

SPATIAL ANALYSIS AND MAPPING OF CRIME IN MUBI METROPOLIS USING REMOTE SENSING AND GIS

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Abstract- *Whether the problem is tactical, strategic, or administrative, any data containing location information can be displayed and analyzed using geographic information system (GIS) technology. GIS is an essential part of a crime analyst's toolkit. In this research work, we determine valuable information for the Police force within Mubi Metropolis by incorporating traditional law enforcement agency (Police) data with data such as demographics, different kind of crimes over a specific period of time, infrastructure, and offender tracking in the form of route analysis, GIS was used to transform information into actionable intelligence, improve critical decision making in a rapidly changing environment and have a direct impact on the safety of Police force and the citizens they serve.*

Hence, the methodology for the study identifies some hotspots (area where the concentration of Crime is more). In this research, Inverse Distance Weighted and Getis-Ord GI methods was adopted using ArcGIS 10.3, Global Mapper 18.1, Google Earth and Surfer 14 software. These results help in determining the hotspots for crime incidence like Stealing/ House Break, Child Abuse, Robbery, Homicide, Drug addiction, Kidnapping, Smuggling, terrorism and Murder in Mubi Metropolis of Adamawa state Nigeria.*

Keywords: Crime, Hotspot, GIS, GPS, Police force

1.0 Introduction

The incidence of crimes such as Stealing, terrorism, kidnaping, rape, murder among others has become a daily occurrence in Nigeria. This increase in crime is attributed to the rising number of unemployed youths and the poor economic situation of the country (Chinedu, & Bartholomew, 2015). The government has allocated billions of naira to curb this rising incidence of criminality without much success. The government has spent billions of naira in the procurement and distribution of equipment such as utility vehicles, communication gadgets, weapons, bullet proof

vests, as well as the building and renovation of dilapidated police stations. More so, there has been the introduction of Joint Task Force (JTF) operation Lafiya Dole; an integration of the army, navy and the police force to join hands with the police to root out crime and act of terrorism in the state. Among all these efforts from the government, the police are still not efficient in the control and management of crime in the city. This is attributed to the old and manual ways they employ in crime fighting. Irrespective of government's huge investment in the Nigerian police force by way of personnel training and crime fighting equipment, crime has remained the bane of social and economic wellbeing of the people of Mubi metropolis making the once peaceful city now a heaven for criminals. The means of getting offenders is very much limited to the police force and vigilante as it appears is yet not fully exposed to modern technologies that will help them combat crime properly. It is therefore with this in mind that this research work is carried out. This research attempts to explore the analytical approach to crime using the GIS technology in Mubi Metropolis. It is hoped that by adopting this innovative approach in combating crime, the spate of crime will be drastically reduced.

The use of computer system and programs have revolutionized the way in which we carry out analysis, processing and presentation of spatial data that are referenced to the earth surface. The geospatial data also known as geographically referenced data describes both the location and the characteristics of the feature called spatial feature which may consist of roads, land extents, and vegetation on the surface of the Earth (Chang, 2012) & (Boba, 2005). The thing that differentiates GIS from other information system is its capability of handling and performing operations on geospatial data. The spatial data may be the location while the attribute data is the characteristics possessed by that location (Chang, 2012) and (<http://aurangabadcitypolice.gov.in>, 2013). Crime mapping and spatial analysis of crime are recognized as powerful tools for the study and control of crime, because crime maps help police identify problems at the block. The most powerful weapon in law enforcement is information technology. Law enforcement needs information management, especially location information. Traditional law enforcement for different types of police applications really deals with data collection. However, data collection without data analysis is useless. Not only GIS allows integration and spatial analysis of data to identify, apprehend, and prosecute suspects, it also aids more proactive measures through effective allocation of resources and better policy setting. Crime analysis mapping is the process of utilizing the geographic information system possessing to gather crime analysis techniques to concentrate on the spatial context of crime and other law enforcement procedures (Boba, 2005). Maps offer graphical representation of the crime and its related issues. To improve the task of fighting crime one must understand why and where the crime took place. Patrolling can be improved by providing the maps displaying the crime location or the area where the concentration of crime is high. A map consisting of trends of criminal activity, high density areas, and temporal information can be very much useful for the policy makers of the police departments (Ahmed & Salihu, 2013).

1.1 LITERATURE REVIEW:

The literature review highlighted on crimes and crime related indices; Definition of crime and crime analysis, Methods for automating the geographical analysis of crime incident data, Spatial perspectives on crime and Tools in the spatial analysis of crime.

