“Round Up the Usual Hotspots”: Improving the Prediction of Motor Vehicle Theft Locations

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INTRODUCTION

Like many other cities, Portland, Oregon has experienced a significant decrease in Motor Vehicle Theft (MVT) over the past 20 years. Despite these declines, MVT remains a concern for many residents and over 3,200 thefts were reported in 2011. Further reductions in the incidences of MVT will likely require the identification of “hotspots” combined with proactive policing efforts at these locations. One approach to the prediction of hotspots is the use of GIS software to map prior incidents and highlight areas with an unusually high density. A major limitation of this approach is that it assumes the geographic distribution of crime is static; that yesterday’s hotspot will be tomorrow’s as well (i.e., “round up the usual hotspots”).

Risk Terrain Modeling (RTM; Caplan & Kennedy, 2009) is a newer strategy that seeks to improve predictions by adding additional parameters. For example, predictions of “shots fired” locations in Irvington, NJ was improved by adding home addresses of known gang members, retail businesses, and the locations of drug arrests to the prior year’s shooting incidents (Kennedy, Caplan, Miller, 2009).

RTM has been applied to a variety of crimes establishing the validity and utility of the procedure. However, one offense this method has not yet been applied to is MVT. The current study evaluates three fundamental assumptions of RTM that must be met in order for this procedure to be useful with this crime.

1. **Is MVT geographically clustered?** If events are largely random distributed then RTM could not be used to predict future locations.
2. **Do MVT “hotspots” change over time?** If there is no geographic variability over time, then RTM could not improve predictions beyond simply using the locations of prior hotspots.
3. **Are geographic features correlated with MVT hotspots?** RTM requires the identification of geographic risk factors that are useful in predicting hotspot locations.

SAMPLE

Data:

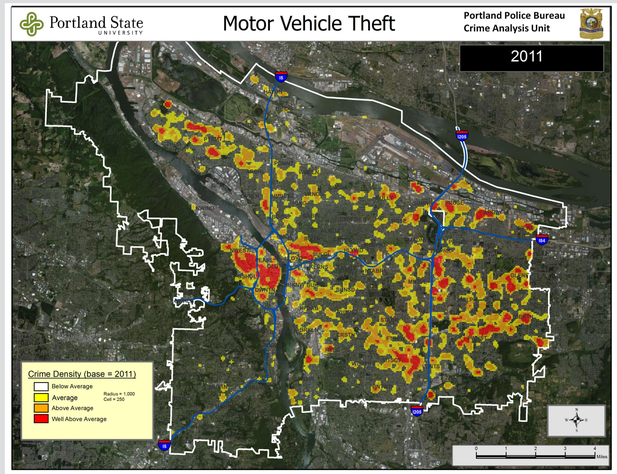
The Portland Police Bureau (PPB) provided geographic coordinates for the 3,276 MVT in 2009, the 3,332 MVT in 2010, and the 3,232 MVT occurring in Portland, Oregon in 2011.

METHODS & RESULTS

Nearest neighbor analyses (NNA) were calculated for each year (2009, 2010, and 2011) to address the first research question: are MVT incidents clustered in Portland or randomly distributed? NNA, which compares the actual distribution of events with a random distribution, found that there was significant clustering for all three years: 2009 (NNI = 0.49, z = -54.96, p < 0.001), 2010 (NNI = 0.55, z = -49.97, p < 0.001), and 2011 (NNI = 0.52, z = -51.98, p < 0.001). One way to visually represent the clustering is through a kernel density map (see Map 1 below). To create this map, first incidents for 2011 were plotted. Based on distribution of incidents that year we created cutoffs for coloring map based on the overall average density throughout the city. Examining Map 1 identifies that not all areas are directly affected by MVT and that specific location such as Down Town and the areas east of I205 have the highest concentrations of well above average MVT regions.

