Crime Generators for Shootings in Urban Areas: A Test Using Conditional Locational Interdependence as an Extension of Risk Terrain Modeling

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Introduction

Certain facilities and infrastructures generate crime. Though there has been a great deal of interest in criminology looking at the concentration of crime, few have ever addressed the concentration effects that certain facilities and infrastructures have on attracting and generating crime. The research briefed here examined the spatial distribution effects of certain urban features (specifically, bus stops, middle and high schools, and public housing) acting as "generators" of gun shootings. We introduced a new technique, Conditional Locational Interdependence (CLI), for empirically determining the effects of these features as crime generators. CLI established causation relationships, not just correlation.

Conditional Locational Interdependence (CLI)

The underlying concept of CLI is simple. Locational interdependence occurs where the locational patterns of two types of entities depend on each other – the locations of each entity are neither random nor independent of each other. The co-location of auto body and auto parts shops is an example of locational interdependence. Conditional locational interdependence occurs where the locational patterns of one type of entity are dependent on the other and in which the dependence does not extend in the other direction. The co-location of crimes and bars is an example of CLI. It is recognized that the locations of crimes would be dependent on the locations of bars, whereas locations of bars are not affected by the location of crimes. If certain facilities are considered crime generators, we need to empirically establish the locational interdependence of these facilities to the distribution of crime incidents. The theoretical underpinning of CLI is that if the mean distance from the hypothetically dependent distribution (crimes) to the independent distribution (e.g. bus stops) is significantly less than the distance of a spatially random pattern of crime, then CLI is established.

Methods

The analysis technique we employed to do CLI is a Nearest Neighbor approach using Monte Carlo Simulation. The advantage of this technique is that it allows for the identification of statistically significant relationships in a conceptually straightforward way without the limitation of arbitrarily determining the size of a quadrat.

We examined three urban features--middle and high schools, bus stops, and public housing--as risk factors for shooting. The study area was Newark and Irvington, NJ--two contiguous municipalities. To solve for edge effects, a buffer of 1,500 feet surrounding the study area was created. All facilities within this buffer and the ecumene were included in the analyses.

We first calculated observed mean distances from actual shooting incident locations to their nearest school locations, bus stop locations, and public housing locations, respectively. Then we applied Monte Carlo Simulation to generate randomly uniform distributed shooting points within the ecumene. Next, we calculated the expected mean distance from simulated shootings to the nearest schools, bus stops, and public housing facilities. Finally, we tested the statistical significance of CLI and calculated the conditional nearest-neighbor spatial-association statistic.

As shown in Table 1, there is conditional locational interdependence of shootings around middle and high schools, bus stops, and public housing. With regard to gun shootings, middle and high schools have higher degree of CLI (0.81) than bus stops (0.79) and public housing (0.66), respectively.

Table 1: CLI Statistics for Gun Shootings in Ecumene

Statistic	Bus Stops	Schools	Public Housing
$\bar{r}$	482.6474	1322.023	997.1226
μ	612.1833	1626.048	1509.572
$\sigma(\mu)$	20.35	51.13	44.20
$\bar{R}_C$	0.79	0.81	0.66
Z	-6.37	-5.95	-11.59
p	p<0.001	p<0.001	p<0.001

