

Understanding hotspots

Spencer Chainey

Director of Geographic Information Science

UCL Jill Dando Institute 
of Crime Science

The logo for the Jill Dando Institute of Crime Science, featuring a stylized blue flower with five petals and a yellow center.

Understanding hotspots

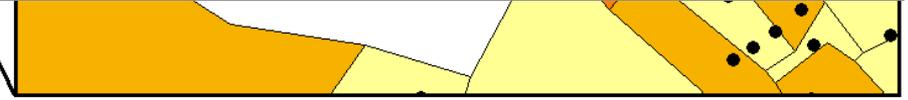
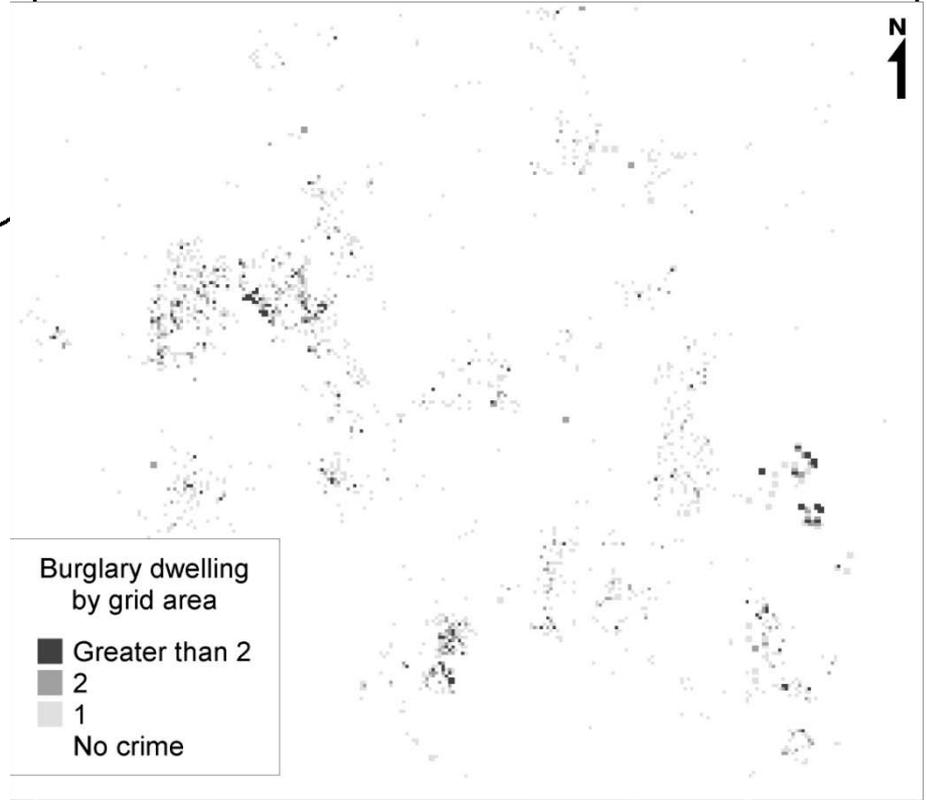
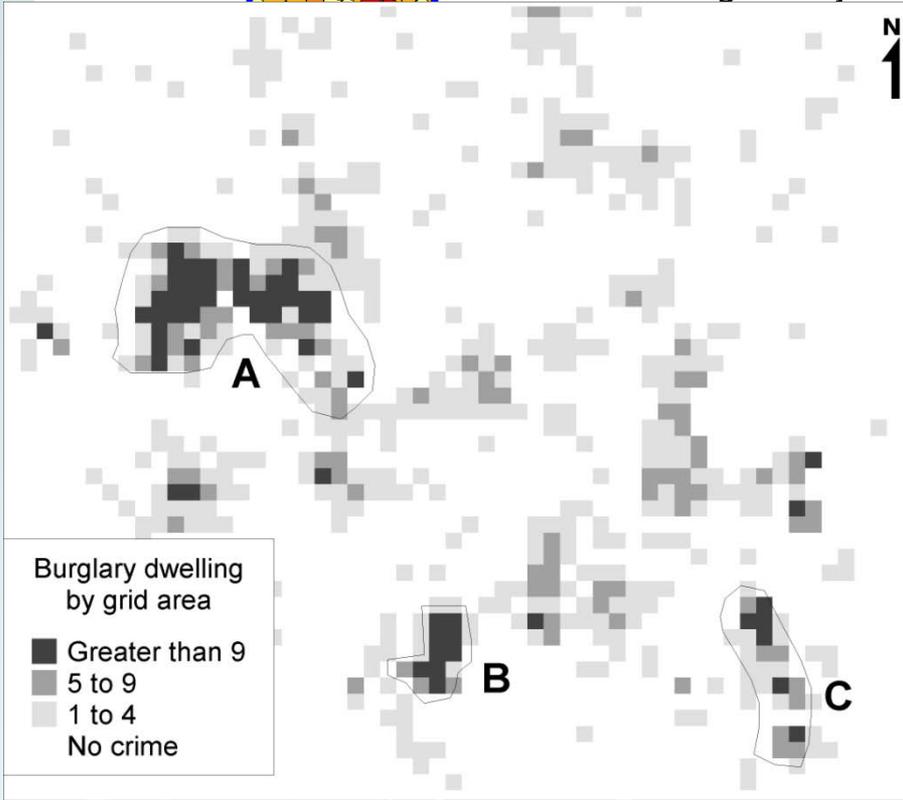
- Definition of a hotspot
- Hotspot mapping techniques
- Defining crime hotspots
- The next generation of hotspot mapping techniques ...

