Predicting local crime clusters using a local indicator of spatial association and a discrete choice model

Martin A. Andresen
andresen@sfu.ca
School of Criminology
Simon Fraser University
http://www.sfu.ca/~andresen/

Motivation for this research

- The limitations of linear models
  - Parameter stability for low and high crime areas?
- Local crime clusters
  - A lack of prediction

Resolving linearity

- Identify low crime and high crime areas
- Model them independently
- Problem: how to identify these areas?
  - Natural breaks? Standard deviations?
  - How many classifications?
  - How should they be modeled?
    - Little remaining variation

LISA

- Local indicators of spatial association
- A method of classifying spatial units
- Not as arbitrary as other possibilities
- Anselin (1995): local Moran's *I*

LISA, cont'd

- 5 classifications
  - low-low, high-high, low-high, high-low
  - Statistically insignificant
- Low and high crime areas identified, now what?
  - Categorical variable, cannot use OLS

Synthesizing my motivation: a two-stage approach

- Identify local clusters of crime using LISA
- Model these 5 categories using a discrete choice methodology

Multinomial logistic regression

- Predicts the probability of a local crime cluster from occurring
- Each type of local crime cluster has its own set of estimated parameters
- Can uncover if low and high crime areas have the "same" relationships with explanatory variables
- Can uncover if all low (or high) crime areas are the same

Crime data

- VPD calls for service, 2001
- Automotive theft, burglary, and violent crime
- All crimes measured as rates per 1000

Ecological data

- Statistics Canada's Census of Population, 2001
- Social disorganization theory
- Routine activity theory

