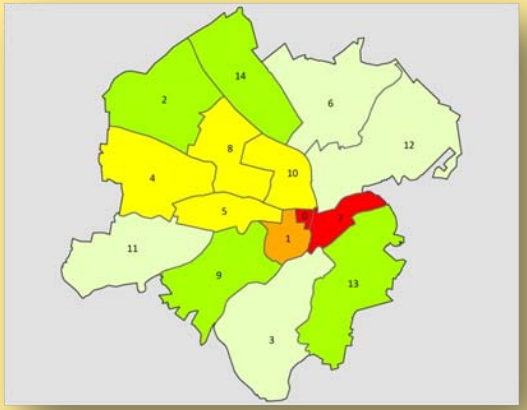
A Micro-Spatial Analysis of Violent Crime



The Experience of a Small Southern City

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Levels of Measurement

- Macro-spatial analysis
  - Crime at the state, regional, or national level
- Meso-spatial analysis
  - Crime at the county or MSA level
- Micro-spatial analysis
  - Crime at the local level within a city or county
  - Crime at the neighborhood level

Roanoke, Virginia

- Located in southwest Virginia at the southern end of the Shenandoah Valley
- Roanoke City Population = 92,238
- Roanoke MSA = 295,700
  - City plus surrounding counties
- Major health-care consortium is the biggest employer
- Former headquarters for the N&W Railroad

Roanoke, Virginia

Violent Crimes

- All violent crimes reported to the city police for the years 2004 – 2006
  - Homicides (09A & 09B)
  - All sexual assaults (11 A, B, C,& D)
  - All Robberies (120)
  - Assaults (13 A & B)
    - Aggravated & Simple Assault
- N = 9549 violent crimes
  - 99.6% nominal geocoding rate

Measuring Crime

- Crime rates
  - Standardized for population “at risk” and modified by a constant to improve understanding (crimes per 100,000)
- Problems with traditional rates
  - The “denominator problem”
  - The Modifiable Areal Unit Problem
    - Low population in a large area distorts the rate
  - Typically constrained to census areas
    - Tracts, block groups, or blocks (rarely)

The Crime Concentration Index (CCI)

- An adaptation of the **location quotient** to the study of crime
- Provides a risk estimator not contingent on an uncertain population at risk
  - Solves the “denominator problem”
- CCIs are based on the comparison between the mix of recorded offences in a specific area and the mix of offences in a broader area

The Crime Concentration Index

$$CCI = \frac{Incidents_{i_n}}{Area_{i_n}} \Bigg/ \frac{\sum_{n=1}^{N} Incidents_{i_n}}{\sum_{n=1}^{N} Area_{i_n}}$$

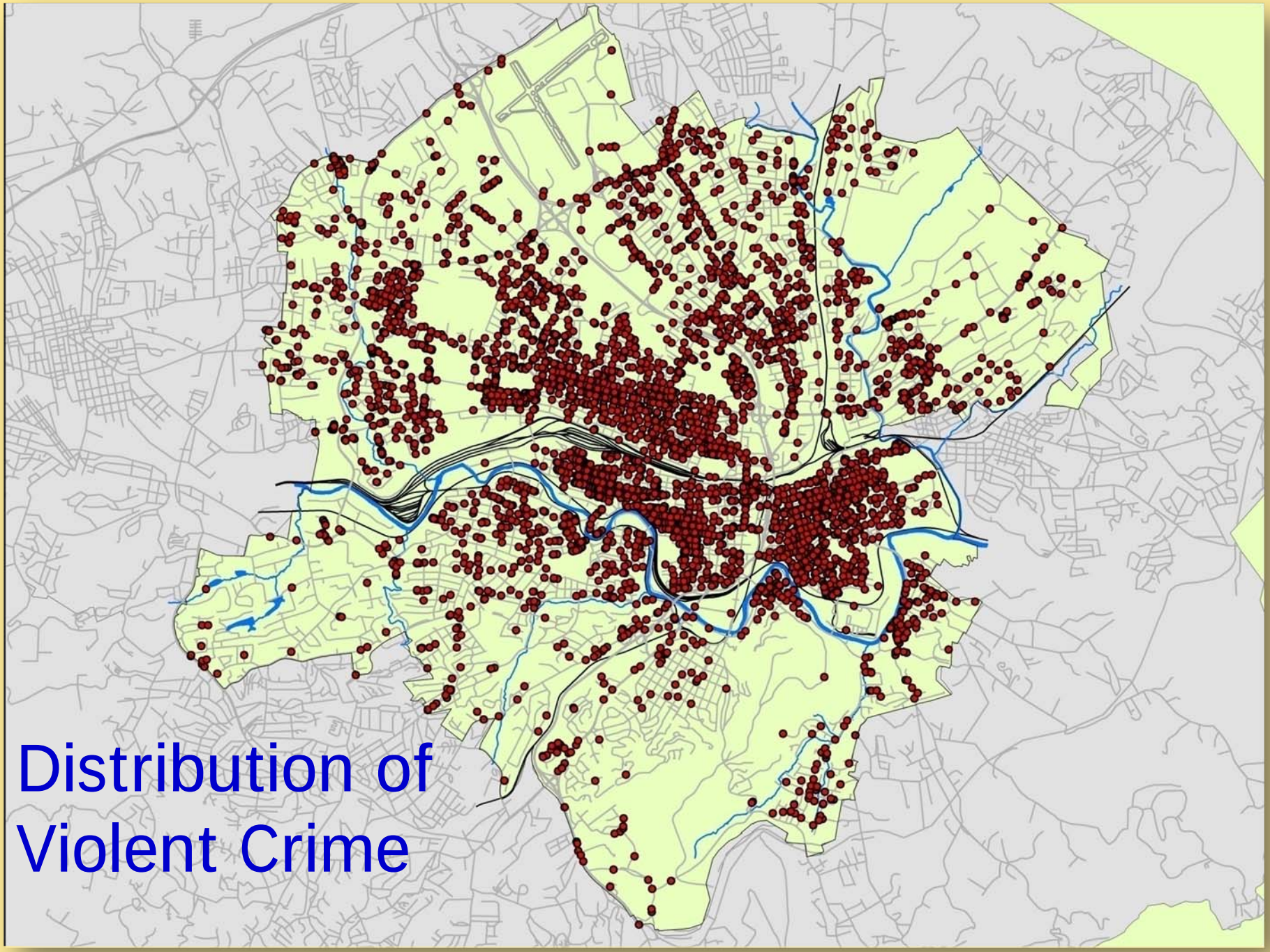
- Incidents = violent crimes per unit area
- Area = area (in sq mi) of polygon

The Crime Concentration Index

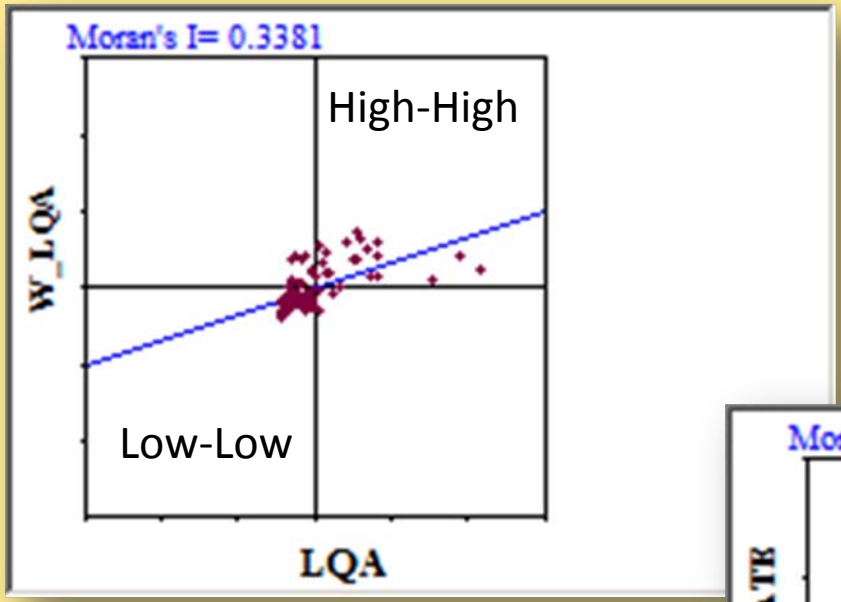
- Provides a relative concentration index based on the total distribution of crime
- A value of 1.0 is the baseline
- Values less than 1.0 indicate crime is less concentrated in that area
- Values greater than 1.0 indicate crime is more concentrated in that area
- Can be “read” as a percentage