According to (Boba, 2005), Crime mapping is a procedure using GIS to conduct spatial analysis of crime problems and police-related issues. Crime mapping is a sub discipline of crime analysis which has three main functions. The first one is to facilitate visual and statistical analysis to unravel the spatial nature of crime. The second one is to provide a link to unlikely data sources on common geographic variables and the last one is to produce maps that help to communicate for analysis results. A geographic information system integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information (Escobar, et al 2014). The use of GIS and remote sensing in police departments has proliferated over the past decade. Crime mapping capabilities are useful for police officers patrolling neighborhoods and investigators trying to solve cases. They can view the recent crime pattern of a neighborhood and query a GIS to search for particular types of crime patterns, such as the location of all recent burglaries within a mile radius of a given intersection (Karen, et al 2003).

The scenario of crime in Nigeria disregards class distinction in the society, as both high (haves), and low (have nots), experienced similar and equal visitation of the hoodlums from time to time. The resultant tragedy, suffering, colossal loss and distress, occasioned by those inimical visits, have been pervasive and had left an indelible mark on our national psyche and societal tranquility. Worse still is the fact that the law enforcement agencies are yet to be computerized for effective record keeping, analysis of cases, easy reference cum retrieval and storage of information to help strategize and adequately plan the combating and eradication of crimes in general. As an entity, crime has spatial attributes, i.e. location, time and process. In essence, availability and quick access to timely and up-to-date spatial information about crime-prone areas, to the law enforcement agencies, will in no small way contribute to effective policing of the entire state. Policing methods in Nigeria are still manual and un-automated. The old filing system of record-keeping is still in use. This limits the force from having the technological edge over the ever increasing technology sophistication of the criminals (Balogun, et al 2014).

Crime mapping implementation is relatively low in Nigeria. However, numerous examples exist in the developed world e.g. MAPS (Map-based Analytical Policing System) developed by Rick McKee of the New Zealand police department in the year 2000 to assist his police colleagues in tackling crime. MAPS was predominantly built for and used by Police intelligence analysts to assist in identifying crime patterns and trends, it allowed basic mapping queries to be compiled with a wizard-based formula that could be conducted by all operational police staff. MAPS allow users to build a query, select, display and explore crimes for any location in New Zealand (Andy & Barclay, 2007).

Based on the increase in crime rate as a result of unemployment by the public and private sectors in Nigeria, there is no experience about GIS and remote sensing (crime mapping) in the police organizations and it is not possible to find any research or article about this case, not only in Nigeria but

also in Most African Countries. However, (Balogun, et al 2014) has examines crime situation in Benin metropolis using questionnaire to elicit information from the public and the police. Result shows that crime is on the rise and that the police are handicapped in managing it because of the obsolete methods and resources at their disposal. It also reveals that members of the public have no confidence in the police force as 80% do not report cases for fear of exposure to the informant to the criminal. In the light of these situations, their research looks at the possibility of utilizing GIS for effective management of crime in Nigeria.

Consequently, The results according to (Chinedu and Bartholomew, 2015) in Owerri, the spatial analysis and a 500m buffering done on the data shows that areas that are more vulnerable to crime, have no police stations situated around them. The research also shows that a GIS based Information system will give the police better insights into crime mapping and analysis which will be a tool to help them effectively manage and combat crime.

(Ahmadi, 2013) highlighted the following on crime analysis:

- 1 – Definition of crime, and crime analysis.
- 2 – Methods for automating the geographical analysis of crime incident data.
- 3 – Spatial perspectives on crime.
- 4 – Tools in the spatial analysis of crime.

The GIS and Remote Sensing can be used for visualizing the data, analyzing the facts, and to take firm decision based on the analysis. This can be used to map the Police stations and to identify the Crime Zone as Hot Spot and to statistically analyze the reported Crime which will help to take effective measures to control the crime (Guta et al, 2012).

1.2 PROBLEM STATEMENT:

It is quite obvious that if the police authorities have goals of improving crime management (crime prevention) in Mubi metropolis, the manual recordings of crime incidents cannot be the way forward. The various police stations under the Mubi police Command have the responsibility of handling the various crime incidences in the boundary under their jurisdiction but at the moment have problems with their recording system and aggregation of crimes incidents in all police stations.

Owing to the rapid increase in the rate of crime in Mubi town and the inefficient method of data usage that will be transformed into information to analyse, checkmate, evaluate and make proper decision by the police force to protect the life and properties of the citizenry, has prompted the need for the best technology such as GIS and Remote sensing for the integration of up-to-date database that will enhance the quality of law enforcement agency to tackle the crime challenges.