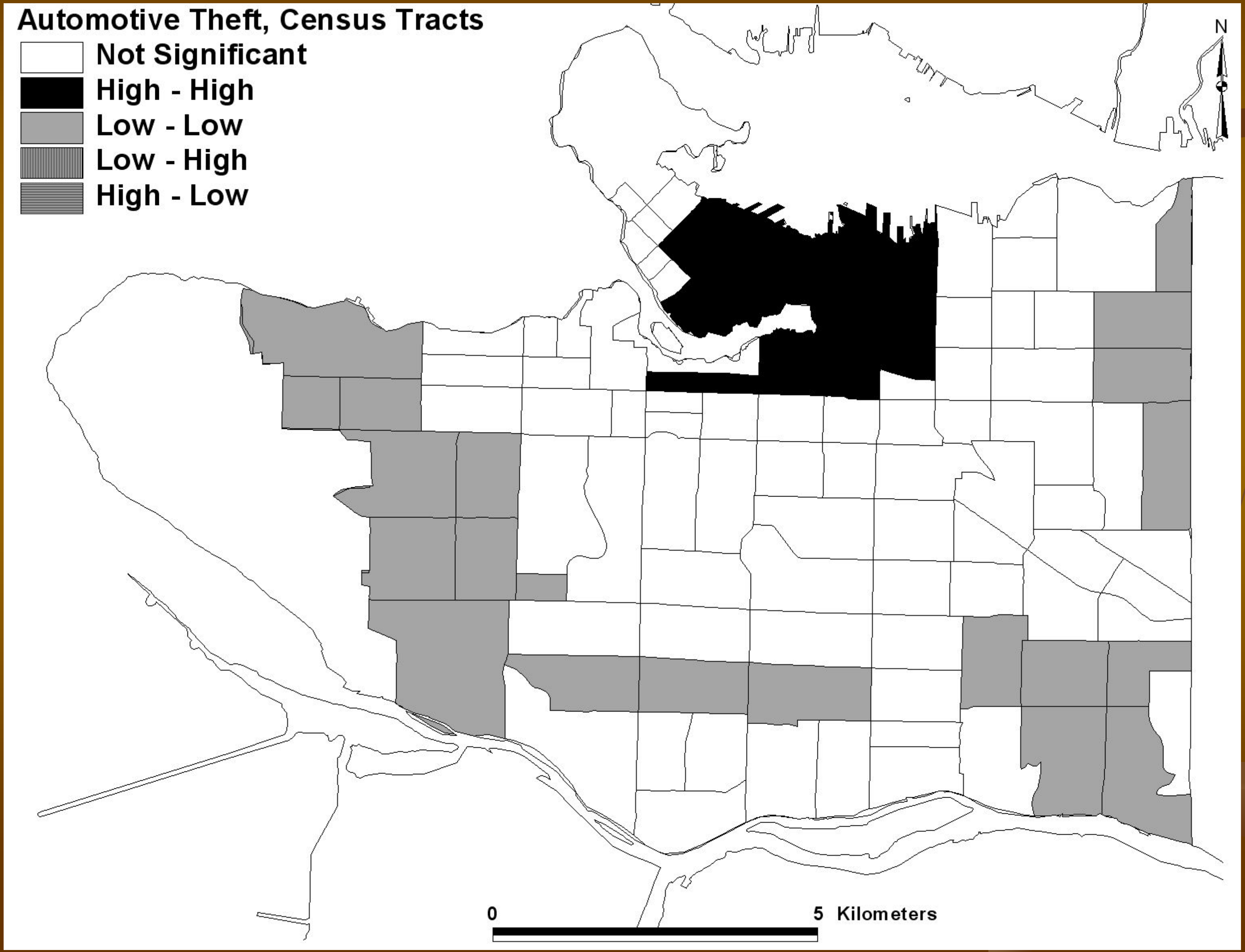
Social disorganization theory

- Ethnic heterogeneity
- Population turnover
- Social and economic deprivation
- Family disruption