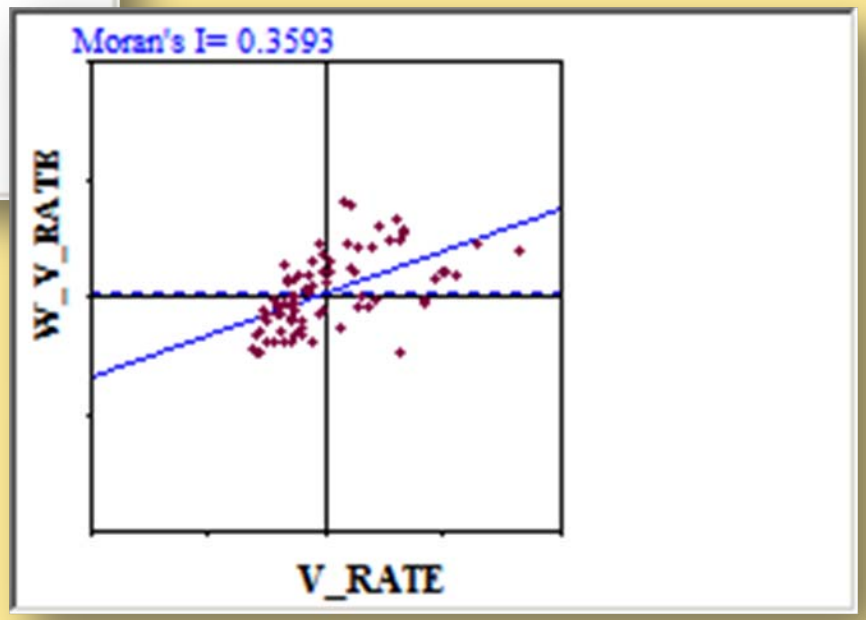
Use of spatial autocorrelation (Moran's I) to test for spatial non-randomness. As values depart above zero it is less likely the crimes are randomly distributed throughout the study area.

ARE THE CRIMES RANDOMLY DISTRIBUTED?


