

# Crime Hotspot Mapping in Bayombong, Nueva Vizcaya

Karen D. Taclay\* and Richard J. Taclay

Department of Mathematics and Statistics  
Nueva Vizcaya State University-Bayombong Campus

\*kdtaclay@gmail.com, richard.taclay@yahoo.com

**Abstract.** Based on the Philippines in Figures 2017, there are 139, 459 reported index crimes and 445, 274 non-index crimes in 2016. Looking at the data from 2014 to 2016, there was a decrease in these numbers. However, these are still alarming numbers as it places almost 566 crimes to occur per 100,000 population in the country. This paper describes the crime-related incidents and where they tend to concentrate in terms of types of crime (index and non-index crimes), location and time. It also determined the hotspots of crime-related incidents at Bayombong, Nueva Vizcaya. It was found that spatial clustered patterns exist when crime-related incidents were grouped according to type of crime (non-index and index) and time of occurrence (morning and afternoon). Moreover, hotspot analysis revealed that particular barangays are prone to vehicular accidents (non-index crimes) while most of the barangays in the town have little to no chances of predictability as to the time of the occurrence of the crime-related incidents.

**Keywords:** hotspots, index crimes, non-index crimes, spatial clustered patterns

## 1. Introduction

Crime is one of the many forms of socio-cultural problems in the world. It is a significant concern not only in urban areas but also in rural areas throughout the Philippines. Crime occurs when someone breaks the law by an overt act, omission or neglect that can result in punishment. A person who has violated a law, or has breached a rule, is said to have committed a criminal offense. Typical crime includes pick pocketing, acquaintance scams in some cases, credit card fraud, carjacking, kidnappings, robberies, and violent assaults. Theft, physical assault, and robbery were the most common crimes reported to local authorities in 2016, according to the Philippine National Police Directorate for Investigation and Detective Management.

Based on the Philippines in Figures 2017, there are 139, 459 reported index crimes and 445, 274 non-index crimes in 2016. Looking at the data from 2014 to 2016, there was a decrease in these numbers. However, these are still alarming numbers as it places almost 566 crimes to occur per 100,000 population in the country.

The province of Nueva Vizcaya is not exempted in experiencing crimes. Its capital, the municipality of Bayombong, a first class municipality consisting of 25 barangays have recorded crime incidents. Crime this decade is becoming abundant, specific locations differ in crime rates while police have spent decades trying to perfect techniques for distributing resources efficiently to cope with these crime hotspots.

Bayombong has one of the highest crime rates in the region. In 2017, it recorded a total of 1, 372 crimes resulting to a crime rate of 178 per 100000 population. Moreover, in the first quarter of 2018, a total of 282 crimes were registered resulting to a crime rate of 148 100000 population. Consequently, it was listed as the foremost in highest crime rates as stated in the Crime Information, Reporting and Analysis System (CIRAS). This is an alarming information since our university is located in Bayombong. Hence, the researchers conceptualized this study to warn others of the possible locations where crimes often occur.

Crime hotspots are areas on a map that have high crime intensity. They are developed for researchers and analysts to examine geographic areas in relation to crime. The technique of Hotspot Mapping is widely used in analyzing the spatial characteristics of crimes which is very

useful for the police and government officials. The spatial distribution of crime is considered to be related with a variety of socio-economic and crime opportunity factors.

Hotspot analysis assists police in identifying high-crime areas, types of crime being committed, and the best way to respond. Hotspot analysis depends on several factors which may vary. These varying factors or elements necessary in analyzing hotspots may include: analysis focus, spatial dependence, crime type, time intervals, barriers, output display, and software. In addition, establishing a stronger link between theory and practice will help avoid the arbitrary approaches to hotspot analysis and give an analyst a scientific foundation from which to work.

Developing maps that contain hotspots are becoming a critical and influential tool for policing. They help develop knowledge and understanding of different areas in a city and possibly why crime occurs there.

In this study, the researchers determined the crime-related incidents and where they tend to concentrate in terms of types of crime (index and non-index crimes), location and time. It also determined the hotspots of crime-related incidents at Bayombong, Nueva Vizcaya.

