Geography and Public Health

Robert Lipton
Prevention Research Center, USA

D. M. Gorman
Texas A&M University, USA

William F. Wieczorek
Center for Health and Social Research, Buffalo State College-State University of New York, USA

Aniruddha Banerjee
Prevention Research Center, USA

Paul Gruenewald
Prevention Research Center, USA

INTRODUCTION

From John Snow's pioneering work on cholera in the 19th century until the present day, placing illness and disease within the context of a geographic framework has been an integral, if understated, part of the practice of public health. Indeed, geographical/spatial methods are an increasingly important tool in understanding public health issues. Spatial analysis addresses a seemingly obvious yet relatively misunderstood aspect of public health, namely, studying the dynamics of people in places. As advances in computer technology increase almost exponentially, computer intensive spatial methods (including mapping) have become an appealing way to understand the manner in which the individual relates to larger frameworks that compose the human community and the physical nature of human environments (streets with intersections, dense vs. sparse neighborhoods, high or low densities of liquor stores or restaurants, etc.). Spatial methods are extremely data intensive, often pulling together information from disparate sources that have been collected for other purposes such as research, business practice, governmental policy, and law enforcement. Although initially more demanding in regard to data manipulation compared to typical population level methods, the ability to compile and compare data in a spatial framework provides information about human populations that lies beyond typical survey or census research. We will discuss general methods of spatial analysis and mapping that will help to elucidate when and how spatial analysis might be used in a public health setting. This discussion will include a method for transforming arbitrary administrative units, such as zip codes, into a more useable uniform grid structure. In addition, a practical research example will be discussed focusing on the relationship between alcohol and violence. A relatively new Bayesian spatial method will be part of this example.

BACKGROUND: GIS CAPABILITIES AND PREVENTION

A basic understanding of the capabilities of geographic information systems (GISs) is critical to the development of prevention activities because alcohol-related problems are not evenly distributed across space. GIS can be defined as a combination of computer hardware, software, spatial data (digital maps), and data with a geographic reference (e.g., alcohol outlets or crime locations) that facilitates spatial analysis. The key functions of GIS provide access to the broad spectrum of potential spatial analyses that can support the simple targeting of resources as well as the development of more complex models of spatial interactions. Both simple maps of problem rates or clusters and spatial interaction models may be useful for targeting traditional individual-based prevention programs or environmental interventions. Spatial interaction models, however, may be more appropriate for identifying the locations of events (e.g., assaults or crashes) that may be most amenable to environmental or regulatory prevention. In addition, GIS capabilities promote the development of a basic spatial/geographic epidemiology of alcohol use and related consequences, which is critical to the development of prevention programs (see Wieczorek, 2000, and Wieczorek and Hanson, 1997, for more details).

The key functions of GIS include geocoding, data overlays, reclassification functions, and distance/adjacency measures. Geocoding is a generic term used to describe the GIS function of providing a specific location to descriptive data. Geocoding applies to point data (e.g., alcohol outlet)

as well as to area data (e.g., number of assaults in a census tract). Sometimes geocoding is known as address matching because the process of matching points to addresses is very common. The advent of the Census Bureau's TIGER system has made geocoding a relatively low cost and widely available GIS function. However, professional geocoding services have developed to assist persons who are not comfortable in geocoding their own data or because of the high cost of updating digital maps based on TIGER in areas of changing population. Geocoding is the most basic of GIS functions because it transforms descriptive information into a format suitable for spatial analysis.
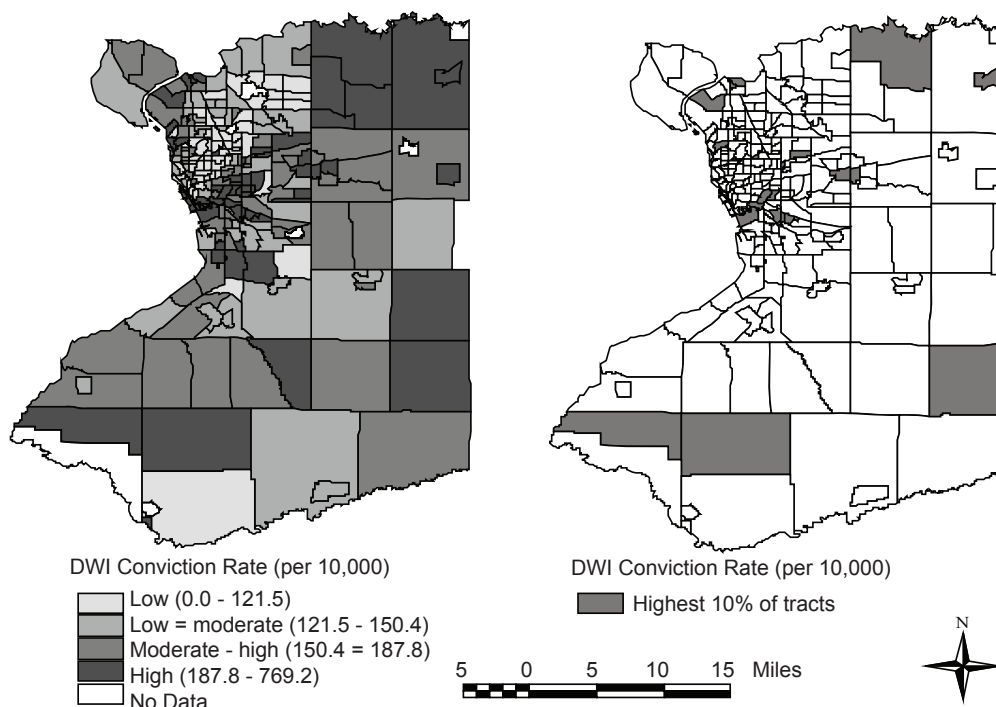
A GIS-based map may consist of multiple sources of data. The ability to combine multiple layers of information is known as the overlay function. An example of an overlay function is to place geographic boundaries (such as the outline of a town) on top of individual points (such as residences of DWI offenders). The points within each area can then be automatically counted to create rate-based maps such as those shown in Figure 1. To create rate-based maps from relevant point information, at least three layers of data are necessary (i.e., map of the points, a map with relevant boundaries, and Census data on population). The ability to perform an intersection between separate maps, to aggregate data into meaningful geographic areas, and to link data to standard sources, such as Census data, highlights some of the processing capabilities of GIS overlay functions, processes nearly impossible to accomplish by non-automated

