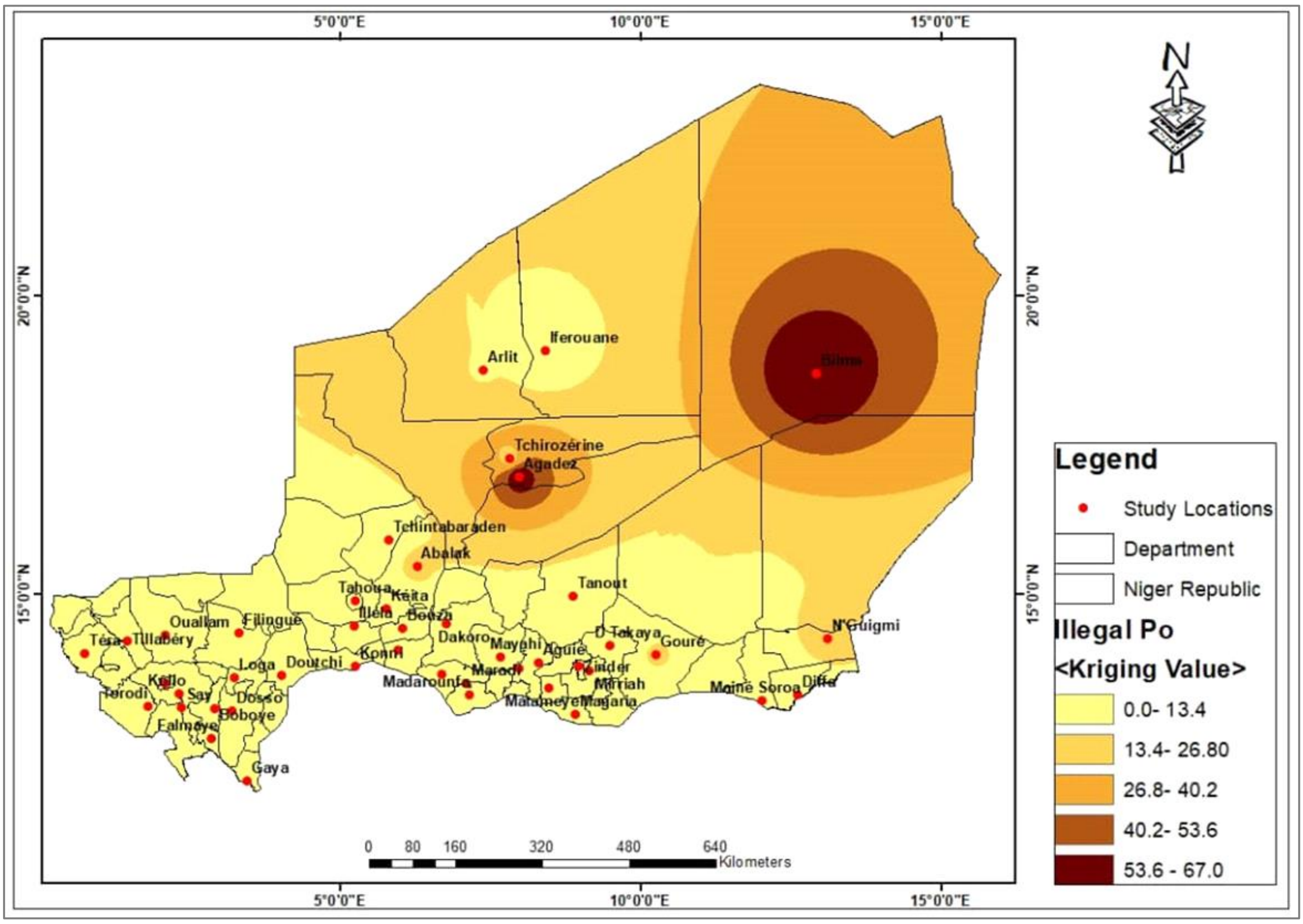

Figure 3i: Spatial Distribution and Hotspot of Crimes Associated with Illegal Arm possession

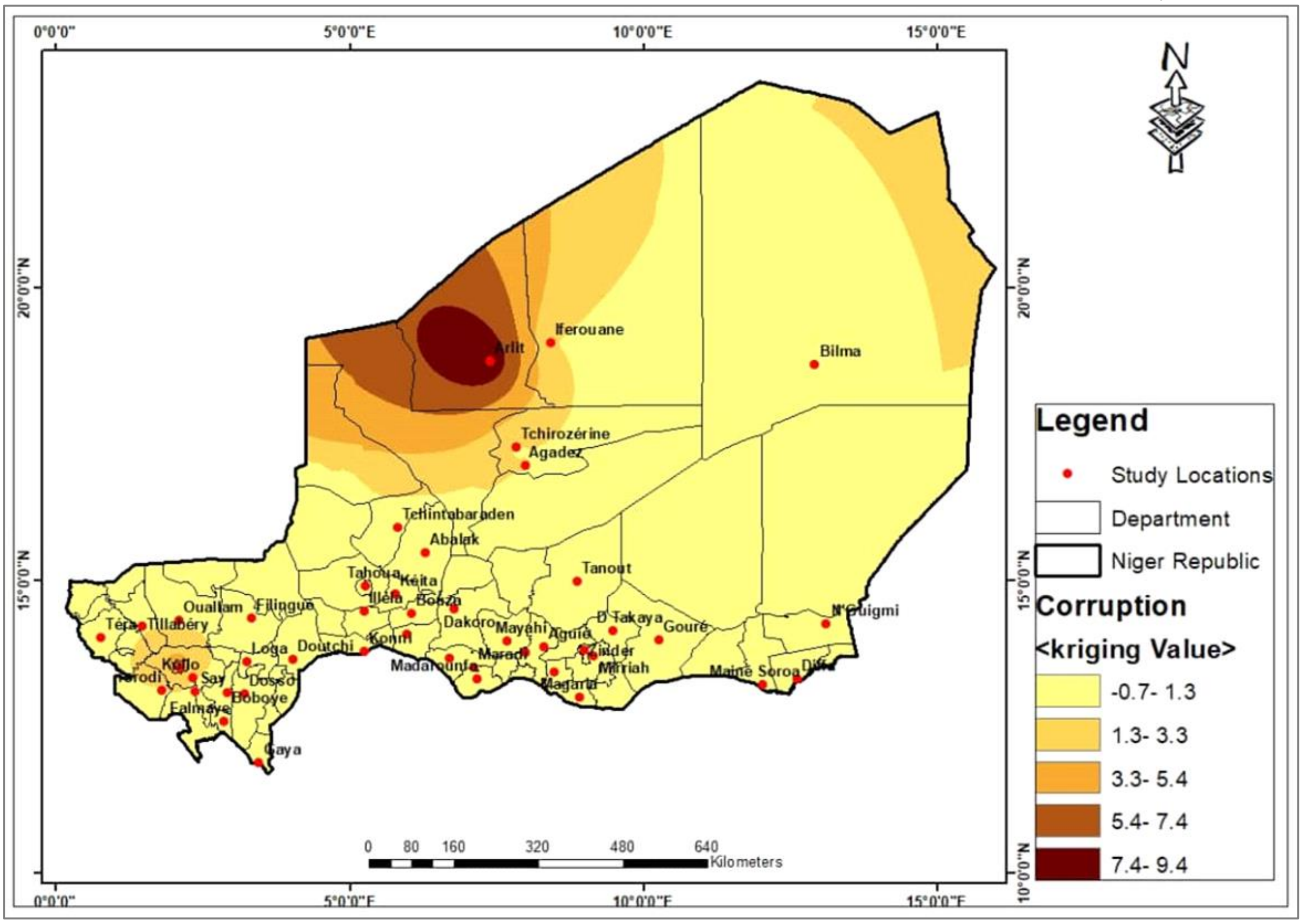

Figure 3j: Spatial Distribution and Hotspot of Crimes Associated with Illegal Arm possession