Distribution of
Violent Crime

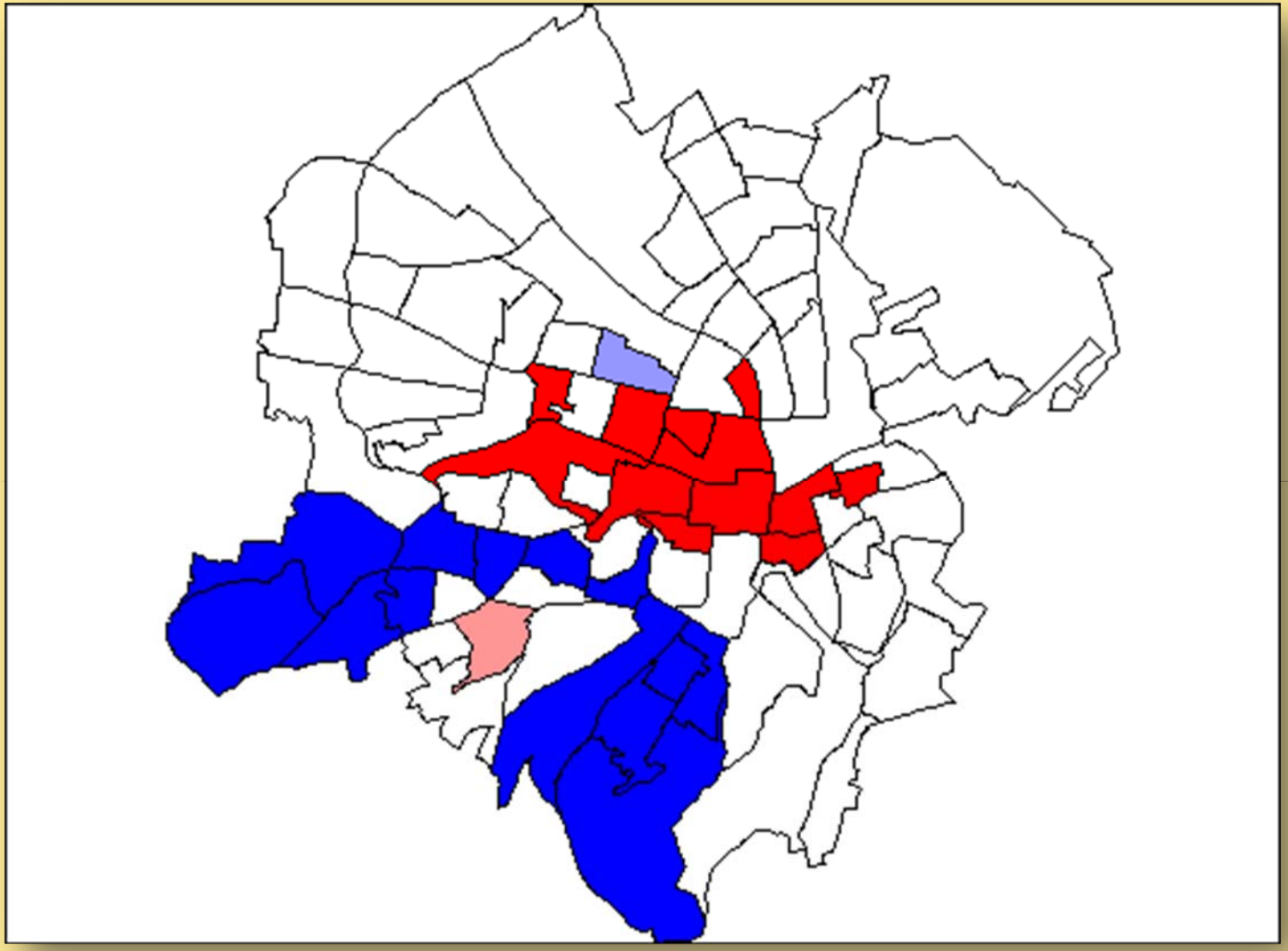
Test for Clustered Distribution



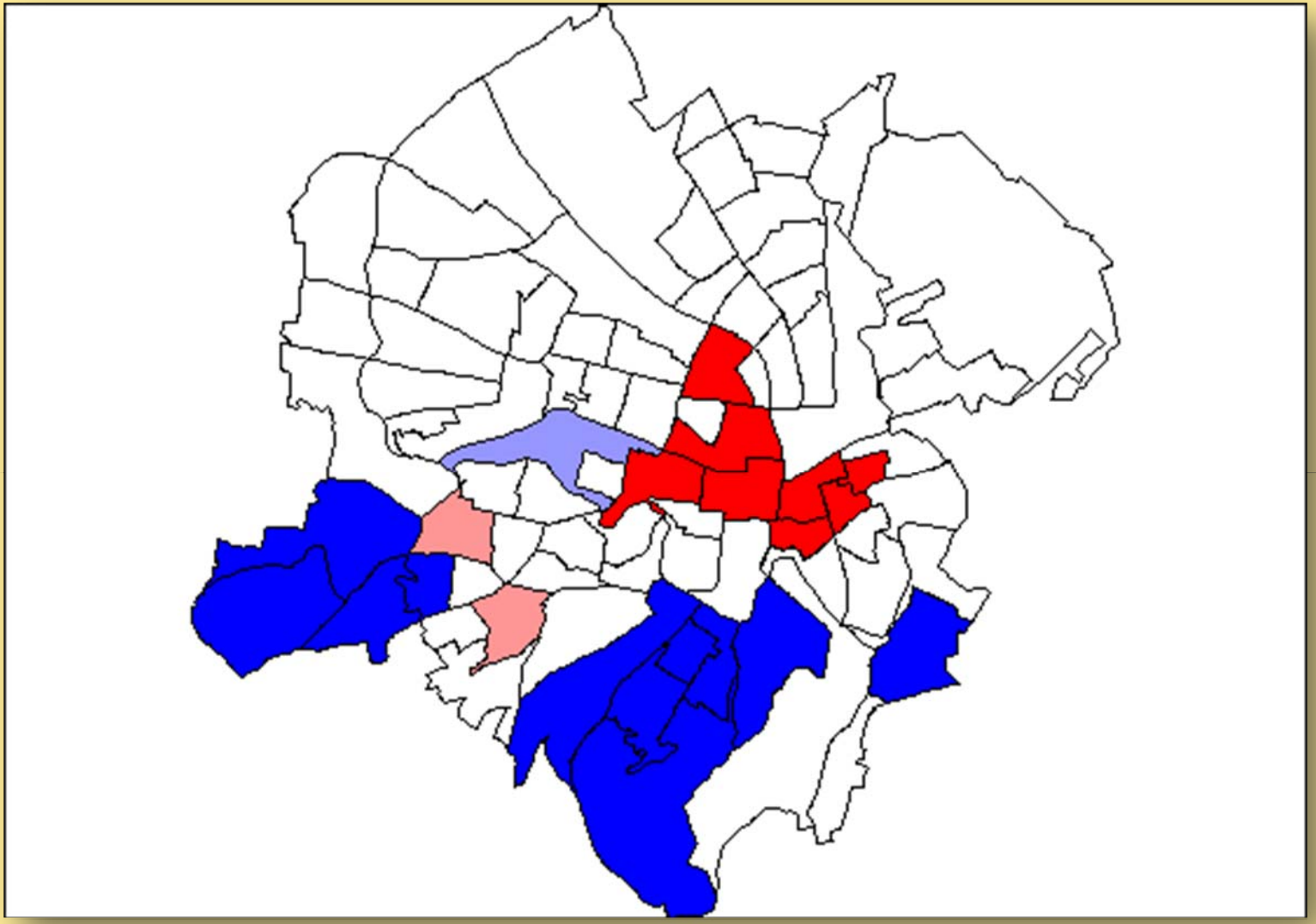


With both indices there is strong evidence of spatial clustering of violent crime