The second research question concerned the temporal variability of MVT hotspots. We examined this using three procedures. First, we calculated the mean center location of crimes for 2009 and 2011. The mean center location shifted a half mile to the Southeast over this period (see Map 2), indicating some degree of variation in MVT’s geographic distribution. Our second approach involved mapping all of the incidents for 2009 and 2011, placing a “dot” at the MVT location. Next we overlaid a 250’ by 250’ grid and counted how many incidents there were per year in each cell. Cells with counts that were three times the average (excluding cells with 0) were classified as a “hotspot” and cells with no incidents for a given year were labeled as a “cold spot”. We then identified all of the hotspots for 2009 that either stayed hotpots in 2011 or changed to a cold spot. 28.3% of the hotspots remained a hotspot two years later, suggesting some degree of geographic stability (see Figure 1). At the same time, 40.7% of the hotspots from 2009 changed to cold spot in 2011, indicating some variation as required for RTM. Our final strategy for answering this question was to run a regression analysis that predicted cell frequencies for 2011 using the frequencies from 2009 and 2010. While the overall model was significant (R^2 = .205, F(2, 59,558) = 7,683.7, p < .000), the prior two years of data were only able to explain 20.5% of the variance in cell frequencies for 2011. This means that other factors still need to be identified if we hope to improve the accuracy of predicting future MVT hotspots.

Map 1. Kernel Density Hotspots



Map 2. Mean Center Locations

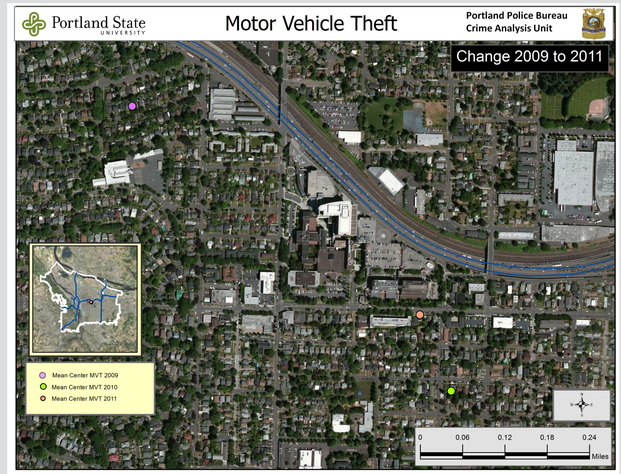


Figure 1. Stable Hotspots and Hotspots No More

	#	%
Hotspot in 2009	113	
Hotspot in 2011	32	28.32%
Coldspot in 2011	46	40.71%
Middle Range 2011	35	30.97%
Coldspot in 2009	56,951	
Hotspot in 2011	32	0.06%
Coldspot in 2011	54,897	96.39%
Middle Range 2011	2,022	3.55%

METHODS & RESULTS CONTINUED

The final assumption of RTM is that there are other aspects of geographic locations that help explain why some are crime hotspots and others are not. For the current study we are exploring the potential utility of parking structures/lots in predicting MVT hotspots. Since there is not an existing database of Portland Parking venues, we joined point data of MVT incidents to a 250ft by 250ft fishnet grid (based on the traditional size of a city block in Portland, which is 260ft by 260ft). We were able to determine the count of each crime within a city block. After establishing a threshold of five MVT within a city block within a year as the cut-off for high risk locations.

METHODS & RESULTS CONTINUED

Bing map aerial images were used to identify surrounding features; specifically examining the existence of commercial and residential parking venues. A commercial parking venue for this research is identified as a parking venue with no less than 40 parking places where individuals do not park at a place of residence. Residential parking venues are identified as an area where parking of motor vehicles is available, with no less than 40 adjacent parking spots and the primary purpose of parking is for residents. Although these finding are preliminary, in Figure 2, 90.9% of the identified high risk locations were either a commercial or a residential parking venue or had one adjacent to the location. Fourteen parking venues were consistent in multiple years as being or adjacent to a high risk location.

Figure 2. Identified Areal Images Parking Venues

	2009	2010	2011
250ft by 250ft cell ≥ 5 MVT	28	15	23
# Commercial Parking Venues	16	11	15
# Residential Parking Venues	9	3	6
Total # of Parking Venues	25	14	21

DISCUSSION

The findings of this study support the potential utility of RTM as a tool in addressing MVT. We found that MVTs were geographically clustered in Portland with distinct hotspots evident. Second, hotspots for MVT change to some degree over time – it is not simply the same locations or “usual suspects” year after year. Third, we found evidence that parking structures and major parking lots are a common feature in locations designated as MVT hotspots.

Additional research will be done in the coming year to identify and map the locations of all major parking lots in Portland and to evaluate the additive value of these geographic features in predicting MVTs. The eventual goal is to build an accurate model for predicting MVT hotspots in the city and to proactively direct crime prevention efforts to these locations.

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