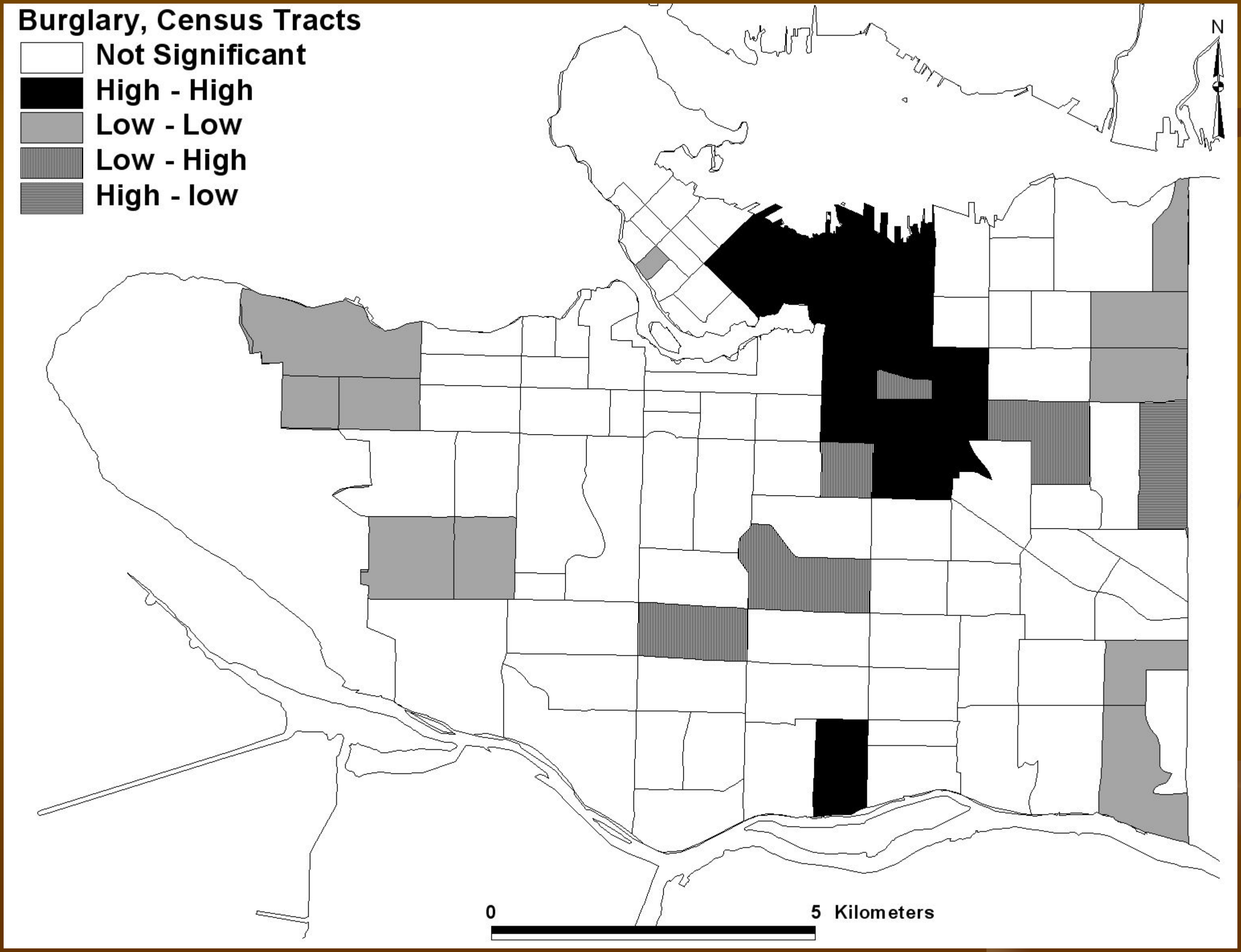
Routine activity theory

- Offenders, targets, and guardianship
  - Age composition
  - Marital status
  - Population counts
  - Employment status
  - Income levels
  - Dwelling values

