Kartografické modelování

X – Prediktivní modelování

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Podstata prediktivního modelování

- Doposud jsme se zabývali problémem, jak počítač „vidí" geografická data prostřednictvím popisných (deskriptivních) technik a vytváří z nich oblasti s určitými vlastnostmi.
- Další logický krok je použití „**prediktivních – předpovědních" technik k vytvoření extrapolačních map předvídajících budoucí podmínky**.
- Využití v řadě oblastí:
  - **Predikce kriminality**.
  - *Zemědělství – odhady výnosu plodin (samostudium).*
  - Archeologie - lokalizace naleziště - ModelBuilder.

Predictive Crime Analysis

- **WHAT?**
- „Predictive policing in the context of place is the use of **historical data** to create a **spatiotemporal forecast** of **crime hot spots.**
- **WHY?**
- 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**.“

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**:

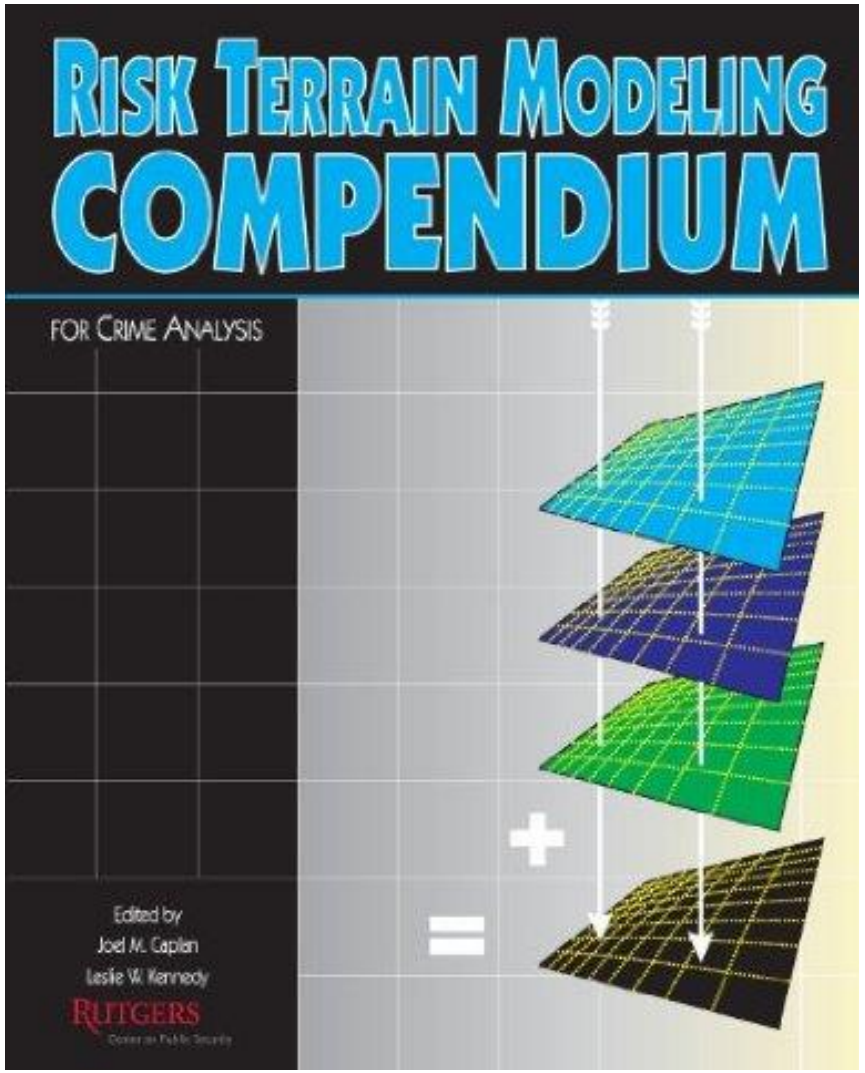
- Equal chance of them happening anywhere at anytime.

But crime **is not randomly** distributed

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

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 (crime).
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.