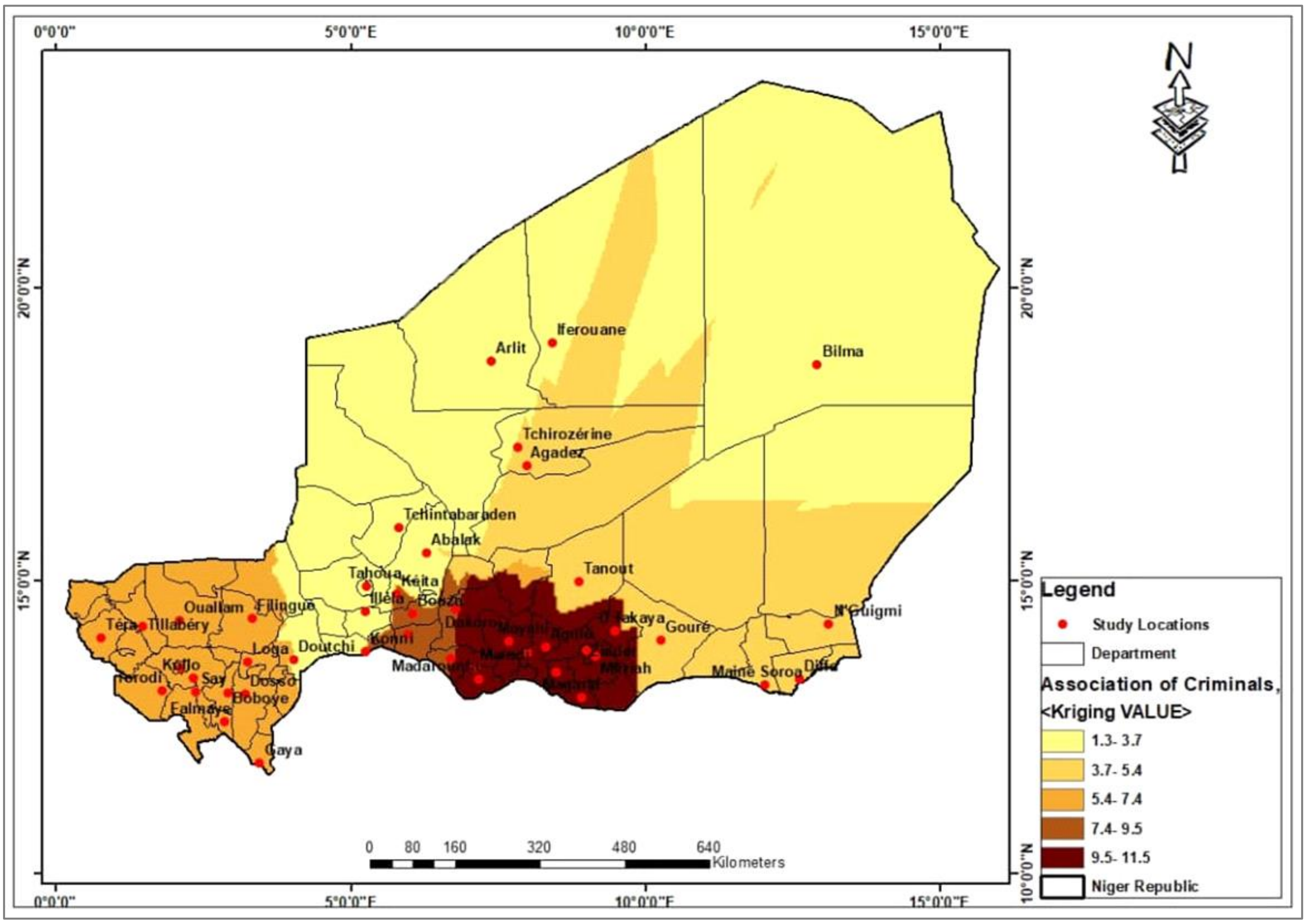

Figure 3k: Spatial Distribution and Hotspot of Crimes Associated with Association of criminals

