Foundations and Theoretical Perspectives

SECTION 1

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Introduction to Crime Mapping

LEARNING OBJECTIVES

This text is written for individuals who are interested in the study and practice of crime mapping. Whether you are a practitioner or a college student, we hope you will find this text useful in your endeavor to learn more about crime mapping. This text, however, is not meant to provide you with an in-depth analysis of theory or an extensive discussion of methods in crime mapping. Rather, it is meant to convey the academic and practical skills the beginning student and analyst need to create crime maps that will be useful and accurate. For students who desire more than a cursory approach, there is a plethora of existing literature, both practical and academic, that is more appropriate for advanced studies. We have listed some of these sources in the Recommended Reading section at the end of each chapter. The exercises included with this text will be challenging and will provide you with skills needed to use ESRI's ArcGIS 10 software to complete a variety of analysis projects. Many other topics could be covered in a text such as this, but we have chosen to include only those that are most appropriate for the students we teach—foundational skills for the beginning crime mapping student and crime analyst. We hope this text will inspire your interest in geographic information systems (GIS) and provide a strong foundation for your future crime mapping success.

As a person interested in the field of crime mapping and analysis, you should understand that it is not a simple field of study. The technology is expanding rapidly, and you will need to work vigilantly to stay current in the field.

This chapter introduces the notion of crime as a “criminal event,” which stresses the importance of understanding how both victims and offenders interact with their environments. This allows us to examine crime from multiple angles and further our understanding of how human behavior and the environment play pivotal roles in the occurrence of crime. This chapter also contains a brief history of crime mapping and introduces the student to the basics of using mapping tools in the analysis of crime. After studying this chapter, you should be able to:

- Define and explain the criminal event and understand the basic theoretical explanations offered for the relationship between crime and place.
- Define and explain the concepts of crime mapping and analysis.
- Identify key research that is rooted in crime mapping and analysis.
- Identify and explain basic map information, data, and various types of maps used by crime analysts.
- List key software and resources used by crime mappers and analysts.
- List the resources available to crime mappers and analysts.
This chapter begins with a discussion of crime as a criminal event. This view differs from other approaches to the study of crime in that it not only seeks to understand the motivations and behaviors of offenders or victims, but also seeks to explain how offenders and victims interact with each other and their environment. Thus, we are studying crime from multiple dimensions (the dimensions of the offenders, victims, and environment) rather than simply trying to understand it from one point of view (for example, trying to understand the motivation of the offender without factoring in victim or environmental characteristics). Viewing crime as a criminal event (Sacco & Kennedy, 2002) allows us to understand crime in a spatial context in that the environment provides varying opportunities for crime by providing cues to both offenders and victims that impact their decision making. Thus, properties of the immediate space in and around criminal events are contributing factors to victimization and cannot be excluded from the study of crime.

Also included in this chapter is a brief discussion of the history of crime mapping. Understanding the history of this field (or any field, for that matter) is important to the discussion of present and future issues in crime mapping. An introduction to basic map terminology and a brief examination of the different types of maps that crime analysts produce are also included in this chapter. A discussion and listing of resources, including mapping and analysis software options, are also provided.

### Theoretical Explanations of Crime and Place

Crime has been a part of life for as long as people have gathered into social groups. A great deal of time and effort has been invested in trying to understand crime, most notably examining why some people engage in criminal behavior and others do not. As a result, there is a plethora of theories under the larger heading criminology (the study of crime and criminal behavior) that attempt to answer these questions. However, thus far, we have no generally accepted theory that explains the existence of crime in a society. For example, consensus
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perspectives of criminology approach crime as a normal and healthy part of any society. Conflict perspectives, on the other hand, argue that crime is the result of group conflict and unequal distributions of power. There is no single theory that accounts for all crime in a society. Some are more comprehensive than others, but we do not have a unified or general theory of crime (at least not one that everyone agrees with!).

Criminological theories also differ in their level of application. Macro-level theories make assumptions about societal-level variables, including the structure of government and the economy and how these variables impact crime rates within a society (which could be a city, state, country, or even the world). Micro-level theories make assumptions about individual characteristics (such as IQ, mental state, temperament, biological characteristics, and personal finances) and how they influence a person’s decision to commit a crime. Sometimes, what holds true at the macro level does not work at the micro level and vice versa.