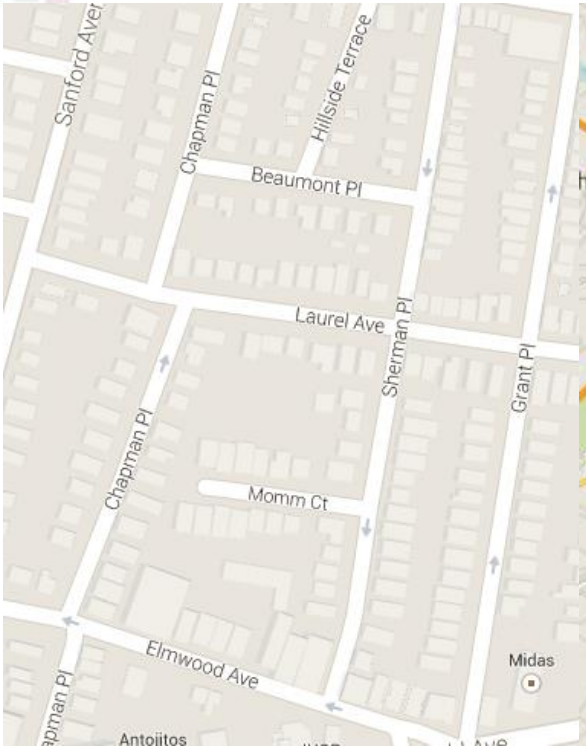
Step 1 -2

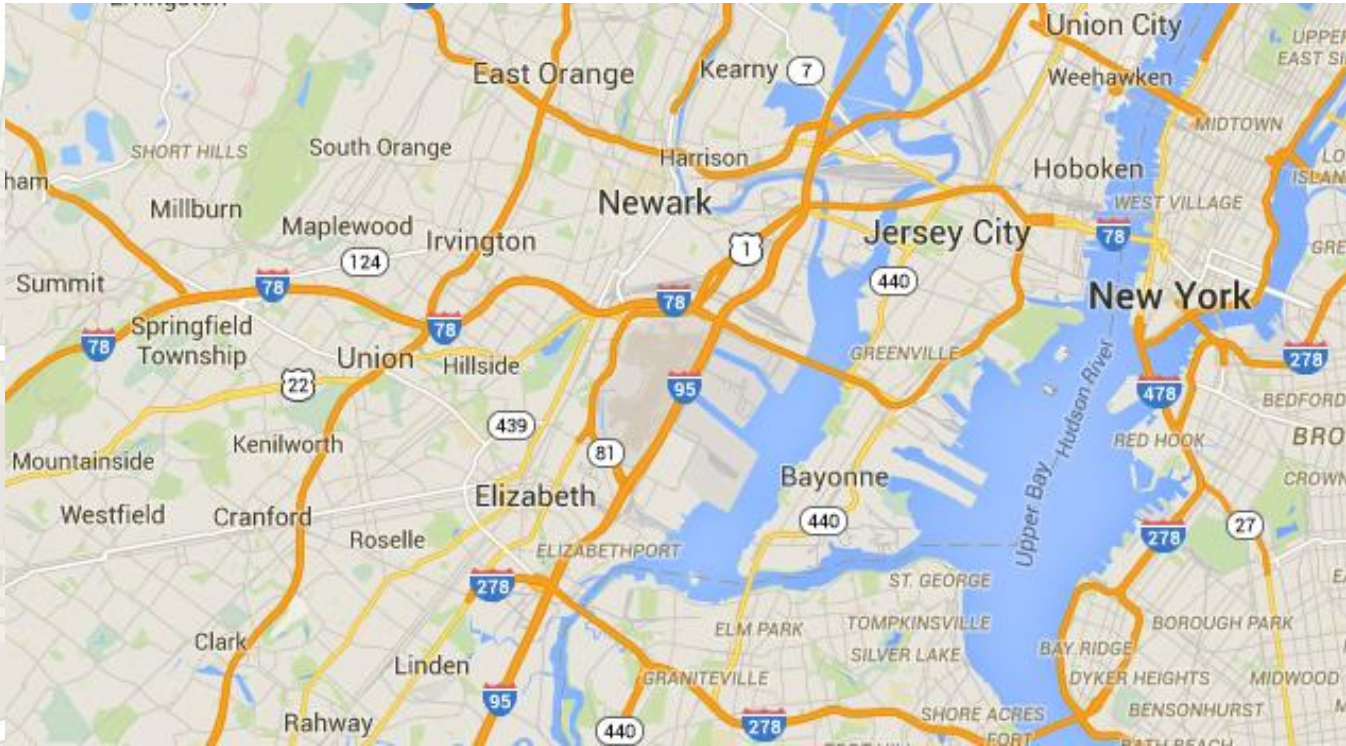
1. Select an outcome **event** of particular interest

Gun shooting incidents.

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

The Township of Irvington, NJ.