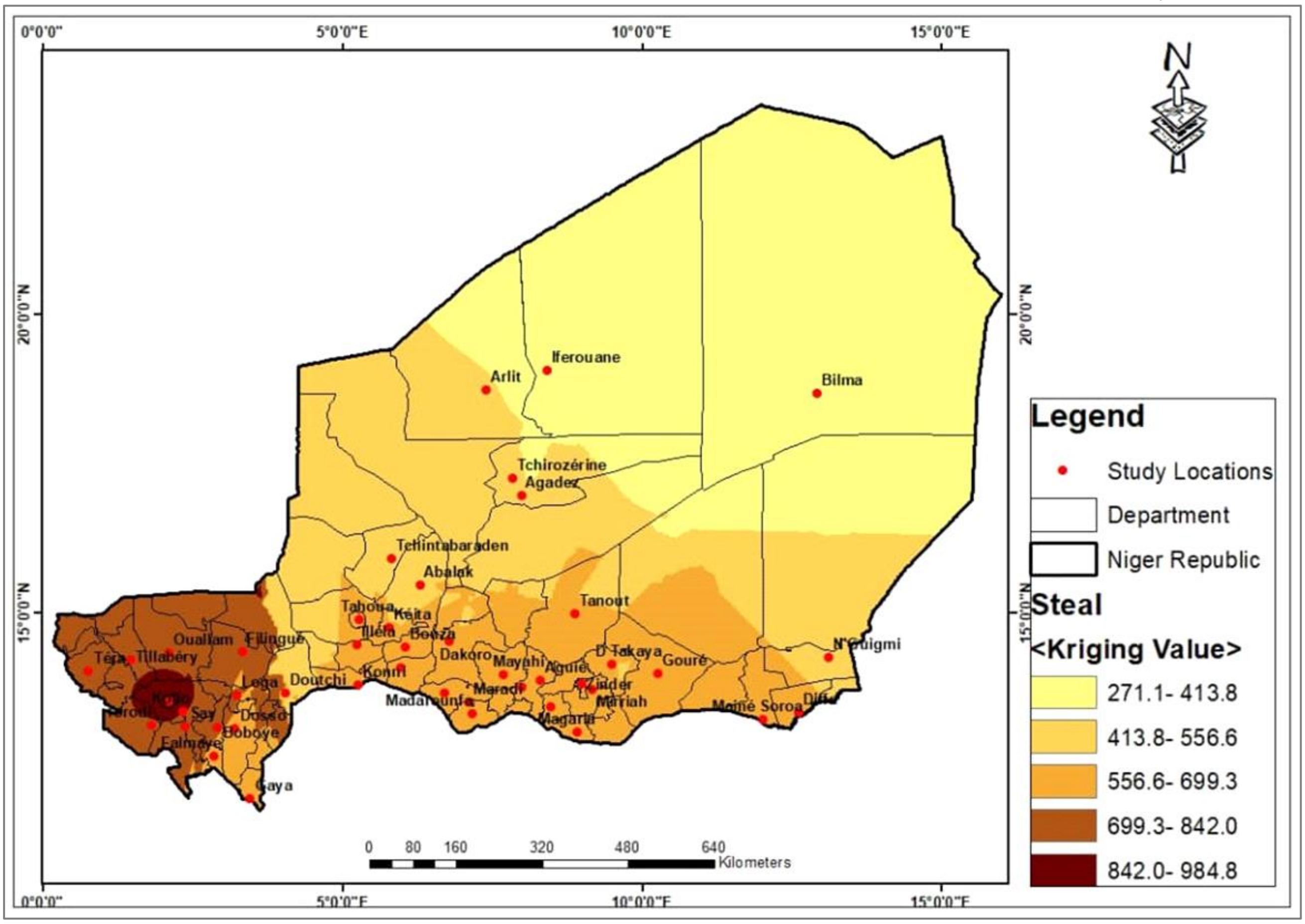

Figure 3l: Spatial Distribution and Hotspot of Crimes Associated with Stealing

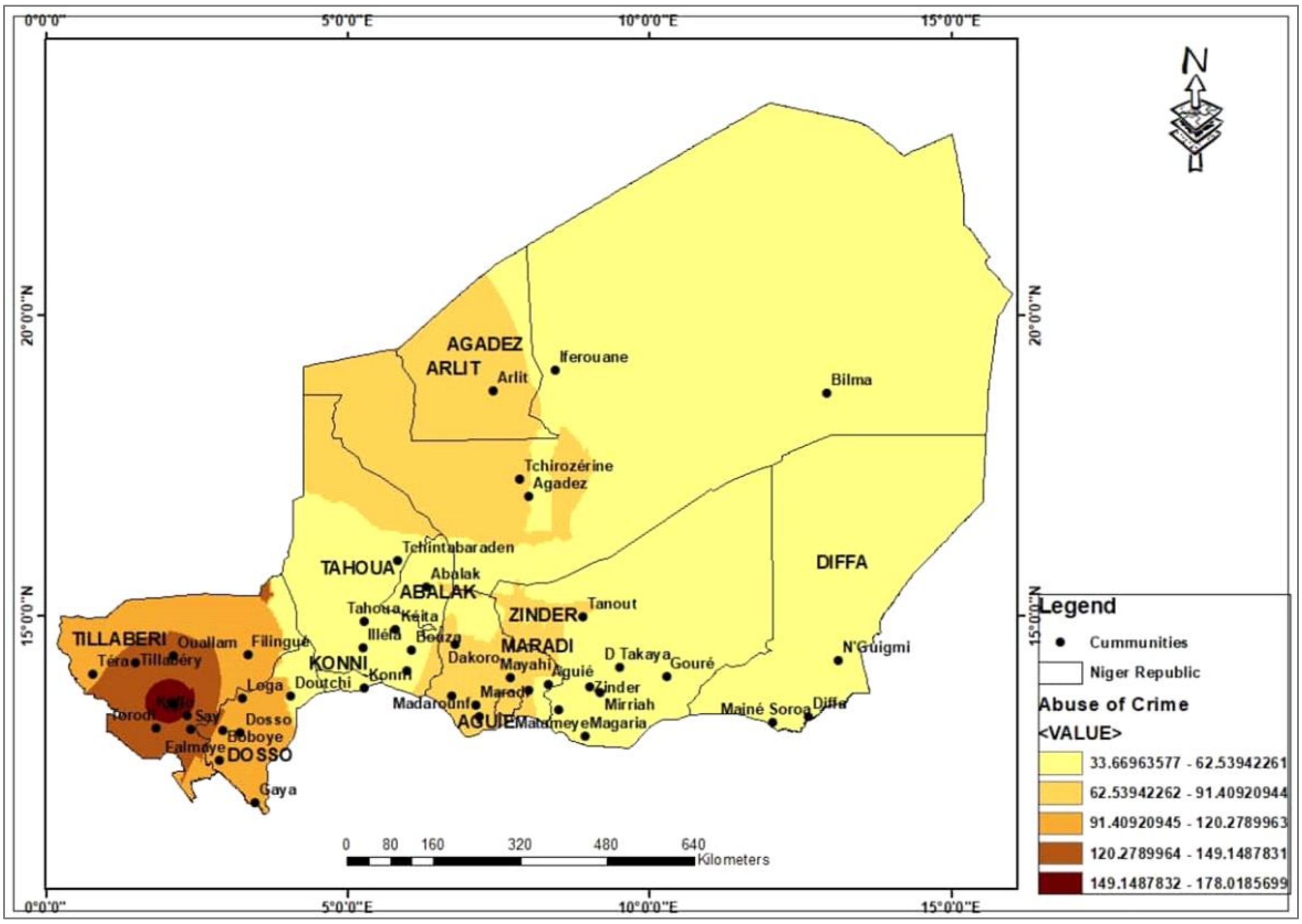

Figure 3m: Spatial Distribution and Hotspot of Crimes Associated with Abuse of confidence

In contrast, the northeast and central regions, including locations such as Ablak, Keita, Bouza, and Dakoro, have very low narcotic-related cases. For the recel cases, Figure 3(c) shows that the hotspot was observed in the southern part of the country, which have boarder with Nigeria. The country that has the highest commercial activity with Niger. The hotspot covers locations like Maradi, Mayahi, and Dakoro. The hotspot radiuses as going to the east or the western part. Figure 3(d) shows the spatial distribution and the hotspots for the case of rebellion. It covers the all-southern part of the country where we have the three borders (Mali, Burkina Faso, and Niger); this is a place where the three countries are fighting terrorism, banditry, and illegal trafficking. There is another hotspot, in the southern part, with a border with Nigeria, with locations like Maradi, Dakoro, Mayahi, and Aguié. The area where kidnappers are disturbing the local populations between the two countries. Figure 3(e) shows the hotspot of cases of murder. It was identified in the center of the western part of the country. For counterfeit crime cases in Figure 3(f), the hotspots were identified in the southwestern part, precisely in Dosso, Boboye, Say, Falmaye, Kollo, and Gaya. This part of the country has a border with Benin Republic and Nigeria. The other hotspot was identified in the south-central with locations like Maradi, Zinder, Tanout, Mayahi and Miriah. These locations share a border with Nigeria. Figure 3(g) shows the spatial distribution map and the hotspots of the case of Scam crime type. The hotspot was observed mainly in the western part of the country and contained locations like Niamey and its neighbours like Kollo, Say, and Torodi. Figure 3(h) shows the map of the spatial distribution of case of embezzlement and its hotspot. The hotspot is slightly observed in the southern part of Boboye and Dogon Doutchi. Figure 3(i) shows the map of the spatial distribution and hotspot of cases of Illegal Arm possession. The hotspot was identified in the north-east of the country and concerns Bilma and Agadez. This area borders Thach in the East and Lybia in the North. It is where most of the weapons circulating in the Sahel region come from. Figure 3(j) shows the map of the spatial distribution and the Hotspot of cases of corruption. The hotspot was identified in the northern part of the country that has a border with Algeria, precisely in Arlit. Figure 3(k) shows the map of the spatial distribution and hotspot of cases of association of criminals. The hotspot is observed in the southern part of the country that have border with Nigeria. It concerns locations like Maradi, Zinder, Dakoro, Mayahi, and Aguié. Figure 3(l) shows the map of the spatial distribution and the hotspot of the case of steals. The hotspot was identified in the western part of the country. It contains locations like Niamey and neighbouring localities. Figure 3(m) shows the spatial distribution map and hotspots of cases of abuse of confidence. The hotspot covers some parts of Tillabery and that of Niamey in the western part.

