Crime Mapping Using IBR Data

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Introduction: What this paper is about

This document examines issues related to the production of maps using an enhanced (or modified) version of the FBI's new data set, the National Incident-Based Reporting System (NIBRS). While the standard NIBRS data elements allow for the production of aggregate-level maps, the addition of a small number of data elements permits the production of much more useful visual displays. Some of the issues we will consider are what type of address data to collect, cautions about the use of such data, and the types of maps and analyses that can be produced. Sources of crime mapping software, publications, and data sets will be provided, and information on the visual display of data—how to make your maps look better and things to avoid—will be discussed.

Background: What's been done before using mapping and crime data

Maps have been used for centuries to display and explore the spatial and temporal organization of data. Their use in the display of crime data, however, is a much more recent development. (For a discussion of the analyses done over the last 150 years on the relationship of crime and place, see Eck and Weisburd.[1]) It has only been in the last dozen or so years that mapping of crime data has come into its own, with many police departments developing the ability to quickly and fairly easily generate their own maps. This can be attributed in large part to the increased sophistication of computers and the dramatic reduction in the price of the hardware and software necessary to create the maps.

The major benefit of the visual display of quantitative information (to borrow the title of Edward Tufte's wonderful book[2]) is that it allows us to grasp the relationship of many points and types of data quickly. Since most crimes occur at a specific place, and since many similar crimes typically occur within a jurisdiction, a visual representation of crime's spatial distribution has obvious benefits for crime analysts, for policymakers, and for managers and administrators. As McEwen and Taxman[3] put it, maps are of two basic types: descriptive, used to provide an overview of the area in question and the various features within it; and analytical, used to aid in

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[1] John Eck and David Weisburd, "Crime Places in Crime Theory," in *Crime and Place*, ed. John Eck and David Weisburd, Crime Prevention Studies (Monsey, NY: Will Tree Press, 1995).

[2] Edward R. Tufte, *The Visual Display of Quantitative Information* (Cheshire, CT: Graphics Press, 1983).

[3] J. Thomas McEwen and Faye S. Taxman, "Application of Computer Mapping to Police Operations," in *Crime and Place*, ed. John E. Eck and David Weisburd, Crime Prevention Studies (Monsey, NY: Willow Tree Press, 1995).

the analysis and interpretation of the features being displayed. (McEven and Taxman also talk about interactive mapping, although this seems more like a melding of the two other techniques). Whatever their uses, full-color maps can provide eye-catching displays that seemingly tell us a great deal of useful information.

Maps can show locations of offenses, offenders, or victims. They can be used to demonstrate the mobility of offenders in finding suitable targets for their offenses, i.e., their "hunting patterns"[4] (useful in the search for unknown offenders). Although they can be thought of simply as a way to display information, maps are important tools that can help in evaluating the effectiveness of strategic decision-making. For example, the implementation of an intensive enforcement policy in one jurisdiction may reduce crime at that site, but increase it at another.[5] A graphic display of offenses over time could quickly and clearly indicate such displacement.

By combining crime data with other information, maps can show areas (neighborhoods, towns, counties) with unusually high (or low) rates of offending in combination with demographic variables. Used in such ways, crime maps can indicate areas of social disorganization—areas where changes in social service delivery may have a positive effect on crime. In addition, by examining the social and economic makeup of a community, it might be possible to predict where increases in crime may occur.

The sociological literature is full of studies which have used "human ecology" to examine the influence of the physical environment on human behavior. The work of Shaw and McKay in Chicago[6] and Shevky and Bell in Los Angeles[7] are two examples that come to mind, but there are literally dozens of studies done in America over the past 50 years. With few exceptions, however, the smallest geographic area examined was the census block group or its equivalent.

One of the problems with mapping crime data has been the difficulty of processing data collected so as to make it mappable–and to do so in a timely and consistent fashion. Although local police

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[4] D. Kim Rossmo, "Geographic Profiling," in *Offender Profiling: Theory, Research and Practice*, ed. Janet L. Jackson and Debra A. Bekerian, Wiley Series in the Psychology of Crime, Policing and Law (Chichester: John Wiley and Sons, 1997).

[5] David Weisburd and Lorraine Green, "Policing Drug Hot Spots: The Jersey City Drug Market Analysis Experiment," *Justice Quarterly* 12, no. 4 (1995). This study actually found little element of displacement and instead suggested a diffusion of benefits to the surrounding area.

[6] Clifford R. Shaw and Henry D. McKay, *Juvenile Delinquency and Urban Areas*, Revised ed. (Chicago: University of Chicago Press, 1969).

[7] Eshref Shevky and Wendell Bell, *Social Area Analysis*, Stanford Sociological Series (Westport, CT: Greenwood Press, 1955).

agencies have typically collected the data needed to map crime, the technology needed to translate street names and numbers into mappable coordinates (latitude/longitude or X and Y coordinates) has been expensive or technologically forbidding.

Computers are not needed to produce maps, of course. Pin maps have been used for many years within local police departments, with the points on the map showing the location of offenses. More expansive pin maps might have different color pins to indicate different offenses or different time periods. The time-consuming effort needed to produce pin maps, however, means that even these low-tech maps are updated infrequently. And too, a physical pin map cannot be easily transported to a senior center or a community meeting for display during a talk.

