Modern trends in crime mapping and analysis

Petr Kubíček

kubicek@geogr.muni.cz

Laboratory on Geoinformatics and Cartography (LGC)
Institute of Geography
Masaryk University
Czech Republic

Subject plan

- 3 sessions dealing with:
  - English.
  - Current trends in crime mapping and analysis.
  - Scientific writing principles.
  - Practical exercises.
  - Team work.
  - Resulting in EN journal article.
- **April 3rd, May 15th (??) – negotiable, let me know ASAP.**

CRIME MAPPING AND ANALYSIS

The role of 'place' in crime

Two key considerations (Spencer Chainey)

- Crime has an inherent **geographical quality**
- Crime is **not randomly distributed**

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).

Crime is not randomly distributed

If crimes were random:

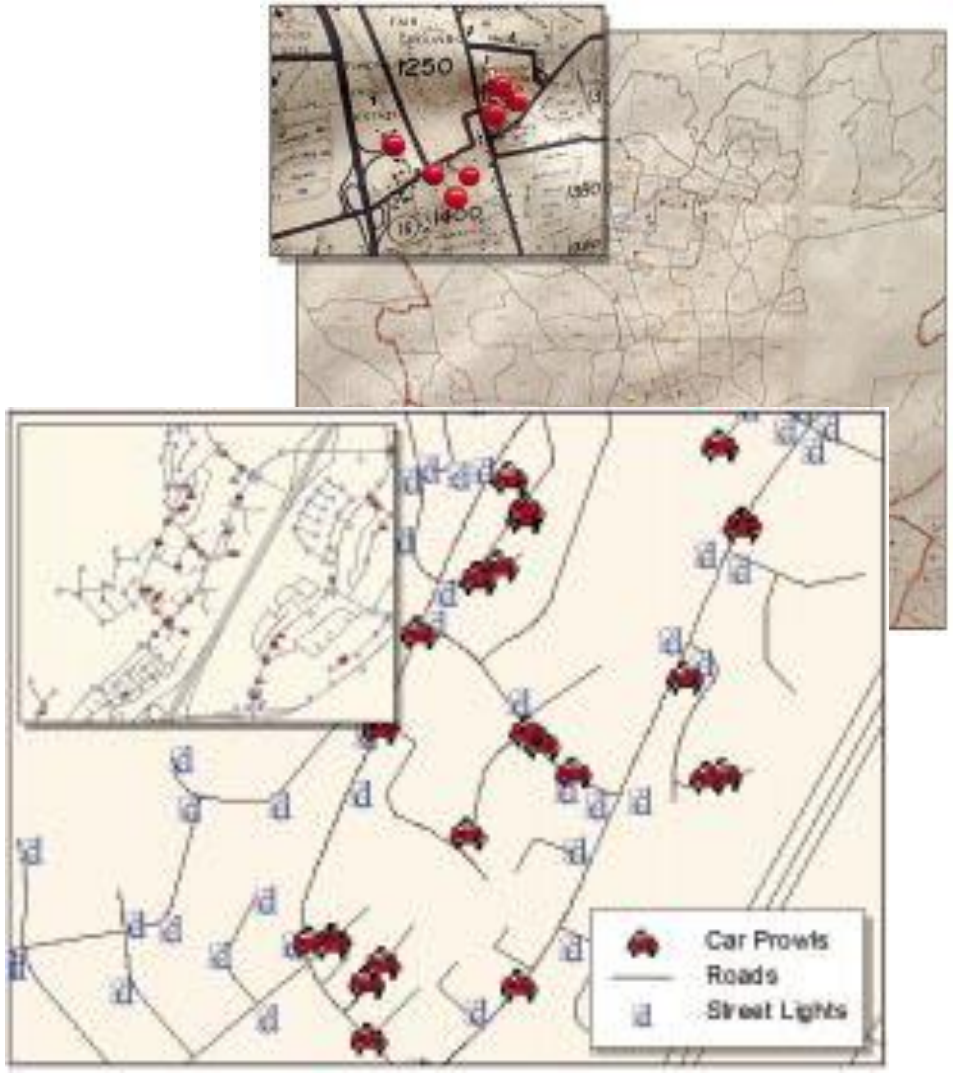
– Equal chance of them happening anywhere at anytime.

But crime is not randomly distributed

- Concentrated into places of activity
  - Crime hotspots
- Series follow geographic patterns
  - Serious and volume crime

Where it all has begun?

- From pin maps to virtual pin maps.
- Space and time limitations and overlaps.
- Crime typology problems.



Current use of GIS in police practice

Logistics

- Manage CCTV locations
- Vehicle Routing
- Case Workload Management
- Fleet Management
- Re-Districting

Planning & Analysis

- Crime Hotspot Analysis
- Special Event Planning
- Critical Infrastructure Pre-Plans
- Grant Applications
- Predictive Analysis

Field Operations

- Field Interviews
- Tactical Planning
- Location-Based Alerting
- Investigative Support
- Real-Time Info

Operational Awareness

- Visualize Real-Time Data
- Dashboards
- Conducting Briefings
- Evaluating Effectiveness
- CompStat

Public Information

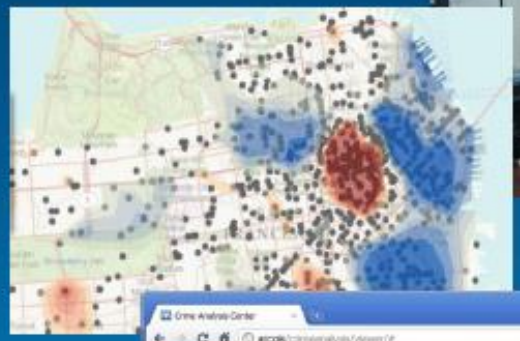
- Public Event Maps
- Quality of Life Complaints
- Crime Tips
- Public Crime Mapping
- Major Case Story Maps
- Social Media Monitoring

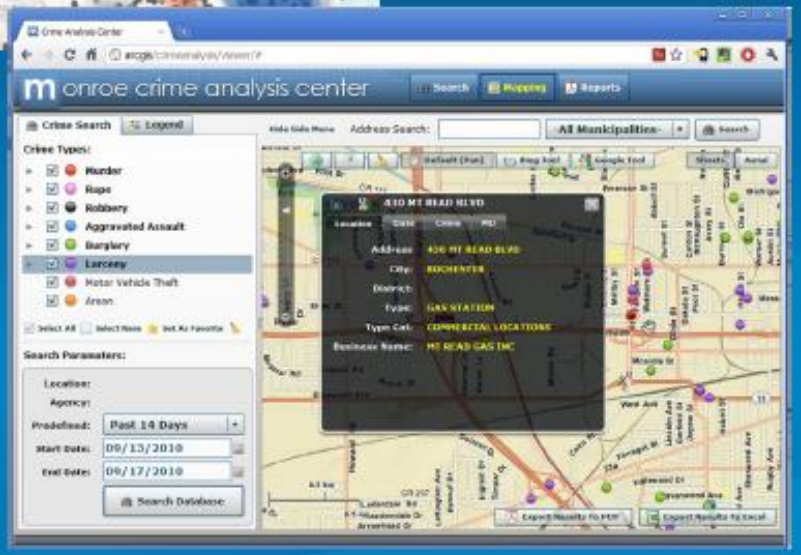
Analysts/GIS Staff

- **What do they do?**
  - Data management
  - Analyzing data
  - Creating analytic products
  - Identifying crime hotspots
  - Predicting future crime trends

- **What kinds of maps are needed?**
  - Easy to read- limited geographic detail
  - "What's hot"
  - Augment officer experience
  - Identify targets
  - Where to spend proactive time
  - Routing/Directions
  - Base map Imagery

  - Do they even need maps? Does GIS have to be maps?

