International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Geographic Information System for Crime Prevention: A Geo-Spatial Analysis in Colombo Suburbs, Sri Lanka

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Abstract: ***A link between spatial technology and criminal investigations has been growing fast for several decades. One of the main proposes of present criminological studies is to predict the possible ways of incidents occurring so that prevention measures can be adopted to the process of strategic planning. This study demonstrates the applicability of Geographic Information Systems (GIS) for identifying such possibility through spatial analysis on different crimes recorded. Spatial data analysis through GIS is becoming more popular in crime mapping and crime analysis in public safety agencies. This research paper attempts to identify the spatial and temporal distribution of crimes in one of the densely populated urban suburbs in Colombo; Peliyagoda Police Area. Recorded crimes during a particular period were the main data set of the study. In data analysis, different data models were created using GIS techniques and applied spatial tools such as Multiple Buffer Analysis, Density Analysis, Hot Spot Analysis and IDW Analysis. One of the main findings of this study is that the highest rate of criminal incidents have been reported within two km range from the Police Station. A specific temporal trend is progressive moving of crimes from South to the North during the period of past ten years. The spatial analysis model formulated by this research can be used to maintain the real time crime data at local, regional and global level.***

Keywords: CrimeMapping, Prevention, Low enforcement, Spatial Analysis, Sri Lanka

1. Introduction

Recent studies have shown that the spatial pattern of crimes have become is an effective way to enhance urban security. GIS is a special information system used to input, store, retrieve, manipulate, analyze and output geographically oriented data or geographic data to assist in decision making. It often enables us to explore the hidden spatial relationships of real objects. It is also used as an interface for integrating and accessing a large number of geographical and computer generated map location based information. GIS plays an important role in mapping and analyzing crime. Response capabilities often rely on different data from different organizations and sources. GIS activities, combined with the capabilities of GPS detection devices, facilitate the monitoring of high-risk individuals travelling through an area. Patrol officers can be more effective in presenting information to crime analysts. It is easier for the police to identify the locations and times that are most responsible for criminal activity. Crime Prevention is a set of ideas for hostile events and helps to simplify the actions of individuals and groups, both public and private. The crime patterns in the Peliyagoda police area are inherently complex and uncertain. To better understand the behaviour of offenders, models involving both space and time are needed. Current trends indicate that criminal activity has become more brutal and sophisticated. This calls for new ways of dealing with crime. GIS is well suited to present spatial and temporal aspects of crime events and to find spatial correlation. Crime mapping combines the skills of people, the practical use of data and information, and the application of technology to capture, analyses, identify and respond to crime problems and improve policing performance. Crime mapping techniques can also be applied to other police data such as incidents, offenders, victims, stops and searches (Blears, 2005).

Population	Sinhala	Tamil	Muslim	Berger	Other
63972	53803	5368	3687	578	627

Source: Census & Statistics Department, 2012
Figure 1: Population abstract for Nationality

Given the inherent geography of a crime scene, GIS is particularly suited to crime data. Mitigation plans can be used as an emergency response planning tool for police officers to determine mitigation priorities, analyze critical quarterly events, and predict future events. Criminal analysis is organized around a number of factors, including the nature and origin. The objective of the present study is to provide a provisional analysis of crime in the Peliyagoda Police Area to introduce a GIS model for crime prevention. In addition, determining the basic parameters that facilitate criminal activity and crime hotspots and ultimately reduce crime rates.

