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ARCH ARTICLE

# Integrating GIS and Remote Sensing for Crime Hotspot Analysis and Police Response Optimization in Owerri Municipal, Imo State, Nigeria

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## ABSTRACT

Rapid urbanization and increasing socio-economic activities have contributed to the growing complexity of crime in many developing cities, including Owerri Municipal, Imo State, Nigeria. Traditional methods of crime recording and response often lack adequate spatial intelligence for proactive policing and effective resource allocation. This study integrates Geographic Information Systems (GIS), Remote Sensing (RS), and Global Positioning System (GPS) technologies to map, analyze, and visualize crime patterns in Owerri Municipal for evidence-based urban security planning. Spatial and non-spatial datasets were obtained from police crime records, field surveys, GPS observations, structured questionnaires, and high-resolution SPOT-5 satellite imagery. The datasets were integrated into a geodatabase developed in ArcGIS 10.3 using the WGS 1984 geographic coordinate system. Spatial analyses, including hotspot mapping, proximity analysis, spatial querying, buffering, and overlay operations, were performed to identify crime concentration zones, evaluate police station service coverage, and determine areas with inadequate security infrastructure. The analysis revealed that major commercial corridors and transportation nodes, including Douglas Road, Control Roundabout, Wetheral Road, Tetlow Road, Warehouse Roundabout, Bank Road, and Fire Service Junction, constitute significant crime hotspots due to intense human activities, commercial concentration, and insufficient police presence. Buffer analysis further indicated that several neighbourhoods lie outside the effective operational coverage of existing police stations and checkpoints, thereby increasing their vulnerability to criminal activities. The study demonstrates that integrating GIS and remote sensing technologies into policing significantly enhances crime visualization, spatial decision-making, emergency response planning, patrol optimization, and strategic deployment of security resources. The developed geospatial database provides a sustainable framework for continuous crime monitoring and supports smart policing initiatives within rapidly urbanizing environments. It is recommended that law enforcement agencies institutionalize GIS-based crime management systems, establish dedicated geospatial intelligence units, strengthen community policing strategies, and expand security infrastructure in identified hotspot areas to improve public safety and urban resilience.

**Keywords:** *Crime Mapping; GIS; Remote Sensing; Crime Hotspots; Spatial Analysis; Urban Security*

## 1. INTRODUCTION

Crime remains one of the most persistent problems; criminal activities undermine economic productivity, discourage investment, reduce social cohesion, and weaken public confidence in governmental institutions. Urban centres in developing countries are particularly vulnerable due to rapid population threats to sustainable urban development worldwide. Beyond the direct loss of lives and property, inadequate urban planning, unemployment, social inequality, and increasing pressure on public infrastructure. Consequently, understanding the spatial distribution of crime has become an essential component of modern urban planning and security management.

Recent advances in Geographic Information Systems (GIS), Remote Sensing (RS), Global Navigation Satellite Systems (GNSS), and spatial analytics have transformed crime analysis from conventional record-keeping into an evidence-based decision-support process. Modern policing increasingly relies on geospatial technologies to identify crime hotspots, analyse spatial patterns, optimise patrol routes, predict crime occurrence, and allocate security resources efficiently. These technologies allow security agencies to integrate multiple datasets into a unified geospatial environment for real-time monitoring and strategic planning.

Crime is inherently spatial because every criminal incident occurs at a specific location and time. Consequently, analysing crime solely through statistical summaries often conceals important geographic relationships. GIS provides the capability to integrate spatial and attribute information, thereby revealing clustering patterns, spatial trends, accessibility relationships, and environmental factors associated with criminal activities. Through techniques such as hotspot analysis, kernel density estimation, proximity analysis, spatial interpolation, and network analysis, GIS has become an indispensable tool for crime prevention and law enforcement worldwide.

Nigeria has experienced increasing concerns regarding urban insecurity over the past decade. Major cities continue to record varying incidences of armed robbery, burglary, kidnapping, auto theft, drug-related offences, cybercrime, cultism, and violent attacks. Owerri Municipal, the administrative and commercial headquarters of Imo State, has similarly witnessed increasing criminal activities associated with urban expansion, commercial development, transportation corridors, and changing socio-economic conditions. These developments necessitate the adoption of innovative technologies capable of supporting intelligence-led policing and sustainable urban security management.

Despite the growing importance of geospatial technologies, crime management in many Nigerian cities still depends largely on conventional policing methods characterised by manual record-keeping, fragmented databases, delayed information retrieval, and limited spatial intelligence.
These shortcomings hinder rapid emergency response, effective deployment of security personnel, and long-term crime prevention planning. The absence of comprehensive geospatial crime databases further limits the ability of security agencies to identify emerging hotspots and allocate resources efficiently.

This study therefore integrates GIS, Remote Sensing, GPS observations, and spatial database management techniques to investigate the spatial distribution of crime within Owerri Municipal. By developing a comprehensive geospatial crime database and producing thematic crime maps, the study provides valuable decision-support tools capable of enhancing policing strategies, improving emergency response, supporting urban planning, and promoting safer communities.

Unlike previous studies that focused primarily on descriptive crime statistics, this research combines high-resolution satellite imagery, field-based geospatial data acquisition, crime incident records, and advanced GIS analytical techniques to identify crime hotspots, assess police service coverage, and recommend evidence-based strategies for improving public safety within the study area. The findings contribute to the growing body of knowledge on geospatial intelligence and demonstrate the practical role of GIS and remote sensing in modern crime management within rapidly urbanizing African cities.

## 2. LITERATURE REVIEW

Crime is a multidimensional phenomenon influenced by socio-economic, environmental, demographic, political, and geographical factors. Contemporary crime analysis has shifted from purely descriptive statistics toward spatially explicit approaches that integrate Geographic Information Systems (GIS), Remote Sensing (RS), Global Navigation Satellite Systems (GNSS), spatial statistics, and increasingly, artificial intelligence (AI). These technologies enable researchers and security agencies to understand not only what crimes occur, but also where, when, why, and under what environmental conditions they occur.

The emergence of GIS-based crime mapping has transformed crime prevention from reactive policing to proactive, intelligence-led policing. Modern geospatial technologies facilitate the visualization of crime distribution, identification of hotspots, prediction of future crime occurrence, optimization of patrol routes, and strategic deployment of security personnel. Consequently, GIS has become one of the most effective decision-support tools for urban security management.

**Concept of Crime**

Crime generally refers to acts or omissions prohibited by law and punishable by the state. It encompasses offences against persons, property, public order, and national security. Crime is both a legal and a social construct, varying across jurisdictions, cultures, and historical periods.

The Nigerian Criminal Code and Penal Code classify criminal offences into several categories, including: Violent crimes (murder, assault, armed robbery); Property crimes (burglary, theft, auto theft); Sexual offences (rape, sexual assault); Drug-related offences; Economic and financial crimes; Cybercrime; Terrorism and organized crime.

Although crime has legal definitions, its spatial manifestation makes geography an indispensable component of crime analysis. Every criminal event occurs at a specific location and time, making geospatial analysis particularly valuable for understanding crime patterns.

**Conceptual Framework of the Study**

The study adopts an integrated geospatial framework in which: Crime Incidents + GPS Coordinates + Police Records + Satellite Imagery + Field Survey Data; Geodatabase Development; GIS Spatial Analysis (Query, Buffer, Overlay, Hotspot Analysis); Crime Pattern Identification; Decision Support; Improved Policing; Enhanced Urban Security; Sustainable Crime Management.

**Theoretical Framework**

This study is anchored in three complementary criminological theories.

*Routine Activity Theory*: Routine Activity Theory, proposed by Cohen and Felson (1979), states that crime occurs whenever three elements converge simultaneously: A motivated offender; A suitable target; Absence of capable guardianship. Commercial districts, transportation corridors, markets, financial institutions, hotels, and entertainment centres naturally attract large numbers of people and valuable assets. Consequently, these environments become highly susceptible to criminal activities due to increased opportunities for offenders. The theory explains why crime hotspots commonly emerge around commercial centres, transport terminals, and densely populated urban neighbourhoods.

