Project

Project ID

Report Overview

**Principal Investigators or Analysts:**

**Contact Info**

Intervention planning Intel Report

## Purpose

To inform the design and implementation of spatially-targeted risk-based interventions that will affect the frequencies and spatial distributions of post-intervention crime events at micro-places.

|  |  |
| --- | --- |
| Priority Crime Type \*\*\*\*\* | Analysis Year \*\*\*\*\* |
| Mean Block Length \*\*\*\*\* | Cell Size (“Micro-place”) \*\*\*\*\* |

## Executive Summary

Based on this analysis, some proposals are recommended for target area selection and risk-based intervention strategies.

Pin map

Visual inspection of the points in the map suggests that **crimes are not uniformly distributed throughout the jurisdiction and may be clustered at certain areas**.

[INSERT MAP IMAGE HERE]

Nearest Neighbor (Cluster) Analysis

We conducted a Nearest Neighbor (NN) analysis for spatial randomness by calculating the distance from each point in a collection to its nearest neighboring point. These distances were then compared to the expected mean NN distance for a random distribution of points to determine if points are statistically closer than expected under spatial randomness.

**Results of a NN analysis suggest that the distribution of crimes is significantly clustered.** The NN index is expressed as the ratio of the observed distance divided by the expected distance—the average distance between neighbors in a hypothetical random distribution. If the index is less than 1, the pattern exhibits clustering; if the index is greater than 1, the trend is toward dispersion or competition.

[INSERT SCREEN CAPTURE OF NN RESULTS HERE]

Kernel Density (Hotspot) Maps

Kernel density mapping serves as a useful follow-up to visual reviews of pin maps and NN analysis because it identifies where the highest concentrations of crime incidents are occurring at more localized places within the study area. A conventional hotspot map of crimes is a raster density map calculated from the locations of crimes from a recent past time period. Here, a hotspot is defined as a place with kernel density values greater than 2 standard deviations (SD) from the mean.

Below is a density map of crimes in **\*\*\*\*\*** for calendar year \*\*\*\*\*. The density map is symbolized according to standard deviational breaks, with all places colored in black having density values greater than +2 standard deviations from the mean density value—which statistically puts these places in the top 5% of the most densely populated with crimes. **The kernel density map suggests that there are \*\*\*\*\* hotspot areas for crime in the jurisdiction.**

[INSERT MAP IMAGE HERE]

Getis-Ord Gi\* (Hotspot) Map

The “Hot Spot Analysis” tool in ArcGIS calculates the Getis-Ord Gi\* statistic (Z score) for each feature in a dataset (using the “Queen Contiguity” conceptualization of spatial influence). The larger the statistically significant positive Z score is, the more intense the clustering of high values (hotspot). The smaller the statistically significant negative Z score is, the more intense the clustering of low values (coldspot). **Results suggest that there are \*\*\*\*\* micro level places where crimes cluster at and around. This patterning is statistically \*\*\*\*\*.**

[INSERT MAP IMAGE HERE]

Spatial autocorrelation (Moran’s I)

Distributions among geographical units, such as grid cells, are usually not independent, meaning that values found in a particular cell are likely to be influenced by corresponding values in nearby cells. Moran’s I measures this autocorrelation, with values approaching 1 when geographical units are situated near other similar geographical units, and approaching –1 when geographical units are situated near dissimilar geographical units. A Moran’s I value of 0 indicates the absence of autocorrelation, or independence, among geographical units.

**Results indicate that spatial autocorrelation \*\*\*\*\* present in the distributions of crime counts across nearby cells in the jurisdiction. This means that crime events at certain micro level places may\*\*\*\*\* affect the occurrence of similar crime events at nearby places. Given the z-score of \*\*\*\*\*, there is less than 1% likelihood that this clustered pattern could be the result of random chance.**

[INSERT SCREEN CAPTURE OF MORAN’S I RESULTS HERE]

COntagion Effects

The examination of contagion effects or “near repeats” explains how past crime incidents can serve as predictors of new crime incidence. Contagion models assume that if a crime occurs in a location, the chances of a future crime occurring nearby increases. Investigations of contagion effects provide an important extension of hotspot analysis as they account for the temporal link between crime events and add a certain level of statistical confidence that new crimes happen within a certain distance of past crimes and within a certain period of time from the prior incident. This can enhance the picture of crime occurrence and help to better focus strategies for place-based interventions

