

Mapping of Crime and Drug Abuse Time-Series Analysis in Mubi Metropolis

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ABSTRACT: In recent years, previous studies have made huge progresses in harnessing the analytic capabilities of GIS to track crime patterns over time and then use this information to create predictive models. These advances turned GIS into a valuable tool to assist and support decision-making strategies for the police forces and security services. This paper describes a mechanism for identifying crime hotspots, and establishing relationships between crime patterns. This study implements clustering mechanisms and analysis tools to identify statistical relationships within the data, track crime hotspots parameters over time, predict crime trends in geographic locations. The area of interest, Mubi metropolis, has been the subject of prior studies. This previous information allows the validation of the results against existing approaches. The results are used in drawing map and chats which displays the collected information to a user through a database tool for a period of three years. This information is displayed in a way that both comprehensive and sensitive, allowing the user to easily navigate the amount of data present in this study. It is believed that the results supports the employed approach as an analysis tool for similar study in other large and or small scale crime datasets, and will enable law enforcement agencies to draw more rapid and accurate conclusions about their own spatiotemporal crime parameters. It shows that burglary crime is highest in Lokuwa ward, followed by Nasarawo and yelwa wards, while it is least in Kolere followed by Sabon-layi ward. This contextual information will provide more efficient resource allocation and better community awareness.

KEYWORDS: GIS, Crime, Drug Dependent, Burglary, Data.

I. INTRODUCTION:

Over the last few years a new worldwide socio-economical order lead to an increasing number of crime rates and raised the need to find new ways to handle information about criminal activities. To understand its causes better at large and smaller scales, security authorities embraced new decision support tools such as Geographic Information Systems (GIS), statistics and other information technologies to harness better solutions. To understand the magnitude of the quantitative and qualitative spatial attributes of this phenomenon, it is necessary to capture, analyze and correlate the variables. Police forces use statistics as important tool for crime analysis effectively. This helps the police in discovering useful information, maximize the use of resources and reduce crime.

Similarly, statistics help strategic decision making and meaningless numbers is converted into geographically and temporally identified crime events. Geostatistic is also crucial when working with spatial data, in the sense that true value of information can be extracted. Mubi metropolis hosts large number of immigrants in the past four years as a result of insurgency affecting the neighbouring villages, this implies an enormous degree of uncertainty in the observation and location of criminal data.

Furthermore, individual crimes are not unique random events but rather share a number of common characteristics, (Hirschfield et al., 1995). The spatial distribution of certain crime types within a given area is of great interest to law enforcement agencies as well as other government agencies and the understanding of such distribution is of great importance for effective policing. Recent research in the area of crime clustering has shifted dimension from large administrative areas to

smaller geographic regions (Weisburd et al., 2009). These new development of interest can be neighborhood or even ward-level areas and can be analyzed to visualize small-scale crime hotspots that may indicate an increased level of crime within the area. Research also suggests that focusing presence to these crime hotspots can lead to significant crime prevention gains, (Lipsey et al., 2007).

However, many studies have stated that recognizing the differences in the spatiotemporal signatures of crimes, and how they vary, can expand our understanding of criminal activity. (Grubestic and Mack 2008), utilized two spatiotemporal methods, the Knox test and the Jacquez k-nearest neighbor test, to evaluate the space-time footprints of burglaries, assaults and robberies in an urban environment in Ohio. This demonstrates the importance of space-time factor to crime hotspot analysis. Results of the study suggested that robbery, burglary and assault have different spatiotemporal signatures (Grubestic and Mack, 2008)

Further studies have looked at the response of crime patterns to police interventions. The association of firearm arrests with subsequent shooting for the city of Philadelphia was evaluated by (Wyant et al., 2012). Results showed that following a firearm arrest, there was a significant decrease in shootings percentage. Self-exciting point processes, normally applied by seismologists to study earthquakes, was adopted by (Mohler et al., 2011) to model spatial-temporal clusters of crime in Los Angeles. Crime patterns were modeled as a space-time Poisson process of background events. Their result shows that this approach provides a more complete picture of the statistical nature of crime and has important implications for crime prediction and prevention. Geographic information systems (GIS) also play a vital role in crime analysis because of their capability to handle spatial data. GIS has consistently emerged as a supreme application.