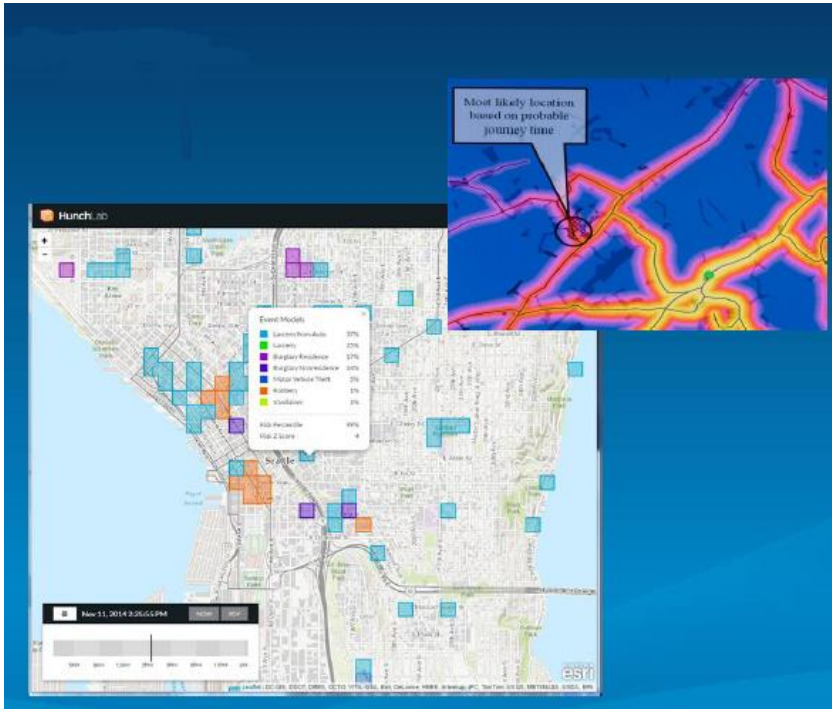




Major GIS Trends in Law Enforcement

Predictive Policing

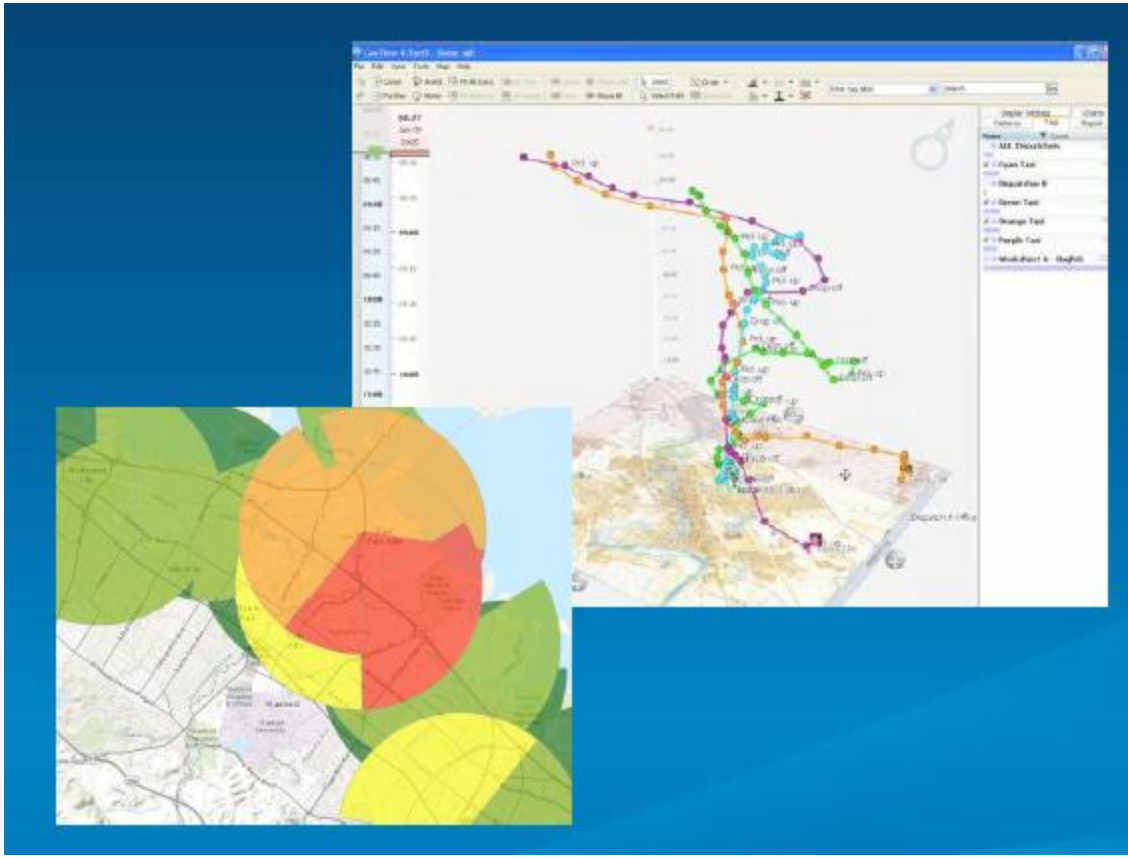
- **Geographic Profiling**
- **Temporal patterns**
- **Weather**
- **Risk-Terrain Modelling**
- **Socioeconomic Indicators**
- **Near-Repeat Patterns**



Major GIS Trends in Law Enforcement

Analysis of Cell and GPS Data

- **Locate cell tower sites**
- **Associate call detail records with tower sites**
- **Determine which tower and sector a specific cellular number passed through.**



Major GIS Trends in Law Enforcement

Enhanced Mobility

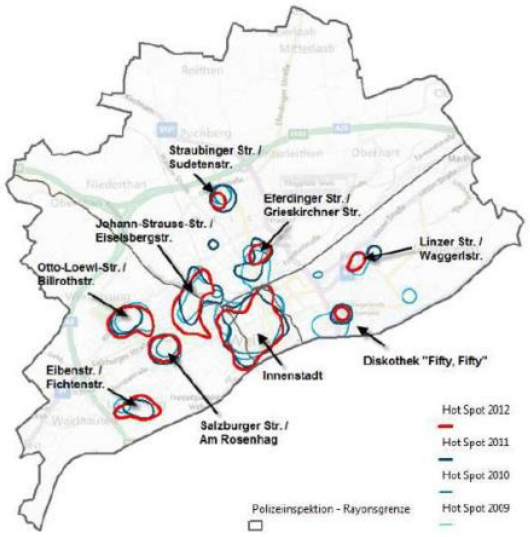
- Maps are now available anywhere on any device
- Can be used in connected or disconnected environments
- Data can be shared from the control room to police in the field in real-time – operational situational awareness.

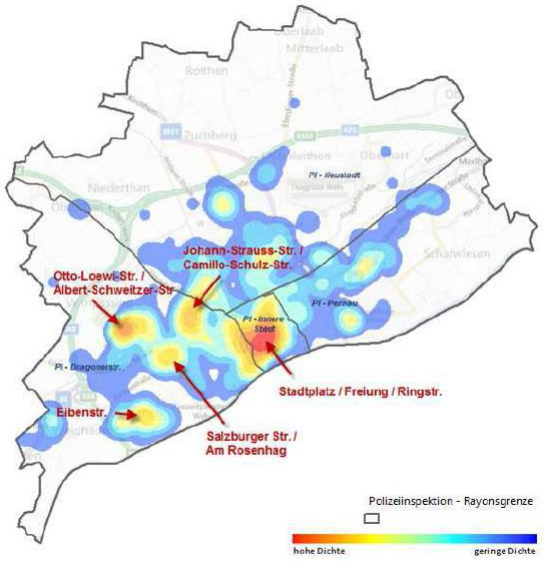
Topics to be covered in a detail

- Hot spot analysis
- Near repeat victimisation
- Risk Terrain mapping principles

Hotspot Mapping

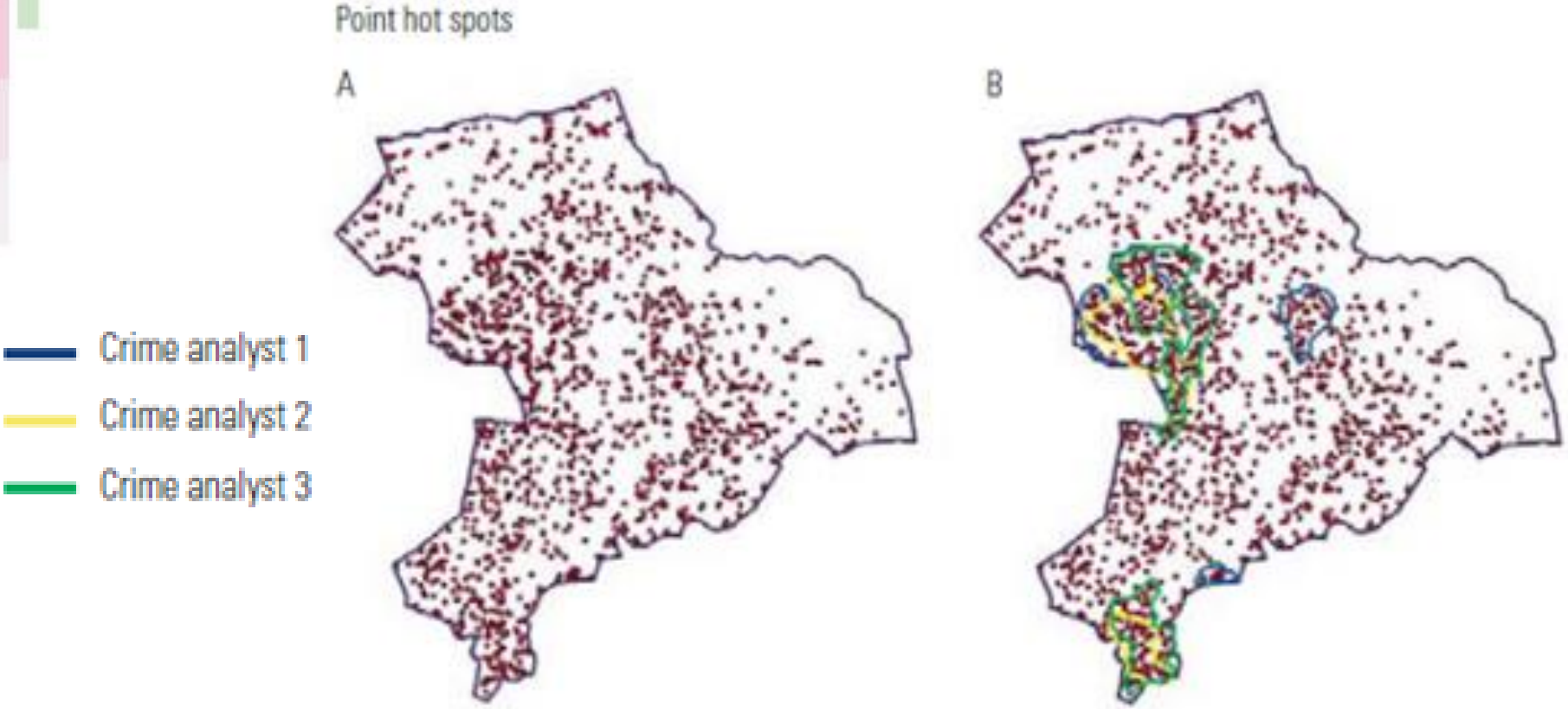
- Areas with high concentrations of crime.
- Sherman (1995) defined hot spots "as small places in which the occurrence of crime is so frequent that it is highly predictable, at least over a 1-year period."
- HM uses locations of past events to anticipate locations of future similar events.