LISA:Rate Violent Crimes



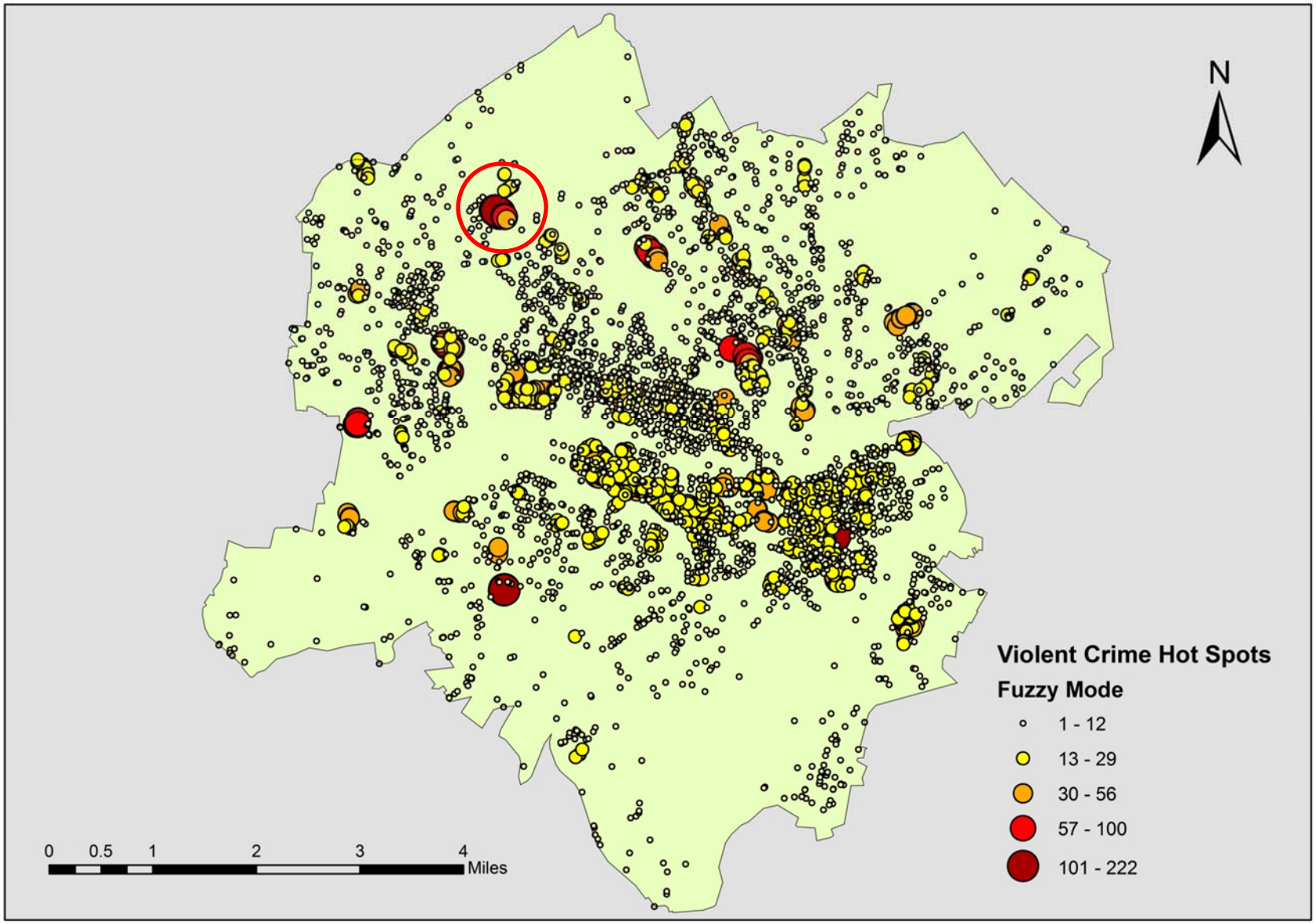
LISA:CCI Violent Crime



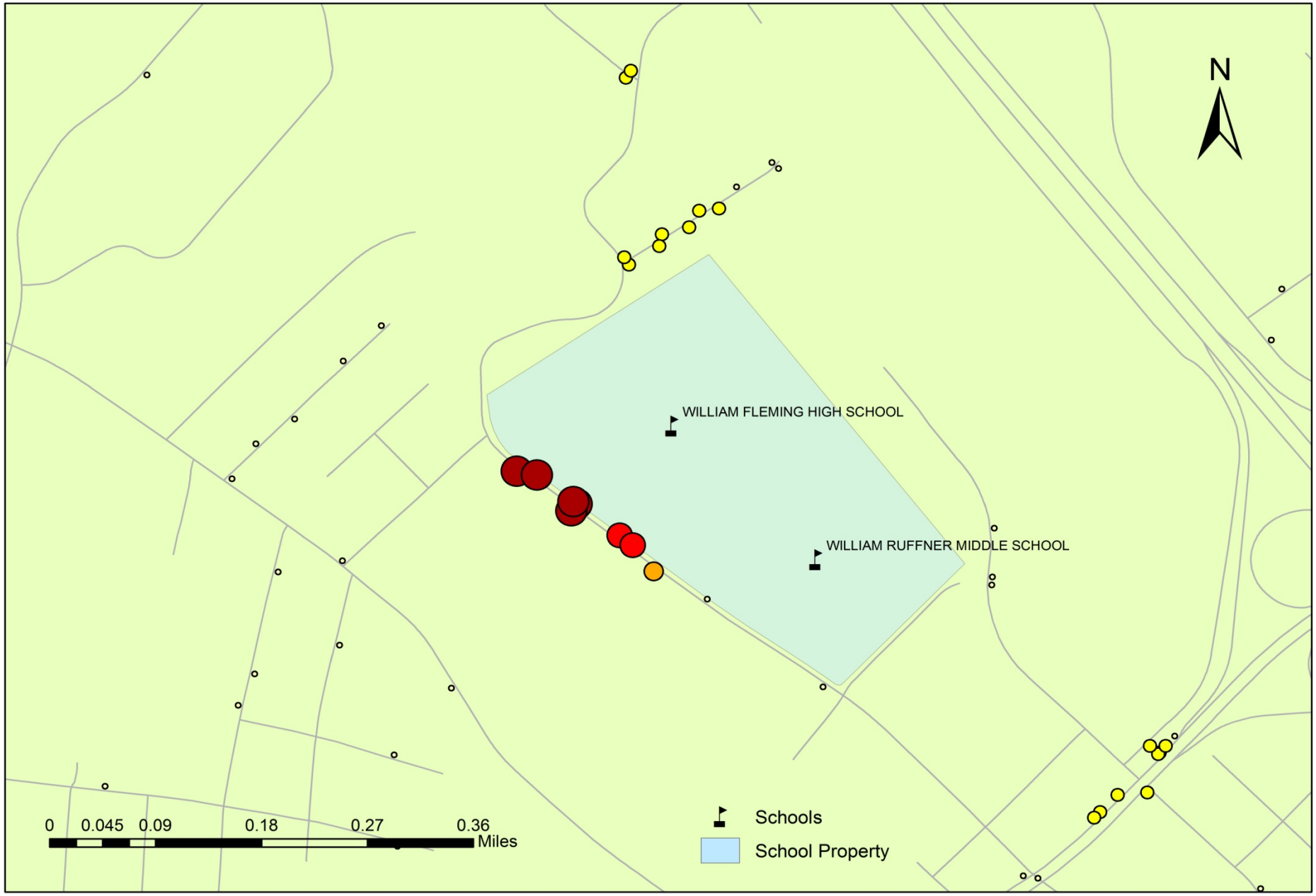
Areas where violent crime clusters

HOT SPOT ANALYSIS OF VIOLENT CRIME

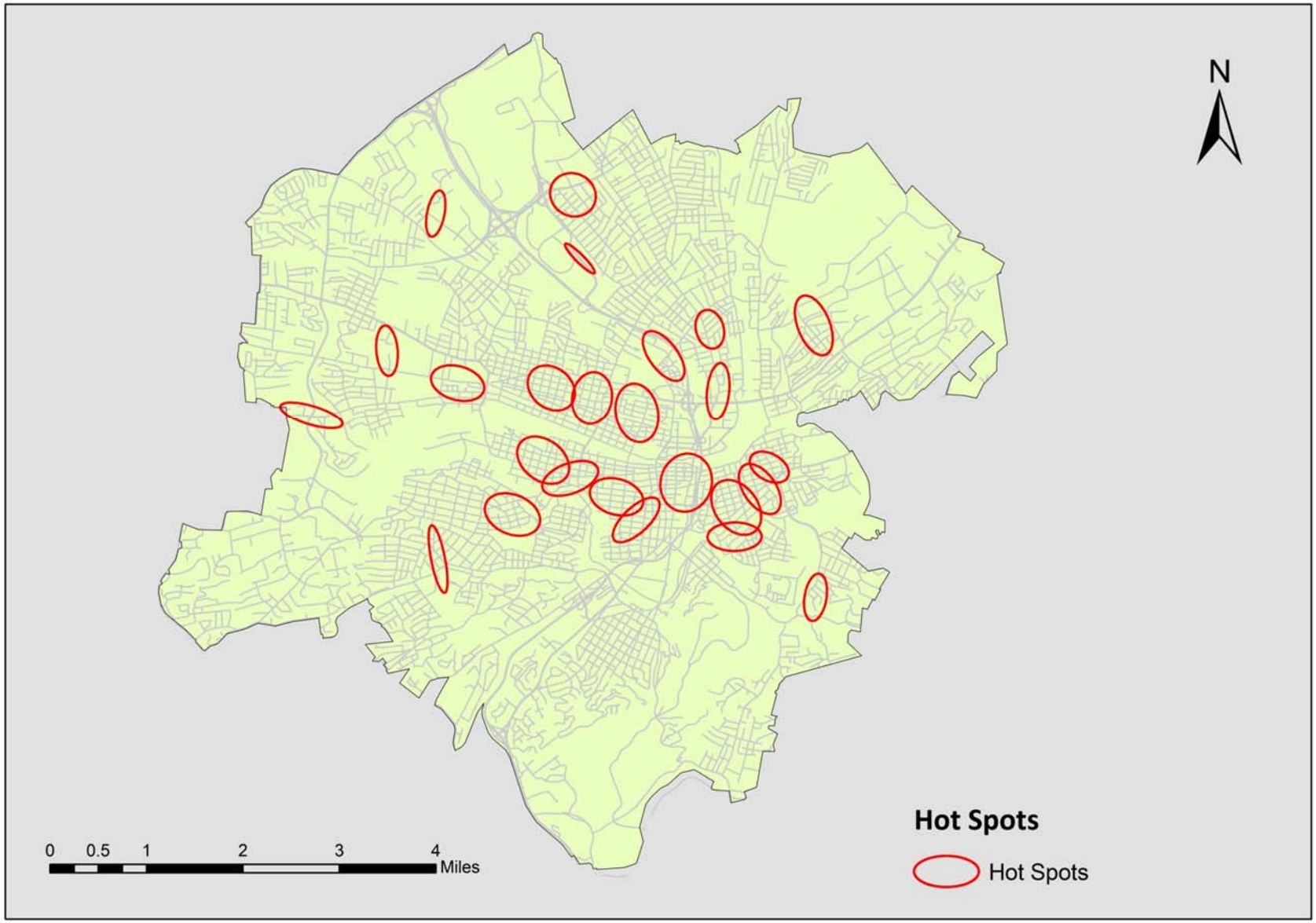
Violent Crimes: Fuzzy Mode Hot Spots



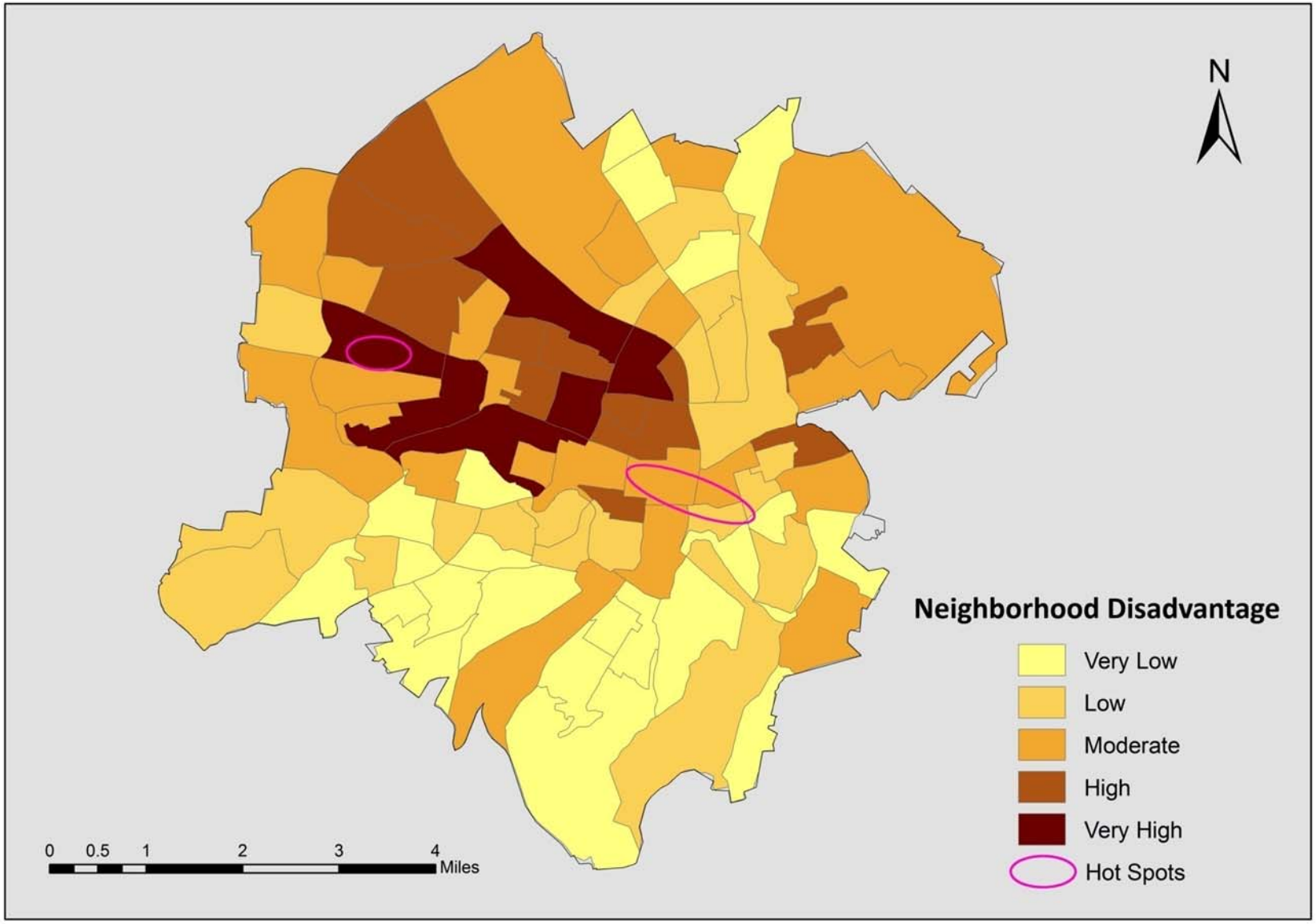
Violent Crimes: School Hot Spot



Violent Crime Hot Spots