*Crime Pattern Theory*: Crime Pattern Theory explains that offenders operate within familiar activity spaces created by their daily movements between homes, workplaces, recreational centres, and transportation routes. The theory suggests that crime is rarely random. Instead,

criminals exploit road intersections, commercial centres, bus terminals, shopping districts, financial institutions; Entertainment centres. This theory strongly supports GIS hotspot mapping because spatial clusters often reflect routine movement patterns of offenders.

*Environmental Criminology:* Environmental Criminology examines how physical environments influence criminal behaviour. According to Brantingham and Brantingham (1993), crime opportunities are shaped by: Road accessibility; Building density; Lighting; Land use; Visibility; Population concentration; Urban design. GIS provides an ideal framework for integrating these environmental variables with crime data.

**Geographic Information Systems in Crime Analysis**

A Geographic Information System (GIS) is a computer-based system designed to capture, store, retrieve, manipulate, analyze, and visualize geographically referenced information. Crime analysis is fundamentally spatial because every crime possesses both geographic coordinates and temporal attributes. GIS enables security agencies to: Map crime incidents; Identify crime hotspots; Detect spatial clustering; Monitor crime trends; Perform proximity analysis; Allocate police resources; Optimize patrol routes; Support emergency response; Improve intelligence gathering. Compared to traditional paper-based crime records, GIS provides dynamic, interactive, and real-time analytical capabilities. Several police departments worldwide—including those in the United States, the United Kingdom, Canada, Singapore, and Australia—have integrated GIS into daily policing operations.

**Remote Sensing in Crime Mapping**

Remote sensing involves acquiring information about the Earth's surface without direct physical contact.

Satellite imagery contributes significantly to crime analysis through: Land use mapping; Road extraction; Building identification; Vegetation analysis; Urban expansion monitoring; Informal settlement mapping; and environmental risk assessment. High-resolution satellite imagery enables accurate extraction of urban features associated with criminal activities. For this study, high-resolution SPOT-5 imagery was employed to develop the base map, extract transportation networks, identify important urban landmarks, and facilitate spatial analysis.

**Crime Hotspot Analysis**

Crime hotspots refer to locations exhibiting statistically significant concentrations of criminal activities. Hotspot identification is among the most important applications of GIS in policing because it allows limited security resources to be concentrated where they are needed most.

Common hotspot analysis techniques include: Kernel Density Estimation (KDE); Getis–Ord Gi*; Moran's I; Nearest Neighbour Analysis; Point Density Analysis; Spatial Autocorrelation. Although the original study relied primarily on spatial queries and buffering, integrating density-based hotspot analysis would further strengthen future investigations and improve predictive policing capabilities.

**GIS Database Development for Crime Management**

The effectiveness of any GIS application depends on a well-designed geospatial database. A crime GIS database typically consists of: Spatial Data (Crime locations; Roads; Police stations; Checkpoints; Rivers; Administrative boundaries; Buildings), Attribute Data (Crime type; Date; Time; Suspect information; Victim information; Police response time; Case status). The database developed in this study integrates spatial and non-spatial information into a geo-relational framework to support querying, updating, visualization, and decision-making.

**Applications of GIS in Modern Policing**

Modern law enforcement agencies increasingly use GIS for: Crime hotspot mapping; Patrol route optimization; Emergency response planning; Surveillance planning; Community policing; Resource allocation; Intelligence-led policing; Disaster response; Event security management; Counter-terrorism operations. Countries with advanced policing systems have demonstrated substantial improvements in operational efficiency through geospatial technologies.

**Previous Studies**

Numerous studies have demonstrated the effectiveness of GIS in crime analysis. Eck et al. (2005) reported that hotspot policing significantly reduces crime by concentrating law enforcement efforts in geographically clustered locations. Groff and La Vigne (2002) demonstrated that predictive crime mapping improves police deployment and emergency response. Fajemirokun et al. (2006) successfully applied GIS to crime

management in Victoria Island, Lagos, revealing the potential of spatial analysis for Nigerian cities. Ratcliffe (2010) emphasized that GIS supports evidence-based policing by integrating crime records with environmental variables to improve strategic planning. More recently, Chainey and Ratcliffe (2022) highlighted the role of geospatial intelligence, machine learning, and predictive analytics in enhancing urban security. Their work demonstrates that integrating artificial intelligence with GIS improves the prediction of crime hotspots and resource allocation. Studies in South Africa, Kenya, Ghana, India, and Brazil have similarly confirmed that GIS-based crime mapping enhances decision-making, reduces response times, and improves public safety.

**Research Gap**

Despite increasing adoption of GIS worldwide, its application within Nigerian policing remains limited. Existing Nigerian studies are constrained by: Limited spatial databases; Manual crime records; Inadequate GPS integration; Lack of predictive analysis; Poor utilization of remote sensing; Minimal integration of satellite imagery with police intelligence; and weak geospatial decision-support systems. Few studies have specifically investigated crime distribution within Owerri Municipal using an integrated GIS, GPS, and remote sensing framework. Furthermore, limited attention has been given to evaluating police service coverage through spatial buffering and proximity analysis. This study addresses these gaps by developing a comprehensive geospatial crime database, integrating GPS observations with satellite imagery, mapping crime hotspots, evaluating police station service coverage, and providing practical geospatial decision-support tools for urban security planning in Owerri Municipal.

## 3. MATERIALS AND METHODS

This chapter describes the research design, study area, data sources, data acquisition procedures, GIS database development, image processing, spatial analysis techniques, quality assurance procedures, and software employed in the study. The methodology was designed to integrate Geographic Information Systems (GIS), Remote Sensing (RS), and Global Positioning System (GPS) technologies for comprehensive crime mapping, hotspot identification, and spatial analysis within Owerri Municipal, Imo State, Nigeria.

**Study Area**

The study was conducted in Owerri Municipal, the administrative headquarters of Imo State in southeastern Nigeria. Owerri Municipal occupies approximately 58 km² and lies between Latitude 5°29'N and Longitude 7°02'E. According to the 2006 National Population Census, the municipality had a population of approximately 127,213, although the current population is considerably higher due to rapid urbanization and economic growth.

Owerri Municipal shares boundaries with Owerri North and Owerri West Local Government Areas and serves as the commercial, administrative, educational, and transportation hub of Imo State. Major road networks connect the municipality to Port Harcourt, Aba, Onitsha, Orlu, Okigwe, and Umuahia, resulting in high daily traffic volumes and significant human mobility.

The municipality contains numerous commercial centres, financial institutions, markets, educational institutions, hotels, government establishments, and transportation terminals that attract large numbers of residents and visitors. These socio-economic characteristics increase opportunities for criminal activities and make Owerri Municipal an appropriate case study for GIS-based crime mapping.