Unfortunately, many theories of crime focus solely on the individual or group that commits a crime and ignore other contributors to crime, including the environment. Recently, theorists have begun to broaden their approach from simple explanations of the criminal and his or her act to include other variables, such as victims’ behaviors (Clarke & Felson, 1993; Cohen & Felson, 1979) and the physical environment (Brantingham & Brantingham, 1981, 1993). Thus, theorists began to examine crime as an “event” that was not simply a product of an interaction between persons but an interaction among victims, offenders, and their environments. When researchers began to examine the contributions of time and space on various criminal events, crime mapping became an important tool in crime analysis. In addition, with the introduction of widespread geographic information systems (GIS) data collection efforts and improved technology, the importance of crime mapping has grown exponentially over recent years to the development of theory and to the development of policy aimed at understanding and preventing crime.

Shaw and McKay (1942) put forth their social disorganization theory, which suggests, in part, that the economic composition of a community contributes to crime by affecting neighborhood order. Building upon the earlier works of Park (1915) and Burgess (1925), they observed that higher juvenile delinquency rates tended to cluster in certain neighborhoods within urban areas. Through their research, they determined that various factors about these neighborhoods contributed to higher levels of crime. The neighborhoods suffered from the effects of poverty and residential instability, which impacted both the physical appearance and the social structure of the neighborhood itself. In these socially disorganized neighborhoods, poverty, high population density, and high population mobility created an atmosphere where higher numbers of suitable targets and motivated offenders coexisted with little or no guardianship. Thus, the clustering of motivated offenders and a lack of guardianship in certain areas of a city, often in socially disorganized neighborhoods, produces higher rates of crime. Shaw and McKay made an important discovery that helped guide the development of more recent theoretical approaches; they found that socially disorganized neighborhoods suffered from higher rates of crime regardless of who lived there. That is, whether the neighborhood was inhabited by Italians, Russians, Cape Verdeans,
or Cubans, for example, the crime rate remained high. Thus, this discovery suggests that the area, not the people, is criminogenic.

Three primary theoretical perspectives have built upon Shaw and McKay’s discovery and have made enormous contributions to the study and understanding of crime in a spatial context: Routine Activities Theory, Rational Choice Theory, and Crime Pattern Theory, all of which are housed within a larger theoretical framework called Environmental Criminology. Each theory provides assumptions about empirical observations of the environment, victims, and/or offenders, allowing predictions to be made about the criminal event. In turn, this provides insight into possible solutions to combat crime, which incorporate environmental factors such as crime prevention through environmental design (CPTED) and other situational crime prevention strategies (Crowe, 2000; Rosenbaum, Lurigio, & Davis, 1998). For example, simply improving lighting or limiting access to a parking lot may reduce thefts from automobiles in that lot, or installing emergency phones and well lit walkways may reduce personal crimes on a college campus.

Environmental Criminology suggests that we analyze a variety of characteristics about the physical landscape, such as land use, access, and visibility, to determine likely areas that are conducive to crime. Brantingham, Dyreson, and Brantingham (1976), in their “cone of resolution,” examined why there existed regional differences in crime rates. In their subsequent work, Environmental Criminology, they suggested that to have a better understanding of crime, theorists must examine four key elements to crime, including the law, offenders, targets, and place (Brantingham & Brantingham, 1981). In 1993, they proposed the groundwork for crime pattern theory, which combines Environmental Criminology with rational choice and routine activities perspectives in understanding crime (Brantingham & Brantingham, 1993).

Routine Activities Theory (Cohen & Felson, 1979) offers that when three core elements coexist in time and space, crime is more likely to occur: These include a motivated offender, a suitable target, and the absence of a capable guardian. When all three elements come together in time and space, the opportunity for crime is greater than when one or two of these elements are missing. Essentially, Routine Activities Theory suggests that at the micro level, individuals are more likely to be victimized in some situations than others. For example, a person walking alone in a park at night listening to an expensive iPod is more likely to be robbed than a couple in the same park walking their large dog, not listening to expensive iPods.

At the macro level, this theory suggests that patterns in victimization have changed, in part, due to patterns in the routine activities of society in general. For example, in the last 3 or 4 decades, the number of women who work outside of the home has dramatically increased. According to the Bureau of Labor Statistics (2011), 40.8% of civilian, noninstitutional women aged 16 years and older were employed in 1970. In 2009, this percentage increased to 59%. This jump left an increased number of homes during the daytime hours unguarded, which may have contributed to an increase in daytime residential burglaries. Women’s civilian employment is projected to increase by 9% from 2008 to 2018, suggesting that this trend
(and perhaps its impact on crime) will continue. In addition, this theory explains that crime rates will vary spatially due to increased opportunities caused by higher numbers of suitable targets and motivated offenders and lower levels of guardianship. Neighborhoods that are characterized by physical and social disorder have more opportunities for crime because they tend to hold more motivated offenders and have a greater lack of guardianship.