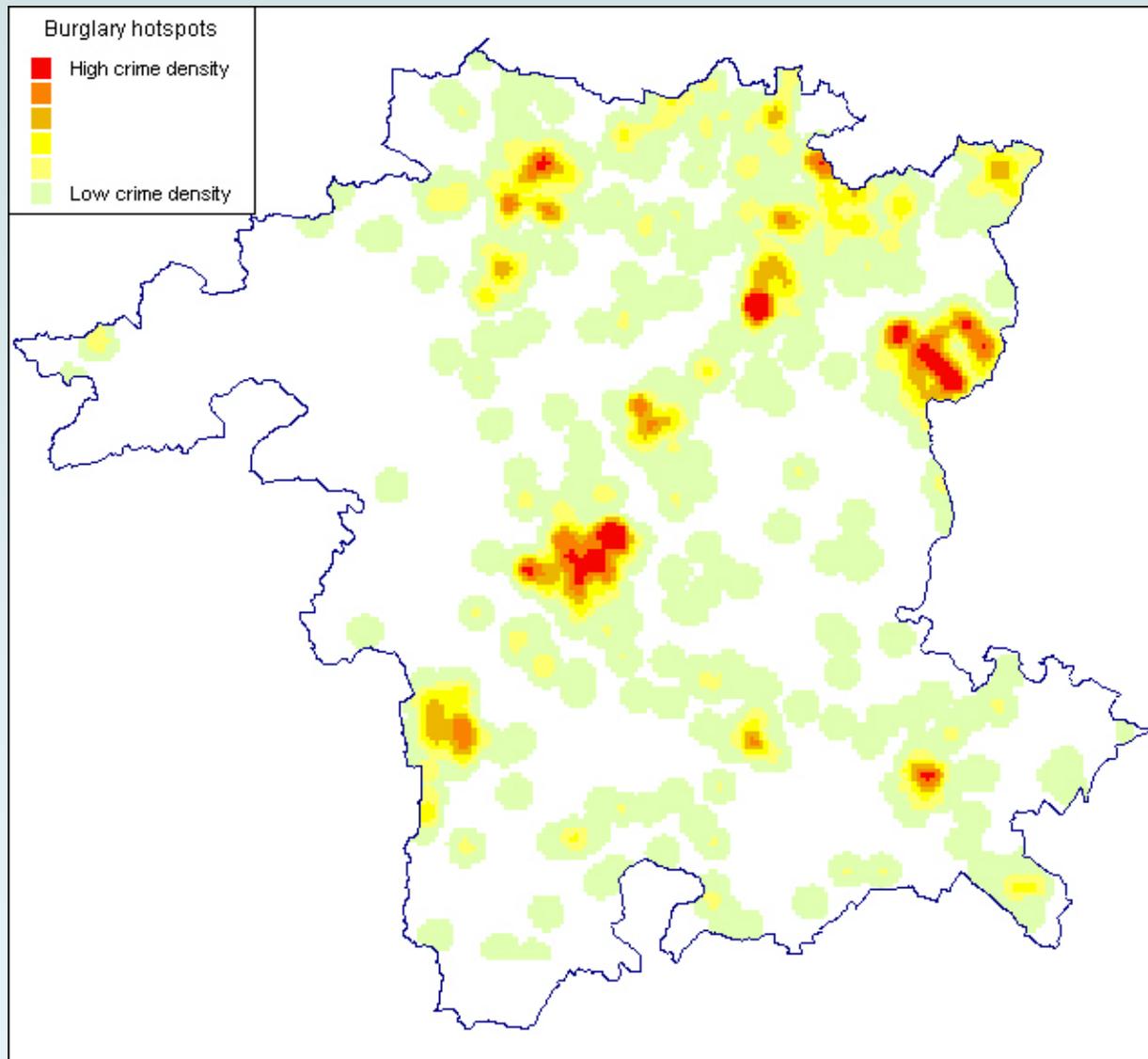
What is a hotspot?

- Geographical area of higher than average crime or disorder
 - Area of crime or disorder concentration, relative to the distribution of crime and disorder across the whole region of interest (e.g district, BCU)
 - Hotspots are areas of clusters of crime or disorder that can exist at different scales of interest

Residential burglary in the London Borough of Croydon.

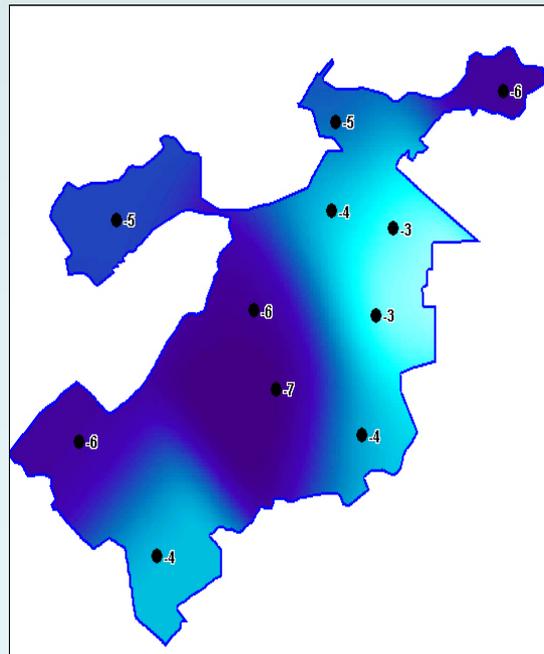
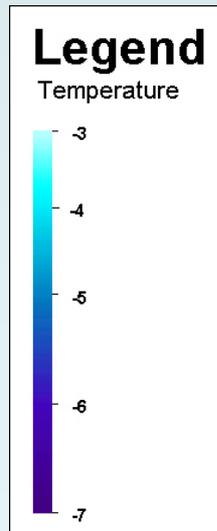
The size and shape of geographic areas when thematically mapped