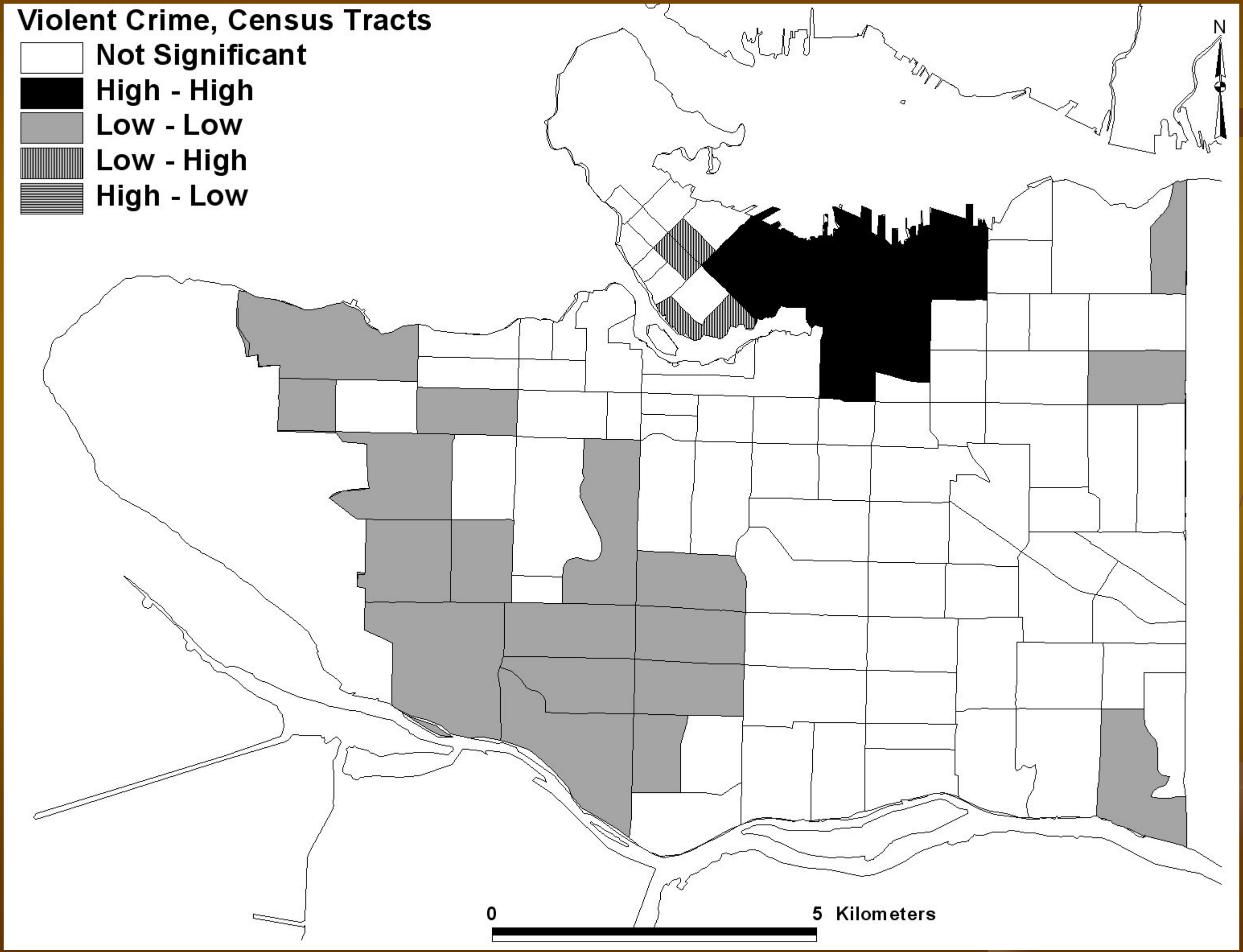
Crime clusters (CTs), automotive theft



Crime clusters (CTs), burglary



Crime clusters (CTs), violent crime



Local crime clusters, CTs

Table 6. Percentages of cluster types, census tracts, Vancouver, British Columbia, Canada, 2001

	Cluster Types				
	Insignificant	High-High	Low-Low	Low-High	High-Low
Automotive Theft	67.3	10.9	21.8	0.0	0.0
Burglary	69.1	10.9	14.5	4.5	0.9
Violent Crime	71.8	6.4	19.1	2.7	0.0

Source. Vancouver Police Department and Statistics Canada, calculations by the author.

Automotive theft results, CTs

Table 7. Multinomial logistic regression results, census tracts, automotive theft

	High-High	Low-Low
Population Change, %	***0.488***	***-2.279***
Single Parents, %	***-1.560***	1.386
Unemployment Rate	***1.357***	1.149
Average Income, 000s	0.072	***0.347***
Probability of cluster	2.34	12.34
Pseudo – R^2	0.337	
Percent Correct	74.55	

