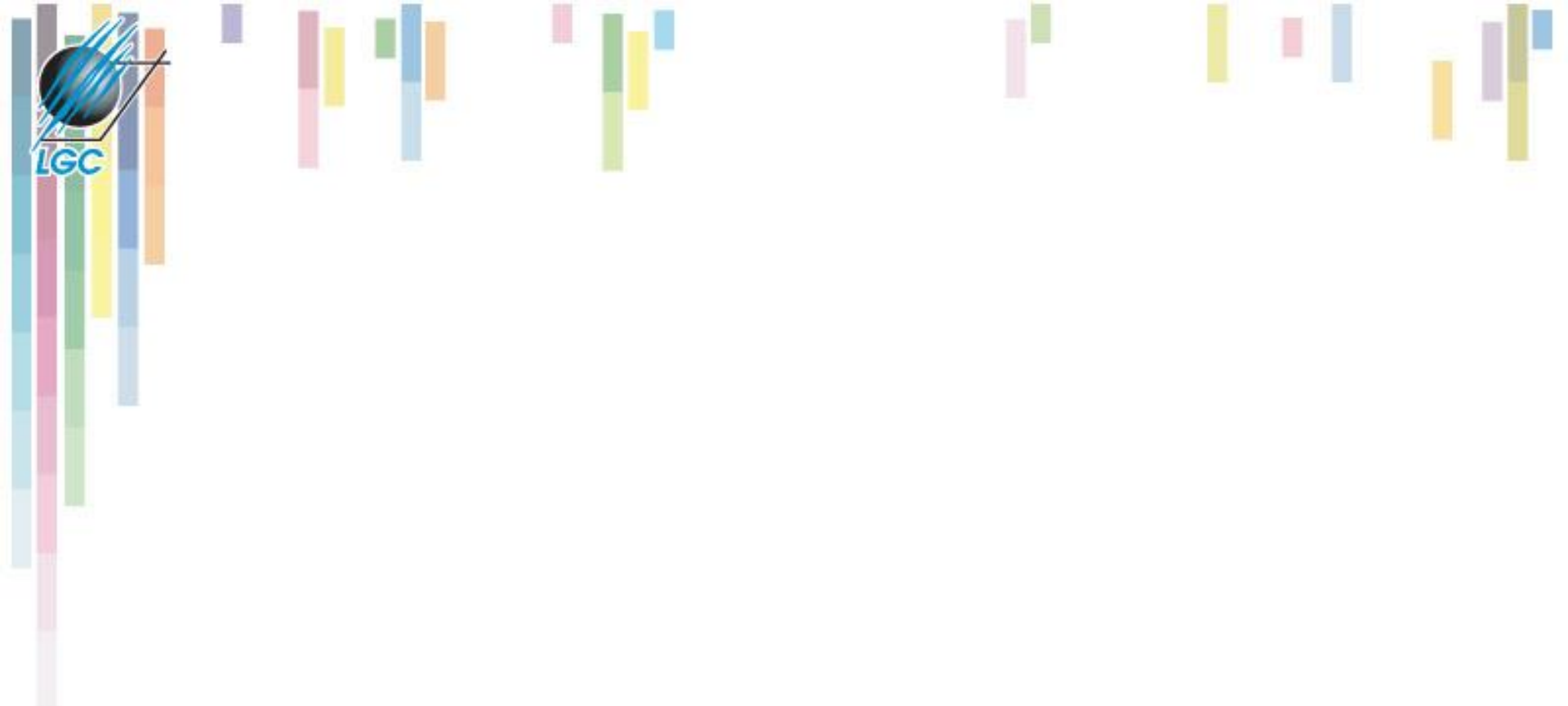# Moderní trendy v analýzách a mapování kriminality
+Geoinformační technologie v sociální geografii

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PREDICTIVE MODELLING USING GIS

What is predictive modelling?

- Modelling with GIS – descriptive – predictive – prescriptive.

- Using historical data to extrapolate the future conditions.

- Case studies:

  – *Agriculture - predictin the yield using RS.*

  – Archeology – predicting the antient arechological sites using ModelBuilder.

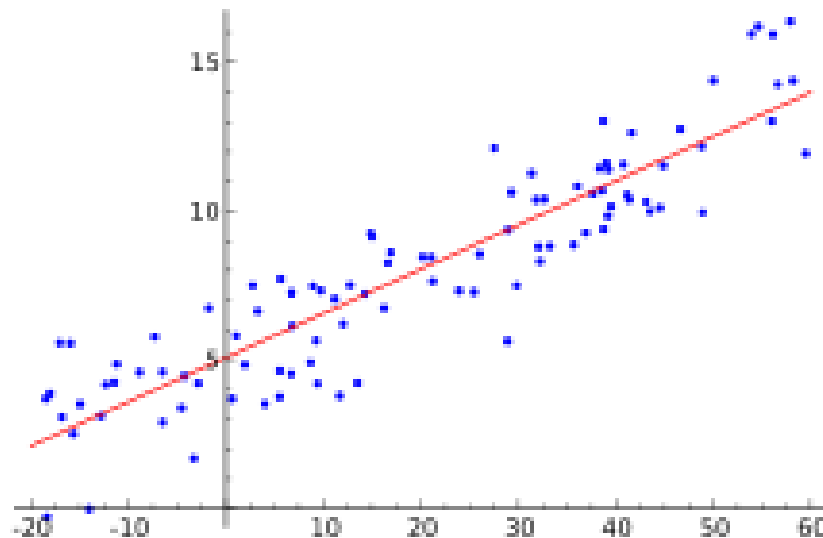 – **Crime mapping and prediction using Risk Terrain modelling**.

Case study I – precision farming

- **Predictive modeling in agricutlture(J. Berry).**

- **Corn yield**– low(39 - red) . high(279 – green) – **dependant varialble** – the phenomenon we want to **predict.**

- **Independent variables** – are used to uncover the spatial relationship—prediction equation.

- RS data – relative reflectance of **red light (RED)** off the plant canopy and near-infrared response (**NIR**).
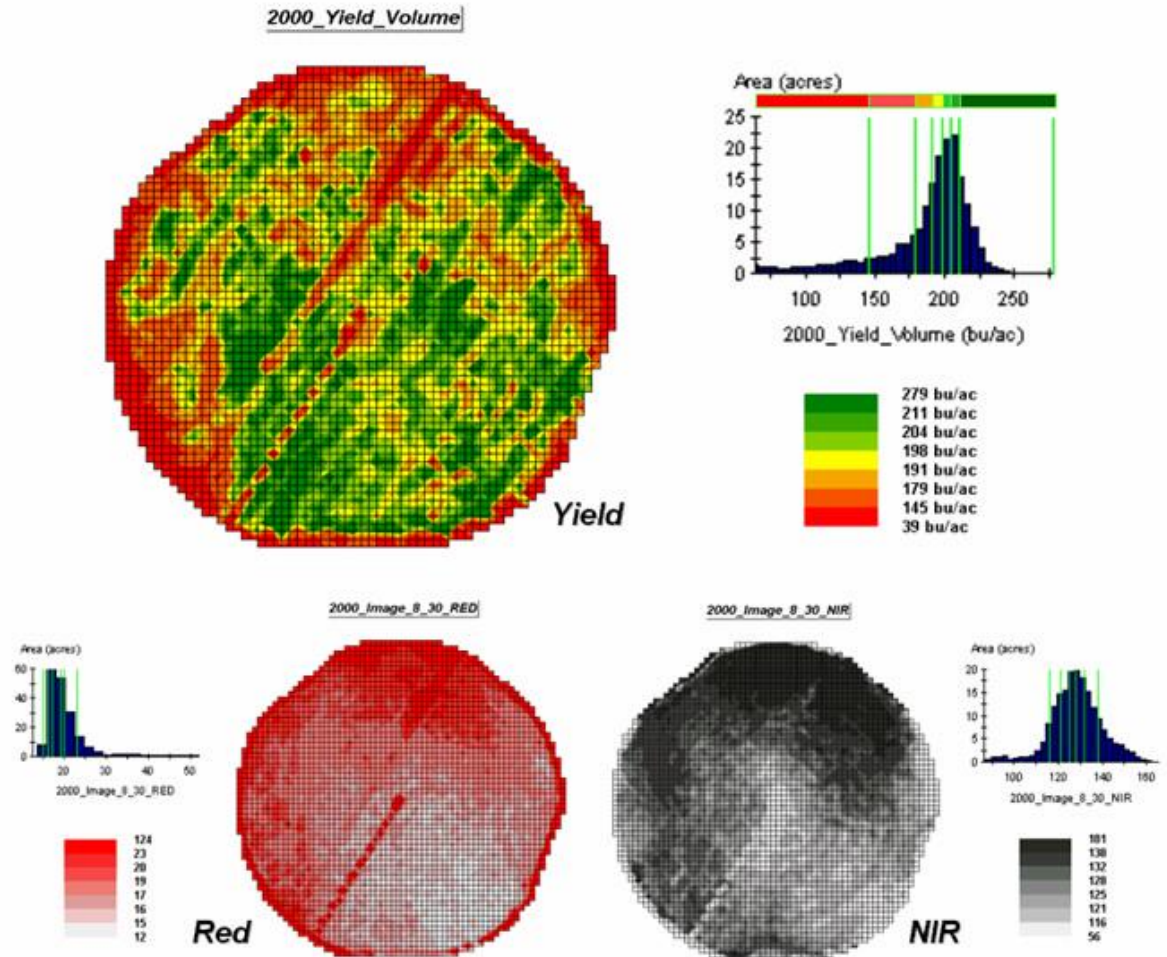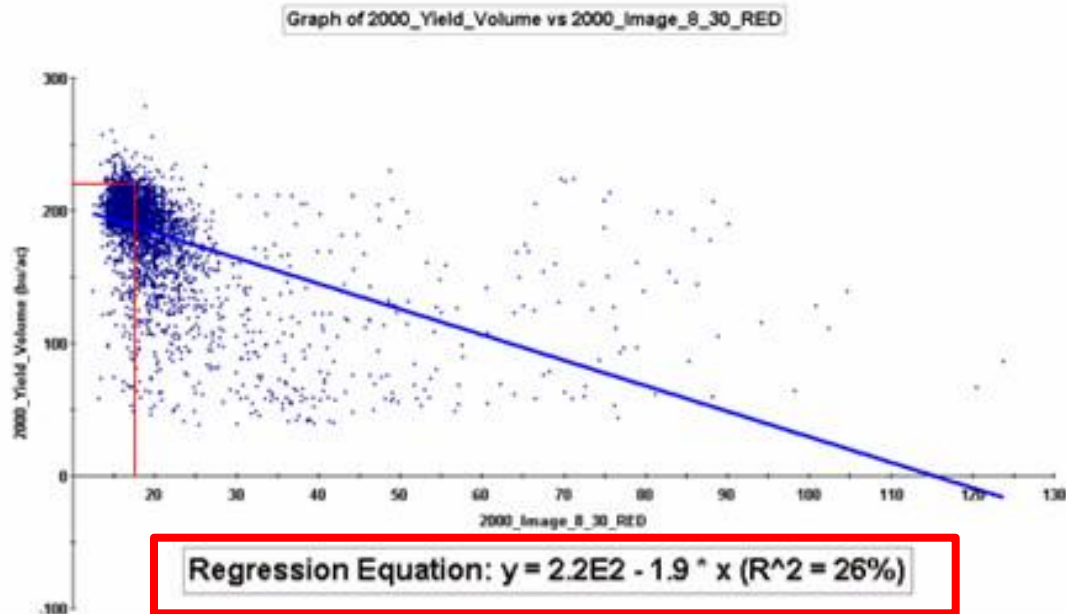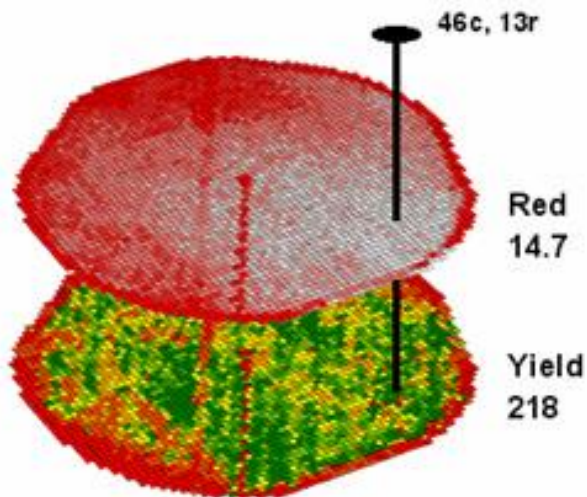
- **Korelační diagram (Scatter plot) pro všechny existující dvojice hodnot.**

- **Predikční rovnice vytvořená pomocí regresní analýzy – křivka nejlépe charakterizující datové rozložení.**

- **Využití predikční rovnice pro další lokality.**

Graph of 2000_Yield_Volume vs 2000_Image_8_30_RED

Regression Equation: $y = 2.2E2 - 1.9 * x$ ($R^2 = 26\%$)

The set of "blue dots" in both of the scatter plots represents data pairs for each grid location. The blue lines in the plots represent the prediction equations derived through regression analysis.
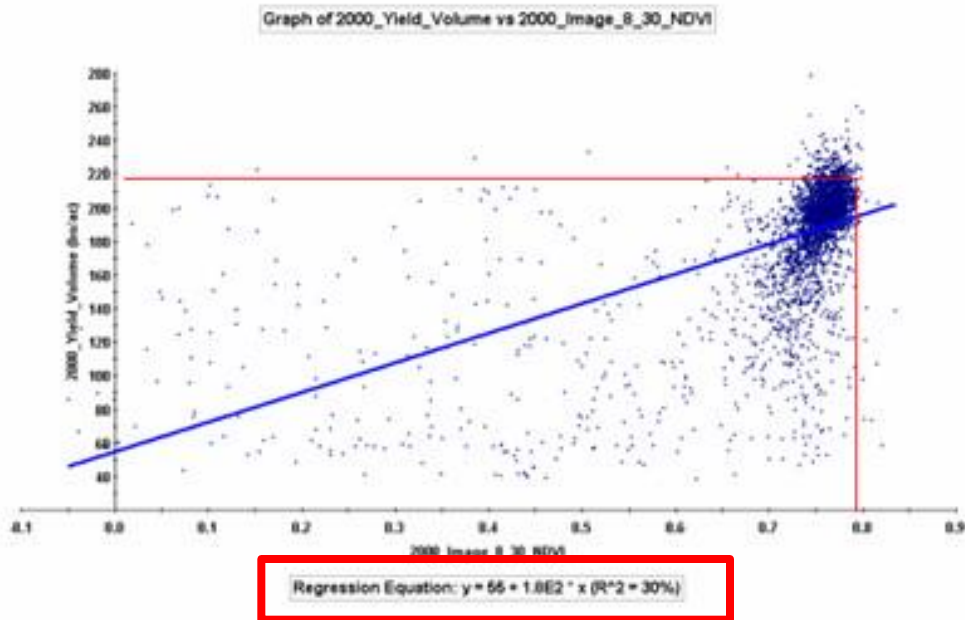

Regression Equation: $y = 1E2 + 0.64 * x$ ($R^2 = 4.7\%$)
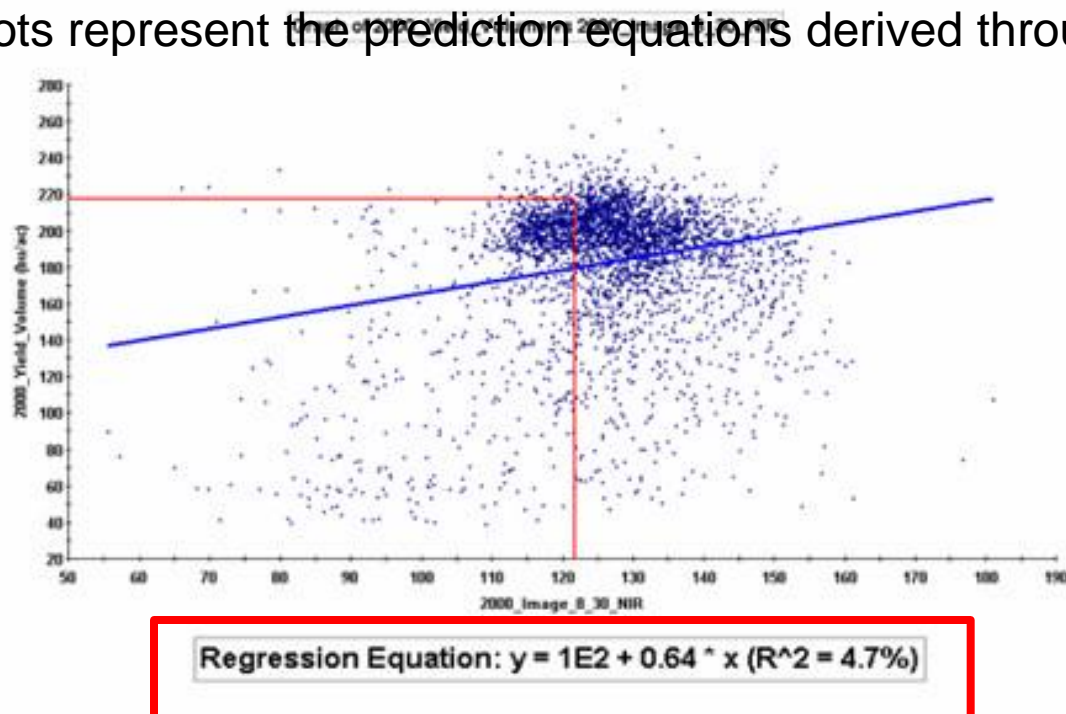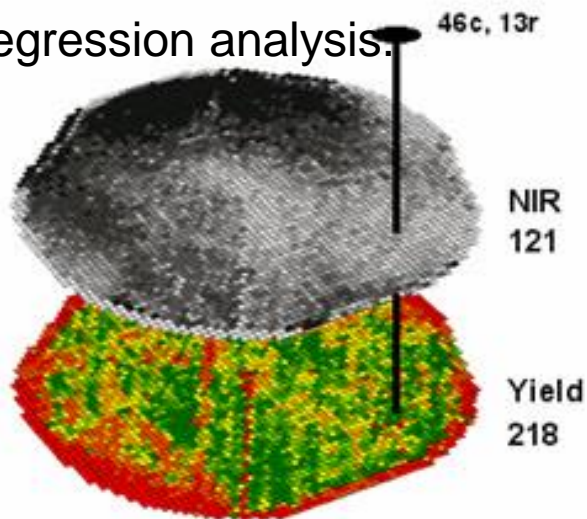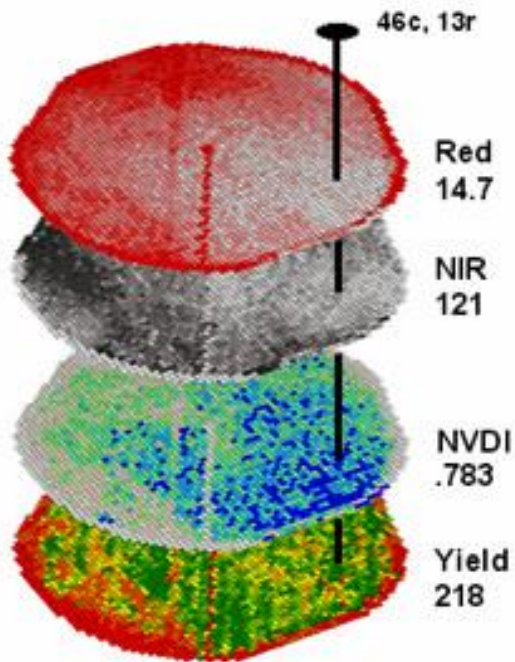
- **What is a problem?**
- **A major problem is that the "r-squared" statistic for both of the prediction equations is fairly small (26% and 4.7%) which suggests that the prediction lines do not fit the data very well.**
- **Use a combination of both independent var:**
- **Normalized Density Vegetation Index (NDVI)**
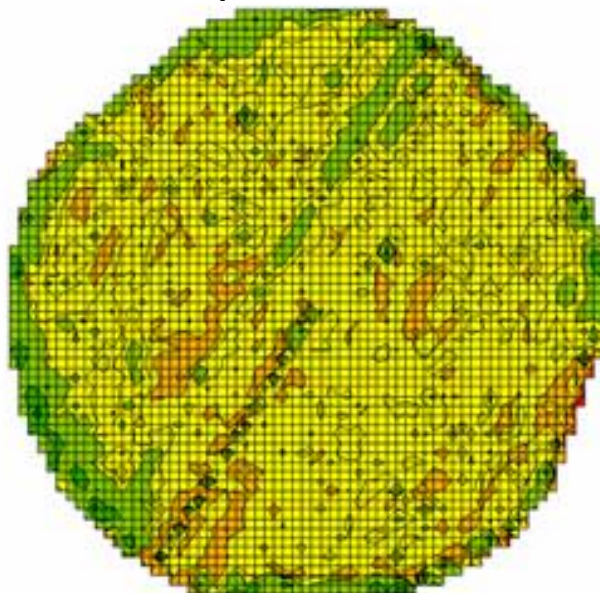- **NDVI= ((NIR – Red) / (NIR + Red))**

