

Risk Terrain Model for Aggravated Assaults in Kansas City, MO

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Risk terrain modeling, or RTM, is an approach to spatial analysis that utilizes a geographic information system to operationalize the spatial influence of risk factors to common geographic units. Separate risk map layers are combined to produce a “risk terrain” map showing the presence, absence, or intensity of all risk factors at every location throughout the landscape. Clustering of illegal activity is explained in a risk terrain model by the unique combination of risk factors that make areas opportune locations for crime. This occurs where the potential for, or risk of, crime comes as a result of all the factors found at these places.

Outcome Event

>Aggravated Assaults

- Address-level data; only substantiated incidents that were recorded and investigated by the department.
- Defined as “an unlawful attack by one person upon another wherein the offender uses a weapon or displays it in a threatening manner, or the victim suffers obvious severe or aggravated bodily injury involving apparent broken bones, loss of teeth, possible internal injury, severe laceration, or loss of consciousness.” Excluded incidents noted as domestic violence (to produce a more reliable measure of “street” crime).

Study Area

>Kansas City, MO

- The largest city in the state of Missouri with an estimated population of 459,787 in 2010. The City encompasses approximately 318 square miles, spanning Jackson, Cass, Clay, and Platte counties.
- A grid of the entire jurisdiction of Kansas City was comprised of 142,221 cells of 250ft x 250ft. Cell size was selected as a function of street segments: approximately half the mean block length in Kansas City (mean=470ft). This allowed us to model the environmental risks of crime as precisely as one corner of a street block.

Time Period

>April 28 thru July 27, 2010 (3 months)

Data Sources

- InfoGroup: Latitude and longitude coordinates for bars, adult entertainment clubs, hotels/motels, dance/night clubs, franchised fast food restaurants, rental halls, and movie theaters.
- Kansas City Police Department (KCPD): Shapefiles for aggravated assaults, packaged liquor stores, grade schools, drug activity, and parks.



Risk Factors Considered and Included

>Each risk factor was operationalized to a binary-valued risk map layer and tested for place-based correlations with aggravated assault incident locations using Chi-Square tests (df=1; p<0.01). Five (**bold font**) were included in the final risk terrain model.

Risk Factor	% of Cells with Any Aggravated Assaults Located within Highest Risk Places (n=397)	Pearson Chi-Square Value
Bars	12.8	61.728
Hotel/Motel	6.8	12.075
Package Liquor	50.1	343.738
Movie Theater	4.0	23.908
Grade School	32.7	88.397
Drug Activity	54.2	606.336
Rental Halls	8.8	74.489
Parks	37.0	77.782
Adult Entertain.	2.3	19.926
Dance/Night Club	5.8	27.988
Franchised Fast Food	20.2	103.911

- Bars, hotels/motels, and reported drug activity were operationalized as kernel density maps (cell size=250ft; bandwidth=1,410ft) because their spatial influence was understood as “areas with greater concentrations of these features, respectively, will increase the risk of those places having aggravated assaults.” All 250ft places with density values greater than +2 standard deviations from the mean density value were considered “highest risk”; all other places were considered “not highest risk”.
- Packaged liquor stores, movie theaters, grade schools, rental halls, parks, adult entertainment clubs, dance/night clubs, and franchised fast food restaurants were operationalized as Euclidian distance maps; their spatial influence was understood as “up to 1,410 feet from these features are at greatest risk for aggravated assaults because targeted victims are most vulnerable when they arrive at or leave these destinations.” Cells that were located within 1,410 feet of each set of features were considered “highest risk” places; all other cells were considered “not highest risk” places.
- The value of 1,410 feet for density and distance parameters was informed by empirical research suggesting that crime-prone places typically comprise just a few street blocks, which qualify as behavior settings.