Crime mapping techniques - Point mapping

- The most common approach for displaying geographic patterns of crime is point mapping
- Interpret spatial patterns and hot spots in the crime point data can be difficult .

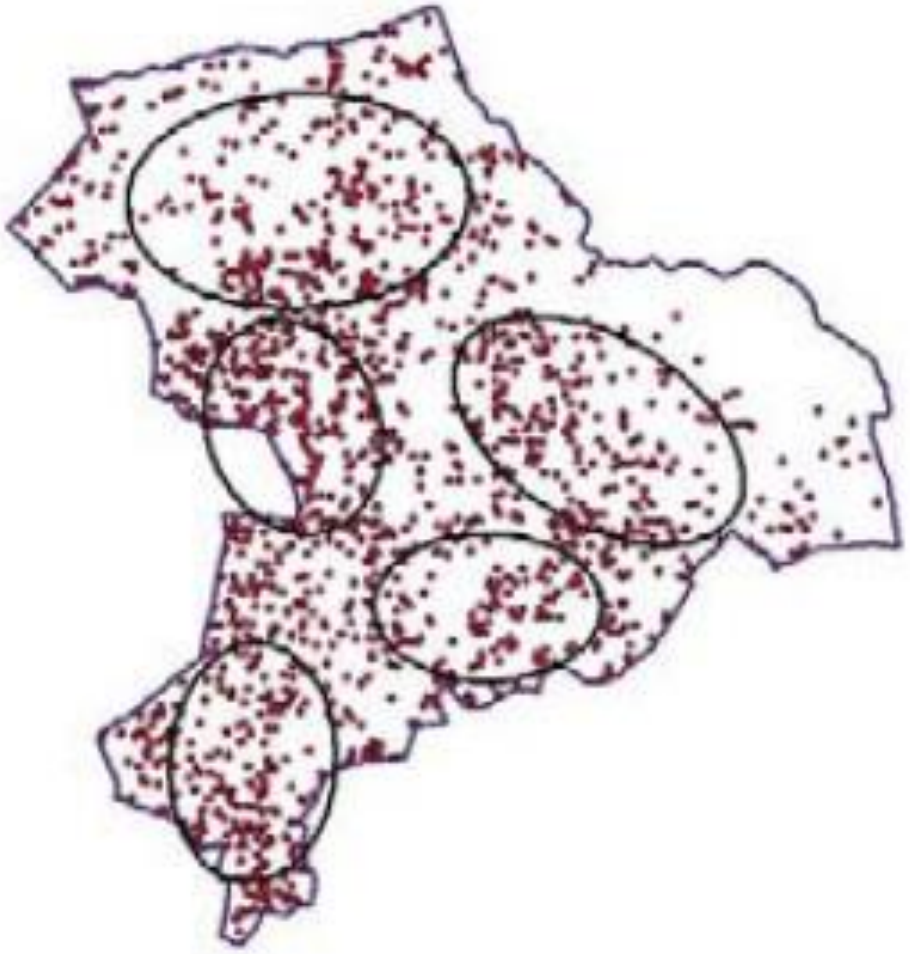


Point and graduated symbols

- Point maps do have their application for:
  - mapping individual events of crime,
  - small volumes of crime,
  - and repeat locations through the use of graduating symbol sizes
- less effective for identifying hot spots of crime, particularly from large data volumes.

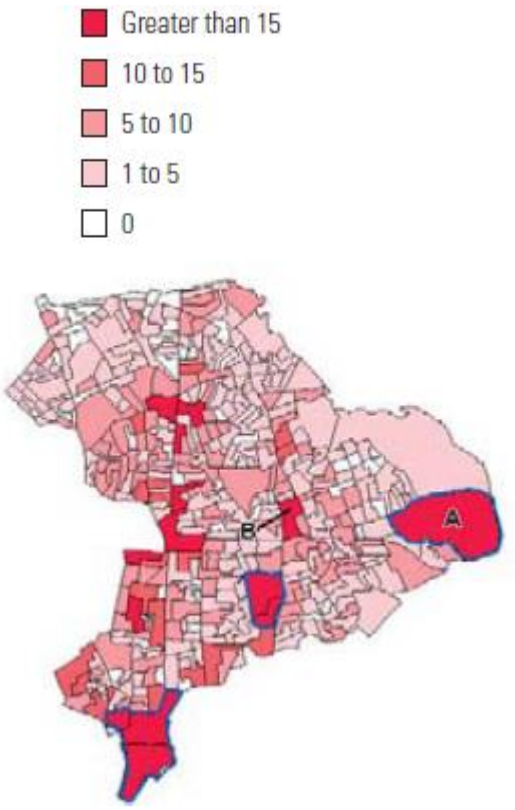
Spatial ellipses

- **SW based spatil clustering**
- Creating standard deviational ellipses around **crime point clusters.**
- spatial ellipse techniques using **hierarchical clustering** and the **K-means clustering** routine.
- Plausible for Hot spot areas **identification**.
- However, **no prioritization**the main crime hot spots to assist in **prevention targeting**.



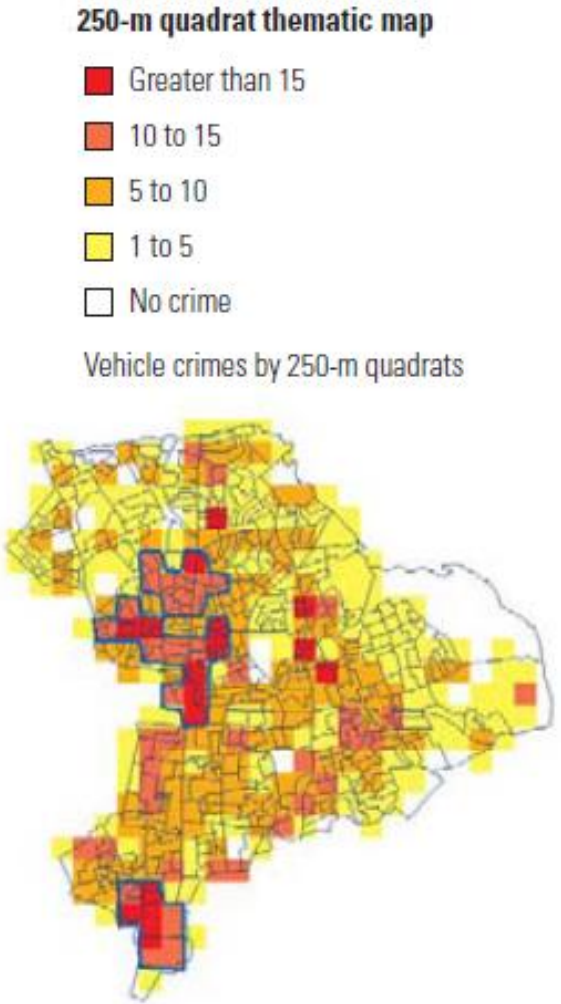
Thematic mapping of geographic boundaries

- A popular technique for representing any spatial distribution .
- Geographic boundaries usually are defined administrative or political areas such as census blocks, polling districts, wards, or borough boundaries.
- Due to the **varying size** and shape of most geographic boundaries, thematic shading can **mislead** the audience in identifying where **the spatial cluster of crime** may exist.



