From Beats to Tracts: A Remote Sensing Approach to the Interpolation of Crime Data

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ABSTRACT

In this article, the author addresses the spatial incompatibility between different types of data that is commonly faced in crime analysis research. Socioeconomic variables have been proved valuable in explaining crime behaviors and in predicting crime activities. However, socioeconomic data and crime statistics are usually collected and aggregated at different spatial zonations of geographical space, making the integration and analysis of these data difficult. Simple areal weighting interpolation technique, although frequently employed, often leads to unsatisfactory results due to the fact that most types of crime do not distributed evenly across space. Using 2007 burglary crime in Houston, Texas, as an example, the author illustrates a remote sensing approach to interpolating crime statistics from police beat enumeration district used by Houston Police Department to census tract defined by the U.S. Bureau of the Census.

Keywords: Burglary, Crime, Interpolation, Land Cover, Remote Sensing

INTRODUCTION

Lack of individual incidence level crime data has been a constant challenge faced by researchers in the fields of crime mapping and analysis. Crime data released by various law enforcement agencies such as city police departments are often in aggregate forms – crime statistics are different levels of summaries over the corresponding reporting units such as police districts or beats. In the cases when incidence level crime data are available, detailed location information is commonly hidden or restricted at the street block level. While this can be perfectly justified for the purpose of keeping confidentiality and reducing reporting costs, aggregated data inevitably hide the internal variation of crime distribution within the reporting geographic area. This problem becomes apparent in crime mapping when choropleth method is used. In creating a choropleth map, a single color/shade is typically applied to an entire region where the quantity being mapped is associated. This creates a spurious homogeneity within the area while the internal variation is lost (Eicher & Brewer, 2001).

In addition to causing false impression in crime mapping and restricting users’ ability to pinpoint the locations of individual crime incidents, using aggregated data also makes the integration of crime data with other relevant variables difficult. According to the

DOI: 10.4018/jagr.2010020906
opportunity theory in criminology, researchers often seek to relate crime statistics to various demographic and socioeconomic factors such as population profile, household value, etc., to explain and predict crime activities (Cornish & Clarke, 1986; Deane et al., 2008; McNulty & Holloway, 2000). While these variables are readily available from the U.S. census or other community survey, integrating them with crime data often encounters a spatial incompatibility problem. The problem arises from the fact that crime statistics are rarely collected and reported over the same spatial zonal system as census or other survey data. How to match these “misaligned” data sources and enable the join between crime data and other explanatory factors on the basis of the same enumeration districts is a key research question.

Various attempts and efforts have been taken to solve this spatial incompatibility problem (Gotway & Young, 2002; Mugglin et al., 2000; Tobler, 1979). Recent developments in geo-spatial technology, especially in GIS and remote sensing, have shown promising improvement (Mennis & Hultgren, 2006; Holt et al., 2004; Yuan et al., 1997) by integrating remote sensing satellite imagery as ancillary data source. Using GIS-based methods and high resolution satellite imagery, it is now possible to integrate a variety of spatial information to create new, relatively more homogeneous, target units within the source zonal system, and to approximate the underlying variations more accurately than results by using the more traditional simple areal weighting and smoothing methods. Worth noting is that most of the early studies that dealt with integrating data of varying configurations often focused on the estimation and interpolation of population over incompatible zones (Chen, 2002; Langford, 2007; Martin, 1998). Applications in crime analysis have still been rare (Poulsen & Kennedy, 2004).

Using 2007 Houston burglary data as an example, this study attempts to develop a methodology to solve the spatial incompatibility problem in crime analysis. Based on the assumption that there is a correlation between crime activities and land cover types, a spatial interpolation model is created to integrate the crime data with land cover maps derived from remote sensing imagery. Specifically, a regression model is built to regress crime statistics to land cover pixels over one spatial zoning system (source). Once the model is estimated and tested, it is in turn used to estimate the crime activities over a spatial zoning system with different configuration (target).

Data

Like many other large cities in the United States, Houston is plagued by all sorts of crimes. According to the CQ Press City Crime Rankings 2008-2009 Report, Houston is listed as one of the top ten highest crime rate cities among the group with half million or more population. Since 2005, Houston has been experiencing a spike in crime, which was due in part to an influx of people from New Orleans following Hurricane Katrina (Leahy, 2006). After Katrina, Houston’s murder rate increased 70 percent in November and December 2005 compared to the levels in 2004 (Villafranca, 2006). In 2006, with a murder rate of 18.2 per 100,000 residents, Houston ranked the second on the list of the nation’s 10 largest cities.

This study only focuses on one specific type of crime, burglary. Burglary has been the most common crime in Houston for years (on average there were more than two thousand burglaries per month in the past few years). More importantly, it is a type of crime whose occurrence only happens at specific locations, in this case, buildings. Burglary, by definition, is the breaking and entering of a building with intent to commit a felony. There would be no burglary if there were no buildings to break in. This special nature of burglary makes it particularly suitable for spatial interpolation study using remote sensing data since the distribution of burglary activities is closely associated with the spatial distribution of buildings, which are more easily detectable in satellite imagery than other socioeconomic variables.

The crime data used in this study were obtained from the Houston Police Department...
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