The daily expected crime count (DECC) is **\*\*\*\*\***, based on the number of crimes that happened in calendar year \*\*\*\*\* (\*\*\*\*\*), divided by 365 days. Considering the DECC helps to estimate resources that may be needed for the intervention so that activities can be temporarily targeted at new crime locations that have a high propensity for attracting near repeat incidents. Taking into account the DECC and available resources, priority attention should be given to high risk places in the target area that are within **\*\*\*\*\*** feet (i.e., the near repeat bandwidth, based on twice the average NN distance of crimes in the jurisdiction) from each new crime incident for a fixed period of time.

Risk Terrain Modeling: Maps

RTM utilizes GIS to attribute qualities of the real world to places on a digitized map. It operationalizes the spatial influences of crime risk factors to common geographic units then combines separate map layers to produce “risk terrain” maps showing the presence, absence, or intensity of all risk factors at every location throughout a landscape. Risk terrain maps show where conditions are most vulnerable for crime events to occur. It helps to diagnose why crimes have already clustered at certain places, and to forecast where crimes are likely to emerge in the future. RTM "paints a picture" of place-based contexts for crime.

The pool of risk factors that were considered for inclusion in the risk terrain models were identified through reviews of existing empirical research publications, insights from police department officials, practical experiences, expert knowledge, and/or focused exploratory analysis of the priority crime in the study area.

**Three** separate risk terrain models were produced for **\*\*\*\*\* in \*\*\*\*\*** using the Risk Terrain Modeling Diagnostics (RTMDx) Utility**:**

* Calendar Year (CY)
* CY Temporally
  + Weekdays
  + Weekend

## RTM: Calendar Year \*\*\*\*\*

An analysis was designed to represent the risk factors for **\*\*\*\*\*** incidents in **\*\*\*\*\*** considering the potential spatial influences of **\*\*\*\*\*** risk factors: **\*\*\*\*\***. All geographic calculations were conducted using raster cells of **\*\*\*\*\*** and assuming an average block length of **\*\*\*\*\***. There were **\*\*\*\*\*** raster cells used in the analysis of which **\*\*\*\*\*** cells contained events.

A significant Risk Terrain Model for **\*\*\*\*\*** was found that contains **\*\*\*\*\*** risk factors. The model has relative risk values for each micro-level place ranging from 1 for the lowest risk place to **\*\*\*\*\*** for the highest risk place. These scores allow places to be easily compared. For instance, a place with a score of **\*\*\*\*\*** has an expected rate of crime that is **\*\*\*\*\*** times higher than a place with a score of 1.

You can manually reproduce this risk terrain model with common GIS software by operationalizing the risk factors using the parameters displayed below. The **\*\*\*\*\*** risk map layers can then be combined through map algebra to calculate relative risk scores. For example, using ArcGIS for Desktop's "Raster Calculator" tool, you can copy and paste the following formula to assign relative risk scores to each cell, updating the raster risk map layer names as needed:

\*\*\*\*\*

[INSERT RTM RESULTS TABLE HERE]

[INSERT RISK TERRAIN MAP IMAGE HERE]

## RTM: Calendar Year \*\*\*\*\*, WEEKDAYS (Mon-Thurs)

REPEAT AS DONE ABOVE

## RTM: Calendar Year \*\*\*\*\*, WEEKENDS (Fri-Sun)

REPEAT AS DONE ABOVE

High-Risk Cluster Analysis

The Mean and Standard Deviation of relative risk values were calculated for each risk terrain model, and are shown below.

**CY\*\*\*\*\* Relative Risk Values:** Mean = \*\*\*\*\*; SD = \*\*\*\*\*

**CY\*\*\*\*\* WEEKDAY Relative Risk Values:** Mean = \*\*\*\*\*; SD = \*\*\*\*\*

**CY\*\*\*\*\* WEEKEND Relative Risk Values:** Mean = \*\*\*\*\*; SD = \*\*\*\*\*

The Getis-Ord Gi\* statistic (Z score) for each place was calculated using the “Hot Spot Analysis” tool in ArcGIS.