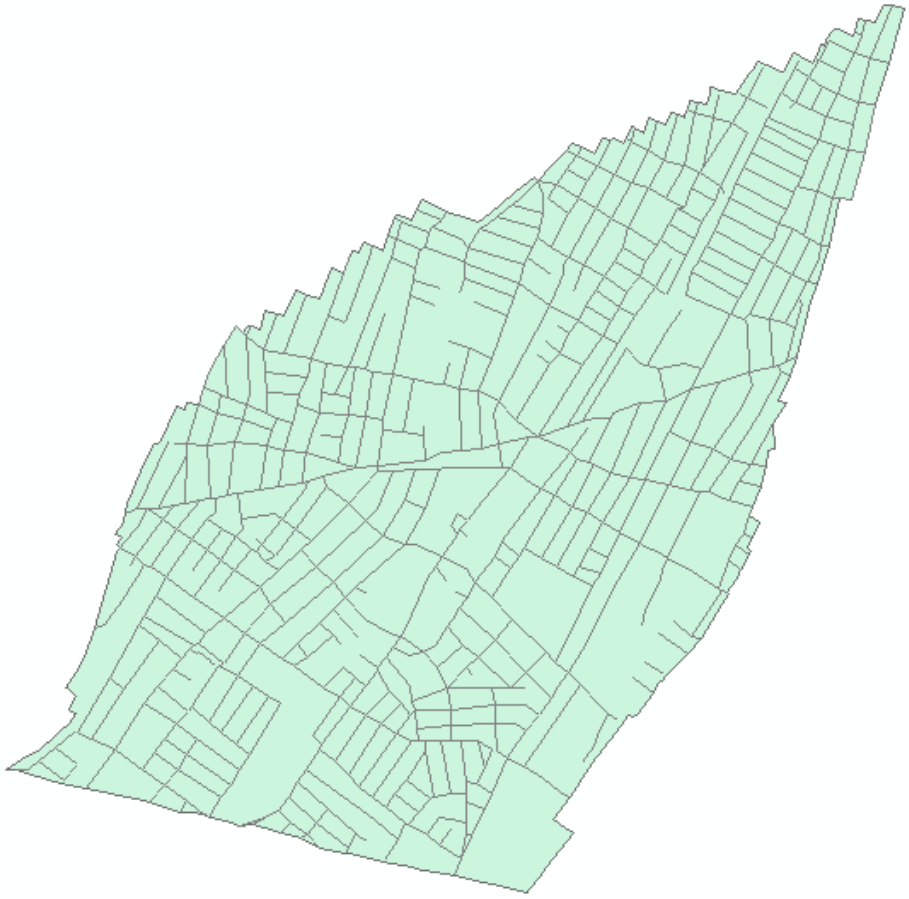
Step 3

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

- ***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

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

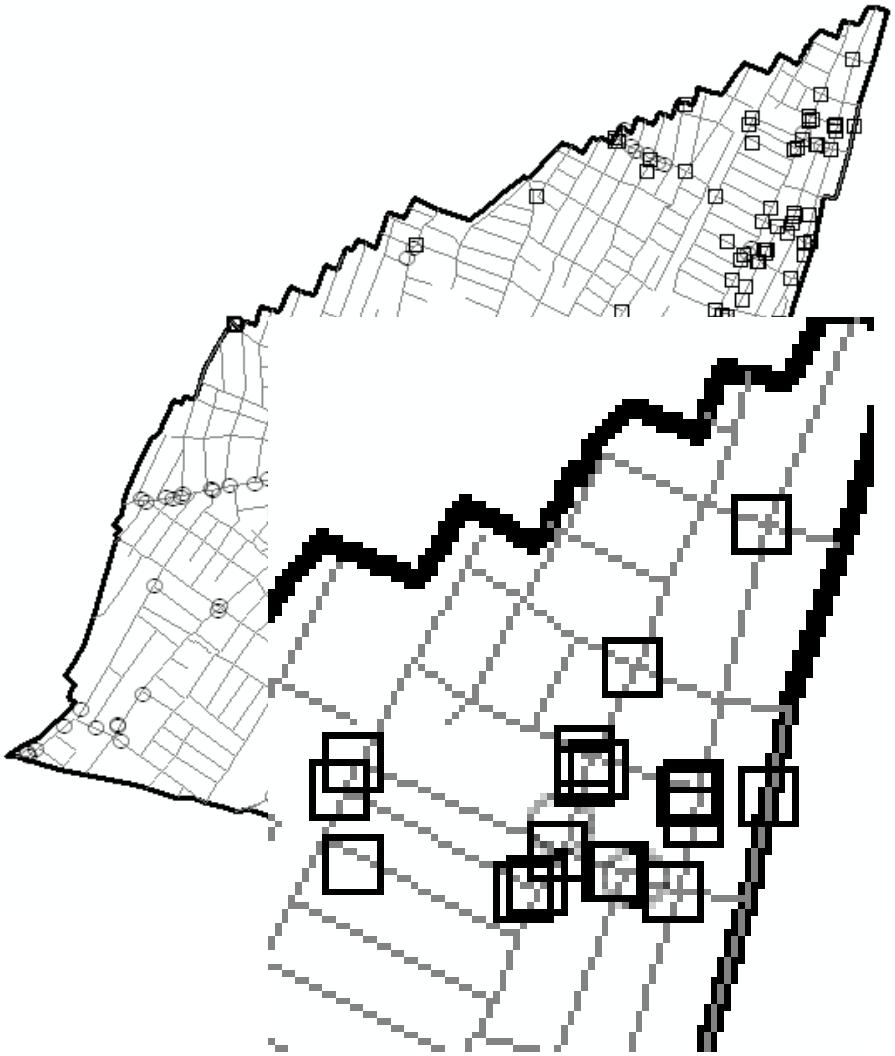
- ***STEP 6: Select particular risk factors to include in the risk terrain model.***
- All three risk factors identified in Step 5 will be included.
- Raw data in tabular form (i.e. Excel spreadsheets) was provided by the Township police and the many **datasets they maintain, validate and update regularly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

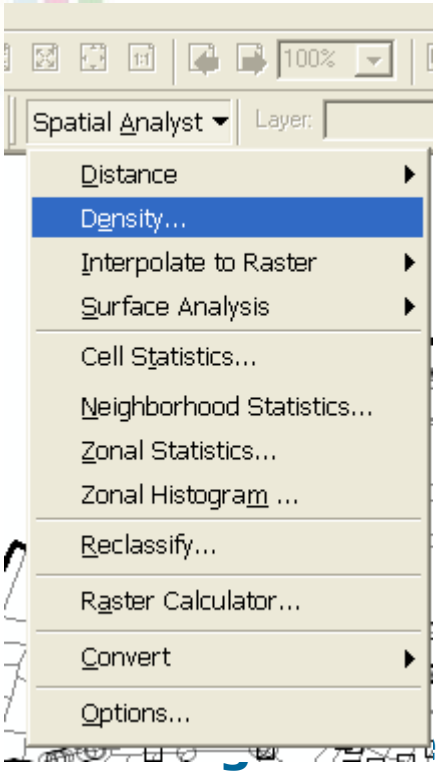
- the locations of gang members' **residences** (hiden on the map to protect the gang members),
- retail **business outlets**
- and **drug arrests**,