Before implementing K-means clustering, the ideal number of clusters can be established in advance or determined during the clustering process itself. This study used the Elbow method to identify the optimal number of clusters. For violence or assault, as shown in Figure 4(a), the Elbow curve analysis indicates four clusters consisting of 1, 6, 7, and 30 observations, respectively. The first cluster contains only Niamey. Cluster 2 comprises Agadez, Arlit, Maradi, Bilma, Iférouane, and Tchirozérine. Cluster 3 includes Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi, while the remaining locations are found in cluster 4. The Elbow curve indicates that the optimal number of clusters for narcotics offenses is four, with sizes of 6, 1, 7, and 30 observations, respectively. The spatial representation of the clusters in Figure 4(b) illustrates how well the four clusters are organized and distinctly defined based on the location coordinates. The first cluster includes Agadez, Arlit, Maradi, Bilma, Iférouane, and Tchirozérine. The second cluster consists of Niamey, while the third cluster contains locations such as Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The remaining 30 locations belong to the fourth cluster.

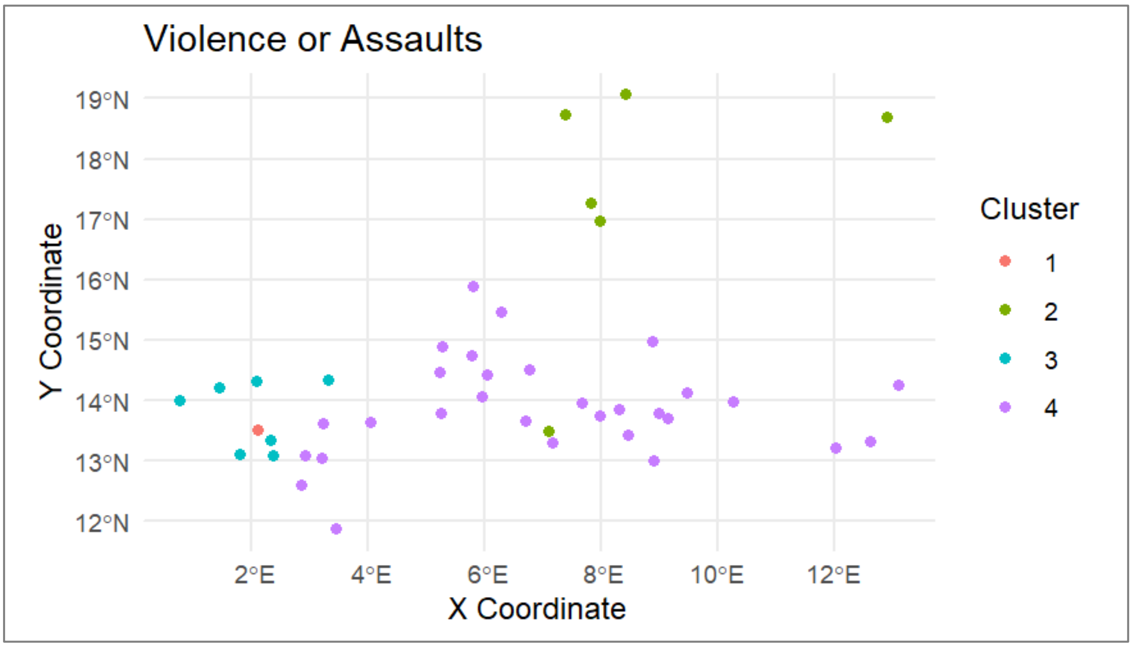

Figure 4a: Spatial plot of Crimes clusters Associated with Violence or assault

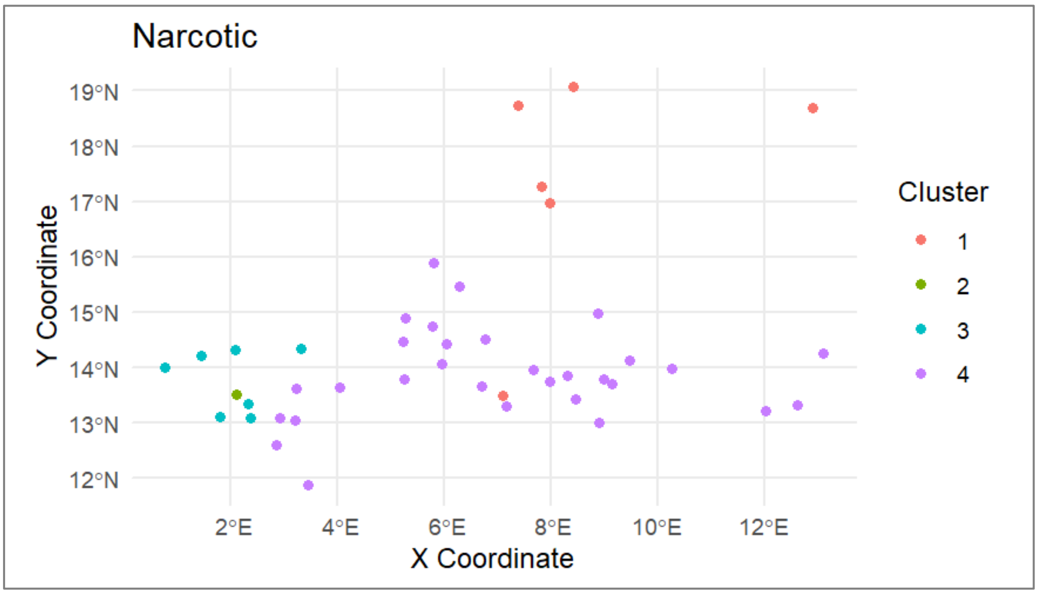

Figure 4b: Spatial plot of Crimes clusters Associated with Narcotic

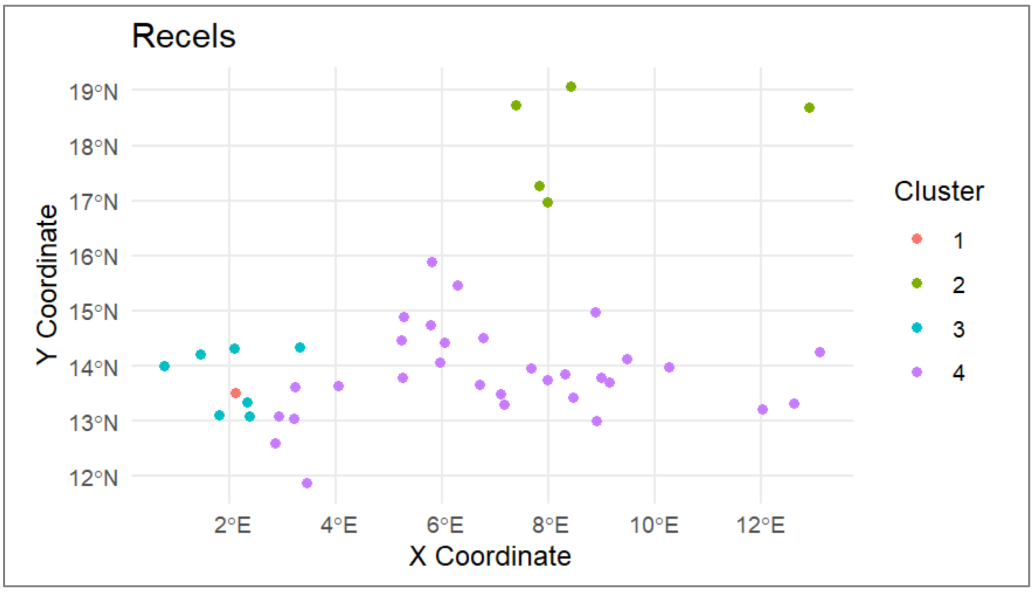