methods (see Wieczorek & Hanson, 2000, for an example using regions and mortality data).

One major contribution of GIS to prevention is its ability to provide useful visualizations of spatial data. The reclassification function of GIS allows the user to easily manipulate the number of categories or select specific information (e.g., crashes by time of day or day of the week) for display. Figure 1 shows how the reclassification function can assist in the targeting of prevention by reclassifying the same data to emphasize highest rate areas.

A second major contribution of GIS to prevention is that the technology enables the development of models of spatial patterns and interactions within and between populations and environments. These models require accurate information on the distance between individual objects (e.g., bars and traffic crashes) and their spatial relationships to one another. Distance and adjacency functions of GIS allow assessments of these relationships. Data generated from these assessments of spatial relationships can be exported from the GIS and used in spatial modeling software. Information about adjacencies of different geographic objects can be used to assess contributions of environmental features (e.g., bars) to problematic public health outcomes in surrounding areas (e.g., assaults) (Gruenewald et al., 1996; Lipton & Gruenewald, 2002). Other important GIS functions are based upon the assessment of distance relationships: neighborhood functions calculate the number of a specific characteristic (e.g., assaults) within a specific radial distance (e.g., 300 yards) of

Figure 1. Reclassification and targeting prevention

DWI Conviction Rate (per 10,000)
- Low (0.0 - 121.5)
- Low = moderate (121.5 - 150.4)
- Moderate - high (150.4 = 187.8)
- High (187.8 - 769.2)
- No Data

DWI Conviction Rate (per 10,000)
- Highest 10% of tracts

Related Content

Mobile Technology
Paul Craggand Prue Chapman (2006). *Cases on Information Technology Planning, Design and Implementation (pp. 234-244).*
www.irma-international.org/chapter/mobile-technology/6371

Reality of Use and Nature of Change in Small Business: A Case Study in Inefficient Compromise
Wita Wojtkowskiand J. Craig Hardesty (2001). *Annals of Cases on Information Technology: Applications and Management in Organizations (pp. 217-225).*
www.irma-international.org/chapter/reality-use-nature-change-small/44617

EIS Systems and Quality Management
Bart H.M. Gerritsen (2010). *Information Resources Management: Concepts, Methodologies, Tools and Applications (pp. 1979-2004).*
www.irma-international.org/chapter/eis-systems-quality-management/54582

Insights Into Tweets Associated With Congenital Heart Disease
Sophia Alim (2018). *Journal of Information Technology Research (pp. 111-128).*
www.irma-international.org/article/insights-into-tweets-associated-with-congenital-heart-disease/196209

Multi-Class Classification of Agricultural Data Based on Random Forest and Feature Selection
Lei Shi, Yaqian Qin, Juanjuan Zhang, Yan Wang, Hongbo Qiaoand Haiping Si (2022). *Journal of Information Technology Research (pp. 1-17).*
www.irma-international.org/article/multi-class-classification-of-agricultural-data-based-on-random-forest-and-feature-selection/298618