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Crime Mapping and Law Enforcement-Scope & Applications

by
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Though computer mapping has been used as a tool for law enforcement since the 1970s, the use of GIS (Geographic Information Systems) has increased particularly in the last few years with the availability of more effective and user-friendly desktop GIS applications. GIS is an umbrella term used to identify a set of procedures and protocols involving hardware/software for organising, storing, retrieving, analysing and displaying data that has a space dimension. A host of operational activities in law enforcement include spatial relationships. Traditionally, these activities have been supported by paper maps and pins. While paper maps will not wane in the immediate future, law enforcement agencies now have the ability to immediately generate maps directly relevant to the situation at hand. Law enforcement agencies collect vast amounts of data from many sources. GIS allows integration and analysis of data to identify, apprehend, and prosecute suspects, it aids more proactive behaviour through effective allocation of resources and better policy setting. In US, GIS has proved to be a powerful decision making tool for investigators, supervisors, and administrators. The Crime mapping Research Center (CMRC) in the US has done immense work in this area. With assistance from this Center, as much as seventy percent of police departments in the US are relying on crime mapping for prevention and control of crime.

The distribution of nature and patterns of crime over space provide meaningful insight to the law enforcement agencies. Crime mapping has facilitated this task in highly effective manner. The linking of information with several databases to an incident location, police can obtain the history of incidents at an address. Access to this breadth of information promotes development of strategies for dealing with ongoing situations and aids in completing investigations.

GIS not only helps analyse crime trends but can also be used as a tool in managing the resources available to the agencies. Balancing workloads by drawing up more equitable beats and evaluating the results of selective traffic enforcement plans are just two ways GIS helps coordinate feedback and allocate resources.

GIS Tools in Crime Mapping and Crime Prevention

There are now desktop GIS packages tailored to meet the varying

needs of law enforcement agencies. Initially, the basic GIS softwares like Arc View/ARcInfo were applied in crime mapping. Eventually, the extension of such softwares addressing to the specific requirements of crime mapping and related matters came into being. A brief gist of GIS softwares would be in order here.

- Arc View
- Arc GIS Spatial Analyst
- Arc GIS 3D Analyst
- Arc View Business Analyst
- Arc View Network Analyst

- Arc View Tracking Analyst
- Arc Logistics Route
- Map Objects
- Internet Map Server

We may now look at briefly to the tools that were specifically developed for crime mapping and allied objectives.

Crime Stat

Developed under aegis of the National Institute of Justice in the US, Crime Stat is a statistical program for the analysis of crime incident locations. This program allows law enforcement agencies and criminal justice researchers some additional statistical tools in their crime mapping endeavours. The programme inputs incident locations (e.g., vehicle theft locations) in "dbf", "shp," "dat" or ASCII formats using either spherical or projected coordinates. The program calculates various spatial statistics and writes graphical objects to Arc View, MapInfo, Atlas GIS, Surfer for Windows, and Arc View Spatial Analyst.

The spatial statistics in *Crime Stat* are sub-divided into five categories. First, there are statistics for describing the spatial distribution of incidents, such as the mean center, standard deviational ellipse, Moran's I spatial autocorrelation index, and mean angle. Second, there are statistics for describing properties of distances between incidents including nearest neighbor analysis, linear nearest neighbor analysis, and Ripley's K statistic. Third, there are three routines for conducting "hot spot" analysis-hierarchical nearest neighbor clustering, K-means clustering, and local Moran statistics. Fourth, there is a single-variable kernel density estimation routine for producing a surface or contour estimate of the density of incidents (e.g., burglaries) and a dual-variable kernel density estimation routine for comparing the density of incidents to the density of an underlying baseline (e.g., burglaries relative to the number of households). Fifth, and finally, there is a journey to crime

module for analysing serial offenders — a calibration routine for identifying a travell distance function and an estimation routine for modelling the likely location of the offender using either the calibration function or a mathematical model.

Crime View

Crime View is used for the mapping, analysis and reporting of crime data. It combines crime data with Arc View GIS software and geographic boundary layers enables law enforcement personnel to better examine, target and reduce crime.