## 2. Methodology

This study applied the exploratory design to determine the cluster maps and hotspots on crime-related incidents in Bayombong, Nueva Vizcaya according to the types of crime (index or non-index crimes) and time.

The crime-related incidents were based from police reports from January 2015 to December 2017 taken from the Bayombong Police Station. The data was then analyzed using GIS (Geographic Information System) to locate crime hotspot patterns and distributions.

In particular, spatial autocorrelation (Moran's I) was applied on the crime-related incidents grouped according to type and time to determine if the incidents tend to be clustered together in space (positive spatial autocorrelation) or dispersed (negative spatial autocorrelation). Hotspot Analysis (Getis-Ord  $G_i^*$ ) was also utilized to determine the hotspot and coldspot areas in Bayombong when crime-related incidents were grouped by type and time.

## 3. Results

### Spatial Distribution of Crimes according to Type

The town of Bayombong has the following recorded crime-related incidents based on the police reports gathered at the Bayombong Police Office from January 2015 to December 2017.

Table 1. Crime-related incidents according to type

<b>Types of Crimes</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>TOTAL</b>
Index Crimes	124	312	261	697
Non-index Crimes	441	1131	1209	2781
<b>TOTAL</b>	<b>565</b>	<b>1443</b>	<b>1470</b>	<b>3478</b>

The figure that follows illustrate the distribution of the crime-related incidents according to type (index and non-index crimes). Moreover, spatial autocorrelation analysis showed that there is clustering according to the type of crimes that occurred in Bayombong. Quantitatively, the z-score of 10.42365 meant that there is less than 1% likelihood that this clustered pattern could be the result of random chance ( $p = 0.000000$ ). It is observed that most of the crime-related incidents are non-index crimes.