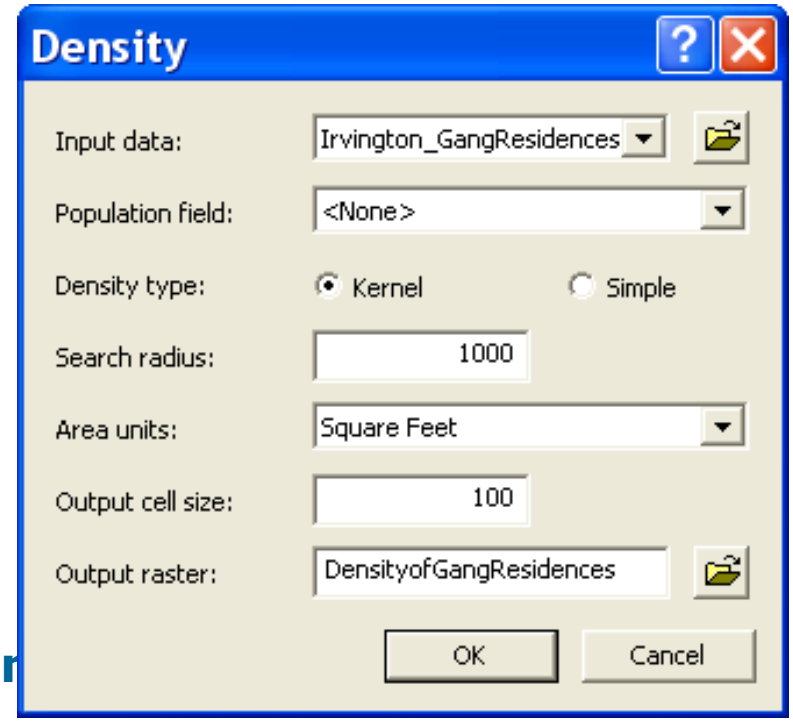
respectively as three separate map layers.

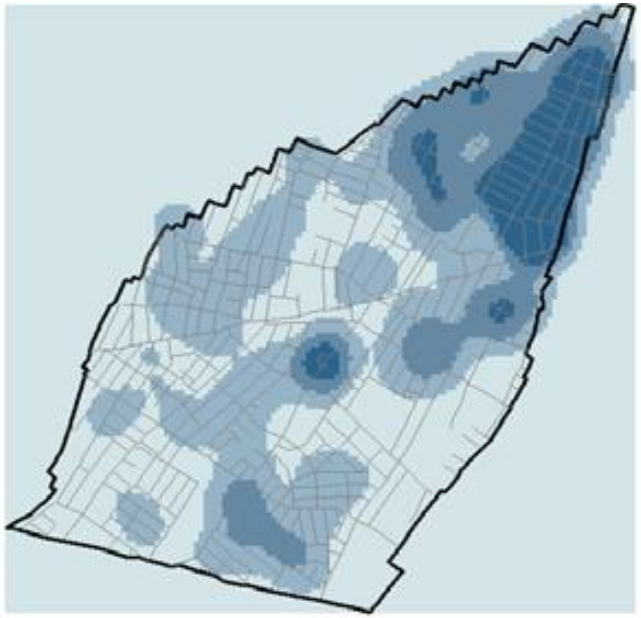


Step 7a – gang member residence

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. **Jádrové vyhlazování – proměnné ?**