Figure 4c: Spatial plot of Crimes clusters Associated with recels

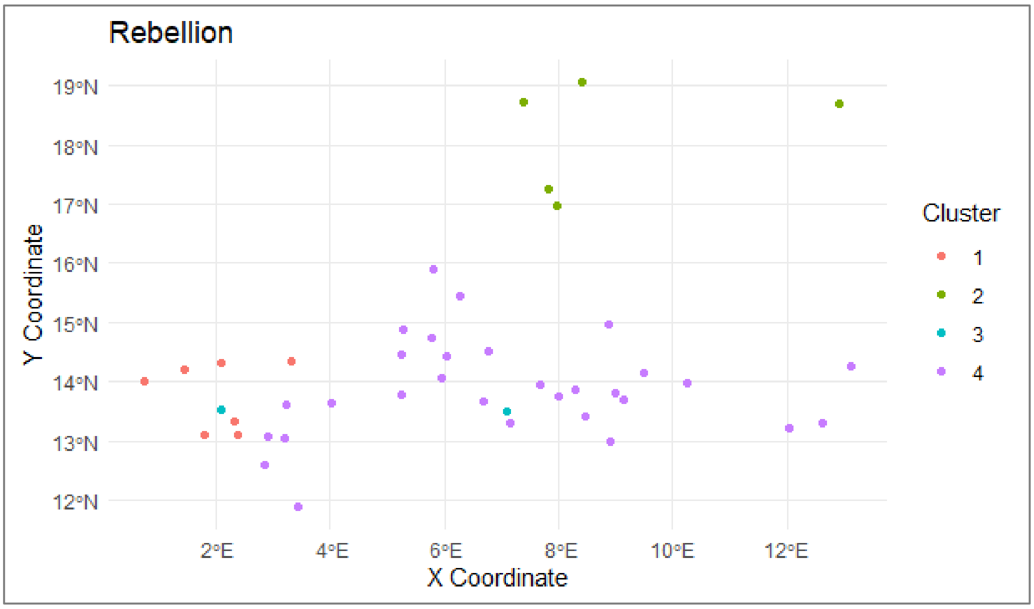

Figure 4d: Spatial plot of Crimes clusters Associated with rebellion

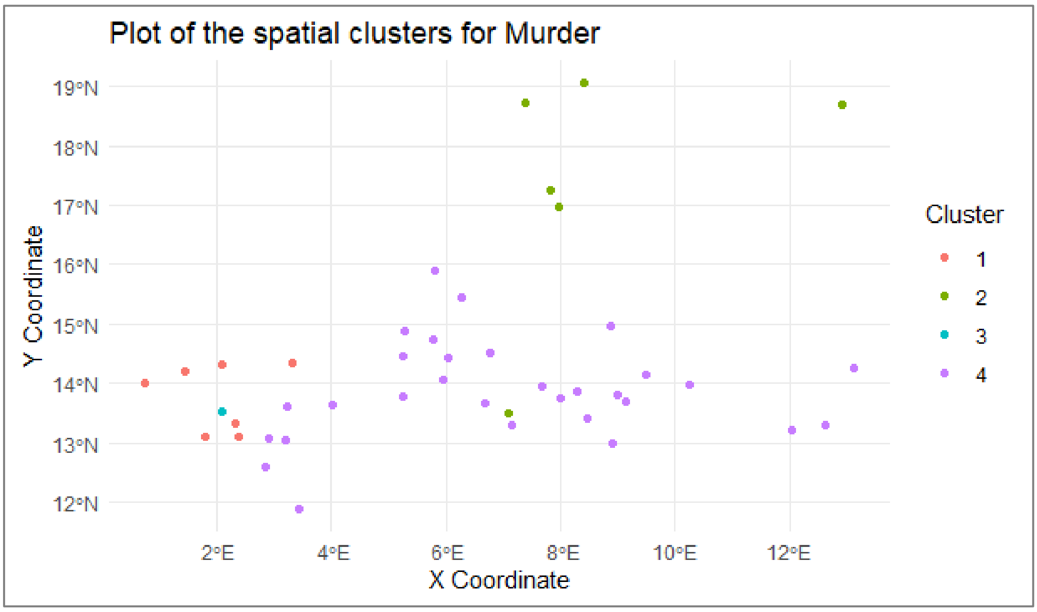

Figure 4e: Spatial plot of Crimes clusters Associated with Murder

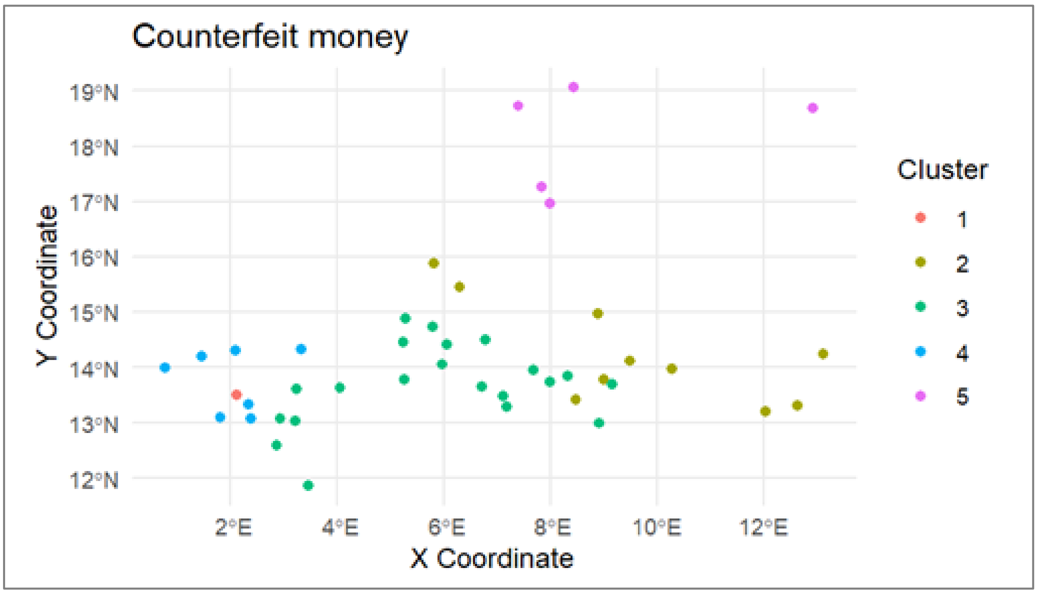

Figure 4f: Spatial plot of Crimes clusters Associated with Counterfeit money

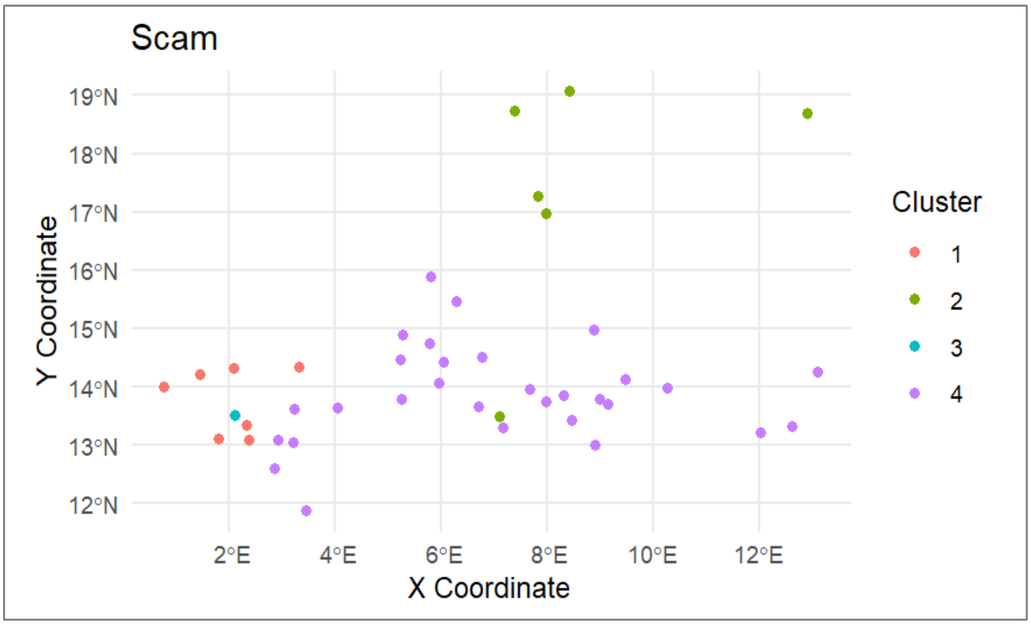

Figure 4g: Spatial plot of Crimes clusters Associated with Scam (419)

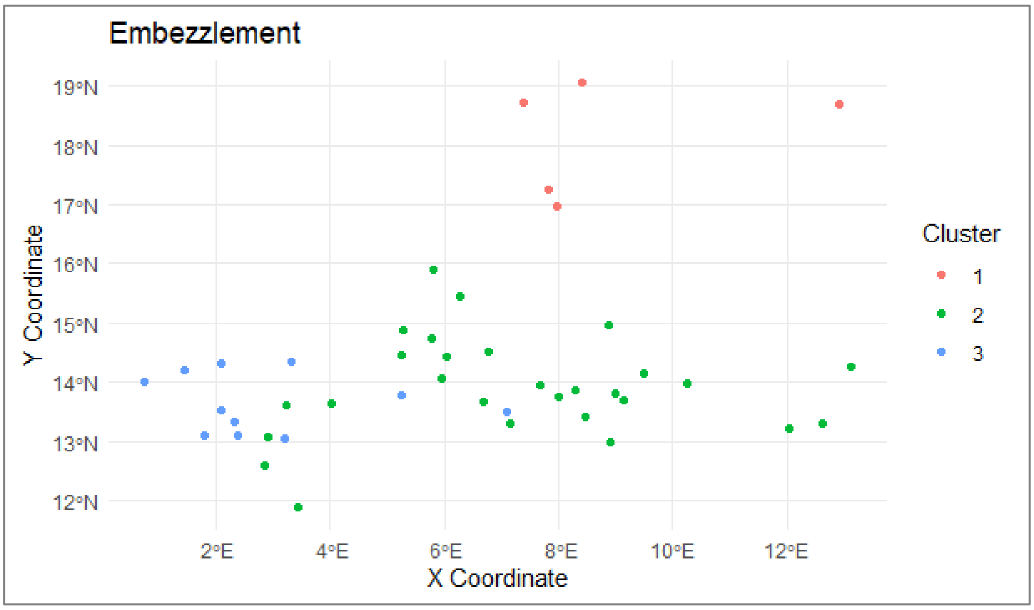

Figure 4h: Spatial plot of Crimes clusters Associated with Embezzlement

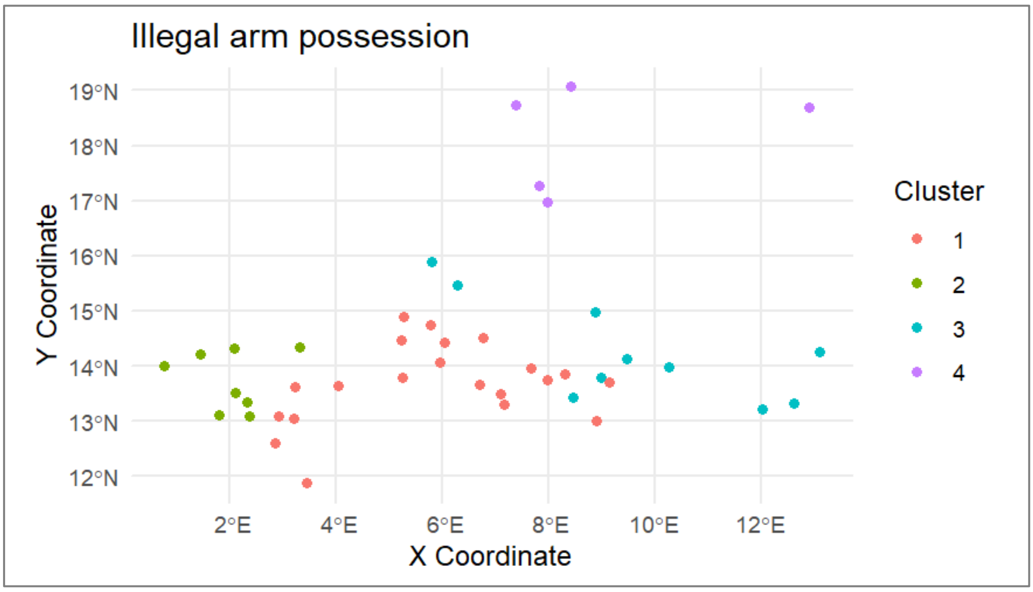

Figure 4i: Spatial plot of Crimes clusters Associated with Illegal Arm possession

