

## Spatial and Temporal Analysis: A GIS-Based Application Tool for Crime Monitoring and Clustering in Malawi

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### Abstract

For the purposes of monitoring, evaluating, and conducting a geographical analysis of crime-related data, the study used geospatial technology to collect crime data based on spatial location and the Malawi Police Data Digest of 2019 and 2020. In a more generic sense, knowing the geographic patterns of crime in Malawi using GIS technology can help determine how to make and implement important decisions to reduce crimes in Malawi. The Malawi Police Service has established a number of database management systems to help with crime monitoring. Notwithstanding, it has not yet fully integrated Geographic Information Systems across all jurisdictions. Maps showing crime locations and crime hotspot zones are therefore not included in the crime data and statistics report provided by the Malawi Police Service. In this light, a lot of people have become victims of various forms of crimes in areas where those crimes are also prevalent. To collect, track, and analyze crime data in Malawi for this study, Geographical Information System (GIS) particularly network analysis techniques were used. Network Analysis was used to identify crime hotspots by analyzing crime data as a network of interconnected events and locations. The rationale behind this was to treat each crime event as a node in the network and the spatial relationships between the crimes as edges. By analyzing this network, patterns and relationships between crime events were revealed, allowing for the identification of crime hotspots. The study found that Lilongwe in the central

region and the capital city registered the highest number of crimes seconded by Blantyre in the southern region and followed by Mangochi. Mzimba recorded high crimes in the northern region. In Malawi, the traditional systems of intelligence and criminal record keeping have failed to satisfy the demands of today's crime situation. Manual methods neither give accurate, dependable, or complete data 24 hours a day nor do they help in trend forecasting and decision assistance. It also leads to poorer productivity and inefficient workforce use. The appropriate application of information technology is the solution to this ever-increasing challenge.

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**Keywords:** GIS, crime, hotspots, police, database systems

## **Introduction**

Modern cultures have been overwhelmed by a growing crime rate, which has resulted in the loss of lives and property (Duffour,2022). Several traditional methods of data collection have been implemented to aid in the fight against crime, but in this era of advanced computer technologies, the introduction of Geographic Information Systems (GIS) has led to crime-fighting agencies developing sophisticated models in the fight against crime.

The absence of geographical data and related qualities of the crime is one of the key issues in investigating crimes, making it impossible to depict the exact locations of the numerous crimes on maps. The Malawi Police Service has introduced several computer technologies for crime database management, such as an automated criminal records database, and a fingerprint identification system (The Nation, 2018). Despite the development of these database systems, GIS has yet to be completely deployed throughout all Malawi jurisdictions. In this light, the study aims to appraise GIS as a tool for crime monitoring and clustering so that hotspots are identified for crime prevention.

## **Literature Review**

### **Importance of GIS in Crime Monitoring and Clustering**

A Geographic Information System (GIS) is an interface for integrating and retrieving enormous volumes of location-based information that employs geography and computer-generated maps ([www.state.ia.us](http://www.state.ia.us)).

GIS enables police officers to better prepare for emergency response, establish mitigation priorities, analyze previous occurrences, and forecast future events. GIS may also be utilized to provide important information to emergency responders at the time of dispatch or while en route to an incident, assisting in tactical planning and response. When no leads are apparent, GIS assists detectives in identifying prospective individuals to expand their suspect base (Johnson, 2000).

GIS assists law enforcement in locating probable crime scenes by assessing apparently unrelated criteria and displays them together in a graphical, layered, spatial interface or map (Harries, 1999). It also assists them in mapping inmate populations, fixtures, and equipment in order to ensure inmate safety by segregating gang members, identifying high-risk or possibly violent inmates, and detecting dangerous areas in an area. It minimizes the likelihood of internal conflict by improving command and control. When GIS features are paired with the capabilities of location identification devices like as GPS, they allow for the tracking of high-risk convicts or at-risk workers across a region. It is less expensive for the crime analyst to get the information than for patrol officers to do it themselves ([www.state.ia.us](http://www.state.ia.us)).

Police personnel may now develop maps that are directly relevant to the issue at hand (Johnson 2000). Police departments gather massive volumes of data from a variety of sources, including calls for assistance, arrests, first information reports, and daily reports. However, data in this format might be difficult to see. The same information shown visually offers investigators, supervisors, and administrators a strong decision-making tool. The graphic format reveals hidden linkages and patterns in the data. GIS might also be used to investigate the connection between crime and the environment.

Crime analysts can use maps to see graphic representations of crime-related concerns ([www.charmeck.nc.us](http://www.charmeck.nc.us)). Understanding where and why crimes occur can help to enhance crime-fighting efforts. Mapping crime can assist police in better protecting residents. Simple maps that show the locations of crimes or criminal clusters can be used to assist and guide patrols to where they are most needed. More complicated maps may be used by policymakers in police agencies to identify patterns in criminal behavior, and maps may be essential in solving criminal cases.

Digital maps are the most efficient way to visualize the complete crime scene (Johnson, 2000). The locations of crimes, arrests, and other occurrences can be frequently presented on maps. Rather than scrolling through a list of events, this gives a simple way to browse activities in a certain location. Maps may also be used to transmit many types of information at the same time. Crime locations can be symbolized based on the day of the week, the kind of crime, the modus operandi (a specific suspect's style of operation when committing a crime), or the frequency.

To help in the investigation of crime trends, maps can be created at any geographic level (e.g., police stations, divisions, or zones) ([www.charmeck.nc.us](http://www.charmeck.nc.us)). Each response area can be coloured to show the number of crimes committed in that region during a given time period. The more events that happened inside the reaction region, the deeper the hue. These themed maps may also be used to depict changes in a community's

crime rate. Shade each location according to whether there was an increase, decline, or no change.

GIS may be used to quantify the amount and kind of problem within a set distance surrounding a certain area (e.g., street intersection, slum, bar, etc.). The distance can be anything that is desired to be used as a radius around a certain spot. For example, we may rapidly investigate the type and quantity of offenses and arrests that happened within 500 meters of a specific place. GIS enables an analyst to swiftly reduce redundant data ([www.charmeck.nc.us](http://www.charmeck.nc.us)). GIS may be used to investigate events that occurred within a specific distance of many sites, in addition to focusing on a single spot. For example, an analyst can discover the number and sorts of crimes committed within 500 meters of all schools. A radial analysis may also be used to decide which residents should be warned when a certain criminal moves into the region.

GIS discovers places with dense groupings of occurrences (hotspots) (Johnson, 2000). These high-density locations frequently need more police attention. GIS, for example, enables an analyst to identify all sites in a police station area where at least five robberies happened within a 1km radius. The map is then outlined using these regions. Using GIS to detect hotspots gives a reliable technique of measuring criminal event concentrations throughout time. Every month, hotspots of violent crime, robbery, home burglary, commercial burglary, vehicle theft, rape, and so on may be determined for each police station area.

Compare hotspot locations over time: Crime hotspots observed across multiple months can be presented at the same time. This enables the identification of places with persistent issues and reveals the direction in which a certain crime may be moving. These maps can also be used to request resources from other public and/or private entities for a specific area.

Hotspots of multiple crimes can be exhibited to show where they overlap. Residential burglary hotspots, for example, might be presented alongside robbery hotspots to see where they intersect ([www.charmeck.nc.us](http://www.charmeck.nc.us)). The intersecting locations can then be thoroughly examined.