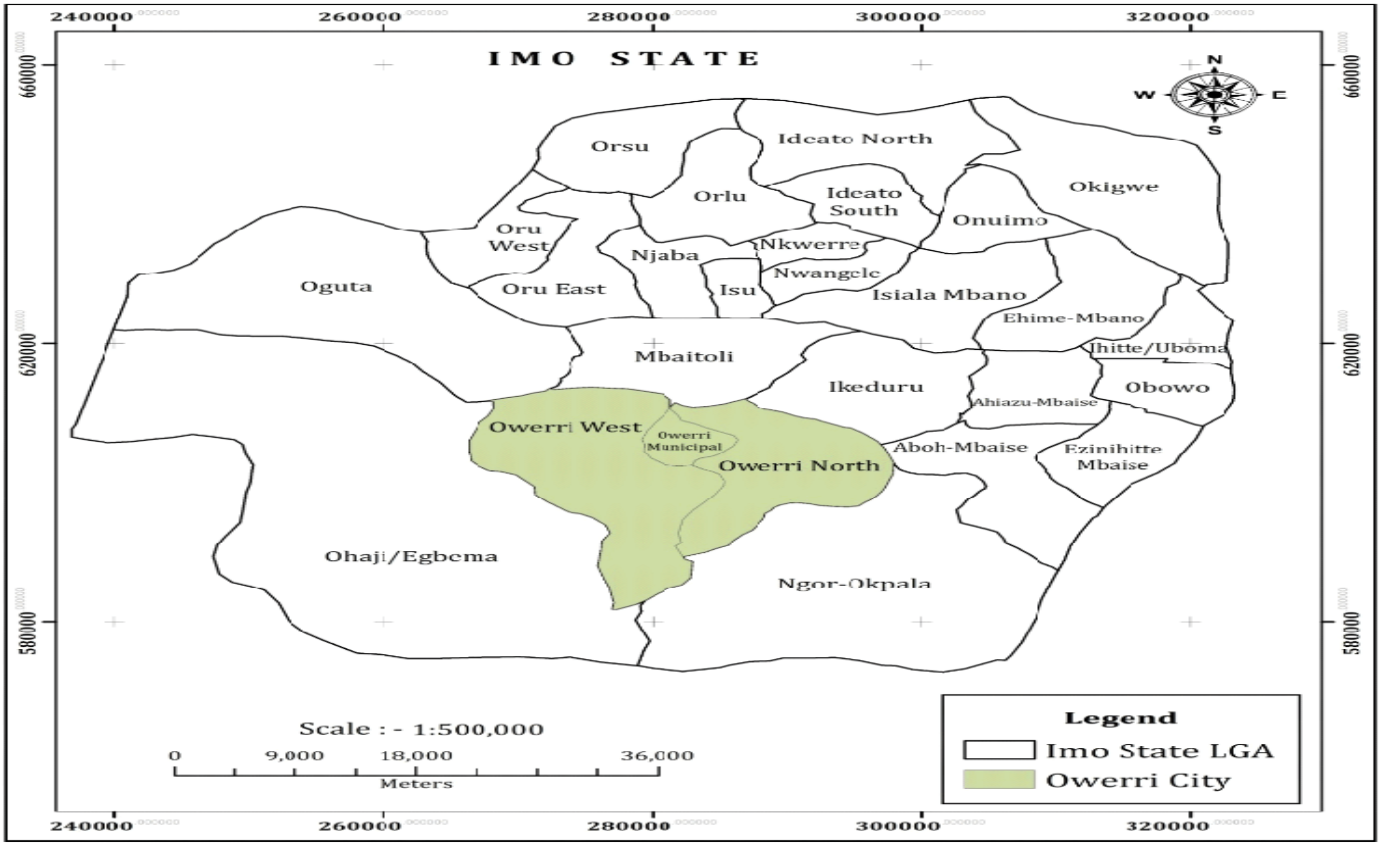


***Figure 1. Map of Imo State showing Owerri Cities***

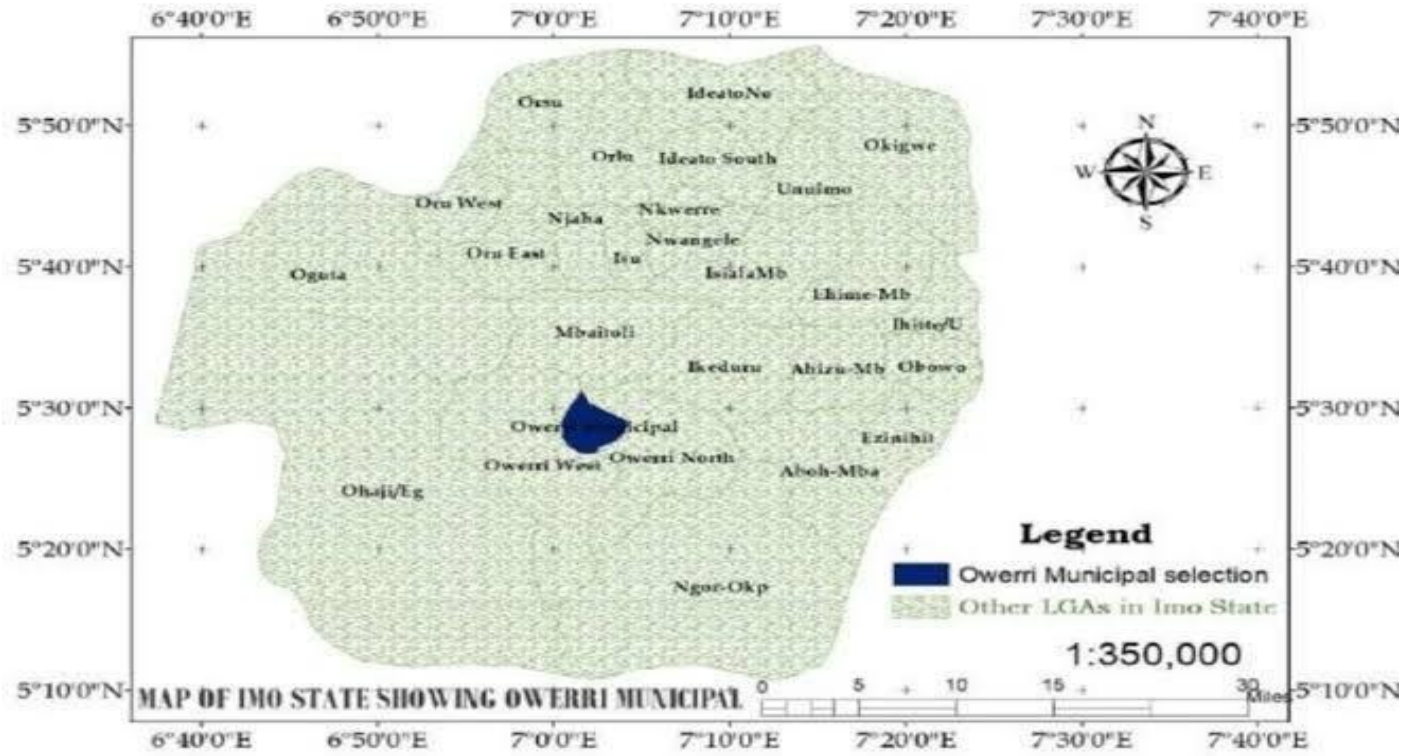

***Figure 2. Map of Imo State showing Owerri Municipal***

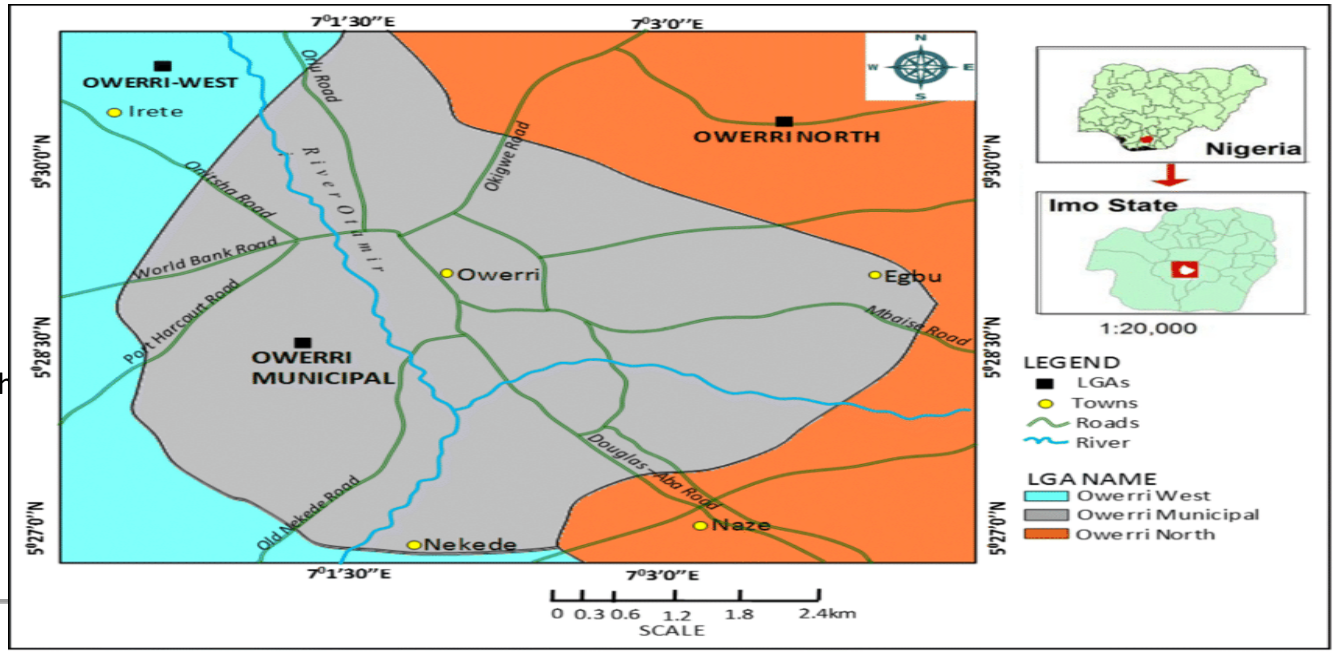


***Figure 3. Map of Owerri Municipal (Study Area)***

**Research Design**

The study adopted an integrated geospatial analytical research design, combining field surveys, GIS, Remote Sensing, GPS observations, police crime records, and questionnaire surveys. The research framework consisted of: Preliminary reconnaissance; Data acquisition; Image processing; GPS survey; GIS database development; Spatial analysis; Crime hotspot identification; Map production; Decision-support analysis. This mixed-method approach enabled both spatial and attribute analyses of crime occurrence within the municipality.

**Data Requirements**

The study utilized both spatial **(**Administrative boundary; Road network; Police stations; Police checkpoints; Crime locations; Rivers and streams; High-resolution satellite imagery; GPS coordinates) and attribute (Crime type; Crime frequency; Date of occurrence; Crime descriptions; Police station information; Questionnaire responses; Population information) datasets. These datasets were integrated into a geo-relational database. Questionnaire surveys were administered to residents to assess perceived crime occurrence and distribution. The original study administered 60 structured questionnaires, which should be reported together with the sampling strategy and response rate.

**Data Sources**

Primary datasets included: GPS observations; Field survey; Questionnaire administration; Ground truth observations. GPS observations were collected for: Police stations; Police checkpoints; Crime locations; Major landmarks. Secondary datasets included: Police crime records; SPOT-5 satellite imagery; Administrative maps; Published reports; Census information; Existing road network data.

**Satellite Image Acquisition**

High-resolution SPOT-5 satellite imagery covering Owerri Municipal was acquired and used as the base dataset for feature extraction.


***Figure 4. Spot 5 Satellite Imagery of the Project Area (not to scale)***

**GPS Survey**

Ground control points were acquired using a handheld GPS receiver. Coordinates collected included: Police stations; Police checkpoints; Crime locations; Major intersections; Commercial centres. Ground observations were referenced to the WGS 1984 Geographic Coordinate System. The coordinates were subsequently imported into ArcGIS for geospatial analysis.

**Image Processing**

Satellite image processing involved the following procedures: Image preprocessing; Geo-referencing; Coordinate system assignment; Boundary extraction; Image enhancement; On-screen digitization; Feature extraction; Topology correction; Quality control; Final map production. This workflow ensured positional consistency and spatial accuracy throughout the analysis.

**Spatial Analyses**

Several GIS analytical techniques were employed. Spatial queries were used to identify: Crime type; Crime locations; Police station locations; High-risk neighbourhoods. A 300 m buffer was generated around police stations and checkpoints to assess their service coverage and identify areas with limited security access. Overlay operations combined: Crime locations; Road networks; Police stations; Administrative boundaries, to identify spatial relationships and support crime hotspot interpretation. Crime hotspot maps were generated by integrating crime locations and attribute data, enabling visualization of areas with high crime concentration.