Burglary results, CTs

Table 8. Multinomial logistic regression results, census tracts, burglary

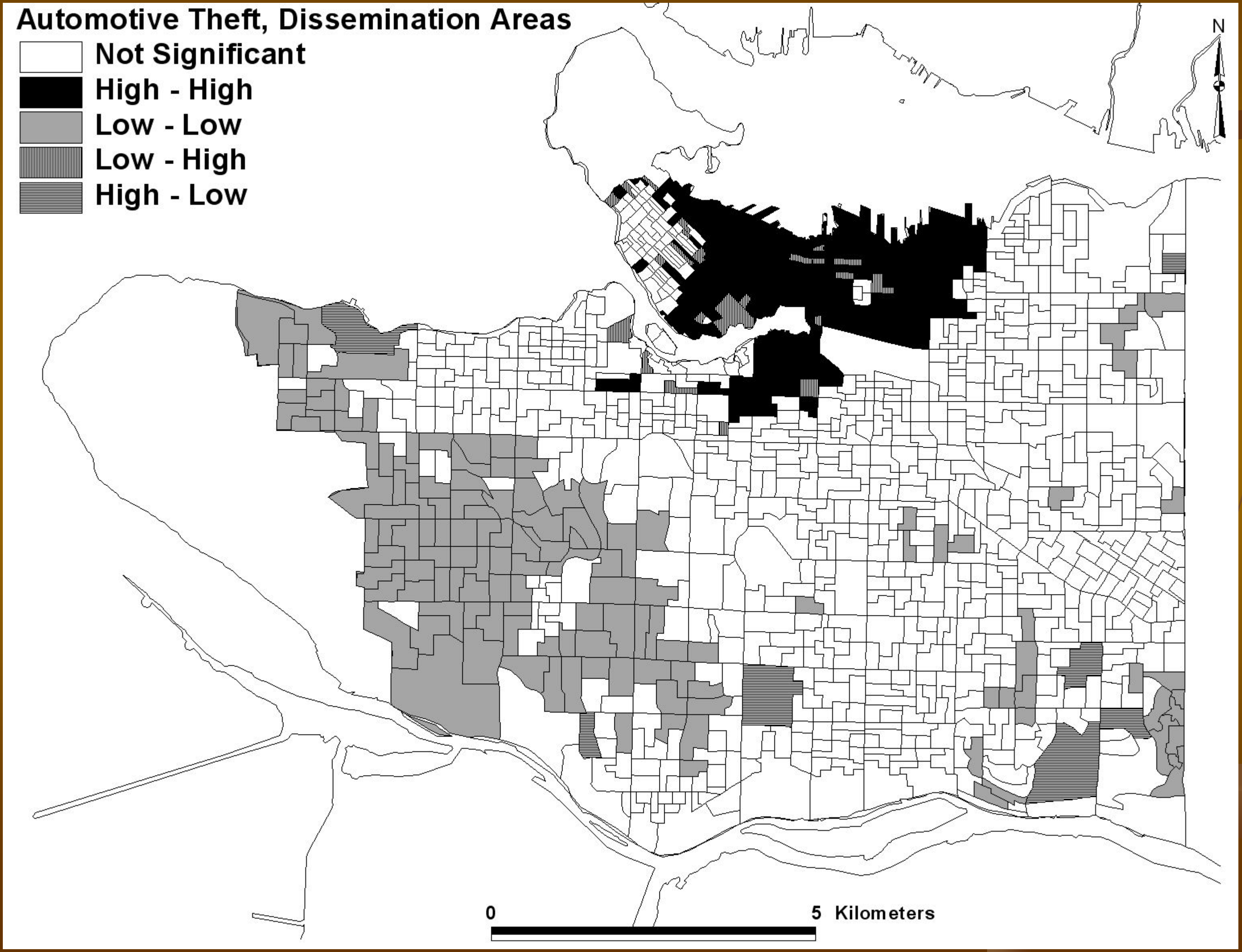
	High-High	Low-Low	Low-High	High-Low
Population Change, %	0.353	***-1.462***	0.038	-0.098
Single Parents, %	0.219	1.206	***1.075***	0.067
Recent Immigrants, %	0.179	***-1.149***	***0.124***	-0.046
Unemployment Rate	***1.877***	0.560	-0.276	0.175
Probability of cluster	3.28	8.09	0.89	0.86
Pseudo – R^2	0.308			
Percent Correct	74.55			