With GIS, the relationship between one variable and another may be examined, and the degree and direction of the link between the two variables can be determined (Johnson, 2000). One may, for example, investigate the association between the number of alcohol permit sites and the frequency of fights. Regression analysis is used to forecast the value of a dependent variable, such as the rate of violent crime, based on the values of independent variables, such as the poverty level in a certain area. Regressing allows for the inclusion of extra factors in the model, such as illiteracy, backwardness, habits, and so on. The findings of this sort of study might be utilized to collect funding from other public/private organizations to help reduce crime.

Different kinds of literature have acknowledged the utility of GIS in crime mapping, some of which have been evaluated in this study. Fajemirokum, Adewale, Idowu, Oyewusi, and Maiyegun, (2006) used spatial data acquisition and attribute data in their study, "a GIS approach to crime mapping and management in Nigeria, specifically in the Victoria Island area," and discovered that the police station in Victoria Island is not in the best location because it is not centrally located for accessibility from other parts of the island. They proposed a police station in zone 4 or 5, adding that the optimal place for a police station in Victoria Island should be anywhere around the crossroads where Adeola Odeku is.

Similarly, Groff and La Vingne (2002) analyzed the various methodologies, defined what is necessary to utilize them, and rated how reliable they are in projecting future crime concentrations, or hotspots when forecasting the future of predictive crime mapping. They changed from analyzing prior event reports to using GIS to delineate anticipated crime and location for efficient police.

Ahmadi, (2003) has emphasized the use of GIS in mapping, criminal control, and preventive programs in his work on crime mapping and spatial analysis. He also emphasized the usefulness of crime maps in the study of criminal ecology and locational characteristics, as well as the ability of maps to visually identify regions of particularly high or low crime concentration. He did, however, point out that maps are just graphical representations of the outcomes of various geographic data computations. He devised a hierarchical model for crime analysis and used it in a regional crime study in Tehran. Using the area-based approach of analysis, the model-assisted in identifying the geographic concentration of crimes in a certain region. Finally, after establishing the hot locations using the approach described above, he utilized a spatial function to determine a good location for a new police station and to send a patrol to the hotspots in order to reduce crime.

Furthermore, in their work; the impact of crime on sustainable tourism in Cross River State, Nigeria, Ukwanyi, Ojong, Austin, and Emeka (2012) observed that the rehabilitation, development of tourism potentials, and the recent introduction of the largest carnival event in Nigeria have constituted a great threat to residents and tourists who have an interest in visiting Cross River State. One main downside of the Calabar Carnival, according to the writers, is that it encourages criminality. According to their crime report analysis, the month of December, when the carnival is held, has the highest crime rate.

They, therefore, recommended that if tourism is to be sustained in Cross River, resort center operators provide adequate security around their business environment, intelligence personnel be deployed to those hotspots environment to monitor movements, vigilante groups be formed and charged

with the responsibility of ensuring security in their domain, and criminals be arrested, charged in court, and punished. According to the researchers, they would assist to reduce crime in the area.

Furthermore, Ayuba, Mugu, Tanko, and Bulus (2016) discovered that theft/stealing and hurting/fighting are the most common documented crimes in Kaduna Metropolis, Nigeria, with 19.29% and 16.82%, respectively. The study found that crime incidence is highest in Tudun Wada at (15.05%), followed by Sabon Tasha and Rigachikun with 10.24% and 10.16%, respectively, based on an overlay analysis of all the gathered coordinates of the crimes depicted on the composite map. The survey also indicated that the biggest crime hotspots in the city are Tudunwada, Sabon Tasha, Rigachikun, and Rigasa. An administrative map of the study region improved the delineation of police districts in Kaduna Metropolis according to the Divisional Police Headquarters Jurisdiction, where a total of 11 crime categories were mapped.

Benue State is not immune to the frightening incidents of criminal activity that have been hurting the world on a social, economic, and political level. This research is significant as a measure of crime prevention and management. The initiative of the Benue State government and the Nigerian Police Force in the distribution of Police Stations and out-posts for effective policing and crime arrest appears to be having less than desired impact because Benue State Security agencies have yet to adopt proactive GIS approaches in the pursuit of an arrest of crime, which has now become a global best practice. This is a prevalent phenomenon in many regions of the developing globe, and it is not unique to Benue State or Nigeria (Ayuba, et al., 2016).

Amissah et al. (2014) employed GIS at the Dansoman Police subdivision in Accra, Ghana, to create crime maps and investigate the spread of crime. The police statistics on crime lacked spatial reference. In light of this, portable Global Positioning System devices were employed to geolocate the numerous crime scenes. Finally, the researchers stated that in future studies, crime data should contain both spatial and attribute data to aid in GIS crime analysis.

Adepoju et al., (2014) employed GIS for crime hotspot mapping and analysis during the ASPRS 2014 Annual Louisville Conference in Kentucky on March 23-28, 2014, utilizing Abuja State as a case study in Nigerian urban security and crime management. In the research region, there was a substantial association between parks and gardens and crime, as well as a positive correlation between slum settlement and crime.

GIS was utilized by Arhin and Duffour (2015) to create Graduated symbols, stacked charts, proportional symbols, and pie charts for hot spot analysis on the KNUST campus. Because the crime data collected from the university's security department lacked coordinates for their research, the



geographical data of the mean center of the crime locations were captured using Google Earth software. The researchers developed a web application that would allow people to report crimes on the KNUST campus.

Ghartey and Gyabeng (2017) used GIS technologies such as ArcGIS software, ArcGIS Online, and the Web AppBuilder to create an updated interactive web-based map with geocoded addresses for the KNUST campus, allowing users to locate pathways to specific areas on campus. However, this platform also supplied students with safety information, warning them of crime hotspots on campus, crime incidents recorded at various locations, and information on security emergency dial-up numbers and checkpoints, in order to assist in combat and minimizing crime on the KNUST campus.

Prakruthi Prakasha et al. (2018) created a web-based criminal record system (CRS) that uses mobile devices instead of standard GPS devices to allow police to collect the location of criminal activities. This online crime detection approach was created to alleviate the problems and hardships that still exist in the traditional manual system of practice.

