RUTGERS Center on Public Security

BRIEF

CASE STUDY:
Applying Risk Terrain Modeling to Shootings in Irvington, NJ

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October 8, 2009

In demonstrating the Risk Terrain Modeling (RTM) approach to risk assessment and its ability to forecast certain outcomes, we focus on the phenomenon of shootings in Irvington, New Jersey, an urban community that has become a particular concern of local and state law enforcement over the last five years. Murder rates for 2007 were 38.7 per 100,000, compared to a national average for similar size cities across the country of 4.9 (UCR, 2007). The community is relatively small, sandwiched between a slightly larger suburban township and the larger city of Newark. The town has drawn a considerable amount of attention as it has become extremely violent, the location of a large number of shootings and other violent crimes. But further, it contains a large, vibrant drug market. In addition, it is also the hometown of a large number of known gang members. The combination of these factors and the growth of violence led the State Police to set up a special task force to police this area as a supplement to the small and overtaxed township police. As a result of this task force operation, there has been an increase in drug arrests and a reduction of shootings in this area. This reduction was dramatic at the onset of the operation; however, it has since leveled off and remained fairly constant. State Police executives are now looking for more robust analyses of the data, specifically the ability to use forecasting to direct police operations. It is in this context that we initially developed RTM.

"…risk assessment using the RTM approach can forecast locations of crimes."

To begin forecasting future risk of shootings, it was necessary to consider existing theory and literature that would help us understand this form of crime. In particular, it is necessary to identify the possible opportunity structures that the literature suggests may be important. For this case study, we operationalize three key factors that would spatially predict shootings: dwellings of known gang members, locations of retail business infrastructure, and locations of drug arrests. These three variables are not an exhaustive list of the likely factors that our literature review identified to be associated with shootings. However, they had the distinction of being readily available from the New Jersey State Police. Specifically, data on these three variables were available in address-level datasets from January 1, 2007 through June 30, 2008. Data were divided into two six-month time periods: January to June 2007 (Period 1) and July to December 2007 (Period 2).

Operationalizing these datasets to raster map layers was done using standard tools available in ArcView's Spatial Analyst Extension. Data were first geocoded to street centerlines of Irvington, NJ (obtained from Census 2000 TIGER/Line Shapefiles) to create point features representing the locations of gang members' residences, retail business outlets, and drug arrests, respectively on three separate maps. The Density Tool in ArcView's Spatial Analyst Extension was then used to create a raster grid for each map and assign values to identically-sized raster cells based on the intensity, or local concentration, of points near each cell's location. This density method for operationalizing geocoded tabular data into raster map layers was repeated for each variable, producing maps with cell values assigned according to the immediate or nearby concentration of key variables in each respective cell. Cells within each raster map layer were then classified into four groups according to standard deviational breaks. This process was repeated for all three density map layers to produce three new raster maps of Irvington with all locations designated as low to high risk for shootings. Since the cells of different raster map layers were the same size and were classified in a consistent way, they could be summed to form a composite risk terrain, as exemplified in Figure 1 to the right.

Figure 1

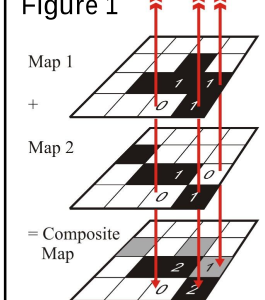
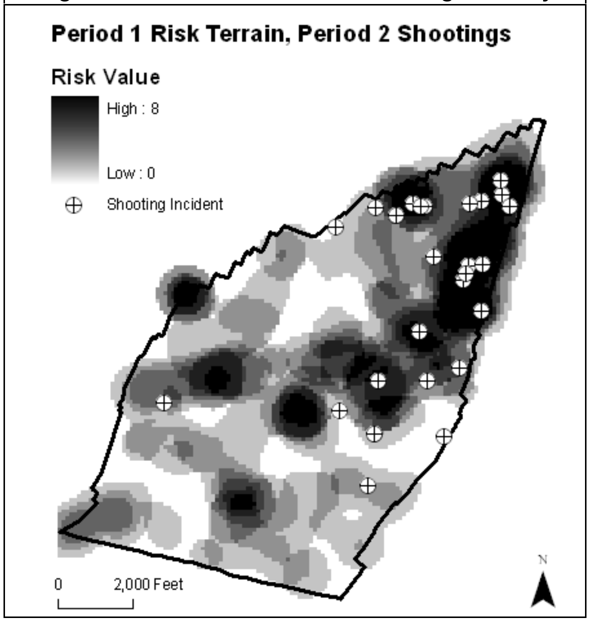


Figure 2: Risk Terrain and Shooting Overlay



A risk terrain map was created using data from Period 1. The predictive validity of this risk terrain was tested using counts of shooting incidents during Period 2 that were appended to the cells of the Period 1 risk terrain using the Spatial Join function in ArcView. Cells of the final risk terrain map, then, had two values attributed to it: 1) risk value and 2) number of shootings during the consecutive time period. Figure 2 illustrates the risk terrain produced from the RTM approach using Period 1 data, together with the shootings for the subsequent six month time period.

As shown in Figure 2, future shooting incidents appear to be located in areas that the risk terrain map forecasted to be higher risk. Logistic regression analysis allowed us to measure the extent to which the Period 1 risk terrain explained the patterns of shooting incidents during Period 2 (Ind. Var. = "Risk Value" [0-8]; Dep. Var. = "Presence of Any Shooting" [Yes or No]). As shown in Table 1, the odds ratio suggested that for every increased unit of risk, the likelihood of a future shooting significantly increased by over 60 percent ($p<0.001$).[1]

Table 1: Logistic Regressions for Risk Value on Shooting

Period 1 Risk Terrain*

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for Exp(B)	
							Lower	Upper
Risk Value	.52	.097	29.06	1	<.001	1.69	1.397	2.048

* -2 Log likelihood = 280.824; Nagelkerke R Square = .11; n=4046 street-intersected cells

Although the effort put into this process was more than that required to produce a conventional hot spot crime map of past events, we suggest that with routinization of the process, such as with ArcView's ModelBuilder, the time taken to regularly build risk terrains need not be beyond the resources and timeframes of operational crime analysts. The flexibility of RTM and the scales to which it can be applied would allow the police to strategically incorporate known areas of concern in their assessment of locations that might generate violence or other particular threats to public safety. Then police could assign resources accordingly at the regional and/or local levels.

Risk terrains can be particularly valuable to police agencies when fiscal budgets are tight because they do not require new or exceedingly great investments in hardware or software. They only require a dynamic way of thinking about crime problems, their causes, and situational impacts of police interventions. While it remains a hypothesis, we might imagine that directing police patrols to a risk terrain's high-risk hotspots in place of the historical crime hotspots could further enhance the already effective strategy of hotspot policing—with greater potential impacts on crime reduction. In the context of shootings, which run a high risk of fatality, this would be a significant dividend.

As shown here, risk assessment using the RTM approach can forecast locations of crimes. This is possible because risk of crime is a measurement, by definition, of probable future events. The implications of forecasting with RTM are great for public safety practitioners (who operate spatially) because it permits strategic decision making and tactical responses within an understandable and familiar context—their own terrain.

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[1] Calculation of Moran's I indicated there was no spatial autocorrelation, so we present here a model that does not include a spatial lag.