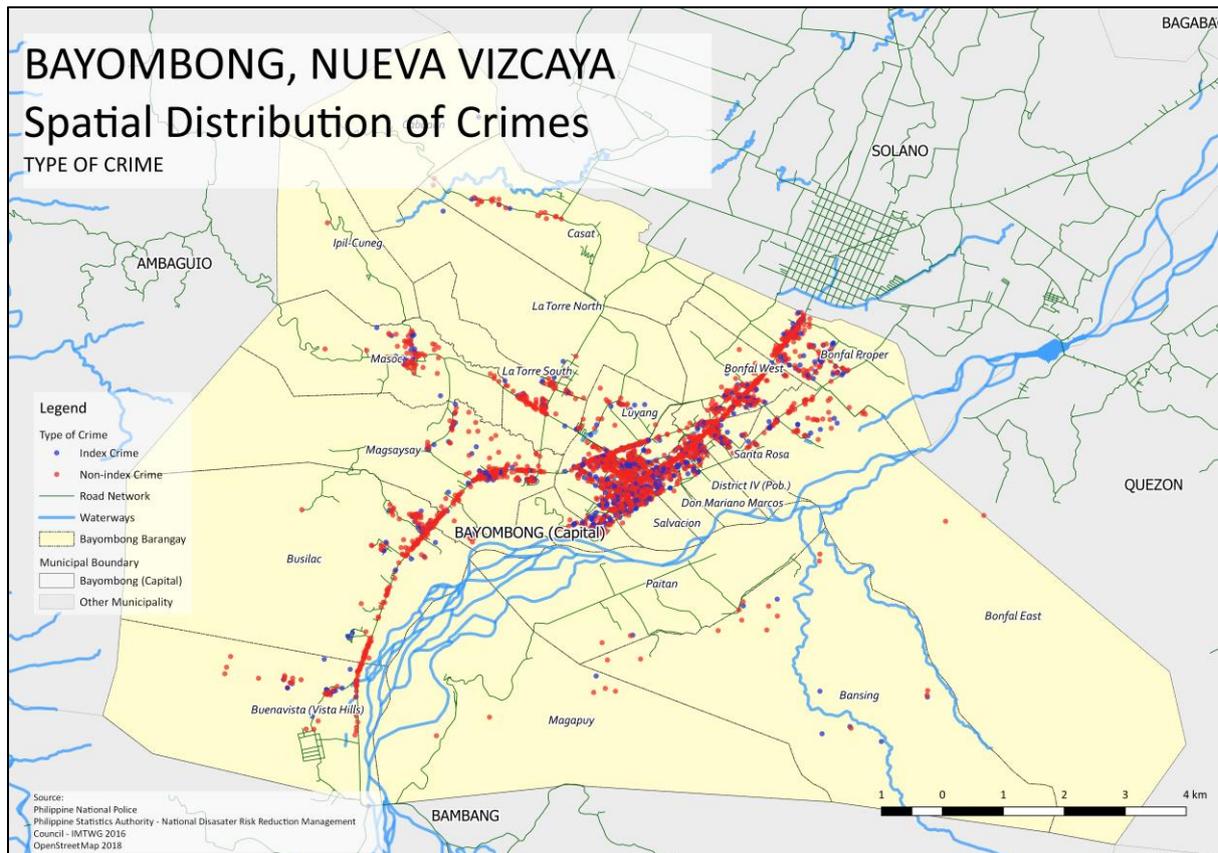


Figure 1. Spatial Distribution of Crimes according to Type

Figure 1 clearly showed that clustering of non-index crimes occur in most of the barangays of Bayombong. Heavy accumulation of points were observed at the central business district of the town. These are mainly the barangays of Don Mariano Marcos, District IV, Salvacion and Santa Rosa. Further investigation shows that most of the non-index crimes are identified as vehicular accidents. Thus, it is seen that most of the crime-related incidents happen in road networks of the town.

In addition, the associated values show positive autocorrelation. This implies that non-index crimes have an assumed great probability of occurring in these barangays.

### Spatial Distribution of Crimes according to Time

In terms of the time that crime-related incidents happen, the computed z-score is 3.365315, there is less than 1% likelihood that the clustered pattern could have been the result of random chance ( $p = 0.000765$ ). It can be observed from Figure 2 that most of the crime-related incidents happen between 12nn and 12mn. Again the clustering occurs at the central business district of the town. These are the barangays of Don Mariano Marcos, District IV, Salvacion and Santa Rosa. Occurrences of crime-related incidents show a clustered pattern meaning these crime-related incidents have a high tendency of happening in the afternoon. As mentioned above, most of the crime-related incidents are vehicular accidents. Thus, with the result of the spatial autocorrelation, one can deduce that vehicular accidents mostly occur in the afternoon in road networks of the central business district.