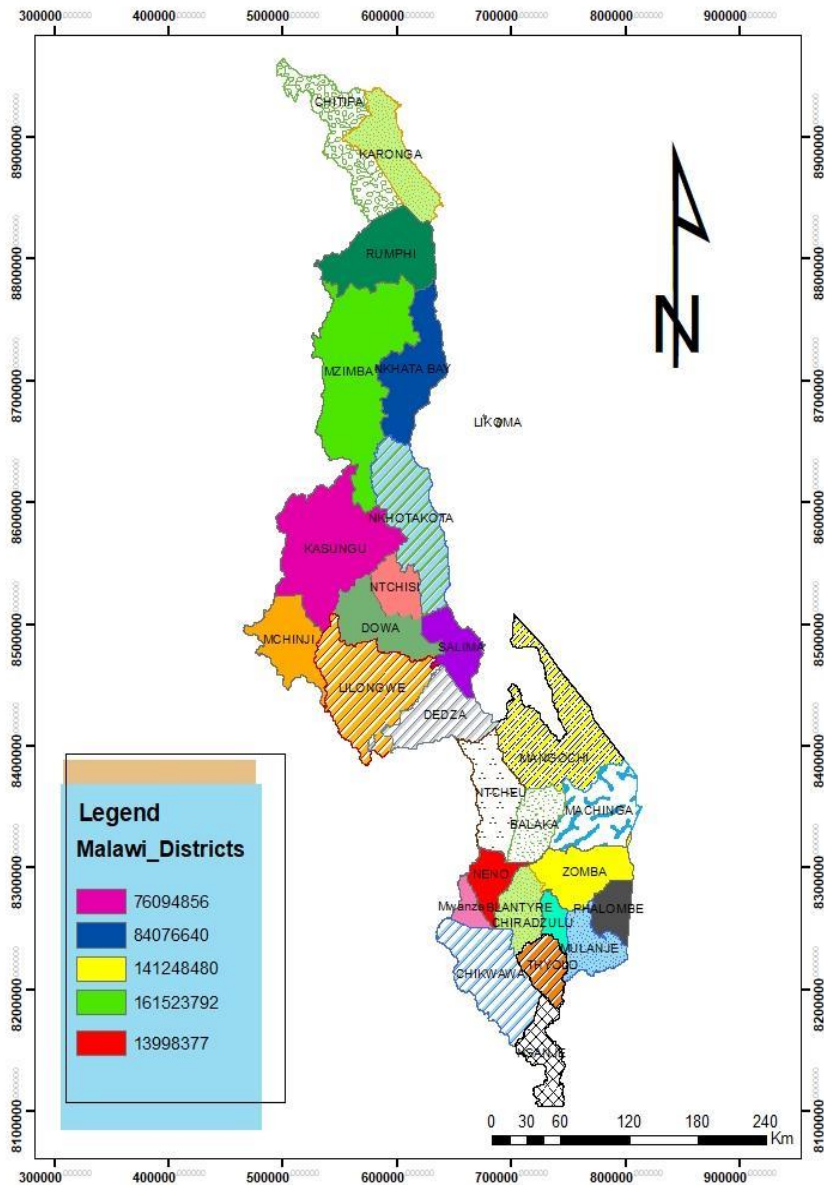
In terms of violence, concentrated crime zones are sometimes referred to as crime hotspots (McLafferty et al., 2000). In other terms, a crime hotspot is a location where the number of violent crimes is higher than average. Places with more criminal incidents are classified as hot, whereas those with fewer occurrences are described as cool. This is related to the fact that crime is spatially dispersed at random.

This article aims to use GIS technology to improve data collecting, visualization, and informed decision-making by mapping crime data, identifying hotspots, and presenting patterns. The forms of crime frequent in La Dade Kotopon municipality were shown using graduated symbol maps.

## **Methods and Materials**

### **Study site**

Malawi has a land area of 118,484 km<sup>2</sup> (45,747 sq mi) and a population of 19,431,566 people (as of January 2021) (NSO, 2022). Lilongwe is Malawi's capital (and largest city). Malawi, a small country in Southern Africa, has the world's fourth-largest proportion of people living in extreme poverty. More than two-thirds of Malawi's population lives in extreme poverty, with practically all relying on small-scale farming for a living. Malawi's economy is heavily reliant on tobacco, which accounts for 69.5% of total exports—a condition that is becoming increasingly troublesome for Malawian households as worldwide demand for tobacco products declines. Furthermore, Malawi has one of the world's youngest populations, with 43% of the population under the age of 15. Agriculture development and diversification are essential concerns for Malawians in order to safeguard and improve their livelihoods and the prospects of their children.



**Figure 1.** Map of Malawi  
*Source:* Author, 2022

## Methods

A network analysis technique was used to determine the crime hotspots and their clusters. This technique was implemented in ArcGIS software that



allowed for the visual representation and mapping of crime hotspots in Malawi. To be precise, the results of network analysis can be used by law enforcement agencies to develop and implement targeted crime prevention strategies. By analyzing crime data as a network and using various network analysis techniques, a more comprehensive and dynamic view of crime patterns and hotspots can be obtained. This information can also be used to guide resource allocation, inform decision-making, and support proactive crime prevention strategies. This approach has been widely used in determining the distance between police stations (Kuta et al., 2014). In this study, ArcMap/ArcGIS version 10.41, was used for data analysis using a network approach. First, high-risk areas of crimes using select-by attributes were identified. After selecting these neighborhoods and delineating from their boundaries, data layers were added showing the spatial distribution of crimes by location in Malawi and its three regions into the selected neighborhoods.

### **Theoretical Review**

A review of Sherman and Weisburd's publications (1995) provides for the hypothesis of crime hotspots. The idea outlines crime clustering around sites where various perpetrators and different targets encounter regularly over time. It refers to locations having a high crime rate. A hotspot patrol technique in policing can help a jurisdiction reduce total crime. As a result, the authors emphasize the use of hotspot maps to illustrate criminal concentration. Furthermore, crime pattern theory claims that while looking for criminal chances, criminals are affected by the geographical character of their daily routine activities. They prefer to focus on regions that are familiar to them. Our hypothesis is crucial to this study because it explains why crime clusters in such areas.

The social disorganization hypothesis proposes that the natural ability of individuals to moderate deviancy in their neighborhoods is hampered in some locations by continual residential change and net outmigration. These modifications either disrupt or inhibit the formation of social networks. According to disorganization theory, because these networks are responsible for the majority of social control in neighborhoods, their disappearance leads to increased levels of deviancy. Poverty and prejudice have also been recognized as elements weakening social networks.

Furthermore, the broken windows theory, which emphasizes crime concentration and was supported by Wilson and Kelling (1982) in their article titled Broken Windows, asserts that in most well-functioning neighborhoods, when small transgressions of social norms are not nipped in the bud, residents' willingness and ability to enforce social order is undermined, and as a result, residents withdraw from enforcing neighborhood norms, allowing further

deviancy to occur. Furthermore, the crime opportunity hypothesis identifies criminal opportunities as the primary source of crime. A congested urban neighborhood, for example, with no off-street parking will have numerous automobiles parked on the street. Such an area may become a hotspot for auto thefts (Eck, Chainey, Cameron, Leitner, and Wilson, 2005).

## **Results**

The study findings are based on a regular update of cases reported to Malawi Police in all 28 districts of the nation, encompassing 34 police stations and focusing on cases of violence and minors in confrontation with the law and the use of ArcGIS to locate hotspots of crimes in Malawi. In the first place, the study established that the traditional intelligence and criminal record keeping methods in Malawi have failed to meet the needs of today's crime situation. Manual methods do not provide precise, reliable, or full data 24 hours a day, nor can they aid in trend forecasting or decision making. It also results in lower productivity and inefficient staff use.

## **Types of Violence and Abuse Cases in Malawi**

The study established that in 2019, only 999 victims of sexual violence reported to the police, up from 999 in 2018 (a 99% increase). Sexual violence victims were reported to police between April and June 2020 (Q2 of 2020), accounting for 11% of all instances reported. Almost the same number of cases were recorded in the second quarter of 2019 (484 instances, accounting for 18% of total cases). In 2019, victims of physical assault reported to police accounted for 23% of all instances recorded. This marks a 40% increase over last year (when 1,886 cases were reported). Economic abuse involves stealing goods, criminal destruction, property grabbing, malicious damage, arson, and failing to render necessities. Child diversion refers to the removal of cases involving minors from official judicial processes, with or without constraints. Rape, defilement, indecent assault, and sexual offenses are all examples of sexual violence.