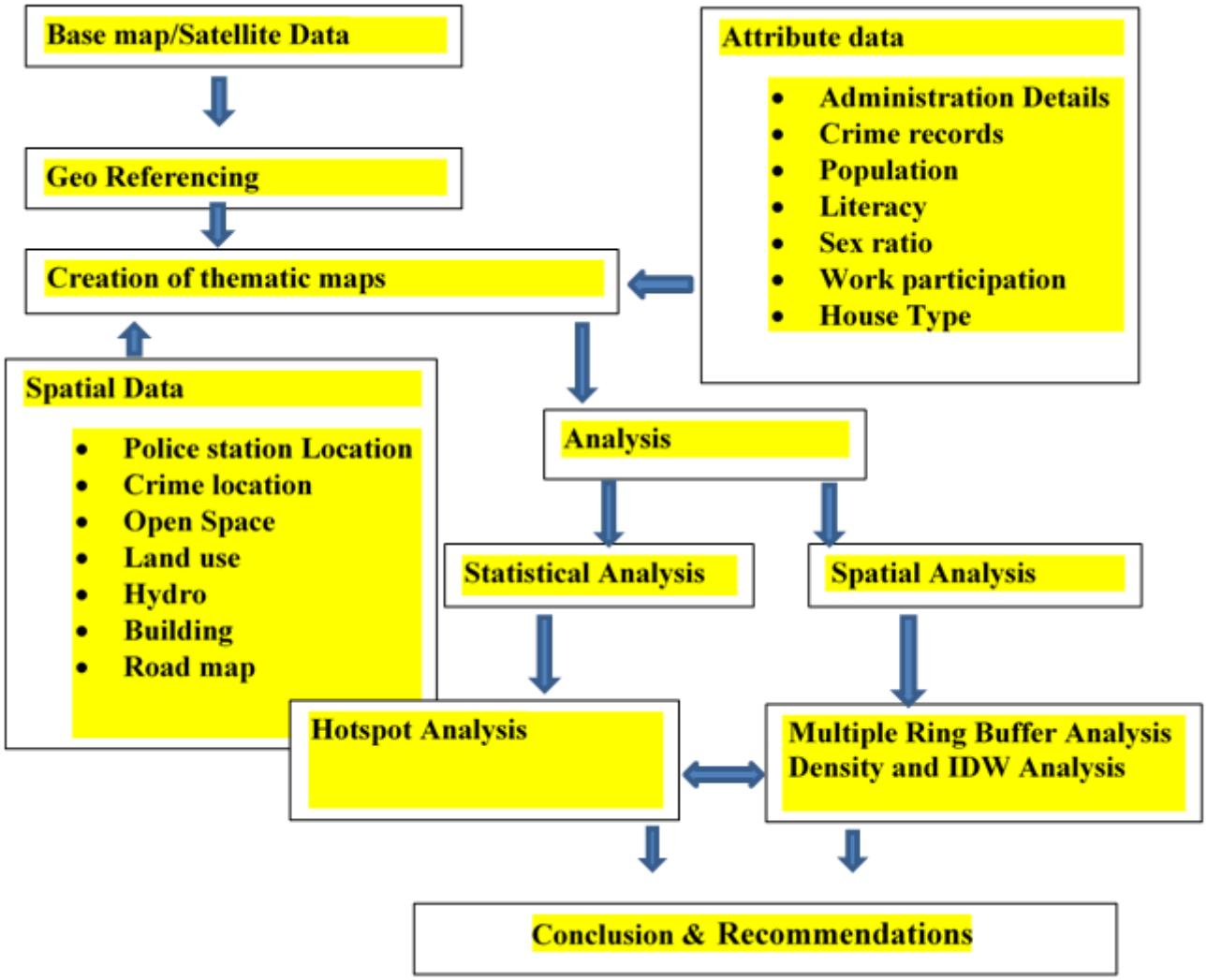


Figure 2: Flow Chart of Methodology

Crime analysis is a law enforcement function that involves systematic analysis for identifying and analyzing patterns and trends in crime and disorder. Information on patterns can help law enforcement agencies deploy resources in a more effective manner and assist on detectives in identifying and apprehending suspects. The study will examine the geographical distribution, crime, socio-economic characteristics of the selected Peliyagoda police area and the environmental factors that could contribute to the crime. It is used for ArcGIS 10.4.1 software analysis for a variety of spatial and temporal applications. Finally, these events analyze the relationship between crime and incidences of other functional growth. Data analysis was undertaken the following parameters.

2. Methodology

This study is based on the crime data collected from Peliyagoda Police Area (PPA) belong to Keleniya Divisional Secretariat in the Gampaha District of Western Sri Lanka. PPA is comprised of different educational, income and other social background including ethnic, social and cultural differentiations; 84.10% Sinhala, 8.39% Tamil, 5.74% Muslim and 1.88% other ethnicities. The main reason for selecting the research site is that the area has recorded highest crime rate compared to the other area of Colombo suburb.

Data variable of the study comprises types of crime, location, time and date of occurrence along with attribute data such as building density, road type, land use pattern as well as relevant demographic data form Census & statistics Department of Sri Lanka. The study has used a variety of criminal reports combined with auxiliary information to obtain crime hotspots in the area. As shown in Figure 02, both spatial and attribute data sets have been used in the study. The two way process of data analysis; statistical and spatial was adopted particularly in different analytical methods such as hotspot, multiple ring buffer, density and IDW analysis.