Pin maps also do not allow for the easy overlay of other data points of interest. The boundaries of police beats or neighborhoods may be drawn on the physical map, for example, but these then become static features and therefore difficult to modify. What if we wish to look at the number of crimes as well as the number of traffic accidents, or ambulance runs, or barking dog complaints? What if we now want to examine whether there is an association between any of these features and the number of derelict properties or the number of students who are truant? Any of these requests may show useful information, but each of them would be difficult or time-consuming to produce.

Mapping crime data on the local level, therefore, has certain difficulties. When we look at mapping crime data collected at the state level by either crime reporting units or Statistical Analysis Centers, the problems become more serious. Most state data collection systems have never collected the right data from local police to allow for the creation of maps. Even if they did, most state agencies do not have the staffing needed for map creation or analysis. As discussed below, these and other problems will need to be examined prior to the development of a mapping and analysis program.

The most common sort of crime data collected has been in the form of the old Uniform Crime Reporting (UCR) system, which presents only a summary of crime data aggregated by reporting agency. These monthly data did not allow for the mapping of crime data by time of day, date, or in any finer level of disaggregation than agency. Summary crime data does allow, however, for the creation of aggregate area maps— maps that display the number of offenses or rate (per 1,000 or 100,000 residents) of offenses for different cities or towns. Various maps could be developed that show the changing picture of crime by month or year.

The FBI's new system of crime data collection, the National Incident-Based Reporting System (NIBRS), contains a vast array of useful statistical, tactical, and policy data. Since data are collected on the crime incident, analyses and maps can be produced showing, for example, rates or volumes of victimization by race, gender, or age, or differing levels of property stolen by type or value. The data collected in most states and on the national level do not have either street

addresses or coordinates that would permit mapping at any finer level of specificity. These types of reports, therefore, would have to be aggregated to the city or town level.

Even if the incident-based data collected had address information, an additional difficulty in regional or statewide mapping and analysis is that each local agency may have somewhat different quality control procedures in place to insure accurate and complete data collection. These would affect both the type of address information as well as the data related to the crime itself.

A department may be collecting location data in the form of place names rather than specific addresses—for example, "Red's Garage" rather than "457 North Main Street." That department may know precisely where Red's Garage is located, but a data user at the regional or statewide level may not. To insure its usefulness, a regional data collection system would require a consistent and uniform method for collecting address information.

A final concern that needs to be addressed before developing a regional data collection system is that appreciation for the utility of data varies among departments, rendering cross-jurisdictional comparisons problematic. Department A requires a written report on all offenses officers respond to, Department B wants reports only on the most serious crimes. Department C has developed an in-house crime analysis function, and has instituted a variety of case review processes. Department D has only a minimal case review function, and no ongoing crime analysis. While it may be possible to gather data in the same format from these four agencies, any analysis that attempts to compare the data among the agencies may be dangerous or misleading. These and other administrative and operational issues need to be considered before the development of any wide-area mapping and analysis program.

A regional or statewide mapping capability has a number of advantages that make overcoming any potential problems developing it worthwhile. First, it provides an additional analytical component to the toolkit of a policymaker or analyst. Just as importantly, however, a statewide mapping capability will make it possible to provide mapping and analytical services to smaller police agencies. These police departments typically have limited resources for either crime mapping or crime analysis, as discussed in a recent report by the Crime Mapping Research Center.[8]

For individual police agencies, even those with mapping capabilities in-house, a regional system can prove beneficial. Police powers end at the political boundaries of the community, although crime and criminal do not know such limitations. A system that would collect and disseminate

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[8] Cynthia A. Mamalian, Nancy G. LaVigne, and Crime Mapping Research Center Staff, *The Use of Computerized Crime Mapping by Law Enforcement: Survey Results* (Washington, DC: National Institute of Justice, 1999).

crime data in a timely fashion from a number of contiguous agencies would provide police with crime data from "over the horizon" and potentially help them identify and (hopefully) respond to emerging regional problems.

In the sections that follow, we will discuss the uses of maps for crime and policy analysis, and demonstrate one way to modify the National Incident-Based Reporting System to allow for the creation of state-level mappable crime data. Some of the advantages and pitfalls of such a system will also be discussed.

Why Maps?

The geographic representation of data is an effective way to display (and, hopefully, understand) a potentially huge number of data points—a method of bringing some order out of what might otherwise be chaos. Through the use of points, symbols, colors, or shadings, data on crime rates (or volumes), demographic information, and other types of data that might be useful for analysis can be presented. By combining several of these attributes, several types or layers of data can be displayed within the same map. Maps with data for different time periods (shifts, days of the week, seasons) can be generated to see if there is a temporal sequence in crime occurrence.

While the advantages of being able to visually represent crime locations are fairly obvious, mapping also provides a number of unexpected benefits, as Maltz et al.[9] discuss in a recent study: data from different sources are made available; an "institutional memory" of a beat is created; detectives can search for patterns more readily; district commanders can practice proactive management more easily; and community relations between the police and community organizations are improved. (p. x). Although Maltz et al. were talking about the benefits of mapping within a particular city, the benefits they describe are just as meaningful at the regional or statewide level.

One of the major problems with maps (as will be discussed later) is that they are by nature static, two-dimensional representations of mostly dynamic, three-dimensional (or more!) realities. In addition, due to any number of factors, the data presented on the maps will undoubtedly be an incomplete and/or inaccurate representation of the underlying reality. These issues may be known to the map creator, but may not be known or appreciated by those who use the maps.