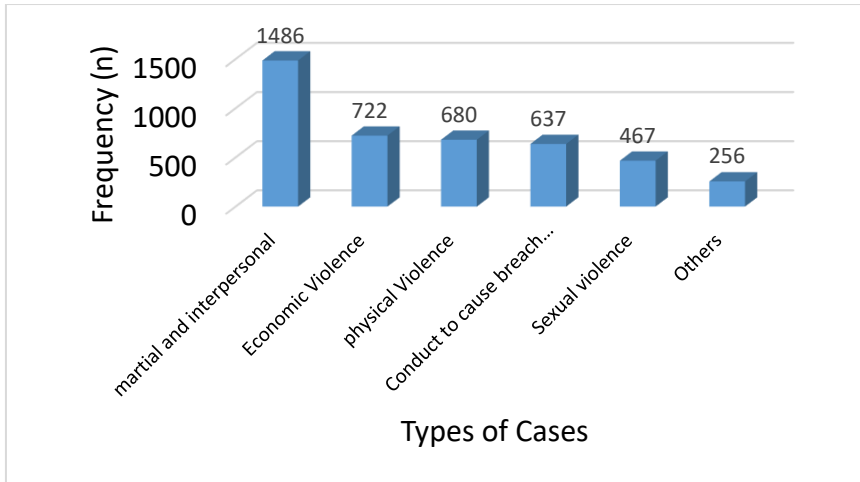
In 2019, 34% of all recorded cases included minors. Child victims were 78% of all sexual assault incidents (n=1,554). Children made up 17% of all victims of physical abuse (n=444) and 24% of all victims of economic abuse (n=568). Females were 96% of all sexual violence cases (1,902), 74% of all physical violence cases (1,971), and 81% of economic abuse cases (1,890). In general, the number of instances of violence increased between 2016 and 2017, with a significant decline in 2018. There were higher occurrences of defilement, economic abuse, and physical assault in 2019 than in 2018. On the other side, there were fewer incidents of behaviour likely to cause a breach of peace and marital and domestic violence. Given the categories of kidnapping, child neglect, various forms of sexual abuse, and

suicide were added. In 2019, the figures are incomparable. Violence in any form was experienced more frequently by girls and women than by boys and men (73% females, 27% males), a pattern that has persisted throughout time.

From January to December 2019, a total of 11,642 new incidents of violence were recorded at police stations around the nation (girls 2,879, boys 1,080, women 5,299, males 2,383). This is 2,848 cases greater than in the same period in 2018 (n=8,794). Physical violence was the most commonly reported kind of violence (23%), followed by marital and interpersonal conflict (22%), and economic violence (20%). Sexual violence accounted for 17% of all cases. The violence of any kind was experienced more frequently by girls and women than by boys and men (70% females, 30% males).

The largest number of cases in one month was 1,271 in November 2019, while the lowest was 728 in December 2019. A comparison of statistics for the year 2018 indicates that the largest number of instances was recorded in March 2018 at 1,137, and the lowest was also in December 2018 at 61. Four regional offices coordinate police formations, and the most cases were reported in the Central Region in most months, and in the Southern region in October 2019.

The study also found that from April through June 2020, a total of 4,248 new incidents of violence were recorded at police stations across the country (899 girls, 380 boys, 2,214 women, and 755 men). Children accounted for 30% (1,279 out of 4,248) of cases, down from 34% (937 out of 2,721) in the second quarter of 2019. The marital and interpersonal conflict was the most commonly reported kind of violence (35%), followed by economic violence (17%), physical violence (16%), behavior likely to cause a breach of peace (15%), and sexual violence (11%) (**Figure 2**). In contrast to Q1 (January-March) 2020, the percentage of marital and interpersonal conflict cases increased from 25% (1,069 out of 4,262) in Q1 to 35% (1,473 out of 4,248) in Q2. Violence in any form was experienced more frequently by girls and women than by boys and men (73% females, 27% males), a pattern that has persisted throughout time.



**Figure 2.** Types of Cases Occurred in 2020  
*Source:* Malawi Police Data Digest Report

The study also found that the maximum number of cases in Q2 of 2020 was 1,488 in May, while the lowest was 1,365 in June. A comparison of the statistics for the same time in 2019 indicates that the greatest number of cases was again reported in May 2019 at 1,015 and the lowest was in June at 798. Police formations are managed by four regional offices, and an increase can be seen in May in both the Southern and Eastern regions, with a decline in the Central area. During the second quarter, there were fewer instances in the Northern area, with a minor increase trend.

In the second quarter of 2020, 77% of all sexual assault cases included minor victims. Children made up 17% of all victims of physical abuse and 24% of all victims of economic abuse. Females accounted for 93% of all incidents of sexual violence, 72% of cases of physical violence, and 84% of cases of economic abuse. Children were victims in about 30% of all incidences of violence. When compared to Q1 2020, the percentage of female victims increased marginally for sexual violence (from 91% to 93% in Q2), physical violence (from 69% to 72% in Q2), and economic abuse instances (from 78% to 84% in Q2).

In the second quarter of 2020, 921 youngsters (108 females and 813 boys) were in violation of the law. The overall number is greater than the same time in 2019 (871), however, there is a considerable decline when compared to Q1 2020. (1,350). During the period, 506 (97 girls and 409 males) were diverted at the police level. Out of the 921 minors detained, 184 (10 girls and 174 males) were hauled to court. The diversion rate was 66% in Q2 of 2019, but it fell to 55% at the same time in 2020. In Q1 2020, the diversion rate was slightly higher, at 57%.

Out of the 921 total arrested instances during Q2 2020, 623 youngsters (68%) were dealt with within 48 hours. In the same time period in 2019, 545 (63%) of 871 apprehended youngsters were processed within 48 hours. More issues were resolved within 48 hours in Q2 2020, with the percentage increasing from 63% (2019) to 68%. (2020).

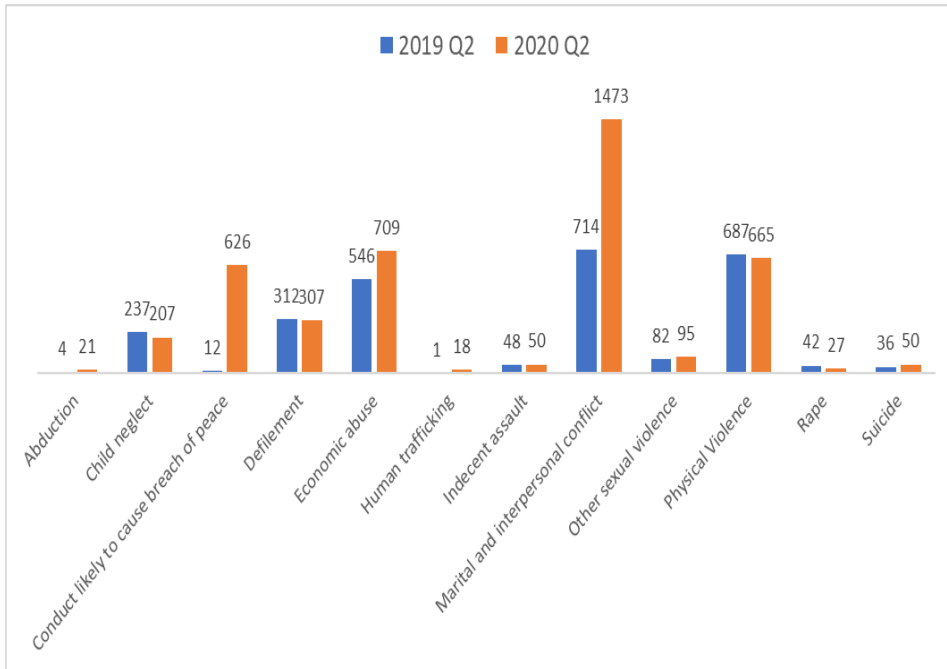
### **Spatial and Temporal Analysis of Crime Hotspots in Malawi**

Overall, the Lilongwe district recorded the most cases in 2019, with 3,017, followed by Blantyre with 1,341. Likoma had the fewest cases, with 39 recorded. Lilongwe had the largest number of sexual assault cases (n=308) throughout the year, followed by Mzimba (n=230) and Blantyre (n=145). Lilongwe (n=803) had the largest number of reported physical violence cases in 2019, followed by Blantyre (n=264) and Mzimba and Dedza (n=143). The most incidents of economic violence were recorded in Lilongwe (n=530), Mangochi (n=317), and Blantyre (n=118).

