Understanding trio robbery crimes through spatial analysis

by Dr. Corné Eloff, CSIR

Social contact crimes and robberies within South Africa are still a dominant criminal behaviour that labels South Africa as one of the most violent crime countries in the world. Contact crimes are social or domestic in nature and occur primarily within the social environment of the perpetrator, such as his/her private residence.

The CSIR undertook research to explain and illustrate the spatial behaviour of the "trio" crimes (carjacking and truck hijacking; robbery at residential premises; and robbery at non-residential premises).

The research is based on spatial analysis at specific geographical interval levels. It uses a combination of remote sensing technology integrated with geographical information systems (GIS) analytical models that are overlaid with geo-coded crime data to provide a spatial technological basis for analysis.

The logic for this analysis is that effective policing takes place at micro-level and not at macro-level. The more precisely the behaviour of crime is understood in a small manageable area, the better the chance to curb the crime within such area.

Area under scrutiny

The trio crimes investigated occurred within the provincial boundary of Gauteng between August 2008 and January 2009.

The spatial analysis used to better understand the behaviour of these trio crimes within Gauteng is based on thematic maps illustrating the crime counts at police precinct, suburb and enumerator area level. Furthermore, the analytic results of hot spot areas as well as the weekday and time analysis will provide valuable information to better understand and combat these crimes in a specific geographical area.

The trio crimes have consistently increased over the past three years despite various operational policing efforts to curb these crimes in 2006 and 2007. Analysis done by the SAPS Crime Information Management Department in 2007/2008 revealed that more than 75% of these trio

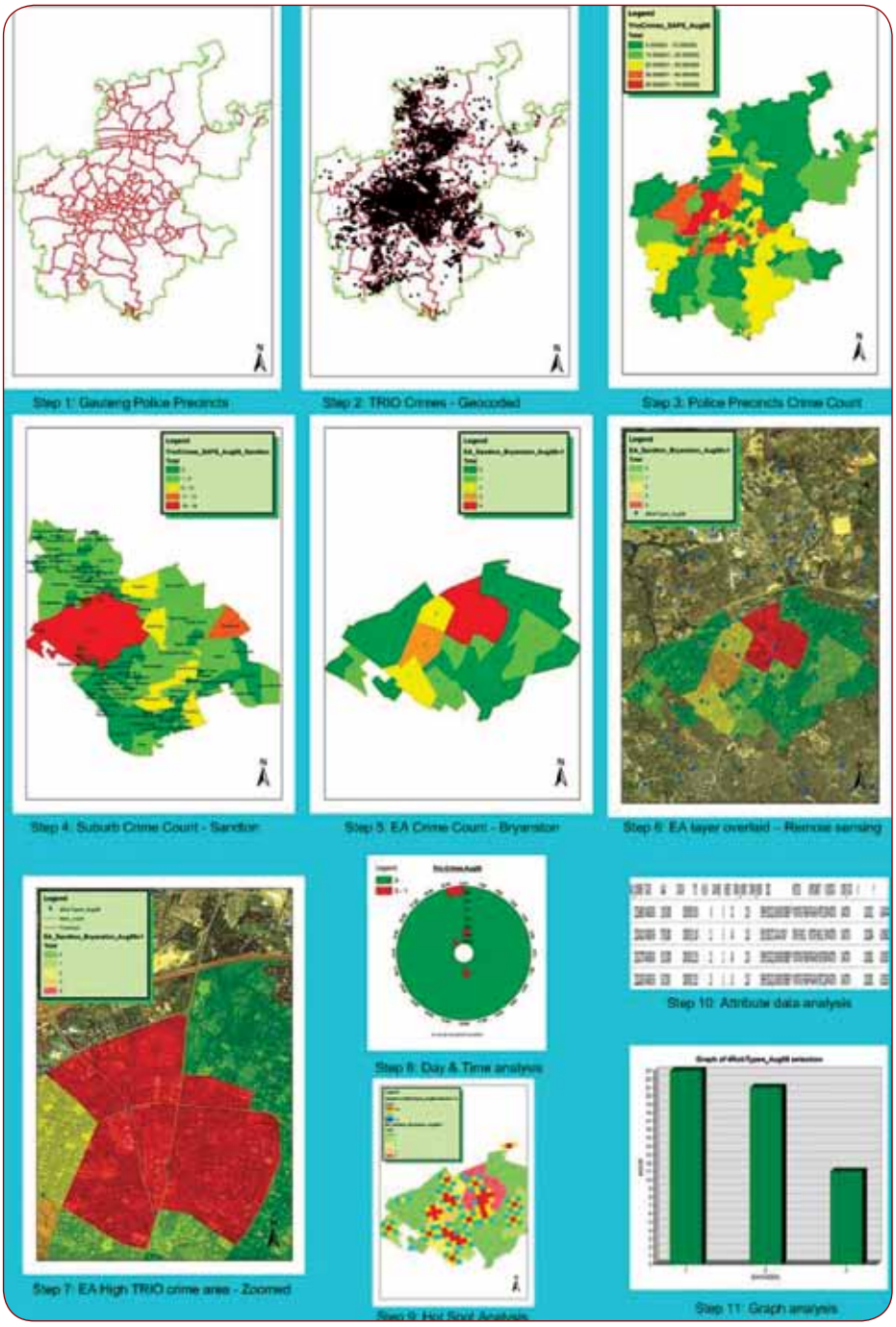

Fig. 1: Trio geo-coded crime within Gauteng.

crimes occurred in Gauteng (50%+) and KwaZulu-Natal (25%+). It thus made sense to select Gauteng as the geographic area of choice for this research.