Continuous surface smoothing

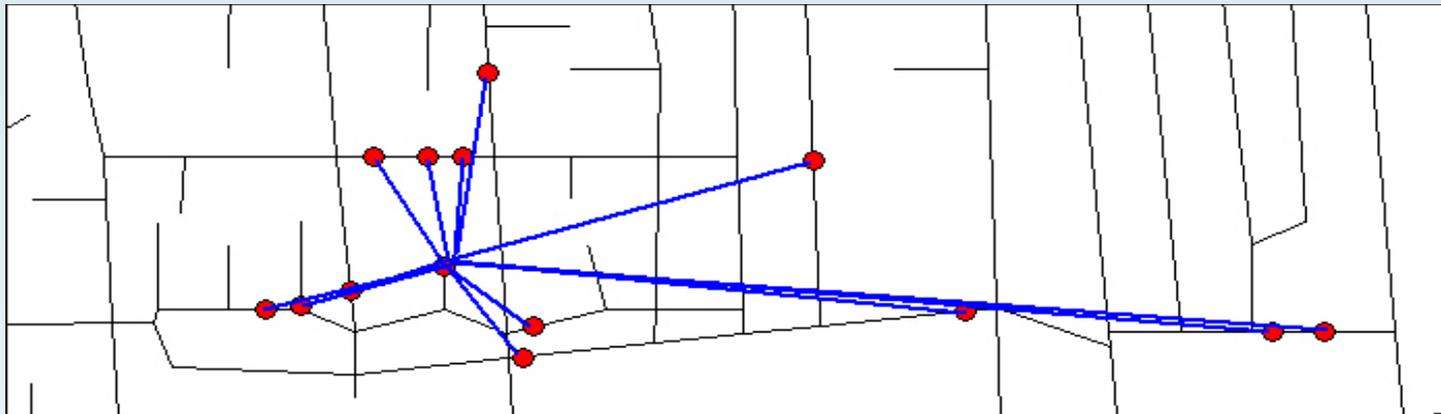
- Interpolation – estimate the value at unsampled locations based on the values at sampled locations



- Weather stations
- Temperature readings (intensity or z value)
- Temperature surface