Quadrat thematic mapping – raster based analysis

- **Use of uniform grid.**
- Thematic value:
  - a count of crimes per grid cell - SUM.
  - a density value calculated from the count and cell area.
- Uniformity - **loss of spatial detail** within each quadrat and across quadrat boundaries. This can lead to **problems of inaccurate interpretation**.

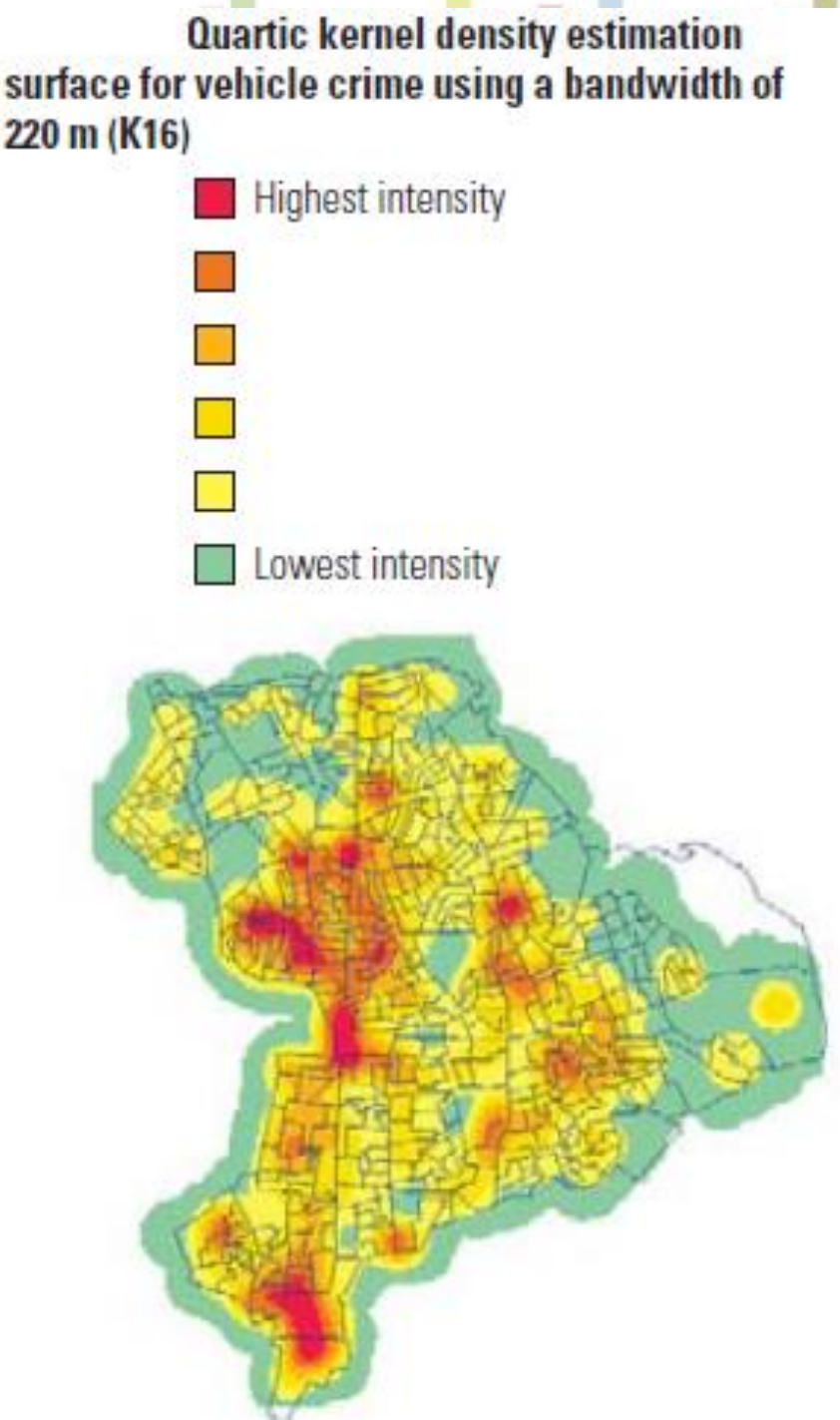


Interpolation and continuous surface smoothing methods

- **IDW, kriging, spline?? Non-continuous crime surface!**
- surfaces that represent the distribution of crime should act as visualizations for helping them **understand crime patterns**.
- Methods that suit the analysts' application should therefore represent, as a continuous surface, **the relationships or densities between crime point distributions.**
- **The quartic kernel estimation** method requires two parameters to be set prior to running. These are the **grid cell size** and **bandwidth** (search radius).
- **Bandwidth** is the parameter that will lead to most differences in output when varied.
- **Guidelines** exist for working out suitable values for these two parameters.

Quartic kernel density Hot spot

- **Continuous surface hot spot maps :**
- Allow **easier interpretation** of crime clusters
- reflect more accurately the **location and spatial distribution of crime hot spots.**



Variations in time

- Each hot spot map considered in this lecture accounts only for a **specific snapshot period** in time.
- New areas of research are beginning to **explore space-time interaction** .
- These methods aim to reveal whether certain types of crime display temporal hot spots in particular areas (e.g., crime **hot spots that emerge only on certain days of the week**).
- The creation of **crime hot spot animations** to visualize space and time interaction.

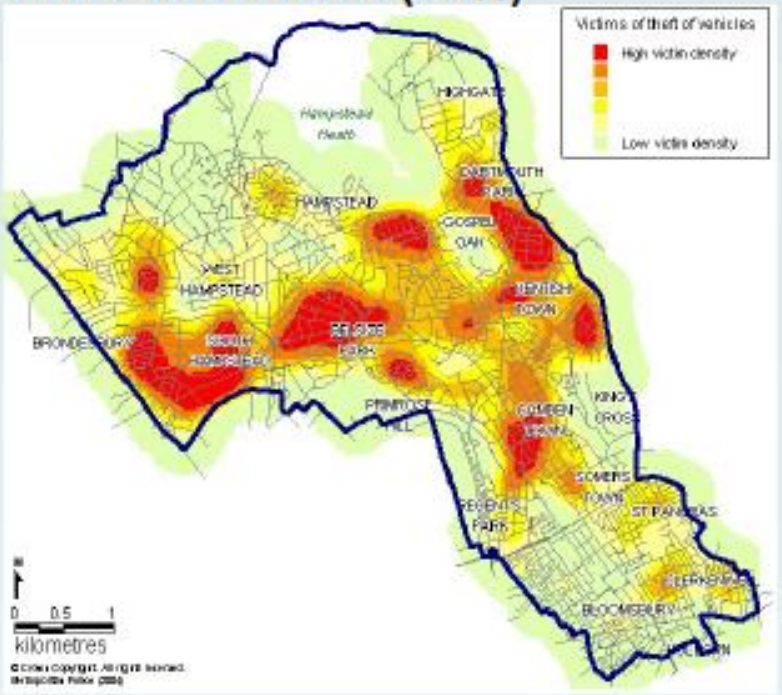
Crime analysis - example

Analysing vehicle crime in central London:

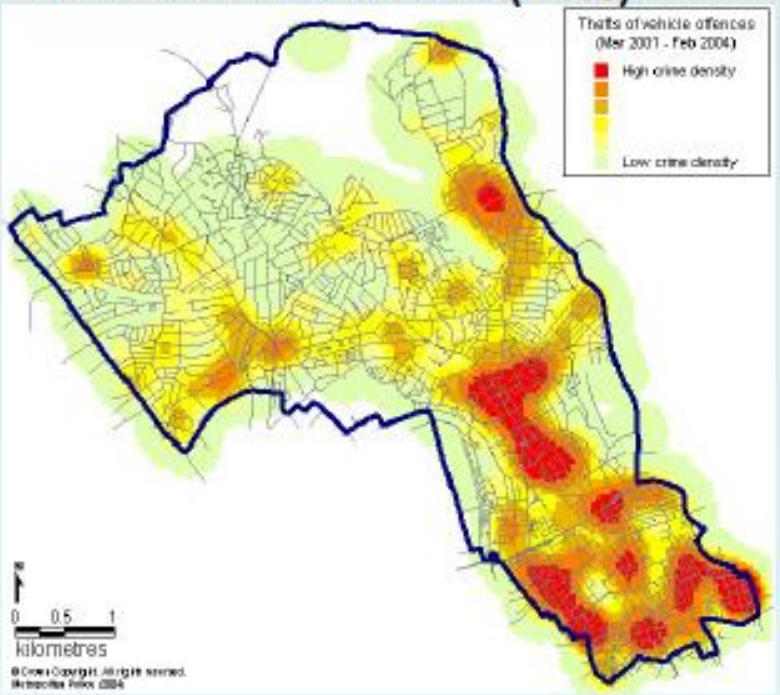
- Hypothesis: "We think it relates mainly to **local residents** having their **cars** stolen **at night**" (The Police)
- Crime analysis involves ***breaking the problem apart*** and exploring the specifics of the problem
- We have a series of questions that we can turn into hypotheses
- Explore 'place' across these
- Helping to explain the problem

