Development of Crime Maps Using QGIS for the Municipality of Bongabong, Oriental Mindoro, Philippines

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Abstract

Crime mapping refers to the used of Geographic Information System (GIS) in analyzing and visualizing crime data. It serves as the backbone of crime mapping, providing precise information through visualization. Combining gathered data, crime mapping creates a visual representation of crime events, enabling the identification of hotspots and the integration of targeted interventions programs. The study incorporates a descriptive research design employing GIS cartography. It aims at systematically defining the spatial delineation as well as the trends of crime within a certain area using maps and visuals. This study was conducted in the Municipality of Bongabong covering its 36 barangays. It aimed to study the crime pattern together with its distribution and its offering insights into crime hot spots. The outcomes of this study serve local leaders and policy makers in formulating strategies meant to reduce crime. This study employed QGIS (Quantum Geographic Information System), a digital tool used to gather, visualize, and analyze spatial data related to crime incidents. In this research, QGIS is utilized to identify crime hotspots, patterns, and trends by integrating geographic and statistical data. The development of thematic maps provided powerful visual tools for understanding the spatial and temporal distribution of crime. The Historical Map tracked changes in crime rates over time, highlighting peak years and potential correlating socio-economic shifts. The Density Map illustrated high-crime areas, enabling strategic prioritization of law enforcement resources. Meanwhile, the Attribute Map offered detailed insights into specific crimes and their locations, facilitating more targeted, data-informed interventions.

Keywords: crime mapping; Geographic Information System (GIS); GIS cartography; Municipality of Bongabong

Introduction

Criminal activities take place on a regular basis. According to the data from the Philippine National Police (PNP), the country's crime volume declined by at least 21 percent. From January 1 to March 9, the PNP recorded 5,939 focus crimes, down from 7,583 during the same period in 2023 a decreased of 21.68 percent (Tupas, 2024). Despite ongoing efforts to combat crimes, it still a public issue. In this regard, the public safety remains a top priority, prompting governments to implement necessary measures to reduce crime rates. Crime analysis is an essential aspect of criminology that examines behavioral trends and seeks to identify the underlying factors or indicators that lead to criminal activities (Mahmud et al., 2017). Through this approach, the

researchers and analysts are able to systematically interpret patterns, asses underlying factors and pinpoint areas most vulnerable to crime.

Crime mapping refers to the used of Geographic Information System (GIS) in analyzing and visualizing crime data. Geographic Information System serves as the backbone of crime mapping, providing a precise and detailed information through visualization. By combining the data gathered, crime mapping creates a visual representation of crime events, enabling the identification of crime hot spots and the integration of targeted interventions programs.

On the other hand, crime volume refers to the total number of crime incidents (including index and non-index crimes) that occur in a given location that are reported and recorded in the police blotter over a specific time period. Analyzing crime volume assists law enforcement agencies and policymakers in determining the efficiency of crime prevention and control efforts, as well as identifying crime prone areas. Maps transmit powerful messages to readers, even though the majority of whom are unfamiliar with the technical aspects of crime mapping.

Police use this understanding on a daily basis. Decisions regarding how to deploy scarce resources are partially based on where crimes are highest and lowest. Hence, community-based policing focuses on community-police ties and partnerships in solving and preventing crimes, with a special emphasis on high-crime neighborhoods where residents have trouble exercising social control. Additionally, problem-oriented policing focuses on strategic planning and tactical implementation to combat crime. Crime analysis often focuses on identifying where crimes happen most frequently, while crime mapping helps in visualizing those high crime areas.

Moreover, areas that have a high crime intensity are often referred to as crime hot spots. Understanding how and where crime happens most often helps law enforcement use their resources wisely, focus on areas that need the most attention, and work toward lowering crime rates. Looking closely at crime hot spots also helps reveal the reasons behind criminal behavior, which can guide better decisions and create safer communities. The idea of a crime hot spot comes from the fact that crime usually happens more in certain locations rather than being spread out evenly everywhere (Karmakar et al., 2024)

Along with these, crime mapping supports one of the Sustainable Development Goals (SDG) which is a universal set of goals, targets and indicators that UN members states will be expected to use to frame their agendas and political policies. One of which is the Sustainable Development Goal or SDG 16 that focuses on “Peace, Justice and Strong Institutions,” it is directly related to the crime mapping through its targets to reduce violence, combat crime, and promote the rule of law, all of which are vital for building safe and inclusive societies. As the key objective of SDG 16, crime mapping also contributes to a safer environment for all, implementation of targeted interventions, such as increased police visibility, community policing initiatives, and crime prevention programs.

