GIS and Crime Mapping

Spencer Chainey
Director of Geographic Information Science
Introduction

• The role of ‘place’ in crime
• The principal spatial theories of crime
• Crime mapping in practice – five examples
  – Intelligence gathering
  – Performance review
  – Crime analysis
  – Criminal investigations
  – Targeting reassurance
• Research agenda
  – Beyond blobology
  – Publishing crime statistics to the public
  – Spatial significance
  – Spatial regression
  – Modelling and simulation
  – Crime prediction
The role of ‘place’ in crime

• Two key considerations
  • Crime has an inherent geographical quality
  • Crime is not randomly distributed
The role of ‘place’ in crime
Crime has an inherent geographical quality

• The four dimensions of crime
  • Legal (a law must be broken)
  • Victim (someone or something has to be targeted)
  • Offender (someone has to do the crime)
  • Spatial (it has to happen at a place - somewhere, in space and time)
The role of ‘place’ in crime

Crime is not randomly distributed

• If crimes were random
  – Equal chance of them happening anywhere at anytime
• But crime is not randomly distributed
• Concentrated into places of activity
  – Crime hotspots
• Series follow geographic patterns
  – Serious and volume crime
But why map it?

• Questioned as a “process that reveals what I already know”...
Example
A Crime and Disorder Reduction Partnership

Vehicle crime - 6% success rate
Routine Activity Theory
Cohen and Felson (1979)

- States that for a crime to occur, three elements must be present
  - Motivated offender + Vulnerable target/victim – the presence of a capable guardian
  - With the crime occurring in some ‘place’, in space and time
- Illustrated by the ‘Crime Problem Analysis Triangle’
- Helps to explain the interaction between offender and victim/target, and the influence of place
- And how we can address the problem
Crime Pattern Theory  
Brantingham and Brantingham (1982)

- **Personal activity space**
  - Nodes: where people live, work, shop or seek entertainment  
  - Paths: routes between nodes  
  - Creates an ‘awareness space’

- **Offender awareness space**
  - Opportunity space  
  - Victims/targets interaction with offender’s awareness space helps explain their risk to victimisation

- **Offenders are restricted in how they move around space**
  - ‘Least effort principle’
  - people will usually exert the minimum effort possible to complete their tasks  
  - shopping, performing recreational activities, visiting friends, traveling to work, and the journey to crime  
  - decay in the frequency of activity against distance  
  - meaning that offenders tend to travel short distances on average to commit their crimes
Crime Pattern Theory
Brantingham and Brantingham (1982)

• The distance decay function can though be different in shape and orientation to represent different types of offending behaviour
  – E.g. shopping trips can be divided into two general categories,
    • Convenience shopping: high frequency of short trips because people will tend to purchase items such as milk or a newspaper from the closest possible source
    • Comparison shopping: buyers are seeking more expensive items, looking for a wider range such as electrical appliances, designer fashion items, furniture, or cars.

• Distance decay difference - applied to crime
  – inquisitive criminal behaviour may be more frequent over shorter distances
  – organised and planned criminal behaviour may travel further distances to complete tasks.
Crime mapping ...

• “a progressive blend of practical criminal justice issues with the research field of geographical information systems and science” (Chainey and Ratcliffe, 2005)

• Exploits the inherent geographical quality of crime
  – Where do offenders live?
  – Where are the most vulnerable communities/targets located?
  – How do offenders travel to the crime location?
  – Why do crimes occur in one area and not another?
  – Where are our emerging problem areas?
Some examples
“Crime mapping technology has provided for an effective electronic mechanism that directly feeds into joint NIM control strategy and tactical processes” Inspector Mark Kenwood
Performance review

Thames Valley Police Performance Group (CompStat)
Going beyond the review of performance

- Non-analysts often interested in exploring beyond performance statistics
  - Often best placed to pose ‘testable ideas’ that the analyst can then explore
  - But need information systems/technology that suit this audience
- Easy to use, reward the user with the information they require within three mouse clicks, available on one page, encourages them to explore