Risk Map Layer Weights

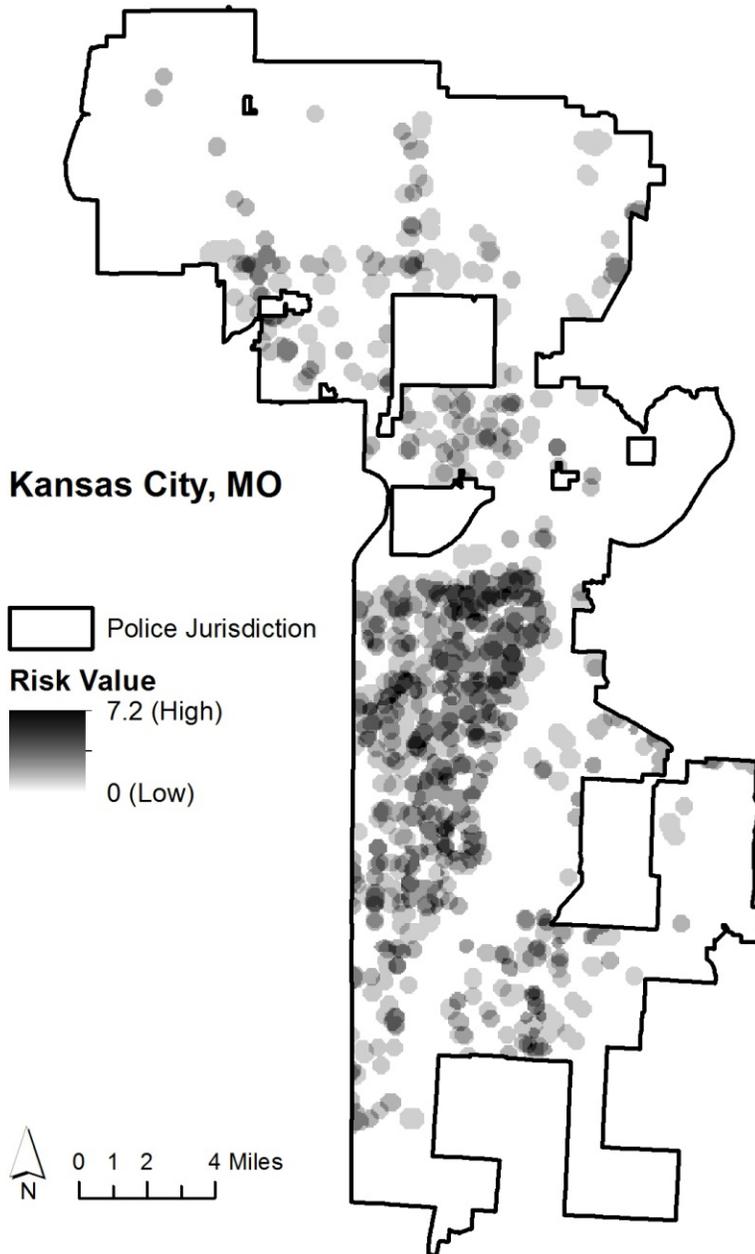
>Weights were calculated by dividing the relative spatial influence (RSI)¹ for each risk map layer by the smallest RSI value (among all risk map layers).

Risk Map Layer (<i>j</i>)	# of Aggravated Assaults Located in Highest Risk Places ($O_{i,t}$)	# of Highest Risk Cells (C_j)	Relative Spatial Influence (RSI)	Risk Map Layer’s Weight
Package Liquor	221	15599	0.0141	1.76
Grade School	144	14961	0.0096	1.20
Drug Activity	233	9097	0.0256	3.20
Parks	162	20142	0.0080	1.00
Fast Food	92	7563	0.0121	1.51



Final Weighted Risk Terrain Map

>With every increased unit of risk, the likelihood of an aggravated assault occurring at a 250ft x 250ft place increases by 96% (N=142,221; B=0.676; S.E.=0.022; Wald=908.204; df=1; Exp[B]=1.967; p<0.001; Nagelkerke R Square=0.133).



Summary

- Aggravated assaults are statistically likely to occur at micro places most suitable for such crimes given the co-existence of package liquor stores, grade schools, drug activity, parks, and fast food restaurants at those places. The presence of these features of the landscape had strong effects on the locations of crime incidents.
- The top 20% of highest-risk places accounted for 81% of the places with aggravated assaults (N=142,221; Pearson Chi-Square=936.528; df=1; p<0.001).
- Risky environments should be taken into account—not only for resource allocation, but to plan interventions that focus holistically on deterring and incapacitating offenders, hardening targets, and mitigating one or more environmental risk factors at high risk places.



Endnotes

¹ The general form of the calculation for relative spatial influence (RSI) is

$$RSI_j = O_{i,t,j} \div C_j$$

Where, RSI_j is the Relative Spatial Influence value for risk map layer j

$O_{i,t,j}$ is the number of outcome events i that occurred during time period t and that were located within the highest-risk cells of risk map layer j

C_j is the number of cells designated as highest-risk for risk map layer j .

