Using a Geographic Information System for Tactical Crime Analysis

PHILIP CANTER

This chapter discusses the uses of a geographic information system (GIS) for tactical crime analysis. A tactical crime analysis GIS is built on the assumption that police managers and line officers need access to timely and accurate information for problem solving, community policing, crime prevention, and enforcement activities. The goal of using a GIS system is to address some of the shortcomings of traditional policing, such as reactive responses prompted by 911 calls for service.

Police in the United States have a well-established practice of using crime statistics to help manage operations. Spelman (1988) notes that Chief August Vollmer of Berkeley, California, was the first police manager to use crime records for short- and long-term planning in 1909. The Bureau of Justice Statistics (1994) reports that crime analysis is frequently used by police departments to provide general management information and to provide tactical and strategic support. Accreditation standards for law enforcement agencies require police departments to use crime analysis information for supporting management and operations.

The use of maps to examine the spatial distribution of crime also has a long history as evidenced by the work of Guerry (1833) and Quetelet (1842/1973), who noted that crime was not evenly distributed across geographic areas in France (Brantingham & Brantingham, 1981). Studies in England by Plint (1851) and Mayhew (1862/1968) also noted the spatial variation in crime, as did research in the United States by Lottier (1938a, 1938b), Shannon (1954), Schmid (1960a, 1960b), and Harries (1971). Comparative studies, most notably the work of social ecologists of the Chicago school of sociology during the first half of the twentieth century, found that high delinquency rates corresponded to communities with other social problems (Shaw, 1929). Comparing the spatial distribution of crime with other data on an area's inhabitants contributed to the development of several criminological theories. Social disorganization theory developed from the work of Shaw

and McKay. Brantingham and Brantingham (1981) noted that early comparative mapping studies were used to support arguments about criminal etiology made by social positivists during the early twentieth century. Examining various aspects of crime within a geographical context has contributed to a better understanding of offender travel patterns (Gabor & Gotthell, 1984; LeBeau, 1987; Pyle, 1974; Rengert, 1972; Rossmo, 1995), the built environment (Jeffery, 1971; Newman, 1972; Taylor, Sumaker, & Gottfredson, 1985), and social ecology (Harries, 1980; Sampson & Groves, 1989; Schuerman & Kobrin, 1986; Shaw, 1929; Shaw & McKay, 1942, 1969).

CRIME ANALYSIS

Crime analysis involves the collection and analysis of data pertaining to a criminal incident, offender, and target. Police managers recognize that competent analysts provide important information to decision makers. One of the most important purposes of crime analysis is to identify and generate the information needed to assist in decisions regarding the deployment of police resources to prevent and suppress criminal activity. In addition, crime analysis can be used to evaluate the effectiveness of programs such as community policing and crime prevention, develop policy through research, justify budget requests, and help identify or define a problem.

Data are an important part of any crime analysis function. Although an agency should collect the best data possible with a minimum resource expenditure, it is critical that data be relevant, reliable, accurate, and timely. *Relevant* data will be guided by an agency's crime analysis function and any research that identifies data elements important to an agency's operation. At a minimum, an agency involved in crime analysis should collect incident data on the type of crime, location, time, date, target, suspect, property stolen, and modus operandi. The data should conform to standard codes and definitions to allow comparisons and to perform pattern and linkage analysis. *Reliability* suggests that multiple data sources and procedures are in place to ensure the continued collection and processing of data. Some agencies may want to supplement data from their 911 system with information collected by investigating officers to reduce data entry costs or to lessen the data collection workload of investigators. Redundant systems should be in place in the event that data collection methods are interrupted. To ensure *accuracy,* records should be sampled and compared against written reports. If possible, source reports used to collect data should be reviewed by line supervisors, a formal report review unit, and analysts using the data. Crime data must be *timely* because the chances of apprehending an offender responsible for a series of cases depends on quick identification of the crime pattern. Agencies may rely on the electronic transfer of data, laptop computers transmitting data through radio frequencies, or scan forms to ensure receipt of timely crime data.

Crime analysis has two broad functions: tactical and strategic. Although the focus of this chapter is tactical crime analysis, the use of GIS for strategic crime analysis should be noted.

Strategic Crime Analysis

Strategic crime analysis usually involves the collection and study of data covering a period of several years. It is generally more research oriented, involving inferential and multivariate statistics. Strategic crime analysis includes crime trend forecasts, resource allocation, and situational analysis.