Case study I

46c, 13r

Red 14.7
NIR 121
NVDI .783
Yield 218

Graph of 2000_Yield_Volume vs 2000_Image_8_30_NDVI

Regression Equation: y = 55 + 1.8E2 * x (R^2 = 30%)
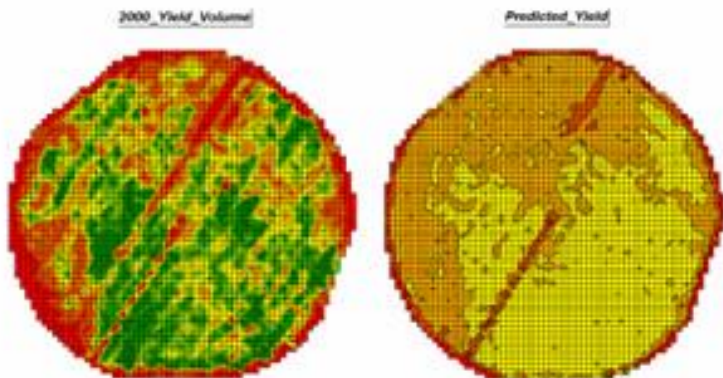
predicted value - actual measurement = error map

Error_Map

Regression Equation: y = 55 + 1.8E2 * x (R^2 = 30%)

2000_Yield_Volume

Predicted_Yield

Statistics	
Min:	-173
Max:	144
Range:	318
Mean:	2.62
Median:	-4.23
Std. Dev.	32
Variance:	1,025
Gridded Area:	189 acres

144
120
80
20
0
-20
-80
-120
-173

67%
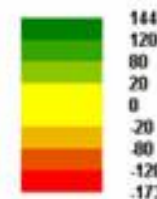
- **Results are smoothign real yield.**
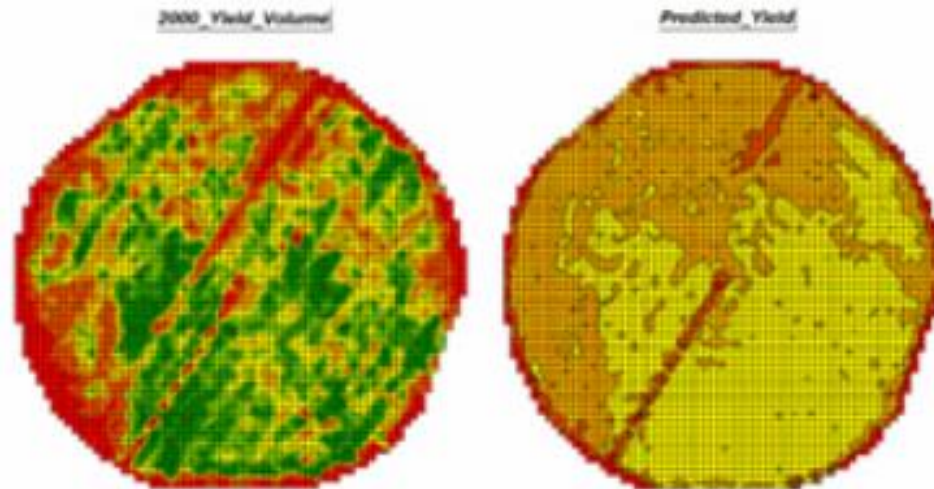
- **Not a real calibration or validation, merely empirical verification of the technique.**
- **How can we improve the model??**

Case study

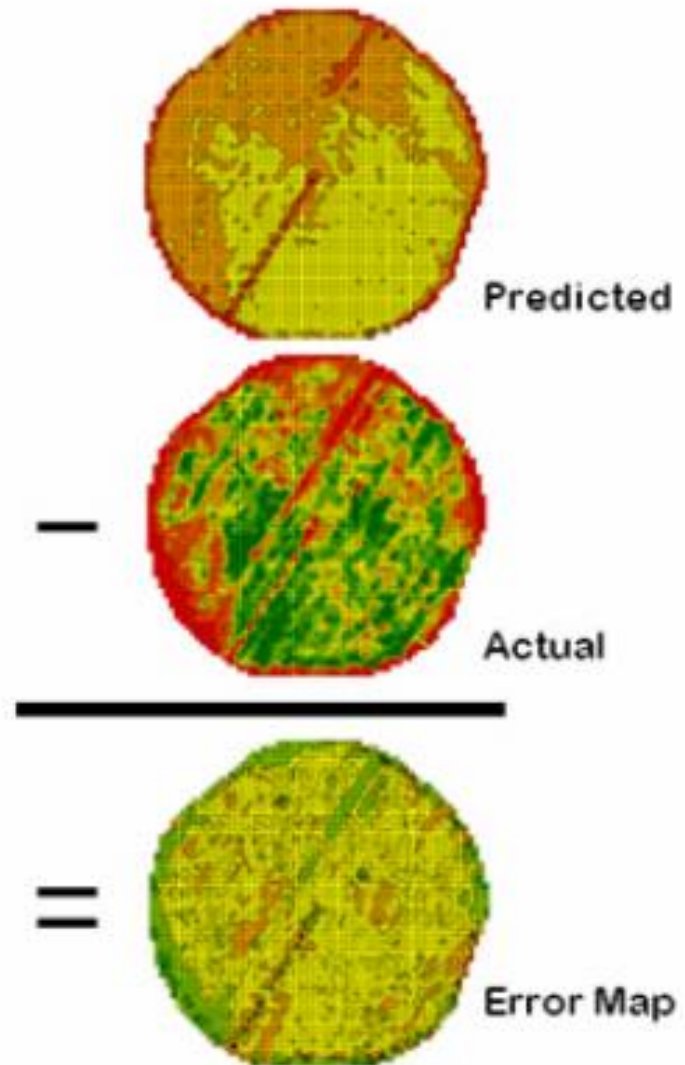- **Closer look to error map.**
- bad—average error of 2,62 bu/ac.
- **67% of the estimate within+- 20 bu/ac.**
- **BUT – extreme location as far as +144 a -173 q/ha.**
- **This is not satisfying.**

Predicted

–

Actual

=

Error Map

- **Solution?**
- **Data set stratification– division into the similar characteristics groups.**
- The vertical bars identify the breakpoints at plus/minus one standard deviation and divide the map values into three strata—zone 1 of unusually high under-guesses (red), zone 2 of typical error (yellow) and **zone 3 of unusually high over-guesses (green).**

Error_zones

Histogram

○ Std. Dev.   ⦿ Ranges   ○ None

Area (acres)

Zone 1   Zone 2   Zone 3

40
30
20
10
0

-50   0   50   100

Error_Zones Distribution

🟥	3 Over estimates
🟨	2 Within +/- 1 SD
🟩	1 Under estimates

Case study
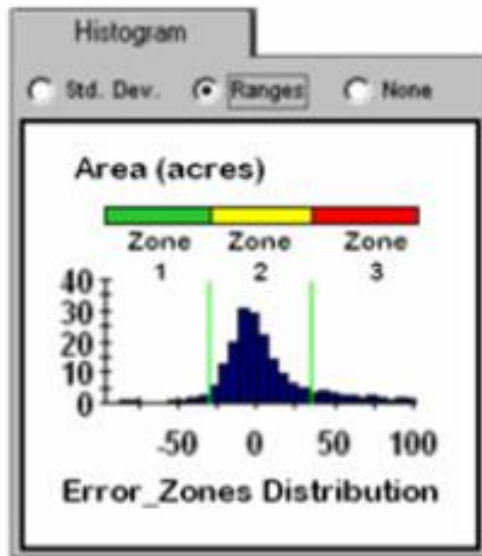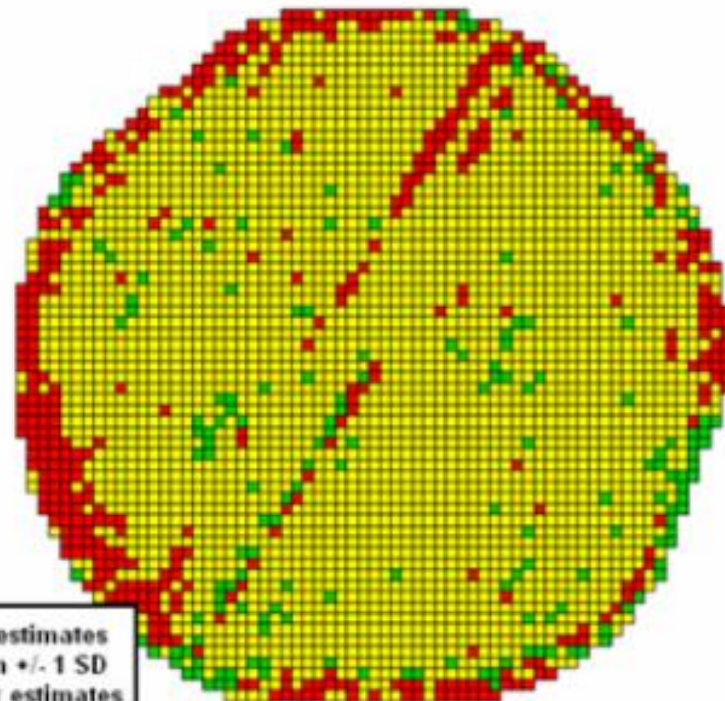
- **prediction equation works better for particular zones than for the whole field.**
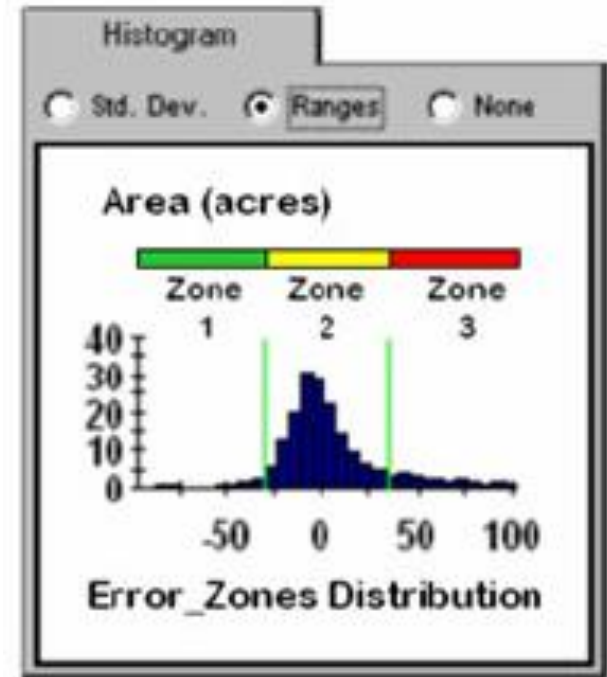- **the breakpoints at plus/minus one standard deviation and divide the map values into three strata.**
- **Prediction works fine for zone 2.**
- **For zones 1 adn 3 are the results over- and under estimated.**
- **We must define a specific prediction equation for each zone.**

Overall prediction using three separate prediction equations

- **Input– NDVI and yield map, Error zones map.**

- **For each map location, the algorithm first checks the value on the *Error Zones* map then sends the data to the appropriate group for analysis.**

- **Once the data has been grouped, a regression equation is generated for each zone.**

- **The "rsquared" statistic for all three equations (.68, .60, and .42 respectively) suggests that the equations fit the data fairly well and ought to be good predictors.**

- **the composite prediction map generated by applying the equations to the NDVI data respecting the zones.**

Template Map — Error Zones

3 Over estimates
2 Within +/- 1 SD
1 Under estimates

Data Maps — NDVI, Yield
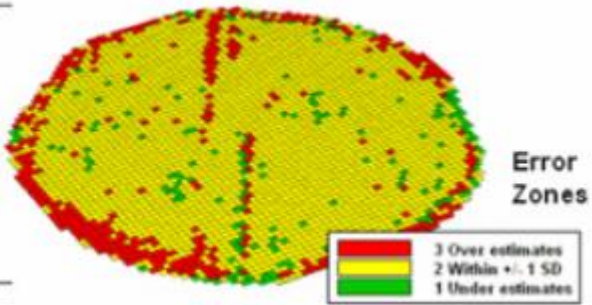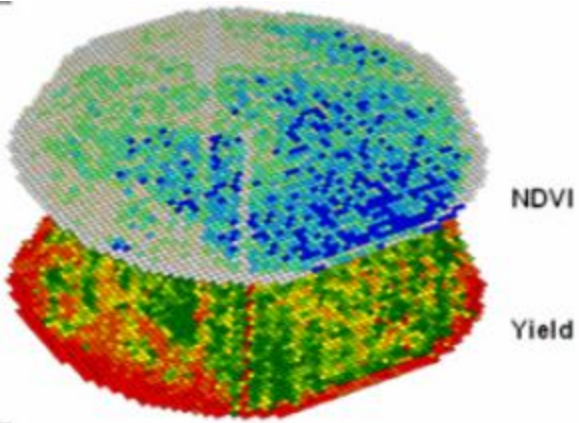
Prediction Equations

Zone 1 — Y= 145.40 + 110.79 X (R² = .68)

Zone 2 — Y= 32.93 + 215.06 X (R² = .60)

Zone 3 — Y= -4.85 + 169.38 X (R² = .42)

Prediction_composite

279 bu/ac
211 bu/ac
204 bu/ac
198 bu/ac
191 bu/ac
179 bu/ac
145 bu/ac
39 bu/ac
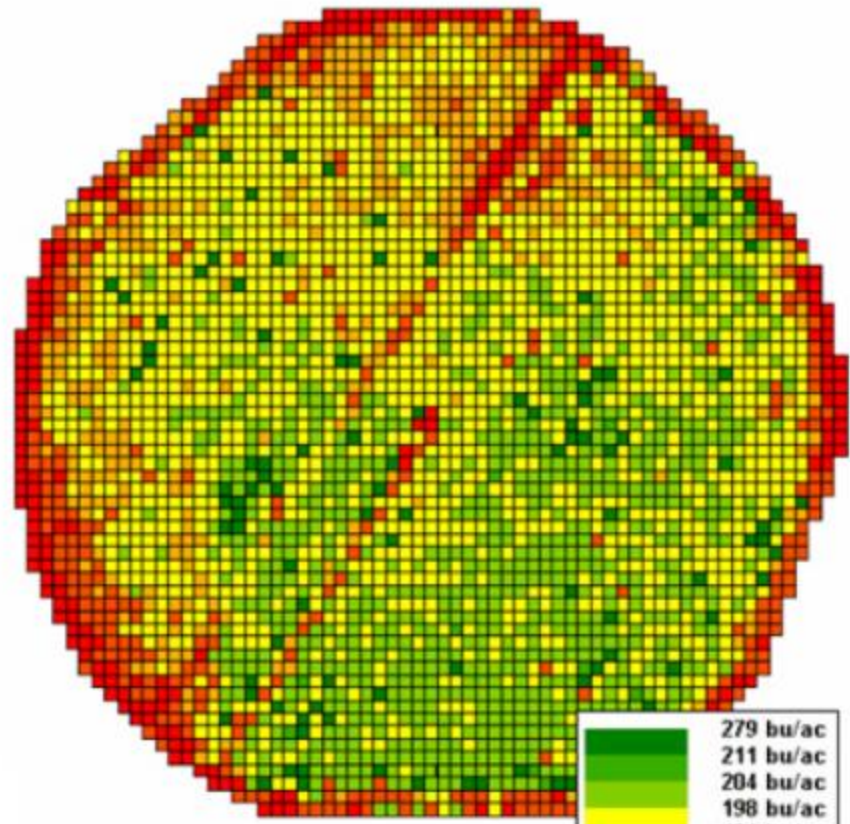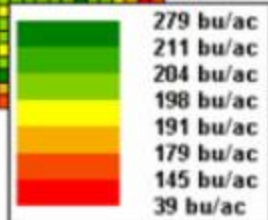
Case study I

- **Visual comparison:**
  - Real yield
  - Prediction map for the whole field
  - Prediction map for stratified prediction
- **Error map for stratified predictions 80%within +- 20 bu/ac.**
- **The average error is only 4bu/ac**
- **Fairly good guessing of yield based on a remote sensing shot of the field nearly a month before the field was harvested** ☺

Min [>=]	Max [<]	Count	acres	% Gridded Area	Color
120	144	0	0	0	
80	120	30	1.72	0.91	
20	80	477	27.4	15	
0	20	1236	70.9	38	
-20	0	1380	79.2	42	
-80	-20	165	9.47	5	
-120	-80	1	0.0574	0.03	
-173	-120	0	0	0	

] 80%

Statistics	
Min:	-81.2
Max:	113
Range:	194
Mean:	3.97
Median:	1.12
Std. Dev.	19.2
Variance:	369
Gridded Area:	189 acres

Actual Yield

Stratified Prediction

Whole Field Prediction

Error Map for Stratified Prediction

| 279 bu/ac |
| 243 bu/ac |
| 209 bu/ac |
| 175 bu/ac |
| 141 bu/ac |
| 107 bu/ac |
| 73 bu/ac |
| 39 bu/ac |

Min [>=]	Max [<]	Count	acres	% Gridded Area	Color
120	144	0	0	0	
80	120	30	1.72	0.91	
20	80	477	27.4	15	
0	20	1236	70.9	38	
-20	0	1380	79.2	42	
-80	-20	165	9.47	5	
-120	-80	1	0.0574	0.03	
-173	-120	0	0	0	

80%

Statistics	
Min:	-81.2
Max:	113
Range:	194
Mean:	3.97
Median:	1.12
Std. Dev.	19.2
Variance:	369
Gridded Area:	189 acres

Other ways to stratify

1) *Geographic Zones*, such as proximity to the field edge;

2) *Dependent Map Zones*, such as areas of low, medium and high yield;

3) *Data Zones*, such as areas of similar soil nutrient levels; and

4) *Correlated Map Zones*, such as micro terrain features identifying small ridges and depressions.

Lessons learned

- **Error map** is important in evaluating and refining the prediction equations. This point is particularly important if the equations are to be extended in space and time.

- **Other locations (PLACE) and dates (TIME) should be used to verify performance.**

- **In precision agriculture it is possible to combine the detail and continuous RS data available just occasionally (once a month/season) with regular sensor measurements done in point locations.**

Predictive modelling in ArcGIS

Single procedures are used independently and repetitively – use ModelBuilde:

ModelBuilder offers three main benefits:

1) It records all of the steps involved in a procedure;

2) 2) It allows the procedures to be easily repeated and shared with others; and

3) 3) It provides a visual representation to help with understanding what is going on in the procedure.

Case study Predictive model for Mayan archaeological sites

- In the context of archaeology, a predictive model is *"a tool that indicates the probability of encountering an archaeological site anywhere within a landscape"*

- Developing a predictive model essentially consists of trying to determine the logic and preferences in site selection of the people who built the archaeological sites in question. .