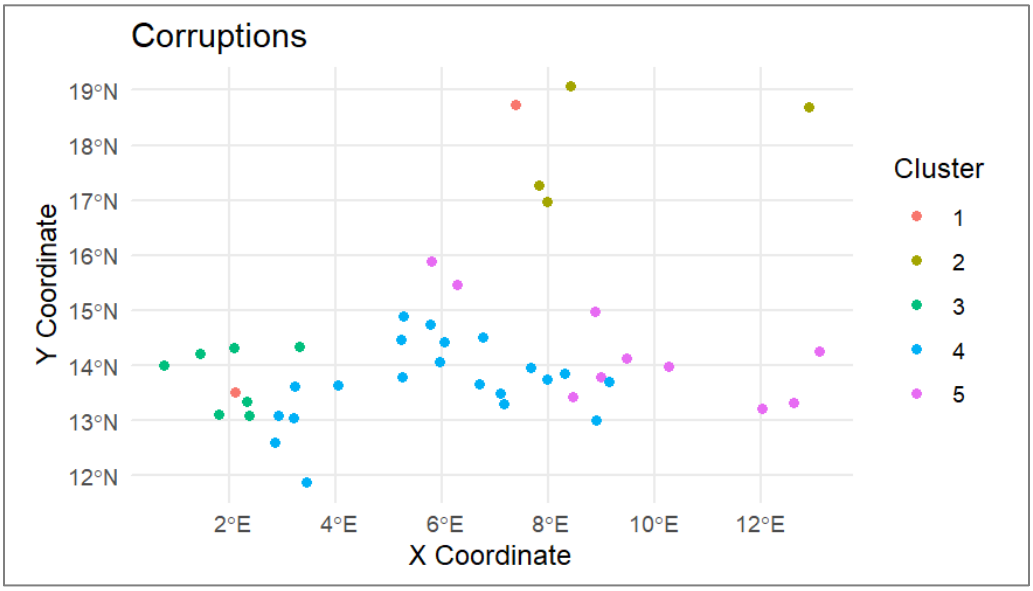

Figure 4j: Spatial plot of Crimes clusters Associated with corruption

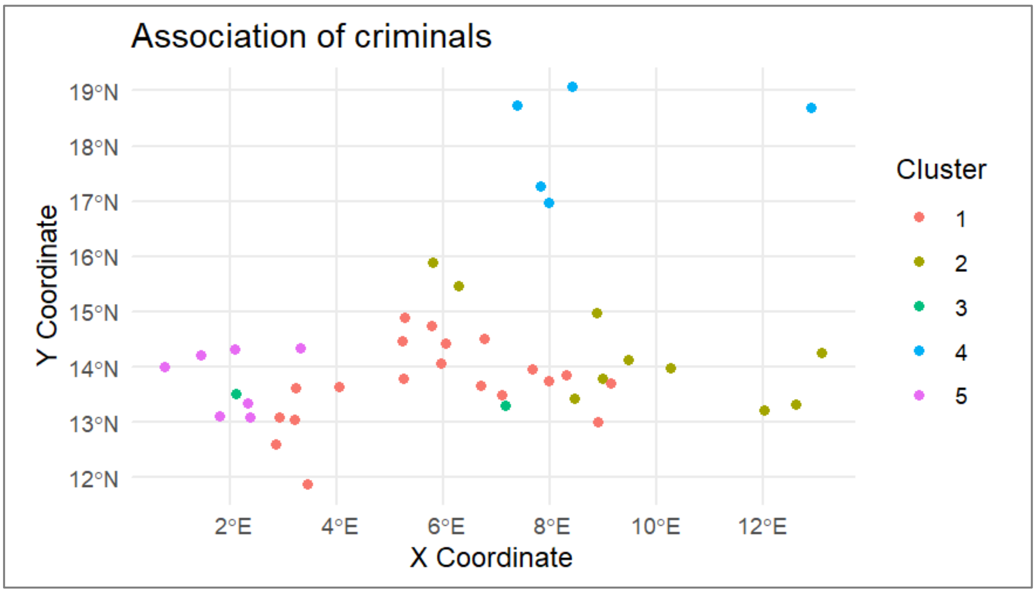

Figure 4k: Spatial plot of Crimes clusters Associated with Association of criminal

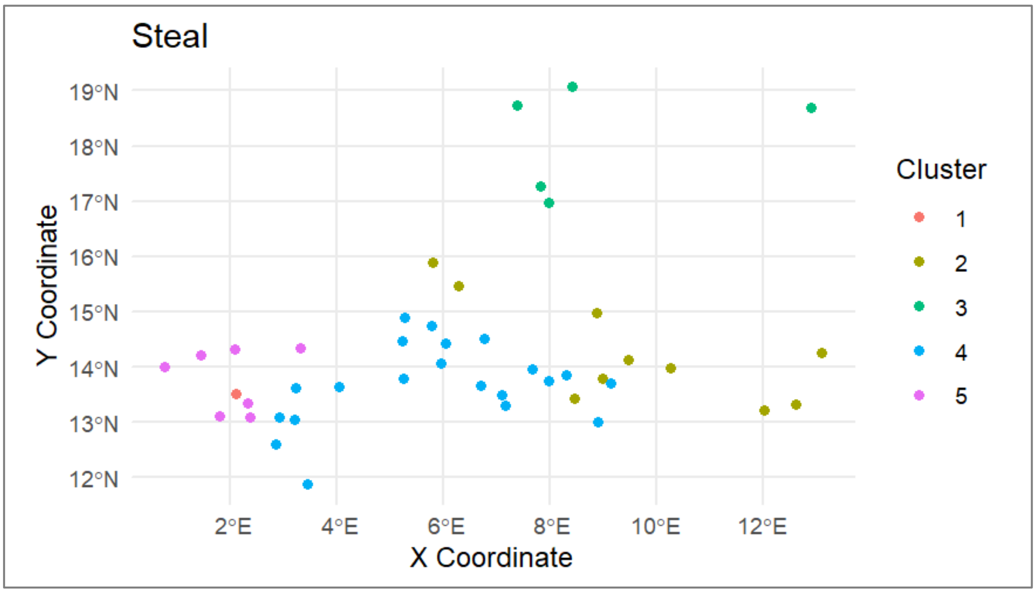

Figure 4l: Spatial plot of Crimes clusters Associated with Stealing

For Recels offenses, the Elbow curve analysis indicates that the optimal number of clusters is four, with sizes of 1, 5, 7, and 31 observations, respectively, as shown in Figure 4(c). The first cluster contains only Niamey, while the second cluster includes Agadez, Arlit, Bilma, Iférouane, and Tchirozérine. Cluster 3 consists of Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The remaining 31 locations are grouped in cluster 4. The Elbow curve analysis identifies an optimal number of four clusters for rebellion offenses, as shown in Figure 4(d). These clusters contain sizes of 7, 5, 2, and 30 observations, respectively. The first cluster includes locations such as Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The second cluster comprises Agadez, Arlit, Bilma, Iférouane, and Tchirozérine, while the third includes Niamey and Maradi. The remaining locations are situated in cluster four. For murder offenses Figure 4(e), the Elbow curve analysis indicates that the optimal number of clusters is four. These clusters have sizes of 7, 6, 1, and 30 observations, respectively. The first cluster includes Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The second cluster consists of Agadez, Arlit, Maradi, Bilma, Iférouane, and Tchirozérine, while the third cluster contains only Niamey. The remaining locations are grouped in cluster four. The Elbow curve analysis indicates that the optimal number of clusters for counterfeit offenses is five, as illustrated in Figure 4(f). These clusters have sizes of 1, 10, 21, 7, and 5 observations, respectively. The first cluster consists solely of Niamey. The second cluster includes locations such as Diffa, Zinder, Abalak, D Takaya, Gouré, Mainé Soroua, Matameye, N'guigmi, Tanout, and Tchintabaraden. The fourth cluster encompasses locations like Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi, which share similar characteristics related to the type of violence seen in cluster 2. The fifth cluster comprises Agadez, Arlit, Bilma, Iférouane, and Tchintabaraden, while the remaining locations are found in cluster three. For scam crimes Figure 4(g), the Elbow curve analysis determines an optimal number of four clusters, with sizes of 7, 6, 1, and 30 locations, respectively. The first cluster includes Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi.