(Cusimano et al., 2010), used GIS to examine the spatiotemporal dimension of violent crime in Canada. Kernel density and choropleth maps were created and compared with location of ambulance dispatches and patient residences with socioeconomic characteristics. Results showed that locations of violent injury and the residence locations of those injured were both closely related to each other and clearly clustered in certain parts of the city characterized by high numbers of bars, social housing units, and homeless shelters, as well as lower household incomes. Contextual analysis and social networks have also been gained to infer

information about the structure of criminal networks. (Frad and Ester, 2009).

Statement of the Problem

Some ideas might suggest that crime analysis shares common objectives with criminal intelligence.

All the fields influence police decisions as a result of an objective understanding of the criminal environment, and they both seek to employ information as the raw material to which analysts add value through their analytical methods. However, there are substantial variances that directly have impact on the ability of law enforcement to protect communities and reduce crime. To explain these differences, it is necessary to generalize the context in this study, through the use of maps, to aid security services with advanced real-time mapping systems.

Scope of the Study:

The scope of this study has been limited only to burglary crime and measure of drug use data:

Burglary: This is theft of materials from a property, often through the act of breaking and entering or forced entry. This should not be confused with “robbery”, which involves some threat or implication of injury, (Michael et al., 2012).

Measure of Drug Use: The measure of drug use is the number of deaths in Mubi Town due to drug poisoning, since data on the amount of drugs consumed are not available.

Purpose of the study:

Security and law enforcement agencies who are vested with crime reduction and prevention responsibilities need quality information in order to make good decisions. A point of concern is how best should they receive this information, and how should they organize their departments to make the best use of the information. Ideally, information should pass through the hands of an analyst so that it can be integrated, filtered, synthesized, and placed into context with other information so that the end result, can give decision makers a concise picture of the criminal environment. Nearly every modern policing strategy, from problem-oriented policing to intelligence-led policing, requires an analysis of the criminal environment as the starting point to choosing a crime reduction strategy. This study addresses the creation of a more holistic analysis of the criminal environment. The goals are better policing, more targeted responses, effective crime prevention, and less crime. Crime analysis can

provide police leaders with an understanding of crime patterns and trends. Without this understanding of both crime patterns and criminal behavior, people who have to make decisions that affect the safety of communities will not have access to the vital information, essential for good planning and strategy.

Another unique feature of the study is the addition of drug use proxies. In the 1980's and into 1990, (Corman H. et.al., 2000), noted that the media focused much attention on drug abuse, crime control, and the criminal justice system. It had been claimed that increases in violence and other crimes were solely due to the drug epidemic. In response to the crack epidemic and increase in crime rates, there was a large increase in resources devoted to drug control, (Becker et. Al.,1991). The inclusion of drug use proxies allows us to compare the relative magnitude of the effects of local law enforcement activities on crime with the magnitude of variations in drug usage on crime.

Significance of Strategic Crime Analysis:

- Identifying problems and potential approaches for possible solutions.
- Exception Reports - identifies unusual levels of activity in an area over a selected time period.
- Crime Trend Forecasts - projects future trends in various types of crimes from past experience.
- Resource Allocation Proposals - suggests shifts of resource(s) to meet new crime related service demands.

- Situational Analysis - provides information about crime problems and the environment in which they are occurring. Often referred to as Beat Profiling.

Aim and Objectives of the Study:

The aim of the study is to identify crime in both spatial and temporal aspects at ward-level. Analysis of crime data should incorporate multiple predictive elements in order to classify crime trend aspects. Such a system should account for:

- Distinct types of crimes to geographic locations
- Determine which types of crimes occur within these locations
- Determine wards with highest distinct type of crime.