- It includes a descriptive analysis of environmental factors to see if any of their possible combinations seem to be repeatedly associated with a type of archaeological site. A quest for spatial pattern.

- **Example**: **previously-known Mayan sites seemed to prefer occupying locations that are near the ocean and close to glades where white sage (**Salvia apiana**) tends to grow.**

- **analyze a region to see which areas in it meet those criteria, and direct your field searches to them**

1. Limit the region of interest

- **clip the rivers layer down to just the region of northern Guatemala on which we are focusing.**

- Input + output + funkce.
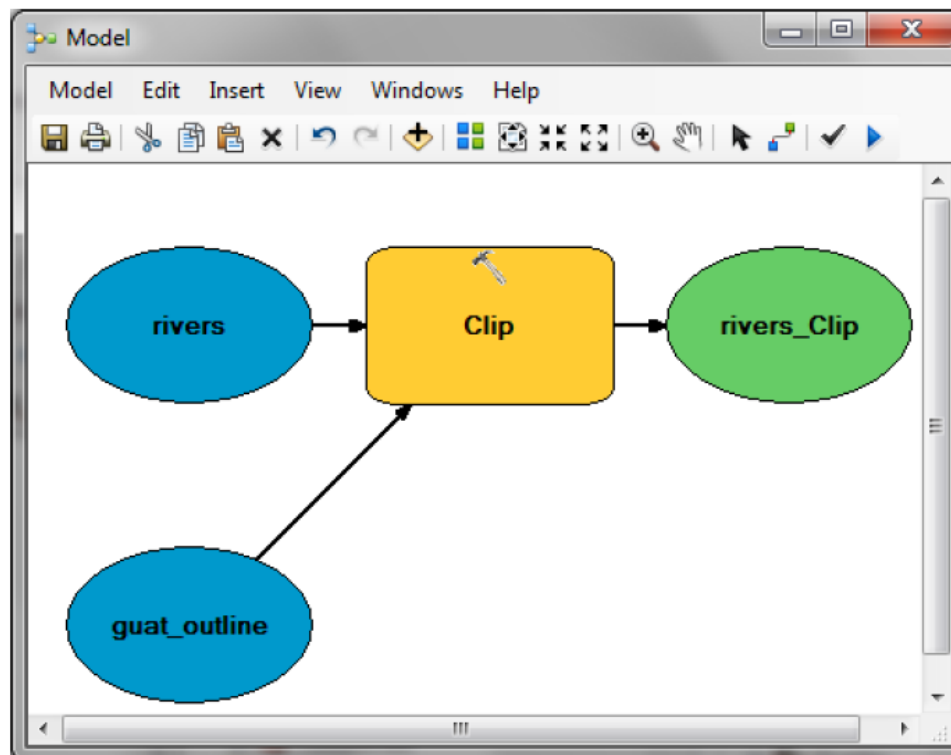
# Step 2: Measure proximity of sites to rivers

- rivers feature class has been reduced to our study area.

- procedure for determining how close the archaeological sites are located to rivers. For this we will be using the **Near** tool, which calculates the distance of points from line features within a given search radius.

- Near = 5km given search radius (**NEAR_DIST)**.

- Other localities labeled -1.

Step 3: Combine vegetation & soils feature classes

- determining which environmental attributes surround each of our archaeological sites.
- **in which vegetation, soils, and aspect polygons the sites reside?.**
- **analysis requires a multi-step procedure**
- Use of *Identity tool*.
- Vegetaiton+soils= PP1
- PP1 + aspect=PP2

INPUT

OUTPUT

IDENTITY FEATURE
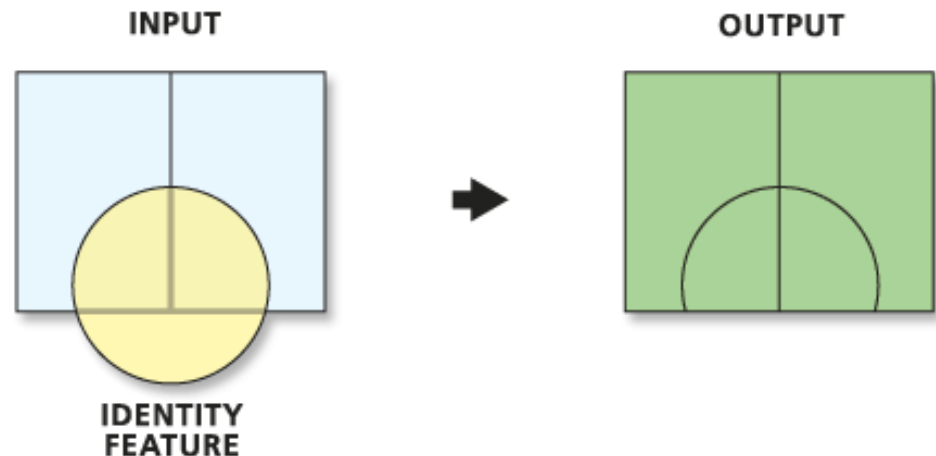
4. Environment conditions for archeological sites

- Archeo sites +PP2 using *IDENTITY.*
- Attributes selection–Idnetity tools preserves all attributes.
- *Frequency tool.*
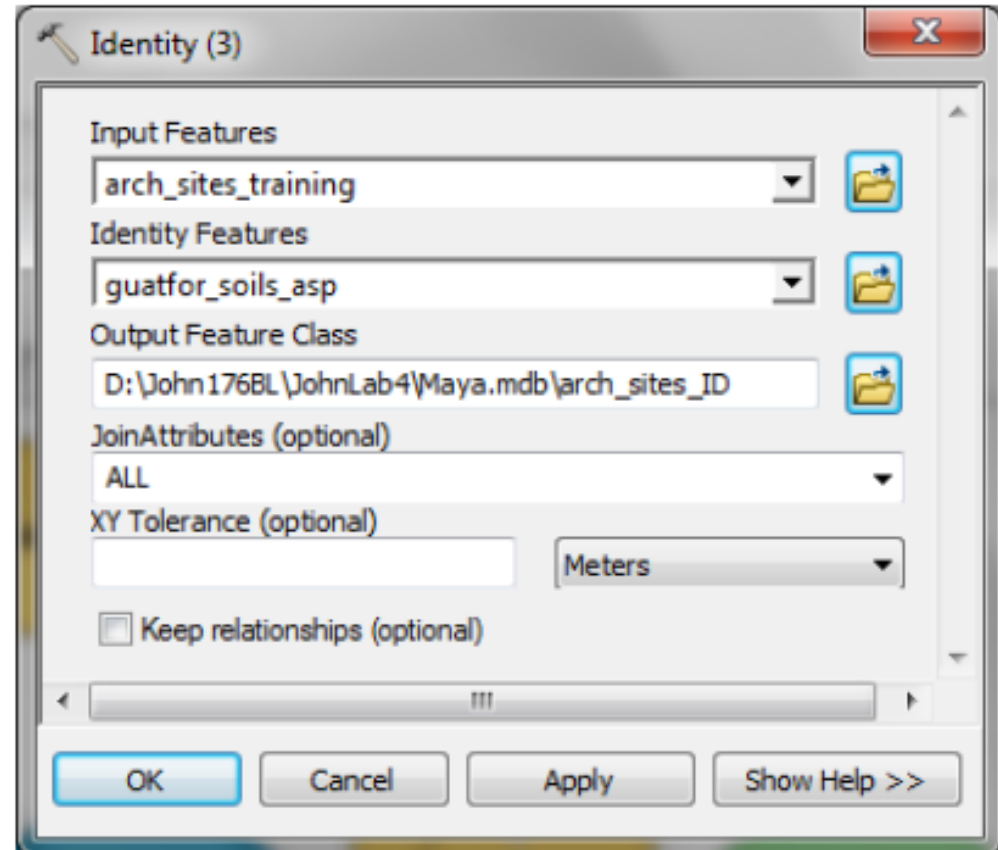
Step 5: Determine site attributes

Input Table
arch_sites_ID

Output Table
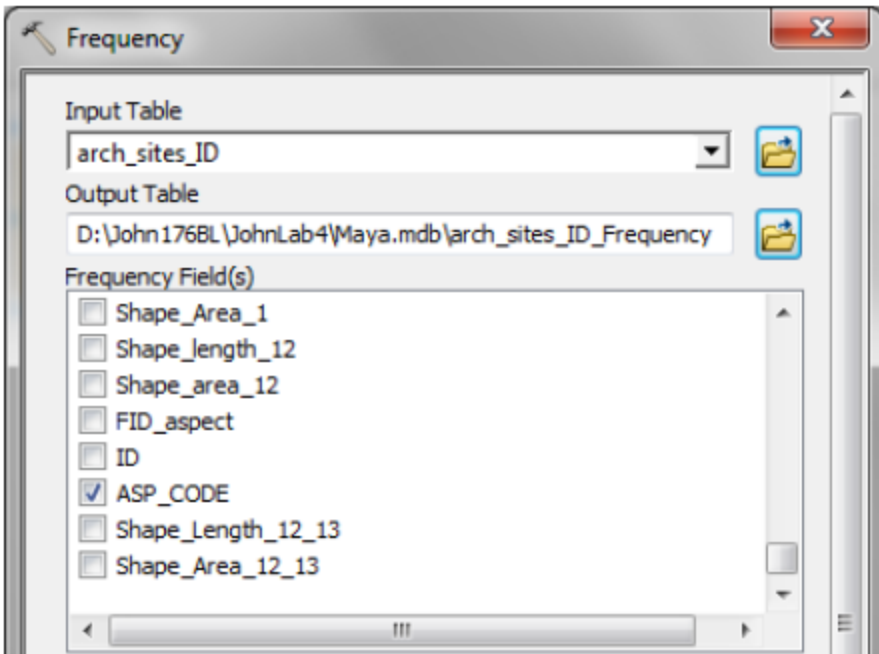D:\John176BL\JohnLab4\Maya.mdb\arch_sites_ID_Frequency

Frequency Field(s)
- ☐ Shape_Area_1
- ☐ Shape_length_12
- ☐ Shape_area_12
- ☐ FID_aspect
- ☐ ID
- ☑ ASP_CODE
- ☐ Shape_Length_12_13
- ☐ Shape_Area_12_13

Select All   Unselect All   Add Field

Summary Field(s) (optional)
- ☐ FID_arch_sites_training
- ☐ AREA
- ☐ PERIMETER
- ☐ ARCH_
- ☐ ARCH_ID
- ☐ PROVINCE
- ☐ POLYGONID
- ☐ SCALE
- ☐ ANGLE

Select All   Unselect All   Add Field

OK   Cancel   Apply   Show Help >>

- **Simplify output:**
  - NEAR_DIST - distance
  - DESC_ vegetation
  - R_FERT - soil
 - ASP_CODE - aspect
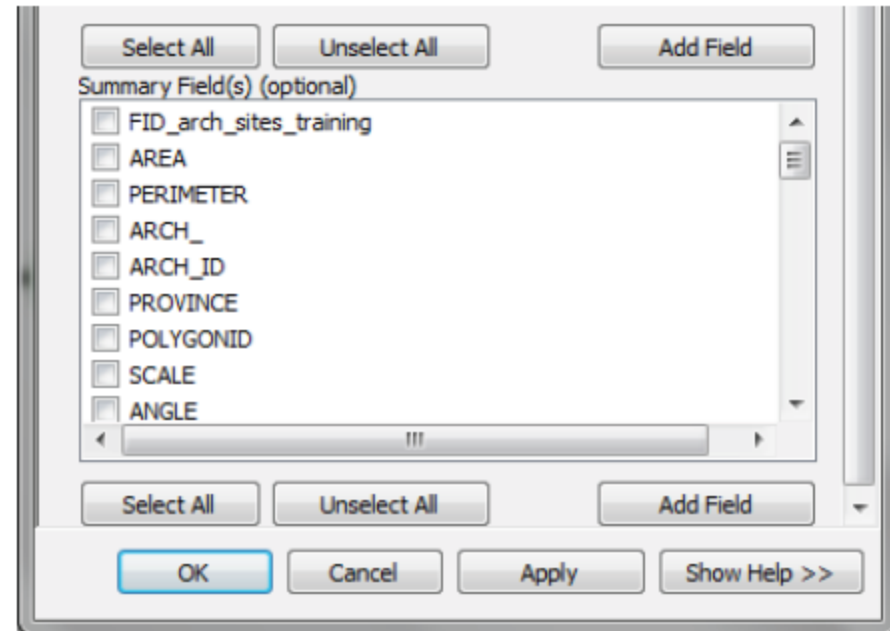
Final model in ModelBuilder

6. RUN and results

- Check the clusters based on Frequency.
- Establish working hypthesis for selected sites (whot is different/ what complies with the original hypothesis)
- Test the hypothesis both using GIS and in the field.

arch_sites_ID_Frequency   ✕

OBJECTID *	FREQUENCY	NEAR_DIST	DESC_	R_FERT	ASP_CODE
1	1	-1	Inland swamp forest	4	10
2	1	-1	Lowland rain forest	1	2
3	2	-1	Lowland rain forest	1	5
4	2	-1	Lowland rain forest	1	9
5	1	-1	Non forest	1	10
6	1	68.570929		2	10
7	1	177.68938		2	9
8	1	274.989335	Lowland rain forest	1	4
9	1	327.802407	Non forest	1	8
10	1	427.268735	Inland swamp forest	2	4
11	1	546.290435	Non forest	1	7
12	1	593.566121	Lowland rain forest	4	6
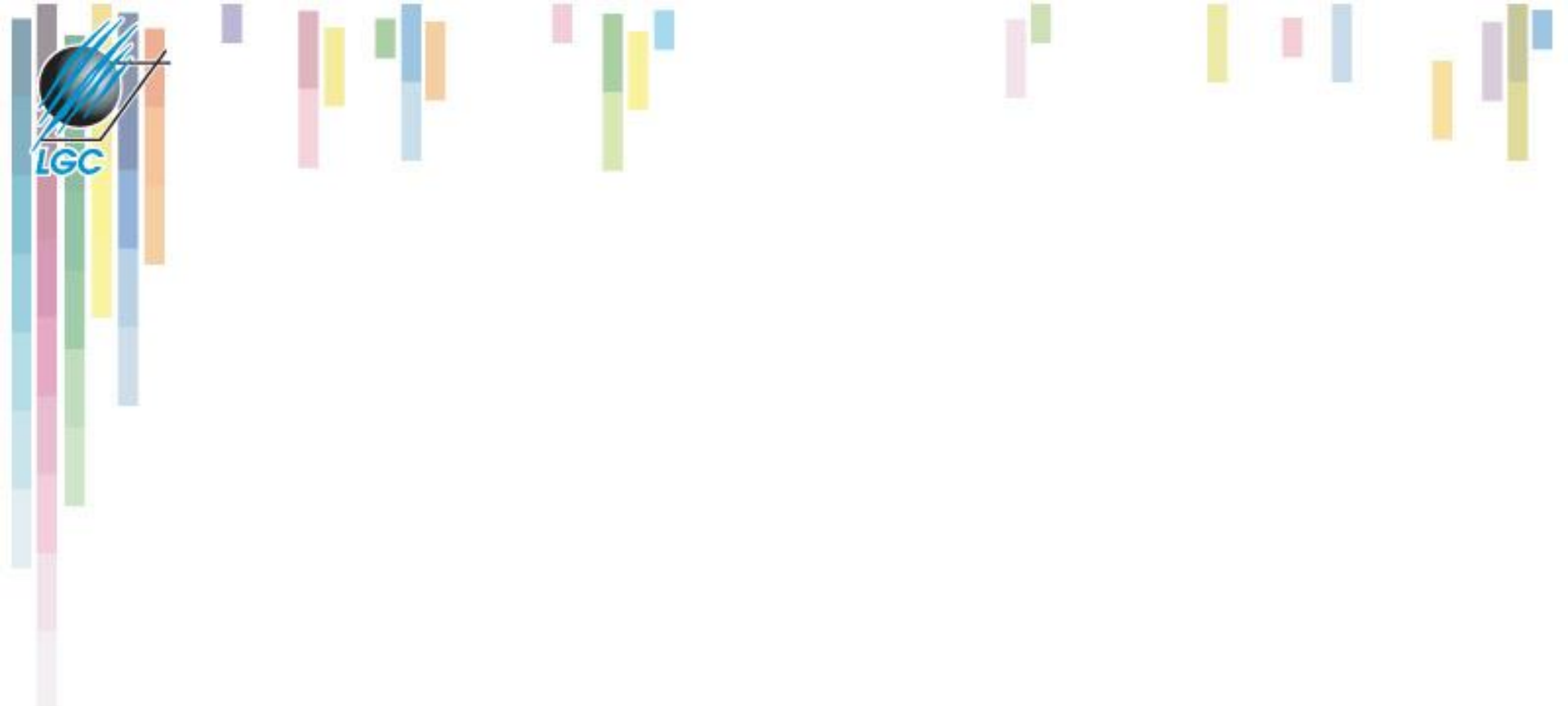
CRIME MAPPING AND ANALYSIS

The role of 'place' in crime

Two key considerations (Spencer Chainey)

- Crime has an inherent **geographical quality.**
- Crime is **not randomly distributed.**
- **DO YOU AGREE?**

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 – Person V – Person O - WHERE

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.**

Car Prowls
Roads
Street Lights

Current use of GIS in police practice

| Logistics	Planning & Analysis	Field Operations	Operational Awareness	Public Information
Manage CCTV locations	Crime Hotspot Analysis	Field Interviews	Visualize Real-Time Data	Public Event Maps
Vehicle Routing	Special Event Planning	Tactical Planning	Dashboards	Quality of Life Complaints
Case Workload Management	Critical Infrastructure Pre-Plans	Location-Based Alerting	Conducting Briefings	Crime Tips
Fleet Management	Grant Applications	Investigative Support	Evaluating Effectiveness	Public Crime Mapping
Re-Districting	Predictive Analysis	Real-Time Info	CompStat	Major Case Story Maps
				Social Media Monitoring

- **Community policing**

Major GIS Trends in Law Enforcement

Predictive Policing

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

Descriptive vs. Predictive modelling
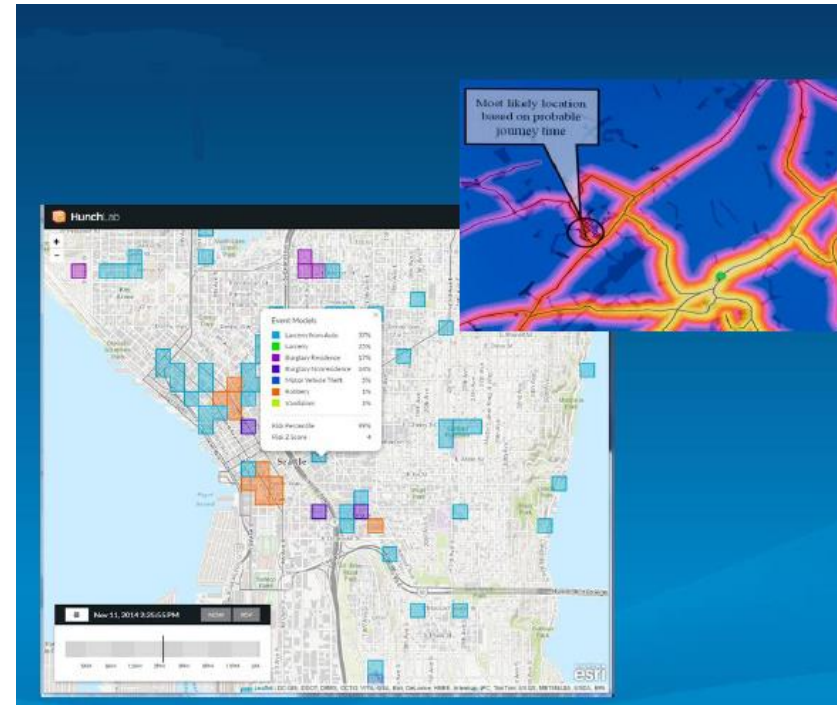
Topics to be covered in detail