Crime Analysis Extension

The Crime Analysis extension for Arc View is designed to provide easy-to-use tools for geographic crime analysis, data management, mapping, and reporting. The software was developed under a cooperative agreement between the National Institute of Justice and the Environmental Systems Research Institute in the US

RCAGIS

The RCAGIS (Regional Crime Analysis Geographic Information System) Crime Analysis System was designed specifically to assist in the analysis of crime incident data across jurisdictional boundaries. RCAGIS was developed by the US Department of Justice, Criminal Division GIS Staff in conjunction with the Baltimore County Police department and the RCAS group.

Geographical Profiling

Geographical analysis of offender movement and location of his residence and scene of crime has come to known as geographic profiling. It is an analytical method that uses the locations of a connected series of crimes to find out the most probable area of offender residence. It is usually applied in cases of serial murder, rape, arson, and robbery, though it can be used in single crimes (auto theft, burglary bombing, etc.) that involve multiple scenes or other significant geographic characteristics.

The basis of geographic profiling is the association between geographic crime site information and the known propensities of serial criminals in their selection of a target victim and location. The system produces a map of the most probable location of the criminal's centre of activity, which in most cases is the offender's residence. When linked with additional information relating to the crime incidents, and with additional data sources, such as motor vehicles databases and suspect databases, geographic profiling has been proven to have a profound impact on the effectiveness of a police

investigation.

Geographic profiling can be used as the basis for several investigative strategies, including suspect and tip prioritisation, address-based searches of police record systems, patrol saturation and surveillance, neighbourhood canvasses and searches, DNA screening prioritisation and motor vehicle searches. It is important to emphasise that geographic profiling does not solves cases, but rather provides a method for managing the large volume of information typically generated in major crime investigations. It should be regarded as one of several tools available to detectives, and is best employed in conjunction with other police methods. Geographic crime patterns are clues that, when properly decoded, can be used to point in the direction of the offender.

Geographic profiling depends heavily on two key factors:

1. valid linkage analysis to determine that a set of crime sites belong to the same series;
2. valid geographic modelling of the travell distance to crime sites for a particular type of crime, criminal, and geographic area.

The first factor is the responsibility of a linkage analysis system such as ViCLAS or VICAR. The second is embodied in Rigel, ECRI's geographic profiling system.

GIS Applications

There can be several areas demonstrating the relevance of GIS applications in distinct areas of law enforcement. This section intends to dwell upon some key areas of GIS application in crime management.

I. Need for Crime mapping

Crime occurs in space. Concentration of crime in space is not a random matter. Crime as human behaviour operates in space and governed by certain principles. Hence, there are subtle linkages and finer undercurrents capable of providing meaningful insight in to the whole matter. Admittedly, these are difficult to identify. GIS facilitated crime mapping is the solution. GIS in law enforcement means crime analysis via crime mapping. GIS can be a vital tool for a multitude of law enforcement activities. GIS mapping provides for layering crime on any kind of classification. Locating criminality alongside the mapping of residential properties like schools, office, transport, market, etc. become quite insightful on the part of police.

Crime mapping facilitates several law enforcement functions. Simple maps that display the locations where crimes or concentrations of crimes have occurred can be

used to help the deployment of police patrols in the areas requiring immediate attention. Policy-makers in police departments

might use more complex maps to observe trends in criminal activity, and maps may prove important in solving criminal cases. For example, detectives may use maps to better understand the hunting patterns of serial criminals and to hypothesise where these offenders might live.

II. Mapping Crime Scene

Mapping of crime locations in the selected area falling under a particular police station provide useful insight to investigators. Traditionally, the police departments have been relying on manually created maps that had many limitations. With the advancement of GIS based mapping, police are able to produce more versatile electronic maps by combining their databases of reported crime locations with digitised maps of the areas they serve.

III. Concentration of Crimes

Assessment of density of crime in the space is always a clue quite useful in the planning and execution decisions at the police station level. The GIS software used to map crime locations can also be used to calculate crime density values, such as the number of crimes per square mile. These density values can be used to create a choropleth map, which uses colour to represent different values among land units within the study area, such as police precincts, city voting districts, or census tracts. Density maps offer the map user a broader look at where crimes occur without his having to interpret a large number of individual locations.