Locals vs visitors

Camden victims (58%)



Non-Camden victims (42%)



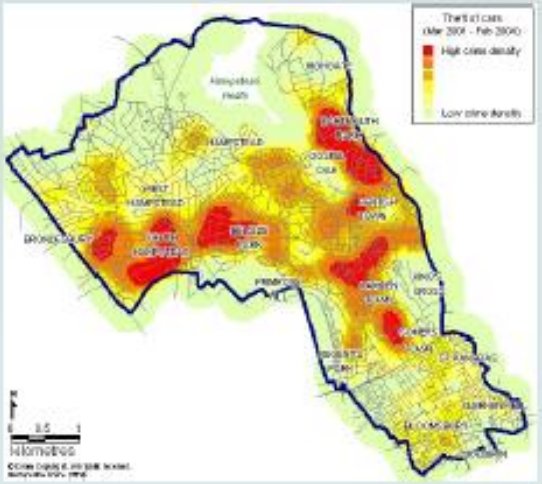
Vehicle statistics

of Crime Sc

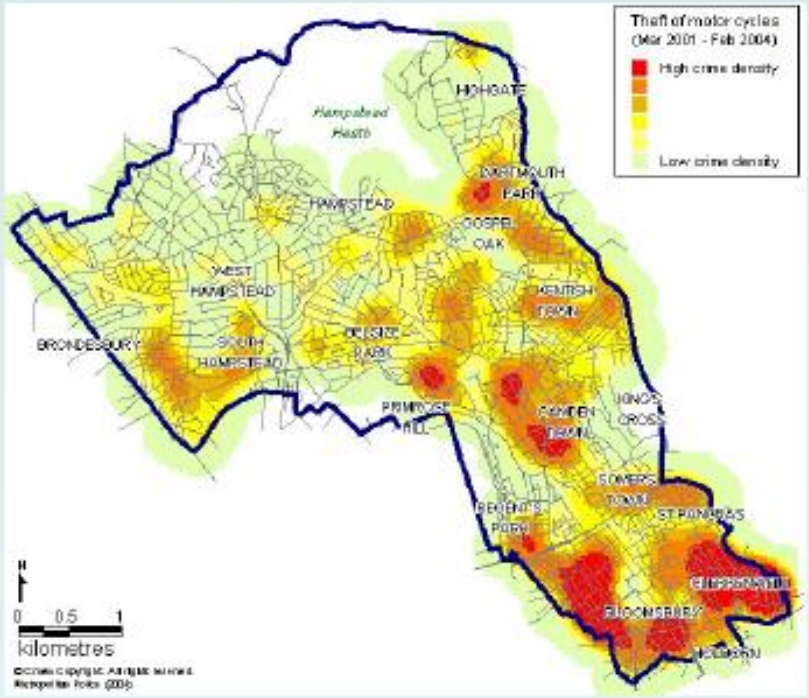
Type of vehicles stolen

Vehicle type description	Offences	%
Hatchback	1258	21.7%
Saloon	1433	24.7%
Estate	220	3.8%
People carrier	45	0.8%
Convertible	120	2.1%
Sports	42	0.7%
4 X 4's	4	0.1%
Moped or scooter	1494	25.8%
Motor cycle	755	13.0%
Motor caravan	11	0.2%
Van	274	4.7%
Other	50	0.9%
Not known	23	0.4%