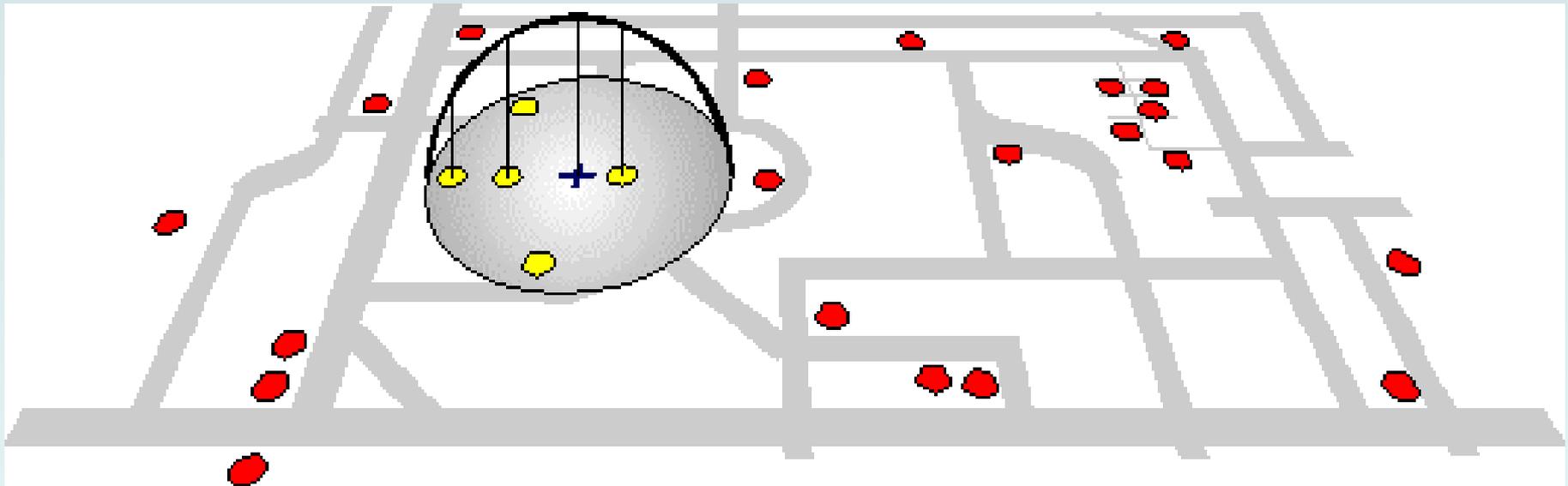
Continuous surface smoothing

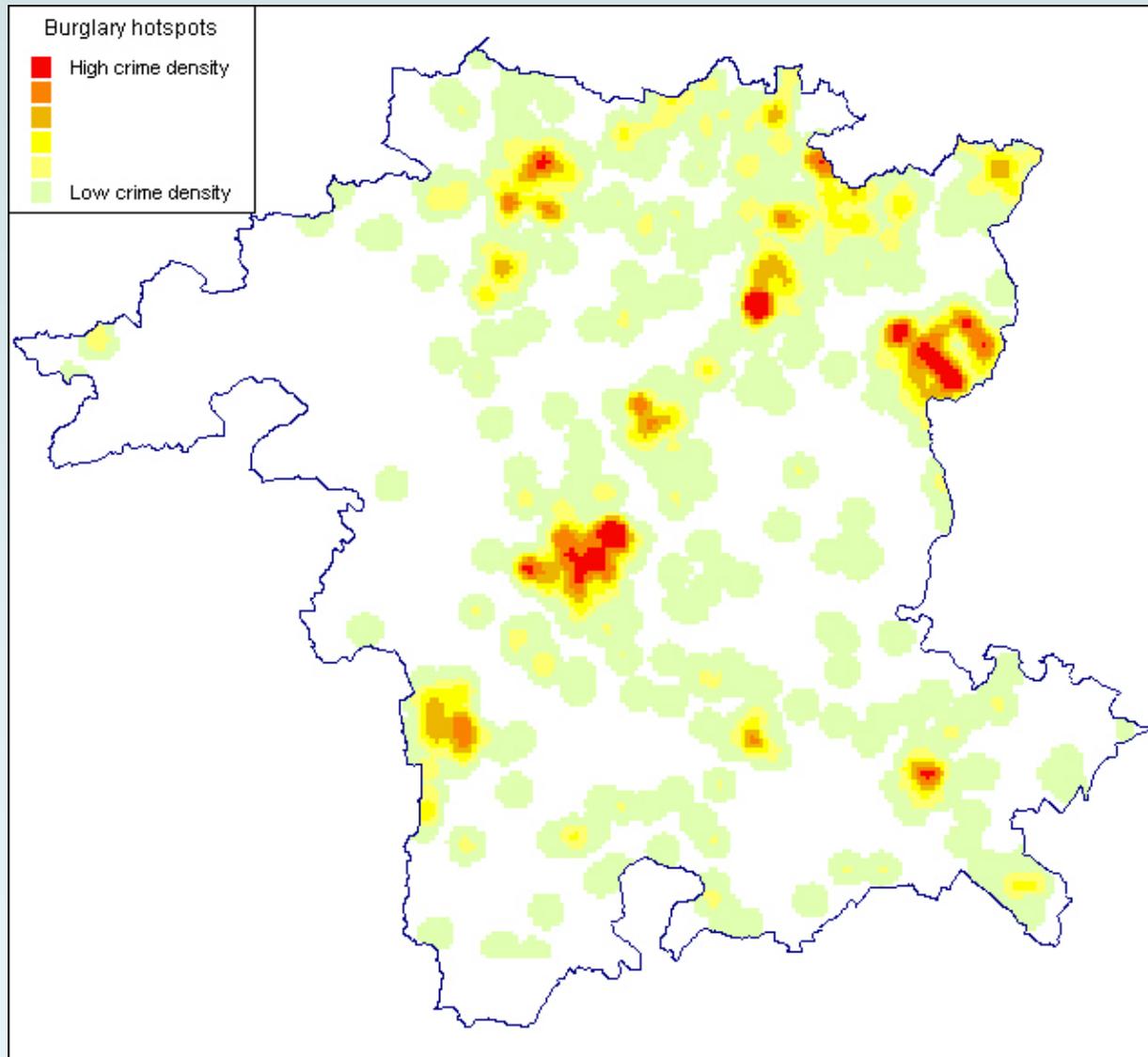
- Crime data
- “*estimate the value at unsampled locations based on the values at sampled locations*” – does not make sense



- Create a surface based on the distribution and density of our crime points

Kernel density estimation





Comparing KDE to other methods

- Results from research
 - Prediction Accuracy Index

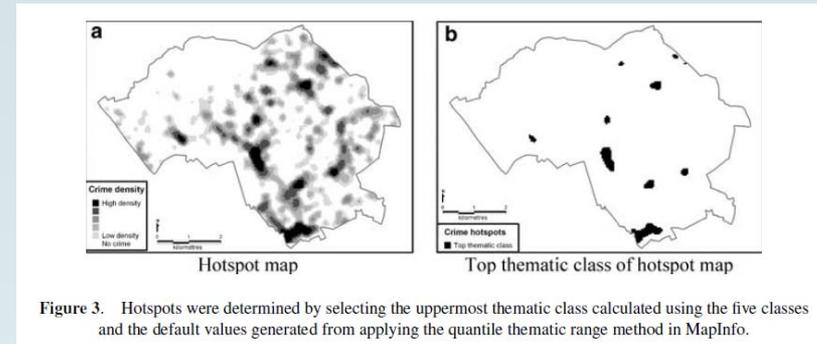


Table 6 PAI values for different hotspot mapping techniques

<i>Hotspot mapping technique</i>	<i>Average PAI (01/01/2003)</i>	<i>Average PAI (13/03/2003)</i>
Spatial ellipses 250 m	1.74	2.25
Spatial ellipses 500 m	<i>1.24</i>	<i>1.52</i>
Spatial ellipses HSD	1.69	2.03
Thematic mapping of output areas	1.91	2.38
Thematic mapping of grids 250 m	2.00	2.34
Thematic mapping of grids HSD	2.06	2.63
Kernel density estimation	2.90	3.41

Values in bold indicate the highest values and values in italics indicate the lowest PAI values. Results are presented for each of the dates when hotspot maps were generated. These results show that KDE consistently produced the best hotspot maps for predicting future events.