<table>
<thead>
<tr>
<th>Ward</th>
<th>Burglary Sept06</th>
<th>Burglary Oct06</th>
<th>Burglary change</th>
<th>Robbery Sept06</th>
<th>Robbery Oct06</th>
<th>Robbery change</th>
<th>VAP Sept06</th>
<th>VAP Oct06</th>
<th>VAP change</th>
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<td>8</td>
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<td>-13%</td>
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<td>-29%</td>
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<td>2</td>
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<td>3</td>
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<td>Trinity</td>
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<td>25</td>
<td>4%</td>
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<td>12</td>
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<td>17</td>
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<td>5</td>
<td>-17%</td>
<td>5</td>
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<td>25%</td>
<td>12</td>
<td>14</td>
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<td>Southfields</td>
<td>18</td>
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<td>-11%</td>
<td>18</td>
<td>21</td>
<td>17%</td>
<td>6</td>
<td>7</td>
<td>17%</td>
</tr>
<tr>
<td>All Farthing</td>
<td>25</td>
<td>24</td>
<td>-4%</td>
<td>24</td>
<td>38</td>
<td>58%</td>
<td>52</td>
<td>67</td>
<td>29%</td>
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</tbody>
</table>
Crime analysis
Analysing vehicle crime in central London

“We think it relates mainly to local residents having their cars stolen at night” (The Police)

- Crime analysis involves breaking the problem apart and exploring the specifics of the problem
- We have a series of questions that we can turn into hypotheses
- Explore ‘place’ across these
- Helping to explain the problem
Victims
Theft of vehicles

Camden victims (58%)

Non-Camden victims (42%)
## Type of vehicles stolen

<table>
<thead>
<tr>
<th>Vehicle type description</th>
<th>Offences</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatchback</td>
<td>1258</td>
<td>21.7%</td>
</tr>
<tr>
<td>Saloon</td>
<td>1433</td>
<td>24.7%</td>
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<tr>
<td>Estate</td>
<td>220</td>
<td>3.8%</td>
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<tr>
<td>People carrier</td>
<td>45</td>
<td>0.8%</td>
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<tr>
<td>Convertible</td>
<td>120</td>
<td>2.1%</td>
</tr>
<tr>
<td>Sports</td>
<td>42</td>
<td>0.7%</td>
</tr>
<tr>
<td>4 X 4's</td>
<td>4</td>
<td>0.1%</td>
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<tr>
<td>Moped or scooter</td>
<td>1494</td>
<td>25.8%</td>
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<tr>
<td>Motor cycle</td>
<td>755</td>
<td>13.0%</td>
</tr>
<tr>
<td>Motor caravan</td>
<td>11</td>
<td>0.2%</td>
</tr>
<tr>
<td>Van</td>
<td>274</td>
<td>4.7%</td>
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<tr>
<td>Other</td>
<td>50</td>
<td>0.9%</td>
</tr>
<tr>
<td>Not known</td>
<td>23</td>
<td>0.4%</td>
</tr>
</tbody>
</table>
Theft of vehicles by time of the day

Place: space and time
So it’s not all to do with residents having their cars stolen at night …
Criminal investigations

Geographic profiling

• One of the biggest clues that an offender leaves behind when they commit a crime is where the crime happened
• Used to support an information management strategy for serial investigations
• Identifying the probable address of serial offenders
Criminal investigations
Geographic profiling

- 24 armed robberies 1995-2005
- 10 Police Forces
- 11,300 sq. miles
- 6.5 million people
- BBC CrimeWatch appeal
- Prioritising identity of suspects
Geographic profiling
High fear neighbourhoods
Reassurance targeting

- Geodemographic data linked to the British Crime Survey
- E.g. The relative likelihood of the resident population perceiving teenagers hanging around as a very big problem in Eccleshill, Bradford (Source: Ashby, Chainey and Longley, 2008)
The future – crime mapping research