**Crime as a Criminal Event**

The criminal event, under Routine Activities Theory, requires that a suitable target, a motivated offender, and the absence of a capable defender or guardian come together at the same time and place. That place might be private, such as at a home (burglary or domestic violence, for example); a more public place than the home, such as work or school (workplace assaults or embezzlement); or in very public spaces, such as public roads, paths, parks, or entertainment spots (robbery, assault, and riots, for example). The specifics of who is assaulted, what is stolen, or who commits the crime may change from place to place, but whenever the three elements of the criminal event converge in time and space, the likelihood of crime is increased. By the same token, if one or more of the elements is missing from the equation, a crime is less likely to occur. Clarke and Eck (2005) expanded Routine Activities Theory and developed the problem analysis triangle (or crime triangle) to include the “controllers,” who are handlers, managers, and guardians (see Figure 1–1).

In this model, guardians are those persons who keep a watchful eye on people and property, including people themselves and police or private security personnel. Handlers are people who know and interact with motivated offenders. They include agents of informal social control, such as family members, friends, or teachers, and agents of formal social control, such as

![Figure 1–1](https://example.com/figure1.png)  
**Figure 1–1**  Problem Analysis Triangle  
probation or parole officers. Last, managers are those persons who have some level of responsibility for the behaviors of persons within a specific location. For example, homeowners are responsible for controlling behavior in their homes, teachers are responsible for maintaining order in their classrooms, and bar managers are responsible for controlling behavior in their bars. Homeowners, teachers, and bar managers, in this sense, are managers.

In studying and mapping the criminal event, it is possible to study not just the individuals involved, but also to map crime and the spatial and temporal variables needed to understand how the specific event occurred, how the elements came together, what actually transpired, and how the event was concluded. When it is understood how a specific event occurred, it becomes possible to examine similar events in an attempt to identify similarities, patterns, and ways to keep that type of event from occurring again.

McGloin, Sullivan, and Kennedy (2012) in their edited volume, When Crime Appears: The Role of Emergence, argue that the “messy” nature of understanding crime must be from an emergence perspective such that:

…criminologists need to consider the individual, the situation, the interaction of the individual and the situation, the role of learning and its impact on future behavior, and the range of alternative methodologies necessary to gain perspective on the complex dynamics involved in explaining crime (p. xi).

In the emergence perspective, McGloin and colleagues (2012) argue that crime analysis should not only examine areas where crime is prevalent, but also areas where crime is likely to emerge in the future. In addition, crime emergence is not tied to any single theoretical approach nor does it adhere to strict linear statistical patterns. Thus, theories to explain crime and methodologies to analyze crime must be developed to capture the role of emergence.

It is also essential to realize that mapping criminal events is only the first step in the crime-fighting process. The criminal event and the circumstances surrounding it must be analyzed to find meaning in the data. Facts do not speak for themselves! They must be critically analyzed. *Hypotheses* (statements derived from theory that can be tested to either support or disprove a theory or its assumptions) must be generated about individual criminal events and criminal events that take place in combination with other, similar events. Could the perpetrator be the same in a series of crimes? Is the method of committing the crime similar? Are times and locations connected in some way? Examining criminal events to identify relationships is the role of a crime analyst, and data collection, analysis, and mapping are the analyst's methods of fighting and preventing crime.

## Crime Analysis

There are three broad categories of analysis that fall under law enforcement analysis: crime analysis, criminal intelligence analysis, and investigative analysis (Bruce, 2004; Gottlieb, Arenberg, & Singh, 1994). There is a wide array of definitions for crime analysis in the existing literature. *Crime analysis*, as Boba defines it, “is the systematic study of crime and disorder problems as well as other police-related issues—including sociodemographic, spatial, and temporal factors—to assist the police in criminal apprehension, crime and disorder...
reduction, crime prevention, and evaluation” (Boba, 2005, p. 6). The International Association of Crime Analysts (IACA; 2005) defines crime analysis as:

...a type of law enforcement analysis that is focused on the study of criminal incidents; the identification and analysis of patterns, trends, and problems; and the dissemination of information that helps a police agency develop tactics and strategies to solve patterns, trends, and problems.