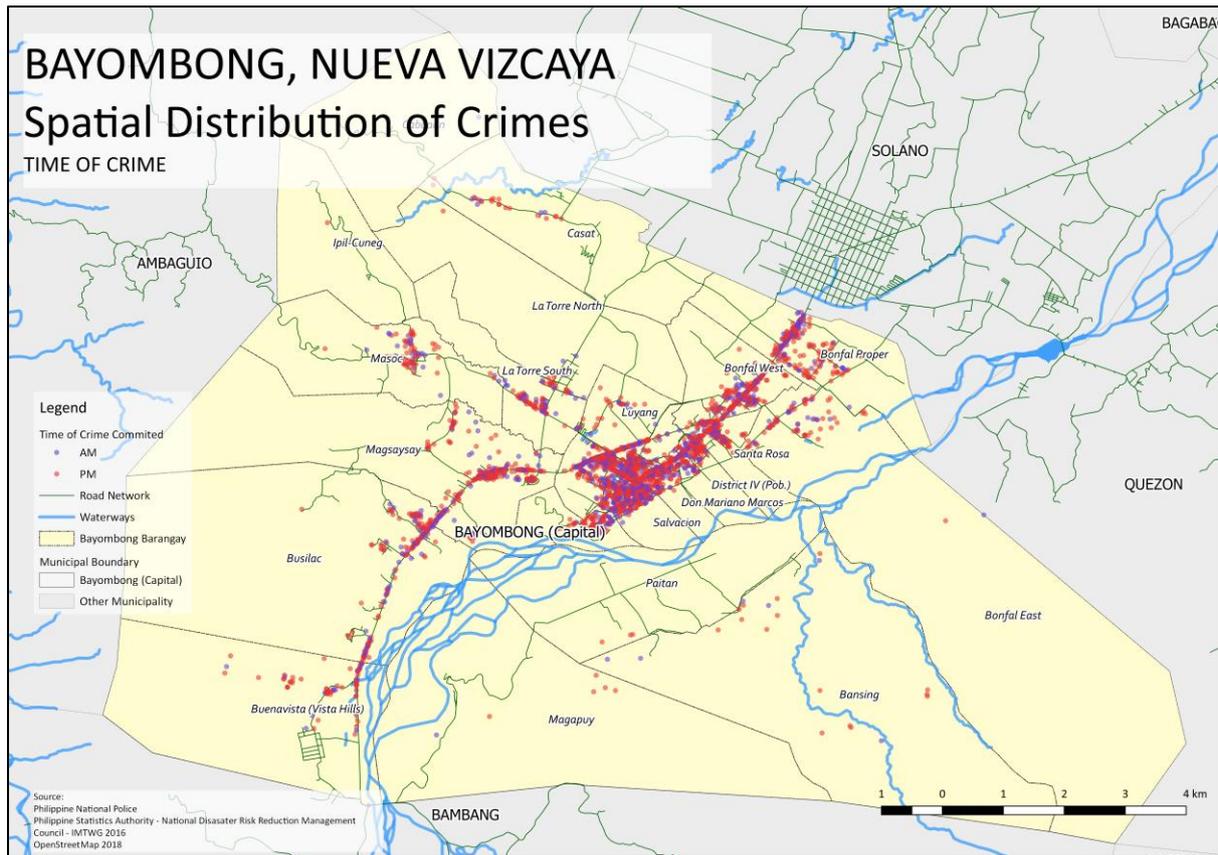


Figure 2. Spatial Distribution of Crimes according to Time

### Hotspot Analysis (Type of Crime)

Figure 3 illustrates the hotspot analysis of the spatial distribution of crimes according to type. Hotspot areas are identified as the barangays of Busilac, Bonfal West, Bonfal Proper. There is 99% confidence that crime-related incidents occur at these barangays. This is an implication that these barangays have greater than the average number of crime-related incidents.

An in-depth look at the barangays revealed that these barangays have road networks passing through the national highway. These are the locations where most of the reported vehicular incidents have happened. Thus, these areas are mostly likely the vehicular accident-prone areas. Currently, the local government units of Bayombong have on-going projects in line with road widening. These may lessen the cases of vehicular accidents but it is yet to be evaluated after its completion.

On the other-hand, there is 99% confidence that crime-related incidents may not occur at barangays Salvacion, Don Mariano Marcos, and District IV.