Risk Adjusted Violent Crime Hot Spots



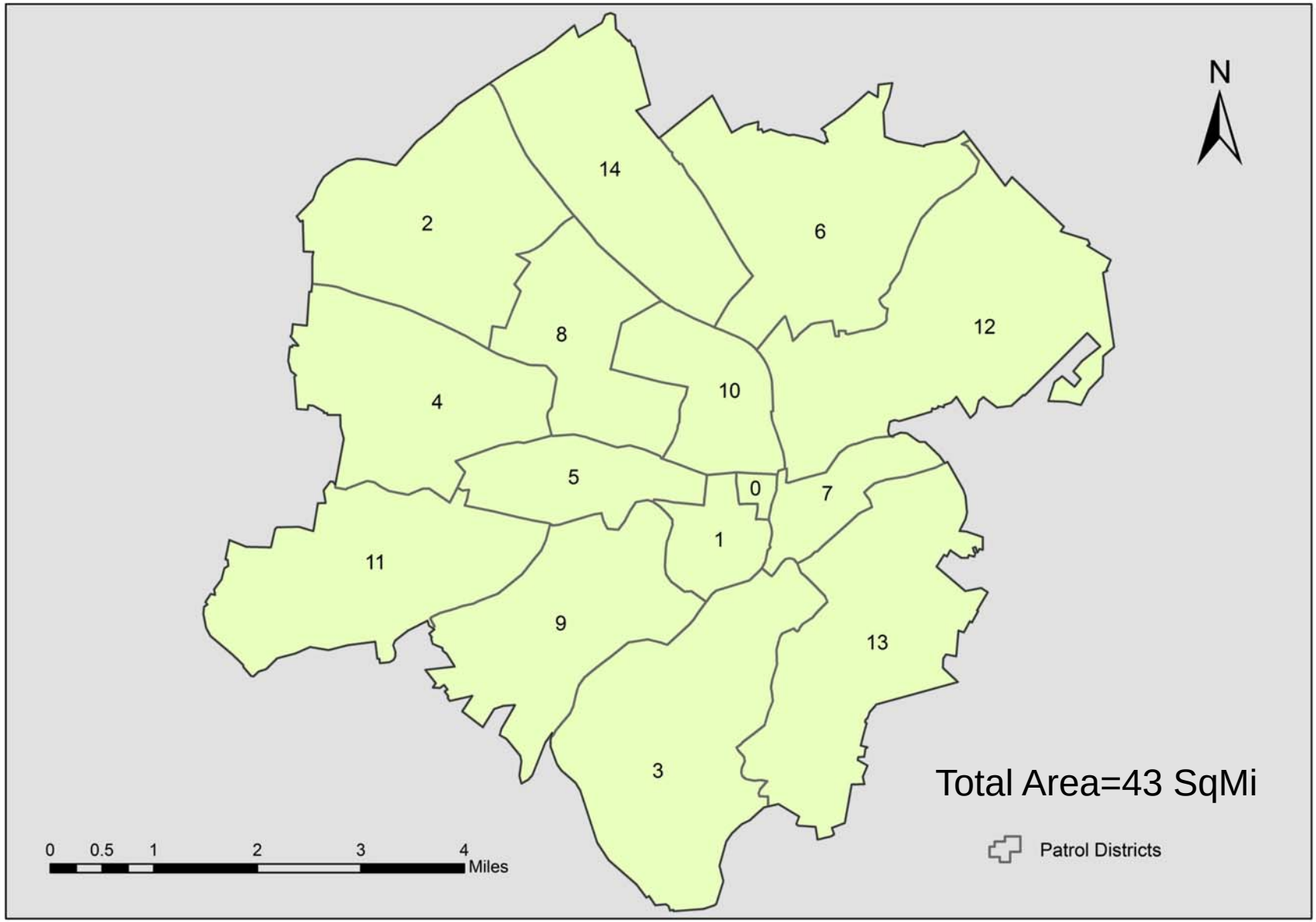
Conclusions

- Violent crime is not randomly distributed throughout the city
- Specific areas in the city have more clustering – hot spots
- At least two areas of concentration are related to social disorganization in the backcloth

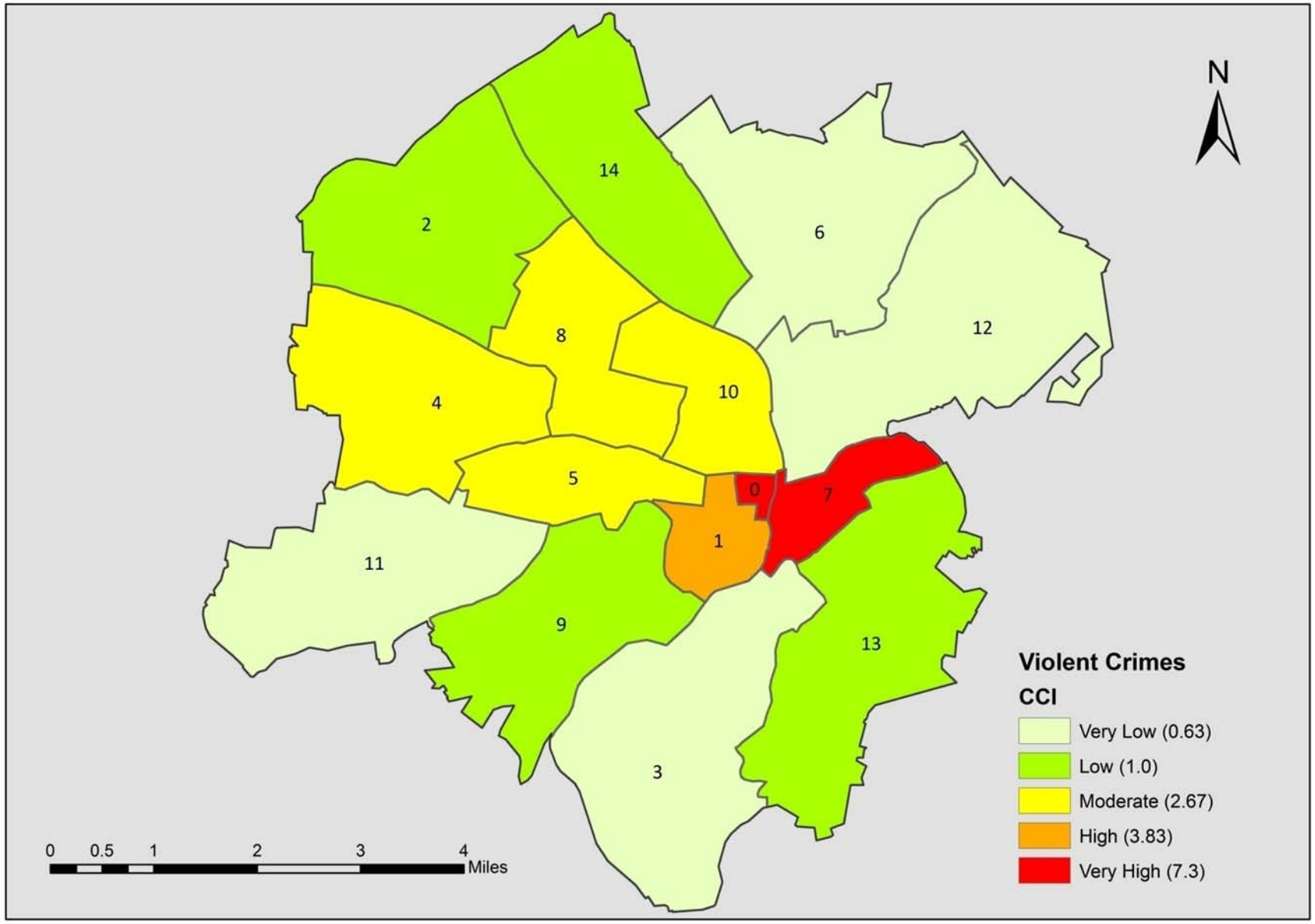
This analysis would not be possible with traditional crime rates