Basic Crime Maps: Summary UCR Data

Crime data have been mapped for decades in useful ways and with many different levels of disaggregation. The summary UCR statistics collected by local, state, and national agencies since the 1920s allow us to look at crime volumes and rates for the nation as a whole, for individual states, and for counties, cities, and towns within states. Since the statistics are generated monthly, it is possible to look at seasonal variations in crime rates. However, the limitations of the data restrict the types of maps that can be generated and the level of disaggregation they represent.

One of the basic types of maps used in crime mapping is the choropleth map—a map in which areas (towns/cities, counties, states, etc) are shaded or colored to distinguish between levels or quantities of an item. Typically a larger quantity is signified by a darker color or shading. (See the Example Maps for examples of choropleth maps.) While a map that displays the actual number of offenses in various communities can be useful, a more meaningful way of displaying differences between areas is by displaying the rate of occurrence of the data item per unit. However, by displaying the rate of occurrence per unit of population, it is possible to compare the relative frequency of offending. For example, town A has 100 crimes in a population of 10,000 while town B has 300 crimes in a population of 30,000. A map that displays the raw number of offenses shows town B as having more crimes and gives the impression that it is more dangerous than town A or has a more serious crime problem. Displaying the rate of offending makes it clear that both towns have the same crime rate.

Advanced Mapping Using Enhanced NIBRS

The data collected in the standard NIBRS data set give us some real advantages in the level of detail they make available. The specific date and time of an incident are collected, allowing more detailed temporal maps to be produced. NIBRS also collects demographic characteristics of both victims and offenders/arrestees, allowing maps of victimization or offending to be produced for various subsets of the population. For example, standard NIBRS data allows us to determine the rate of aggravated assaults where the victims are white females under 12 years of age (see example maps). A series of maps could thus be generated showing the victimization rates for this particular crime for various age and sex combinations, thereby visually focusing attention on the cohort most at risk.

Even with the advanced level of detail now available through NIBRS, however, the smallest geographic area displayed by a standard map is still the city or town. The technique of dasymetric mapping, which has the potential for producing maps with smaller levels of geographic focus, may be of more use for certain types of offenses. For example, say we have burglary data that specify that the crime took place in either a residence or business. If we knew that in a particular town the residential neighborhoods had no businesses, we could produce maps of burglary rates per square mile (say) by location of burglary type without have a specific address.[9]

The NIBRS data set provides basic data elements that have many useful qualities. If the FBI's standards are used, each agency reporting in that format will have collected incident information in a uniform way, using standard definitions of offenses and standard methods for enumerating victims, offenders, and offenses. Even if the state has added variables or values to the FBI data set, it is anticipated that local police contributors have been trained to report them in a

[9] See for example Erika Poulsen, "Using Dasymetric Mapping for Spatially Aggregated Crime Data and Exploratory Spatial Data Analysis," in *Translating Spatial Research into Practice* (Dallas, Texas: Crime Mapping Research Center, 2001).

standardized format. This data standardization is what makes NIBRS the best existing data source for the development of a regional or state-wide crime analysis and mapping program.[10] With the addition of address data (to be covered in the following sections), a wide variety of new sorts of maps can be generated. Instead of crime data aggregated to the city or town level, now maps of crime by police beat or neighborhood boundary can be produced. With the addition of specific street addresses, it is possible to merge crime data with other sources of information, such as census data on socioeconomic variables like income, unemployment status, or age of residents by gender and race.

Geocoding and Addressing

In order to map crime with any degree of specificity, it is necessary to add additional fields that allow for geocoding to the standard federal data set. This process will allow us to determine a latitude and longitude that corresponds to a given address. But where does the address information come from? Which address do we want to use for coding purposes? How do we go about geocoding? And, finally, how accurate are the data —in other words, how good is good enough?

A recent paper by Ratcliffe[11] presents the issues and concerns about the accuracy and validity of geocoded addresses in detail. He mentions ten factors that can affect the results:

- abbreviations or misspelling
- local name variations
- address duplication
- nonexistent addresses
- line simplification
- noise in the address file
- geocoding non-address locations
- geocoding imprecision
- ambiguous or vague addresses

Some of his points are fairly straightforward. The data entry process may allow for individualized abbreviations, or may permit street names or types to be misspelled. There may be two (or more!) streets with the same name within a large jurisdiction, making accurate geocoding

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[10] Although there are some regional crime analysis programs in existence, most of them allow police to collect and report data in whatever format the local department currently uses; the regional program then must perform some recoding and reclassifying in order to maintain a uniform data set.

[11] Jerry H. Ratcliffe, "On the Accuracy of Tiger-Type Geocoded Address Data in Relation to Cadastral and Census Areal Units," *Int. J. Geographical Information Science* 15, no. 5 (2001).

difficult. If there is not an accurate and up-to-date geobase of correct addresses, the caller or call-taker may enter a nonexistent street name. Some systems may put in a default street number value to indicate the actual number is missing (perhaps 999). Whatever the reason, mistakes and imperfections will undoubtedly appear in the address file.

Although almost every criminal incident has a specific address, it is also true that almost every criminal incident has several addresses associated with it. There is the address of the crime itself, though the location of an abduction, for example, may not be the address where the victim is released (or murdered). A crime may take place in location A but the arrest of an offender may occur in location B. Property may be recovered in location C. And the offender may live in location D.

Each of these addresses may be useful for some types of analyses. Crime location may be useful in determining hot spots of offending, or in examining issues of social disorganization. Where an offender lives or is arrested may be helpful in understanding "hunting patterns." Locations where stolen property is recovered can be used to determine the location of 'chop shops' or areas where increased preventative patrols may prove useful. However, for each address that may be of use, there are concerns that must be addressed.