The Gauteng province calculates to an estimated 18 000 km^2 and consists of 159 police precinct areas. The geo-coded trio crime incidents over Gauteng from August 2008 until January 2009 calculate to 11 069. The crime clusters dominate the Johannesburg and Pretoria metropolitan areas as illustrated in Fig. 1.

Setting out to work

The methodology applied during this analysis is illustrated in Fig. 2.

Step 1: Select area for spatial analysis

The first step is to select the specific area for analysis without exceeding the provincial boundary area. The spatial analysis extent was limited to police precinct polygon areas. These police precinct areas are the first formal spatial analytical areas to be used to clip the geo-coded crime.

Step 2: Select geo-coded crimes

During analysis, the selection of specific crime types, incident period and geographical location is required to understand the behaviour of crime within a specific polygon area.

Step 3: Crime count within police precinct area

The analytical crime result within the police precinct is done by using a point-to-polygon count algorithm. The spatial location of the point feature (crime) is used to count its location within a specific polygon (police precinct). The preparation of both layers (point and polygon feature) is essential for accurate results.

Step 4: Crime count within suburb areas

The crime-count analysis over the police precinct areas revealed the high-crime areas, coloured in red and orange. The illustration of high crime at a police precinct level is not good enough to pinpoint the actual crime problem within such a precinct. Thus, a further drill down into a smaller formal boundary area is essential.

Step 5: Crime count within enumerating areas

An enumerating area (EA) is the smallest formal statistical boundary available for spatial analysis; each polygon represents an estimate of 250 households. This level of crime analysis enables the researcher to determine the behaviour of crime at a micro-level. The crime types, modus operandi, time of incidents, characteristics of the perpetrator as well as the victim, can be determined at this spatial level to influence a proper and informative policing strategy to curb crime in such an area.

Step 6: Remote sensing imagery

The use of high resolution satellite imagery or aerial photography to visually interpret the environmental surroundings, land cover and land use classes within a specific area is of critical importance to better understand the rationale for specific crime incidents at a specific place and time. Changes within a specific area could attract a specific crime type.

Step 7: Interpret the crime incidents

The identification of the actual crime incidents within an EA enables the research to study their characteristics. The imagery, geo-coded crime features and auxiliary spatial layers viewed at a scale below 1: 2500 enable the viewer to interpret the area at the actual spatial location of the crime incident.

Step 8: Data clock analysis

Each crime incident has various attribute information such as the time and date when the incident occurred. Selecting the crime incidents within a specific EA, suburb or police precinct will enable the researcher to determine the peak weekdays and time of occurrence for a specific crime type.

Step 9: Hot spot analysis

Applying specific spatial statistical analysis techniques over an area will highlight the geographical density of crime events. It is recommended that the cell size output is modified in relation to the extent of the area being analysed. The larger the area, the larger the cell output; the smaller the area, the smaller the cell output.

Step 10: Attribute data analysis

Each geo-coded crime incident has various attribute information layers that can be used for multi-variable analysis. The researcher can, for example, determine the correlation between a specific vehicle type and

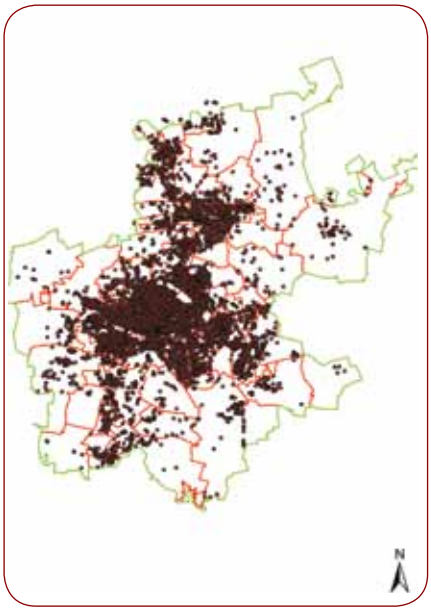

Fig. 2: Workflow process for spatial crime analysis.

the time of the carjacking, or the correlation between the characteristics of the victim and the method used during the occurrence of the crime.

Step 11: Graphical presentation of data analysis

The last step is the use of the correct visual display of data analysis results, other than just the spatial maps. The use of specific types of graphs to illustrate the correlation between two or more variables is very important to explain the results. The use of scatter diagrams, 2D or 3D axis graphs could, for example, be used for illustration purposes.

The research (full paper, including case study, is available from www.csir.co.za/research-space) techniques are neither in isolation of each other nor limited to those introduced. The essential concept illustrated during this research is that crime can best be understood and curbed over a smaller geographical area compared to a general analysis over a large area. The downside of micro-analysis is that inaccurate results can enter easily if the geo-coded crime data with their attribute information are incorrect. The researcher must therefore ensure the validity of the data to ensure truthful results.

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