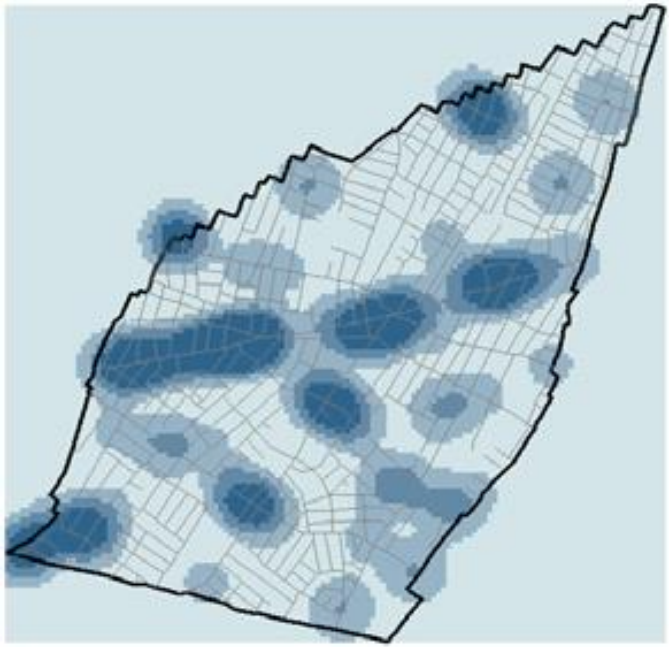






Step 7b - infrastructure

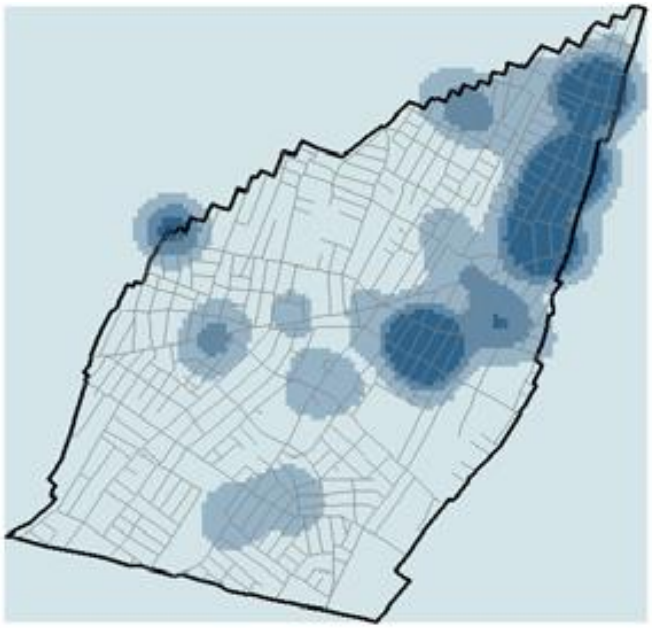
- The spatial influence of the "infrastructure" risk factor was operationalized as:
- "**High concentrations** of bars, strip clubs, bus stops, check cashing outlets, pawn shops, fast food restaurants, and liquor stores **will increase the risk** of those dense places having shootings."



Step 7C – the drug arrest

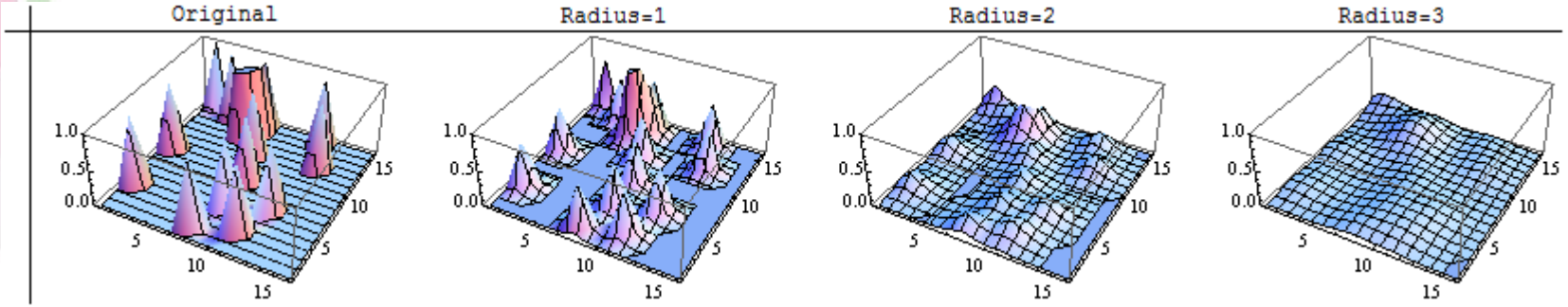
the "drug arrest" risk factor was operationalized as:

- "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.

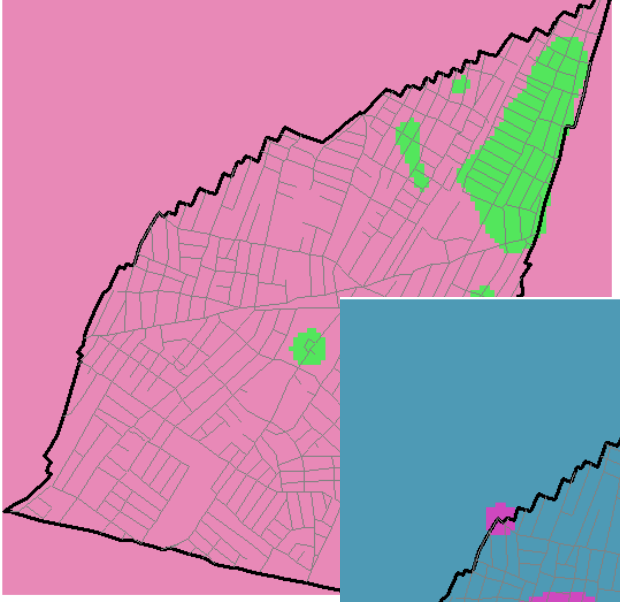
Step 7d – distance from infrastructure

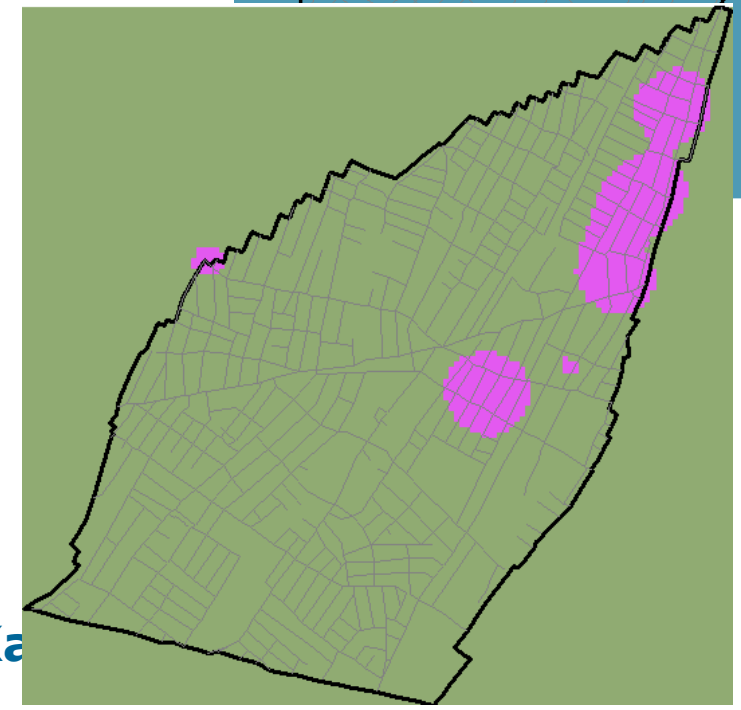
- The spatial influence of the "infrastructure" risk factor was also operationalized as:
- "The **distance of one block**, or about 350ft (app. 100 m), from a facility poses the greatest risk of shootings because **victims** are often **targeted** when **arriving** at or **leaving** the establishment."