- **Hot spot analysis**

- Near repeat victimisation

- **Risk Terrain mapping principles**

- most hot spot analysis methods fall into one of five categories:

- *visual interpretation*,

- *Choropleth mapping*,

- *grid cell analysis*,

- *Cluster analysis*,

- and *spatial autocorrelation*

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 .
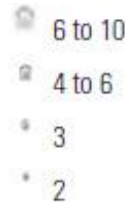
Point hot spots

A

B
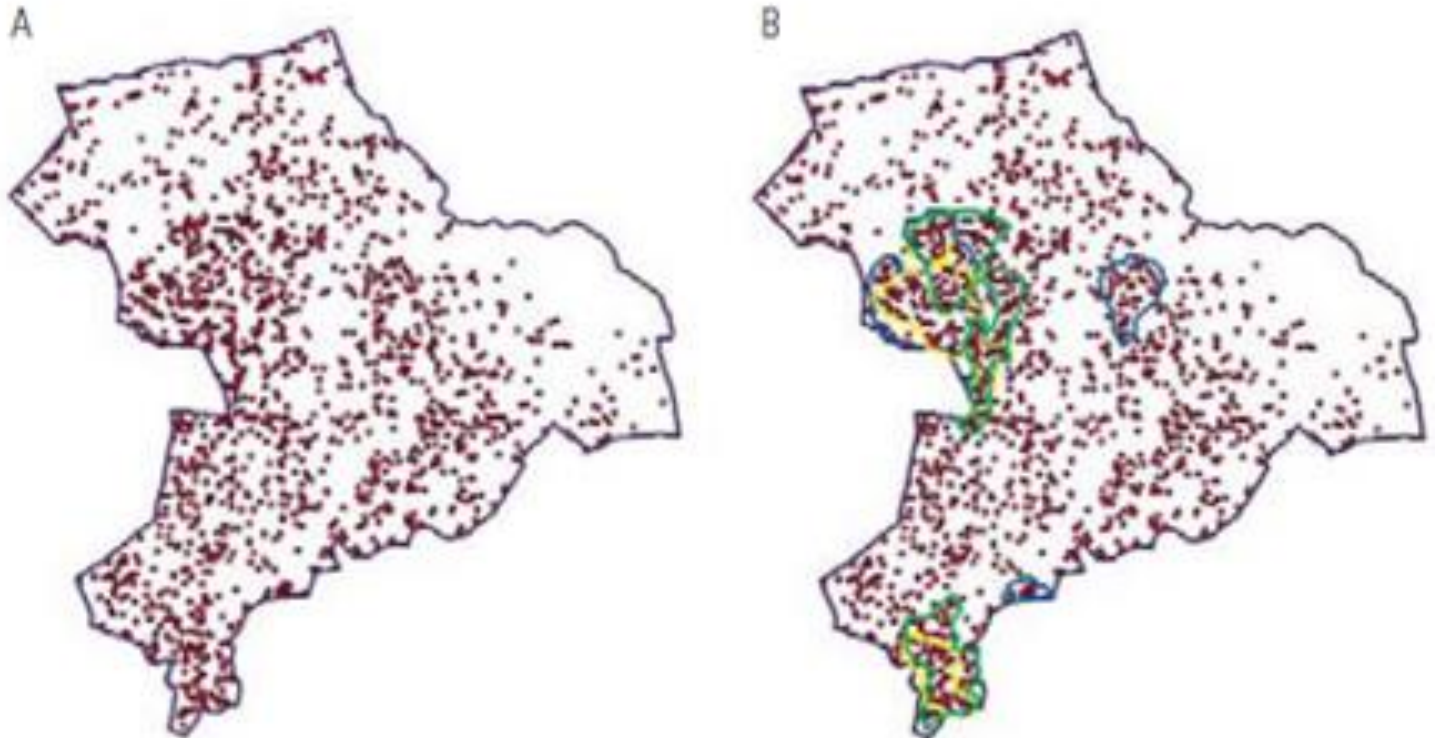
— Crime analyst 1
— Crime analyst 2
— Crime analyst 3

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.

6 to 10

4 to 6

3

2

Spatial ellipses

- **SW based spatial 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**.
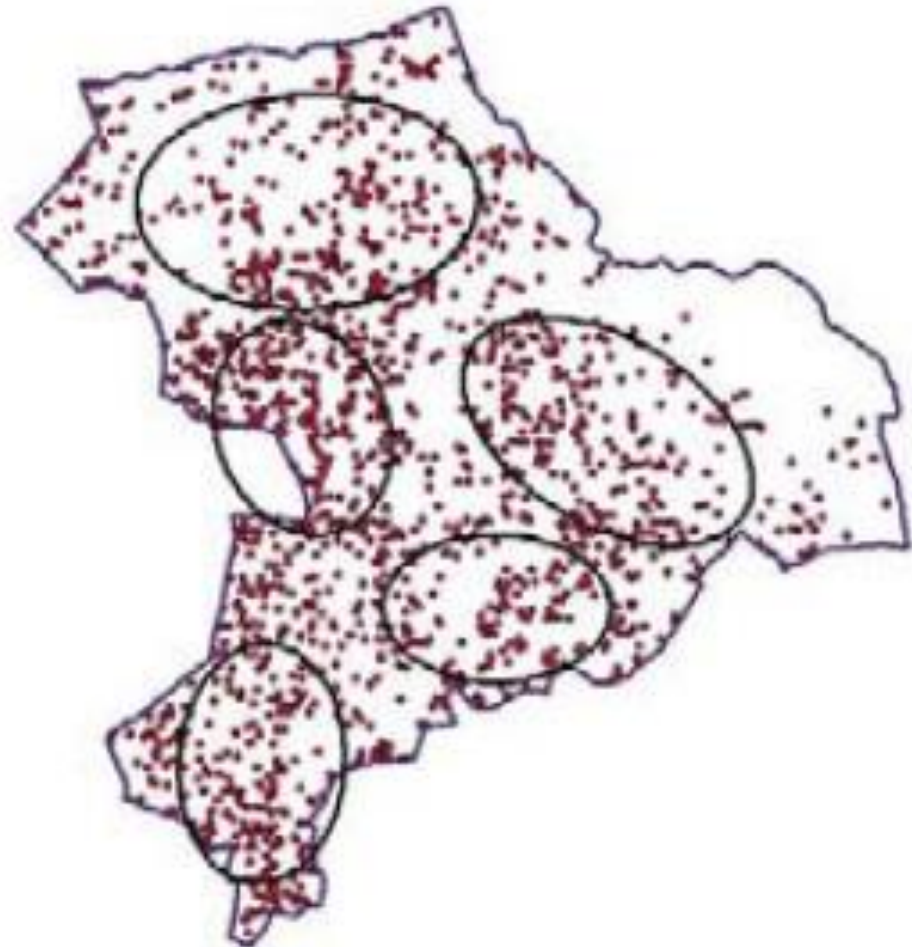
Thematic mapping of geographic boundaries

- 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.


Greater than 15
10 to 15
5 to 10
1 to 5
0
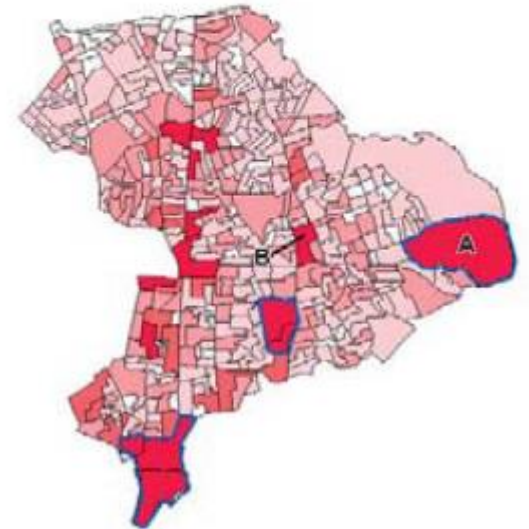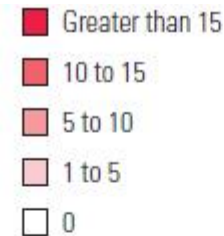
Quadrat thematic mapping – raster based analysis

- **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**.

250-m quadrat thematic map

■ Greater than 15
■ 10 to 15
■ 5 to 10
□ 1 to 5
□ No crime

Vehicle crimes by 250-m quadrats
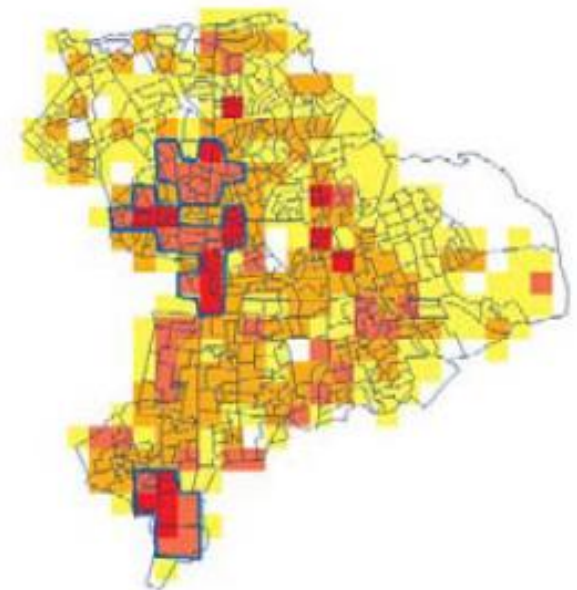
Interpolation and continuous surface smoothing methods

- **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.

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.
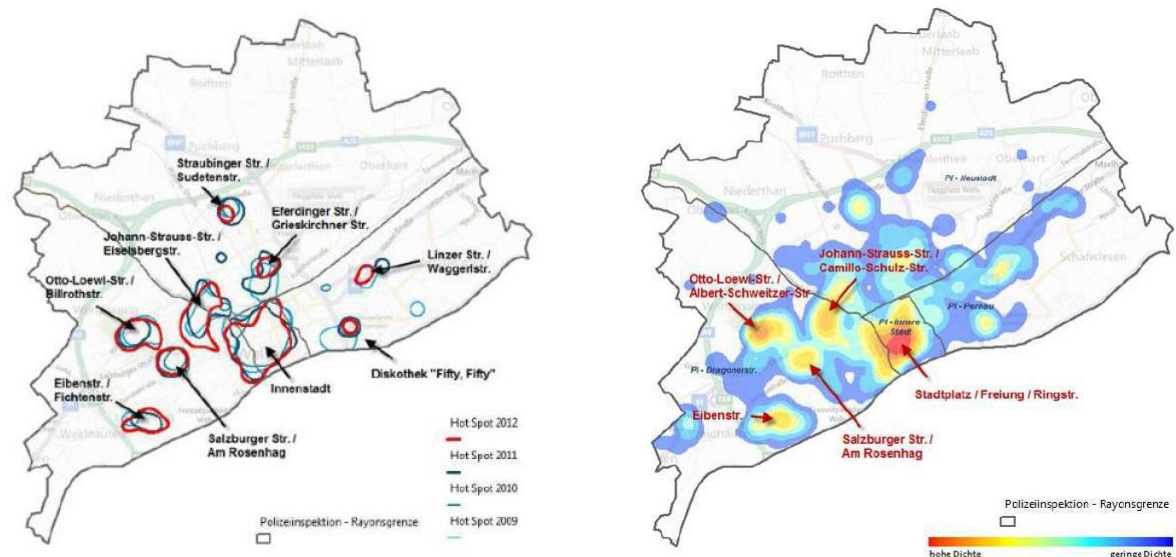
Quartic kernel density Hot spot

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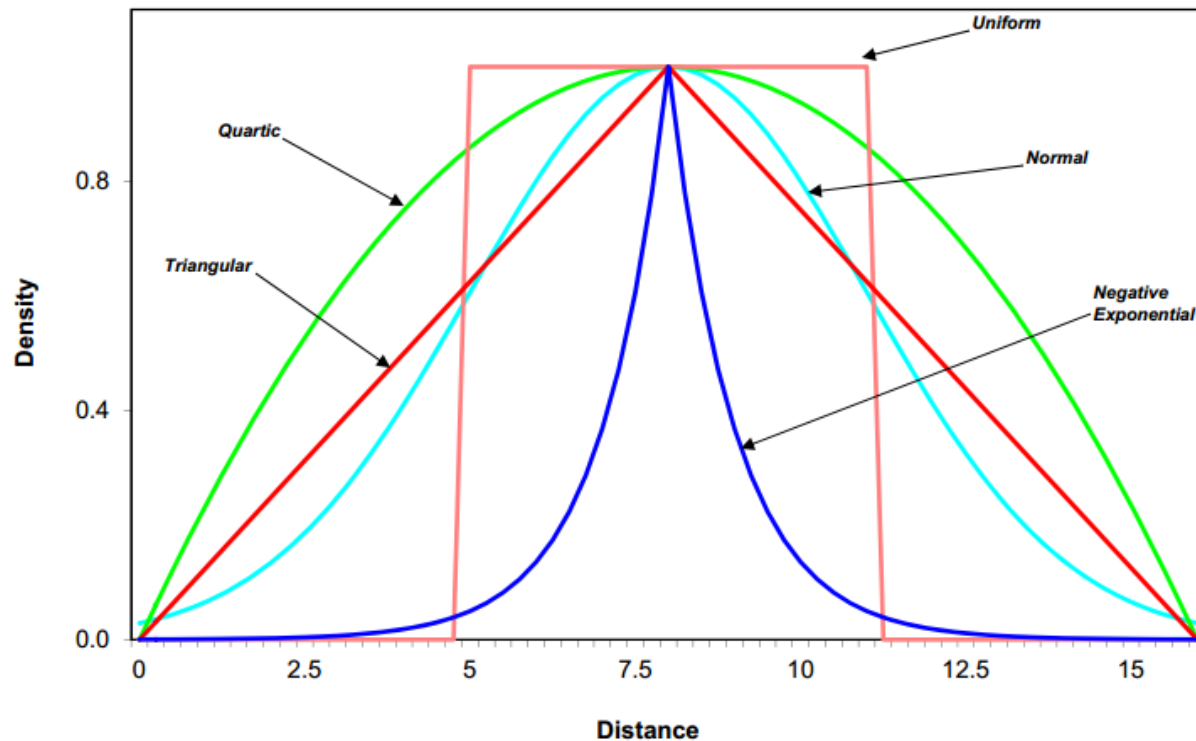- reflect more accurately the **location and spatial distribution of crime hot spots.**

Quartic kernel density estimation surface for vehicle crime using a bandwidth of 220 m (K16)

- Highest intensity
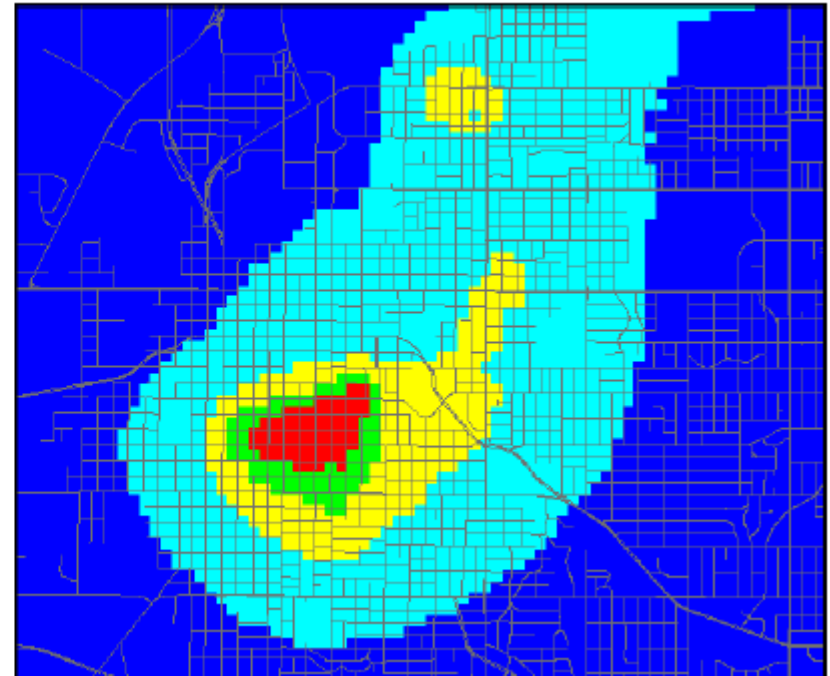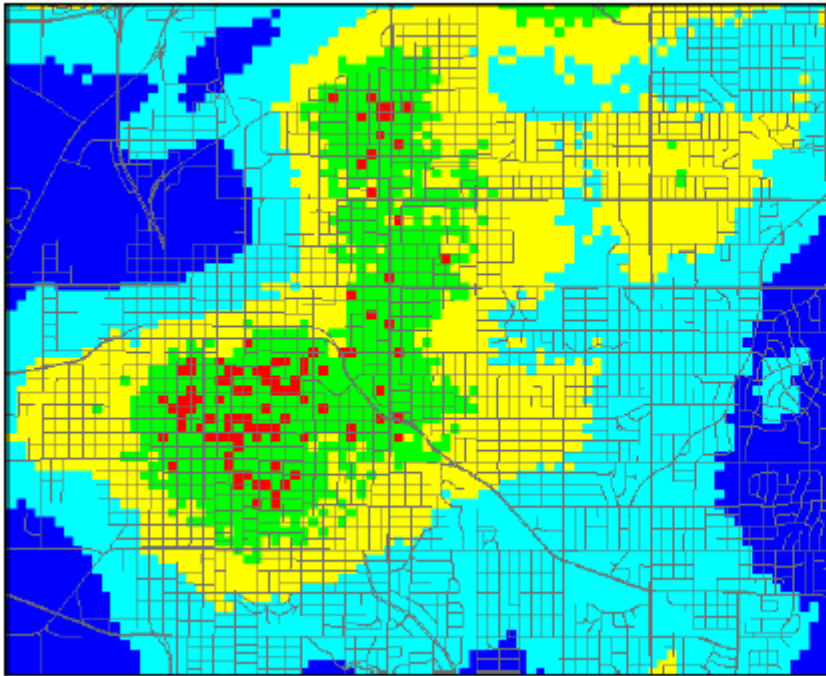- Lowest intensity
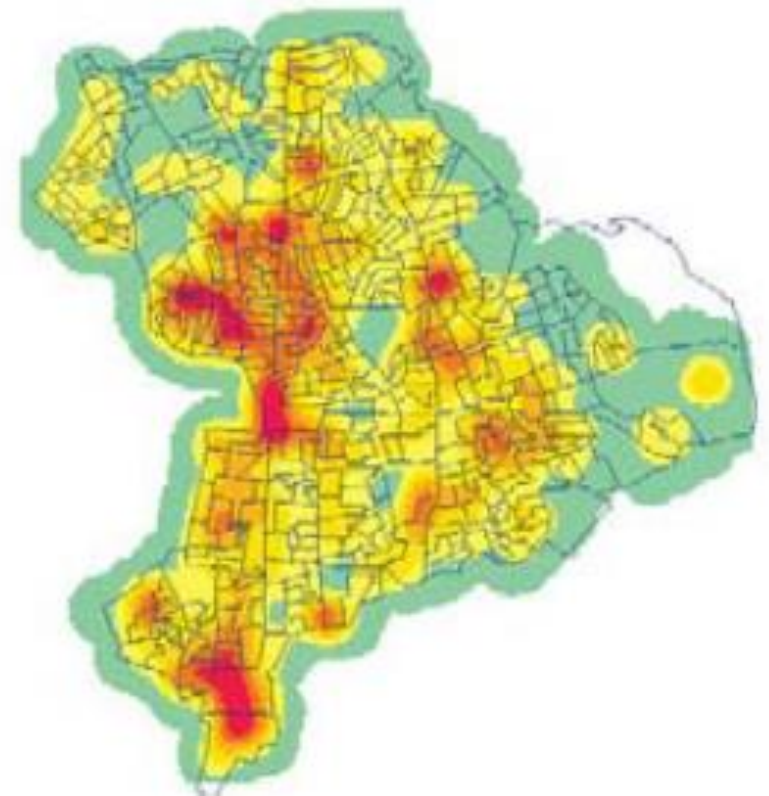
Tech box – Hot spot mapping methods

- **Technical problems:**
  - Kernel type and its size:
    - Normal, Uniform, Quartic, Triangular..