Where do the data come from and is the information routinely and accurately collected? Incident address may come from the police CAD (computer-aided dispatch) system, from the victim in a walk-in to the police, or from the patrol officer who comes upon a crime in progress or who is stopped while on patrol by a victim or witness. Each of these sources of information has value, but each also brings with it the potential for error. Addresses that might be useful from a theoretical perspective may not be routinely collected. The benefit of requesting or requiring a police agency to collect additional address data must be weighed against the difficulty in or resistance to collecting it.

The two most common errors in address data are variant spelling and missing street numbers. Variations in spelling of street names and street-type abbreviations (street, avenue, etc) are the bane of every system of data entry. It is clearly difficult to dispatch an officer to an address if the address is unknown, but saying an address is much different than typing it into a report. In Boston, for example, "Dorchester Avenue" is a well-known street. It is also known locally as "Dot Ave." Either might be typed into a record management system, and either might be understandable to the officer. If the data were sent to a user in another agency or jurisdiction, the meaning might be lost. It is also quite surprising how many spelling variations there may be for a common street name: Smith, Smithe, Smyth, etc. A simple mistake in typing an address may also make geocoding impossible or inaccurate

Many dispatch systems have look-up tables that will not allow incorrect spelling of street names or types. However, in the interest of speedy data entry, such systems might allow data entry with a reminder to correct spelling errors at the end of the dispatch or shift, rather than forcing the

operator to stop and correct errors immediately. Case or record review is therefore an extremely important component of any data entry system.

Missing street numbers may seem to be an incongruous situation when every crime must, it seems, occur at a specific location. However, it is a fairly commonplace occurrence in real-world systems. When police are dispatched to a location, the address will be specified. Many times, however, the police will discover a crime in progress (or be flagged down by a victim of or witness to a crime). In those cases, the responding officer may indicate that the call was made on Main Street, for example, but not at a specific house number. It may be that the lack of a street number for a less-serious incident may be overlooked (but note that these "'less serious'" incidents may be important quality of life crimes that have a disproportionate impact on a community). This is another area where a routine case review process can be used to catch and correct errors.

The best data to collect in order to do mapping is a latitude and longitude —the exact geographic coordinates of a place. With a "lat" and "long" geocoding is not needed. It is assumed that a police department would use a high-end global positioning system (GPS) device to specifically identify each legitimate address within its jurisdiction in order to capture these data elements. If the police agency does capture these data, no other street location data elements are needed. Unfortunately, most police agencies (at least in Massachusetts) do not collect those data elements within their geobase file.

A street address is a commonplace item, but some thought must go into deciding which data elements should be captured for mapping, and what format they should have in the database. An address is composed of several parts. Ideally, each needs to be collected in a separate field within the database. The minimum data elements that should always be collected are:

- Street name and type
- Street number
- Street direction
- Intersecting street (or cross street information)

Other address elements that may be useful or necessary are:

- Additional descriptive information; e.g., lot number, apartment number, floor, etc.
- Neighborhood or village name
- State name
- Zip code

There is some discussion about the utility of collecting address attribute data, such as police patrol district (or "beat"), zip codes, census designations (tract or block number), or neighborhood names. Each may have some degree of utility and may improve the ability to aggregate crime data. However, the definition of each one of these variables can change over time. Zip codes can be redefined. The Bureau of the Census can divide tracts. Neighborhood

boundaries expand or contract. By placing these data into the database, incorrect mapping can result at some later point. Their use, therefore, is possible, but limited.

Part of the determination of what type of data to collect depends on the standards or situation within each agency or state. For example, the District of Columbia has the city divided into sections (NW, SE, etc). If a street address did not include that identifier, it would not be possible to accurately map data in Washington. In other parts of the country, cities may be located near or at the border of a state or the nation. Those jurisdictions may need to have a "state" or "nation" field. Some larger cities that have grown through the annexation of other areas may have neighborhoods with duplicate street names. In these cases, a neighborhood or village name may be necessary, along with the city or town name, in order to uniquely identify a location.

These subdivision names (town, village, neighborhood) may also be needed if the reporting agency has cross-jurisdictional police power. These agencies may include transit authorities, state or county police, drug task forces, and other similar departments.

Depending on the needs of the users and the type of locations involved, a third locational dimension may be needed. For crimes occurring in large facilities (office buildings, hospitals, dormitories, etc), a "Z" coordinate may be needed to pinpoint the incident location. It is of some small use to say that certain crimes took place at 100 Main Street, the main entrance of a high-rise. A different picture emerges if we can say that the crimes occurred on different floors, but only in locations where lights were not functioning.

The accuracy of our geocoding process is a basic concern. For operational or tactical purposes on the local level, a hit rate of 98% or higher is necessary. A vital part of policing is to accurately know the location of victims, offenders, incidents, emerging problems, and problematic areas. The level of accuracy that is needed for other types of analyses—and certainly for analysis at a larger scale of resolution—is somewhat lower. Rates in the range of 75% to 85% are probably good enough for a wide variety of uses. An overall mean rate which falls within this range, however, should not mask the fact that some large agencies have a high rate of geocoding accuracy, while other, smaller agencies have much lower rates.

What Ratcliffe calls "geocoding precision" is the final area of concern about accuracy. Although our software may state that it has determined a specific latitude and longitude for a given address, how can we know that it has found the precise and accurate point on the map? In reality, for most addresses we cannot. The author has come across situations where the geocoding software has found a specific latitude and longitude for an address—but placed it nearly 100 miles away from the town in which it actually occurred!