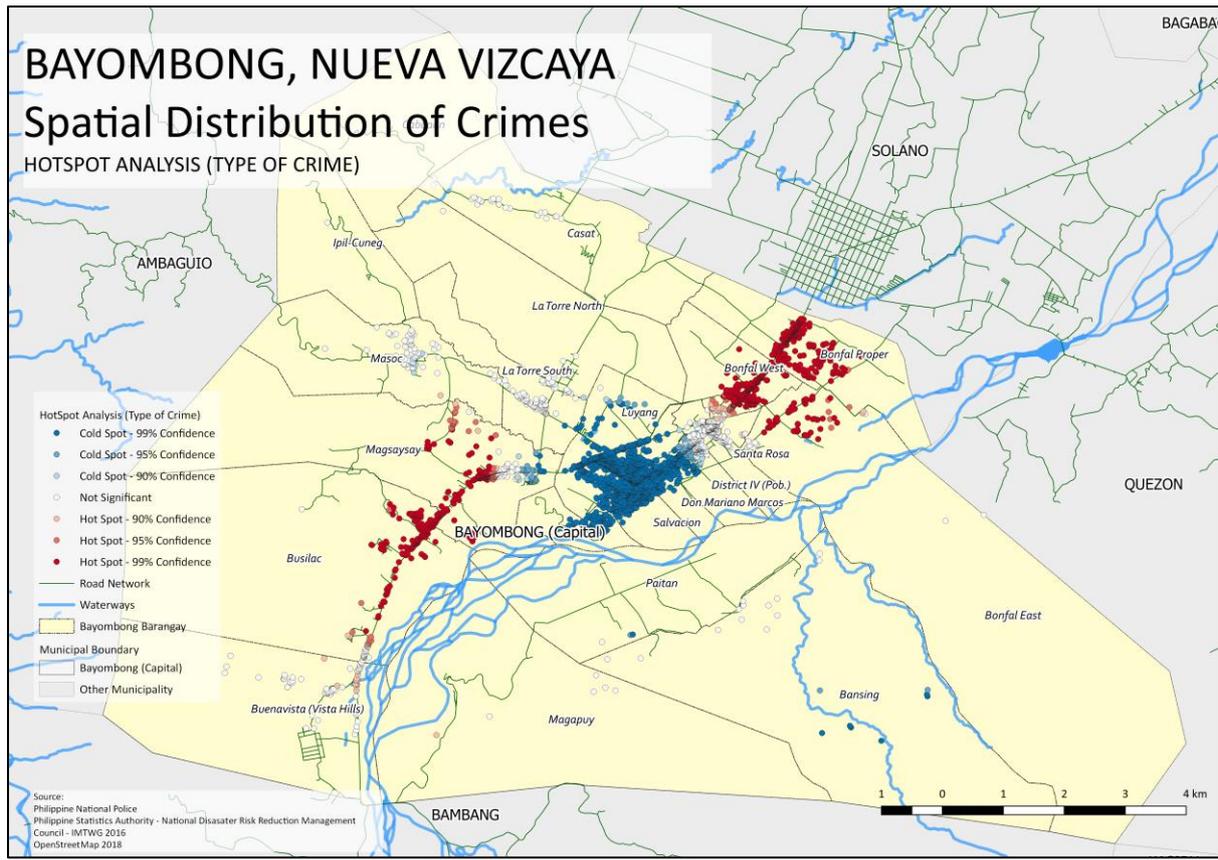


Figure 3. Hotspot Analysis according to Type

Hotspot Analysis (Time of Crime)

Figure 4 presents the hotspot analysis of the spatial distribution of crimes according to type. Hotspot areas identified are portions of barangays of Bonfal West and Santa Rosa. There is 90% to 95% confidence that crime-related incidents occur at these barangays when grouped according to time. This is an implication that these barangays have greater than the average number of crime-related incidents. These barangays are prone to crime-related incidents specially, in the afternoon.

Looking closely, these barangays particularly Bonfal West Barangay have the second highest population (4, 484) in 2015. At the same time, it is also the area where most vehicular accidents (non-index crime) occur. Santa Rosa on the other hand, have a population almost half of that of Bonfal West. However, this barangay has vast vacant lots as well as congested areas. These increase the chance of crime-related incidents to occur.

On the other-hand, there is no significance that crime-related incidents may occur at most of the barangays of Bayombong when grouped according to time. Thus, the time of occurrence of crime-related incidents in these areas have minimal predictability.