Kernal type dependencies

- **Triangular   vs. Normal (Gauss)**

Kernel size

- **Even more important than type.**
- **Adaptive size vs. Fixed size**
- **Adaptive – varying size covering at least defined number of events. For heterogeneous data types (different concetrations of events/crimes in different parts of the city).**
- **Fixed size – regardless the number of events. Can be crime specific.**

Druh kriminality	Druh kernelu	pásmo (m)
Loupež	Kvartická	200
Výtržnictví	Kvartická	200
Úmyslné ublížení na zdraví	Kvartická	200
Krádeže motorových vozidel	Válcová	100
Krádeže věcí z aut	Válcová	100

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%)
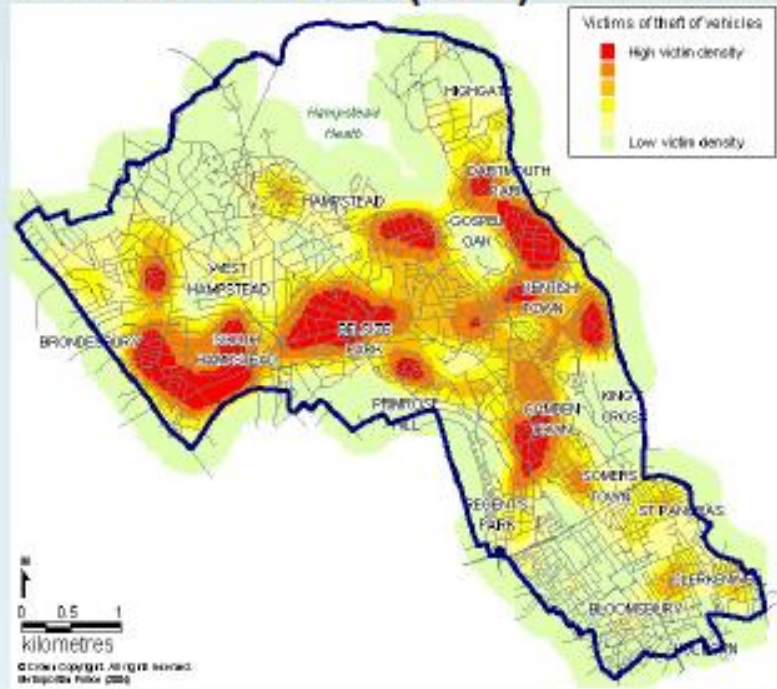
Non-Camden victims (42%)
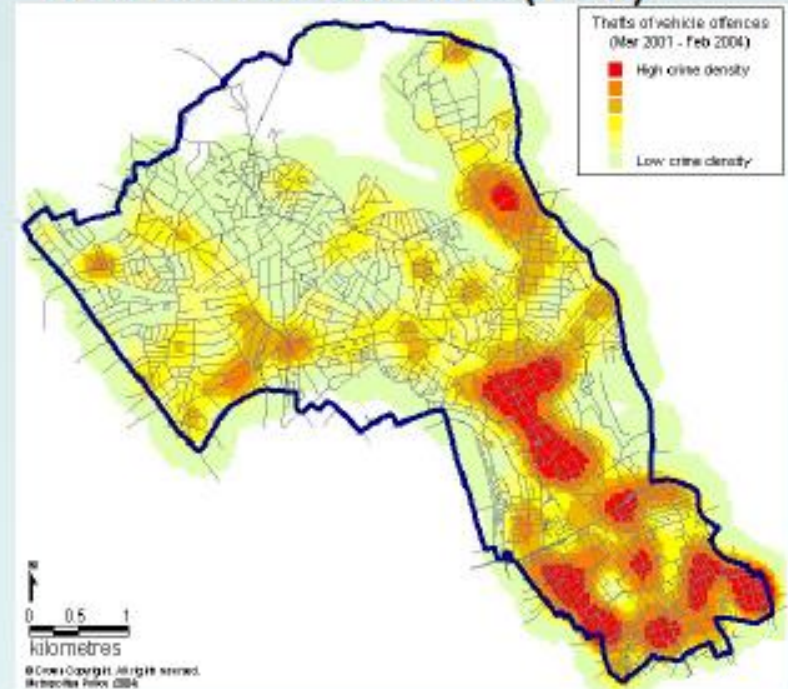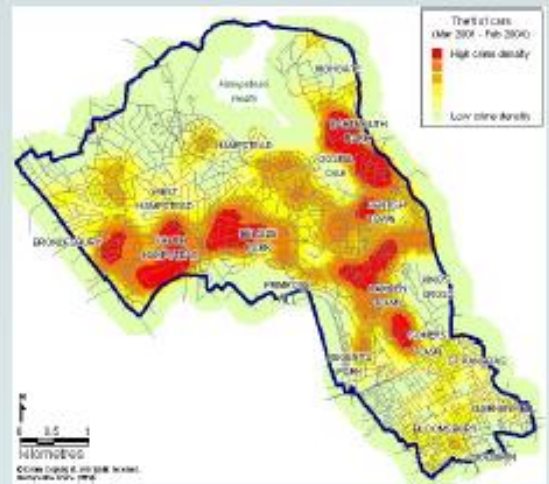
of Crime Sc

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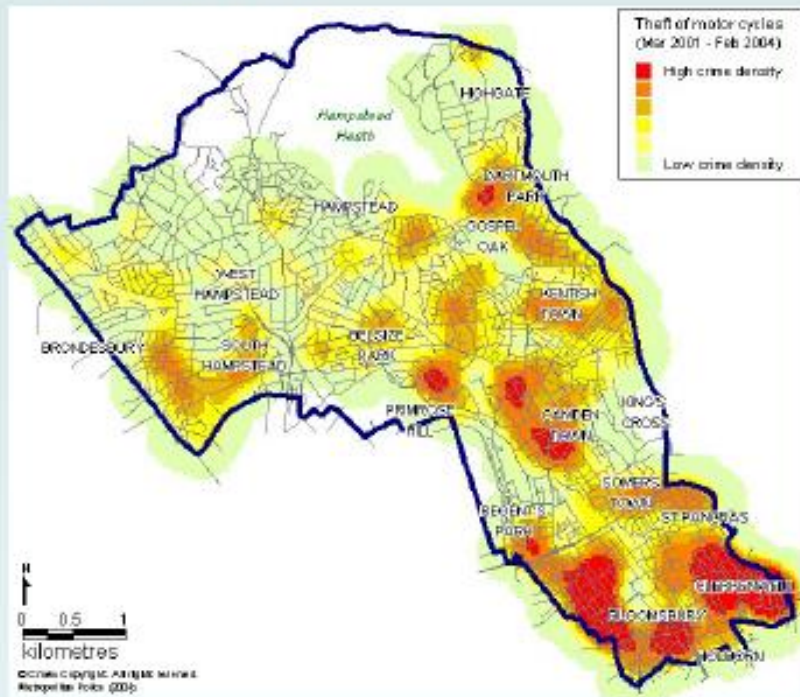
Vehicle type description	Offences	%
Hatchback	1258	21.7%
Saloon	1433	24.7%
Estate	220	3.8%
People carrier	45	0.8%
Convertible	120	2.1%
Sports	42	0.7%
4 X 4's	4	0.1%
Moped or scooter	1494	25.8%
Motor cycle	755	13.0%
Motor caravan	11	0.2%
Van	274	4.7%
Other	50	0.9%
Not known	23	0.4%

Cars

Motorbikes

Scooters and mopeds

Theft of vehicles by time of the day

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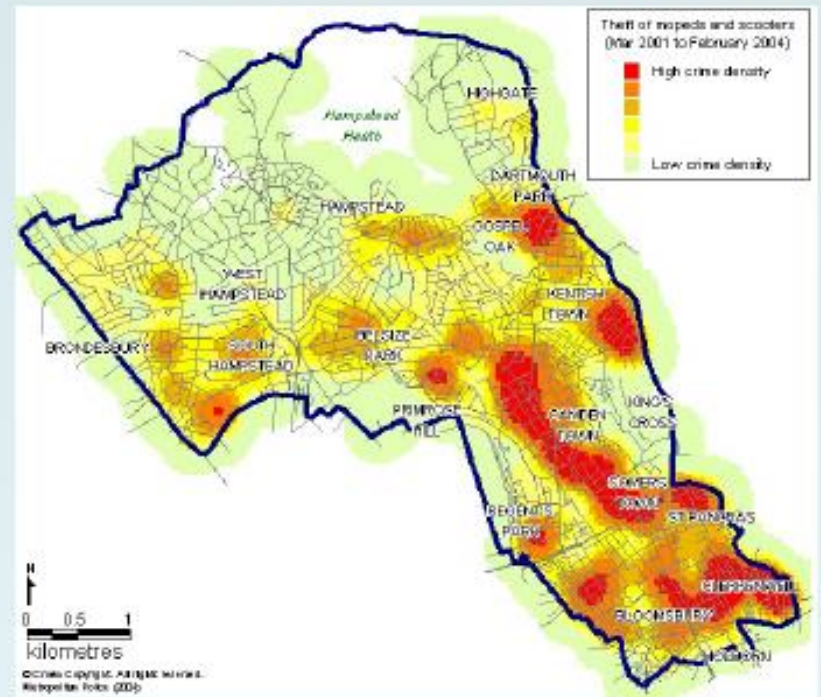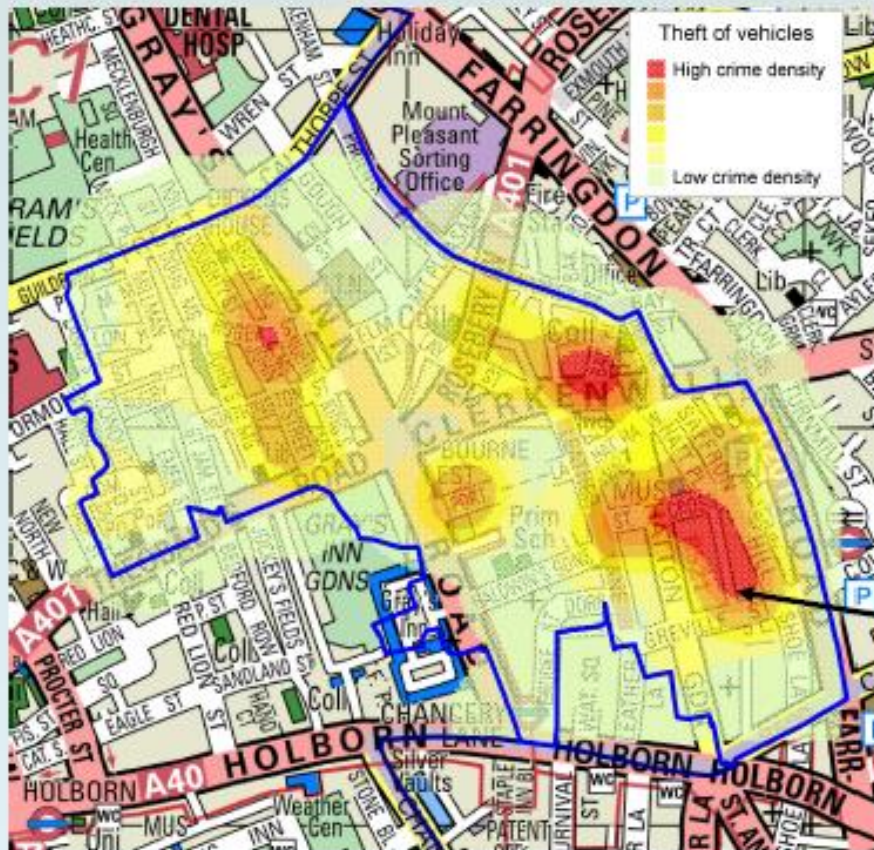
Vehicle type	Camden	Clerkenwell (n)	Clerkenwell(%)
Car	51%	41	18%
Sports or convertible	3%	5	2%
Scooter or moped	26%	95	42%
Motor cycle	13%	70	31%
Van	5%	3	1%
Other	2.0%	10	4%
Not known	0.5%	0	0%

Theft of vehicles
High crime density
Low crime density

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

Methodology for KDE (Horák et al, 2015)

Standardized manual of kernel density estimation (KDE) utilisation for identification of anomalous crime localities.
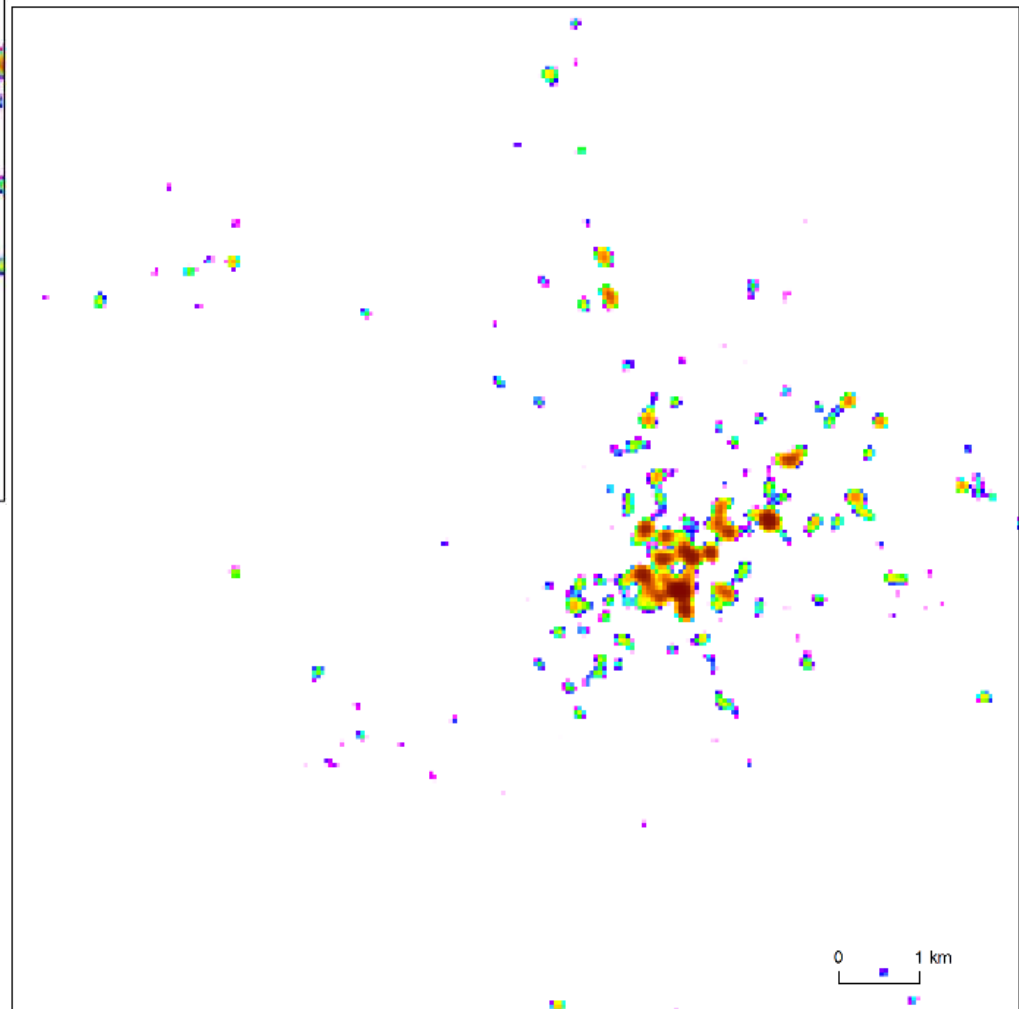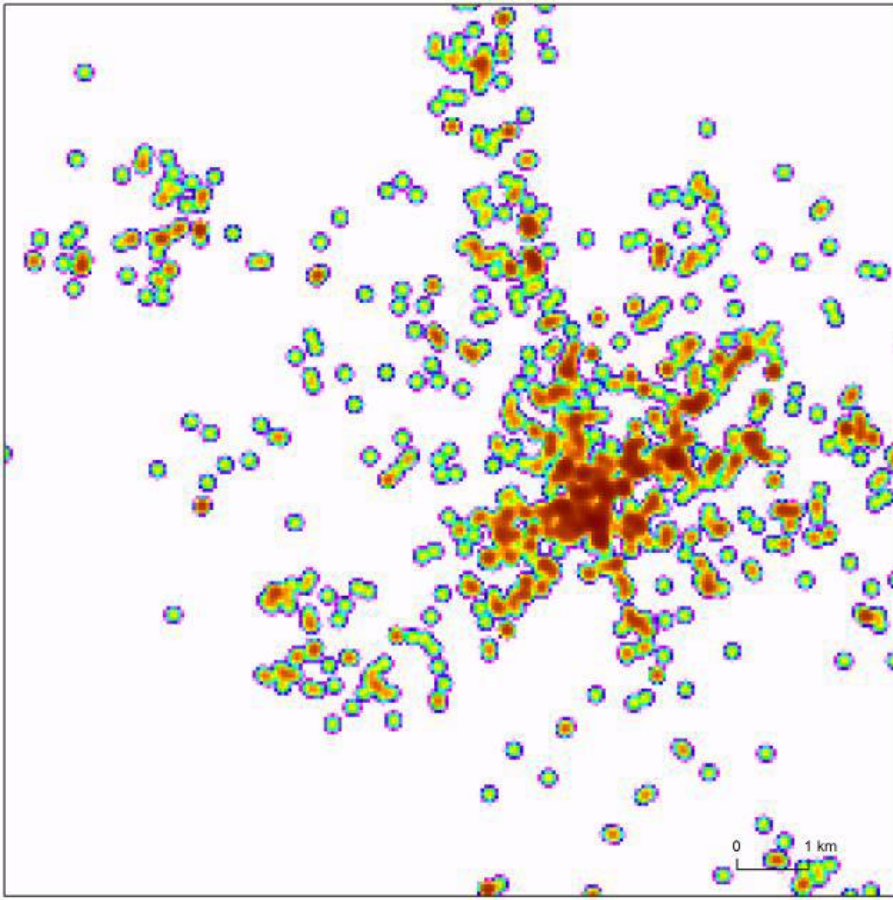
- **Data preparation – point data, correct and precise.**
- **Method settings – fixed, adaptive, cell size, extent**
- **Data processing – highest values only (based on purpose)**
- **Visualization**