Depending on the purpose of our mapping, these accuracy rates can be a very significant issue. For example, a state may have laws that provide for a sentencing enhancement when a drug offense is committed within 1,000 feet of a school. Another state may require the notification of

residents who live within a certain radius of the home of a convicted sexual offender. A statewide crime mapping program may be satisfied with a geocoding hit rate of 80% and a accuracy rate of 90%, but these levels might create serious problems for the local police department which is trying to enforce the law.

Cautions and Precautions

Although maps can be extremely useful tools in the right hands, it is possible to misuse them or produce misleading information. Anyone who creates a map must make a conscious choice between complete or comprehensive coverage of data, leading to complex maps which may be difficult to understand, and simplification, leading to more easily comprehensible maps, but ones which may leave off important data. Harries[12] calls this a tradeoff between more and less abstraction. The way we represent data on the map is a conscious choice we make, and one that may influence the viewer's perceptions of what we are presenting.

In talking about some of the "white lies" the mapmaker may produce, Monmonier[13] lists five ways in which geometric lines may be generalized. Selection of lines to be displayed means that the most important ones will be displayed. Simplification of lines indicates that only the most important points along the line are shown. Displacement physically moves some lines in order to more clearly display other lines. Smoothing removes some points or displaces others along a line. Enhancement artificially adds points to a line in order to make it appear more realistic.

Depending on the functionality of the software used or the abilities of the mapmaker, any of these techniques may be done deliberatively to aid in the display and interpretation of the data. They might also be used to subtly shape the impressions of the viewer.

Software

Once address information is collected, it is necessary to convert that data into mappable information in a process known as geocoding. Geocoding takes a specific street address and imputes a specific X and Y coordinate for it. The imputation process determines not the precise coordinates but rather makes an estimate of where that location is. Streets are divided into segments, which are typically block-long units. The geocoding software "knows" the odd and even house numbers at each end of the segment, as well as their specific and (hopefully) accurate X and Y coordinates. The address we wish to geocode is fed into the software which computes the approximate coordinates for it.

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[12] Keith Harries, *Mapping Crime: Principle and Practice* (Washington, DC: US Department of Justice, 1999)., p 10.

[13] Mark Monmonier, *How to Lie with Maps*, 2nd ed. (Chicago: University of Chicago Press, 1996), pp 25-27.

This process works well in certain areas of the country: the most populated and urbanized cities and towns. It also works somewhat better in places undergoing less development, as new streets and subdivisions would need to be entered into the geocoding software database in order to be usable for coding.

Rural and country areas are much more difficult to geocode. Part of the reason is that there may be less economic incentive on the part of the software developers to include these areas within their geocoding packages. Adding to the difficulty, some of these areas may have streets without house numbers, having "Star Route" or "RFD" box numbers instead. In these areas, the "hit rate" or percentage of addresses that are successfully coded may be disappointingly low. It should be remembered that it is the police agencies in these areas that might reap the greatest benefit from the development of a regional crime mapping and analysis program, so every effort should be made to increase the geocoding hit rates.

Whether in urban or rural areas, the software used for geocoding must be constantly upgraded to account for new construction, new roads, and new developments. As certain unincorporated areas become absorbed by nearly cities, street names and numbers may be changed. In addition, the software companies are hopefully increasing the accuracy of prior versions of their product. For all these reasons, the initial investment in a geocoding package should be seen as only a "first payment" in what may be an ongoing investment.

The number of companies that provide geocoding and mapping software is ever increasing. Although MapInfo and ESRI are two of the best-known and widely used suppliers of such programs dozens of other packages are now available. The level of sophistication, cost, and comprehensiveness of these programs varies widely, so some considerations should be kept in mind prior to any purchases.

First, is there a statewide standard in software for mapping purposes? Many states have a data center that develops standards for coordinate systems and has a variety of base maps available at minimal or no cost. Although it is possible to convert from one mapping software system to another, it may be easier to use the standards already in place. As in many other cases, it is much better not to reinvent the wheel.

If it is possible, surveying local units of government to determine which mapping software is most used can be very helpful. Using a widely available mapping program makes training and data dissemination much easier. A state-level program that generates wonderful maps in a format that few local agencies or users support may have difficulties in transferring data or maps to the people it aims to serve.

Finally a mapping program should be able to produce maps with enough accuracy for the purposes to which they will be put. Maps are a general representation of a physical reality, but any map will have a level of inaccuracy built into it. A 5% or 10% level of inaccuracy in a

statewide map may be acceptable, while such an error rate may make the map unusable at the town or neighborhood level.

Practical Issues in Developing a Regional/Statewide Program

The routine collection of crime data which are then sent to a state-level program—whether using the summary UCR system or NIBRS—typically is noncontroversial for police administrators. The collection of address data, however, may be more problematic. State statutes may contain prohibitions against the dissemination of identifying information related to crimes against children, sexual offenses, or domestic violence. Other open cases may be under active investigation. In smaller jurisdictions, the release of incident address could uniquely identify a victim. In any of these situations, the public release of address information could be illegal, improper, or could damage an ongoing case.

Police in general are very willing and anxious to get data about crimes and conditions in the areas surrounding their jurisdiction. They are clearly aware that factors outside their knowledge and control can have a direct impact on them. There may be some degree of hesitation, however, in making their data available to others.