IV. Merging and Matching of Data from Multiple Sources

Spatial data from sources other than law enforcement can be very relevant in crime analysis. For instance, mapping of schools, traffic routes, market places, schools, bus or rail terminals in relations to crime distribution could provide significant understanding to police about likely target and hot locations. This merging of data from multiple sources is therefore pertinent.

V. Mapping Hot Spots

Hot spots are intensive clustering of spatial locations that carry uncommonly high concentration of crime events. Jefferies (1999) suggests five methods of hot spot analysis. They are— visual interpretation, choropleth mapping, grid cell analysis, point pattern analysis and spatial autocorrelation. *Crime Stat* software with the help of Arc View package conducts an effective hot spot analysis that becomes highly useful for the police in planning and executing their strategies for controlling and preventing crime.

Mapping of crime infested locations or hot spots provide many useful insights to police for resource allocations and deployment of patrolling staff in the locality. The police can also think of specific measures that could be

undertaken by them to curb special kinds of crime. Although concentrations of crime locations may be discernible on a relatively simple point-map of crime locations, multiple crimes occurring at a single address may deceivingly be represented by a single point on such a map. Hot spot analysis is frequently performed using special

software, such as the Spatial and Temporal Analysis of Crime (STAC) which draws ellipses based on the densest concentrations of mapped incidents.

VII. Mapping Closed Circuit Television

Closed Circuit Television (CCTV) cameras are being extensively used in the UK and US as tool for crime prevention, investigation, and evidence collection. These are strategically positioned in public areas. The tasks of placing cameras where they can be most helpful and then understanding the limits of their use can be facilitated through the use of maps.

VIII. Interpolating Crime Data and Isopleth Maps

GIS mapping is also capable of making useful projections on the basis of spatial distribution of crime patterns. This is known as interpolating of one set of data to understand its future concentration in the adjoining areas of the same spatial region. Mapping software can interpolate crime data for locations between the places where the events actually occurred and create an isopleth map. This type of map represents the data through colour-coded classes, just as with choropleth maps, but eliminates the need for figures to be calculated within boundaries that are not related to crime, such as those of political jurisdictions or census tracts. Basically, by treating crime data as if it occurred continuously over the surface of an area, interpolated maps highlight specific places with high concentrations of crime events without regard to unrelated land units. This interpolation serves as a expedient method to examine change over time.

IX. Recovery Locations & Tracking of Serial Offenders

Rossmo (1995) is of the view that the locations where stolen vehicles are recovered to be more relevant in solving crimes than the locations from where they are stolen. Unless a thief has an alternate mode of transportation, he will likely leave a stolen automobile close to some desired destination — quite possibly a chop shop, where stolen cars are stripped down for parts.

Tracking of serial criminals can be facilitated through special kinds of mapping. According to Rossmo (1995), these maps, called Criminal Geographic Targeting (CGT) models, help investigators in their attempt to determine where serial criminals most likely reside given the locations of their crimes. The CGT model is based on the assumption that a certain relationship exists between the residences of serial offenders and where

they chose to commit their crimes. Serial criminals, like everybody else, conduct their routine activities-travellling to and from work, shopping, etc. within a certain space with which they have become familiar. Within this routine activity space, most people identify with a single anchor point, or place of central importance in their lives, usually the home. The CGT model assumes that serial criminals commit their crimes within their areas of routine activity, but at the same time they are careful not to conduct this activity in the immediate proximity of their residences. A crime analyst using a CGT model would delineate a hunting area, the region where serial offenders seek out or encounter potential victims. With the aid of special software, each point within this area is assigned a probability of being the residence of the offender. If crime analysts have a significant number of crime locations with which to work, a serial offender's residence can be narrowed down to a small number of probable locations using such a CGT model.

Indian Scenario

Despite placing lot of emphasis on computerisation, the police department in Indian states have hardly reached to the state of applying GIS tools in their efforts of managing crime events. Though a modest beginning in Tamilnadu, Karnataka and Maharashtra has been made in this direction. Crime mapping becomes even more relevant in case of India as the police in India are considerably overloaded and they have limited resources at their command. This requires perceptible planning and thoughtful allocation of resource on the part of police leadership. Experiences across the globe tell that this kind of job can easily be carried out by resorting GIS applications in decision-making.

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