ANALYSIS OF VIOLENT CRIME BY PATROL DISTRICT

Roanoke City Police Patrol Districts



Violent Crime Concentration by Patrol Districts

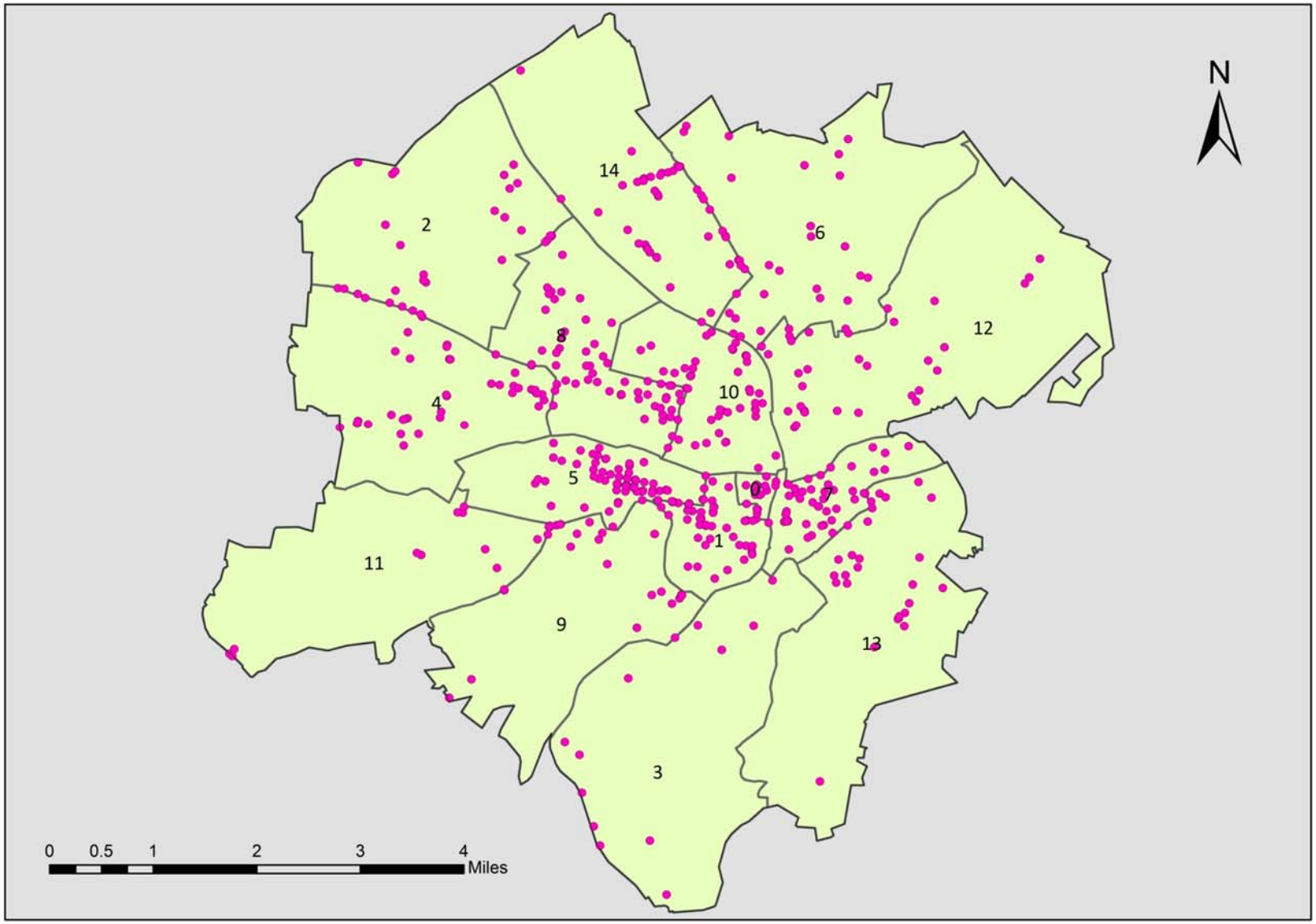


During the study period the city experienced a 17.6% increase in robbery (2004 – 2006). There were 644 robberies during this period.

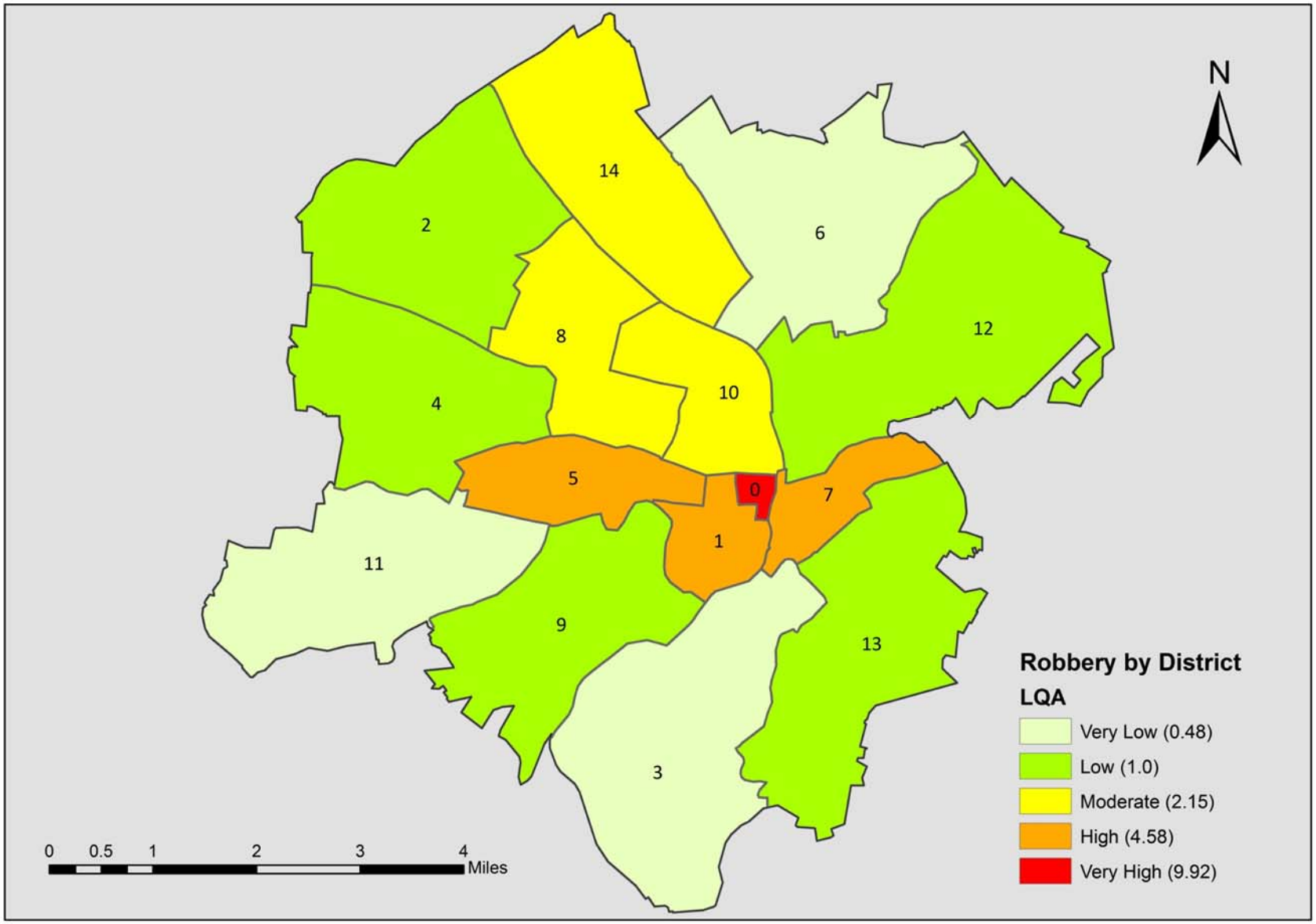
During the period from 2000 until 2006 the city experienced a 77.4% increase in robbery.