As an issue of interagency cooperation, all that may be needed to get the necessary address data is an informal agreement among the parties involved. Depending on your state statutes and past practices, a more formal memorandum of understanding may need to be drawn up, specifying what sort of data are being requested, who will collect and maintain them, and to what use they may be put.

Depending on the state's public access laws, it may also be necessary to carefully examine the rights the public has to data from individual police agencies. Data that might be protected from disclosure under a Freedom of Information Act request at the local level might be more exposed to dissemination once it has been transmitted to the state. At the most extreme level, prior to developing the mechanism of a regional crime mapping program, it might be necessary to draft statutory changes to preserve the confidentiality of crime information.

Another data quality concern is the need to insure that the address being collected as the incident location is in fact that and not simply the location where the crime was discovered. It was once reported in Boston that a large number of crimes were occurring at 1 Fruit Street. In fact, this was the address of a major hospital's emergency ward. The so-called "Green River" serial killings in the Seattle area are named after the location where many of the victims' bodies were found, although many of the identified victims were last seen on the streets of Seattle.

Design and Display Considerations

A map is a type of graphic display. Some ways of displaying data enhance the information the data contain, others serve to obscure it. Edward Tufte,[14] who has published several books on how to effectively display data, writes that "Graphical displays should:

- show the data
- induce the viewer to think about the substance rather than about methodology, graphic design, the technology of graphic production, or something else avoid distorting what the data have to say
- present many numbers in a small space
- make large data sets coherent
- encourage the eye to compare different pieces of data
- reveal the data at several levels of detail, from a broad overview to the fine structure
- serve a reasonably clear purpose: description, exploration, tabulation, or decoration
- be closely integrated with the statistical and verbal descriptions of a data set."

If we would look at the maps we are creating with these points in mind, the quality of our work will surely increase.

All maps should have certain descriptive or identifying labels on them. A scale should indicate what distance on the map is represented by what measurement on the actual land surface being mapped. Each may should have also have an indication of the map's orientation— typically, an arrow showing North. These labels might seem superfluous to you or to the local users of the map, but they are very useful to others who may not be as familiar with the locale.

When designing a map, you should consider how it will be produced, the method of display, and the audience to which it is directed. A map that may look legible and instructive when displayed on a desktop computer with a high resolution color monitor may be less meaningful or legible when viewed over the Internet or when printed in black and white. If the map is to be projected through an LCD projector and viewed in a large room, the symbols and lettering must be clearly visible to the people sitting in the back row.

Resources

The Crime Mapping Resource Center (CMRC) of the National Institute of Justice is a primary source for a number of useful reports, software programs, and other free items. The Center's annual conference features dozens of sessions and preconference training seminars dealing with

[14] Tufte., p 13.

the analysis and display of crime data. The CMRC also hosts a listserv for people with an interest in crime mapping.[15] The CMRC Web address is www.ojp.usdoj.gov/cmrc.

One of the best written sources of data on crime mapping is a book published by the CMRC: Keith Harries' *Mapping Crime: Principle and Practice*. The work is an excellent introduction to mapping in general and crime mapping in particular. Its many illustrations add to its utility, demonstrating a number of ways to present data that are both meaningful and understandable. The book can be downloaded from the CMRC Web site or ordered free of charge from the National Criminal Justice Reference Service (1-800-851-3420).

Among the resources that the CMRC has sponsored is CrimeStat, a comprehensive software program that calculates an extensive number of spatial statistics. Developed by Ned Levine, CrimeStat accepts data in a variety of formats, thereby making it easy for users of various mapping programs to calculate and map the results. One of the program's best features is the extensive and extremely well-written manual that accompanies it. While it does explain the operation of the software, it also goes into detailed but understandable explanation of the statistical techniques involved. CrimeStat can be downloaded from:

http://www.icpsr.umich.edu/NACJD/crimestat.html

The CMRC has also commissioned the production of tutorials for users of either ArcView or MapInfo in the techniques of crime analysis and mapping. The software comes complete with sample data sets for use in training. Although this will not take the place of a hands-on class, it is an inexpensive way to gain the basic skills needed: "The purpose of the tutorial is to provide police with the skills and knowledge to produce the day-to-day crime maps that have been proven to help reduce crime. There are three parts: 1) using a crime mapping GIS, 2) geocoding police data, and 3) building area and pin maps." The tutorials can be downloaded from this Web site:

http://www.icpsr.umich.edu/NACJD/cmtutorial.html

Another notable spatial analysis packages is the Spatial and Temporal Analysis of Crime package (STAC). Developed by the Illinois Criminal Justice Information Authority, it is also available free of charge upon written application to the Authority. STAC performs a variety of analyses, and produces outputs that can be displayed by the user. Many of the STAC routines are now being incorporated in the newest version of CrimeStat (not yet available at the time of this writing). Further information about STAC can be obtained at :

http://www.icjia.org/public/index.cfm?metaSection=Data&metaPage=STACfacts

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[15] It should be mentioned that users of ArcView© or MapInfo© also have listservs set up for their particular software. Information on these is available through the main address of the software company: www.mapinfo.com and www.esri.com.

The Police Foundation has set up a Crime Mapping Laboratory as a method of developing and disseminating information on the subject. One of its products is the *Crime Mapping News*, a quarterly publication on the subject. This report is available online from the Foundation's Web site: www.policefoundation.org.