The second cluster consists of Agadez, Arlit, Maradi, Bilma, Iférouane, and Tchirozérine. The third cluster is made up solely of Niamey, while the remaining locations are grouped in the fourth cluster. For embezzlement offenses Figure 4(h), the Elbow curve analysis reveals an optimal number of three clusters with sizes of 5, 28, and 11 observations, respectively. The first cluster includes locations such as Agadez, Arlit, Bilma, Iférouane, and Tchirozérine, which share similar characteristics regarding embezzlement cases. The second cluster comprises Diffa, Dosso, Konni, Maradi, Niamey, Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The remaining locations are categorized into cluster three. For illegal arms possession offenses Figure 4(i), the Elbow curve analysis identifies an optimal number of four clusters with sizes of 21, 8, 10, and 5 observations, respectively. The second cluster includes Niamey, Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The third cluster consists of locations such as Diffa, Zinder, Abalak, D Takaya, Gouré, Mainé Saroua, Matamaye, N'gourti, Tanout, and Tchintabaraden. The fourth cluster is made up of Agadez, Arlit, Bilma, Iférouane, and Tchirozérine. The remaining 21 locations are grouped in cluster one, as illustrated in the analysis. For corruption offenses Figure 4(j), the Elbow curve analysis suggests an optimal number of five clusters with sizes of 2, 4, 7, 21, and 10 observations, respectively. The first cluster includes locations such as Arlit and Niamey. The second cluster consists of Agadez, Bilma, Iférouane, and Tchirozérine. The third cluster comprises Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The fifth cluster contains Diffa, Zinder, Abalak, D_Tayya, Gouré, Mainé Saroua, Matamaye, N'guigmi, Tanout, and Tchintabaraden. The remaining locations are classified in cluster four. For offenses related to criminal associations Figure 4(k), the Elbow curve analysis identifies an optimal number of five clusters, with sizes of 20, 10, 2, 5, and 7 observations. The first cluster includes locations such as Arlit and Niamey. The second cluster consists of other locations that were not specified. The third cluster features Niamey and Madarounfa. The fourth cluster includes Agadez, Arlit, Bilma, Iférouane, and Tchirozérine. The fifth cluster comprises Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi, while the remaining locations are part of cluster one. For theft offenses Figure 4(l), the Elbow curve analysis indicates an optimal number of five clusters with sizes of 1, 10, 5, 21, and 7 observations, respectively. The first cluster consists solely of Niamey. The second cluster includes locations such as Diffa, Zinder, Abalak, D Takaya, Gouré, Mainé Saroua, Matamaye, N'guigmi, Tanout, and Tchirozérine. The third cluster includes Agadez, Arlit, Bilma, Iférouane, and Tchirozérine. The fifth cluster consists of Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. The remaining locations are grouped in cluster four, which includes Dosso, Konni, Maradi, Tahoua, Aguié, Boboye, Bouza, Dakoro, Doutchi, Falmaye, Gaya, Guidan Roumji, Illela, Keita, Loga, Madaoua, Madarounfa, Magaria, Mayahi, Mirriah, and Tessaoua. For abuse of confidence offenses Figure 4(m), the Elbow curve analysis reveals an optimal number of four clusters with sizes of 10, 21, 8, and 5 observations, respectively. The first cluster consists of locations such as Diffa, Zinder, Abalak, D. Takaya, Gouré, Mainé Saroua, Matamaye, N'guigmi, Tanout, and Tchirozérine. The second cluster comprises Dosso, Konni, Maradi, Tahoua, Aguié, Boboye, Bouza, Doutchi, Falmaye, Gaya, Guidan Roumji, Illela, Keita, Loga, Madaoua, Madarounfa, Magaria, Mayahi, Mirriah, and Tessaoua. The third cluster includes Niamey, Tillabéri, Fillingué, Kollo, Ouallam, Say, Téra, and Torodi. Lastly, the fourth cluster consists of Agadez, Arlit, Bilma, Iférouane, and Tchirozérine.

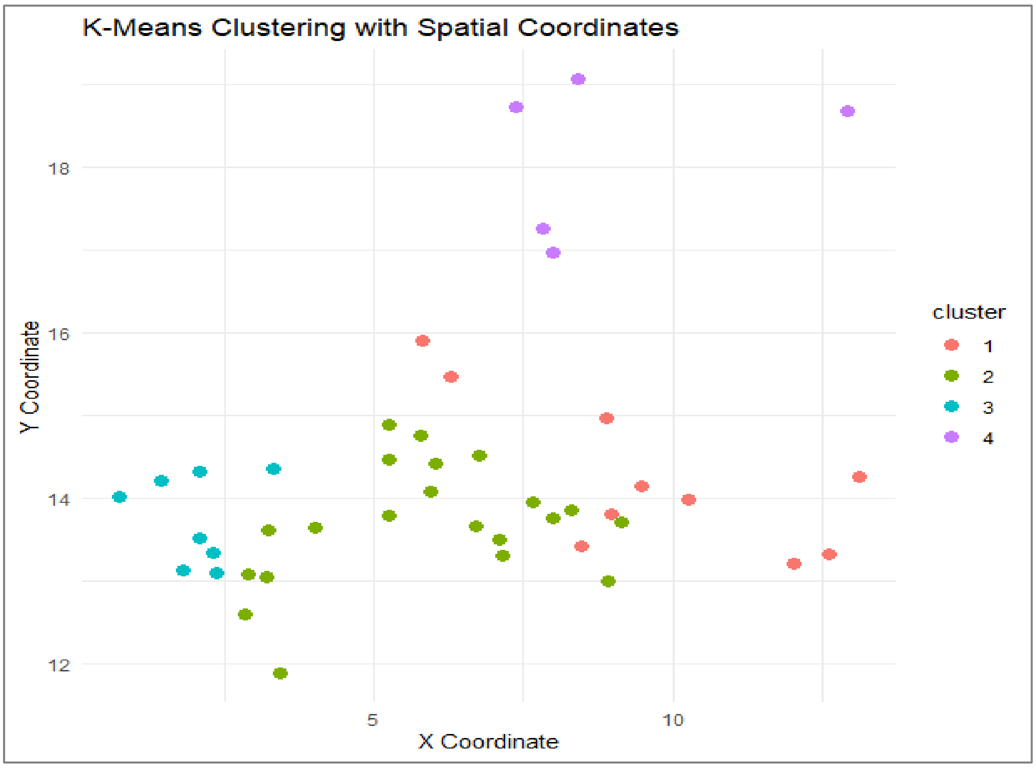

Figure 4m: Spatial plot of Crimes clusters Associated with Abuse of confidence

CONCLUSION AND RECOMMANDATION

In conclusion, it was found that some of the crime types have four clusters, some with five, and only one crime type having three clusters. The analysis indicated that crime rates in Niger Republic were influenced by spatial relationships with neighboring countries like Libya, a central point of insecurity in the Sahel, as well as Mali, Chad, Burkina Faso, Algeria, and Nigeria, as evidenced by some of the hotspots. Factors such as insufficient punishment for offenders and weak border security agencies were also identified as contributing elements.

Based on the findings of this paper, the following recommendations are proposed:

Implement Targeted Law Enforcement Strategies: This is to improve law enforcement efforts in identified hotspot areas to address specific crime patterns. Emphasis on the four primary clusters of crime and assign resources accordingly to disrupt criminal activities.

Strengthen Border Security: That is to Intensify collaboration with neighboring countries like Libya, Mali, Chad, Burkina Faso, Algeria, and Nigeria to improve border security measures. This can be done through joint patrols, information sharing, and coordinated responses to cross-border crime.

Enhance Legal Consequences for Offenders: That is, reform of the penal system ensures that sentences for offenders are more effective and dissuasive. It can involve reviewing sentencing guidelines and increasing the application of existing laws to discourage criminal behavior.

Community Engagement and Awareness: To involve the community in crime prevention initiatives by raising responsiveness about crime patterns and the importance of reporting suspicious activities. Encouraging public participation can enhance local security and cooperation with law enforcement.

Conduct Further Research: Continue to monitor and analyze crime trends in Niger to adapt strategies as necessary. Ongoing research should focus on the dynamic nature of crime and its relationship with socio-economic and political factors in the region.

The implementation of these recommendations can better address the challenges posed by crime and enhance overall safety for the citizens of Niger Republic. For future work, geospatial models like Poisson regression kriging can be applied to have a model for the prediction of crimes in the study area.

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