Violent crime results, CTs

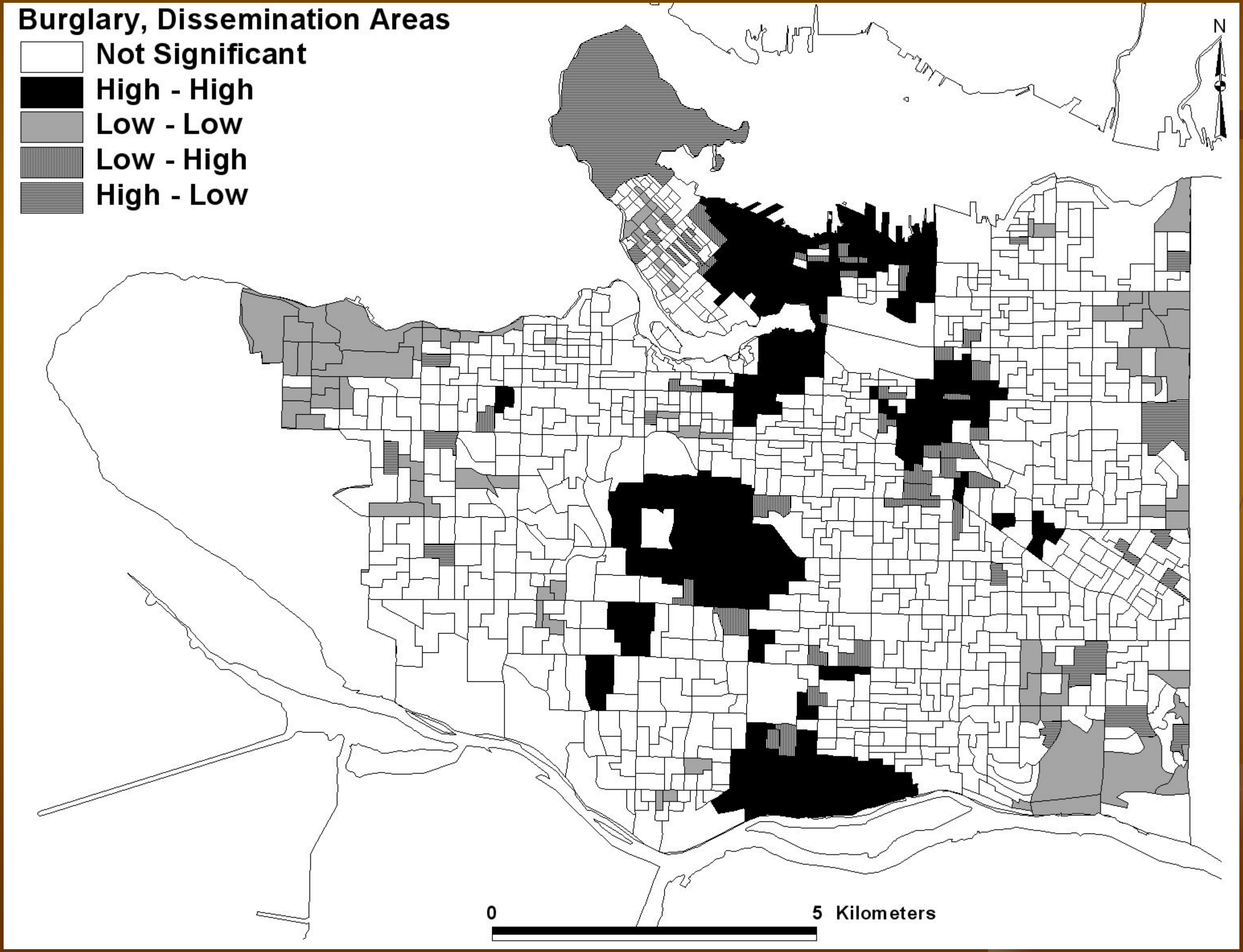
Table 9. Multinomial logistic regression results, census tracts, violent crime

	High-High	Low-Low	Low-High
Population Change, %	0.078	***-2.099***	***0.047***
Unemployment Rate	***0.470***	2.192	0.009
Average Income, 000s	0.013	***0.475***	0.004
Probability of cluster	0.53	8.85	0.12
Pseudo – R^2	0.476		
Percent Correct	83.64		