50 – 200 – 400 m extent
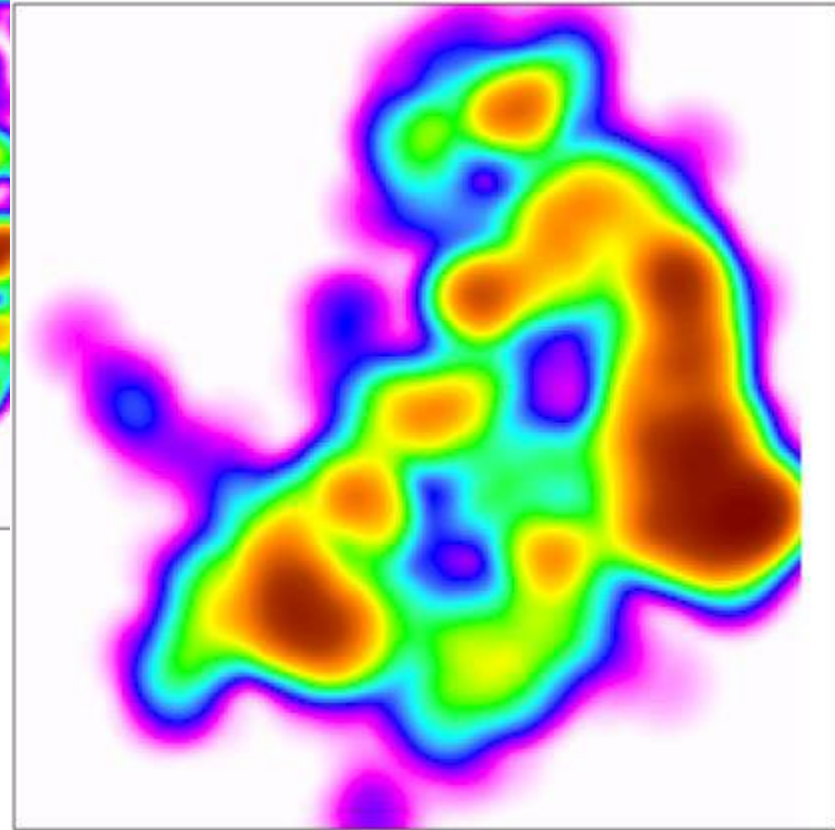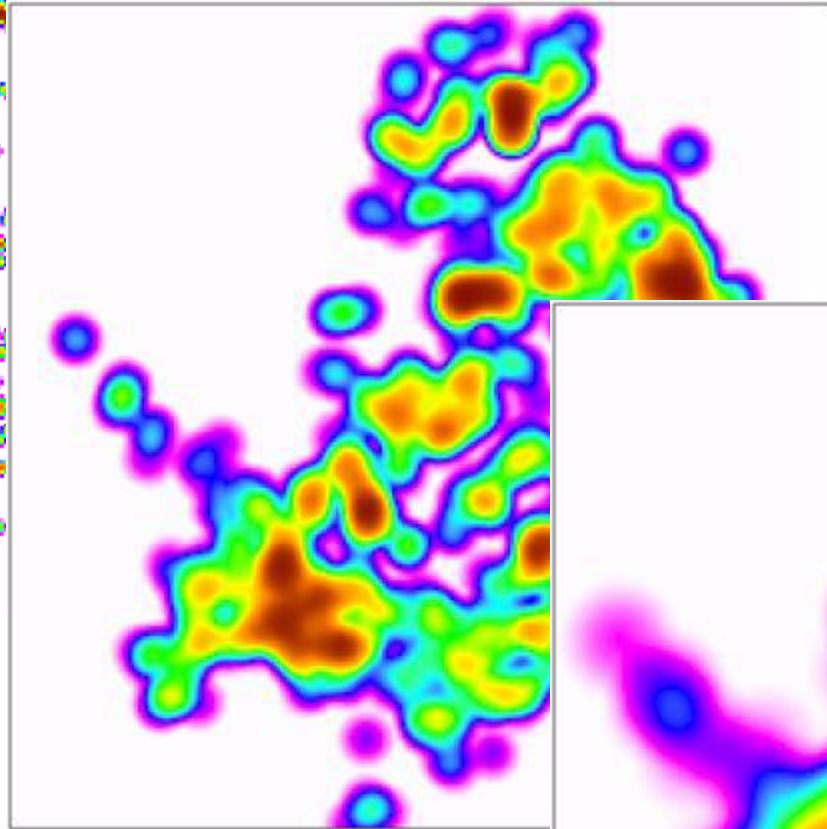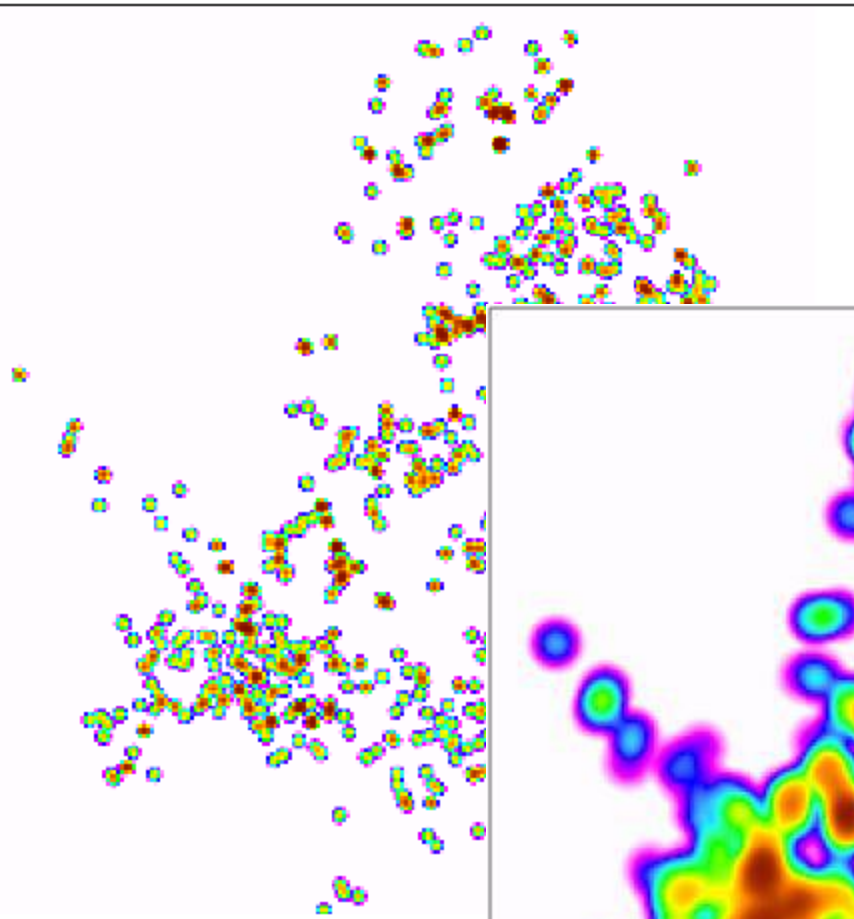
Complete data vs.
Upper 10%

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

Multifamily Repeats
- 2
- 3
- 4
- 5 - 6
- 7 and higher

Single Family Repeat
- 2
- 3
- 4
- 5 - 6
- 7 and above
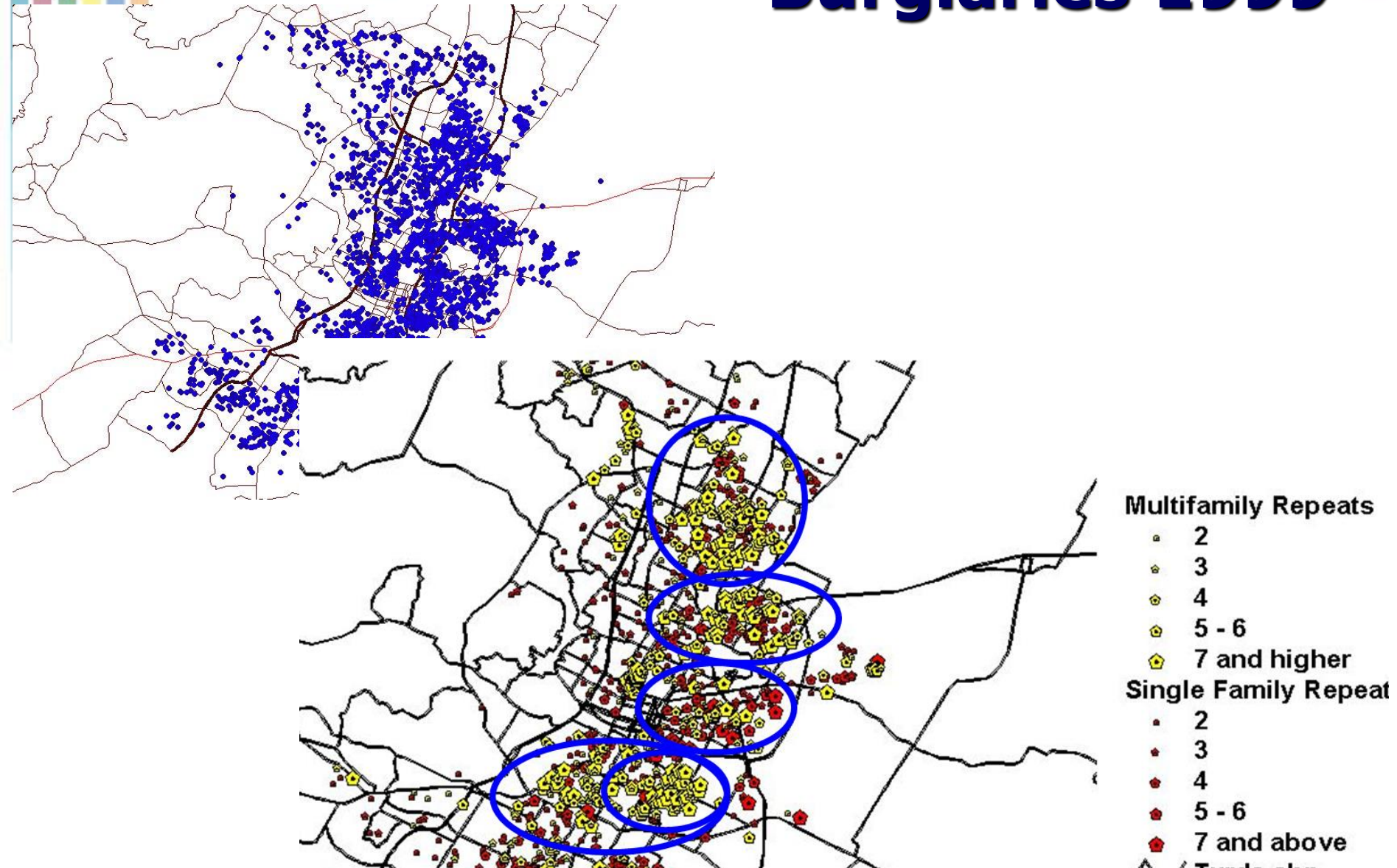
Explaining Repeat Victimisation

- 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.
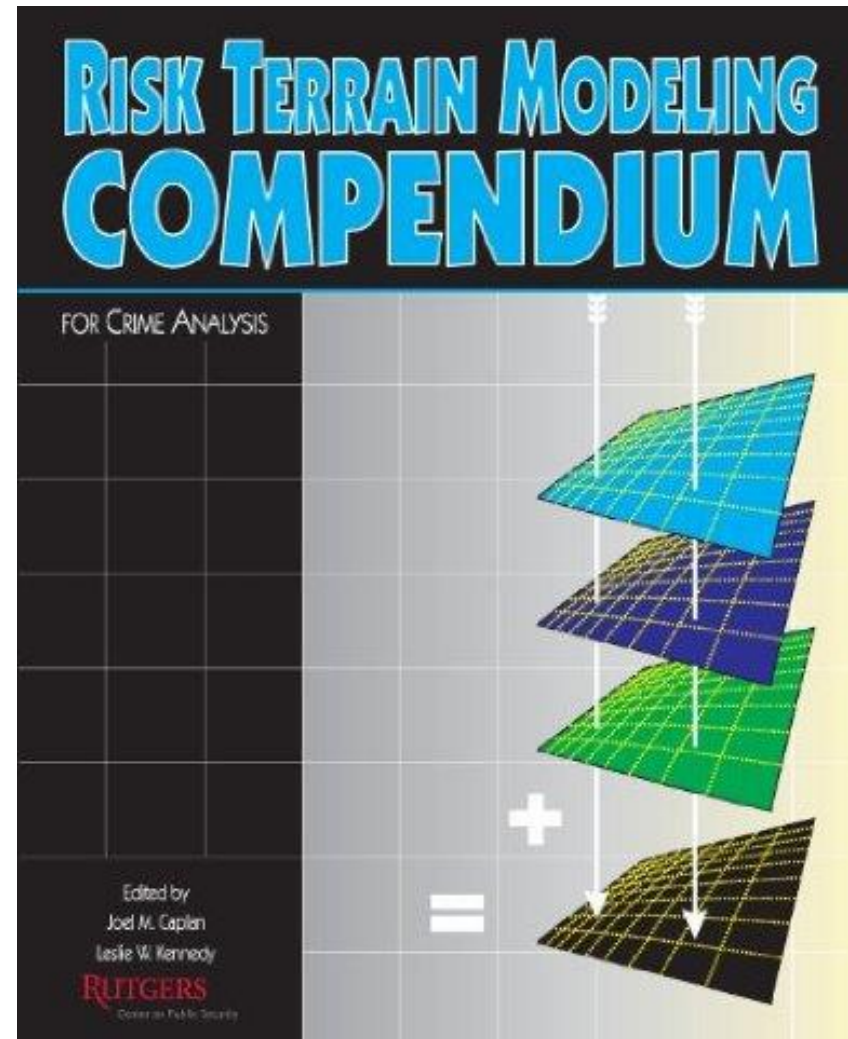
Predictive Crime Analysis

- „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 ☺

RISK TERRAIN MODELING COMPENDIUM

FOR CRIME ANALYSIS

Edited by
Joel M. Caplan
Leslie W. Kennedy

RUTGERS
Center on Public Security

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
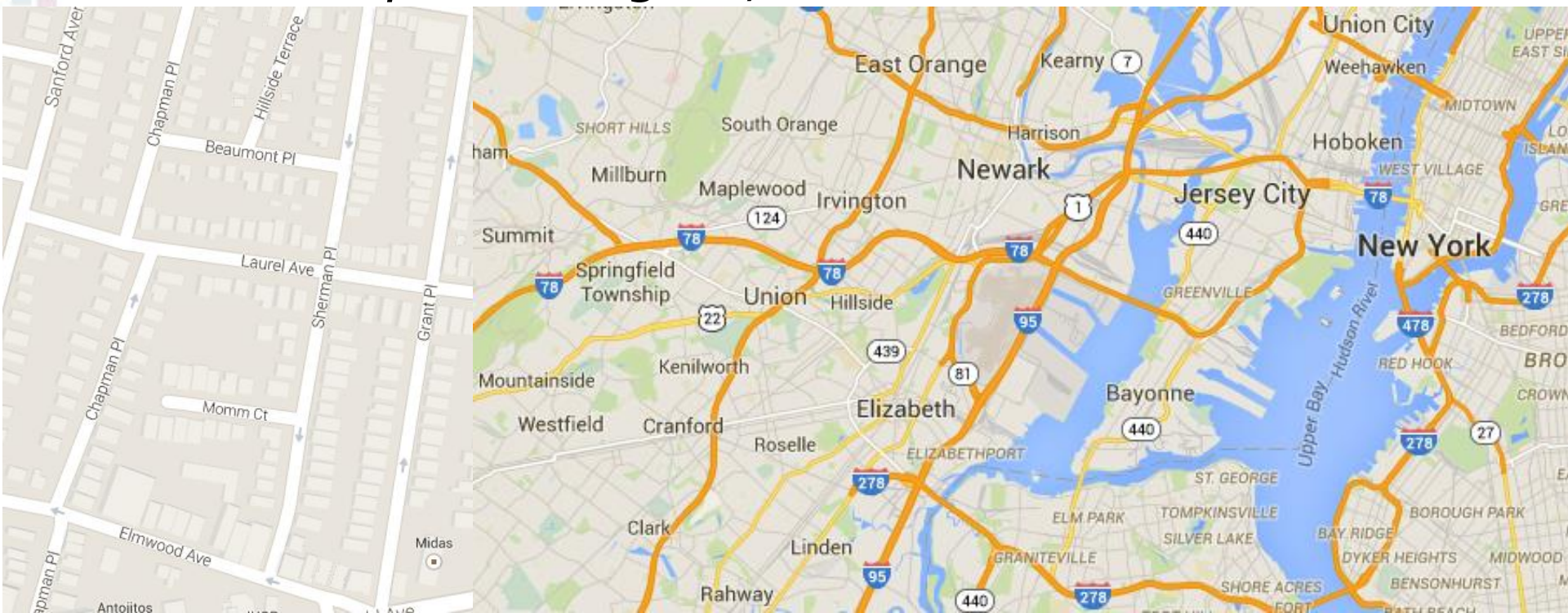10. **Finalize** the risk terrain map to **communicate** meaningful and actionable information.

Step 1 -2

1. Select an outcome **event** of particular interest
Gun shooting incidents.

2. Choose a study **area *on which risk terrain maps will be created.***

The Township of Irvington, NJ.

STEP 3: Choose a time period to create risk terrain maps for.

- Six month time period: January 1 to June 30.

- It is expected that this time period will adequately assess the place-based risk of shootings during the next 6-month time period (July 1 to December 31).

- **Data availability and comparability ?? Is it really justifiable and valid for the Czech Republic?**

- ***STEP 4: Obtain base maps of your study area.***

- Two base maps were obtained from Census 2000 TIGER/Line Shapefiles:

  - 1) Polygon shapefile of the Township and

  - 2) **Street centerline** shapefile for the Township.
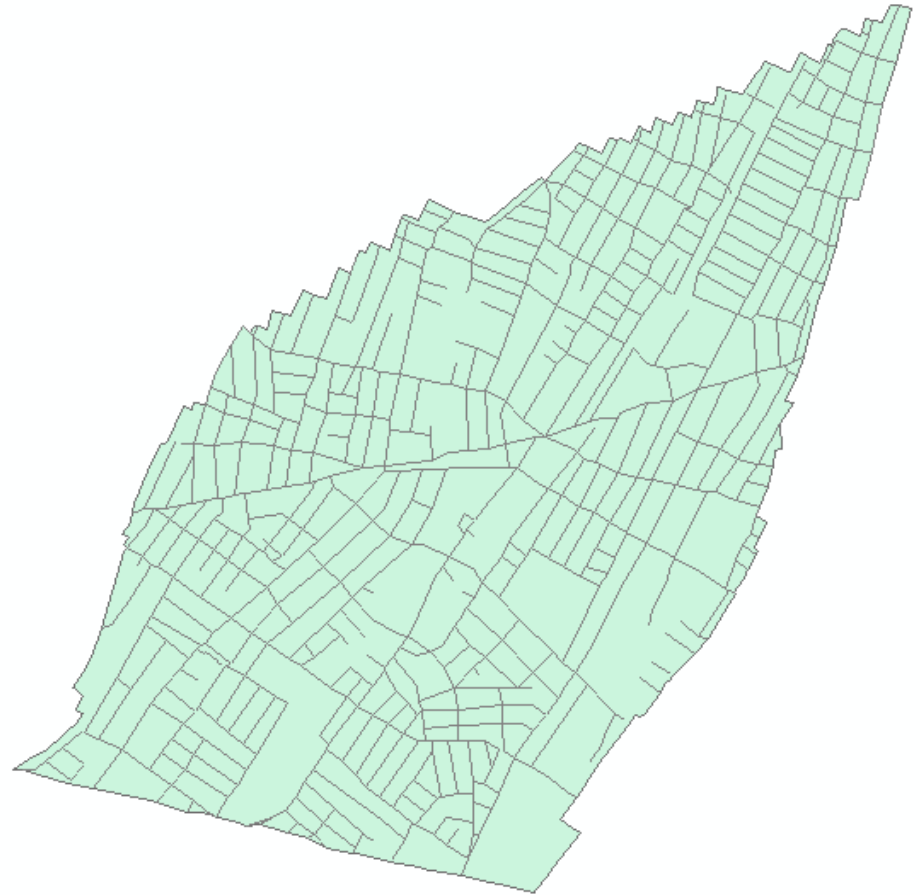
STEP 5: Identify aggravating and mitigating risk factors that are related to the outcome event.

- Three **aggravating factors** were identified based on a *review of empirical literature*:
  - dwellings of known gang members (**habitual offenders**),
  - locations of **retail business infrastructure (**bars, strip clubs, bus stops, check cashing outlets, pawn shops, fast food restaurants, and liquor stores),
 - locations of **drug arrests** (places, where the police action happened).