Study Area:

Mubi is one of the oldest towns and notably a commercial area of Adamawa State Nigeria. It is located on geographical coordinate 100 16' 18" North, 130 16' 14" East and situated Northeast of Nigeria. Mubi metropolis consists of seven (7) geopolitical wards, namely: Lokuwa, Sabon layi, Kolere, Gude, Lamurde and Yelwa wards shown in figure 3.1. Federal Republic of Nigeria official gazette (2006) provides that Mubi metropolis has a total population of 128,700. Mubi shares boundary with Michika on the Northeast, Hong on the West, Maiha on the South and Cameroun on the East.



Figure 2.1 Political wards in Mubi metropolis

II. METHODOLOGY:

Two methods for crime analysis and prediction were employed in this study. Crime in a spatiotemporal framework to parameterize crime hotspot locations was first analyzed, shapes and point assignments. After a comprehensive analysis of the spatiotemporal clusters yields usable information, these analyses were validated against existing known crime data using ward boundaries as related locations.

Furthermore, health data (measure of drug use) was also used to identify the potential reasons for seeing particular crime patterns for a location. As an example, (Micheal et al., 2012), predicted that, Southport, UK shows the maximum concentration of antisocial behavior in the whole of Merseyside. This suggests that possibly, Southport has underlying factors which cause it to exhibit abnormally high antisocial behavior. This paper tries to identify similar examples for the crime trends and patterns that were observed in Mubi metropolis, using clustering analysis results.

Crime Pattern - The occurrence of similar offenses in a defined geographic area, defined by administrative boundaries.

Crime Series - A crime pattern which shows there is reason to believe the same person(s) committed the crimes.

Crime Trend - A general tendency about recurring patterns of crime revealed over a period of time.

Data Collection: This study utilizes data set which was constructed using records of the Crime Unit of the Mubi North Local Government Area Police Division, and the Department of Psychiatric, General Hospital Mubi. The data obtained from the Police Division and Department of Psychiatric General Hospital, span the period, January 2015-July 2017. These data form the core of our data set. The research on criminal activity has focused on a single "index" crime: burglary. Data restrictions prevent the use of other crime variables such as rape, car theft, robbery, etc., and number of police, and also because reporting frequencies vary significantly over time. The measure of drug use is the number of deaths due to drug poisoning, since data on the amount of drugs consumed are not available.

Studies by (Miron and Zwiebel 1991, 1995) and (Miron 1998) used the death rate from the liver cirrhosis, the death rate from alcoholism, the drunkenness arrest rate and the number of first admittances to mental hospitals for alcoholic psychosis as proxies for alcohol consumption during prohibition for similar reasons. Although the

codes allow the psychiatrist to specify the type of drug, most of the cases were coded as drug type unknown. Therefore, it cannot disaggregate drug deaths by type of drug. (DeJong et al., 1992) suggest that these data have the advantage of not requiring honest self-reporting, and of being closely tied to heavy use. Because of the difficulty and importance of measuring drug usage, alternative measures of drug usage was examined, the number of releases from the psychiatric department, where the primary reason of admission was drug dependence and drug poisoning. It has been claimed that drug deaths may be inversely related to drug usage. When drug prices are high, usage would decrease, but adverse reactions by drug users would increase due to greater adulteration, (Corman and Mocan, 2000).

All-time series relate to Mubi town and cover the period from January 2015 until July 2017. The graphs presented in Figures 4.1 display burglary crime and drug related deaths. The trend component enables the reader to visualize the long-term swings of the variable, with most of the noise eliminated. The Figures demonstrate the importance of covering a long time span, and thus observing sufficient variation in the variables.

System Design:

The structure of this analysis system contains three key stages explained in detail in the following sections. The initial stages of this study were focused primarily on data gathering and selections, choosing which data were appropriate for the study. The core of this paper focuses on the analysis of the data, knowledge discovery, and finally presented in the form of Pie chat, bar chat and choropleth map which allows a user to analyze the data at once and draw conclusion about data relationships. Fig. 3.1 shows the visual representation of the analysis system architecture.