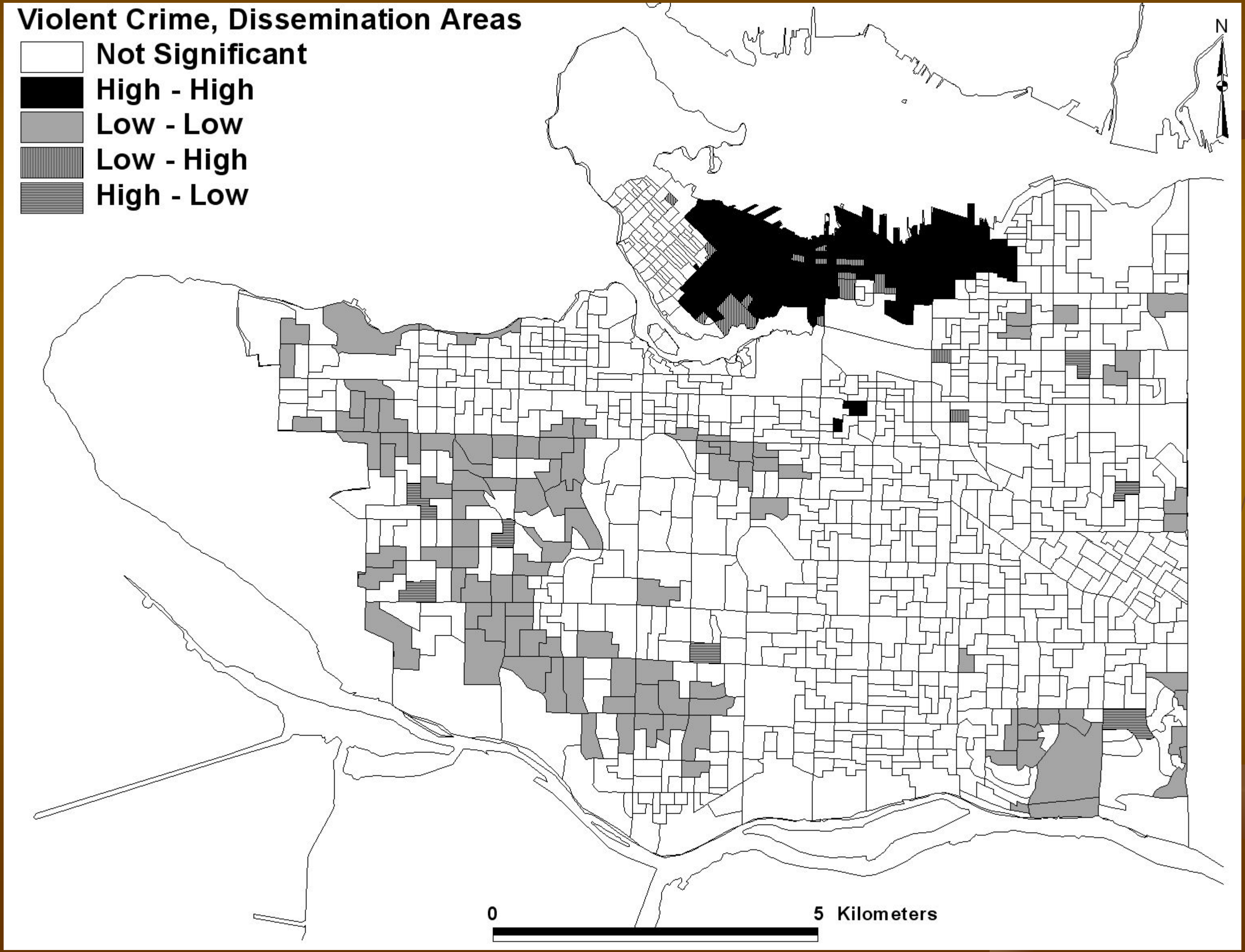
Crime clusters (DAs), automotive theft



Crime clusters (DAs), burglary



Crime clusters (DAs), violent crime



Local crime clusters, DAs

Table 10. Percentages of cluster types, dissemination areas, Vancouver, British Columbia, Canada, 2001