**Results suggest that there are \*\*\*\*\* high-risk clusters for robbery in the jurisdiction.** This pattern is **statistically \*\*\*\*\*significant**.

[INSERT MAP IMAGE HERE]

**Results suggest that spatial risks cluster \*\*\*\*\* on weekdays compared to weekends.** This pattern is **statistically \*\*\*\*\*significant**.

[INSERT TWO MAPS, SIDE BY SIDE, HERE]

[INSERT COMPOSITE OF THE TWO/SUPERIMPOSED MAP HERE]

RTM Diagnostics

The CY risk terrain map diagnoses environmental attractors of CY crimes and crime hotspots. This is visually evident in that high risk clusters appear to be defining many crime hotspots. All of the factors in the CY RTM were attractors of illegal behavior and facilitated hotspots during \*\*\*\*\*. This supports the premise that a risk terrain map to be produced for **\*\*\*\*\*** crimes during the intervention year would proactively identify places where crime is likely to emerge.

[INSERT MAP IMAGE HERE]

Spatial Stability Analysis

Below are kernel density maps showing hotspots of **\*\*\*\*\*** during each quarter of \*\*\*\*.

[INSERT 4 MAP IMAGES ACROSS TWO ROWS AND TWO COLUMNS HERE]

## Chi-Squared Test of Kernel Density Hotspot Maps

As Table 1 shows, density hotspot map­ping can yield respectable place-based forecasts of **\*\*\*\*\* crimes**. In the **\*\*\*\*\*** × **\*\*\*\*\*** places on the quarterly density hotspot maps (above), about **\*\*\*\*\*** of subsequent (i.e., next quarter) crime incidents occurred within these same places. This means, however, that **\*\*\*\*\*** of future crime events did not occur at recent-past hotspot areas. **Crimes do not always occur in the future where they often did in the past.**

According to Table 1, \*\*\*\*\* micro-level places within larger hotspot areas account for the new crime incident locations. For instance, Q1 Hotspots covered **\*\*\*\*\*%** of the jurisdiction’s area, but only **\*\*\*\*\*%** of the micro places within the hotspot areas hosted any Q2 crimes. **This suggests that something more than hotspots of recent-past crimes are attracting new criminal behavior at micro-level places.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 1** | | | |
| \*p< 0.01 | % of cells with any crimes during the following quarter | Hotspot area accounts for this % of jurisdiction | % of places within hotspot areas that host any future crimes |
| Q1 Hotspots |  |  |  |
| Q2 Hotspots |  |  |  |
| Q3 Hotspots |  |  |  |

## Joint Utility of RTM and Recent-Past Crimes

As presented in Tables 2a-c, recent past crimes is **\*\*\*\*\* predictor** of new crime locations, when controlling for relative risk values at micro places. Though, each unit of risk at a micro place increases the likelihood of a crime occurring at that place. **In \*\*\*\*\*, crimes are \*\*\*\*\* likely to emerge at high risk places. The odds of further crimes occurring at these \*\*\*\*\* x \*\*\*\*\* places \*\*\*\*\* with each new incident. Contagion appears to be happening at high-risk micro-level places.**

**Remember:** The range of relative risk scores for this risk terrain model is **1-\*\*\*\*\***. So, based on the observed Odds Ratio in Table 2a, a place with a risk value in the top 5% of relative risk (e.g., above +2SD) has a **\*\*\*\*\*%** **(\*\*\*\*\* x \*\*\*\*\*)** increased likelihood of experiencing crime. Places with risk values greater than three standard deviations above the mean (i.e., high risk clusters) have a **\*\*\*\*\*%** **(\*\*\*\*\* x \*\*\*\*\*)** increased likelihood of experiencing crime. These probabilities are statistically significant. So, **higher risk places are likely to experience crime, particularly those high risk places located within known hotspot areas.**

**Table 2a:** Results of logistic regression on **\*\*\*\*\* Q2 \*\*\*\*\***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Odds Ratio** |
|
| Relative Risk Value |  |  |  |  |  |  |
| Q1 Crime Count |  |  |  |  |  |  |
| n = \*\*\*\*\* | | | | | | |