**Software and Hardware**

The following software and equipment were employed: ArcGIS 10.3, Microsoft Excel, GPS Utility, Microsoft Word; Handheld GPS receiver, HP LaserJet printer; Desktop computer; Field notebook; Digital camera.

**Quality Assurance and Validation**

To ensure data reliability, GPS observations were verified through repeated measurements; Digitized features were checked for topological consistency; Attribute tables were validated against original police records; Ground truth observations confirmed feature identification; Spatial layers were examined for overlaps, gaps, and geometric errors. These procedures enhanced the positional accuracy and integrity of the GIS database.

**Ethical Considerations**

The crime records used in this study were analysed at an aggregated spatial level to protect individual privacy and maintain confidentiality. Personal identifiers were excluded from the database, and all analyses focused on spatial patterns rather than identifiable individuals. Field surveys and questionnaire administration were conducted with informed consent from participants, and the resulting data were used solely for academic research and urban security planning.

**Limitations of the Methodology**

The study acknowledges several limitations: Crime records depended on officially reported incidents, and unreported crimes may not be represented; The analysis covered the period January 2021 to March 2022, which may not capture longer-term trends; The sample size of 60 questionnaire respondents provides useful perception data but limits broader statistical generalization; Advanced spatial statistics (e.g., Kernel Density Estimation, Getis–Ord Gi*, Moran's I) were not applied in the original analysis and are recommended for future studies.

## 4. RESULTS AND DISCUSSION

This chapter presents the results obtained from the spatial analyses performed on the crime database developed for Owerri Municipal. The analyses were carried out using Geographic Information Systems (GIS) techniques, including spatial querying, buffering, overlay analysis, and thematic mapping. The results are presented using maps, tables, and descriptive analyses to reveal the spatial distribution, concentration, and characteristics of criminal activities within the study area. Each result is interpreted in relation to urban land use, accessibility, commercial activities, transportation networks, and police service coverage.

**Crime Pattern in Owerri Municipal**

Analysis of police records and field observations indicates that crime incidents are not uniformly distributed throughout Owerri Municipal. Rather, they exhibit clear spatial clustering around major commercial centres, transportation corridors, markets, financial institutions, and densely populated neighbourhoods. These clusters reflect the influence of land use, population density, economic activity, and accessibility on crime occurrence. The crime distribution demonstrates that urban activities significantly shape opportunities for criminal behaviour, supporting the principles of Environmental Criminology and Routine Activity Theory discussed.