3. Results and Discussion

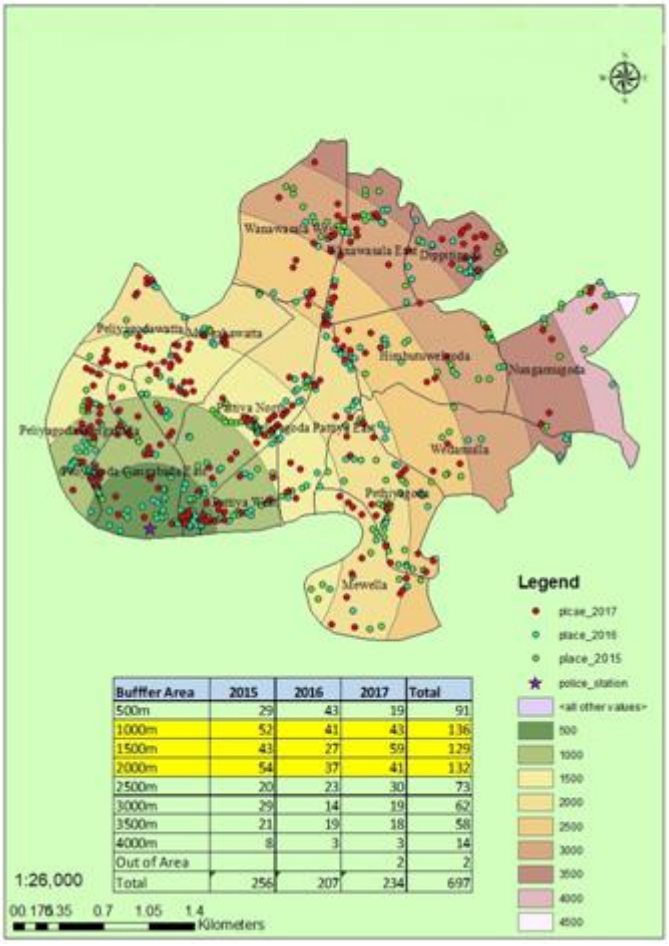
Data analysis of the study has been undertaken with six parameters as follows.

Distance between the location of crime incident and the police station.

- Density of different type of crimes.
- Temporal distribution of crimes.

- Determination of hotspots.
- Identification of crime patterns.
- Identify of spatial relationships.

The first parameter distance between the location of crime incident and the police station concerns to identify whether there is a distance between police station and crime incidents occurred during the selected period of three years from 205-2017. This analysis was made by using "Multiple ring buffer tools" on Arc GIS. Moreover, distance unit were considered as 500 meter per each one ring buffer zone from, Police station to Police area boundary. Digitizing grave crimes point map used to the buffer analysis and each year point map indicate in different colours. Figure 03 shows the output of multiple ring buffer analysis in a map form. According to the results for the year 2015, 2016 and 2017, the total criminal incidents were recorded as 136, 129 and 132 from 500 to 2000 meters buffer region respectively. This buffer zone exists high density of population, factories, roads and shanties.



Bufffer Area	2015	2016	2017	Total
500m	29	43	19	91
1000m	52	41	43	136
1500m	43	27	59	129
2000m	54	37	41	132
2500m	20	23	30	73
3000m	29	14	19	62
3500m	21	19	18	58
4000m	8	3	3	14
Out of Area			2	2
Total	256	207	234	697