Crime trend forecasting uses time series to estimate future crime based on past trends. Methods vary, but they often include linear techniques, exponential smoothing models, and autoregressive integrated moving average methods. By identifying discrepancies between predicted and observed crime rates, time series analysis can help determine if an outside influence, such as a crime prevention program, may be influencing criminal activity. Time series can also be used to determine seasonality, such as an increase in no-force burglaries during warm-weather months, so that a department can plan and not react to anticipated changes in crime. For example, Harries, Stadler, and Zdorkowski (1984) found that some low-status Dallas, Texas, neighborhoods were more susceptible to heat stress-related assault because they did not have the resources to protect themselves from high temperatures and humidity. Although most police would admit there is little they can do about climatic conditions, a GIS could identify low-status neighborhoods for possible intervention at the outset of anticipated heat waves.

Resource allocation involves the distribution of personnel in response to changes in service demand. A typical example involves the design of police posts or sectors in response to changes in workload during a 24-hour period. A GIS can adjust post boundaries in response to temporal and geographical changes in workload. Modifications performed within a GIS can often be exported as a file directly into a computer-aided dispatch system.

Situational analysis is used to describe details about a particular area, such as a community's inhabitants, type of land use, built environment, and crime history. It allows analysts to examine the spatial interrelationship of criminogenic factors. Examinations of crime in taverns and liquor stores (Block & Block, 1995), abandoned buildings (Spelman, 1993), public housing (Roncek & Francik, 1981), and high schools (Roncek & Lobosco, 1983) are examples of situational analysis. The information resulting from the overlaying of multiple databases in a GIS can provide new perspectives on crime and crime interdiction strategies.

Tactical Crime Analysis

Tactical crime analysis involves pattern detection, linkage analysis for suspect-crime correlations, target profiling, and offender movement patterns. The main difference between strategic and tactical crime analysis is the timeliness of the data. Strategic crime analysis usually involves data covering at least a year-long period, whereas tactical crime analysis uses data collected during several days.

Pattern detection occurs when offenses reported during a short period of time have common attributes, such as type of crime, modus operandi, and type of weapon used. A crime pattern could occur over a large geographic region, or it may

occur in a relatively small area. A crime pattern occurring in a relatively small area is called a "hot spot" or cluster. Sherman (1995) defines a hot spot as "small places in which the occurrence of crime is so frequent that it is highly predictable, at least over a 1 year period" (p. 36). Block (1990, 1994) notes that hot spot areas are defined by clusters of events or locations. The high concentration of cases and the greater probability of future cases occurring within the same area make it a suitable target for crime-suppression strategies. The ability of a GIS to map one or more attributes associated with reported offenses makes it an invaluable tool for pattern analysis. Analytical methods available for identifying hot spot areas include using point locations in a GIS to construct contour maps, standard deviational ellipses, and k means clustering.

Linkage analysis correlates a suspect to one or more criminal incidents. It requires matching information maintained in a suspect database, such as modus operandi or physical description, against the same attributes associated with criminal incidents. The objective of linkage analysis is apprehension and case clearance. Some studies (Pyle, 1976; Rand, 1986; Rengert & Wasilchick, 1985) have found that suspects tend to travel within a predictable range to commit a crime. Linkage analysis can narrow search areas by identifying known criminals or other suspects who reside within a certain distance from incident locations.

Target profiling identifies locations that may have an unusually high likelihood of victimization within an active pattern area. Within a large geographic area, offenders tend to target certain types of locations rather than others, especially for crimes influenced by the location of commercial or service-oriented activity, such as convenience stores or banks. A GIS can assist in target profiling by mapping the location of all potential targets, such as fast-food restaurants, relative to actual incident locations.

Developing a profile for potential targets within a hot spot area sounds simple, but a hot spot area for residential burglary may contain thousands of potential targets. Profilers catalog the common features of actual targets located within a hot spot area, and then they identify all targets sharing these features. Often, these features may not be collected as part of a crime analysis database but may be maintained as part of another agency's database files. Detailed information about the physical structure of dwelling units, for example, is usually available from tax assessment files. Information about guardianship may be available from alarm company registrations or bureaus licensing dogs, and the number of targets, such as retirees, is available from the decennial census. A GIS can select and match features obtained from files maintained by outside agencies with incident locations. A GIS can then identify potential sites within a target area that contain the same unique features.