Essentially, crime analysis draws on a variety of different types of data, including crime data, to gain a better understanding of criminal activity and the root causes of criminal activity, and to develop more effective means of combating crime and preventing victimization.

The field of crime analysis appeared to gain both significant attention and momentum in the late 1990s after the successes in New York City with the computerized statistics program (otherwise known as CompStat) and the large reductions in crime associated with this intelligence and analysis philosophy. The various policing methods and philosophies associated with CompStat (including the now in vogue intelligence-led policing and evidence-based practice are discussed later in this text).

In general, analysts look at crime and other law enforcement data using formal analytical and statistical techniques and research methods that have been developed in the social sciences. They study arrests, crime reports, offender and victim characteristics, and crime scene evidence. They also examine other types of data collected, such as calls for service, traffic citations and accidents, census data, weather and traffic patterns, and data from other criminal justice agencies, including probation and parole reports. By analyzing numerous sources of information, the crime analyst can provide useful information to assist decision makers in a police department to fight and prevent crime.

Crime analysis includes tactical and strategic analysis (focused on criminal activity) and administrative analysis (focused on police activity). Tactical crime analysis examines recent criminal events and potential criminal activity by analyzing how, when, and where the events occur to establish patterns and series, identify leads or suspects, and to clear cases (Boba, 2005). Tactical analysis focuses on specific information about each crime, such as method of entry, point of entry, suspects’ actions, victims’ characteristics, type of weapon used, and the date, time, and location of the crime. It also considers information developed in the field from patrol officers, such as suspicious activity, calls for service, criminal trespass warnings, field interrogation cards, and personal identifying marks (such as scars and tattoos) (Boba, 2005). Usually, crimes examined under tactical crime analysis are those in which the victim and offender are unknown to one another. The focus of tactical analysis is the daily examination of data to identify trends and patterns concerning recent criminal activity. When a crime pattern, suspect, or investigative lead is identified, the information is compiled and disseminated to patrol officers and detectives. Crime mapping is used in tactical analysis to reveal clusters of criminal activity and to identify spatial relationships between crime and various geographic variables (Boba, 2005). Tactical analysis is used to develop a prediction of an offender’s future behavior so surveillance units can be deployed to where an offender is predicted to strike again. Another type of tactical analysis entails predicting where an offender may live based on the locations of his or her crimes in the series.
Strategic crime analysis involves the study of crime and other law enforcement issues to identify long-standing patterns of crime and other problems and to assess police responses to these problems (Boba, 2005). Typically, this analysis involves collecting a great deal of information about criminal events. In addition, “helping agencies to identify root causes of crime problems and develop creative problem-solving strategies to reduce crime” is a key goal in strategic crime analysis (IACA, 2005). Strategic analysis is the backbone of most police agency crime analysis efforts, as this is where the analyst identifies problems and begins to work toward prevention strategies.

Administrative crime analysis involves the presentation of key findings of crime research and analysis to audiences within law enforcement, local government, and citizenry based on legal, political, and practical concerns. Bruce (2004, p. 22) provides several examples of administrative crime analysis, including:

- A report on demographic changes in the jurisdiction
- Miscellaneous crime statistics to support grant applications
- Preparation of Uniform Crime Reports (UCRs) or National Incident-Based Reporting System (NIBRS) reports

Another example of administrative crime analysis is the establishment of a department website to inform the general public about public safety issues. Police operational analysis is another type of analysis that is also conducted. Its focus is on the operations of police agencies, including staffing and resource deployment. Operations analysis seeks to identify how to better organize the internal operations of a police department to minimize inefficiency and maximize effectiveness (Bruce, 2004).

Crime analysis is different from criminal intelligence analysis in that criminal intelligence analysis typically looks at organized criminal activity and seeks to link people, events, and property. Much of the information that is analyzed is obtained by law enforcement efforts, including surveillance, informants, and undercover operations (Boba, 2005). Information that is analyzed is not necessarily criminal information and can include telephone taps, travel information, financial and tax records, and family and business relationships of the person(s) being investigated (Boba, 2005).

Crime analysis is also separate from criminal investigative analysis in that with criminal investigative analysis, the focus is on serial criminals (Boba, 2005). Victim characteristics and elements of crime scenes are studied to discover patterns that link related crimes together. Sometimes, in geographic profiling, a profile of the offender based on the nature of the crime and the facts of the case is developed. Often these types of serial crimes cross jurisdictional lines, and many different law enforcement agencies may become involved in high-profile cases. (See Rossmo [2000] for a more in-depth discussion of geographic profiling; a discussion on geographic profiling and journey to crime analysis is also provided elsewhere in the text).