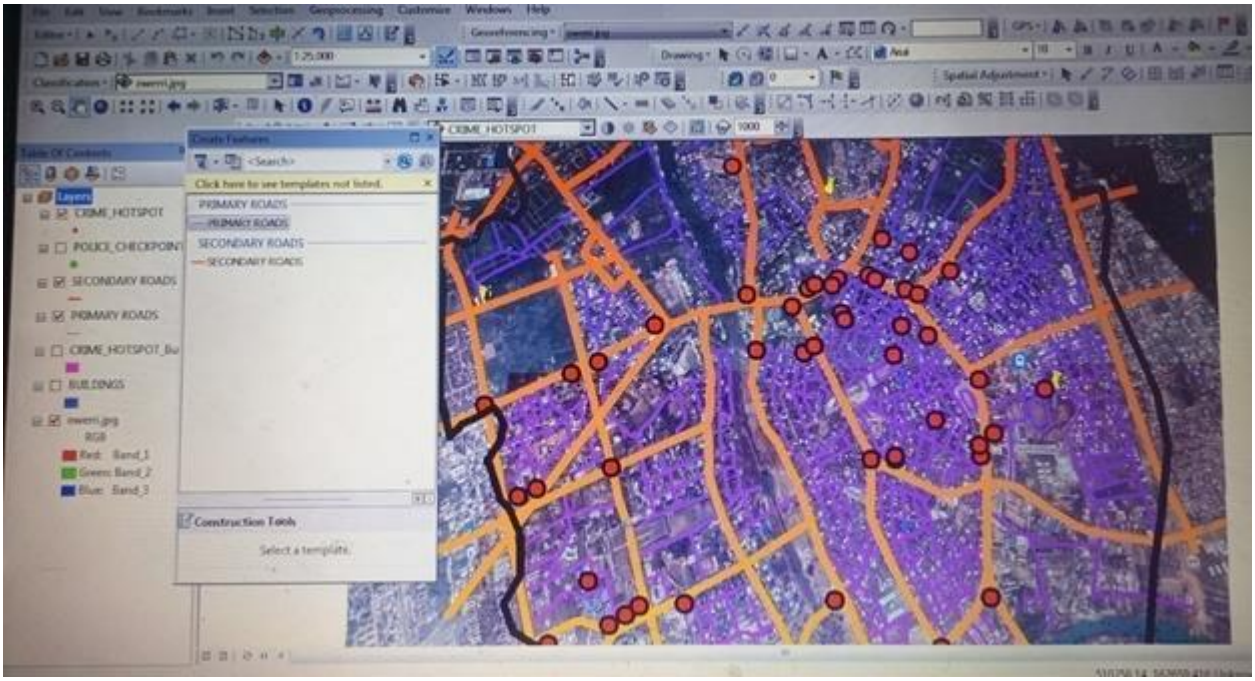


***Figure 5. Overall crime hotspot distribution within Owerri Municipal.***

The hotspot analysis indicates that the highest concentrations of criminal activities occur around: Douglas Road, Control Roundabout, Warehouse Roundabout, Fire Service Junction, Bank Road, Tetlow Road, Wetheral Junction, and Mbaise Road. These areas function as major commercial and transportation hubs characterized by high pedestrian and vehicular traffic, numerous financial institutions, markets, hotels, and public facilities. The concentration of valuable assets and continuous human movement creates favourable conditions for opportunistic crimes. The spatial clustering observed suggests that crime in Owerri Municipal is highly associated with commercial land use and accessibility rather than being randomly distributed. These findings agree with studies by Eck et al. (2005), Ratcliffe (2010), and Chainey and Ratcliffe (2022), which showed that crimes frequently cluster around locations with intense routine human activities.

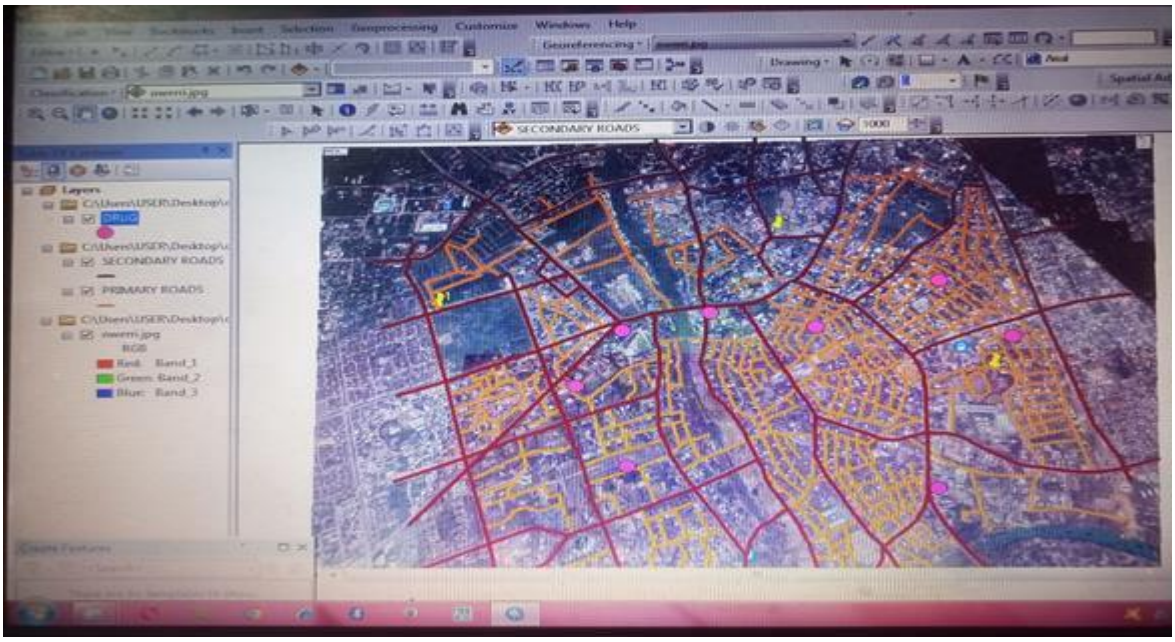


***Figure 6. Spatial distribution of drug-related crimes. Drug-related***

The offences are concentrated around Control Roundabout, Tetlow Road, Wetheral Road, Okigwe Road, and Ikenegbu. These locations contain hotels, bars, recreational centres, transport terminals, supermarkets, and commercial establishments that attract large and diverse populations. The concentration of drug offences in these areas suggests that commercial entertainment districts provide environments conducive to illicit drug activities. The findings are consistent with previous studies demonstrating that drug crimes tend to cluster around nightlife and high-activity commercial zones.

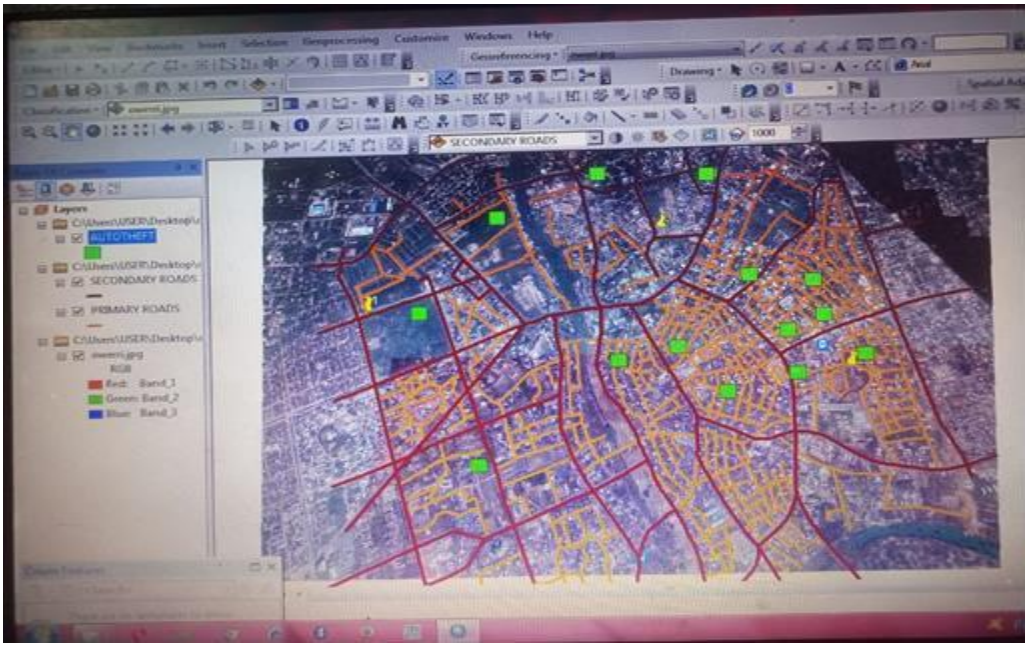


***Figure 7. Distribution of auto theft incidents.***

Auto theft was observed to be prevalent along Port Harcourt Road, Concord Junction, Control Roundabout, Onitsha Road, Tetlow Road, and Ikenegbu. These locations are characterized by heavy vehicular movement, shopping centres, hotels, and extensive parking areas. The availability of numerous parked vehicles increases opportunities for vehicle theft. The observed pattern indicates that vehicle-related crimes are closely linked to transportation infrastructure and commercial land use. Similar spatial relationships have been documented in urban studies across Lagos, Johannesburg, and Nairobi.