• To date research has been limited to exploring the where and when
  – Identifying retrospective concentrations of crime in space and time, and treating space and time discreetly
• More robust treatment to the current techniques
  – E.g. kernel density estimation: influence of cell size and bandwidth
• Exploring space and time together
• Beyond blobology
• Publishing crime statistics to the public
• The significance of where and when (spatial significance)
  – E.g. understand how unusual the crime pattern is
• Why (spatial regression)
  – E.g. relationship between why crime happens where it does against other features
  – Not just as a global relationship but as a local relationship
• What if (spatial modelling)
  – E.g. if we target an intervention to a particular place what impact may it have, including displacement and diffusion of benefit effects
• Where and when will it happen again (predictive modelling)
  – Forecasting, early warning system, predictive crime mapping
Beyond blobology - defining hotspots

- Crime generators  
  - High volume, low rate
- Crime attractors  
  - High volume, high rate
- Crime enablers  
  - Low volume, low rate
Daytime pedestrian counts in London's West End.
Average pedestrians per hour (pph)
1. Leicester Square: 7500pph
2. Oxford Circus: 5500pph
3. Long Acre: 3000pph
4. Greek Street: 1000pph
5. Ramilies Street: 175pph
Beyond blobology - defining hotspots

Daylight robbery

Oxford Circus: crime generator

Scotland Yard: crime enabler

Daylight robbery rate
(by pedestrian population)
Beyond blobology - defining hotspots
Middlesbrough - Theft from shops
Beyond blobology - defining hotspots
Middlesbrough - Theft from shops

Crime attractor
(high vol; high rate)
Cause: attracts offenders
Response: discourage offenders

Crime enabler
(low vol; high rate)
Cause: Erosion of controls
Response: restore guardianship handling and/or place management

OS Address Layer ‘shops’ as the denominator
Neighbourhood crime stats for the public

• If we tell the public the facts about crime in their local area it will increase their fear of crime?
  “We don’t get the true picture, we want to know what’s really going on in our area, rather than just relying on stories from the press” West Yorkshire Resident

• The public perception of crime is often 10 to 100 times greater than actual crime levels

• Why is it important to provide the public with neighbourhood crime facts
  – support a positive reassurance message that addresses the public’s fear, worries and perceptions of crime.
  – demonstrate how the police and partners are performing
  – promotes transparency and accountability
  – improves the credibility of crime statistics
  – manages and supports public and media enquiries on crime statistics
  – supports a Police force’s and CDRP’s freedom of information obligations

• How do we provide them with the facts at the moment?
Essex, Gwent, Merseyside, North Wales, Nottinghamshire, Suffolk police forces
Durham police and South Wales police

- Don’t look at us – visit the Home Office website if you want crime stats ….
### SUMMARY OF NOTIFIABLE OFFENCES IN OXFORD: 1 APRIL - 31 MARCH 2005