FOCUS ON ROBBERY

Robbery Pin Map



Robbery: Crime Concentration by Area

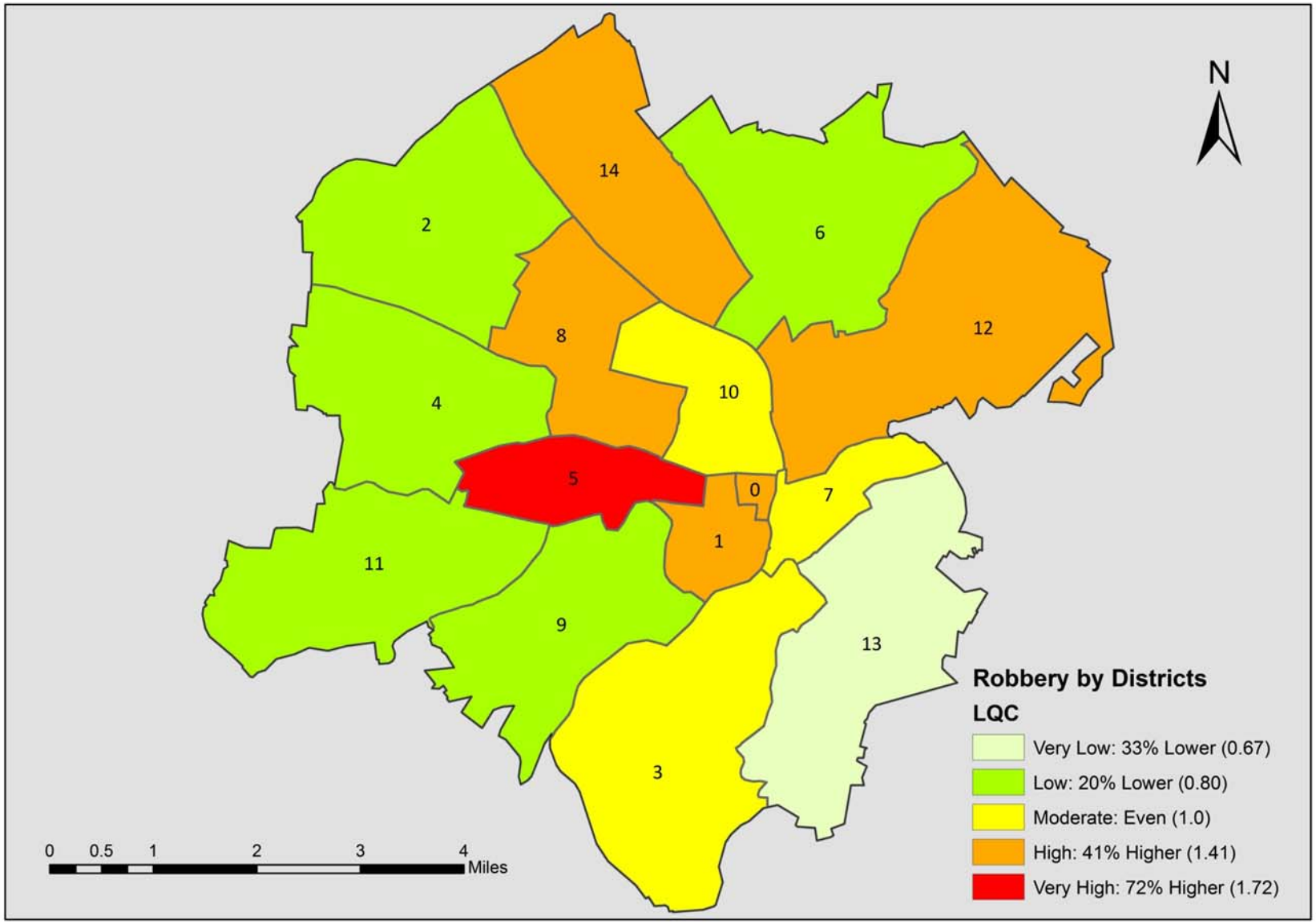


Crime Concentration Index

- CCI by area: concentration in an area
- CCI by crime: concentration of a specific crime (robbery) compared to the distribution of total crime (violent crimes)

$$CCI = \frac{Robberies_{i_n}}{ViolentCrimes_{i_n}} \Bigg/ \frac{\sum_{n=1}^{N} Robberies_{i_n}}{\sum_{n=1}^{N} ViolentCrimes_{i_n}}$$

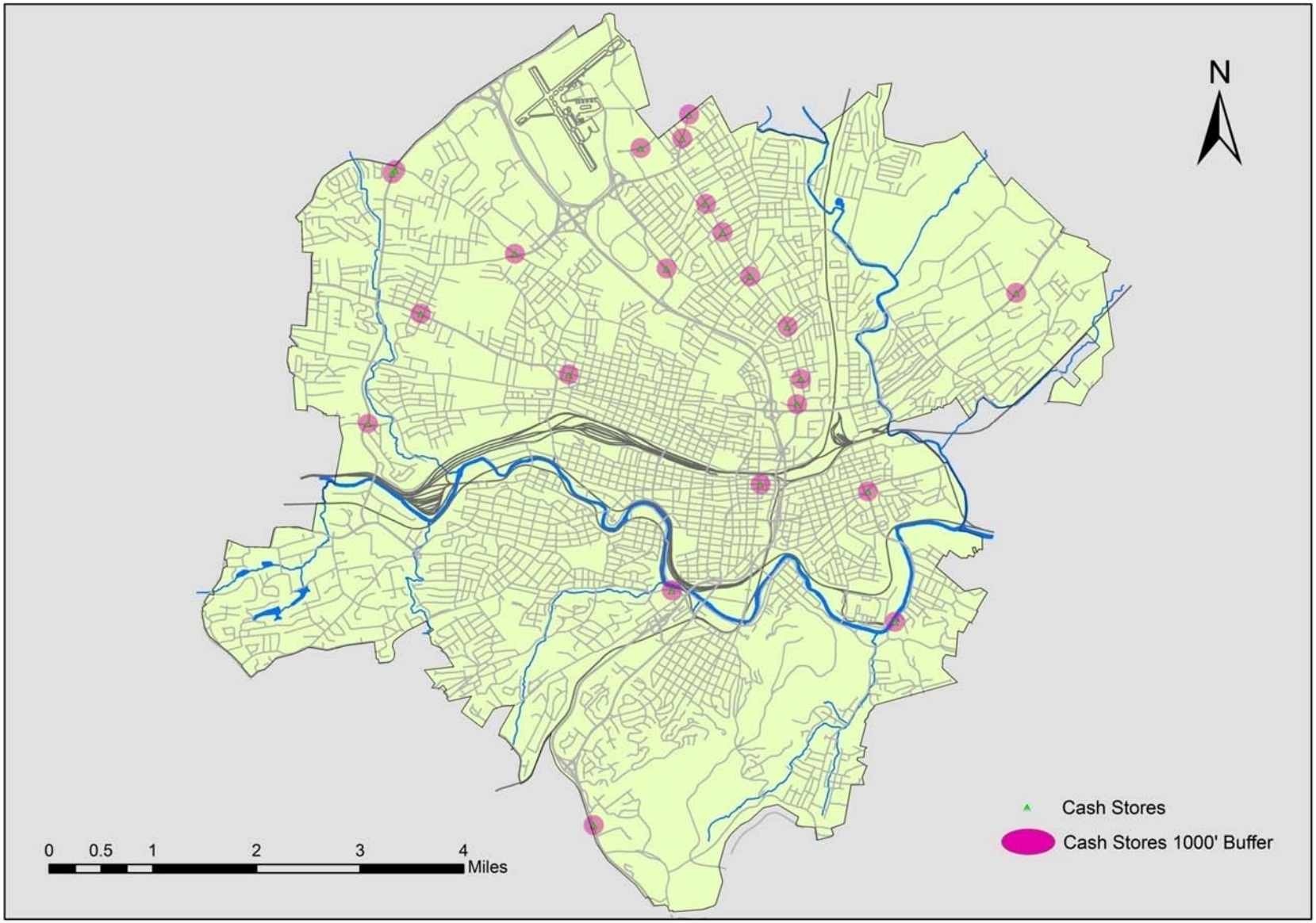
Robbery: Crime Concentration by All Violent Crime



