Beyond the Hotspot:
Exploring the impact of Land Use and Transportation Networks on the Spatial Crime Distribution

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Urban Development and Crime:

• Context:
  – Crime is not randomly distributed
  – The spatial distribution of crime is impacted by the built environment
    • Land use
    • Road networks
  – Local relationships are important
The Local Context

• Measures the impact of built environmental features on crime patterns
  – Locally-based
  – Looking beyond the site of the feature itself

• *Does crime also cluster around high-crime features?*

• *If so, how far?*
What has been done?


• Song et al. (2016). **Crime on the edges:** Patterns of crime and land use change. *CaGIS.*
Study Site & Data Sets

• Coquitlam and Port Coquitlam, BC
• Crime Data:
  – 2009 Crime Event Data for Coquitlam Detachment
  – n = 39,387 Records
  – Geocoded at 94% success rate
  – All points outside of Coquitlam and Port Coquitlam were excluded
  – All records relating to “founded” criminal code events were selected
  – Final dataset contains 12,786 records
Data Sets

• Land Use Data:
  – 2009 British Columbia Assessment Authority
  – Provided by Cities of Coquitlam and Port Coquitlam
  – Detailed data for every property in each city
  – $n = 59,711$ records, geocoded at 99% success
  – Data merged by address/land use
  – Final $n = 37,039$ including:
    • 1 Large Regional Shopping Centre and 7 Community-level Malls
    • 2 Hospitals
    • 65 Educational Institutions

Image: http://www.coquitlam.ca
Data Sets

• Road Network
  – GIS Innovations – 2008 data
  – 776 Kilometers of roads in Coquitlam & Port Coquitlam
    • 96 Kilometers of Arterial Roads; 99 Kilometers of Collectors
    • 60% of total road length classified as local roads

Image: http://www.coquitlam.ca
Coquitlam and Port Coquitlam: Land Use and Road Network, 2009

Land Use Category
- Residential
- Farm
- Commercial
- SOFA
- Industrial
- TCU
- CIR

Local Road Network
- Local Roads
- Major Roads
- Highways
- Freeways

Local Municipalities
- Coquitlam
- Port Coquitlam
- Neighbouring Cities

Projection: NAD 1983 UTM Zone 10N
Sources: Land Use: Cities of Coquitlam and Port Coquitlam, 2009
Boundaries and Roads: GIS Innovations, 2008; DMTI Spatial, 2006
K. Wuschke, 2016
Identifying Environmental Features

• Starting with the literature:
  – Crime patterns tend to concentrate around key features within the built environment:
    • Major Roadways
    • Major Nodes (Shopping Centres, Pubs, etc.)

• Looking Local:
  – Crime patterns vary from location to location
  – Important to identify which environmental features impact crime on a local level

Key reference: Kinney et al. (2009)
Image: http://www.coquitlam.ca
### Identifying Local Features

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Road Length (KM)</th>
<th>% Total Road Length</th>
<th>Count of Crime Events</th>
<th>% of Crime Events</th>
<th>Events/KM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial Roads</td>
<td>96.4</td>
<td>12.4</td>
<td>4541</td>
<td>35.5</td>
<td>47.1</td>
</tr>
<tr>
<td>Collector Roads</td>
<td>98.9</td>
<td>12.7</td>
<td>1911</td>
<td>15.0</td>
<td>19.3</td>
</tr>
<tr>
<td>Freeways</td>
<td>13.3</td>
<td>1.7</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Highways</td>
<td>34.1</td>
<td>4.4</td>
<td>266</td>
<td>2.1</td>
<td>7.8</td>
</tr>
<tr>
<td>Local Roads</td>
<td>461.1</td>
<td>59.4</td>
<td>6011</td>
<td>47.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Other Roads</td>
<td>72.2</td>
<td>9.3</td>
<td>57</td>
<td>0.5</td>
<td>0.8</td>
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<tr>
<td>Grand Total</td>
<td>776.0</td>
<td>100</td>
<td>12786</td>
<td>100</td>
<td>16.5</td>
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</tbody>
</table>
### Identifying Local Attractors

<table>
<thead>
<tr>
<th>Land Use Category</th>
<th>Units</th>
<th>% of All Units</th>
<th>Count of Crime Events</th>
<th>% of all Events</th>
<th>Records per 100 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>35342</td>
<td>95.4</td>
<td>5267</td>
<td>54.9</td>
<td>0.2</td>
</tr>
<tr>
<td>Commercial</td>
<td>981</td>
<td>2.7</td>
<td>3390</td>
<td>35.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Civic/Institution/Recreation (CIR)</td>
<td>507</td>
<td>1.4</td>
<td>897</td>
<td>9.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Farm</td>
<td>79</td>
<td>0.2</td>
<td>10</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Industrial</td>
<td>78</td>
<td>0.2</td>
<td>23</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Transportation, Communication, Utility (TCU)</td>
<td>49</td>
<td>0.1</td>
<td>6</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Stratified Facilities</td>
<td>3</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Grand Total</td>
<td>37039</td>
<td>100</td>
<td>9593</td>
<td>100</td>
<td>0.26</td>
</tr>
</tbody>
</table>

- Within these broad categories, several sub-types display higher crime rates:
  - Commercial: Shopping Centres (regional and community)
  - CIR: Schools, Hospitals
Crime Rates around Key Features

• With key built environmental features in hand (major roads, shopping centres, schools, hotels)
  – Create micro-buffers in 15 meter intervals
    • ArcGIS Network Analyst – Road Network based
  – Join crime event data to buffers
    • All events at site of feature itself are excluded
    • Results in a count of crime events at micro-distance intervals from features of interest
    • Rates standardized by total road distance

Key References: Groff (2011); Ratcliffe (2012)
Image: http://www.coquitlam.ca
Density of Crime Events by Distance From Malls - 15m Intervals

Distance from Malls - 15m Categories

- Crimes Against Persons
- Property Crimes
- Other Criminal Code Violations
- Drug Violations
- Other Federal Violations
- Traffic Offences

Events Per Kilometer of Road

Distance from Malls (in 15m intervals):
- 15
- 90
- 165
- 240
- 315
- 390
- 465
- 540
Density of Crime Events by Distance From Schools - 15m Intervals
Density of Crime Events by Distance From Hospitals - 15m Intervals

Distance from Hospitals - 15m Categories

- Crimes Against Persons
- Property Crimes
- Other Criminal Code Violations
- Drug Violations
- Other Federal Violations
- Traffic Offences
Discussion

• Macro – Meso – Micro level

• This method:
  – Identifies crime concentrations at micro areas beyond the key feature itself
  – Visualizes how these concentrations change across space
  – Emphasizes the different concentrations around different features
Reflections

• Emphasizes importance of micro-scale analysis
  – Benefits – increased detail and nuanced patterns
  – Drawbacks – increased variability

• Future Directions
  – Further distinction between crime types rather than broad categories
  – Explore patterns within other areas
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