Blantyre district recorded the most cases overall in Q2 of 2020, with 801, followed by Lilongwe (565), and Mangochi (511). Likoma had the fewest instances, with only six reported. In comparison, the largest number of cases in Q2 of 2019 were reported in Lilongwe district (783), followed by Blantyre district (220). Likoma had the fewest instances, with only six reported.

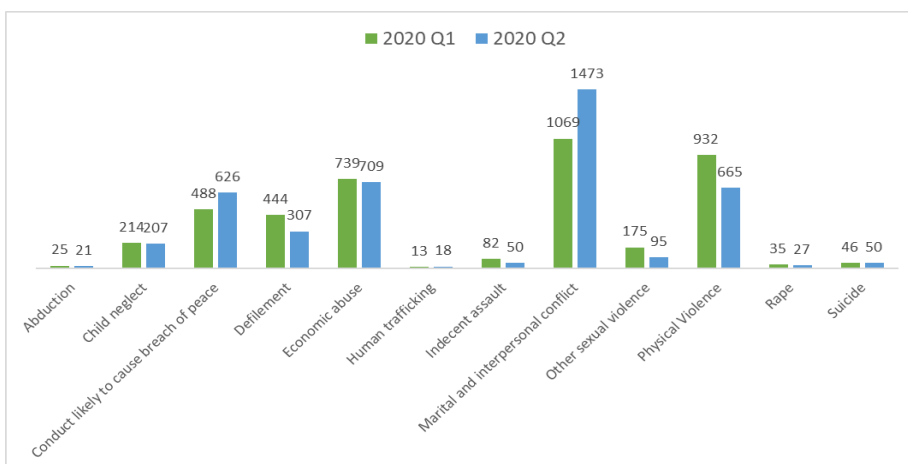
Mzimba had the greatest number of sexual assault cases (n=73) during the second quarter of 2020, followed by Blantyre (n=62). Lilongwe had the most recorded incidents of physical violence (n=108), followed by Blantyre (n=71). Blantyre had the largest number of recorded incidents of economic violence (n=100), followed by Mangochi (n=86).

Figure 3 depicts a case-by-case comparison between Q2 2020 and Q2 2019. In 2020, there was a significant increase in marital and interpersonal conflict, conduct likely to cause a breach of peace, human trafficking, and kidnapping. Similarly, there has been a minor rise in economic abuse, indecent assault, other sexual violence, and suicide. On the other hand, there has been a minor decrease in child neglect, defilement, physical abuse, and rape.



**Figure 3.** Types of cases in Q2 2019 and Q2 2020  
**Source:** Malawi Police Data Digest, 2020

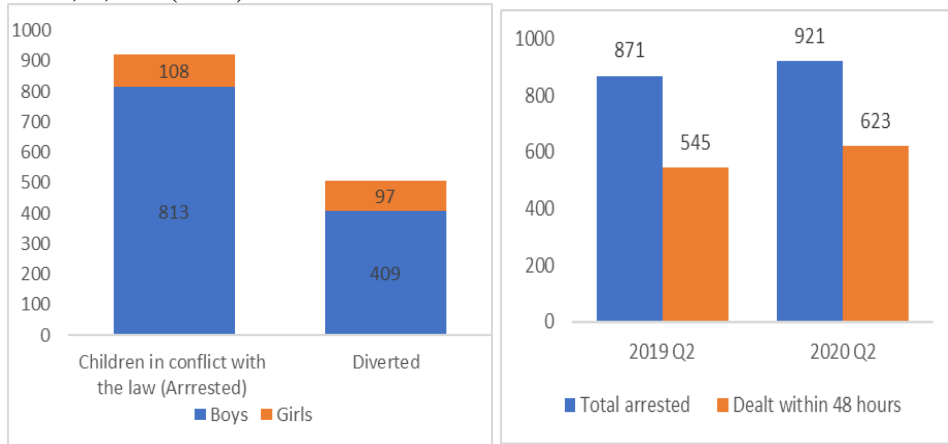
Figure 4, depicts a comparison of Q1 2020 and Q2 2020. Notably, there is a 38% rise in cases of marital and interpersonal conflict in Q2 2020 against Q1 2020, as well as a 28% increase in cases of conduct likely to cause breach. Human trafficking and suicide have seen a minor increase, but other categories such as abduction, child neglect, defilement, economic abuse, indecent assault, other sexual violence, physical violence, and rape have shown a decrease.