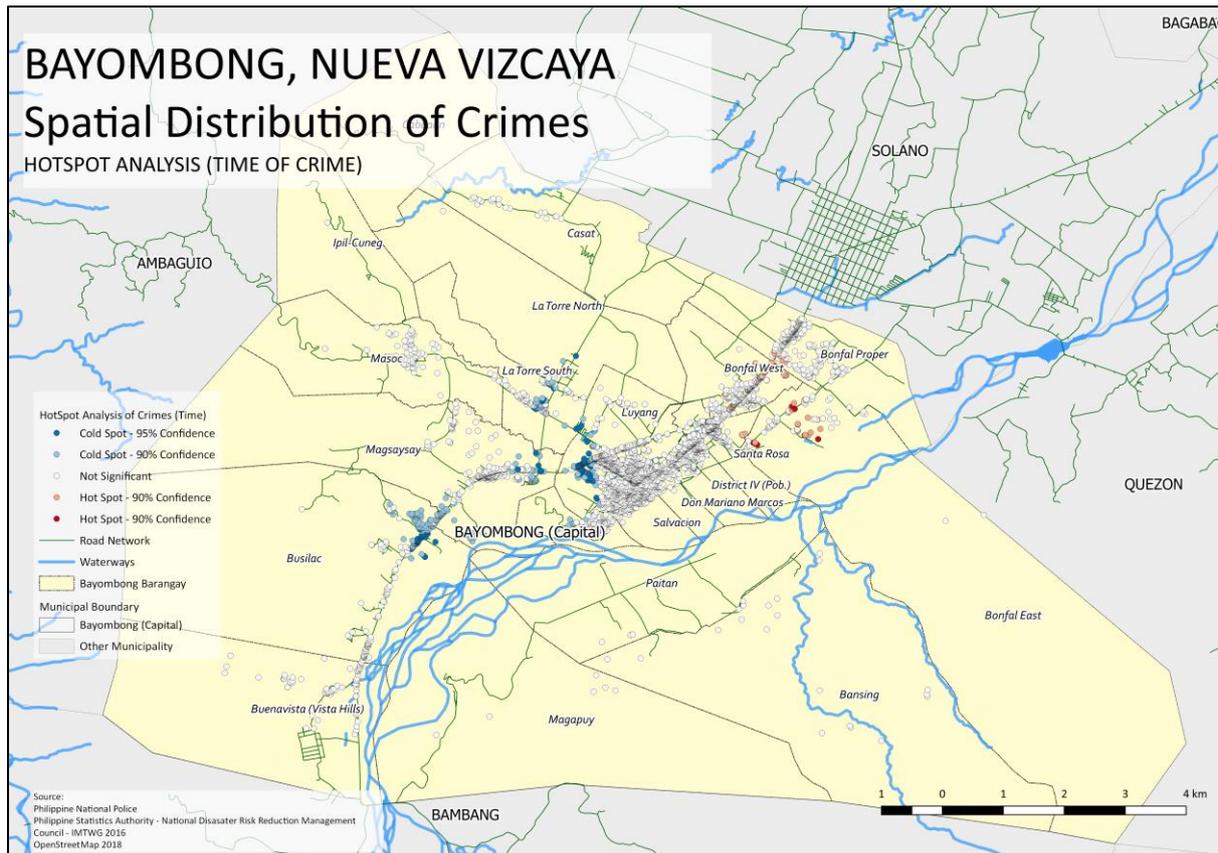


Figure 4. Hotspot Analysis according to Time

#### 4. Conclusion and Recommendations

The crime-related incidents according to type and time of occurrence fall within the spatial clustered pattern. Moreover, vehicular accidents were found to be the most occurring crime-related incidents in the town. The predictability of the crimes to occur were also considered. Particular barangays were pointed out as prone to high predictability of occurrence of the crime-related incidents particularly the non-index crimes.

In line with these results, the researchers investigated the areas through ocular inspection and interviews. This study aimed at furnishing the police force with a guide (the hotspot analysis maps and cluster maps) to minimize if not prevent further occurrence of crime-related incidents in their vicinities as well as warn the residents of the time and areas to be more vigilant.

#### 5. References

- Barangay Population Data Municipality of Bayombong. Retrieved from: [http://122.54.214.222/population/BgyPop.asp?prov=NUV&Mun=BAY&Munic=Bayombong%20\(Capital\)](http://122.54.214.222/population/BgyPop.asp?prov=NUV&Mun=BAY&Munic=Bayombong%20(Capital)).
- Gonzales, A., Schofield, R. and Hart, S. (2005) *Mapping Crime: Understanding Hot Spots*. NIJ Special Report.
- Gorr, W., Kurland, K (2012). *GIS Tutorial for Crime Analysis*, ESRI Press, Redlands CA 92373
- 2017 Philippines in Figures. Retrieved from: <https://psa.gov.ph/content/2017-philippines-figures>.