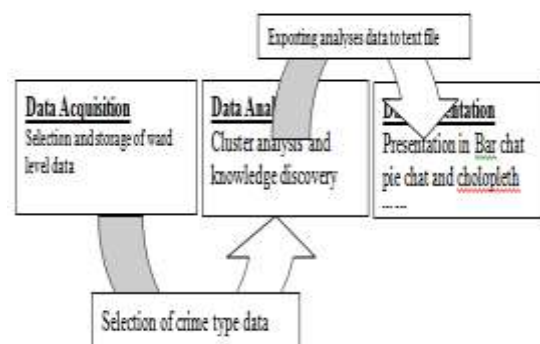


Fig.3.1. Visual Representation of Analysis System Architecture

Data Analysis and Presentation:

As a case study, all crime instances categorized as burglary and drug dependence were analyzed over a period of 31 months, spanning from January 2015 through July 2017. The data flow for this study involves the clustering of spatial crime data to identify hotspots, parameterization of

hotspots, and tracking of spatiotemporal trends in hotspots.

Figure 3.2 shows an example map of Mubi, and six (6) arbitrarily-chosen points to act as sample hotspots.



Fig 3.2.Mubi six burglary arbitrary hotspots

Prosecution Data Analysis: Figure 3.3 shows the prosecution data for the burglary crime type for various wards in Mubi metropolitan area. The

prosecution data contains information about the current state of prosecution and whether the reported crime was solved or not.

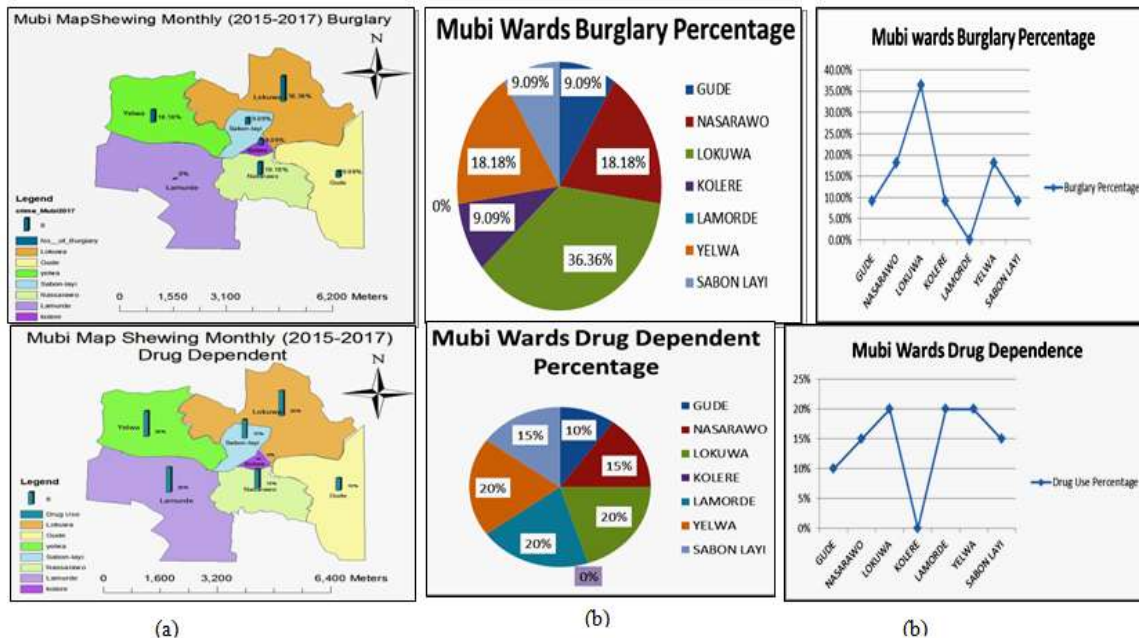


Fig. 3.4. Percentage of Drug Dependents in Mubi metropolitan.