In an effort to better understand the crime situation in the Municipality of Bongabong, the researchers aim to explore and analyze key aspects of reported criminal incidents. This study is aimed to develop a map of crime events in the Municipality of Bongabong based on recorded data available in Philippine National Police database.

Methodology

Research Design

The study incorporates a descriptive research design employing GIS Cartography. It aims at systematically defining the spatial delineation as well as the trends of crime within a certain area using maps and visuals. With this design, researchers are able to gather, depict, and interpret data pertaining to crime incidents and their distribution within a municipality.

Research Locale

This study was conducted in the Municipality of Bongabong covering its 36 barangays. It aimed to study the crime pattern together with its distribution and its offering insights into crime hot spots. The outcomes of this study serve local leaders and policy makers in formulating strategies meant to reduce crime.

Research Instrument

This study employed QGIS (Quantum Geographic Information System), a digital tool used to gather, visualize, and analyze spatial data related to crime incidents. In this research, QGIS is utilized to identify crime hot spots, patterns, and trends by integrating geographic and statistical data.

Data Gathering

The maps were created using crime volume data gathered from the Crime Incident Recording and Analysis System (CIRAS) through the Municipal Police Station. Through the analysis of these data sources, the study was able to produce various types of crime maps.

Results and Discussion

Developed map of crime events in the Municipality of Bongabong

This section presents the crime maps developed for the Municipality of Bongabong, which include a Historical Map, a Density Map, and an Attribute Map. These maps highlight all barangays along with the specific types of crimes committed in each area and the years in which they occurred.

Figure 1. Historical Map Representing the Rape cases 2020-2024

A historical map is a specialized form of cartographic representation that captures the layout, events, or characteristics of a place as they existed in the past. Typically created using early surveys or records from explorations, these maps reflect the appearance and organization of specific regions during distinct historical periods. They frequently include key details such as territorial boundaries, physical landforms, demographic patterns, and other historically relevant data. While their original purpose often involved aiding navigation, historical maps are now widely valued for their role in examining past geographies, documenting cultural transformations, and tracing the evolution of cartography (Atlas, 2025).

Building upon this understanding, the main role of a historical map is to illustrate the geographical, societal, and political landscape of a location at a given moment in history. By showing how terrains, settlements, and borders have changed over time, these maps offer a visual context that deepens our understanding of historical movements, such as migrations, conflicts, and economic exchanges. Importantly, they serve as tools for analysing how historical environments shaped human choices and behaviour. For researchers, historians, and planners, historical maps act as essential resources that not only educate but also provide analytical insight into the causes and consequences of past developments including, in specific cases, patterns of criminal activity.

In the specific context of Bongabong, the use of historical mapping plays a crucial role in tracking the evolution of crime across multiple years and barangays. Through visual representation, it becomes possible to observe how criminal incidents have shifted geographically and temporally, allowing stakeholders to identify recurring hotspots and fluctuations in crime intensity. This comparative analysis of different timeframes sheds light on how factors such as population movement, economic challenges, and changes in community structures have influenced crime rates.

As a result, the insights gained from these maps guide more strategic and evidence-based planning for crime prevention and intervention. Overall, historical maps empower the municipality to craft safer and more responsive public safety policies based on a clear understanding of past trends.

Specifically, the historical crime map covering the period from 2020 to 2024 provides a comprehensive visualization of the changes in crime within the Municipality of Bongabong. The

data clearly shows that 2023 experienced the highest incidence of crime, followed by 2024 and then 2020. Conversely, 2021 and 2022 recorded the fewest crime cases, suggesting a temporary downturn during that interval. These variations in crime levels can be attributed to a range of contributing factors, including increased migration into certain barangays, widespread poverty, unemployment, and behavioural influences such as substance abuse, peer pressure, and weak parental guidance. This analysis underscores the importance of acknowledging both socio-economic and behavioural contexts when designing tailored crime-reduction initiatives for different communities.