Cash Stores & Robbery

- Cash Stores
  - A business based on the “sale” of cash: check cashing, pawn, & pay-day lending
  - Customers (often on foot) leave these locations with cash in their pocket
- Buffered locations
  - Cash store locations plus 1000’ buffer
  - 1000’ is the distance most people will walk in a city before seeking alternative transportation

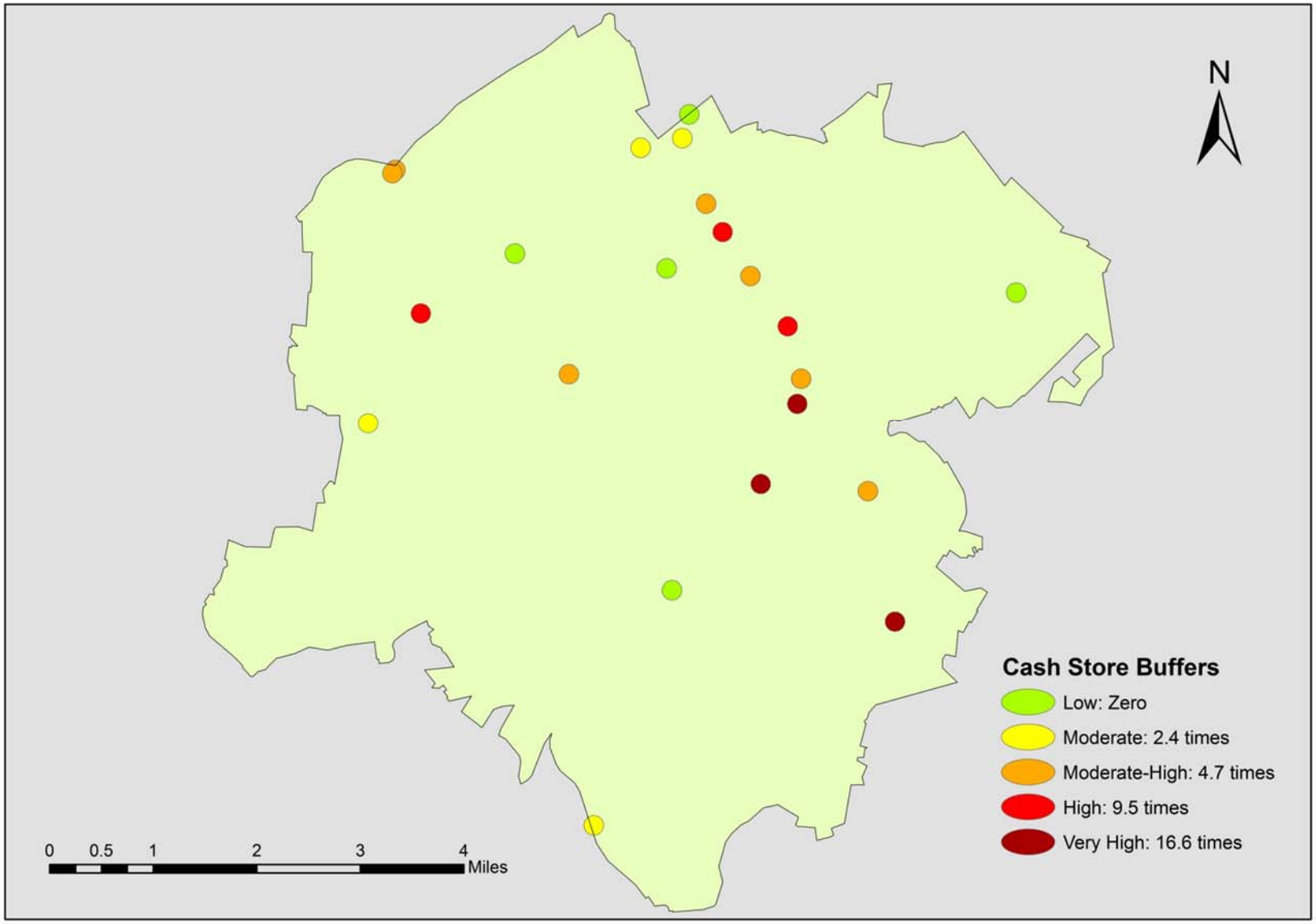
Robbery & Cash Stores



Localized CCI for Robberies

$$CCI = \frac{Robbery_{buffer}}{Area_{buffer}} \Bigg/ \frac{TotalRobberies}{TotalArea}$$

Robbery & Cash Stores



Linear Concentration Index

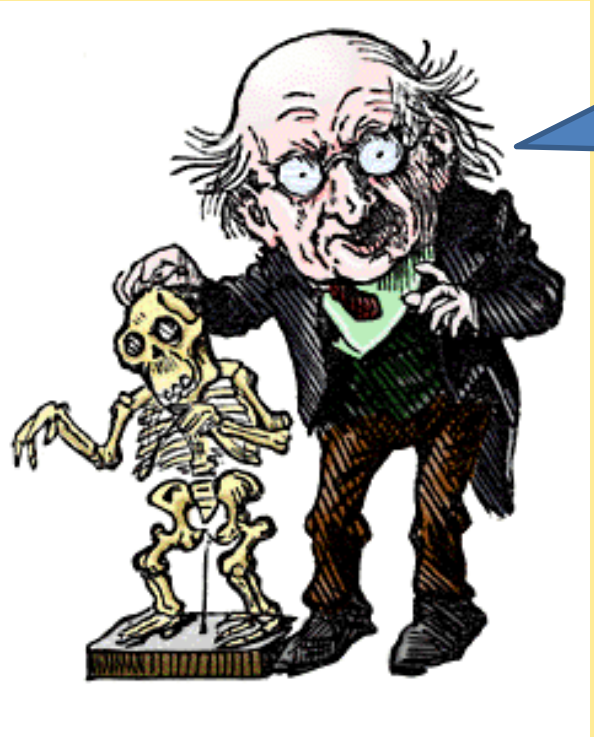
- Aggregate crimes to street segments with a spatial join
- Calculate a CCI using segment length rather than area
- Display the output using color and line width to enhance qualitative understanding

Robbery & Streets

Conclusions

- Violent Crime is not randomly distributed and clusters near the city center
- Crime concentration indices are a better method for examining the distribution of crime at the micro-spatial level
- CCIs have flexibility in their application which allow for the study of crime from different perspectives

Questions?



If I can help:
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These slides will be available at:
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