Comparing KDE to other methods

Table 7 PAI values for different hotspot mapping techniques, by crime type

<i>Hotspot mapping technique</i>	<i>Residential burglary</i>	<i>Street crime</i>	<i>Theft from vehicle</i>	<i>Theft of vehicle</i>
<i>(a) PAI values calculated from the 1 January 2003 measurement date</i>				
Spatial ellipses 250 m	1.38	2.36	2.18	1.65
Spatial ellipses 500 m	1.34	<i>1.46</i>	1.54	<i>0.82</i>
Spatial ellipses HSD	1.43	2.45	2.12	1.29
Thematic mapping of output areas	<i>1.10</i>	4.20	<i>1.17</i>	1.18
Thematic mapping of grids 250 m	1.70	4.04	1.82	1.37
Thematic mapping of grids HSD	1.68	3.46	2.12	2.06
Kernel density estimation	2.31	4.68	2.29	2.32
<i>(b) PAI values calculated from the 13 March 2003 measurement date</i>				
Spatial ellipses 250 m	1.32	2.59	2.15	2.93
Spatial ellipses 500 m	1.31	<i>1.40</i>	<i>1.55</i>	1.82
Spatial ellipses HSD	1.29	2.63	2.63	<i>1.59</i>
Thematic mapping of output areas	<i>1.25</i>	3.32	2.93	2.01
Thematic mapping of grids 250 m	1.67	3.58	2.43	1.66
Thematic mapping of grids HSD	1.95	4.14	2.55	1.89
Kernel density estimation	2.33	4.59	3.66	3.05

Values in bold indicate the highest values and values in italics indicate the lowest PAI values. These results show that KDE consistently produced the best hotspot maps for predicting spatial patterns of crime for all crime types, and that in some cases STAC was not the worst performer. Instead, thematic mapping of output areas generated the lowest PAI values for residential burglary, and in one case for theft from vehicles.

Comparing KDE to other methods

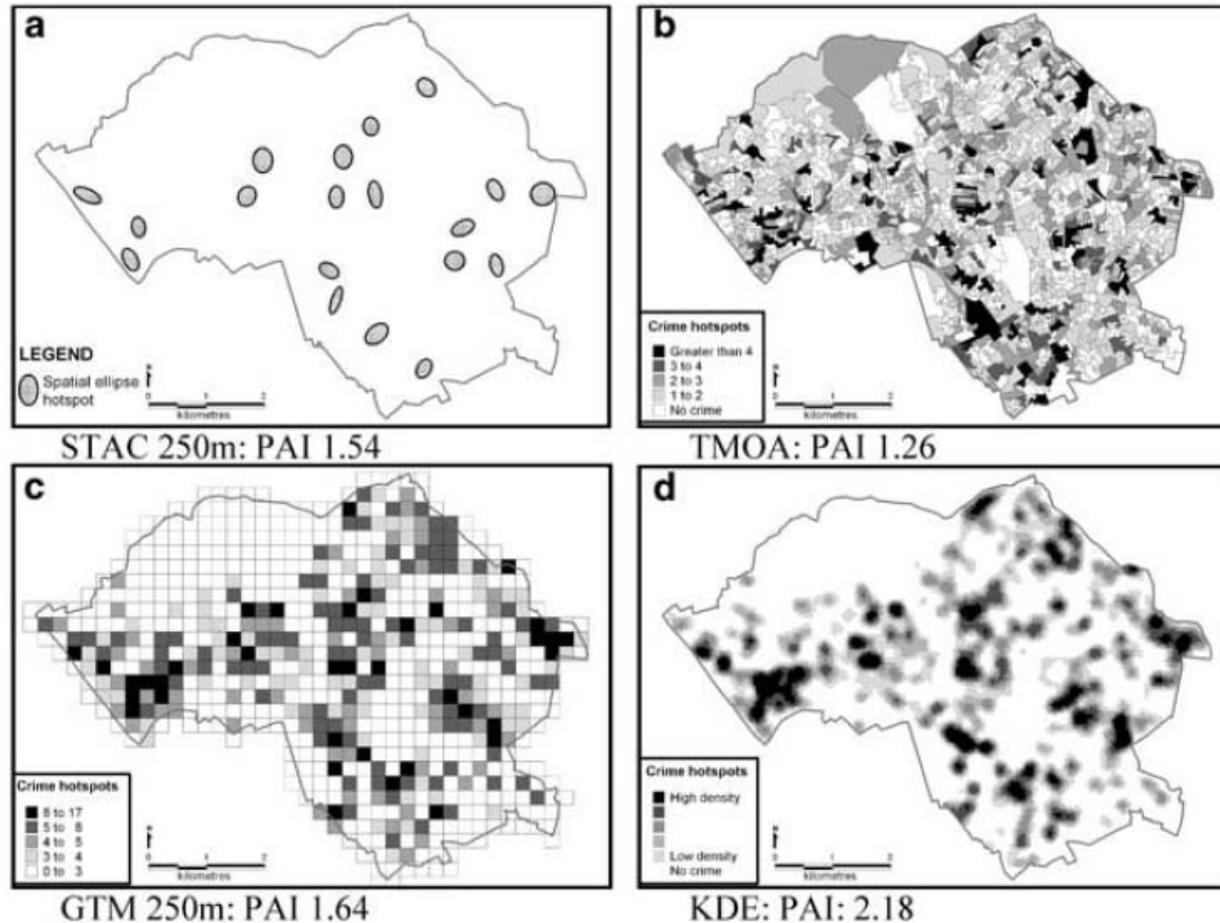
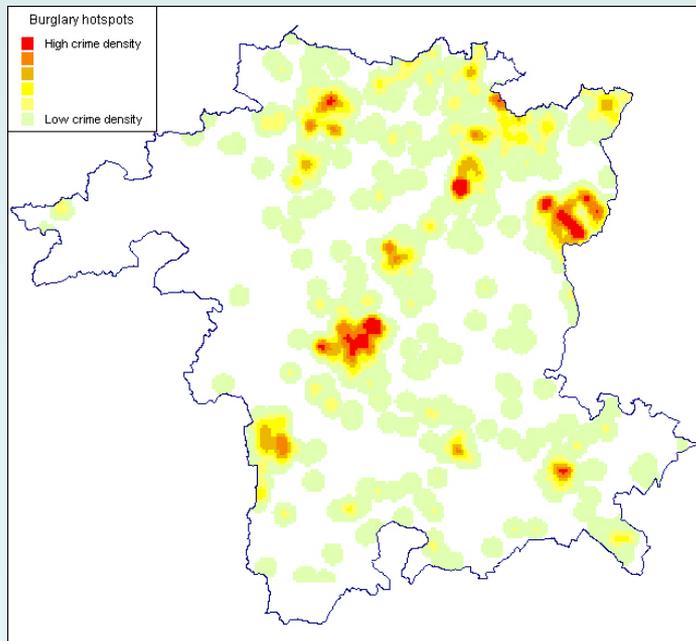