To further clarify, historical maps can also be defined as cartographic images representing either specific events from the past or the state of a location at a given historical moment, highlighting patterns of land use and settlement as they were recorded at the time (Keyworth, 2015).

According to Piovan (2019), these maps enable the examination of how past spatial arrangements evolved, supporting both qualitative and quantitative longitudinal studies. Moreover, historical maps serve a distinct role in portraying the geographical perceptions and realities of specific periods and locations.

As noted by Kirby (2024), these maps are vital to historical inquiry because they preserve spatial records that are often absent from traditional documents. They reveal how various communities lived, occupied land, and organized space, allowing modern viewers to visualize and better understand the dynamics of earlier societies.

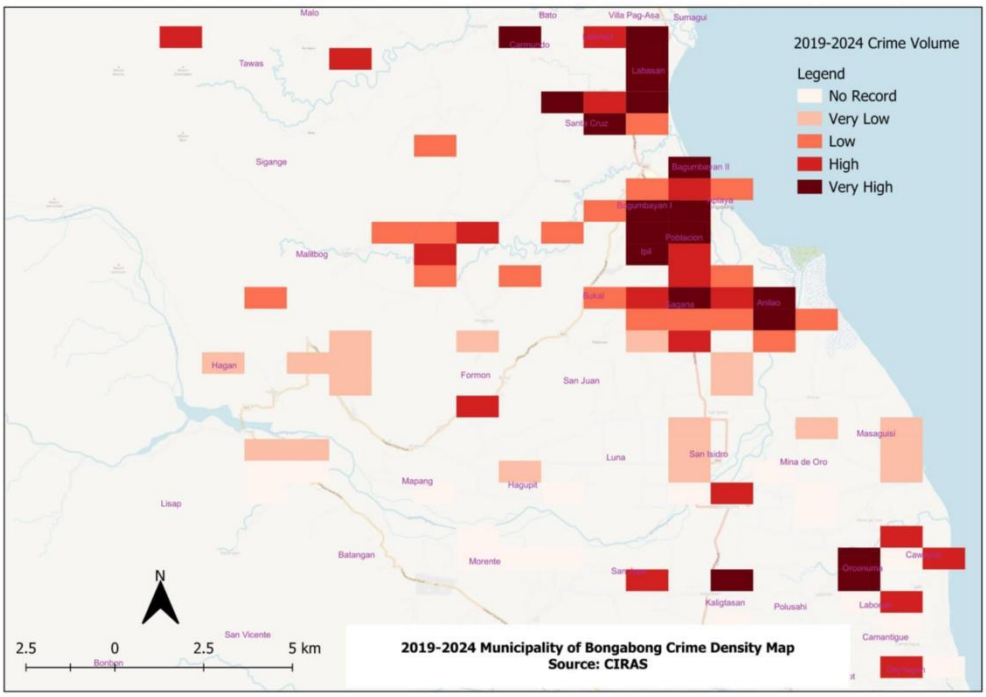


Figure 2. Density Map representing the crime volume of 2019-2024

A density map in Geographic Information Systems (GIS) is a powerful visualization technique that displays how concentrated or dispersed certain features such as points or lines are within a specific area. It is widely applied to examine spatial phenomena, including population

distribution, crime frequency, and the spread of diseases. These maps are generated through interpolation methods, which estimate how densely a feature occurs across a geographic surface (NCESC, 2025).

Expanding on this, the primary function of a density map is to depict the intensity or frequency of a particular event such as criminal activity within a defined location. In the field of crime analysis, these maps are essential for pinpointing hot spots, or areas where crimes are most prevalent. By converting raw data into a visual format often using gradient color or shading density maps make it easier to identify spatial patterns and trends. This enables law enforcement and policymakers to allocate resources more effectively by focusing on areas requiring immediate intervention. In essence, density maps act as essential tools for visualizing data and guiding strategic decision-making in public safety and planning.