**Figure 4.** Types of cases in Q1 2020 and Q2 2020  
**Source:** Malawi Police Data Digest, 2020

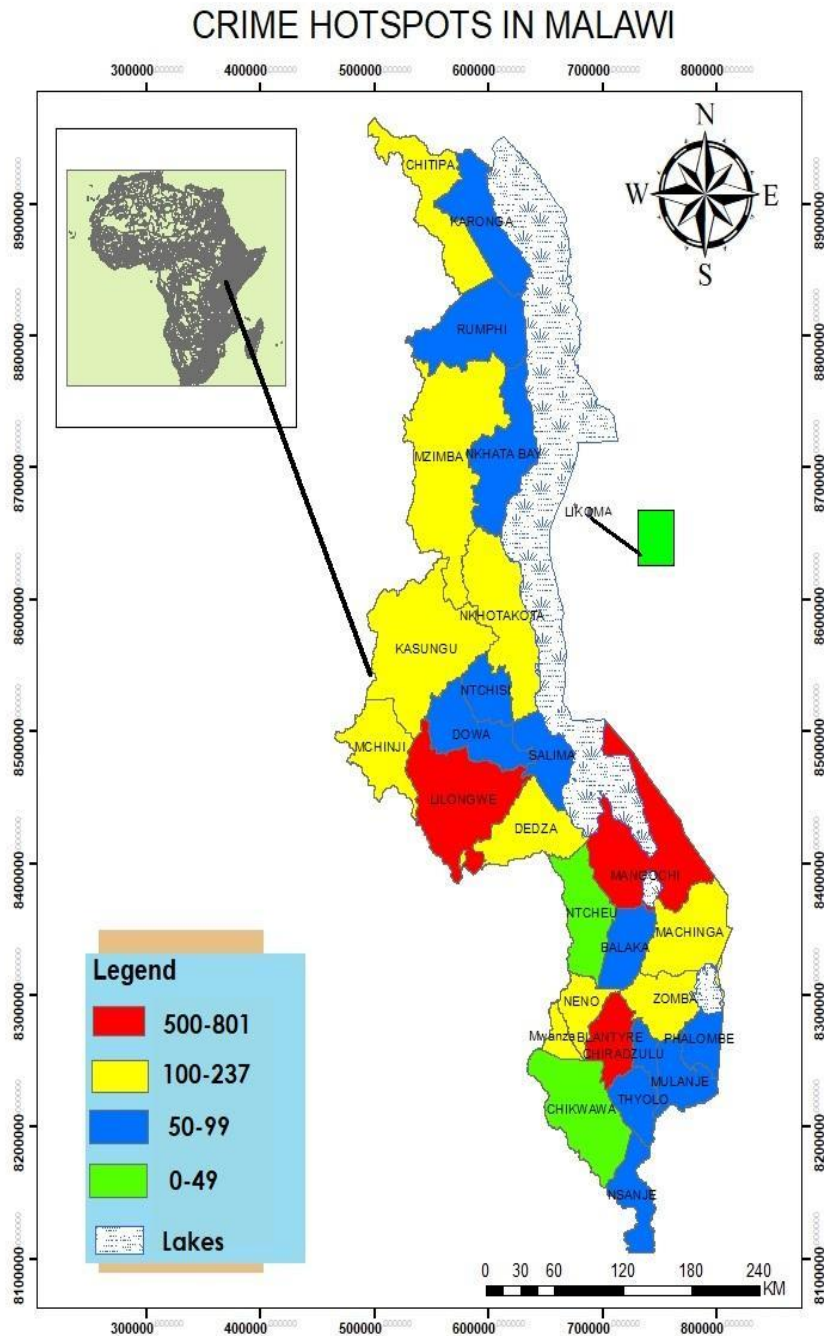


In 2019, 3,948 minors were in violation of the law. Between January and December 2019, 2,433 of these were redirected at the police level. This total included (339 girls, 2,094 boys). Out of the 3,948 youngsters apprehended, 888 were hauled to court (53 females and 835 boys). In 2018, there were a total of 2,086 kid diversions. In 2019, the diversion rate was 62%, somewhat lower than in 2018 (66%). Out of the 3,948 youngsters detained in 2019, 2,485 (63%) were dealt with within 48 hours.



**Figure 5.** Children in conflict with the law and diverted in Q2 2020 and those arrested and dealt with within 48hours in Q2 2019 and Q2 2020  
*Source:* Malawi Police Data Digest, 2019 and 2020.

Based on figure 6 below, the hotspots of crime in Malawi are Lilongwe, Blantyre, and Mangochi. The study found that high levels of income inequality, rapid and uncontrolled urbanization, high unemployment among the young population, a poorly resourced criminal justice system, the proliferation of firearms, and, ultimately, have bred crimes that have engulfed the country's major urban cities, particularly Lilongwe, the capital city, and Blantyre, the nation's commercial hub including Mangochi. The study also established that there is an unprecedented rise in conventional crime (murder, robbery, burglary, rape) and organized crime (illicit drugs, arms, humans, timber, wildlife, and minerals trafficking), as well as the rising proportions of both grand and petty corruption.



**Figure 6.** Crime Hotspots in Malawi  
*Source:* Author, 2020

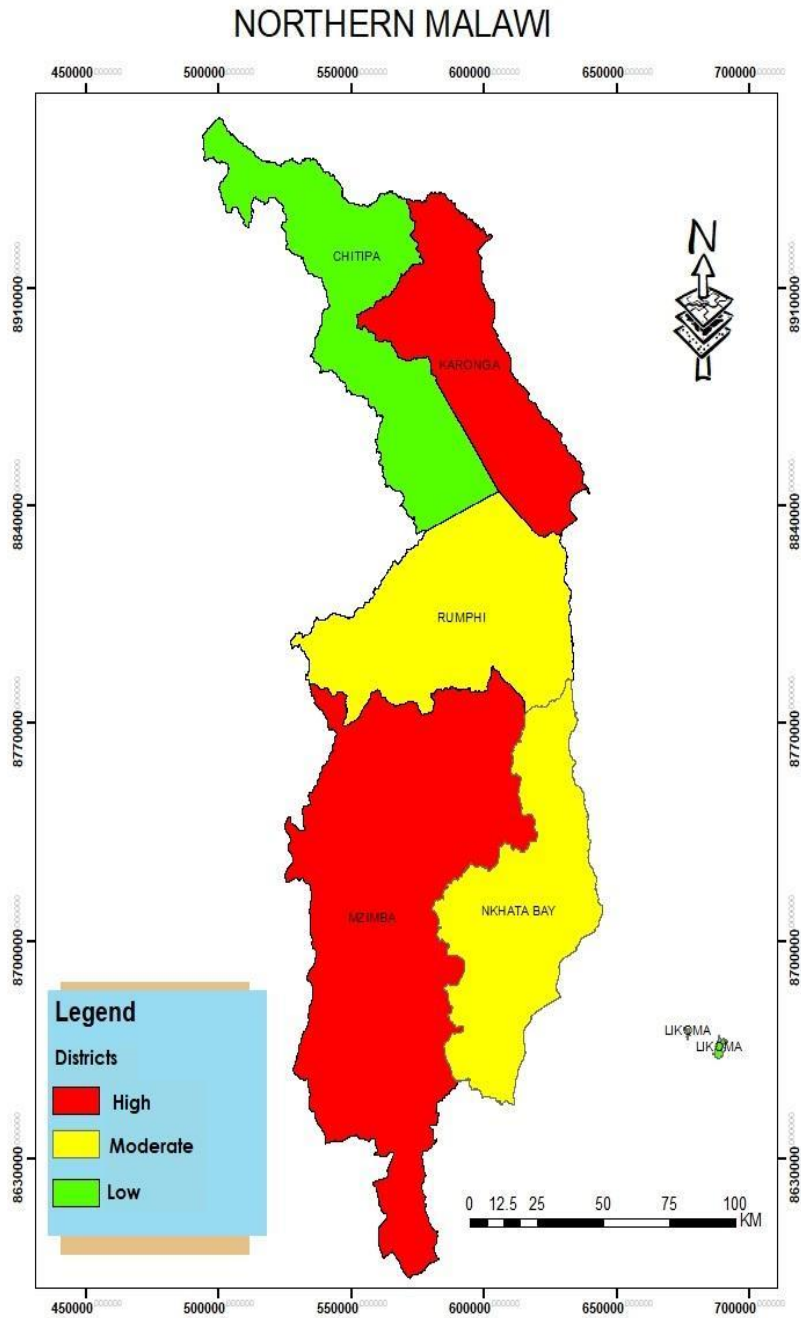
### **Spatial Distribution of Crime Cases in the Northern Region**

The study found that there are many crimes reported in the northern region. These include but are not limited to interpersonal conflict behavior that cause a breach of peace, rape, robbery, physical violence, economic violence, defilement, sexual assault, abduction, and suicide among others.

The study found that the rise in disputes between natives and immigrants is also mirrored in the excessive socioeconomic competitiveness that has emerged in the corporate world. To be precise, in the northern region of Malawi there are reported cases of disputes between citizens and immigrants. For instance; there was a situation whereby Malawians protested about immigrants stealing commercial monopolies at Chikangawa and other business centers such as Taifa market and Mzuzu's "Matabwa" or lumber market.