Figure 4. Hotspot maps generated from 3 months of residential burglary input data (measurement date of the 1 January 2003) using (a) STAC, (b) thematic mapping of output areas, (c) grid thematic mapping and (d) KDE. Each map is shown with its PAI value, based on 1 month of measurement data.

Defining hotspots

- Crime generators
- Crime attractors
- Crime enablers



Defining hotspots

- **Crime generators**
 - Where people congregate
 - **Place:** Lots of people
 - **Offenders:** Lots of opportunities
 - **Victims:** Lots of unprotected targets
 - Examples: Shopping malls, transport hubs



Defining hotspots

- **Crime attractors**
 - Where specific opportunities or crime services exists
 - **Place:** Well known for particular opportunities
 - **Offenders:** Good reputation for success
 - **Victims:** Fit the profile of the particular opportunity
 - Examples: Street prostitution, drug areas, robbery



Defining hotspots

- **Crime enablers**
 - **Place:** Where there is little regulation of behaviour
 - **Offenders:** Easy to carry out their actions, rules of conduct are absent or not enforced
 - **Victims:** Isolated or exposed
 - Examples: Car parks, park pavilions, back seat of the bus



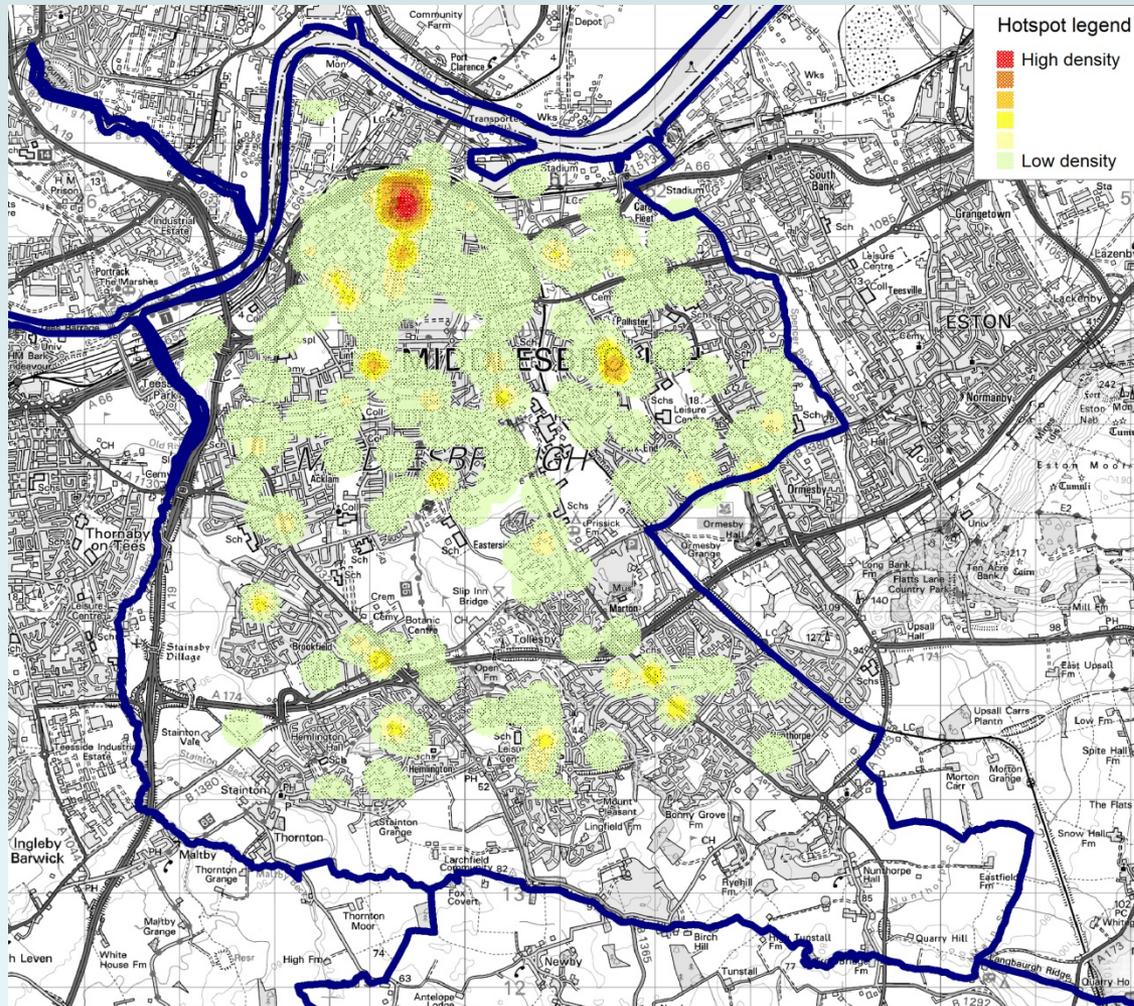
Defining hotspots

- How do you distinguish between different types of hotspots?

	Number of crimes	Rate
Crime generators	HIGH	LOW
Crime attractors	HIGH	HIGH
Crime enabler	LOW	HIGH

Defining hotspots

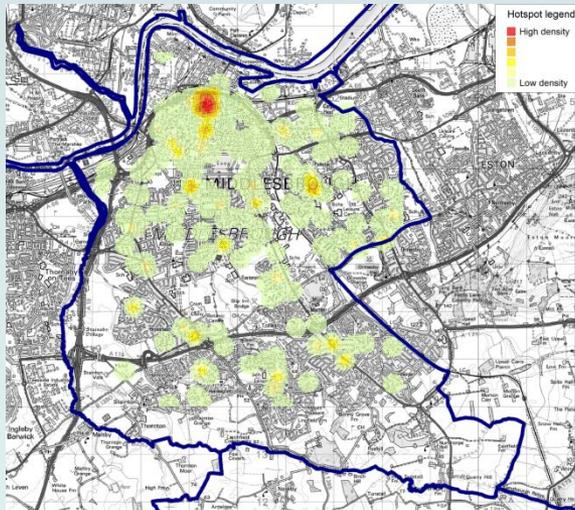
Middlesbrough - Theft from shops



Defining hotspots

Middlesbrough - Theft from shops

OS AddressPoint 'shops' as the denominator

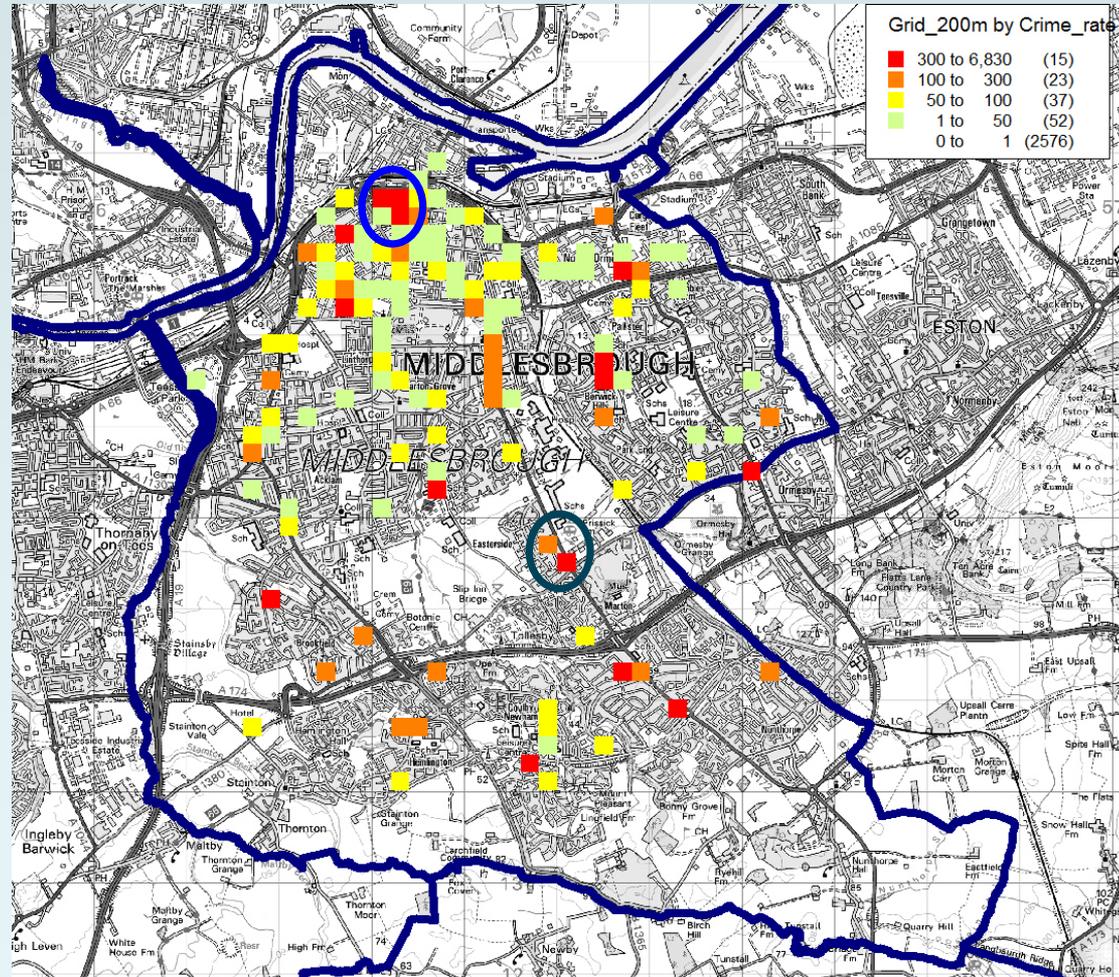


Crime attractor

(high vol; high rate)