- ***STEP 6: Select particular risk factors to include in the risk terrain model.***
- All three risk factors identified in Step 5 will be included.
- Raw data in tabular form (i.e. Excel spreadsheets) was provided by the Township police and the many **datasets they maintain, validate and update regularly to support internal crime analysis and police investigations**.
- Attributes + **addresses** + time stamps + ??
- **State of the art of the investigation including the punishment and legal procedure.**

- ***STEP 7: Operationalize risk factors to risk map layers.***

- The tabular data was geocoded to street centerlines of Irvington to create point features representing:

  - the locations of gang members' **residences** (hiden on the map to protect the gang members),

  - retail **business outlets**,

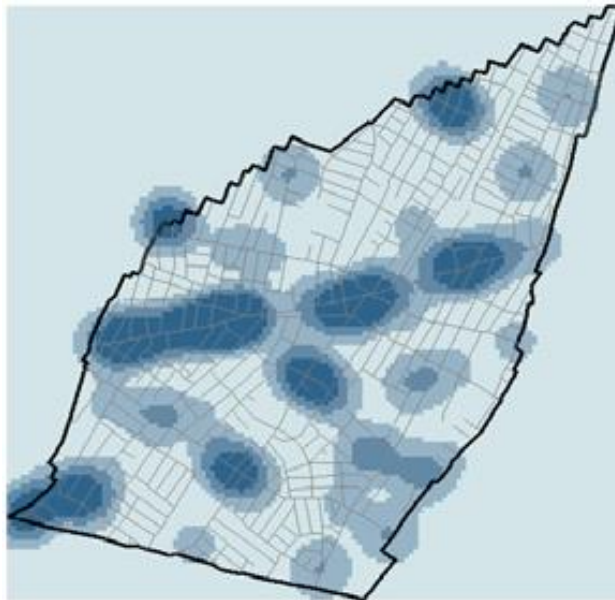 - and **drug arrests**,

  respectively as three separate map layers.
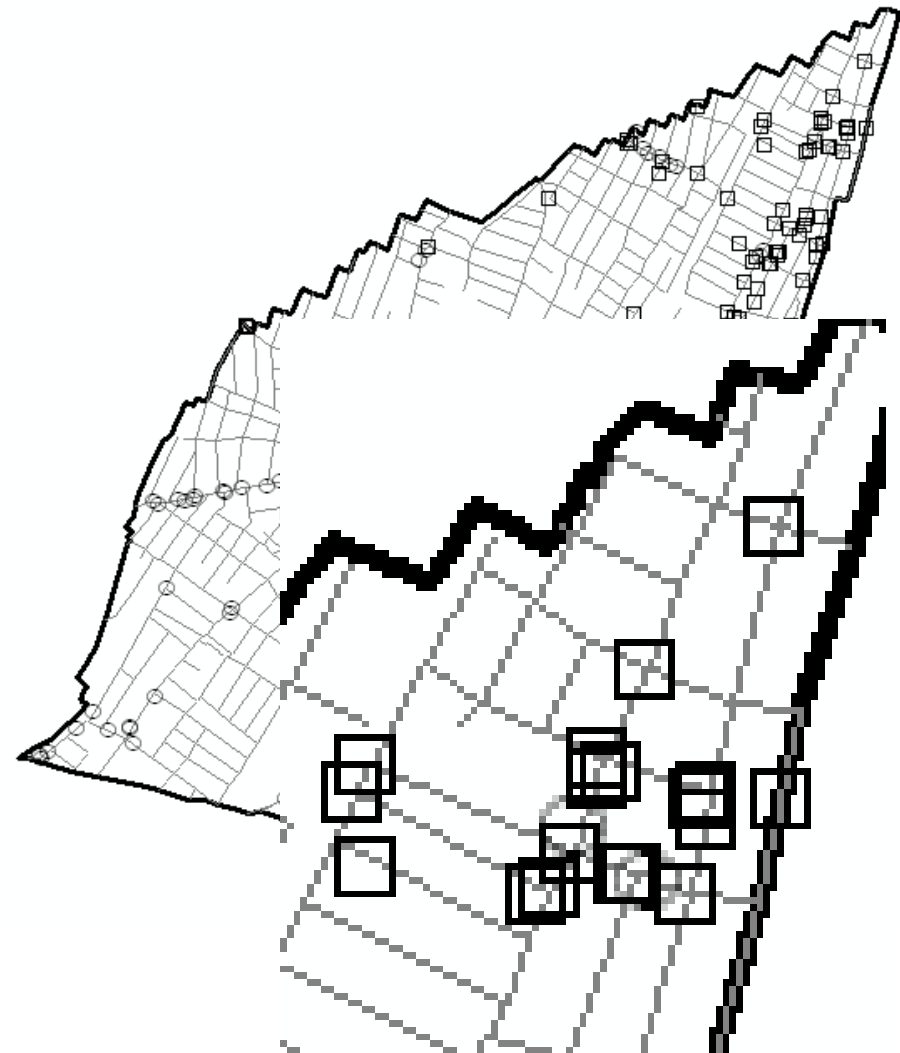
Step 7a – gang member residence

The spatial influence of the "gang members' residences" risk factor was operationalized as: "Areas with **greater concentrations of gang members residing will increase the risk of those places having shootings**." So, a **density map** was created from the points of gang members' residences.
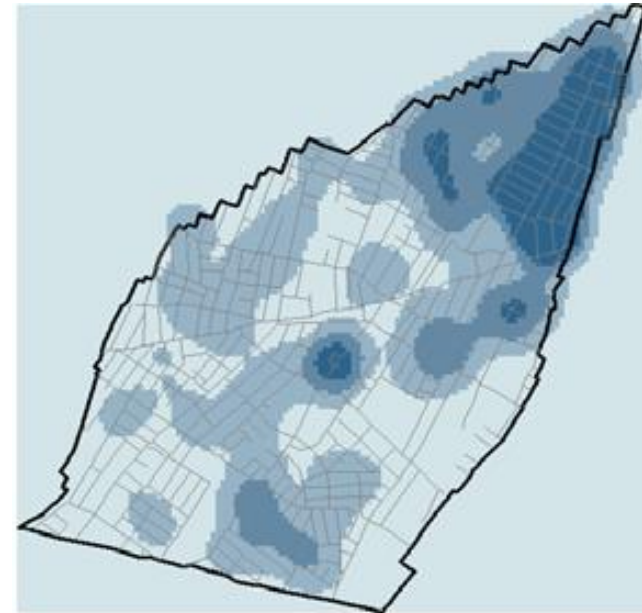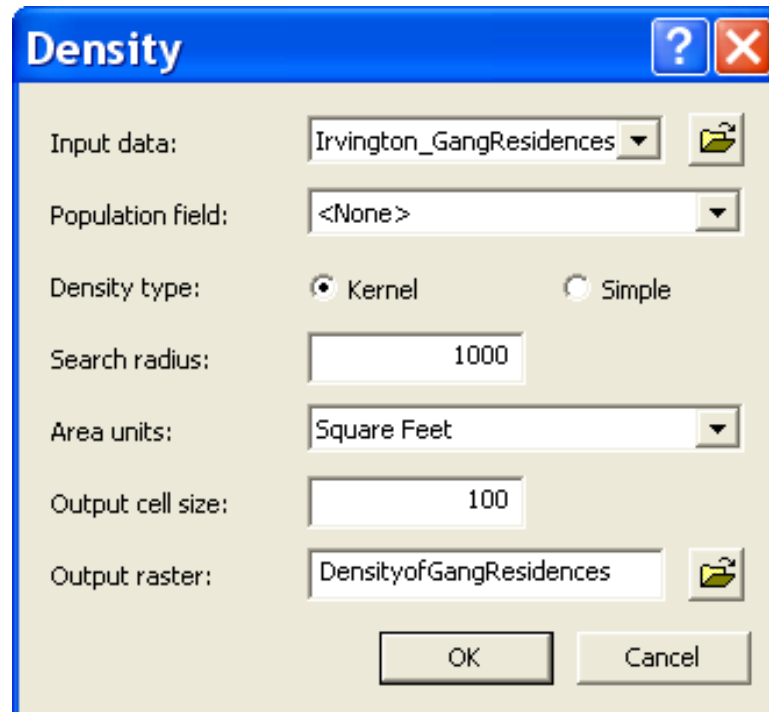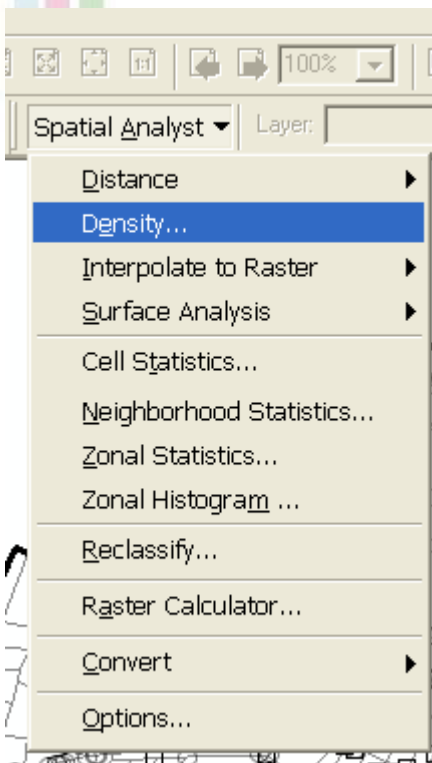
Step 7b - infrastructure

- The spatial influence of the "infrastructure" risk factor was operationalized as:

- "**High concentrations** of bars, strip clubs, bus stops, check cashing outlets, pawn shops, fast food restaurants, and liquor stores **will increase the risk** of those dense places having shootings."
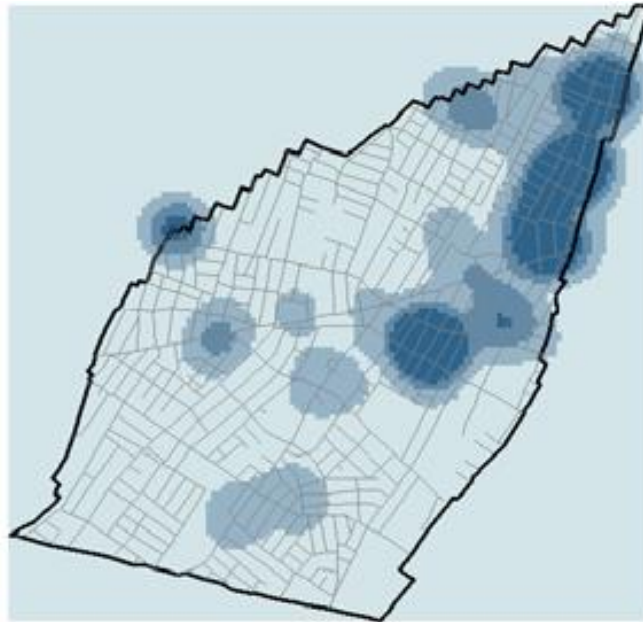
Step 7C – the drug arrest

the "drug arrest" risk factor was operationalized as:

- "Areas with **high concentrations** of drug arrests **will be at a greater risk for shootings** because these arrests create new 'open turf' that other drug dealers fight over to control."

Step 7 – map density method details

- **Kernel density** values were calculated for each of the risk map layers so that *points lying near the center of a cell's search area would be weighted more heavily than those lying near the edge*, in effect smoothing the distribution of values.

- Cells within each density map layer were **classified into four groups according to standard deviational breaks**. The dark blue colored cells had values in the **top five percent** of the distribution and were considered the "**highest risk**" places.

Step 7d – distance from infrastructure

- The spatial influence of the "infrastructure" risk factor was also operationalized as:

- "The **distance of one block**, or about 350ft (app. 100 m), from a facility poses the greatest risk of shootings because **victims** are often **targeted** when **arriving** at or **leaving** the establishment."
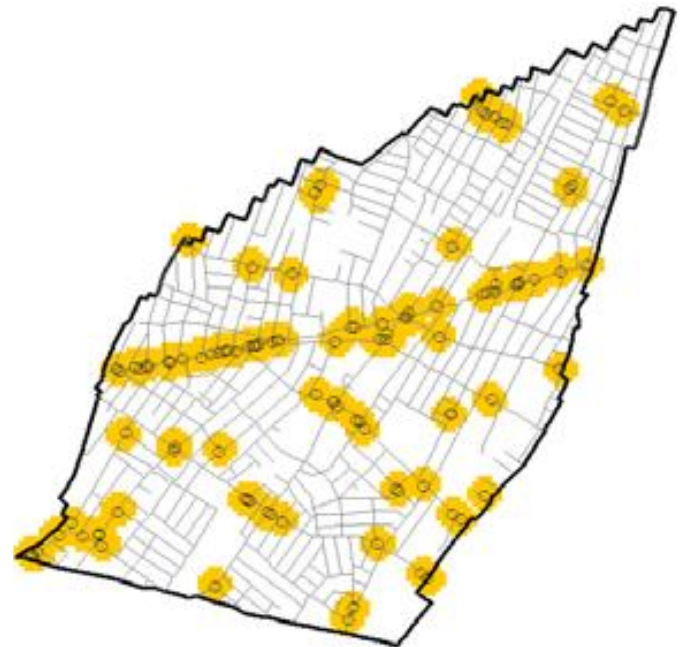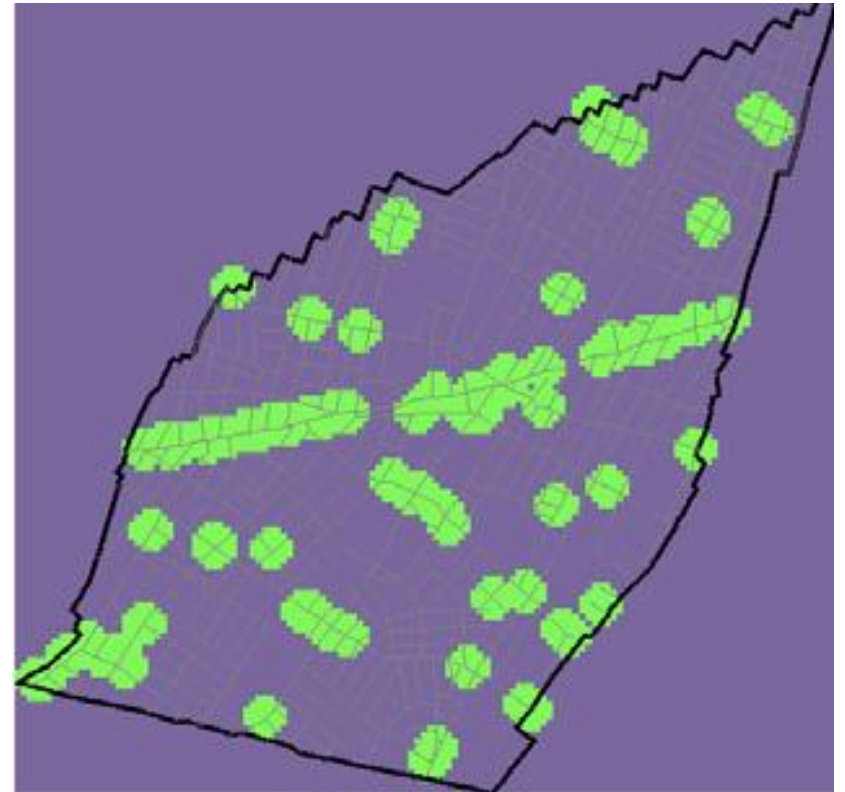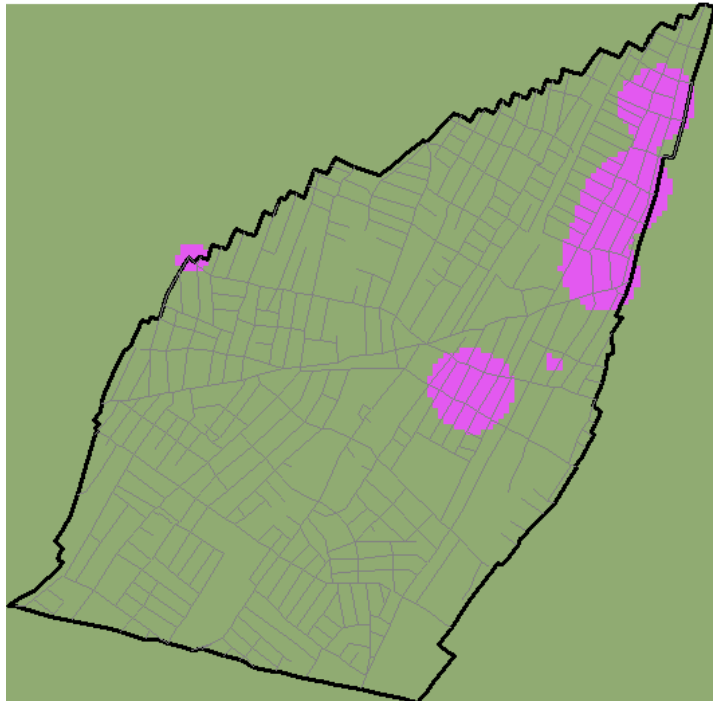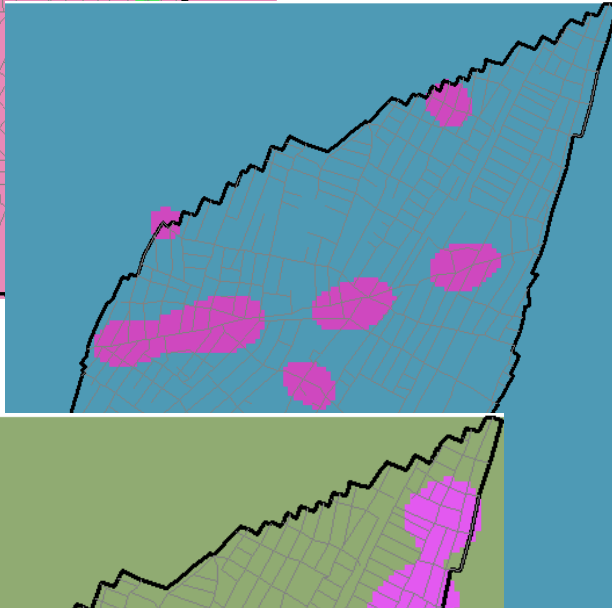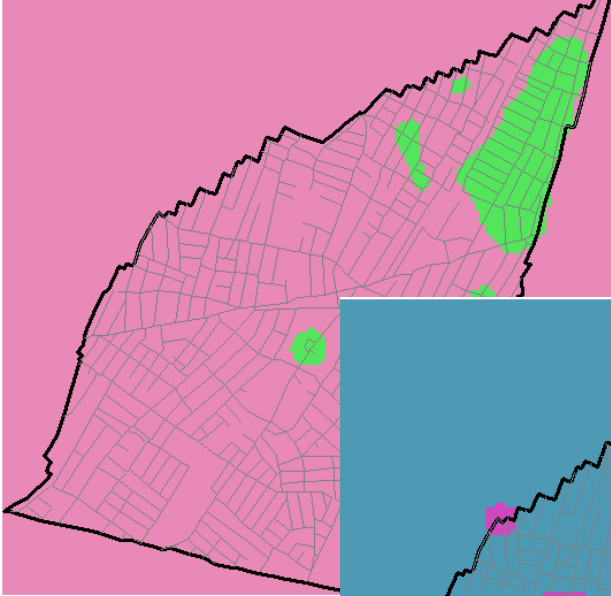
7e – final operationalization

- **We** are only interested in knowing where places are the most at risk for shootings, so we used a **binary-valued schema** to designate the "**highest risk**" places across all four risk map layers.

- The highest risk places of each risk map layer, respectively, will be given a value of "1"; all other places will be given a value of "0".