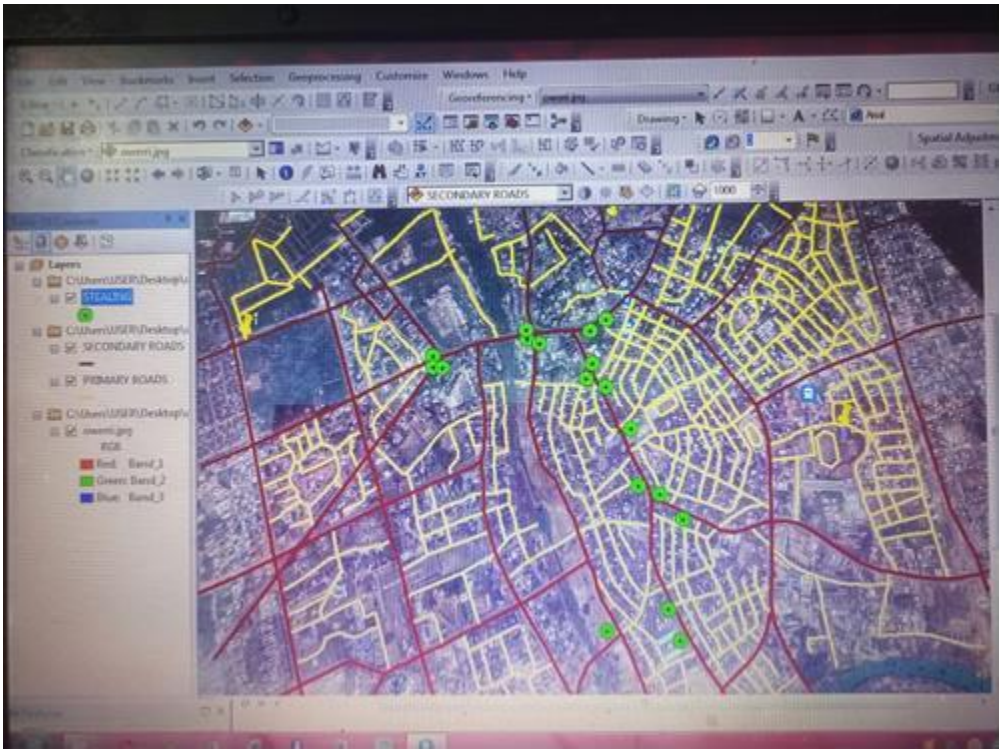


***Figure 8. Locations where stealing occurs most frequently.***

The highest incidence of stealing occurs around Douglas Road, Ama JK, Tetlow Road, Wetheral Junction, the Concord Area, Orlu Road, and Ikenegbu. These commercial districts accommodate markets, retail shops, supermarkets, banks, and office complexes. The high concentration of pedestrians, shoppers, and commercial transactions creates increased opportunities for theft and pick-pocketing. This result supports the proposition that property crimes increase with commercial activity and human mobility.

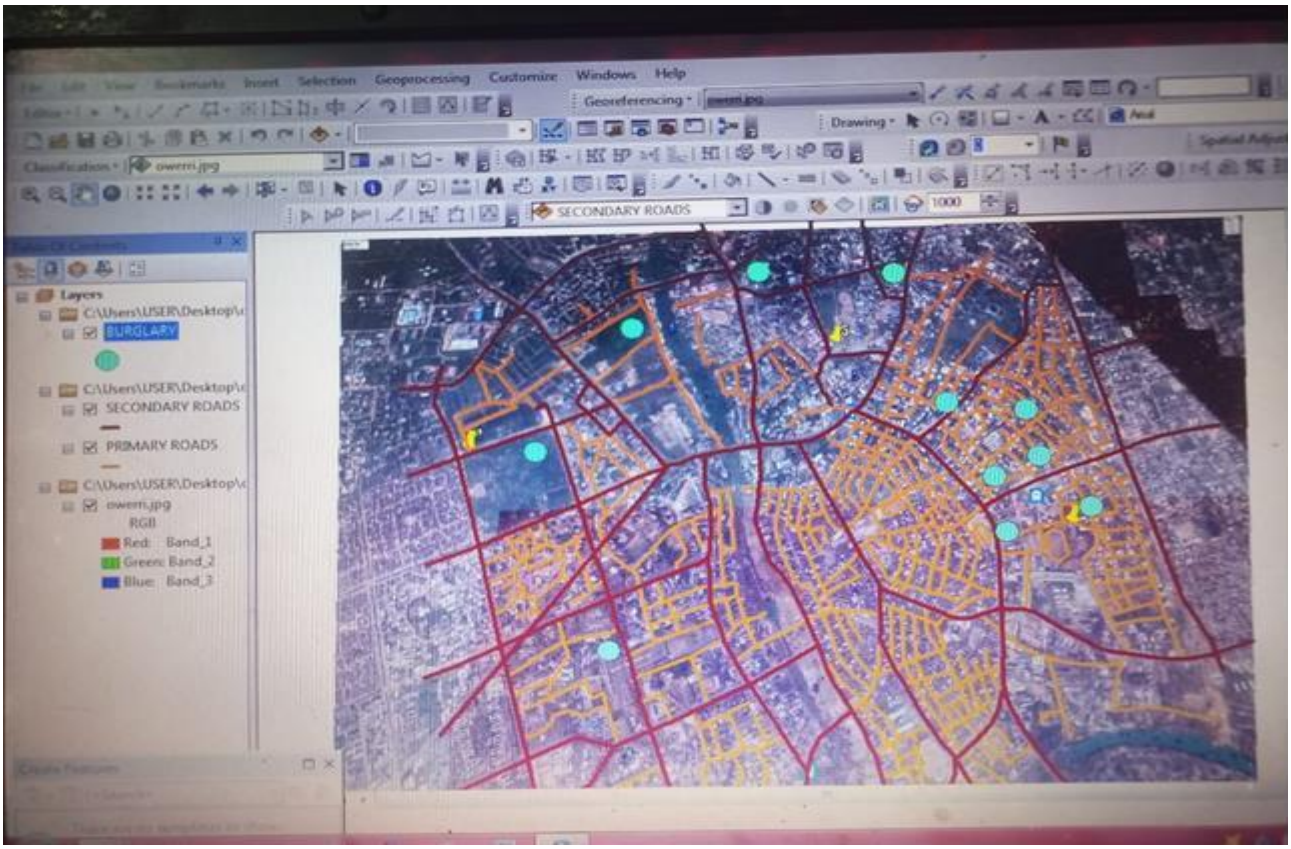


***Figure 9. Burglary hotspots***

Burglary is concentrated around Douglas Road, Tetlow Road, and Ikenegbu. This concentration is largely attributed to the presence of boutiques, warehouses, supermarkets, restaurants, and other commercial buildings in these areas. These facilities contain valuable goods that attract criminal activities. The findings indicate that commercial property protection requires improved surveillance and policing.