Figure 3: Distance between the location of crime incident and the police station

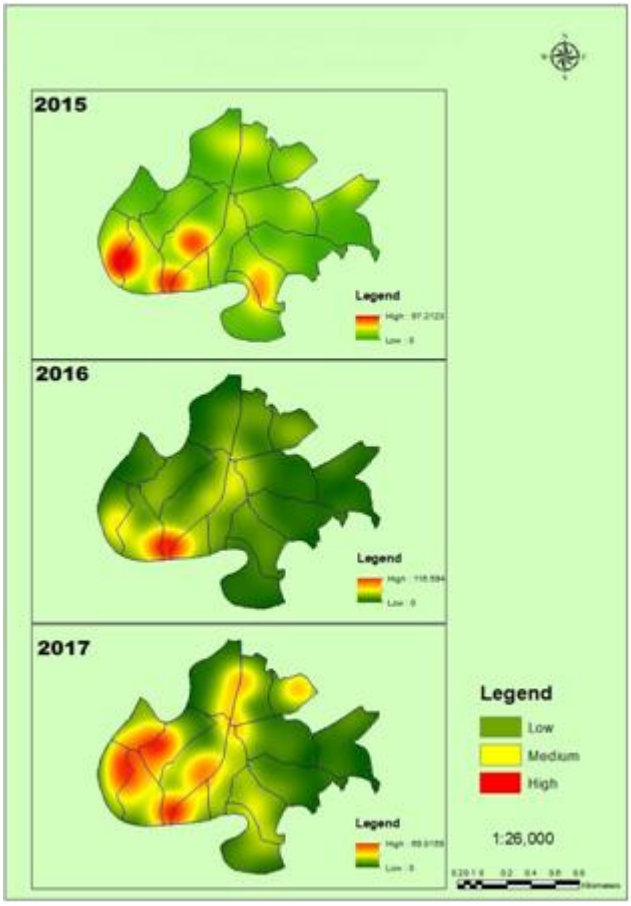
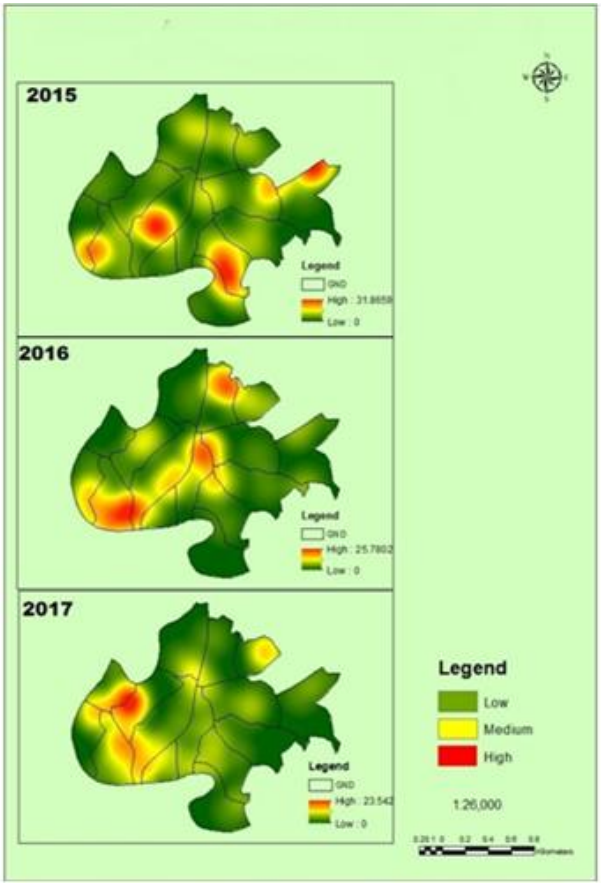


Figure 4: Density of grave crines 2015-2017



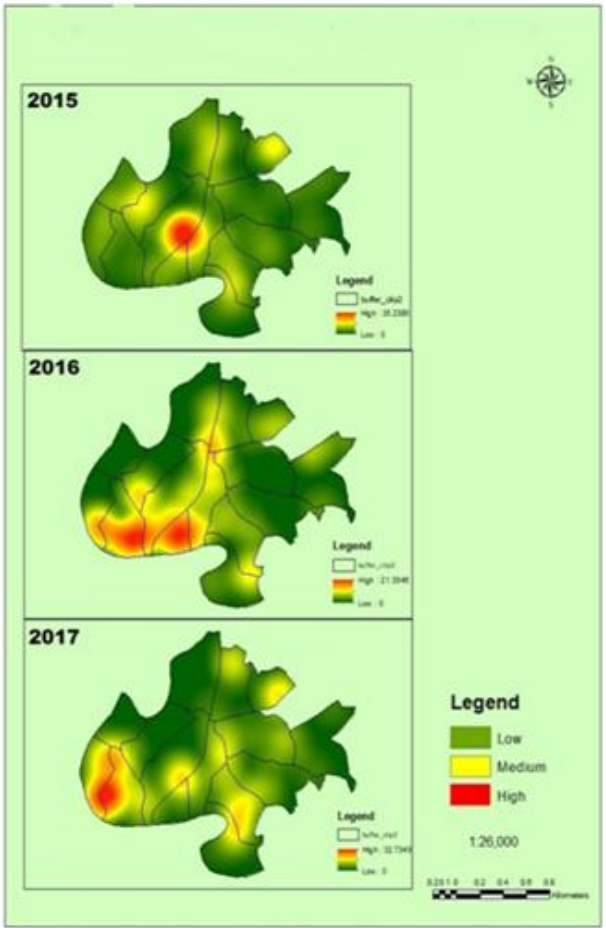


Figure 5: Distribution of crimes against property – Night time and Day time

The Kernel density estimation approach offers a number of practical advantages over the use of census tracts in visualizing complex crimes patterns. This allows understanding where crime is occurred as well as determining if there are any patterns. GIS kernel density analysis is a valuable tool as it allows police to not only identify areas of high crime but also explore variables that are affecting crime patterns. According to the Figure: 04 in the year 2015 high density of grave crimes were reported in Peliyagoda gagabada, Peliyagoda gagabada east, Pattiya west and Pattiya north GN divisions while Peliyagoda gagabada east and Pattiya north GN divisions were reported in 2016. This had been slightly changed in 2017 as Peliyagoda gagabada east, Peliyagoda gagabada, Paliyagodawatha, Meeghawatha, Pattiya north and Pattiya west GN divisions. During the three years of period most of the grave crimes were occurred in three divisions particularly; Palliyagoda north, Paliyagodagagabada and Meeghawatha GN Divisions.