- All risk factors are operationalized as **aggravating factors**, so these values will **remain positive**.
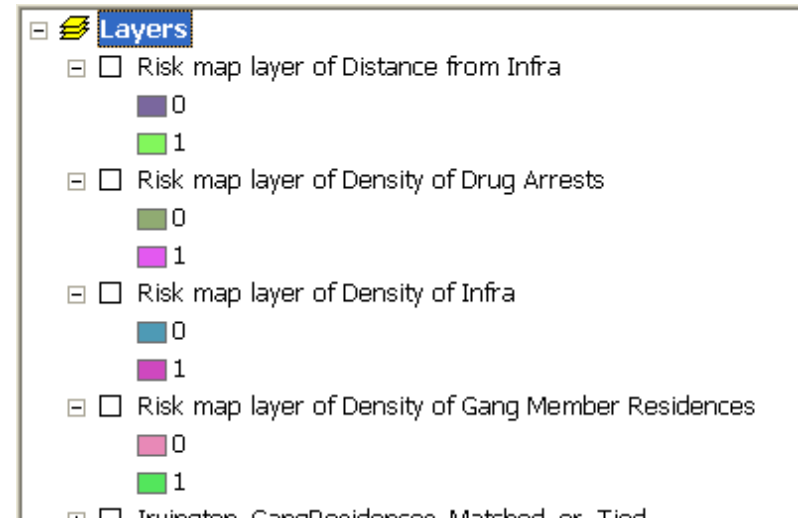
Step 7 - reclassification

Step 7 – final comparison

- We now have **four (final) risk map layers, operationalized from three risk factors.**

- **Binary** reclassification – 0 – 1

- The cells of different map layers are the same size and were classified in a standad way, the risk **map layers can be summed together** to form a **composite risk terrain map**.

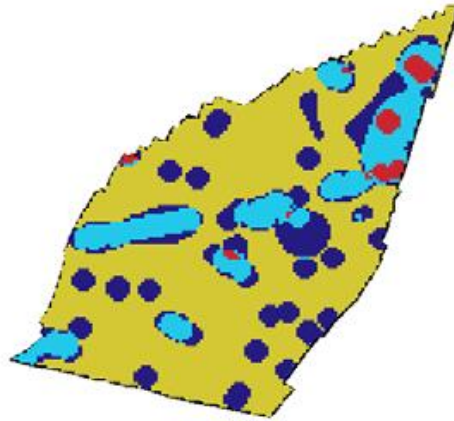# Step 8 + 9 - *Inter Risk Map Layer Weighting and CRTM*

All risk **map layers** will carry equal weights to produce an **un-weighted risk terrain model**. It is assumed, for example, that being in a place with a high concentration of drug arrests **poses the same risk** of having a shooting as being in a place with a high concentration of gang member residences. Unless we know better ☺ !!
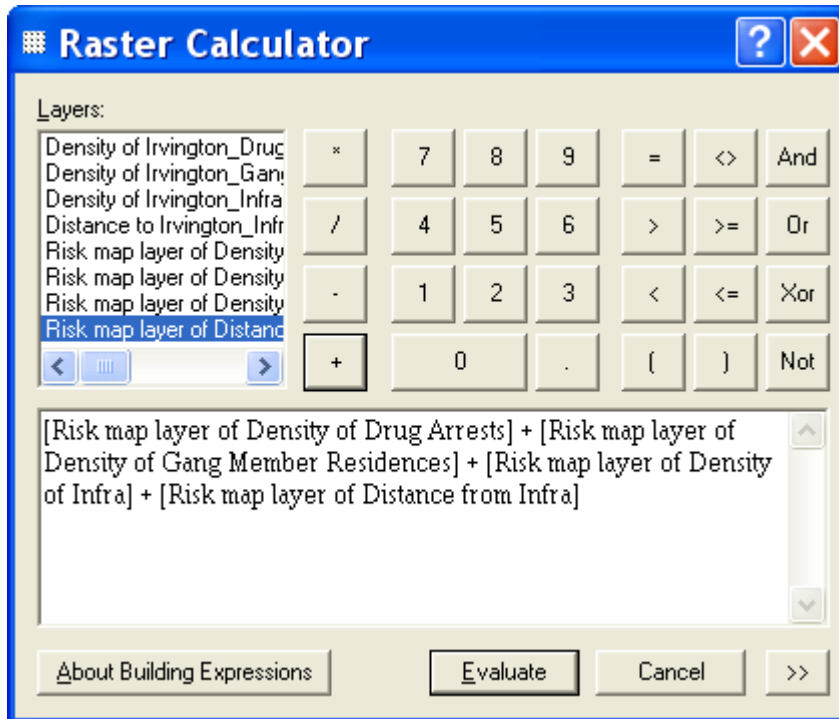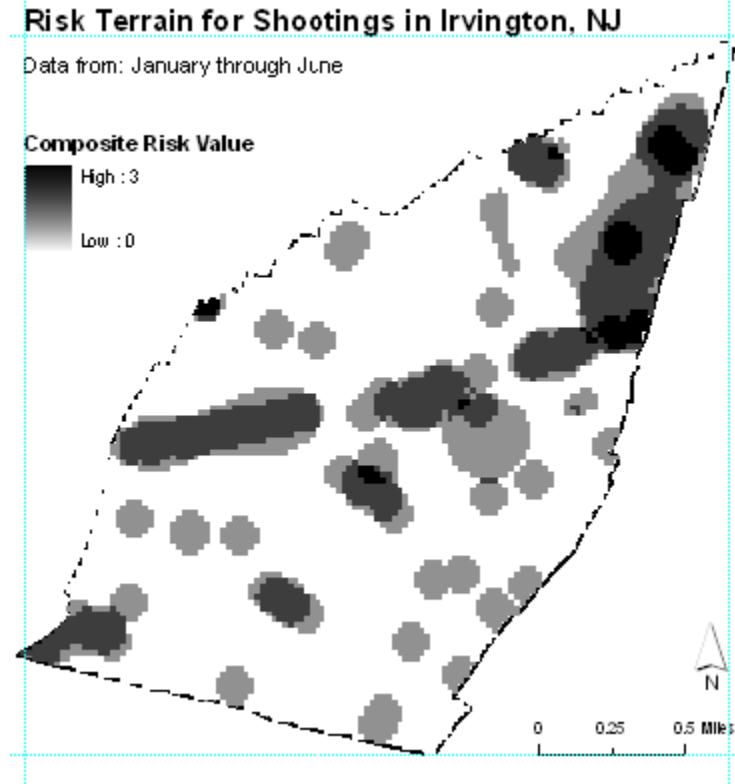
STEP 10 - Finalize the Risk Terrain Map to Communicate Meaningful Information.

- Clip our risk terrain map to the boundary of Irvington.

- produce a final map with shades of grey and layout.

Risk Terrain for Shootings in Irvington, NJ

Data from: January through June

Composite Risk Value

High : 3

Low : 0

N

0   0.25   0.5 Miles

Step 10 – make the risk count

- convert the risk terrain map from raster to vector we can (still using the regular structure converted to square polygons):

- **count the number of shootings that actually occur in the high-risk areas during the subsequent time period**;

- calculate the **square area** of the highest risk areas (i.e., places with a composite risk value of 3);

Step 10 – make the risk count

- Select all street segments within these areas to inform police commanders about where patrols might be increased.

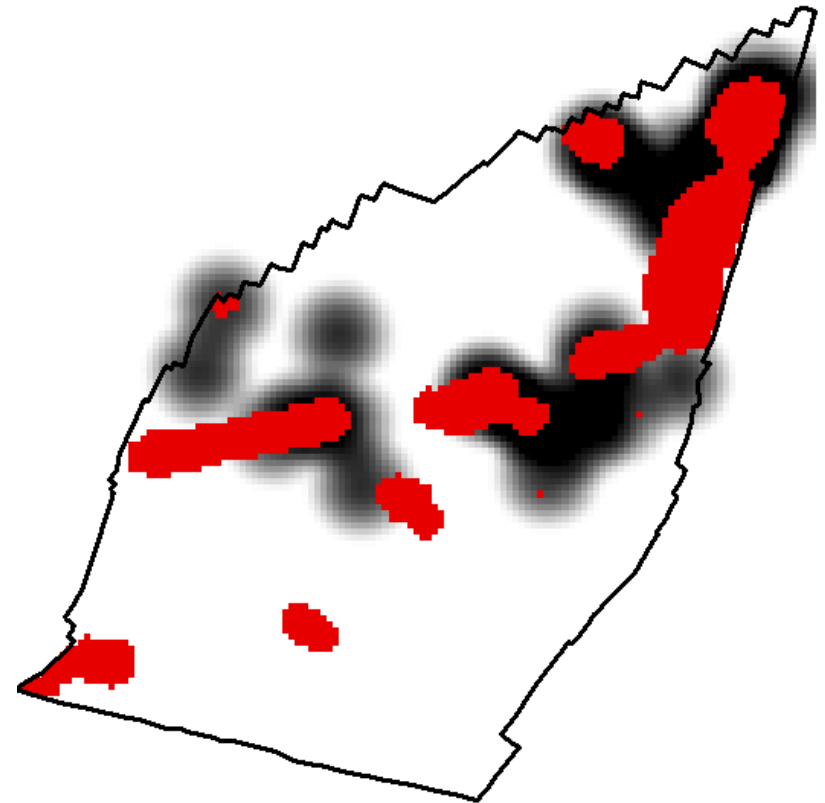- Operationalise the command and controll on the day by day basis.

- **Comparison with the subsequent time period (June 1 – December 31) – high risk RTM classes and hot spot analysis of actual shooting accidents.**

- About 50% (15 out of 31) of the shootings during the subsequent time period (July 1 to December 31) happened in these high-risk cluster areas.

Things to remeber

- **Remember**, risk terrain modeling is only a *tool for spatial risk assessmen*t; it is not the solution to crime problems.

- You (the analyst) give **value and meaning to RTM**, so be innovative in your thinking about risk factors and how risk terrain maps can be applied to police operations.
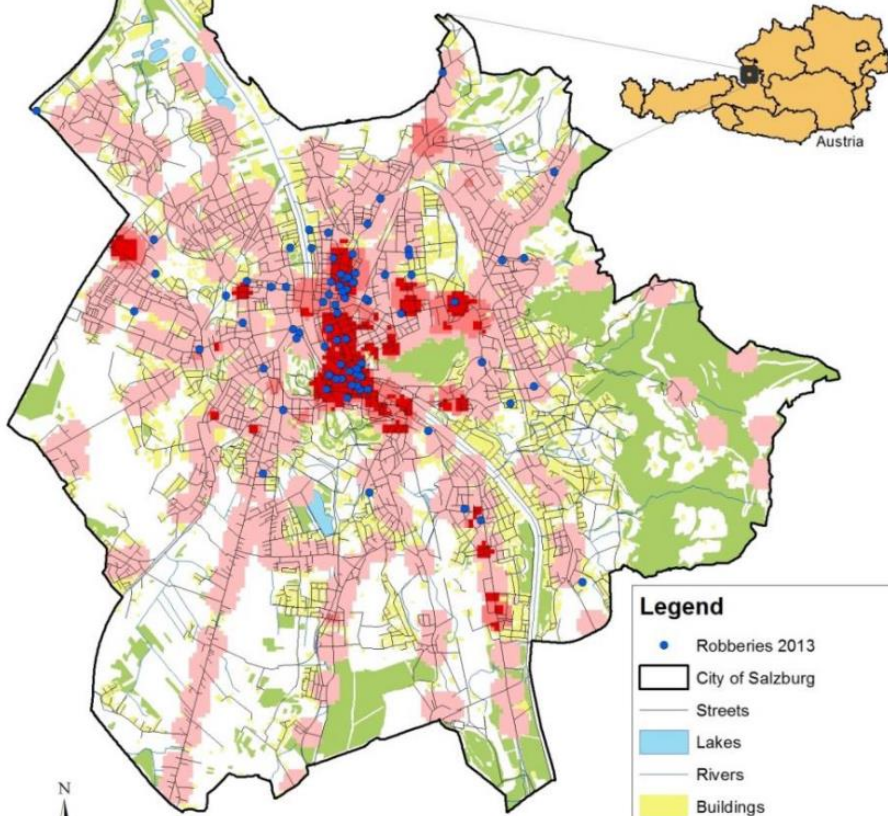
Risk Terrain Modelling

Risk Terrain Map - Robbery 2013

Prediction for the City of Salzburg
of Robberies for 2013
Based on a Maximum Spatial Influence of 2 Blocks (220m)

Austria

Date: April 2014
Author: Milena Kocher
Data Sources: © SAGIS, Austrian Federal Criminal Police Office,
State Police Headquarters of the City of Salzburg

Legend
- Robberies 2013
- City of Salzburg
- Streets
- Lakes
- Rivers
- Buildings
- Forests

RTM - Risk Values
- 1.0 - 7.0: Low Risk
- 7.1 - 22.3: Medium Risk
- 22.4 - 44.6: High Risk
- 44.7 - 252.5: Highest Risk

Risk Terrain Map - Robbery 2014

Prediction for the City of Salzburg
of Robberies for 2014
Based on a Maximum Spatial Influence of 2 Blocks (220m)

Austria
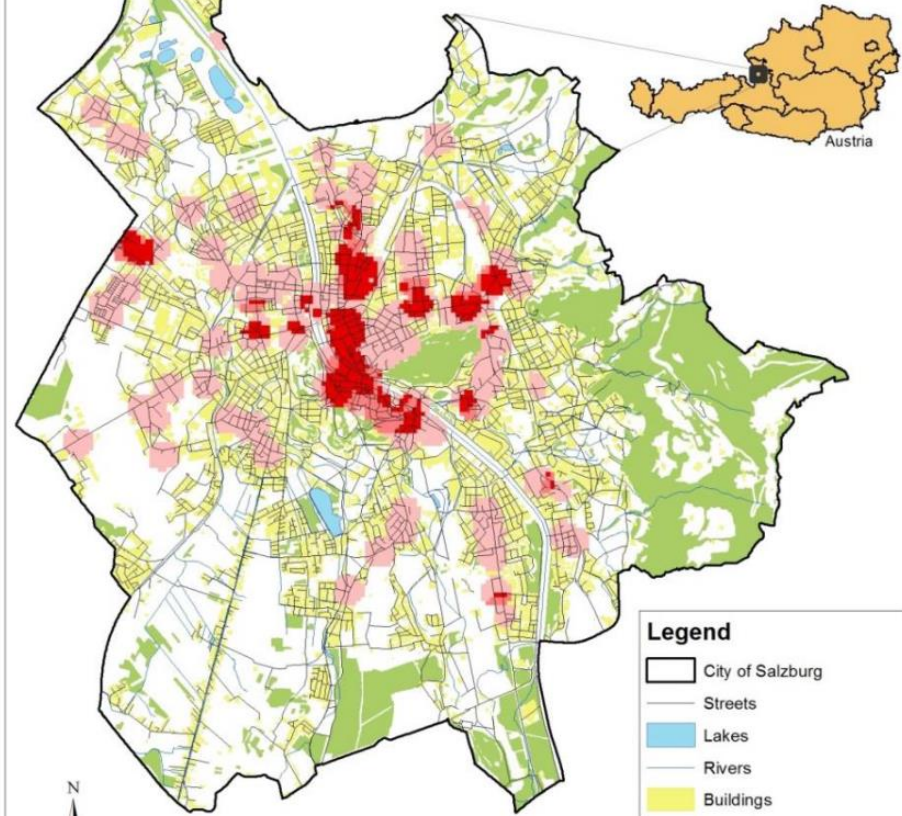
Date: April 2014
Author: Milena Kocher
Data Sources: © SAGIS, Austrian Federal Criminal Police Office,
State Police Headquarters of the City of Salzburg

Legend
- City of Salzburg
- Streets
- Lakes
- Rivers
- Buildings
- Forests

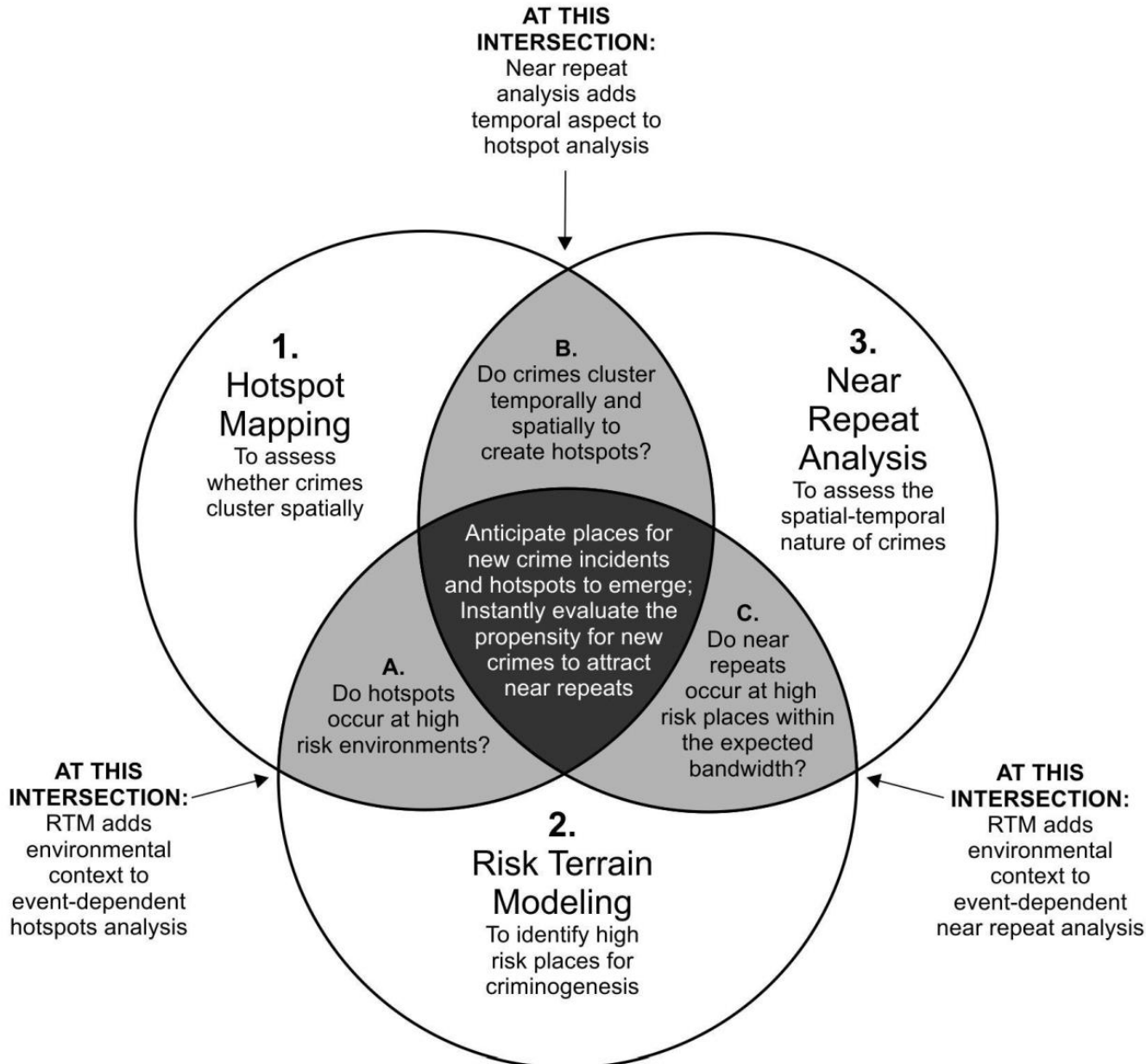**RTM - Risk Values**
- 1.0 - 5.2: Low Risk
- 5.3 - 18.7: Medium Risk
- 18.8 - 37.4: High Risk
- 37.5 - 314.6: Highest Risk

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

Homework for the last lesson

- **Work on your dissertation topic. Prepare a brief Introduction section (max. 1,5 page).**

- **Expected structure:**

1. Problem and broad context for your specific topic

2. What is already known – only important references!

3. What we need to know – the need for your topic made clear.

4. Purpose/Aim or Research Question (s) for your topic.

- **Write in a way that takes the reader from general to specific, from the known to the unknown.**

- **Prepare a presentation based on your manuscript – 6-8 minutes max.**