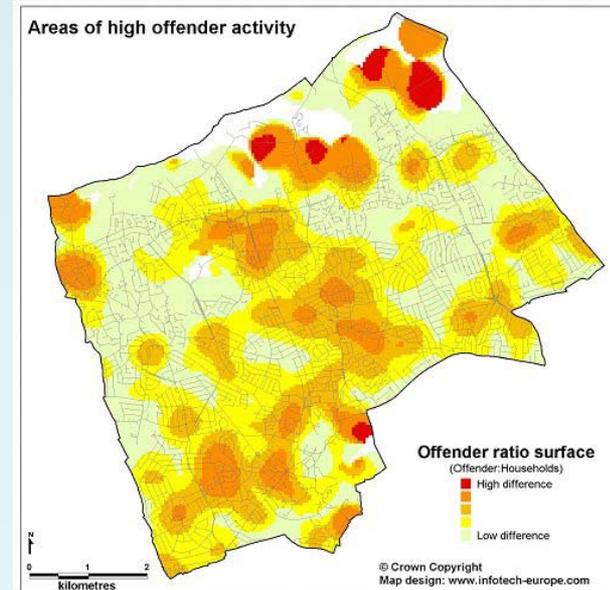
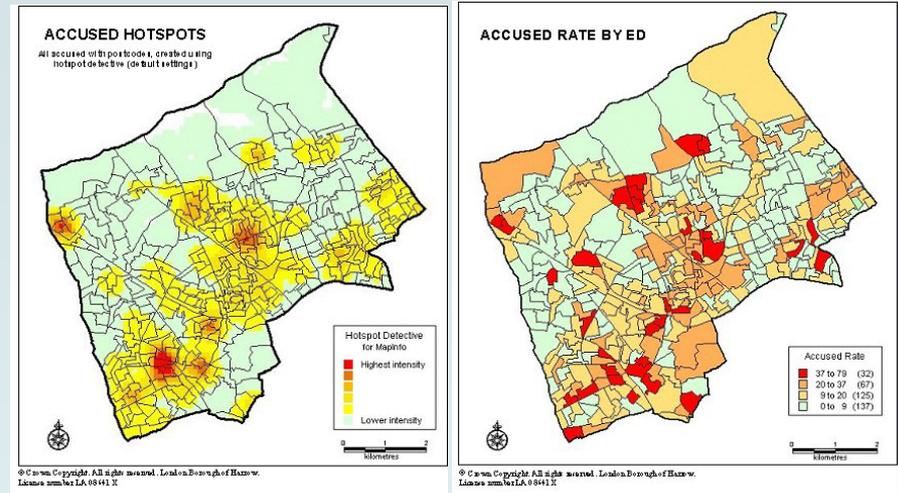
Crime enabler

(low vol; high rate)



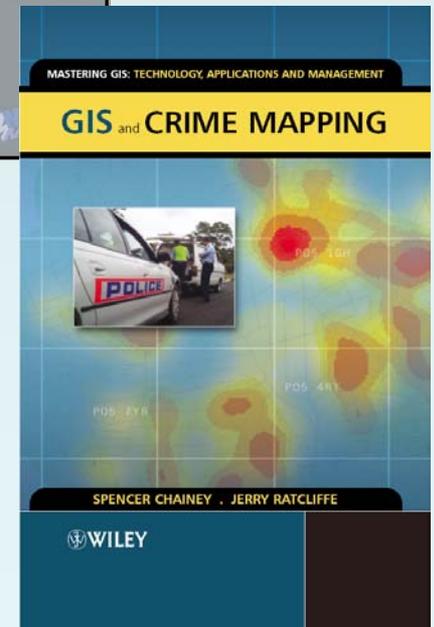
The next generation of techniques

- Spatial significance testing
 - Identify what really is hot
 - **Thursday: Spatial significance mapping**
- Generating rate maps not constrained to artificial boundaries (i.e. Considers underlying population as points rather than aggregated to a geographic unit)
 - E.g. Dual KDE and GAM/K
- Integrating temporal component to hotspot analysis
 - Not Knox and Mantel! – only tells you something interesting has happened in space and time, but not where or when ...!
 - Where and when were there crime concentrations that were significant - see work by Renato Assunção and Martin Kulldorf
- Whilst all hotspot maps look at the past, provides one of the best methods for predicting the future



Where can I get more details?

- ***Understanding hotspots*** (2005), Eck, Chainey, Cameron, and Wilson. US NIJ free publication
- ***GIS and Crime Mapping*** (2005), Chainey and Ratcliffe
- Chainey, S.P., Tompson, L., Uhlig, S. (2008). ***The utility of hotspot mapping for predicting spatial patterns of crime.*** Security Journal



Summary

- Lost of different techniques
 - Some are better than others
 - Accuracy and visual presentation: KDE
- KDE: still only describes a pattern
 - Next step involves understanding why there is a hotspot
 - Defining the hotspot is a useful step forward in helping to do this
- Need to begin to consider other techniques that provide an extra, more robust dimension:
 - Spatial significance mapping: Thursday
 - Space and time

Thankyou

Contact details.

Spencer Chainey

Director of Geographic Information Science

The Jill Dando Institute of Security and Crime Science

University College London

Brook Street

London.

WC1E 7HN

W: www.ucl.ac.uk/jdi

E: s.chainey@ucl.ac.uk