Analysis has been utilized for many years on an informal basis, but with newer technology, especially since the 1990s, its prominence and utility in law enforcement applications has grown. After the events surrounding 9/11, the need and demand for good analysis has
exploded. Good analysis and presentation are essential. This text is dedicated to providing you with the tools necessary to complete useful and accurate analysis that, when properly presented, can make a difference in fighting crime.

Jack Dangermond (2007), the president and cofounder of Esri (the company that created the ArcGIS software that is used to complete the exercises contained elsewhere in this text), suggests that:

To gain a greater understanding of our world we need a framework that I call the “geographic approach.” The geographic approach uses geographic science supported by geographic information system (GIS) technology as a framework for understanding our world and applying geographic knowledge to solve problems and guide human behavior.

The ability to utilize such an approach has not always been an option for law enforcement. However, with the arrival of GIS and inexpensive desktop computers and printers with speed and large memory/storage capacity, even the smallest agency can use analysis and crime mapping in its daily battle against crime and disorder.

## A Short History of Crime Mapping

This chapter contains only a brief discussion of the history of crime mapping. For a deeper understanding of its history, there are several sources you may want to look at, including Weisburd & McEwen (1988), Harries (1999), Boba (2001), and Chamard (2006). In addition, for a good general resource for crime analysis, see Osborne and Wernicke (2003).

Mapping itself has a long history, but crime mapping, the subject of our study, has been traced to the early 1800s when social scientists began creating maps to illustrate their crime theories and research. Social scientists Adolphe Quetelet and A. M. Guerry are credited as being two of the first people to use spatial analysis to research crime. Using crime and other social data from France, they determined that crime was not evenly distributed across space and that it also clustered geographically with other observable social-level variables, such as socioeconomic status and population density.

In the early 1900s, the New York Police Department and other large departments began to utilize single-symbol point maps (pin maps) to illustrate crime locations. In the 1920s and 1930s, sociologists at the University of Chicago used graduated area maps of crime and delinquency to show the relationships between crime and social variables, such as poverty. These maps were drawn by hand and were very labor intensive.

It was not until the 1960s and 1970s that crime maps were created with the use of computers. These early computers were large, mainframe computers that were affordable only to the largest agencies. They were very expensive to operate, and producing maps was still very labor intensive. In addition, the maps that were produced were of poor quality and unsuitable for many law enforcement purposes.

Desktop computers that were capable of mapping (still with limited quality) became available in the 1980s, but they had slow processing speeds, limited memory, and poor printer quality. In the 1990s, desktop computers with GIS capabilities and the ability to be integrated with law enforcement record management systems and other data made mapping possible.
for many law enforcement agencies. The additional contributions of government funding, expanded training, a more tech-savvy workforce, and higher quality computers and printers further enhanced this ability. Studies that examined the use of crime mapping in law enforcement agencies suggest that the utilization of crime mapping software, the program(s) being used, and how crime mapping is applied within an agency vary significantly (Chamard, 2006; Mamalian et al., 1999; Paynich, Cooke, & Mathews, 2007). In general, large departments with an expansive data collection effort that serve a diverse and geographically dispersed population and that provide adequate funding and personnel to accommodate training and equipment expenses have been the most successful in adopting mapping as a strategy and have maintained their involvement through networking, conferences, and the Internet. Mid-sized and smaller agencies have been slower to adopt a crime mapping policy, primarily due to a small service population, a low crime rate, and a lack of resources and personnel. However, with examples of successful implementation, decreasing equipment costs, rising workforce capabilities, and increased training and funding available in the post-9/11 era, crime analysis and mapping will continue to grow and improve law enforcement agencies’ analytic capabilities.

■ Mapping Basics

A map is a two-dimensional or flat-scale model of the Earth’s surface or a portion thereof (Rubenstein, 2003). Maps portray a portion of the real world in a form we can use to find our way or find answers to questions we may have about an area we are interested in. They may be rough sketches of the way to “Aunt Trudy’s house” or a precise computer map of a community that details every important landmark. The science of mapmaking is called cartography and is centuries old.