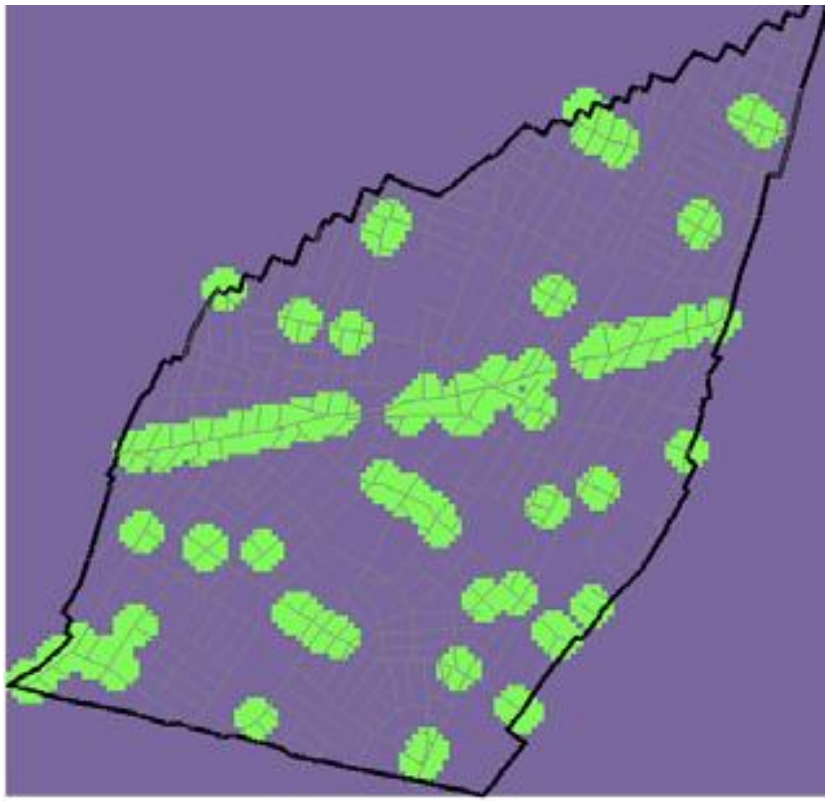
7e – final operationalization

- **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

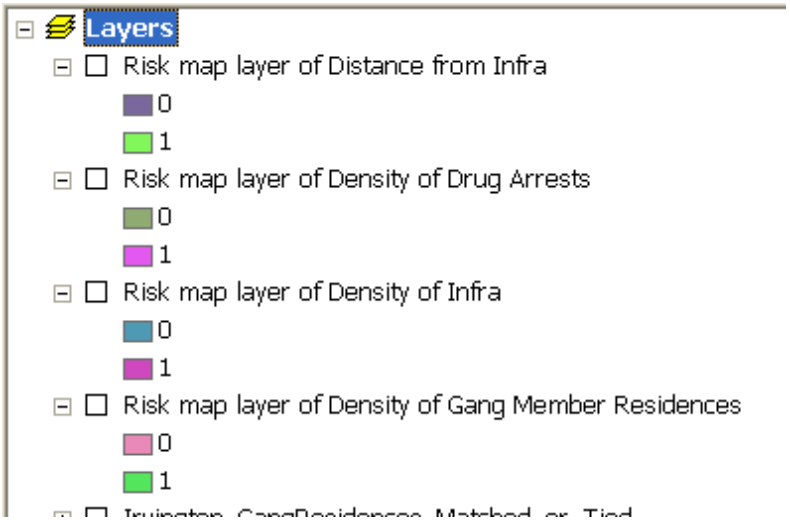






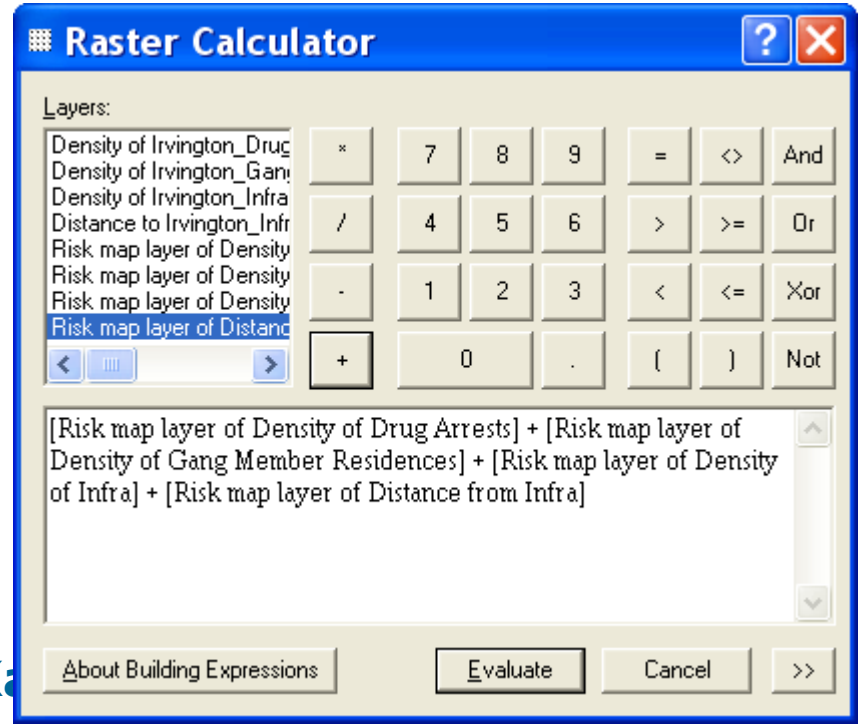
Step 7 – final comparison

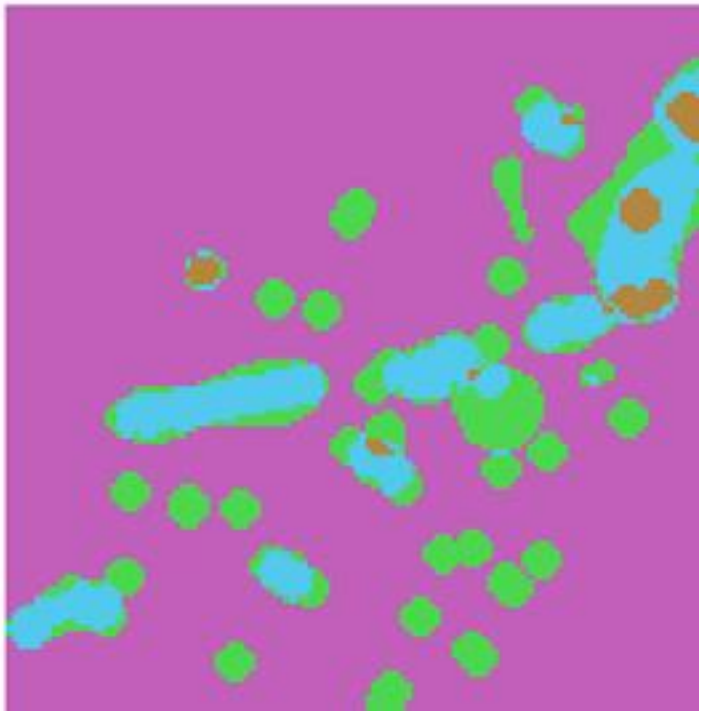
- We now have **four (final) risk map layers, operationalized from three risk factors.**
- **Binary** reclassification – 0 – 1
- The cells of different map layers are the same size and were classified in a standard way, the risk **map layers can be summed together** to form a **composite risk terrain map**.