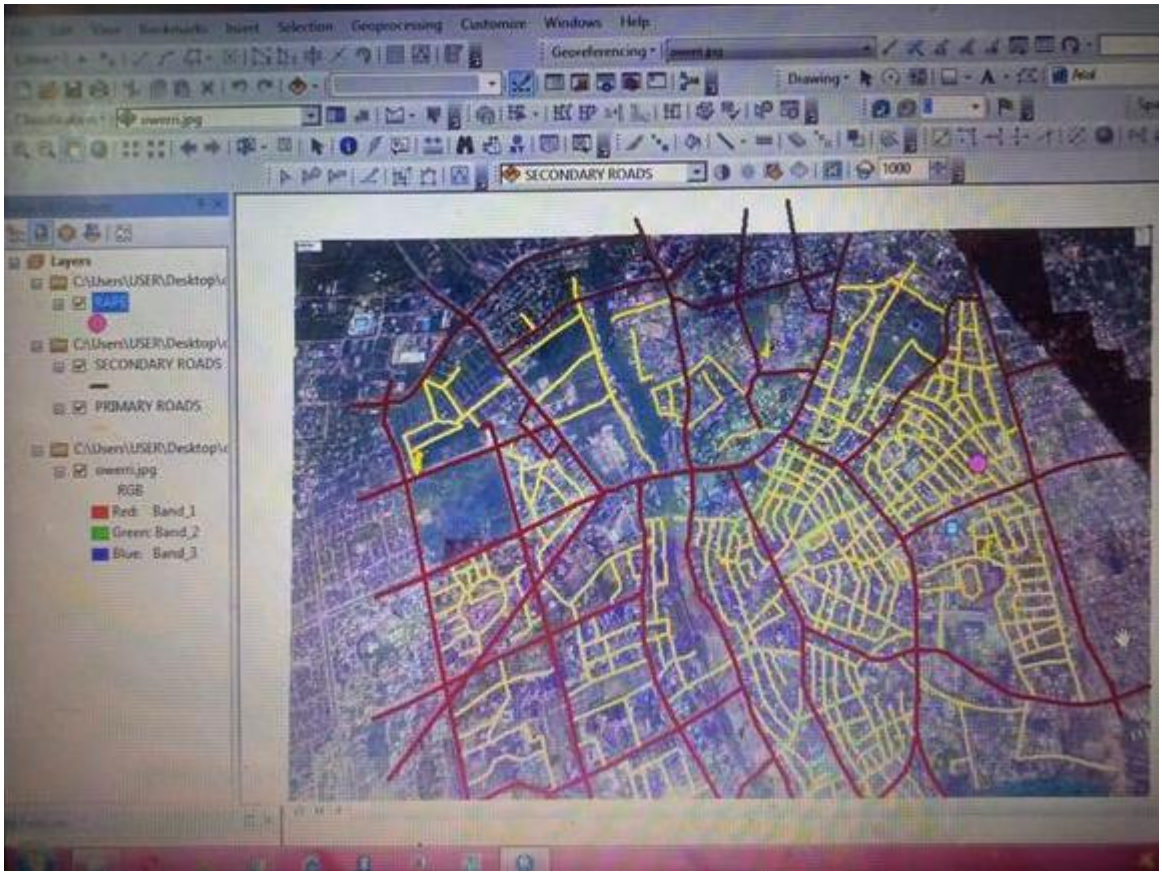


***Figure 10. Distribution of rape cases.***

Reported rape incidents were relatively few and were mainly concentrated around the Relief Market axis. While the recorded occurrence appears low, this result should be interpreted cautiously because sexual offences are widely acknowledged to be underreported due to stigma, fear of retaliation, and cultural barriers. Consequently, the mapped distribution may underestimate the true spatial extent of sexual violence.

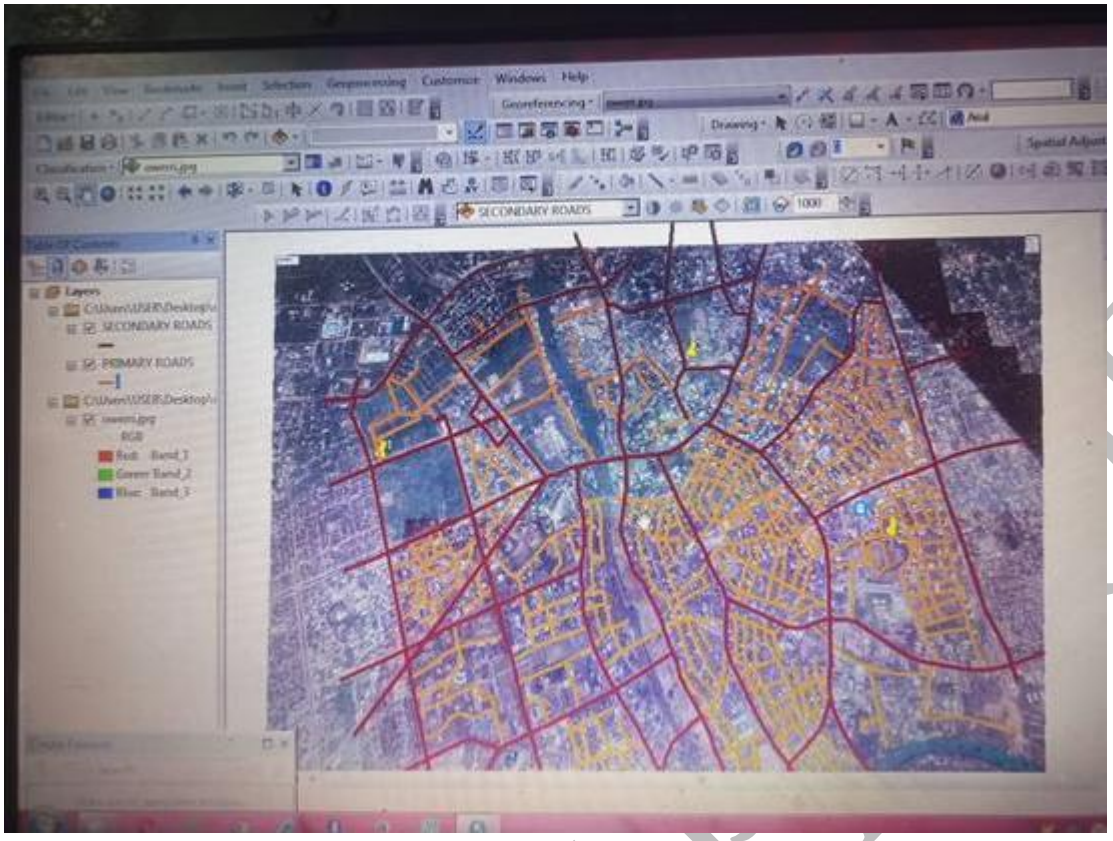


***Figure 11. Reported murder cases***

Murder incidents were comparatively infrequent during the study period. This finding suggests that although violent crime exists within Owerri Municipal, offences against property occur more frequently than homicide. This pattern is common in medium-sized urban centres where economic crimes often outnumber violent crimes.

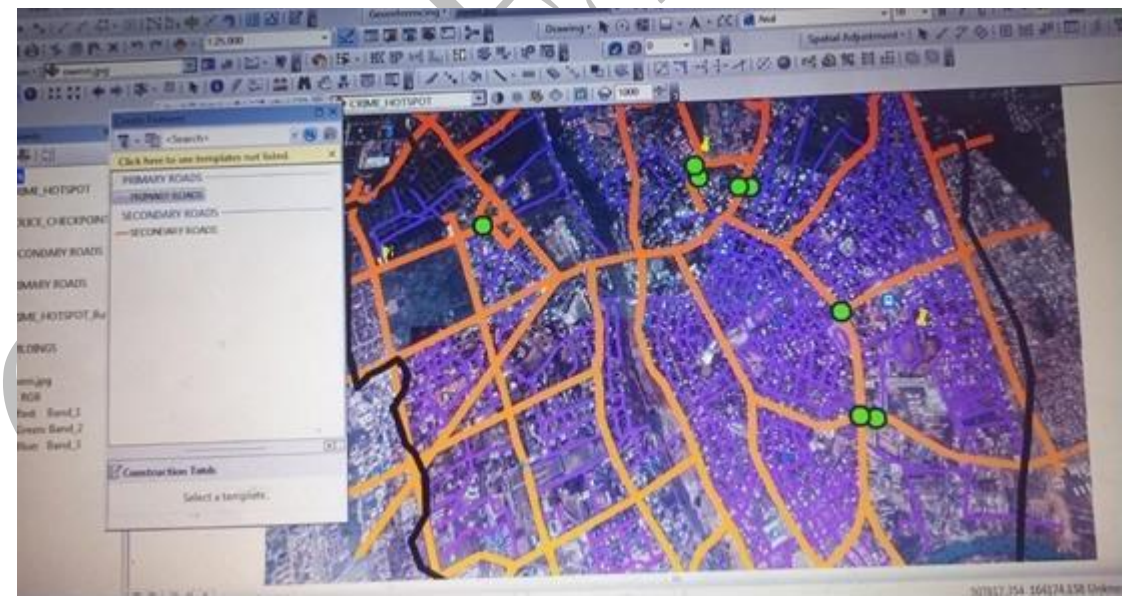


***Figure 12. Spatial distribution of police stations and checkpoints***

The spatial arrangement indicates that police infrastructure is concentrated around central commercial districts. Peripheral neighbourhoods experience relatively lower police presence. This uneven distribution contributes to delayed response times in several crime-prone locations. The result suggests the need for improved spatial planning in locating future police facilities.