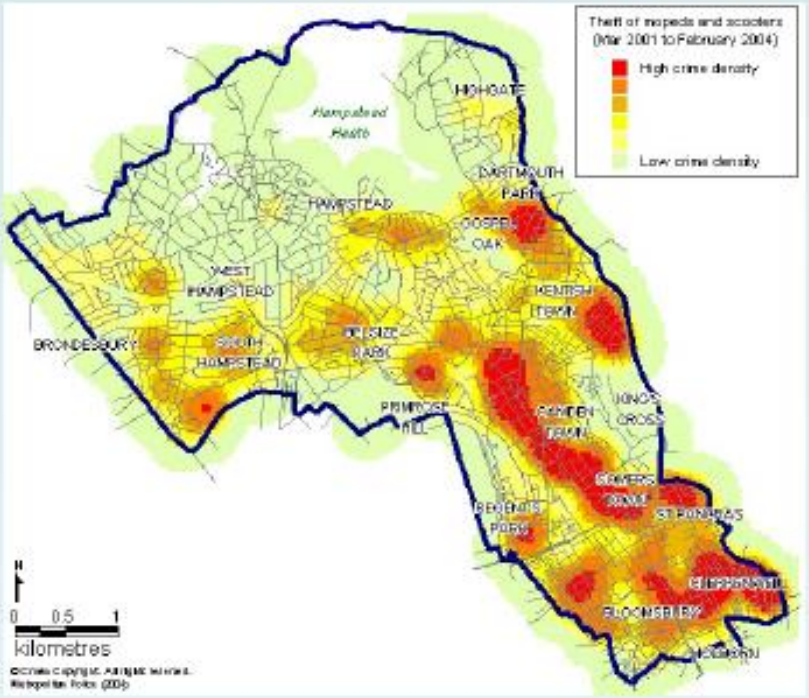
Cars



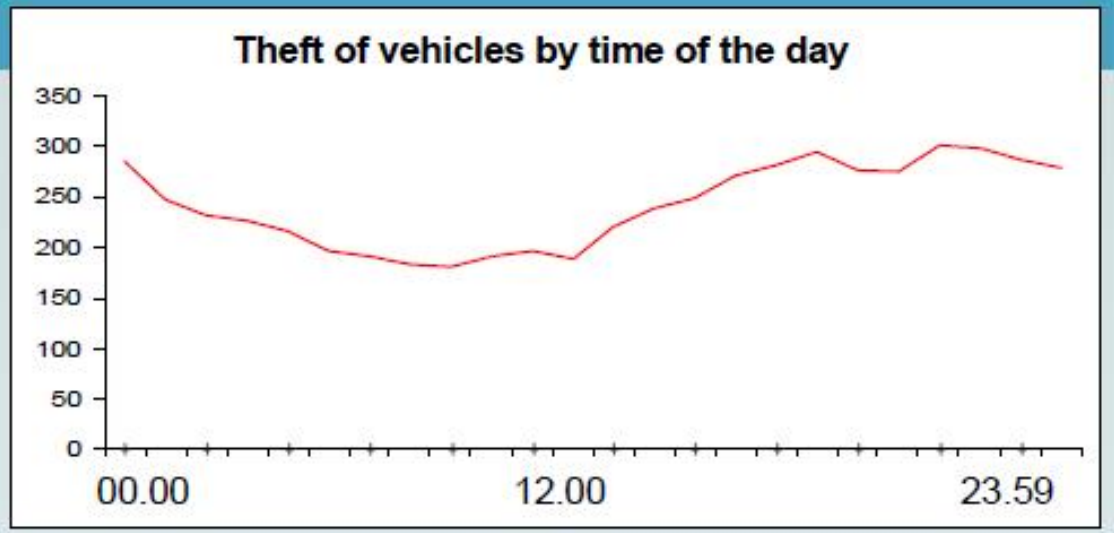
Motorbikes

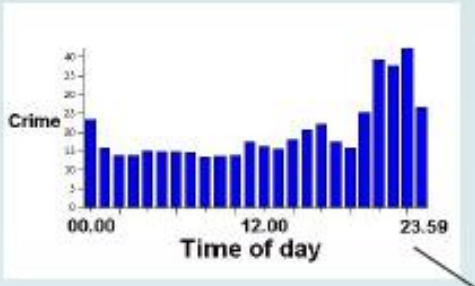


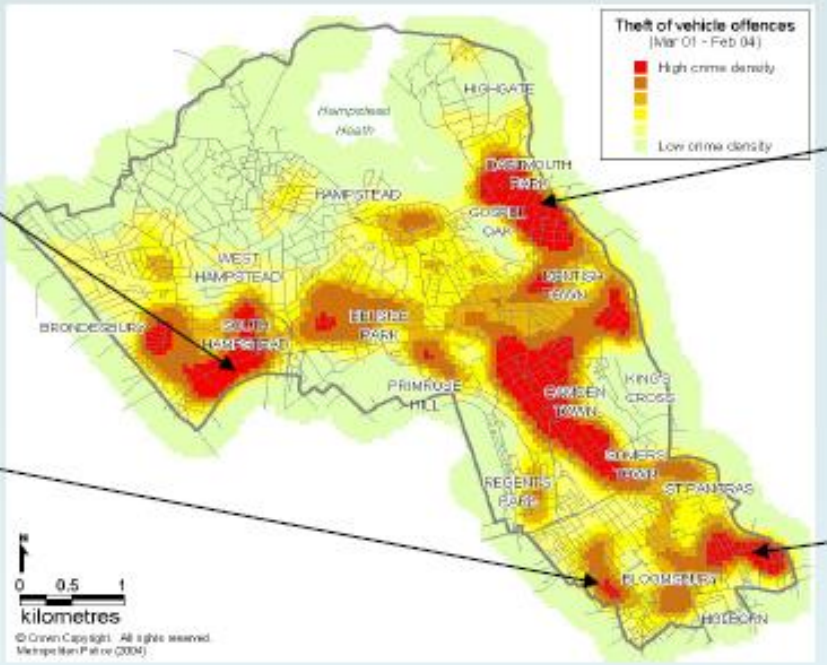
Scooters and mopeds

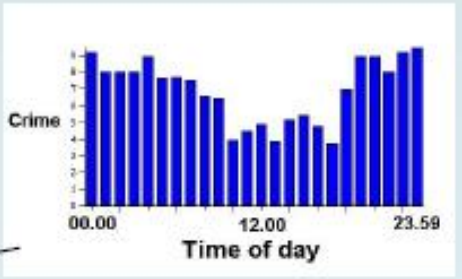


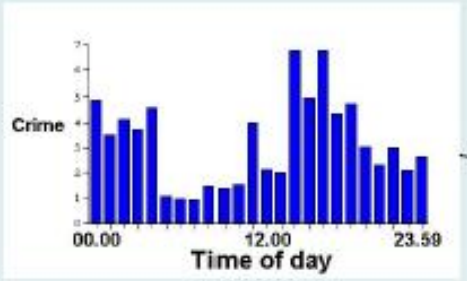
Place: space and time

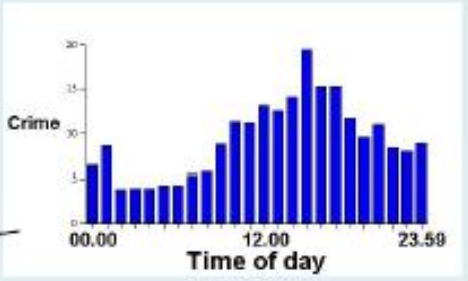






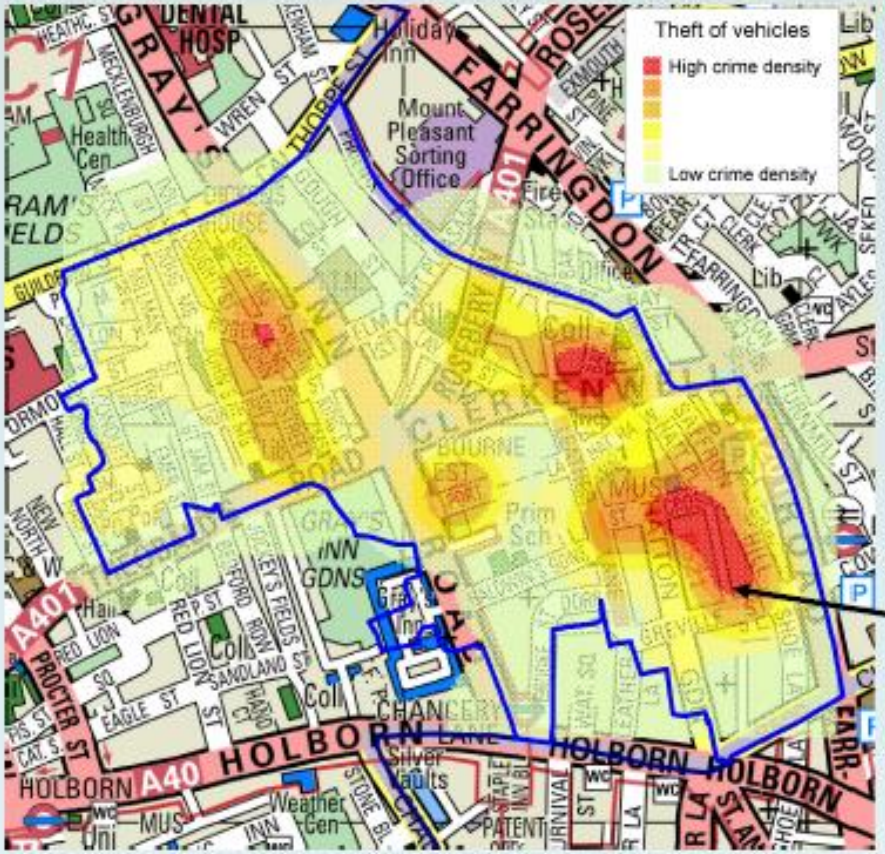






Detail view

Vehicle type	Camden	Clerkenwell (n)	Clerkenwell(%)
Car	51%	41	18%
Sports or convertible	3%	5	2%
Scooter or moped	26%	95	42%
Motor cycle	13%	70	31%
Van	5%	3	1%
Other	2.0%	10	4%
Not known	0.5%	0	0%

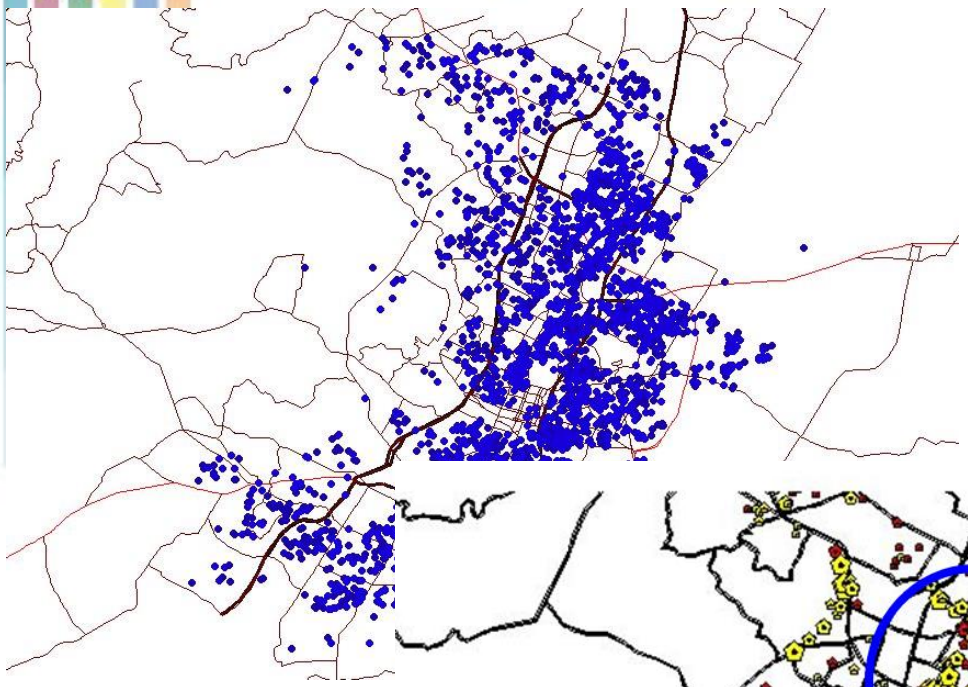


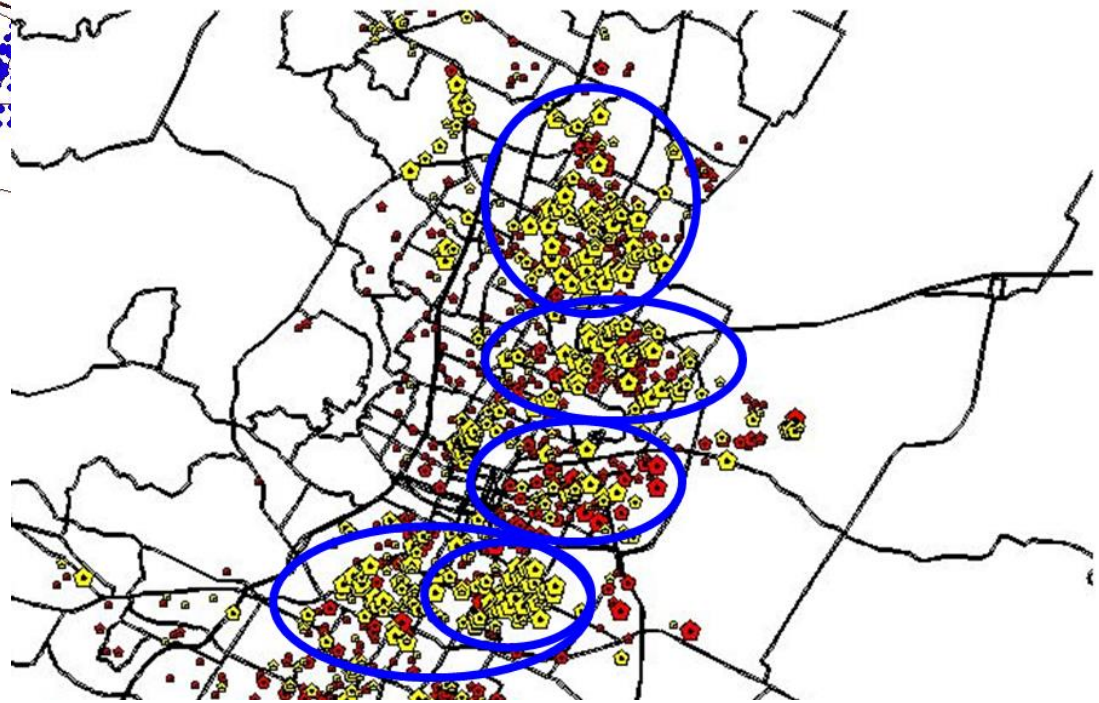
So it's not all to do with residents having their cars stolen at night …