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

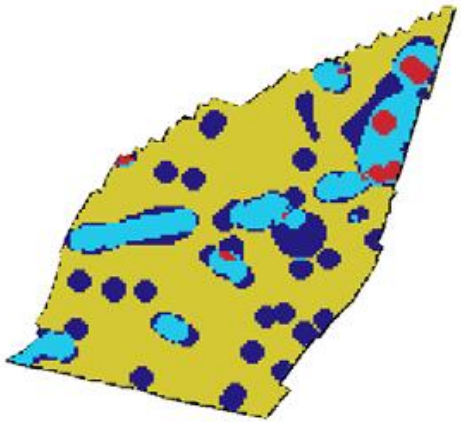
All risk **map layers** will carry equal weights to produce an **un-weighted risk terrain model.** It is assumed, for example, that being in a place with a high concentration of drug arrests **poses the same risk** of having a shooting as being in a place with a high concentration of gang member residences.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



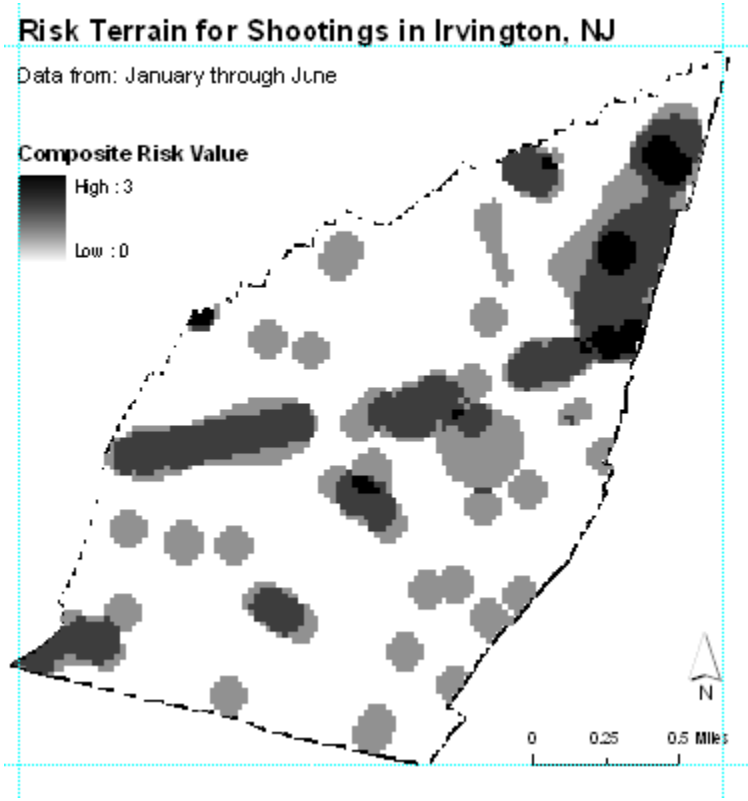


STEP 10 - Finalize the Risk Terrain Map to Communicate Meaningful Information.