There is a significant temporal pattern of the distribution of crimes against property during 2015-2017 period as shown in figure 05. The past densities and the extreme density of crimes over the past three years are just the same in harmony with the gravity of the crimes committed in the same region. Serious crimes were committed in the same area during the day and night time too. There is no considerable difference of the crimes against property in day or night time as shown in the Map.

Figure 06 indicates the result of hotspot analysis for grave crimes in PPA in 2017. The recorded incidents presented by dots while graduated colour represents the hotspot where criminal incidents were mostly recorded. The hotspots can be identified in GN divisions of Pattiya North and the Meegawatte. The IDW Intervention Crimes Analysis shows that the areas shown in white color patches are more vulnerable and more at risk of serious crimes than others. The area that the IDW interference refers to is a relationship rather than a hotspot area. In 2017, serious crime hotspots were detected in Pattiya Junction, Pattiya Junction, Railway Bridge, Fish Market and Suburbs.

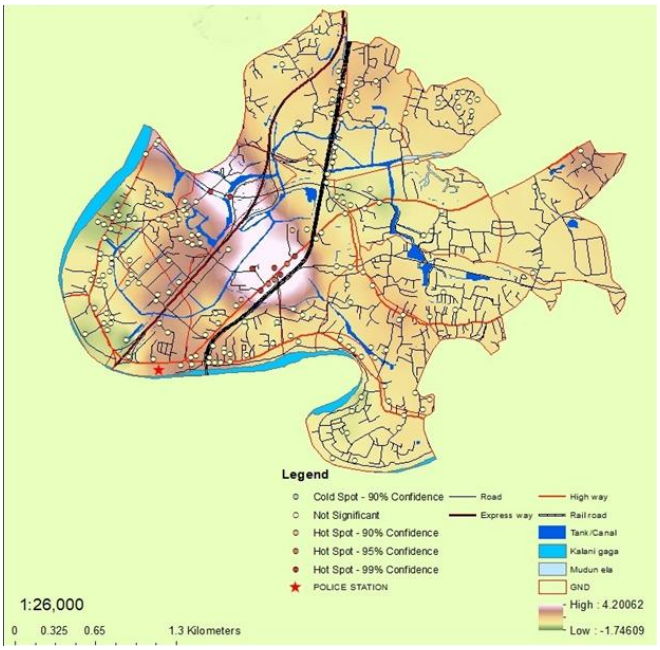


Figure 6: Hotspots of Grace crimes in 2017

4. Conclusion

The main problem with this study is to check the reliability of GIS procedures to investigate the crime pattern of the Peliyagoda Police area using the available data. Study is being used to identify the spatial and temporal pattern of identifying the crime. Comparison with our results and data in this study was successful in comparing different types of GIS applications. In this study GIS methodology is systematically analyzed as follows.

a) Buffer analysis
c) Density analysis
d) Hotspot and IDW analysis

Initial studies have demonstrated the effect of a variable resolution of the space for a significant space. In all recoded crimes on investigations carried out in the Peliyagoda Police area , year 2015, 2016 and 2017 distance between police station from 0.5 to 2 Km meters away from recoded grave crimes on highest than in other areas were detected. This area recognizes a crime

classification pattern for the total data. According to the crime density analysis, there was a highest level of reported grave crime incidents in PPA in Gagabada, Gagabada east, Pattiya north and Pattiya west GN divisions. The area of the highest grave crimes is around 2.5 Km2 range. Densities of the crime over the year 2017 are just the same in harmony with in the same region during the day-time and during the night-time.

IDW and hotspot analysis is a system used for data analysis. However, although all interconnected systems can be restricted, IDW and Hotspot interconnection systems are the predictor of crime. Above GIS analysis explains the spatial and temporal variation in relationship among geographic dataset and across geographic regions in PPA. The Peliyagoda Police Station is closely bound up with the social factors associated with crimes. The GIS operating system is a better tool to reduce the crime rate through better crime prevention policies and planning.

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