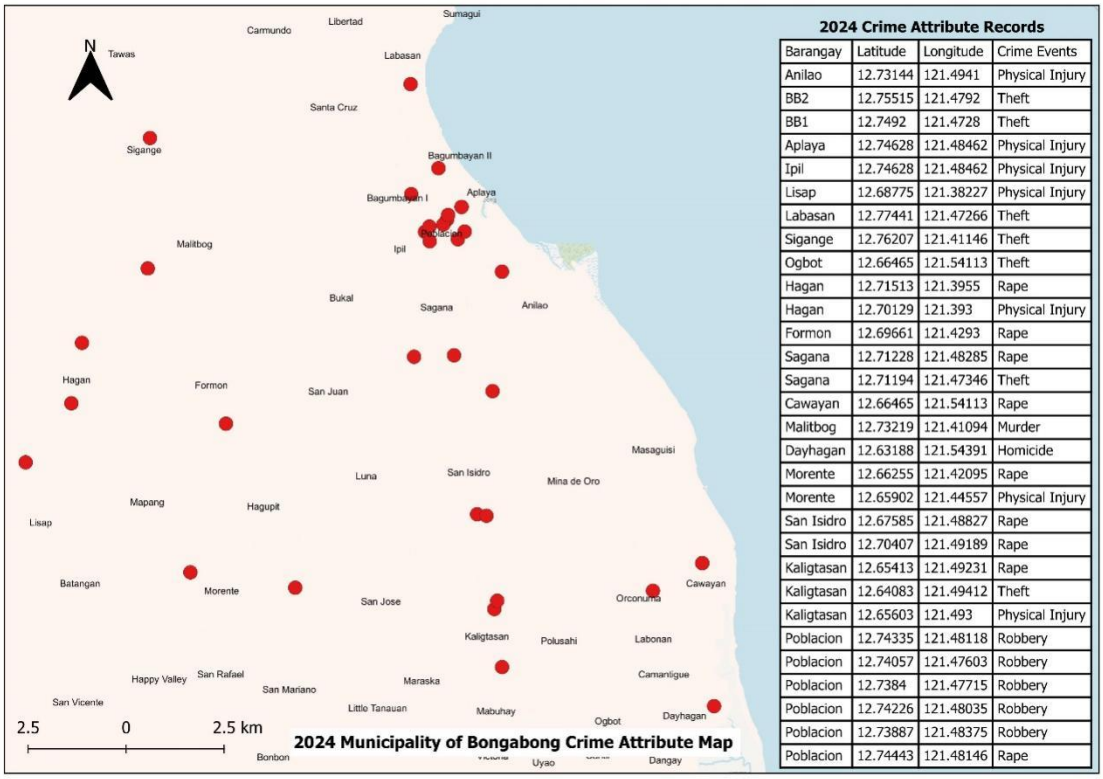
In the context of Bongabong, the use of density maps plays a significant role in understanding the geographical concentration of crime over time. These maps display how criminal incidents are clustered across various barangays from year to year, providing a clearer picture of where crimes are increasing or persistently high. Through this visualization, researchers and local authorities can monitor evolving crime patterns and identify barangays experiencing heightened criminal activity. This information is crucial for uncovering root causes such as economic difficulties, demographic changes, or societal influences. Therefore, density maps support the development of focused, timely, and effective crime prevention strategies tailored to the needs of specific areas within the municipality.

The density map representing Bongabong and its barangays offers a detailed spatial overview of crime trends over a six-year span, from 2019 to 2024. Its visual representation uses lighter color to indicate areas with no reported crimes, while darker shades highlight regions with high crime rates, allowing for swift and easy interpretation of crime patterns.

This mapping approach enables users to identify which barangays consistently report high levels of criminal activity and which remain comparatively safer. By highlighting both persistent and emerging hot spots, the map provides valuable context for understanding the geographic shifts in crime and supports data driven decisions for improving local security.