Map Information

For our purposes, we will focus on geographic information systems (GIS)—high-performance computer software that allows users to process geographically related data. This data (topography, political boundaries, population density, calls for service, crimes, etc.) is stored as information in virtual layers (one layer for each variable) to be displayed on the computer in the form of a multilayer, virtual map. A single layer may be displayed, or several layers can be combined to show relationships among the layers (types of information or what is called geoprocessing). In crime mapping, the layers sit atop one another, resulting in an overall picture of crime and its spatial context. This is much like an anatomy textbook that contains different transparency sheets with drawings of the skeletal, muscular, cardiovascular, central nervous, and digestive systems. You may choose to look at the systems individually or layer them atop one another to see how they overlay and get a better picture of the entire human anatomy. In crime mapping, you may have a map with layers representing police boundaries, streets, key landmarks, and various crimes. Using GIS, you can select various layers to use in your analysis. The use of GIS to analyze environmental and social phenomena, such as crime, is what crime analysis and mapping is all about.
The Earth is very nearly a sphere, and while it may be accurately portrayed as a globe, that is not practical for most uses. Problems arise when you try to draw a sphere on a flat surface because the image is distorted. The method used to transfer locations on the Earth’s surface to a flat map is called **projection**. Mapmakers have devised numerous ways of producing flat maps, but none are without flaw. There are cylindrical and conical projections, but each has distortions. The distortion produced is more severe when you attempt to map the entire world and less so as the mapped area becomes smaller. For most law enforcement purposes, the geographic area of interest is small enough that projection does not cause serious problems and can be ignored (Harries, 1999). Projection systems are discussed in more detail in the exercises elsewhere in this text, but for our purposes here, you should know that there are many different projection systems to choose from, and it is important to know what system your data is projected with. Nevertheless, you should be aware of the problem and work with local experts to address this issue and, if necessary, create solutions for your purposes. The problem becomes more important as the **scale** of the map increases (from municipal to regional level, for example) and when importing and exporting data between applications. This is especially important in **geocoding** events onto a map. In the geocoding process, street addresses are positioned onto a map using latitude and longitude coordinates. “**Projections** determine how the latitude and longitude grid of the earth is represented on paper. **Coordinate systems** provide the x-y reference system to describe locations in two-dimensional space” (Harries, 1999, p. 14). Different states use different projections, and it is important for the analyst to understand which projections are used by the map layers he or she is working with. This becomes especially important when using data from multiple sources because without knowing the projection of each data layer, it may be difficult to get them all to line up on the map surface as expected.

**Types of Maps Used by Crime Analysts**

There are many different types of maps that might be constructed depending on what information the analyst wants to present and what audience will receive the information. He or she might map a simple, single event (such as that depicted by traditional pin maps) or show the distribution of crime across a particular area (a choropleth map or shaded grid map, such as a police beat or district or a census block), multiple hotspots located across a jurisdiction that are related to multiple criminal events (which typically include liquor stores, pawn shops, high schools, drug houses, shopping malls, etc.), or a series of connected criminal events (such as crimes committed by a child molester or serial murderer). An analyst might also utilize the statistical capabilities provided in GIS software and other programs, which expand the programs’ capabilities to attempt to predict an offender’s next target (such was the case in the Washington sniper case) or areas where offenders might live, work, play, or retreat to after performing a criminal event. Caplan and Kennedy (2011) have also developed a method to produce risk terrain maps that analysts can use in efforts to identify variables, or risk factors, most associated with a particular crime or crimes and to predict emerging hotspots.
Map Data

Many different maps can be created. However, most crime maps include a limited number of map components. The five major components of a GIS include hardware, software, data, personnel, and methods. Real-world data are represented by four feature types in a GIS:

- **Point features**: A discrete location usually depicted by a symbol or label. It is like a pin placed on a paper wall map. Different symbols are used to depict the location of crimes, motor vehicle crashes, traffic signs, buildings, police stations, cell towers, etc.
- **Line features**: A geographic feature that can be represented by a line or set of lines, such as railways, streets, rivers, powerlines, bus routes, etc.
- **Polygon features**: A multisided figure represented by a closed set of lines, such as city boundaries, census tracts or blocks, patrol beats, neighborhood boundaries, and gang turf. Polygon features may be as large as countries or as small as a single place (like a park or cemetery) or even a single building (such as a school). Points, lines, and polygons are typically called “vector” types in that they have finite limits, locations, or beginning and ending points, and do not cover the entire surface of the map.
- **Image features**: A vertical photo (usually taken from an airplane or satellite) that is digitized and placed within the geographic information system coordinates that are associated with it. These and hotspot maps are often called “raster” images in that they are actually small pixels of data which cover the entire map surface and each pixel has some value as in the colors and locations of an aerial image.