Offender movement pattern analysis ties at least two or more points to one or more criminal incidents. One example is the theft location and recovery site of a stolen motor vehicle. Connecting the two locations, theft and recovery, may help identify the roads used by an offender after stealing an automobile. Similarly, relating an offender's last known residence to an arrest location such as an open-air drug market can identify roads used by dealers to transport drugs. Intelligence information collected on individuals seen in a known drug market can be linked to their

place of residence or other locations, such as place of employment or recreation, and subsequently associated with a crime pattern occurring within that individual's activity space.

GEOGRAPHIC INFORMATION SYSTEMS

The ability of a GIS to relate and synthesize data from a variety of sources enables analysts to examine various aspects of criminal activity, including the built environment, crime risk and opportunity measures, and offender search patterns. Several examples of the uses of a GIS for both strategic and tactical crime analyses have previously been cited.

The utility of a GIS depends on (a) the accuracy of the data; (b) the data attributes associated with each incident; and (c) the database, mapping, and analytical capabilities of the GIS. The purpose of this section is to summarize the important mapping features of a GIS as they relate to tactical crime analysis. Specifically, a GIS has two broad applications that can be used for tactical crime analysis: descriptive mapping and analytic mapping.

Descriptive Mapping

Descriptive mapping displays thematic information assigned to a point location or boundary. The thematic display is based on one or more attributes associated with the mapped object. Examples include burglary locations color coded by day of week and a thematic map showing the number of robberies per week by census block group. Another type of descriptive map assigns multiple attributes obtained from different databases to a point or boundary. For example, an analyst may wish to determine the location of residential burglaries by assessed value of the targeted dwellings over time. The analyst may then be able to determine whether an offender is targeting dwellings within an assessed dollar range or if a relationship exists between the assessed value of a structure (and presumably the value of property stolen) and the length of time between successive cases. Descriptive mapping can also relate geographic information such as the size of a census block group to the number of crimes reported in the respective census block group. The resulting crime density map attempts to compensate for variations in the number of reported crimes that might result from differences in a boundary's land area.

Descriptive mapping is similar to automated pin mapping used by crime analysts. The ability to query databases to select point locations based on specified case attributes is helpful in detecting crime patterns. Examining the spatial distribution of crime may contribute to an understanding of an observed pattern, and by describing the spatial distribution of crime one may anticipate or predict future activity. The interpretation of mapped information remains subjective, however, given that a point pattern or thematic boundary map is not being compared to a hypothetical distribution.

Analytic Mapping

Analytic mapping describes spatial patterns associated with two types of distributions: discrete and continuous. Discrete spatial distributions are defined at certain locations, such as an incident address or a census tract. Spatially discrete point patterns can be examined relative to a study area using quadratic or distance methods or relative to each other using measures of arrangement. A spatially continuous distribution varies over a surface and can be measured only by sampling at discrete locations.

Analytic mapping can test hypotheses about the spatial distribution of discrete patterns. Crime locations identified as points on a map, or grid cells containing the number of reported crimes during a period of time, can be compared against an expected randomized spatial pattern. Point distributions that are not random, and by inspection appear to be clustered as opposed to dispersed, suggest an unusual amount of criminal activity. Note that the pattern depends on time and space, and both dimensions are defined by the analyst according to study objectives. It assumes that accurate and timely information on crime is being collected for analysis.

In the absence of any detailed information about a crime incident, analysts can still identify a crime pattern based on the number of incidents occurring within a given time period and study area. In this situation, the crime analyst can identify high concentrations of criminal activity taking place during a short period of time. Pattern detection suggests that (a) a greater than expected number of crimes are being reported for a given area, (b) it is likely that the pattern will continue without intervention, and (c) the same criminally active area may contain a high amount of unreported crime. Pattern detection and analysis can be used to efficiently manage police operations by deploying resources to criminally active areas and may increase the rate of apprehension, reduce or displace crime, and assist in identifying other factors that may contribute to criminal events.

CONCLUSION

Several methods that have potential use for tactical crime analysis were discussed in this chapter. Crime analysts and researchers are making substantial progress in identifying high crime activity areas and predicting future target locations. It is clear that descriptive and analytic mapping will be an important part of strategic and tactical crime analysis efforts.

REFERENCES

Block, C. R. (1990, December). *Hot spots and isocrimes in law enforcement decision making.* Paper presented at the conference on Police and Community Responses to Drugs: Frontline Strategies in the Drug War, University of Illinois at Chicago.