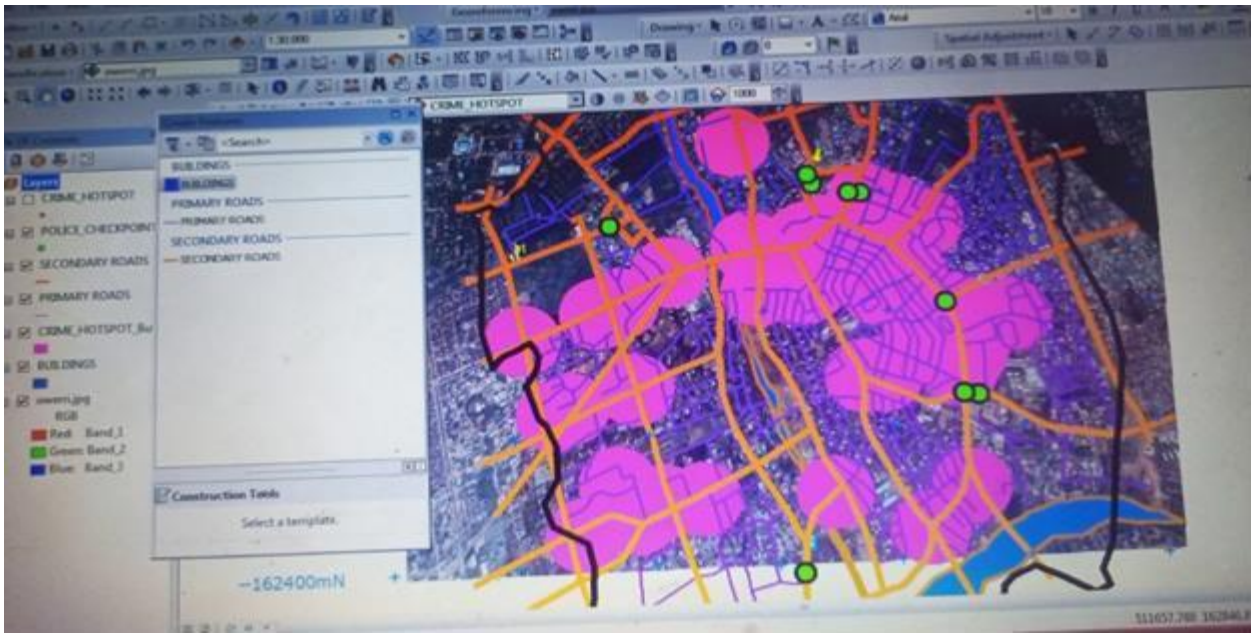


***Figure 13. The 300-m buffer generated around police stations and checkpoints***

Buffer analysis demonstrates that several sections of Owerri Municipal fall outside the effective operational radius of existing police stations and checkpoints. Neighbourhoods located beyond the 300 m service distance experience limited access to immediate police intervention. These uncovered areas correspond closely with many of the identified crime hotspots. This finding highlights the importance of strategically locating additional police posts and patrol units within underserved areas to improve response times and enhance public safety.

**Questionnaire Analysis**

Sixty questionnaires were administered to residents to assess perceptions of crime occurrence. Respondents identified stealing, drug-related offences, and auto theft as the most common crimes within Owerri Municipal, while murder and arson were perceived as relatively infrequent. These perceptions align closely with the spatial patterns derived from the GIS analyses, providing additional confidence in the reliability of the identified hotspots.

**Discussion of Findings**

The study demonstrates that crime in Owerri Municipal exhibits clear spatial clustering rather than random distribution. High-risk areas coincide with major transportation corridors, commercial centres, markets, financial institutions, hotels, and densely populated neighbourhoods. These observations support the principles of Routine Activity Theory and Crime Pattern Theory, which propose that crime opportunities emerge where motivated offenders, suitable targets, and limited guardianship intersect. The results further show that GIS provides a robust framework for integrating crime records, GPS observations, and satellite imagery into a single geospatial database capable of supporting evidence-based policing. The identified hotspots correspond closely with areas of intense socio-economic activity and with locations beyond the effective

service coverage of existing police infrastructure. From a practical perspective, the findings indicate that expanding police presence in underserved neighbourhoods, enhancing surveillance along commercial corridors, and institutionalizing GIS-based decision-support systems could substantially improve urban security. The study also illustrates the value of geospatial technologies in optimizing patrol deployment, emergency response, and long-term security planning. Overall, the results confirm that GIS and remote sensing are effective tools for crime mapping and provide a scientific basis for intelligence-led policing in Owerri Municipal.

## 5. CONCLUSION

The increasing rate of urban crime presents significant challenges to sustainable development, public safety, and socio-economic growth, particularly in rapidly urbanizing cities within developing countries. This study successfully demonstrated the application of Geographic Information Systems (GIS), Remote Sensing (RS), and Global Positioning System (GPS) technologies in mapping, analysing, and visualizing the spatial distribution of crime within Owerri Municipal, Imo State, Nigeria.

A comprehensive geospatial crime database integrating police crime records, GPS observations, satellite imagery, questionnaire responses, and field survey data was developed to facilitate crime analysis and decision-making. The integration of spatial and attribute datasets provided an effective framework for identifying crime hotspots, assessing police service coverage, and evaluating spatial relationships between criminal activities and urban infrastructure.

The findings revealed that crime incidents are spatially clustered rather than randomly distributed across the municipality. High concentrations of criminal activities were observed around Douglas Road, Control Roundabout, Tetlow Road, Wetheral Junction, Warehouse Roundabout, Fire Service Junction, Bank Road, Port Harcourt Road, Concord Area, and sections of Ikenegbu. These locations are characterized by intensive commercial activities, transportation hubs, financial institutions, markets, hotels, entertainment centres, and high population densities, which collectively create favourable conditions for criminal activities.

Buffer analysis further demonstrated that several neighbourhoods fall outside the effective operational coverage of existing police stations and checkpoints. These underserved areas correspond closely with many of the identified crime hotspots, suggesting that inadequate spatial distribution of security infrastructure contributes to increased crime vulnerability. The results therefore highlight the importance of optimizing police deployment based on geospatial evidence rather than administrative convenience.

The study confirms that GIS and Remote Sensing technologies provide efficient tools for crime visualization, hotspot identification, patrol planning, emergency response optimization, and strategic allocation of security resources. The developed geospatial database offers a sustainable platform for continuous crime monitoring, rapid information retrieval, and intelligence-led policing.

Beyond crime mapping, the study demonstrates the broader role of geospatial technologies in supporting urban planning, infrastructure development, disaster management, transportation planning, and smart city initiatives. The integration of GIS into policing therefore represents a strategic investment capable of enhancing operational efficiency, improving public confidence, and strengthening urban resilience.

Overall, the study concludes that the adoption of GIS-based crime management systems by law enforcement agencies will significantly improve crime prevention, emergency response, and evidence-based decision-making within Owerri Municipal and other rapidly growing Nigerian cities.

Based on the findings, law enforcement agencies should institutionalize GIS and geospatial crime databases for effective crime mapping, surveillance, investigation, and intelligence-led policing. Police infrastructure and GPS-enabled patrol systems should be expanded in identified crime hotspots, supported by predictive spatial analysis and remote sensing to improve crime prevention and response.

Community policing, public crime-reporting platforms, regular capacity building, and collaboration with academic institutions should be strengthened. Government should provide adequate funding for GIS facilities, surveillance technologies, and geospatial equipment, while crime maps should be updated regularly. Finally, public awareness and youth empowerment programmes should be promoted to improve crime reporting and address socio-economic factors contributing to criminal activities.

## 6. COMPETING INTEREST

None to declare

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