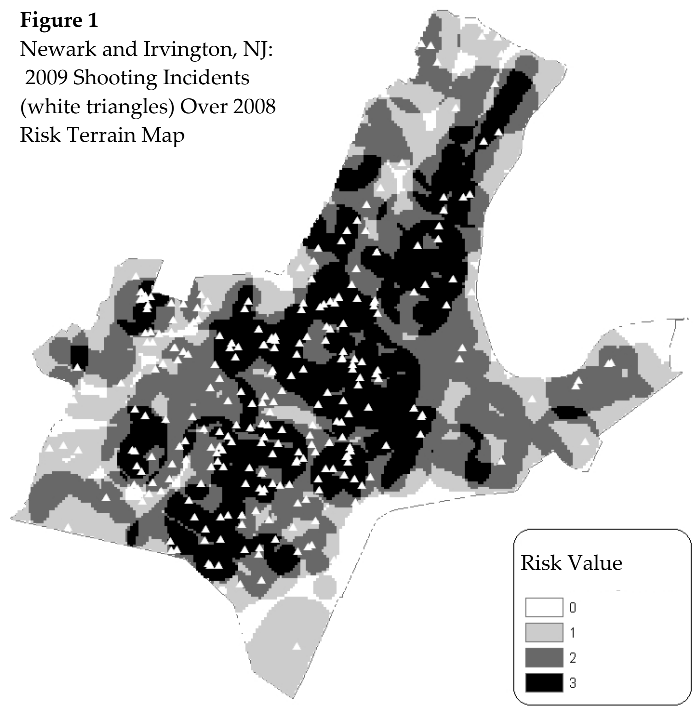
CLI and Risk Terrain Modeling

CLI supports Risk Terrain Modeling (RTM) by addressing two issues. The first is the CLI technique's ability to identify risk factors as (causally) significant generators of certain crimes. In this study, we proved that middle and high schools, bus stops, and public housing are generators for shootings. So, in RTM, we can confidently select middle and high schools, bus stops, and public housing as environmental risk factors. Secondly, the CLI technique calculates cutoff values of maximum "high-risk" distances for risk map layers in a risk terrain model. We obtained 652 feet as the cutoff value for bus stops, 1770 feet as the cutoff value for schools, and 1648 feet as the cutoff value for public housing.

Based on the CLI results, a risk terrain model was created to forecast future gun shooting incident locations in the ecumene, , as depicted by the map in Figure 1. A logistic regression analysis was used to test the predictive validity of the risk terrain model. Spatial lag values were included in the logistic regression since results of a Moran's I test suggested that spatial autocorrelation existed.

Results of the logistic regression suggested that the risk terrain model is statistically significant with a Chi-square value 95.705 and degree of freedom of 2 (p<0.001). The risk value is statistically significantly related to the occurrence of shooting with a Wald value of 57.610 and a degree of freedom of 1 (p<0.001). The odds ratio of 1.894 indicates that for every one unit increase in risk, the odds of gun shooting happening in a 140ftx140ft area during the subsequent time period increase by at least 89%. This is an improved model compared to the inaugural risk terrain maps produced by Caplan and Kennedy in Irvington[1] and it covers a much larger study area. Therefore, most accurate risk assessments of future crime events can be achieved by using the CLI method to include only the risk factors that are proven crime generators.

Figure 1
Newark and Irvington, NJ:
2009 Shooting Incidents (white triangles) Over 2008 Risk Terrain Map



Conclusion

Gun shootings are not randomly distributed throughout a terrain; but rather, are concentrated in a statistically significant way around certain features. In Newark and Irvington, these features are middle and high schools, bus stops, and public housing. This research validated a statistical tool for establishing how risk clusters emerge and how certain features influence the distribution of crime in an urban setting. The clustering that takes place relates not only to the interrelationship among crime incidents themselves, but also to interdependence established between criminal behavior and features of the environments where such behavior takes place. This is a particularly important finding since risk terrain modeling can be used to articulate such insights to a map for use in operational policing.

Results of this study complement other studies[2] on risk terrain modeling in that crime behavior relates to risk clusters in places based on the layering of certain correlates of crime. Now we can improve forecasting models by including risk factors that are known--to a certain degree of statistical confidence--to be crime generators. Notably, we do not assume that crime generators always attract crime. But if they do, as was the case in Newark and Irvington, they can be included in a risk analysis framework that assists in identifying where problems are most likely to occur and where police resources are most needed.

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Endnotes

[1] see www.rutgerscps.org/publications/Risk_Terrain_Case_Study_Brief.pdf

[2] e.g., see: Caplan, J. M., Kennedy, L. W., Miller, J. (in press). Risk terrain modeling: Brokering criminological theory and GIS methods for crime forecasting. *Justice Quarterly*; Kennedy, L. W., Caplan, J. M., & Piza, E. L. (in press). Risk Clusters, Hotspots, and Spatial Intelligence: Risk Terrains Modeling as an Algorithm for Police Resource Allocation Strategies. *Journal of Quantitative Criminology*.