	Cluster Type				
	Insignificant	High-High	Low-Low	Low-High	High-Low
Automotive Theft	77.2	5.6	14.0	2.5	0.7
Burglary	76.7	8.6	8.3	3.9	2.5
Violent Crime	82.9	4.0	10.7	1.6	0.7

Automotive theft results, DAs

Table 11. Multinomial logistic regression results, dissemination areas, automotive theft

	High-High	Low-Low	Low-High	High-Low
Population Change, %	0.016	***-0.240***	***0.051***	***-0.000***
Males 15-24, %	***-0.119***	***1.533***	-0.180	-0.000
Single Parents, %	***-0.130***	***0.597***	0.030	0.000
Ethnic Diversity	***0.019***	***-0.171***	-0.001	-0.000
Unemployment Rate	***0.105***	0.163	***0.114***	0.000
Post-secondary, %	***0.021***	0.082	0.018	0.000
Average Income, 000s	***0.018***	***0.105***	***0.021***	-0.000
Population Density	***-0.004***	***0.001***	0.000	***-0.000***
Dwelling Value, 000s	***-0.007***	0.010	***-0.005***	0.000
Rentals, %	0.009	***-0.106***	0.012	0.000
Major Repairs, %	***-0.060***	***-0.349***	-0.023	-0.000
Probability of cluster	0.66	6.08	0.99	0.00
Pseudo – R^2	0.337			
Percent Correct	82.32			

Burglary results, DAs

Table 12. Multinomial logistic regression results, dissemination areas, burglary

	High-High	Low-Low	Low-High	High-Low
Population Change, %	***0.158***	-0.012	-0.004	-0.045
Males 15-24, %	-0.329	-0.181	-0.255	***0.379***
Recent Immigrants, %	0.020	***0.180***	0.010	***-0.079***
Ethnic Diversity	***0.152***	***-0.110***	0.033	***-0.040***
Unemployment Rate	***0.435***	0.022	***0.153***	-0.012
Dwelling Value, 000s	***0.016***	***0.007***	***-0.009***	***-0.009***
Major Repairs, %	0.096	***-0.244***	-0.040	-0.044
Probability of cluster	6.06	5.83	2.31	1.30
Pseudo – R^2	0.074			
Percent Correct	76.67			

Violent crime results, DAs

Table 13. Multinomial logistic regression results, dissemination areas, violent crime

	High-High	Low-Low	Low-High	High-Low
Males 15-24, %	-0.041	***0.719***	-0.115	-0.000
Single Parents, %	***-0.046***	0.280	-0.091	***0.000***
Ethnic Diversity	***0.008***	***-0.158***	0.020	-0.000
Unemployment Rate	***0.038***	***-0.299***	***0.066***	0.000
Average Income, 000s	***0.005***	0.032	0.008	-0.000
Population Density	***-0.001***	***0.002***	-0.000	***-0.000***
Dwelling Value, 000s	***-0.004***	***0.009***	-0.002	0.000
Rentals, %	0.003	***-0.125***	***0.017***	***-0.000***
Major Repairs, %	***-0.018***	-0.139	-0.012	-0.000
Probability of cluster	0.24	6.20	0.56	0.00
Pseudo – R^2	0.255			
Percent Correct	83.43			

Interesting results

- High and low crime areas
  - Different sets of independent variables
  - Magnitudes are different
- Low-low and low-high crime areas
  - Not all low crime areas are the same
  - Low-high crime areas are more similar to high crime areas than other low crime areas

Explanations

- High and low crime areas
  - When continuously measured
  - Estimated parameters are “averages”
- Low-low and low-high crime areas
  - Collective efficacy
  - Edges

Conclusions

- Continuous linear models are problematic
- Of limited value for understanding truly different contexts
- Current methodology leads to instructive results
- These instructive results are common sense

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