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# *National Institute of Justice*

## **Bringing Geography to the Practice of Analyzing Crime Through Technology**

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## **Mapping, Spatial Analysis and Geography at the National Institute of Justice**

In 1997, the National Institute of Justice (NIJ) established the Crime Mapping Research Center (CMRC) using funds for technology assistance from the fiscal year (FY) 1996 Appropriations Act. CMRC was established under the Institute's behavioral sciences division, the Office of Research and Evaluation (ORE). The center's primary focus was on using geographic information systems to visualize crime data and understand spatial patterns of criminal activity. Its target constituency was and is state and local law enforcement and other criminal justice organizations.

In 2002, NIJ transformed CMRC into the Mapping and Analysis for Public Safety (MAPS) program. The MAPS program works toward integrating spatial statistics into the measurement of geographic crime patterns. When the program was expanded into NIJ's Office of Science and Technology (OST), it began to examine emerging technologies (beyond software) that would be key tools in the study of crime.

With mature visualization and statistical techniques for analyzing geographic data, the MAPS program now works to promote the integration of geographic theories and principles into the study of crime. This involves intramural research within the program and grant funding of proposed projects from the field. This combination of research, practice and technology facilitates the crafting of significant public policy that best addresses the most pressing crime and public safety problems.

Analysis solely from statistics and modeling is simply not enough to inform policy. Spatial analysis and mapping must be based in geography in order to craft public policy, because policy requires answers based on sound fundamentals. For instance, Stephen Hall wrote in 1994 that society is currently reconsidering how to use space to understand a variety of problems (Hall, 1994). The primary tool in Hall's book is computerized mapping.

As a contribution to this way of looking at geographic space, this paper examines how NIJ's grant-funded research is integrating geography and technology to alleviate pervasive crime.

### **Defining Crime Mapping**

Much of what the MAPS program does is referred to as "crime mapping." This is in many ways an inaccurate term, because crime mapping involves much more than simply plotting crime locations in space. Crime mapping is usually coupled with the use of a geographic information system (GIS). A GIS is a tool for visualizing and manipulating geographic data that is used to prepare data for statistical analysis and to display the output from analysis. Although some GISs include spatial analysis tools, their analysis is confined to locating and examining geographic objects as they relate to one another in space. Spatial data analysis combines spatial analysis with associated attribute data of the objects being analyzed. GIS can be used to create the spatial structures for this analysis in

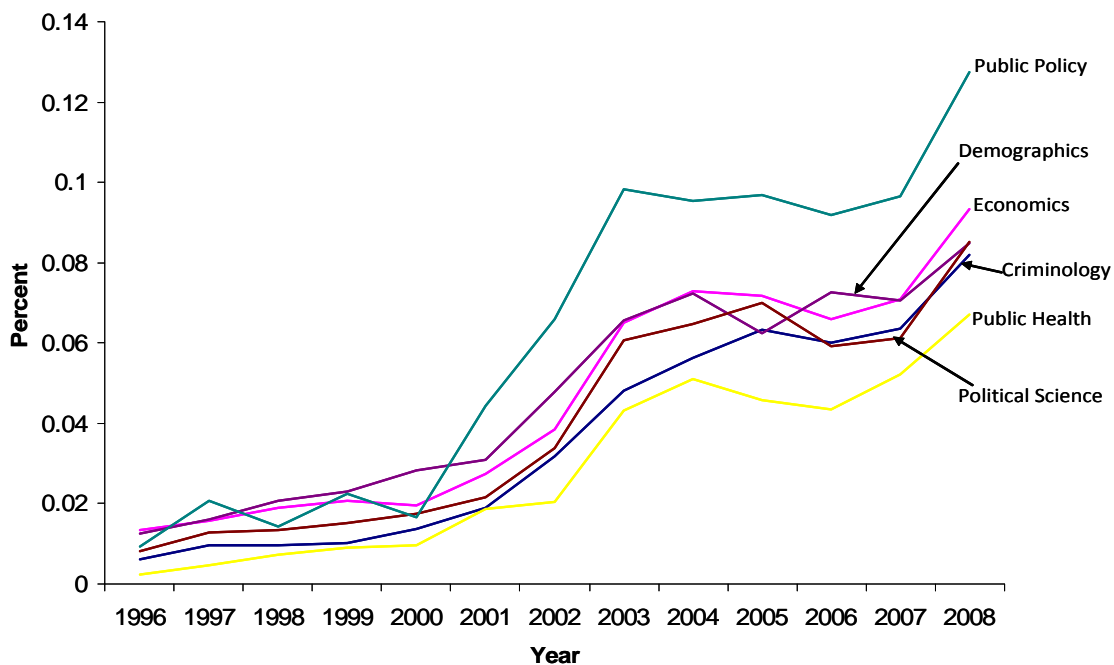
more complex modeling. Crime mapping, then, can apply any one of these approaches to the analysis of geographic data.