**Table 2b:** Results of logistic regression on **\*\*\*\*\* Q3 \*\*\*\*\***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Odds Ratio** |
|
| Relative Risk Value |  |  |  |  |  |  |
| Q2 Crime Count |  |  |  |  |  |  |
| n = \*\*\*\*\* | | | | | | |

**Table 2c:** Results of logistic regression on **\*\*\*\*\* Q4 \*\*\*\*\***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Odds Ratio** |
|
| Relative Risk Value |  |  |  |  |  |  |
| Q3 Crime Count |  |  |  |  |  |  |
| n = \*\*\*\*\* | | | | | | |

Power Analysis

Power refers to the probability that a statistical test will detect a crime reduction generated by the intervention, particularly by generating a statistically significant result. Statistical power is used here to inform the optimal sample size and duration of the targeted intervention. Generally speaking, a low powered test has a heightened risk of generating a “false negative.” An example of a “false negative” could be a blood test not detecting the presence of a disease in a patient when in fact a disease is present. In respect to the current project, a false negative would be the evaluation determining that the intervention did not have a significant effect on crime when it really did. This project’s evaluation of the intervention will incorporate two separate tests: An independent samples t-test and a more rigorous negative binomial regression analysis. Since power analyses are test specific, power estimates were conducted separately for these tests, with desired statistical value set to 0.8.

Findings suggest that micro-place sample sizes of **42 (21 Targeted), 102 (51 Targeted), and 620 (310 Targeted)** would be necessary for the t-tests to detect large, medium, and small intervention effects, respectfully. In each case, half of the sample should be designated as target areas for the intervention with the others serving as the control areas. According to the power analysis for the negative binomial regression models, the necessary number of crime incidents in the target areas (across the pre- and during-intervention periods) to achieve a power of at least 0.8 with at least a 30% crime reduction is **60 incidents**. The duration of the intervention should be long enough to expect this many incidents in the targeted areas under “normal” circumstances.

Target Area Selection

Street segments that intersect certain areas will be precisely targeted places (e.g. “Market St. between Broad St. & Mulberry St”), and serve as the micro-level unit of analysis within target areas.

Based on this analysis of the spatial nature and distribution of crimes in the jurisdiction, we recommend the following guidelines for target area selection:

1. **Select places with higher risk values.**
2. **Give priority to hotspot areas containing a high proportion of high risk places.**
3. **Include high risk places that are outside of, but nearby, hotspot areas.**

Intervention Strategy Guidelines

The risk-based interventions for this project should include at least 3 simultaneous activities—at least one that relates to each of the following categories:

1. Reducing the criminogenic spatial influence of one or more environmental crime risk factors.
   1. The risk factors that were empirically selected and included in the risk terrain models (presented above) are what should receive focused attention for purposes of mitigation efforts, with priority given to factors in order of their weighted influence.
2. Developing evidence-based practices, such as activities related to target-hardening, situational prevention, and/or community awareness.
3. Using policing activities/patrols to deter and incapacitate known/motivated offenders.

The intervention should be designed in a manner that does not place an undue burden on police department resources or finances. This means that the intervention’s activities should be considered to be “reasonably” sustainable/repeatable under “normal conditions” without external (i.e., grant) funding.

The interventions will be time-limited, with consideration of requirements for valid and reliable statistical impact assessments.

Analytical Intervention Strategy

We propose the integration of strategic/tactical intervention activities that are routinely informed by dynamic crime analysis for the purpose of resource allocations at micro-places within the established target areas.

Given the expected occurrence of repeat victimization and near repeat incidents within a certain distance and period of time from new crime incidents, we propose that each new crime incident located within the target areas be evaluated for its propensity to become an instigator for near repeats based upon the proportion of high-risk places within the expected near repeat bandwidth. Police officials can then prioritize place-based deployments of resources within the target areas by comparing new crime incidents relative to all others according to the surrounding environment's suitability for hosting new near repeat incidents. Priority attention can temporarily be given—and limited resources (re)allocated, to new crime incidents that have more high-risk "slices of the pie" than other incident locations.

ArcGIS Layer Packages

A layer package includes both the layer properties and the dataset referenced by the layer. This allows for the saving and sharing of everything about the layers presented in this report, including symbolization, labeling, field properties, and the data. You will be able to view layer packages in ArcMap, ArcGlobe, ArcScene or ArcGIS Explorer.