Near Repeat Victimization Concept

- After an initial crime event, nearby targets have an increased risk of victimization for a short period of time.
- Space and time clustering
- **High Crime Areas - Primarily high crime areas are high because of numbers of repeat victims.**
- **The British Crime Survey contains no area where *more than half the people are victimised*, but does contain areas where those victimised each suffer many times.**

Austin Repeat Residential Burglaries 1999





Explaining Repeat Victimisation

- Possible explanations - contagion or boost

Boost Explanations

- repeat victimization **reflects the successful outcome of an initial offense**. Specific offenders gain important knowledge about a target from prior experience and use this information to re-offend. **– PřF MU??**

Contagion (Flag) Explanations

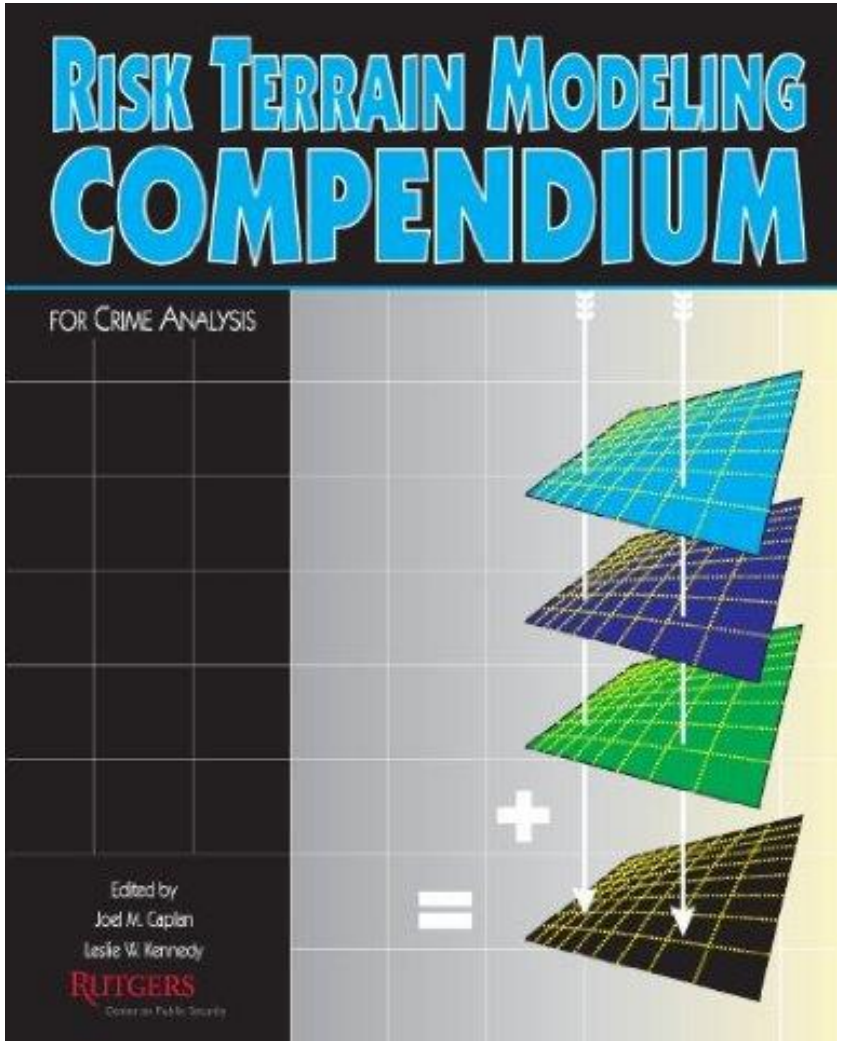
- some targets are unusually attractive to criminals or particularly vulnerable to crime.

Predictive Crime Analysis

- „Predictive policing in the context of place is the use of **historical data** to create a **spatiotemporal forecast** of crime **hot spots**
- that will be the **basis for police resource allocation** decisions with the expectation that having officers at the proposed place and time **will deter or detect criminal activity**."

Risk Terrain Modeling Prediction

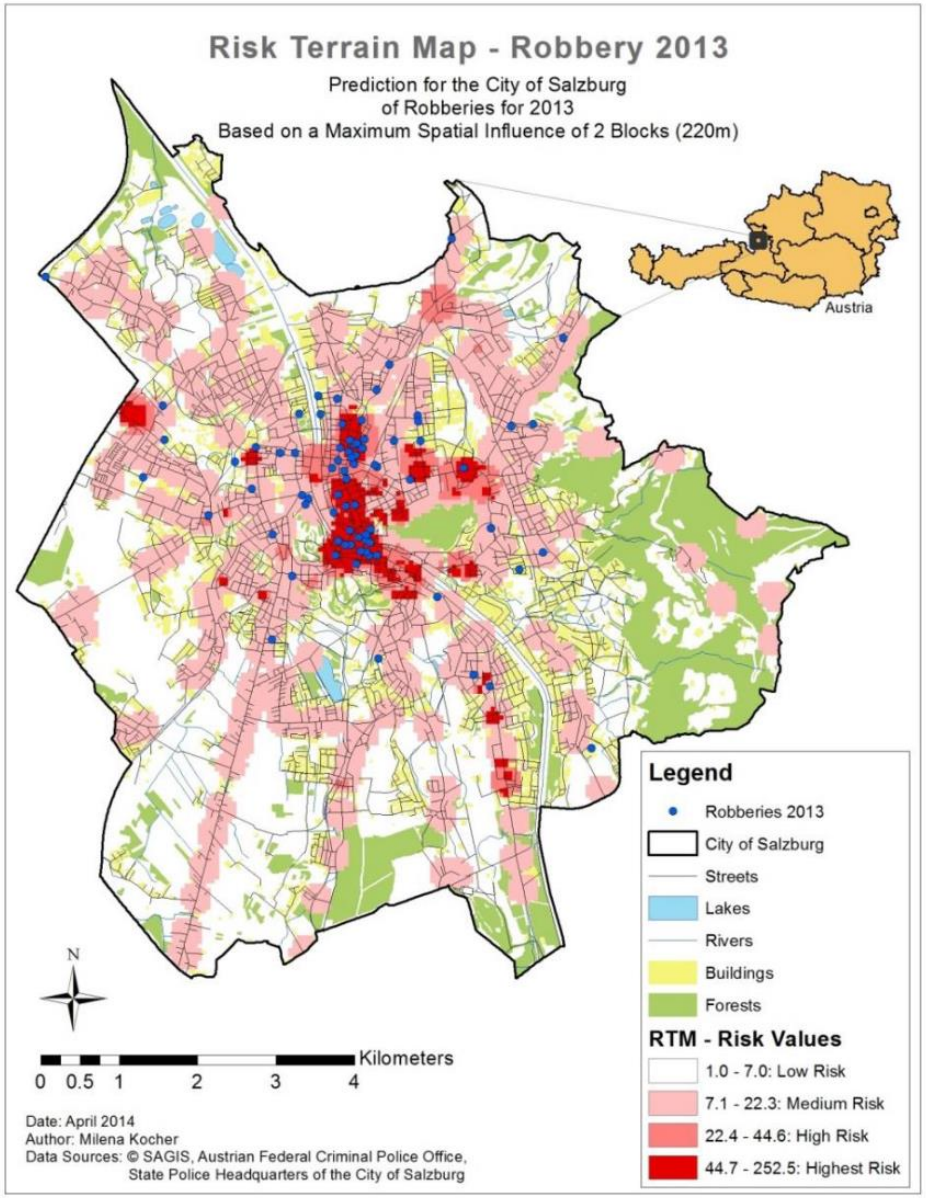
- Risk terrain modeling (RTM) is an **approach to risk assessmen**t in which separate **map layers** representing the influence and intensity of a **crime risk factor** at every place throughout a geography is created in a geographic information system (GIS).
- Map layers are combined to produce a **composite "risk terrain" map** with values that account for all risk factors at every place throughout the geography.
- Available in PDf – ask your lecturer ☺