To further clarify, density mapping is essentially a technique used to show where data points or lines are concentrated within a given space (Altaweel, 2017). A related method, the dot map also known as a dot density or dot distribution map uses uniform point symbols to represent occurrences of a particular phenomenon across geographic areas. These maps are commonly utilized in disciplines such as geography, urban planning, and demography to visualize spatial distributions (Todd, 2024).

Additionally, choropleth maps serve as another powerful visualization method, transforming complex datasets into visually accessible formats. By doing so, they help viewers quickly interpret numerical information and draw meaningful conclusions about the geographic patterns being studied (Spatial Post, 2024).



2024 Crime Attribute Records

Barangay	Latitude	Longitude	Crime Events
Anilao	12.73144	121.4941	Physical Injury
BB2	12.75515	121.4792	Theft
BB1	12.7492	121.4728	Theft
Aplaya	12.74628	121.48462	Physical Injury
Ipil	12.74628	121.48462	Physical Injury
Lisap	12.68775	121.38227	Physical Injury
Labasan	12.77441	121.47266	Theft
Sigange	12.76207	121.41146	Theft
Ogbot	12.66465	121.54113	Theft
Hagan	12.71513	121.3955	Rape
Hagan	12.70129	121.393	Physical Injury
Formon	12.69661	121.4293	Rape
Sagana	12.71228	121.48285	Rape
Sagana	12.71194	121.47346	Theft
Cawayan	12.66465	121.54113	Rape
Malitbog	12.73219	121.41094	Murder
Dayhagan	12.63188	121.54391	Homicide
Morente	12.66255	121.42095	Rape
Morente	12.65902	121.44557	Physical Injury
San Isidro	12.67585	121.48827	Rape
San Isidro	12.70407	121.49189	Rape
Kaligtasan	12.65413	121.49231	Rape
Kaligtasan	12.64083	121.49412	Theft
Kaligtasan	12.65603	121.493	Physical Injury
Poblacion	12.74335	121.48118	Robbery
Poblacion	12.74057	121.47603	Robbery
Poblacion	12.7384	121.47715	Robbery
Poblacion	12.74226	121.48035	Robbery
Poblacion	12.73887	121.48375	Robbery
Poblacion	12.74443	121.48146	Rape

Figure 3. Attribute Map representing the year 2024

Attribute mapping refers to the process of systematically associating complex data types, user defined classes, or collections with objects in a domain model, enabling the representation of diverse data within a structured system (Information Systems, 2019). The primary function of an attribute map is to visually display specific data or characteristics tied to geographic locations, allowing users to analyze patterns beyond physical boundaries. In crime mapping, these maps illustrate data such as crime types, frequency, and socio-economic factors within each barangay, helping researchers and policymakers compare areas and identify correlations such as the connection between poverty and crime. By integrating tabular data with spatial information, attribute maps simplify the interpretation of complex datasets and enhance their practical application.

In the context of crime analysis in Bongabong, attribute maps serve to visually represent data on crime types, frequencies, and contributing social factors across barangays. This enables the identification of trends and relationships between geographic areas and the variables influencing crime, supporting strategic interventions based on accurate, location specific data.

The attribute map of Bongabong displays the municipality's barangays along with their latitude and longitude coordinates, highlighting specific crime incidents within each location. This combination of spatial and attribute data allows for more detailed crime analysis, helping to reveal patterns and trends that can inform evidence-based planning for crime prevention.

In support to these maps, SAS Graph Template Language (2024) explains that attribute maps maintain consistent graphical properties for specific values or value ranges, regardless of data order or range, which ensures visual consistency in graphs. Additionally, Gomes (2016)

emphasizes that dot maps are particularly effective for representing absolute values in thematic cartography, making them a useful tool in visualizing crime data.

Conclusion

The development of thematic maps provided powerful visual tools for understanding the spatial and temporal distribution of crime. The Historical Map tracked changes in crime rates over time, highlighting peak years and potential correlating socio-economic shifts. The Density Map illustrated high-crime areas, enabling strategic prioritization of law enforcement resources. Meanwhile, the Attribute Map offered detailed insights into specific crimes and their locations, facilitating more targeted, data-informed interventions.

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