The Crime Mapping and Analysis Program provides technical assistance and training to local and state agencies in the areas of crime and intelligence analysis and geographic information systems (GIS). It provides free hands-on training in both MapInfo and ArcView at various sites throughout the nation. Further information about its programs can be obtained at:
http://www.nlectc.org/cmap/

Boundary files are necessary both for the display of political divisions and for the development of choropleth maps. There are two easily accessible and free sources for such data. The US Census Bureau has a wide variety of boundary files on its web site (www.census.gov/geo/www/cob/). These range from the usual (census block groups and tracts) to the more unusual (zip code areas and traffic analysis zones). The files are immediately available, but only in ARC/INFO or ArcView formats. The other source of data is the Socioeconomic Data and Applications Center (SEDAC) of Columbia University (http://plue.sedac.ciesin.org/plue/ddcarto). The data are available in either Atlas GIS or MapInfo formats. The MapInfo data files take one day to process.

Each state has an agency that collects and disseminates mappable data—either boundary or data attribute files. The US Centers for Disease Control and Prevention has a Web site with what appears to be an exhaustive listing of data sources. Although the site's primary purpose is to provide public health researchers with access to information, the listing of data sources will be of great use to crime analysts and mappers. The site is accessible at www.cdc.gov/epiinfo/EIhlgeog.htm

Other recent publications that may be of interest and that are freely available are:

Strategic Approaches to Community Safety Initiative (SACSI): Enhancing the Analytic Capacity of a Local Problem-Solving Effort, by Elizabeth Groff, December 2000
http://www.ojp.usdoj.gov/nij/sacsi/sacsi.pdf
http://www.ojp.usdoj.gov/nij/sacsi/index.html

Research in Brief, *Disorder in Urban Neighborhoods Does It Lead to Crime?*
by Robert J. Sampson and Stephen W. Raudenbush, February 2001
http://www.ncjrs.org/pdffiles1/nij/186049.pdf

Measurement and Analysis of Crime and Justice

A new publication released by NIJ, *Measurement and Analysis of Crime and Justice*, Volume 4, has a chapter on the spatial analyses of crime. http://www.ojp.usdoj.gov/nij/criminal_justice2000/vol4_2000.html

Possibilities and Examples

Mappable crime data can be used for any number of operational, tactical, or management purposes. The data collected on a regional or statewide basis will almost always have limitations when compared to those stored and maintained at the local level (amount of detail, timeliness, etc.) but they will still be useable for a number of different types of analyses. Some examples of potential uses follow.

Enhanced NIBRS and Problem-Oriented Policing

Enhanced NIBRS can be of great benefit in discovering patterns of crime which cross jurisdictional boundaries, as shown by Faggiani et al..[16] in a recent paper. Using a year's worth of data from several contiguous cities in central Massachusetts, the authors' demonstrate that a drug offending problem can cross boundaries, and that its characteristics can be significantly different. One town in the study shows a high rate of drug selling, while an adjoining town has a problem with drug possession. An intervention strategy that treated both towns in the same manner might be prone to failure. La Vigne[17] has also pointed out the utility of crime mapping for problem-oriented policing, as well as for the dissemination of crime prevention information.

Community Organizations

A recent study by Rich[18] showed how community organizations in Hartford, CT, used mappable crime data . Although the data set was not in the NIBRS format, it is clear that incident-specific crime data were helpful to the organizations in a number of ways. Community groups were able to use the information to form new block watch groups or to support existing ones, to support neighborhood-level organizations, to raise community awareness of crime and disorder problems, and to facilitate communications between the local organizations and the police.[19]

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[16] Donald Faggiani, Daniel B. Bibel, and Diana Brensilber, "Regional Problem Solving Using the National Incident-Based Reporting System," in *Solving Crime and Disorder Problems*, ed. Corina Sole Brito, Melissa Reuland, Lisa Carroll (Washington, DC: Police Executive Research Forum, 2001).

[17] Nancy G. LaVigne, "Computerized Mapping as a Tool for Problem-Oriented Policing," *Crime Mapping News* 1, no. 1 (1999).

[18] Thomas Rich, *Crime Mapping and Analysis by Community Organizations in Hartford, Connecticut* (Washington, DC: National Institute of Justice, 2001), NCJ 185333.

[19] Ibid.

Final Thoughts and Caveats

Most of the work that has been done to date in the area of crime analysis and crime mapping has focused on fairly small geographic areas—cities, neighborhoods, block faces. For most researchers and especially for most police officials, this was appropriate. Apart from the problems of collecting data from larger areas, police powers only extended to the boundaries of the political jurisdiction. It made little sense to be concerned with the analysis of wide-area data.

As we have pointed out here, this is no longer true. It is possible to collect crime data from a multijurisdictional area that may encompass several departments, and, in fact, several state-wide programs are either underway or under development.[20] But there are no known statistical techniques that can deal with crime patterns scattered over a large area, and few, if any, research reports that can assist the user in developing such a system.

Mapping crime data, using enhanced NIBRS or some other data collection system, provides us with an exciting tool with which to present data. Thoughtful presentation of the data will help in the process of converting them into some sort of information. And with the use of our background, skills, and expertise, we should be able to convert that information into useable knowledge. With the advent of relatively inexpensive computer hardware and software, even the least skilled practitioner is now able to produce good looking maps and disseminate them widely. But it is important to ask, should we be doing this?