Crime Trends: This section compares the burglary crime type and drug dependence trends for the study period within the research area. This gives us very vital information about how the different crime types have evolved as compared to their numbers in other regions. An example of this visualization tool is shown in Figure 3.4. A few interesting observations from these trends are as follows:

- The variables have different dimension as compared to other wards. In figure 4.1, the blue line shows the data for burglary crime and the red line shows the data for drug dependence.
- In all the crime type, we can see seasonal effects where the crime type decreases in some wards and then increase in other wards.
- Each of the crime shows significant difference between the crimes reported in some wards as compared to adjacent wards, probably because of the difference in social factors.

III. DISCUSSION:

The pattern of the distribution of the burglary crime, in Mubi metropolitan is shown in figure 3.3. The pattern shows that there is variation in the distribution of the burglary crime in different wards. It is observed that burglary crime is highest in Lokuwa ward, followed by Nasarawo and yelwa wards, while it is least in Kolere followed by Sabon-layi ward. Although there are clustered residential houses in those wards, they seem to face less threat from burglary crime. In the previous research in 2015, using socioeconomic variables to determine health issues, it revealed that Lokuwa which has the highest crime record shown in figure 4.1, is one of the areas with lower percentage of educated people within Mubi metropolis. Kolere which has the least reported burglary crime has the highest percentage of educated people. The correlation can predict that socioeconomic factors have effect over crime.

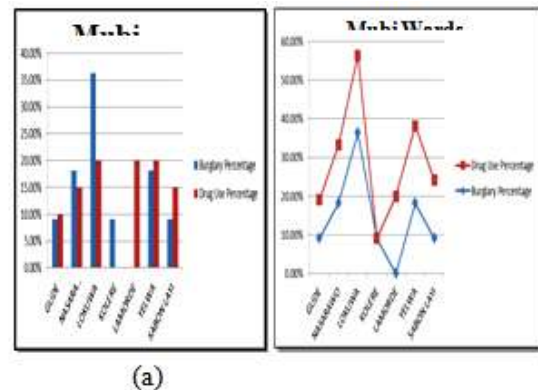


Fig 4.1. Correlation between Burglary and Drug Use

Although other ward, shows significant correlation between burglary crime and Drug dependence, Kolere and Lamurde wards shows no significant relationship between the two variables, thus can be concluded that there is no enough evidence to proof beyond doubt if there exist relationship between these variables.

IV. CONCLUSION:

Putting crime data into a GIS and create a map with a clear visualization and purpose is the starting point of many crime analysis. To extract information from data and to transform that information into knowledge is the primary objective of a decision-making process. But to draw a good map is always a challenging task. The importance of data quality is essential to obtain effective results but the precision of spatially referenced data is also crucial. The decision to proceed with this new administrative scenario is so difficult as to decide about new ways to deal with this new territorial sketch.

In recent years, researchers and technicians have made huge progresses in harnessing the analytic capabilities of GIS to track crime patterns over time and then use this information to create predictive models. These advances turned GIS into a valuable tool to assist and support decision-making strategies for the police forces and security services. Now that many law enforcement agencies have adopted crime mapping and have begun to produce the types of tools mentioned, they desire more. The demands for more sophisticated spatial analytic techniques lead to the research on predictive models to help the prevention of the future crime.

This paper describes a mechanism for identifying crime hotspots, and establishing relationships between crime patterns. The

technique implements clustering mechanisms and analysis tools to identify statistical relationships within the data, track crime hotspots parameters over time, predict crime trends in geographic locations. The area of interest, Mubi metropolis, has been the subject of prior studies. This previous information allows the validation of the results against existing approaches. Finally, these results are formed into a map and charts which displays the collected information to a user through a database tool, cluster shape and assignment parameters over a period of three years. It is believed that the above results strongly support our approach as an analysis tool for similar study in other large and or small scale crime datasets, and will enable law enforcement agencies to draw more rapid and accurate conclusions about their own spatiotemporal crime parameters. This contextual information will result in more effective resource allocation, better community awareness, and hopefully a decrease in crime in general.

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