<table>
<thead>
<tr>
<th>OFFENCES</th>
<th>FINALLY RECORDED</th>
<th>CRIMES PER 1000</th>
<th>POPULATION/HOUSEHOLD</th>
<th>CRIMES PER 1000</th>
<th>CLEARED UP</th>
<th>CRIMES PER 1000</th>
<th>CLEARED UP</th>
<th>CLEAR UP RATE</th>
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<tbody>
<tr>
<td>Burglary Dwelling and Assaulted Offences</td>
<td>1,276</td>
<td>1,250</td>
<td>982</td>
<td>24.5</td>
<td>20.4</td>
<td>19.5</td>
<td>14.42</td>
<td>23.2</td>
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<tr>
<td>Burglary Dwelling (Households)</td>
<td>1,077</td>
<td>1,236</td>
<td>984</td>
<td>23.4</td>
<td>19.7</td>
<td>18.5</td>
<td>13.22</td>
<td>21.2</td>
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<td>Burglary non Dwelling</td>
<td>1,107</td>
<td>1,317</td>
<td>943</td>
<td>4.7</td>
<td>3.1</td>
<td>2.6</td>
<td>2.60</td>
<td>4.6</td>
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<td>Burglary in Other Buildings</td>
<td>184</td>
<td>200</td>
<td>163</td>
<td>9.3</td>
<td>7.5</td>
<td>6.5</td>
<td>6.36</td>
<td>8.6</td>
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<tr>
<td>Vehicle Crime and Related Offences</td>
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<tr>
<td>Theft of Vehicle</td>
<td>796</td>
<td>781</td>
<td>744</td>
<td>5.4</td>
<td>5.1</td>
<td>4.9</td>
<td>3.76</td>
<td>5.1</td>
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<tr>
<td>Theft of Motor Vehicle</td>
<td>7,164</td>
<td>6,991</td>
<td>6,406</td>
<td>47.6</td>
<td>47.5</td>
<td>47.6</td>
<td>1,048</td>
<td>1,427</td>
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<tr>
<td>(Total Theft of and from)</td>
<td>3,496</td>
<td>3,432</td>
<td>3,137</td>
<td>25.8</td>
<td>25.4</td>
<td>25.6</td>
<td>25.2</td>
<td>25.4</td>
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<td>Vehicle-related Offences</td>
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<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
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<tr>
<td>Theft from Vehicles</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
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<td>Crime Damage to Vehicles</td>
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<td>1,116</td>
<td>1,095</td>
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<td>6.3</td>
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<td>Violent Crime</td>
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<td>Violence Against the Person (excluding Disorder)</td>
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<td>2,551</td>
<td>2,234</td>
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<td>18.7</td>
<td>19.6</td>
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<td>4,326</td>
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<td>Disorder (Public Order/Violent Disorder/Riot and Affray)</td>
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<td>234</td>
<td>203</td>
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<td>2.4</td>
<td>2.7</td>
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<td>Sexual Offences</td>
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<td>264</td>
<td>215</td>
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<td>3.4</td>
<td>2.4</td>
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<td>277</td>
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<td>Theft of Motor Vehicle</td>
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<td>391</td>
<td>379</td>
<td>2.5</td>
<td>2.4</td>
<td>2.4</td>
<td>2.9</td>
<td>391</td>
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<tr>
<td>Total Robbery</td>
<td>1,893</td>
<td>1,878</td>
<td>1,776</td>
<td>14.8</td>
<td>14.8</td>
<td>14.6</td>
<td>26.77</td>
<td>28.4</td>
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<tr>
<td>Total Violent Crime</td>
<td>3,488</td>
<td>3,223</td>
<td>3,177</td>
<td>15.0</td>
<td>16.3</td>
<td>15.6</td>
<td>26.77</td>
<td>28.4</td>
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<td>Robbery Business</td>
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<td>24.5</td>
<td>19.7</td>
<td>19.8</td>
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<td>Robbery Personal</td>
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<td>142</td>
<td>124</td>
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<td>15.6</td>
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<td>Snatch Theft</td>
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<td>10,533</td>
<td>10,533</td>
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<td>16.3</td>
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<td>16.75</td>
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<td>Drug Offences</td>
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<td>Drug Trafficking</td>
<td>36</td>
<td>48</td>
<td>52</td>
<td>29.9</td>
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<td>2.4</td>
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<td>Possession of Controlled Drugs (Excluding Cannabis)</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
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<td>Possession of Controlled Drugs (Cannabis)</td>
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<td>5</td>
<td>3</td>
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<td>Total Drug Crime</td>
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<td>59</td>
<td>63</td>
<td>6.3</td>
<td>6.5</td>
<td>6.5</td>
<td>6.3</td>
<td>6.3</td>
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<td>Total All Crime</td>
<td>36,566</td>
<td>21,904</td>
<td>21,449</td>
<td>22.7</td>
<td>21.9</td>
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<td>Other Incidents</td>
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<td>Domestic Incidents - Recorded Crime</td>
<td>836</td>
<td>858</td>
<td>1,108</td>
<td>9.8</td>
<td>12.3</td>
<td>13.3</td>
<td>9.24</td>
<td>10.3</td>
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<tr>
<td>Domestic Incidents - Non Recorded Crime</td>
<td>523</td>
<td>792</td>
<td>913</td>
<td>11.8</td>
<td>14.2</td>
<td>14.2</td>
<td>13.76</td>
<td>13.7</td>
</tr>
<tr>
<td>Non-accidental - Recorded Crime</td>
<td>23</td>
<td>32</td>
<td>42</td>
<td>22.5</td>
<td>2.2</td>
<td>2.2</td>
<td>2.0</td>
<td>1.7</td>
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<td>Non-accidental - Non Recorded Crime</td>
<td>37</td>
<td>38</td>
<td>46</td>
<td>3.0</td>
<td>3.2</td>
<td>3.2</td>
<td>2.92</td>
<td>2.9</td>
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<tr>
<td>Total Recorded Crime</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>8.5</td>
<td>8.5</td>
<td>8.5</td>
<td>8.0</td>
<td>8.0</td>
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<tr>
<td>Force target achieved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Force target not achieved</td>
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</tr>
</tbody>
</table>