The study established that the main issue is that immigrants offer things at lower prices, drawing more customers than Malawian vendors. These tensions foster emotions of xenophobia, as seen by the invasion of stores owned by immigrants during the 20 July 2015 protests. The protests led to the loss of lives and property damage. Nevertheless, the study highlights that it is worth noting that there is no statistical data to explicitly show how much illegal immigration has contributed to international risks.

In this light, the lack of statistical proof should be appreciated in light of the sensitivity of the matter, as well as the fact that illegal immigrants operate underground beyond the casual observation of the security officers. The study also showed that there have been some incidences of armed robbery by immigrants recorded in Mzuzu city. The study shows that in the northern region, many cases were reported in Mzimba and Karonga, seconded by Rumphu and Nkhatabay and then Chitipa and Likoma Island (Figure 7).



**Figure 7.** Spatial Distribution of Crimes in the Northern Region of Malawi  
*Source:* Author 2022

### Spatial Distribution of Crimes in the Central Region of Malawi

The study shows that Lilongwe District has the highest crime cases in the central region. These cases include but are not limited to car theft, rape, physical violence, burglary, economic violence, human trafficking, abduction, suicide, a child with conflict with the law, defilement, and sexual assault among others. Districts such as Kasungu, Nkhosvota, Dedza, and Mchinji are second. In Salima, Dowa, and Ntchisi districts cases were moderate while low cases were reported in Ntcheu (Figure 8).

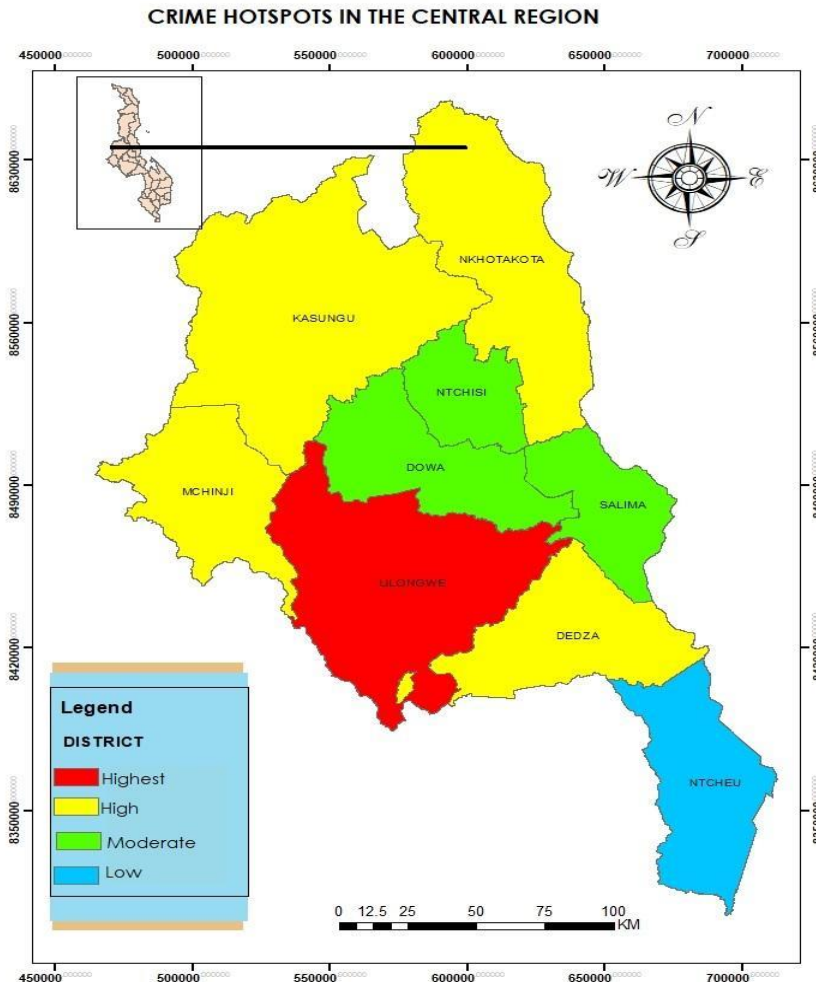


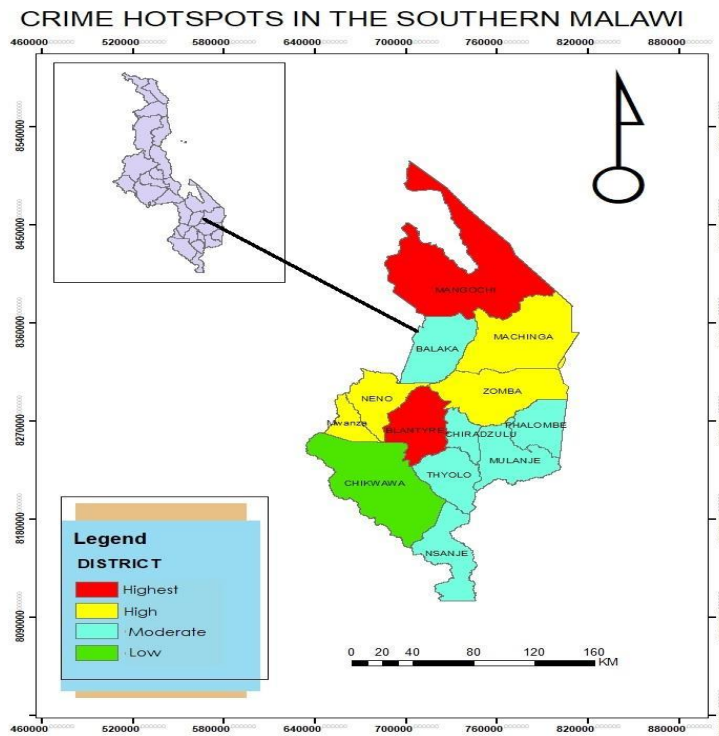
Figure 8. Spatial Distribution of Cases in the Central Region  
Source: Author, 2022

### Spatial Distribution of Cases in the Southern Region

The study found that there were many reported cases in Blantyre and Mangochi seconded by Neno, Mwanza, Zomba, and Machinga. Nsanje, Thyolo, Mulanje, Phalombe, Chiradzulu, and Balaka reported moderate cases while only Chikwawa had low cases (**Figure 9**). These cases are; rape, robbery, sexual assault, burglary, and suicide among others.

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**Figure 9.** Spatial Distribution of Cases in Southern Region  
*Source:* Author, 2022

## Discussion

### Types of Violence and Abuse Cases in Malawi

Based on the findings, it is revealed that there were many victims that were reported to the police from 2019 to 2020. These included sexual violence such as Rape, defilement, indecent assault, and physical assault, and economic



violence such as stealing goods, criminal destruction, property grabbing, malicious damage, arson, and failing to render necessities. The findings are also similar to the study conducted by Ayuba, et al (2016) in Nigeria. The study discovered that theft/stealing and hurting/fighting are the most common documented crimes in Kaduna Metropolis, with 19.29% and 16.82%, respectively.

### **Spatial and Temporal Analysis of Crime Hotspots in Malawi**

The study established that Lilongwe had a high crime rate record in 2019 and 2020 followed by Blantyre which are capital and commercial cities respectively in Malawi. Mangochi the fastest-growing urban area recorded high incidents of crimes of different types. Mzimba district in the northern region also reported high crime cases. The results are in line with the study conducted by Ayuba et al. Based on an overlay analysis of all the acquired coordinates of the crimes represented on the composite map, the study discovered that crime incidence is highest in Tudun Wada (15.05%), followed by Sabon Tasha and Rigachikun with 10.24% and 10.16%, respectively. According to the report, the most dangerous neighborhoods in the city include Tudunwada, Sabon Tasha, Rigachikun, and Rigasa. A study region administrative map enhanced the demarcation of police districts in Kaduna Metropolis according to the Divisional Police Headquarters Jurisdiction, where 11 crime types were mapped.