A map by itself is only a tool that can prove useful in the hands of a skilled analyst. It cannot and should not take the place of the eyes and the expertise of that person, who can tease out the meaning behind the numbers, points, and colors. An excellent example of the strengths and limitations of computerized crime mapping and analysis can be seen in the Crime Mapping Research Center's "Hot Spot" Project.[21] Ten different software programs were run against the same set of burglary data from Baltimore County. Each software program found a somewhat different set of crime hot spots—and each of those was different from the hot spots found by a trained crime analyst who "just" used her eyes and her expertise. As Bruce points out,[22] we

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[20]Daniel B. Bibel, "Statewide Crime Mapping and Analysis: An On-Going Project," *Crime Mapping News* 2, no. 3 (2000).

[21] Eric Jefferis, *Crime Mapping Research Center "Hot Spot" Project* [Web site] (Crime Mapping Research Center, 1998, accessed 12/26/2001); available from www.ojp.usdoj.gov/cmrc/pubs/hotspot/hotspot.html.

[22] Christopher W. Bruce, *A Thousand Words for a Picture: Is the Overvaluation of GIS Disrupting a Critical Balance in Crime Analysis?* [Web site] (Massachusetts Association of

appear to be moving toward "a growing culture in which crime mapping—a tool of crime analysis—is superceding the analysis itself."

Even the best map is an abstraction of reality and a compromise between information overload and oversimplification. Our individual biases, conscious or unconscious, lead us to suppress or enhance various items on those maps. The maps we make will be used to guide decisions. We can only hope those decisions are wise ones, informed by accurate data that have been presented in a concise and comprehensive way.

Crime Analysts, 2001, accessed September 24, 2001); available from www.macrimeanalysts.com/rt/f2cb1p.htm.

Bibliography

Bibel, Daniel B. "Statewide Crime Mapping and Analysis: An On-Going Project." *Crime Mapping News* 2, no. 3 (2000): 1-4.

Bruce, Christopher W. *A Thousand Words for a Picture: Is the Overvaluation of GIS Disrupting a Critical Balance in Crime Analysis?* Massachusetts Association of Crime Analysts, 2001. Accessed September 24, 2001. Web site. Available from www.macrimeanalysts.com/rt/f2cb1p.htm.

Eck, John, and David Weisburd. "Crime Places in Crime Theory." In *Crime and Place*, ed. John Eck and David Weisburd, Vol 4. Monsey, NY: Willow Tree Press, 1995.

Faggiani, Donald, Daniel B. Bibel, and Diana Brensilber. "Regional Problem Solving Using the National Incident-Based Reporting System." In *Solving Crime and Disorder Problems*, ed. Corina Sole Brito, Melissa Reuland, and Lisa Carroll, 155-173. Washington, DC: Police Executive Research Forum, 2001.

Harries, Keith. *Mapping Crime: Principle and Practice*. Washington, DC: US Department of Justice, 1999.

Jefferis, Eric. *Crime Mapping Research Center "Hot Spot" Project*. Crime Mapping Research Center, 1998. Accessed 12/26/2001 2001. Web site. Available from www.ojp.usdoj.gov/cmrc/pubs/hotspot/hotspot.html.

LaVigne, Nancy G. "Computerized Mapping as a Tool for Problem-Oriented Policing." *Crime Mapping News* 1, no. 1 (1999): 1-3.

Maltz, Michael D., Andrew C. Gordon, and Warren Friedman. *Mapping Crime in Its Community Setting: Event Geography Analysis*. New York: Springer-Verlag, 1990.

Mamalian, Cynthia A., Nancy G. LaVigne, and Crime Mapping Research Center Staff. *The Use of Computerized Crime Mapping by Law Enforcement: Survey Results*. Washington, DC: National Institute of Justice, 1999.

McEwen, J. Thomas, and Faye S. Taxman. "Application of Computer Mapping to Police Operations." In *Crime and Place*, ed. John E. Eck and David Weisburd, 4. Monsey, NY: Willow Tree Press, 1995.

Monmonier, Mark. *How to Lie with Maps*. 2nd ed. Chicago: University of Chicago Press, 1996.

Poulsen, Erika. "Using Dasymetric Mapping for Spatially Aggregated Crime Data and Exploratory Spatial Data Analysis." In *Translating Spatial Research into Practice*. Dallas, Texas: Crime Mapping Research Center, 2001.

Ratcliffe, Jerry H. "On the Accuracy of Tiger-Type Geocoded Address Data in Relation to Cadastral and Census Areal Units." *Int. J. Geographical Information Science* 15, no. 5 (2001): 473-485.

Rich, Thomas. *Crime Mapping and Analysis by Community Organizations in Hartford, Connecticut*. Washington, DC: National Institute of Justice, 2001, NCJ 185333.

Rossmo, D. Kim. "Geographic Profiling." In *Offender Profiling: Theory, Research and Practice*, ed. Janet L. Jackson and Debra A. Bekerian, 159-175. Chichester: John Wiley and Sons, 1997.

Shaw, Clifford R., and Henry D. McKay. *Juvenile Delinquency and Urban Areas*. Revised ed. Chicago: University of Chicago Press, 1969.

Shevky, Eshref, and Wendell Bell. *Social Area Analysis* Stanford Sociological Series. Westport, CT: Greenwood Press, 1955.

Tufte, Edward R. *The Visual Display of Quantitative Information*. Cheshire, CT: Graphics Press, 1983.

Weisburd, David, and Lorraine Green. "Policing Drug Hot Spots: The Jersey City Drug Market Analysis Experiment." *Justice Quarterly* 12, no. 4 (1995): 711-735.