Local Reduction Targets: Robbery 5%, Burglary Dwelling 5%, Vehicle Crime 10%.
Local Detection Targets: Robbery 20%, Burglary Dwelling 25%, Vehicle Crime 25%.

From April 2002 crimes recorded in previous years and no crimes in the current year is discounted from crime figures. This results in fewer crime and higher detection rates. This does not apply to historic data.

Source: EIS & CEDAR

London

www.met.police.uk/crimefigures/index.php

**LATEST CRIME FIGURES FOR WANDSWORTH**

**Key Initiatives**
- Safer Neighbourhoods officers inspected New Covent Garden Market and seized £140,000 worth of counterfeit DVDs, CDs and computer games, along with a firearm, saw and a knife.
- Wandsworth Police met with officers from Japan to discuss policing methods and how they serve their respective communities. The Japanese delegation were given a tour of the borough and Chief Inspector Derek Hamblard commented, "It is always interesting to hear how police services in other countries operate and both parties went away with good ideas."
- Superintendent David Stelling, who provided excellent service to the borough, has now moved to Brixton to train senior officers.

**Choose View:** Rolling 12 Month

<table>
<thead>
<tr>
<th>Select crime:</th>
<th>Burglary (Per 1000 Population)</th>
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<tbody>
<tr>
<td></td>
<td>Wandsworth Common</td>
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<tr>
<td>No. of crimes (12 Months to December 2005)</td>
<td>18</td>
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<tr>
<td>% change</td>
<td>-9.3%</td>
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**Description:**
Burglary is the theft or attempted theft from a building where access is not authorized. Damage to buildings that appears to have been caused by a person attempting to enter or commit a burglary is also counted in this category as a burglary. Residential and commercial burglaries are distinguished by the nature of the building. Click here for crime prevention advice.
Sussex

...15 clicks later
It’s easy to see what’s going on by just looking at the maps, much better to look at a picture like this than a load of statistics which I won’t understand”
West Yorkshire Resident

“In most cases, the incidence of offending is lower than people perceive and the effect is to reassure, rather than alarm the viewer”
West Yorkshire Police Authority
Significance? Where is something really usual occurring?

KDE

Gi*
Why? Spatial regression

- Geographically Weighted Regression: to see how crime varies over space in relation to the spatial distribution of searches (i.e. where are there more (or less) searches than we would expect in relation to the distribution of crime?)

The challenges of using Poisson distributed data
Where is it going to happen next?
Prospective mapping

- Research: properties within 400m of a burgled house are at an elevated risk for up to one month – ‘near repeats’ (Bowers et al, 2004)
  - Burglary patterns were similar to those of communicable diseases
  - Were measured using techniques that were developed for epidemiology
  - Adapted these techniques for prospecting where burglary would spread to
Predicting the future
Prospective mapping

- 35% more accurate than common hotspot mapping techniques for showing where crime would happen next (accuracy measure does account for differences in hotspot area)

Traditional hotspot mapping (KDE)  Prospective hotspot mapping
Summary

• Place is important
  – Plays a key role for helping to understand and tackle crime problems
• Crime mapping supports many forms of operational, tactical, investigative and strategic policing and crime reduction activity
• Still only scratching the surface in how we exploit the place dimension of crime
• “Crime mapping … has been fundamental in improving police performance in the West Midlands, and in recent months reducing all crime by 20%"

Assistant Chief Constable Nick Tofiluk
West Midlands Police
Thank you

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• My book …
• And my next book!
• Links to other publications