Each type of feature has “attributes” or a table of data that describes it. The ability to view, query, relate, and manipulate the data behind these features is the real power of a GIS. Simply clicking on a point, line, polygon, or image can produce the data associated with that particular feature. For example, you can very easily identify a specific point on the map and be instantly given detailed information (as long as it is contained in the attribute table). In crime data, this information may include victim and offender characteristics, motives for the crime, and temporal (date and time of incident) and spatial (address and name of location) details.

### Mapping Software and Resources

In today’s world of crime analysis, the beginner analyst is fortunate to have a plethora of crime mapping tools, software, and resources at his or her disposal from a variety of sources. This section provides a brief overview of some of the most known and commonly used programs and resources. It is by no means a complete listing of the wonderful resources available to analysts. The field is rapidly changing and growing and these changes bring new software and resources on an almost daily basis.

### Software

The wide use of crime mapping and analysis has greatly increased due to the development and availability of relatively inexpensive computers, printers, and analysis software that are...
adequate to the task. Today there are many mapping and GIS programs available on the market, and more are being developed each year. For the purposes of this introduction, we will look at five of the more common programs. Three are professional, commercial systems, and two are programs that were developed for special use under government funding and are available free online. The first two programs, currently the leaders in GIS systems used by law enforcement in the United States, are MapInfo (www.mapinfo.com) and ArcGIS (www.esri.com). ArcGIS is the most commonly cited program used by police departments that utilize crime mapping applications in the United States (Paynich et al., 2007). GeoDa is a standalone spatial analysis program developed by Dr. Luc Anselin, then at the University of Illinois, for use as an introduction to spatial analysis. CrimeStat is a standalone spatial statistics program for the analysis of incident locations. It was developed under research grants from the National Institute of Justice (NIJ) by Dr. Ned Levine & Associates, who is the sole distributor of CrimeStat and makes it available for free to law enforcement and criminal justice analysts and researchers (Levine, 2003). You will use CrimeStat in several of the exercises contained elsewhere in this text. CrimeStat must be used in conjunction with a mapping program, such as ArcView or MapInfo, to project the analysis onto a map. Without it, the analyses are simply numerical outputs to be interpreted by analysts. Another commercially available tool for crime mapping and analysis is CrimeView (put out by the Omega Group). CrimeView is an extension for ArcGIS that allows the user to perform specific analyses as needed or to create automated analyses, including hotspot maps, threshold alerts, and cyclical reporting. There are many tools available for analysts for a variety of procedures—some are developed by other crime analysts or academics in criminal justice; some are borrowed from other fields entirely such as earthquake prediction, animal science, or anthropology; and some analysts who are proficient in programming syntax can make their own.

Mapping Resources

There are also a variety of online and other resources for beginning analysts to use in their quest for information about crime analysis and mapping. Many of these sites have links to free software, with accompanying workbooks and tutorials, and publications written about topics pertinent to the analysis of crime and related social problems. New sources are always being developed and older sites might be abandoned. For example, the Mapping and Analysis for Public Safety (MAPS) program at the NIJ (www.nij.gov/nij/topics/technology/maps/welcome.htm), along with the Community Oriented Policing Services (COPS) office (www.cops.usdoj.gov/), and the Center for Problem-Oriented Policing (www.popcenter.org/about/?p=sara) are all good places to start to learn more about how crime mapping fits in with law enforcement’s mission to prevent crime. In addition, students may want to join an email group list, such as the LeAnalyst listserv (http://sites.google.com/site/joinleanalyst/), to learn and share information about crime mapping and analysis with other people interested in the topic. The email content of this group ranges from discussions about the best software to buy, how to use various applications, where to find data, and recommendations of various publications and general crime analysis questions. Other online sources worth looking at are listed at the end of the chapter.
Conclusion
This chapter introduced you to the world of crime mapping and analysis. A discussion of the basics of crime mapping, along with a brief history of how crime mapping has evolved, was provided. Various types of data, analyses, and maps were described, and outside sources were recommended. This chapter by no means covers all of what you should learn to be a trusted crime mapper, but it will get you started. There are many other discussions concerning the effect different police methodologies and philosophies have had on crime mapping and crime analysis in general. Many of these discussions are found elsewhere in this text. Programs such as the Problem-Oriented Policing (POP) program, Community Oriented Policing Services (COPS), Data-Driven Approaches to Crime and Traffic Safety (DDACTS), intelligence-led policing, and predictive policing or predictive analytics have all had an impact in one form or another to increase (and often guide) the use of crime mapping technologies in the day-to-day crime suppression efforts of many law enforcement agencies.