### Current Use of Spatial Analysis in the Study of Crime

Over the past three decades, the lack of adequate software has kept other social sciences from using geographic analysis principles (Dobson, 1983, 1993; Goodchild, 2006; Griffith, 1990). As technology has advanced, this trend has slowly begun to change. The turning point was the creation of software that allowed law enforcement to study the spatial aspects of crime. Advances in computational speed and the development of integrated development environments that make software writing more efficient have produced what Dobson (1983) called the “automation” of geography.

Software has become a primary scientific instrument for understanding and solving society’s problems (Wilson, 2007). This is because software has become a mechanism for expressing scientific thought and creating models of the world. GIS software is currently a dominant tool for analyzing crime data, particularly in law enforcement agencies. Figure 1 shows how, in the past decade, many different social science disciplines, including criminology, have been influenced by the use of GIS and spatial analysis software. Specifically, it provides the percentage of articles in each social science discipline that use some form of mapping or spatial analysis and that have been published from 1996 to 2008.<sup>1</sup> As illustrated, the use of mapping and spatial analysis in the social sciences is rising.<sup>2</sup> In criminology, improved tools have allowed social scientists to directly address the need to understand the spatial aspects of crime.

**Figure 1.** Percentage of Social Science Articles Using Mapping or Spatial Analysis, by Discipline, 1996-2008



Source: Sociological Abstracts, Applied Social Sciences Index and Abstracts, and Social Service Abstracts.

Technology and its use are often responsible for social change, regardless of whether the change is expected or not. The impact of geographic technologies on crime analysis has bigger implications. Advancements in geospatial technologies have led to large changes in law enforcement strategies. As a result of these technological developments, there has been a recent shift toward more geographically focused policing practices. Hot spots policing<sup>3</sup> is one geographically focused policing strategy that is being adopted in the law enforcement community.

The MAPS program has contributed to technological research and development by funding the CrimeStat III spatial statistics software packages, which are essential to hot spots policing.<sup>4</sup> This software incorporates a range of spatial statistical tools that allow descriptive and advanced modeling techniques. CrimeStat III is commonly used by law enforcement to identify hot spots. Hot spots policing has grown dramatically over the years to become one of law enforcement's main tools for allocating resources and direct patrols. Its popularity may be due to advances in software technology that have automated geography for practical purposes.

Overall, the analysis of crime has been greatly affected by the advances made in GIS and other spatial analysis technologies. Continued development of geospatial technologies has led to improvements in crime analysis. The effective combination of criminological theory and geographic analysis principles has allowed the field to gain prominence and acceptance.

### **Grant-Funded Research From the MAPS Program**

Over the past few years, the MAPS program has funded several geospatial technology research projects with the goal of advancing the collection and geographical analysis of crime data. The range of these projects spans from simple to advanced. Twelve technology projects related to geospatial analysis have been funded under the MAPS Program. These software-driven grant projects have resulted in advanced data collection and analysis technologies. A few of these grants are described below:

- **Semiautomated 3D Geocoding of Large Urban Structures (#2007-DE-BX-K010)** — **University of North Carolina, Charlotte.** This project focuses on developing visual analytic tools for emergency responders in large urban indoor environments. The research consists of two parts:
  - Semiautomated processing of 2D building computer-assisted design (CAD) files to produce a 3D building network.
  - A server/client-based architecture for communication between responders in the field and a central command post.