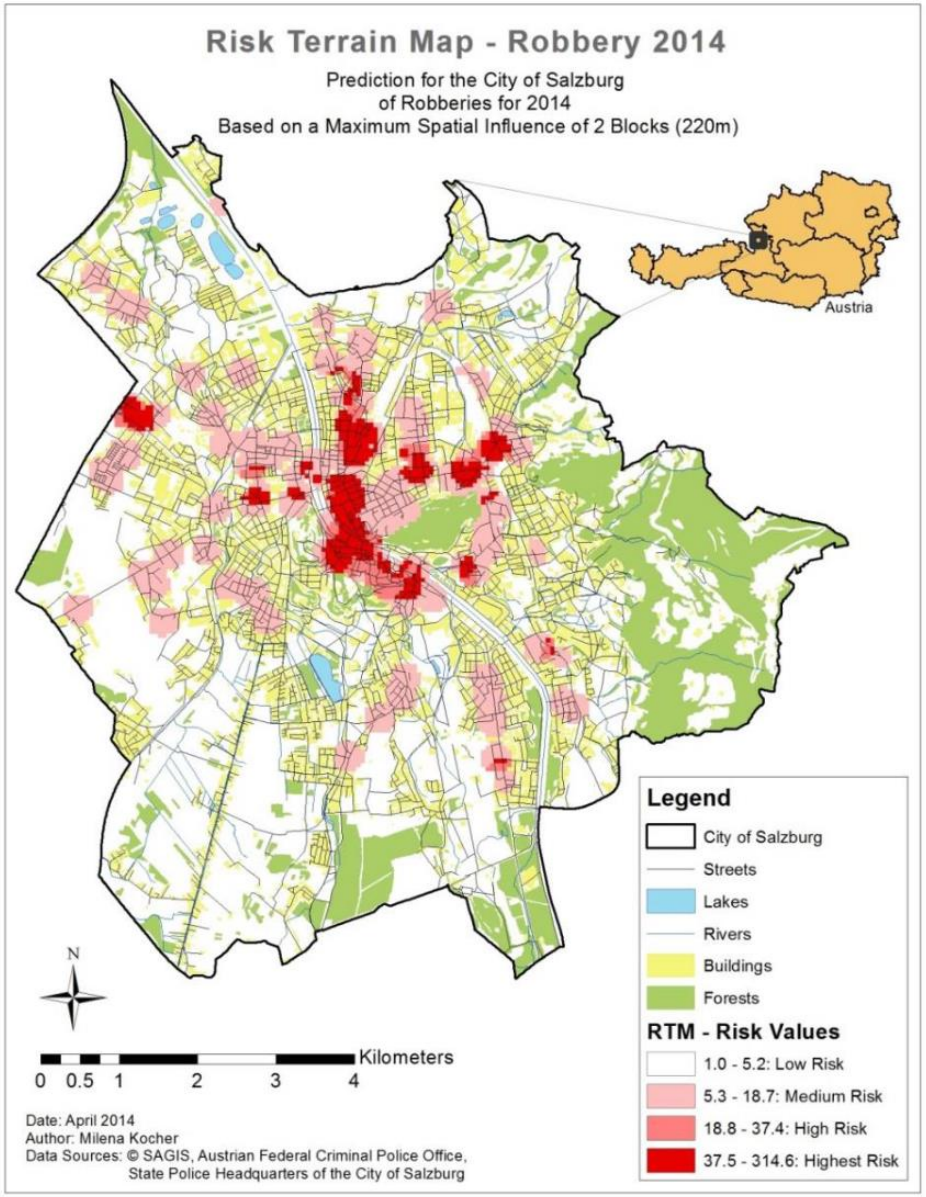


RTM steps

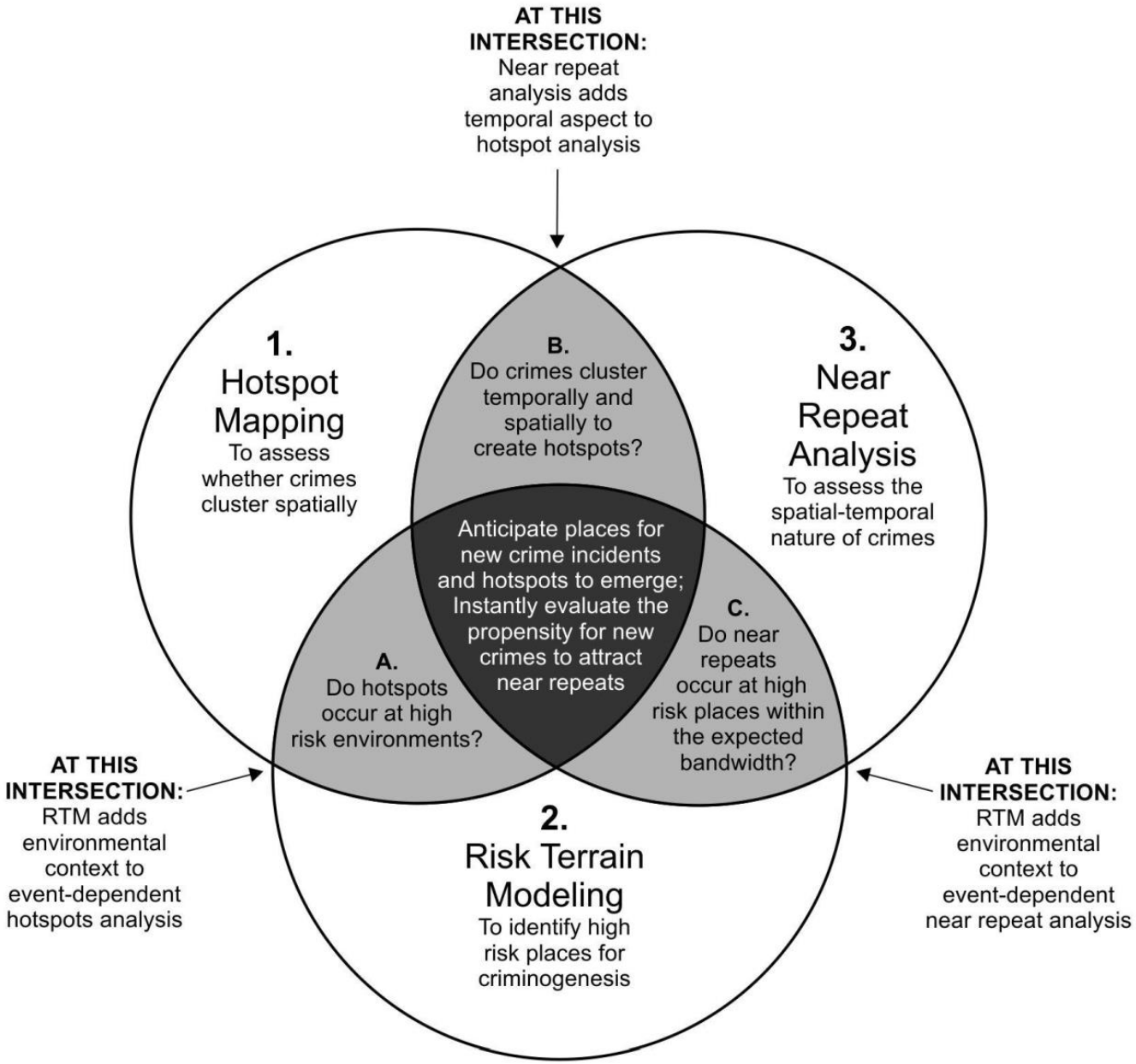
1. Select an outcome **event** of particular interest
2. Choose a study **area**
3. Choose a time **period**
4. Obtain **base maps** of your study area
5. Identify **aggravating** and **mitigating** factors related to the outcome event
6. **Select** particular **factors** to include in the RTM
7. **Operationalize** the spatial influence of factors to risk map layers
8. **Weight** risk map layers relative to one another
9. **Combine** risk map layers to form a composite map
10. **Finalize** the risk terrain map to **communicate** meaningful and actionable information.

Risk Terrain Modelling





Synthesis


AT THIS INTERSECTION:
Near repeat analysis adds temporal aspect to hotspot analysis
1.
Hotspot Mapping
To assess whether crimes cluster spatially
B.
Do crimes cluster temporally and spatially to create hotspots?
3.
Near Repeat Analysis
To assess the spatial-temporal nature of crimes
Anticipate places for new crime incidents and hotspots to emerge; Instantly evaluate the propensity for new crimes to attract near repeats
A.
Do hotspots occur at high risk environments?
C.
Do near repeats occur at high risk places within the expected bandwidth?
AT THIS INTERSECTION:
RTM adds environmental context to event-dependent hotspots analysis
2.
Risk Terrain Modeling
To identify high risk places for criminogenesis
AT THIS INTERSECTION:
RTM adds environmental context to event-dependent near repeat analysis