Chapter Glossary

Administrative crime analysis  Administrative crime analysis involves the presentation of key findings of crime research and analysis to audiences within law enforcement, local government, and citizenry based on legal, political, and practical concerns.

Cartography  The science of mapmaking.

CompStat  The term generally associated with the New York model of policing which includes accountability, crime mapping and analysis, and problem-solving processes by the police department to reduce crime; often utilized by other police departments in a variety of forms to help focus efforts in targeted areas in an organized, strategic manner.

CPTED  The acronym for crime prevention through environmental design. Refers to strategies to reduce crime that incorporate making changes to the physical environment to limit the opportunity for crime to occur.

Crime analysis  Several good definitions exist for crime analysis, but essentially, crime analysis is the study and analysis of crime and crime-related factors in efforts to inform and develop strategies to reduce crime and the fear of crime.

Criminal intelligence analysis  Criminal intelligence analysis typically looks at organized criminal activity and seeks to link people, events, and property.

Criminal investigative analysis  With criminal investigative analysis, the focus is on serial criminals. Victim characteristics and elements of crime scenes are studied to discover patterns that link related crimes together.

Criminology  The study of crime and criminal behavior.

Geocoding  In geocoding, street addresses and other geographic reference points are positioned onto a map using latitude and longitude coordinates for computer mapping and analysis.

Geographic profiling  In geographic profiling, a profile of the offender, based on the nature of the crime and the facts of the case, is developed.
Hypotheses Statements derived from theory that can be tested to either support or disprove a theory or its assumptions.

Macro Macro-level theories of crime focus on societal-level variables, including the structure of government and the economy and how these variables impact crime rates within a society. Macro-level theories could focus on city-, state-, country-, or global-level influences.

Micro Micro-level theories of crime focus on individual characteristics, including (but not limited to) IQ, mental state, temperament, biological characteristics, and personal finances, and how they influence a person's decision to commit a crime.

Police operational analysis Police operational analysis focuses on the operations of police agencies, including staffing and resource deployment.

Projection The method used to transfer locations on the Earth's surface to a flat map.

Scale The scale of a map indicates how miniature the representation is; the larger the scale, the smaller the area shown on a map.

Strategic crime analysis Strategic crime analysis involves the study of crime and other law enforcement issues to identify long-standing patterns of crime and other problems and to assess police responses to these problems.

Tactical crime analysis Tactical crime analysis examines recent criminal events and potential criminal activity by analyzing how, when, and where the events occur to establish patterns and series, identify leads or suspects, and to clear cases.

Questions for Review

1. What is the difference between micro- and macro-level theories of crime?
2. What is the problem analysis triangle?
3. What is crime analysis?
4. How does crime analysis differ from criminal intelligence analysis? From criminal investigative analysis?
5. Briefly define and provide an example for each of the following: strategic crime analysis, tactical crime analysis, and administrative crime analysis.
6. What are projections and coordinate systems?
7. What are the four types of map data? Provide an example of each.
8. Describe raster and vector data. Provide examples of each.

Online Resources

A list of online resources is as follows. Please note that this is far from a complete list.

Arizona Association of Crime Analysts: www.aacaonline.org
Center for Problem-Oriented Policing: www.popcenter.org/about/?p=sara
ESRI Mapping Center: http://mappingcenter.esri.com
International Association of Crime Analysts: www.iaca.net
International Association of Law Enforcement Intelligence Analysts: www.ialeia.org
International Association of Law Enforcement Planners: http://www.ialep.org/
Mapping and Analysis for Public Safety (MAPS): www.nij.gov/topics/technology/maps/welcome.htm
Massachusetts Association of Crime Analysts: www.macrimeanalysts.org
Office of Community Oriented Policing Services: http://cops.usdoj.gov
The Omega Group: www.crimemapping.com and www.theomegagroup.com
Police Foundation: www.policefoundation.org
Rutgers Center on Public Security: www.rutgerscps.org/rtm/

## Recommended Reading


Dana, P. H. (1999) at the Department of Geography, University of Texas at Austin gives a good discussion of map projections: www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html.


Swartz, C. at the Center for Applied Studies of the Environment, City University of New York, maintains a rather extensive list of references related to crime mapping and analysis. To view this list, visit: www.geo.hunter.cuny.edu/capse/projects/nij/crime_bib1.html.

## References