According to Figure 6, the crime hotspots in Malawi include Lilongwe, Blantyre, and Mangochi. The study discovered that high levels of income inequality, rapid and uncontrolled urbanization, high unemployment among the young population, a poorly resourced criminal justice system, the proliferation of firearms, and, ultimately, have bred crimes that have engulfed the country's major urban cities, particularly Lilongwe, the capital city, and Blantyre, the nation's commercial hub, including Mangochi. The survey also discovered an unprecedented surge in conventional crime (murder, robbery, burglary, rape) and organized crime (illicit narcotics, arms, people, timber, wildlife, and minerals trafficking), as well as growing proportions of both grand and petty corruption.

This is concomitant with the Malawi government's (2015) report titled 'Rapid evaluation of the small weapons situation in Malawi,' which states that "safety and security in Malawi are typically bad," as evidenced by the proliferation of illicit factory-built and handmade firearms, as well as the illegal use of licensed arms in crime. The report notes "a significant jump in corporate and home expenditure on security, great fear in the insurance sector as respects auto theft, alarming increases in violent crime are all signs of a country and culture where safety and security are in decline". So far, criminality has contributed to the loss of family productivity and

breadwinners. It has forced victims to pay medical bills at already overwhelmed facilities that operate on a limited budget.

The study also unveiled that GIS is a tool for decision-making. Locations, where crimes occur, have been produced. Maps act as models that can help victims of crimes to be aware of the crimes committed in different locations such as sexual violence, and robbery among others. People can avoid such places hence reduction of crime incidents. This is also similar to a study conducted by Adepoju (2014) in Nigeria. During the ASPRS 2014 Annual Louisville Conference in Kentucky on March 23-28, 2014, Adepoju et al., (2014) used GIS for crime hotspot mapping and analysis, using Abuja State as a case study in Nigerian urban security and crime management. There was a significant link between parks and gardens and crime in the study area, as well as a positive correlation between slum settlement and crime.

Again, Arhin and Duffour (2015) used GIS to develop hot spot analysis symbols such as graduated symbols, stacked charts, proportional symbols, and pie charts on the KNUST campus. Because the crime data acquired from the university's security department lacked coordinates for their research, Google Earth software was used to record the geographical data of the mean center of the crime sites. The researchers created a website that allows users to report crimes on the KNUST campus.

Additionally, Gharthey and Gyabeng (2017) created an updated interactive web-based map with geocoded addresses for the KNUST campus using GIS technologies such as ArcGIS software, ArcGIS Online, and the Web AppBuilder, allowing users to identify paths to particular sites on campus. However, in order to combat and decrease crime on the KNUST campus, this platform also provided students with safety information, such as warnings of crime hotspots on campus, crime incidents recorded at various places, and information on security emergency dial-up numbers and checkpoints. All these studies show the effectiveness of GIS in crime monitoring and clustering.

### **Spatial Distribution of Crimes in the Northern Region**

The survey discovered that there are several crimes recorded in the northern area. Interpersonal conflict, breach of peace behavior, rape, robbery, physical violence, economic violence, defilement, sexual assault, kidnapping, and suicide are examples. According to the Malawi Police Data Digest (2019 and 2020) report, the growth in conflicts between natives and immigrants is mirrored in the extreme socioeconomic rivalry that has evolved in the corporate sector. To be more specific, there have been reports of conflicts between citizens and immigrants in Malawi's northern area. For example, Malawians formerly agitated against immigrants seizing commercial

monopolies in Chikangawa and other economic areas such as Taifa market and Mzuzu's matabwa or timber market.

The report also revealed that there have been some instances of armed robbery by immigrants in Mzuzu. This is consistent with the findings of Chiundira (2010). He claims that in 2007, approximately 6,000 crimes were committed in Mzuzu. Illegal immigrants were responsible for 800 of these crimes. The transgressions were divided into four categories: organized crime, violent crime, sexual crime, and minor crime. Automobile hijacking, armed robbery, drug trafficking, fraud and forgery, and so on were examples of organized crimes, whereas violent crimes included burglary, housebreaking, fighting, and so on. According to the survey, several instances were documented in Mzimba and Karonga in the northern area, followed by Rumphu and Nkhatabay, and finally Chitipa and Likoma.

### **Spatial Distribution of Crimes in the Central Region**

According to the survey, the Lilongwe District has the greatest number of crime cases in the central area. Car theft, rape, physical violence, burglary, economic violence, human trafficking, kidnapping, suicide, a child in confrontation with the law, defilement, and sexual assault are only a few examples. Kasungu, Nkhotakota, Dedza, and Mchinji are the second most populous districts. Cases were considerable in Salima, Dowa, and Ntchisi districts, but low in Ntcheu (Figure 8). This is comparable to the Malawi Police Digest Report (2020).

### **Spatial Distribution of Crimes in the Southern Region**

The survey discovered that Blantyre and Mangochi had the most recorded instances, followed by Neno, Mwanza, Zomba, and Machinga. Only Chikwawa recorded low incidences, while Nsanje, Thyolo, Mulanje, Phalombe, Chiradzulu, and Balaka reported moderate cases (Figure 9). Among the crimes are rape, robbery, sexual assault, burglary, and suicide. This is consistent with the Malawi Police Digest reports for 2019 and 2020. According to the report of the Commissioner of Police for the South, the findings are likewise identical (The Times Group, 2020). According to the data, the crime rate in the Southern Region increased by 20% in the first half of 2020 compared to the same period in the previous year, so 2019.

### **Conclusion**

This study provides a user-friendly program for gathering crime data based on spatial location in real-time for hotspot mapping, crime detection, categorization, crime spatial distribution, and resource allocation to police personnel in Malawi Police Service. GIS models were created to meet the

study's goals and objectives, with various functional tools. To improve visualization, hotspot analysis was performed using percentage symbol maps.

The usage of this technology aided in the identification of crime hotspots as well as the enhancement of efficient crime spatial planning and analysis in Malawi and its regions for the reduction of crimes.

Based on the findings, the study has come up with the following recommendation;

Geospatial technology should be integrated into the Malawi Police Service' activities. As proven in this study, these include mobile and geographic database management systems. This program will aid in the fight against crime by supporting them in determining the specific location of the numerous crimes existing in their jurisdiction.

In future research, crime data based on geographical location should be gathered over a longer period of time to identify the spatial patterns of crime within the country and regions.

There is a need to have a mobile application. In this light, before recording data, users of the mobile app should visit the crime site. This will aid in determining the precise location of crimes.

In order for the mobile and online applications to work, they must have access to the internet and a Global Positioning System (GPS) built into the mobile device.

The general public should have access to spatial information on crime hotspot locations. This will prevent people from becoming victims of the same crime in the same areas, hence lowering crime.

**Conflict of Interest:** The authors have no conflict of interest.

**Data Availability:** All data are included in the content of the paper.

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### **Ethical approval**

Ethical clearance was sought from the University Research and Ethics Committee (UNILIA REC) Review Board. All Research was completed in accordance with the Declaration of Helsinki.

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