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2.0 Materials and Methods:

Method of data collection and analysis

The data for this research work consist of primary and secondary data source.

Primary data source: The primary data was obtained in the field using GPS

(global positioning system) in the form of coordinate (i.e. easting's and northing's or latitude and longitude) of police stations, hot spots areas, boundary delineation of new police stations within the study area. The coordinate was plotted on a georeferenced quick-bird image of the area under study, for visual interpretation and spatial analysis.

Secondary source of data: the secondary data consist mainly of police records of various crimes; such as murder, sexual assault, theft and robbery, pick pocket, drugs etc. A data base of such records was created in ArcGIS 10.3 environment for information quarrying and analysis.

To implement the Hotspot techniques the methodology shown in the Fig 3 below was followed. It consists of six steps before reaching to the Result and Analysis part. Data Collection is the basic step for implementation, after that Georeferencing of the raster dataset takes place. In the third step the Spatial features from the dataset was digitized and the police stations, roads, Rivers, Wards, Crime points and Security Check points etc. was mapped respectively. In the fifth step, crime data base was created and mapped after which the Hotspot method was applied on the dataset and then the Result and Analysis was executed respectively.

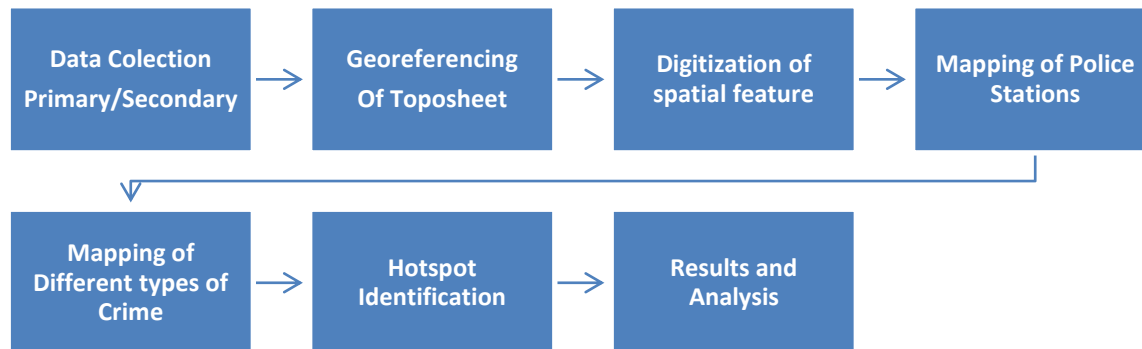


Figure.3 The flowchart of the methodology for the execution of research.

Spatial data used in this study include;

- 1) GPS coordinates of crime hotspots in Mubi metropolis
- 2) GPS Coordinates of police stations in the research area

- 3) Land use and road map of Mubi metropolis gotten from the Department of Surveying and Geoinformatics, FPM Mubi.

Attribute data include;

- 1) Records of types of crime
- 2) Attributes of police stations in the research area
- 3) Attribute of crime hotspot

Spatial Analysis Methods: In this analysis the checking of the locations, attributes, and connection of features in spatial data among overlay and other analytical techniques was done; and it was applied in acquiring knowledge that can be used in different aspect of the research analysis. The Spatial analysis creates or extracts different new information from spatial data.

Interpolation Methods: In this process, the use of points with better-known values to propose values at alternate unknown points was adopted. This analysis foretell unknown values at any geographic point data, which can be used in the field of rainfall, noise levels, chemical concentrations, elevation, or other spatially-based phenomena. It is the approximate judgment of surface values at the points which are un-sampled based on the surface values of surrounding points which are known. Interpolation was used as a raster operation, but using a TIN (Triangulated Irregular Networks) surface model

Spatial Autocorrelation: In this analysis, the degree to which a set of spatial features and the data values associated was auto correlated. It can be clustered together in Space (positive spatial autocorrelation) or Scatter Widely (negative spatial autocorrelation).

http://aurangabadcitypolice.gov.in/police_jurisdiction.php , 19-09-2013.

Georeferencing of the Toposheet: In the process the Toposheet was Georeferenced and the features were registered through digitization into Geographic Coordinate System (GCS). The GCS for mubi is WGS_84. Mubi comes under the Universal Transverse Mercator (UTM) zone 33 N.

Adding the dataset into the Arc Map : While adding a raster dataset into an ArcMap 10.3, it does not have pyramid. The programme was used to build a pyramid. Pyramids are necessary because they improve the speed of drawing for raster datasets which are displayed at less than their full resolution.