- **Flexible Geospatial Visual Analytics and Simulation Technologies to Enhance Criminal Justice Decision Support Systems (#2009-SQ-B9-K101) — Arizona State University.** This research project will develop a methodology to integrate new techniques for geospatial visual analytics and spatial econometrics with state-of-the-art geocomputation technologies. This integration will yield the basis for an enhanced decision-support system for criminal justice interventions. In addition, the research will yield an open-source and cross-platform modular software toolbox that will be available through a number of user interfaces.
- **Urban Crime Simulator (#2007-IJ-CX-K014) — South Carolina Research Authority/Kent State University.** Based on routine activities theory, deviant places theory and neighborhood life-cycle concepts, an urban crime simulator was developed. This tool estimates changes in crime rates in urban neighborhoods based on known or projected changes in neighborhood characteristics. The simulator can use GIS-formatted data and operational environment. The MAPS program is jointly participating in this research with the grantees.
- **Smart Police Deployment: Evaluation of the Use of Automated Vehicle Locator Technologies in Policing (#2007-IJ-CX-K153) — The Police Foundation.** This study examines the reliability and usefulness of automated vehicle locator (AVL) technology to quantify police presence. The study examines the impact of police presence on crime in specific geographic areas in Dallas. More important, it tests whether AVL technology can be an effective tool for deploying officers. This project will advance information-led policing nationwide by providing a technology-based strategy for crime prevention and reduction.

These grants represent both current and future directions of NIJ's geospatial technologies portfolio. For a full description of all research projects in the MAPS program, see: <http://www.ojp.usdoj.gov/nij/maps/projects.htm>.

## **Future Directions**

To date, spatial analysis has been employed through the use of software. This is primarily because GIS has provided useful solutions to some of the most immediate problems law enforcement must address. But software can only go so far. Research must integrate other technologies that collect or create geographic information and use them to analyze geographic events that are not easily reported or otherwise observed. It must employ technologies that capture ground truths more objectively than traditional means of capturing social science data (e.g., observation). These technologies can be more direct and unbiased in recording events than such traditional methods because value judgments affect their programming only, not their data collection.

In particular, employing sensor technologies is a priority for the MAPS program. Positioning technology already uses sensor technologies to track human travel behavior. Acoustic technologies are being used to capture sounds associated with human activities, and spatial cognition technologies are being employed to understand how people make

spatial decisions. Each of these has applications in understanding both general patterns of criminal behavior and individual crimes. More important, these technologies can capture geographic data that traditional means of data capture cannot. Specifically, they capture the subtleties of incidents, actions and factors that help form the four families of geographic theories.<sup>5</sup>

Funding research in these areas will continue to expand the field of crime mapping and analysis. The main focus of new research will be developing cutting-edge geospatial software, but there is also increased interest in geospatial sensor technologies, spatial cognition technologies, and location-based technologies and analysis.

The impact of many software applications and technologies is not yet known. Many claims are made about the use of geospatial software applications and technologies that reduce crime, deploy law enforcement resources more efficiently, and lighten agency workloads. Many of these claims have not been substantiated in any meaningful and scientific way. The MAPS Program will continue to advance geospatial technologies by developing solicitations for research, development, testing and evaluation. These MAPS-funded projects will help measure geography's contribution to targeting crime.

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## Notes

1. The search was conducted using the following keywords: "spatial," "mapping," "geographic information systems," "GIS," "hot spots" and "crime mapping." The last two



keywords were used in an attempt to maximize the number of hits for criminology related articles and to select mapping articles that used the term “mapping” but would not have been picked up otherwise. The three databases searched included Sociological Abstracts, Applied Social Sciences Index and Abstracts and Social Services Abstracts.

2. The keyword “geography” was purposely left out of the search because the percentage of articles that would have appeared was so high that it would have made the other trends indistinguishable.

3 .Hot spots policing uses mapping software to identify locations with clusters of crime (called hot spots) on a map and sends patrols to target these locations.

4. CrimeStat was developed by Ned Levine and Associates through grant funding by NIJ under grant numbers 1997-IJ-CX-0040, 1999-IJ-CX-0044, 2002-IJ-CX-0007, and 2005-IJ-CX-K037.

<sup>5</sup> The four families of geographic theories are spatial dependence, heterogeneity, organization and interaction.

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