Digitization: Digitization of Spatial feature means to extract the Road network using the Editor toolbar. From the available features from the set like Point, Line and Polygon was selected. As for Road Network the Line Feature was used. Network Index of Road network was calculated to finding out the optimal path to reach the Crime scene and the Police station.

The Mapping of Police Stations and their Boundaries: In this phase, all the Police stations was placed on the map according to their coordinates. For coordinates, Field Survey was adopted to collect the accurate locations. The Police station was a Point Feature. The zone boundary information gathered in the first phase was used for mapping the boundary according to the police stations. The polygon feature was used for representing the boundary.

IDW Method: Inverse Distance Weighted (IDW) Interpolation method was used to enforce the condition that the estimated value of a point is influenced more by nearby known points than by those farther away. The IDW create layered shaded area of the crime incidence.

Getis-Ord G_i^* Method: G-statistics, separate clusters of high values from clusters of low values were analyzed. It shows the Hotspot and the Cold spot area within the research area with different colors. The G_i^* results are in point wise Hotspot detection, and it create the smoothing of the layer effects. It also shows different Police station Boundaries with their crime incidence showing the rate of Murder, Day House Break and Night House Break crimes under each boundary. The maximum and minimum crime rate areas can be identified which is based on the assumed hypothetical data based on the coordinates of the Toposheet.

3.0 Results and Discussion:

The Data required for the production of the Crime maps and Analysis was captured from the field survey and it was then imported into Global mapper software and the selected layers was converted into shape file (.Shp) inform of point, line and polygon. Shape file are the best and most suitable format for all GIS platform. Once the layers were in GIS format, the Quick Bird georeferenced image of the study area was downloaded and the layers were combined.

The coordinates and projection system used in this research was; projection system UTM, Datum WGS84, Zone33. The ground control point (CGCP) acquisition was done using Mangella Triton GPS receiver .

For this research work, the eight major wards in Mubi was selected as the metropolis. Fig 2. Depicts the wards within the study area. Fig4. Show all the crime zones in Mubi metropolis, 19 crime zones were selected with CZ1, CZ11 and CZ15 in Locuwa ward, CZ10in Digil Ward, CZ13 in Sabon Layi ward, CZ5, CZ6 and CZ18 in Yelwa Ward, CZ4, CZ14 and CZ7 in Lamurde Ward, CZ2, CZ3,CZ8 and CZ12 in Nasarawo Ward, CZ9, CZ16 and CZ17 in Gude ward and CZ19 in Kolere Ward. Fig 5. Reperesent all the positions of security outlets within Mubi Metropolis. the Police Stations, NSCDC, Custom Barack, Police Barack, Military Barack, 3 Police Check Points and 4 Military Check Points where maped out. The proximity of crime zones withrespect to the law enforment agency is very close in most cases, but far in some few others cases. the 1 killometer Buffer of the police stations covers only three (3) Crime Zones, like CZ3, CZ13 and CZ19 respectively, two (2) of the Bomb blast also occured within this Buffer Zones as shown in Fig. 6. Fig. 7 depicts the Major crime Hotspot zones in Mubi

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Table 1: the levels of crime in Mubi Metropolis.

| S/N | NAME OF WARD | LEVEL OF CRIME | LEVEL OF BLAST | % OF CRIME | % OF BLAST | Crime Pattern |
|-----|--------------|----------------|----------------|------------|------------|---------------|
| 1 | Locuwa | 3 | 0 | 16 | 0 | Low Hotspot |
| 2 | Digil | 1 | 0 | 5 | 0 | Coolspot |
| 3 | Nasarawo | 4 | 0 | 21 | 0 | Hotspot |
| 4 | Gude | 3 | 0 | 16 | 0 | Low Hotspot |
| 5 | Kolere | 1 | 0 | 5 | 0 | Coolspot |
| 6 | Lamurde | 3 | 0 | 16 | 0 | Low Hotspot |
| 7 | Sabonlayi | 1 | 2 | 5 | 40 | Hotspot |
| 8 | Yelwa | 3 | 3 | 16 | 60 | Hotspot |
| | Total | 19 | 5 | 100 | 100 | |

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4.0 Conclusion:

This research work was able determine the locations of security forces and crime Zones in Mubi metropolis through the integration of satellite remote sensing and Geographical Information System. The use of Remotely Sensed data and GIS has made the collection of base map for this study very easy. The implementation of the Quick bird imagery in collaboration with the GPS positions of vector data collected in the field has improve the accuracy of the analysis of this study.

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