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



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

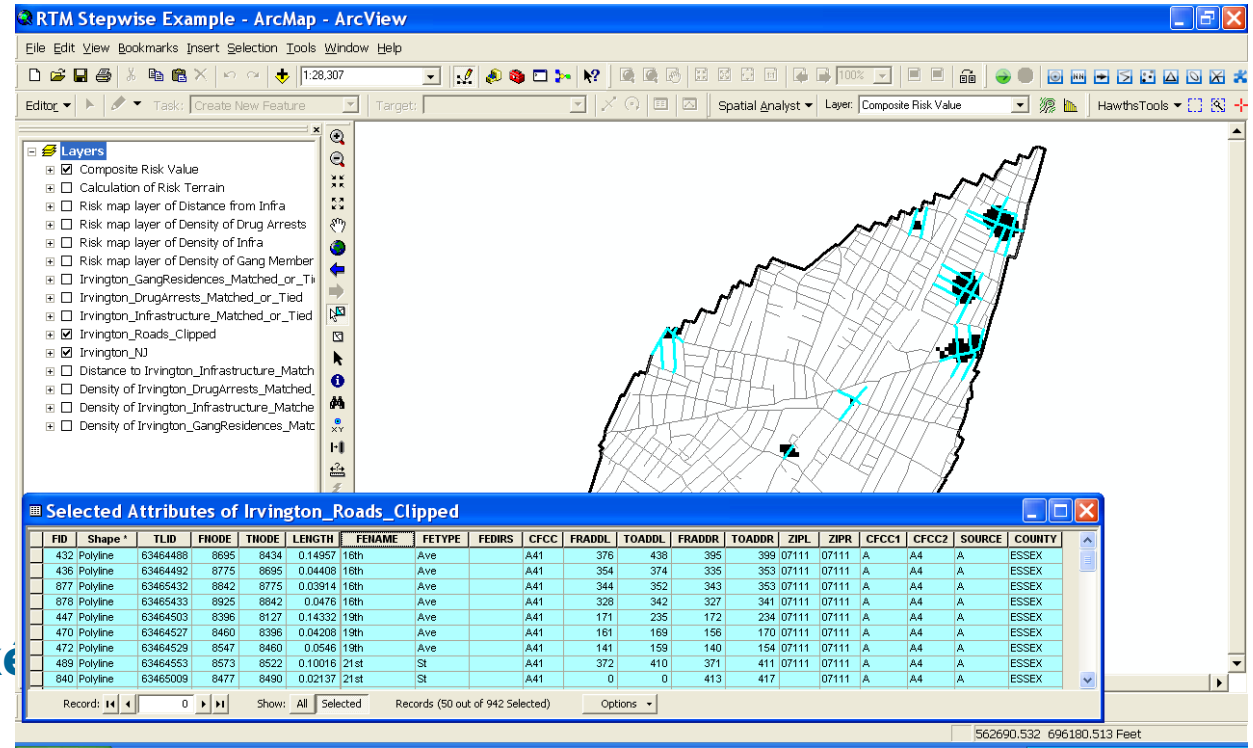


Step 10 – make the risk count

- 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);

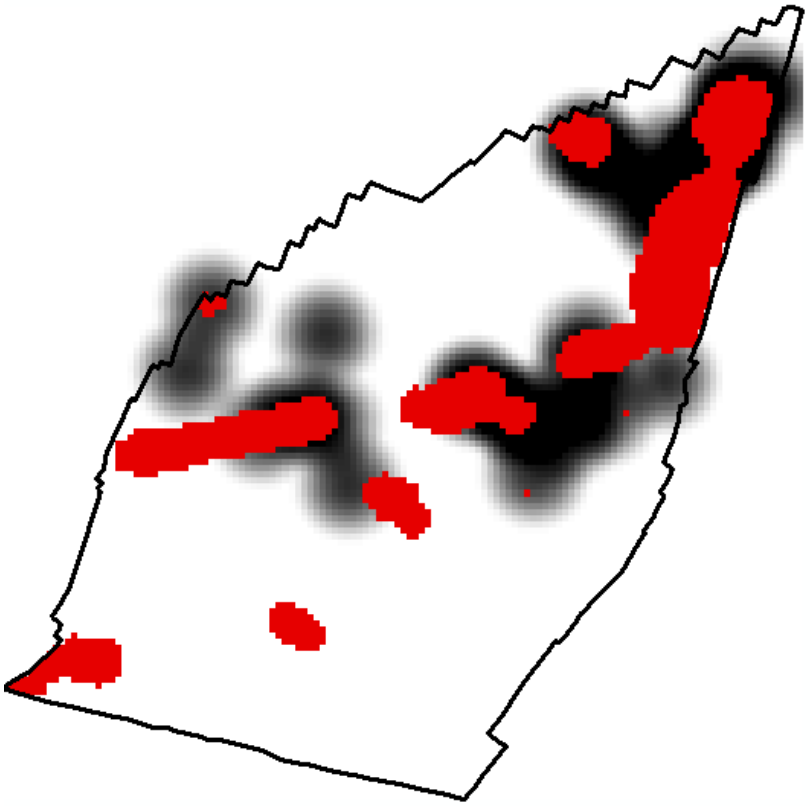
Step 10 – make the risk count

- 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.



RTM validation

- **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.

Prediktivní modelování v ArcGIS

Obvykle se jednotlivé procedury modelování spouští samostatně a opakovaně - možnost využít ModelBuilderu pro:

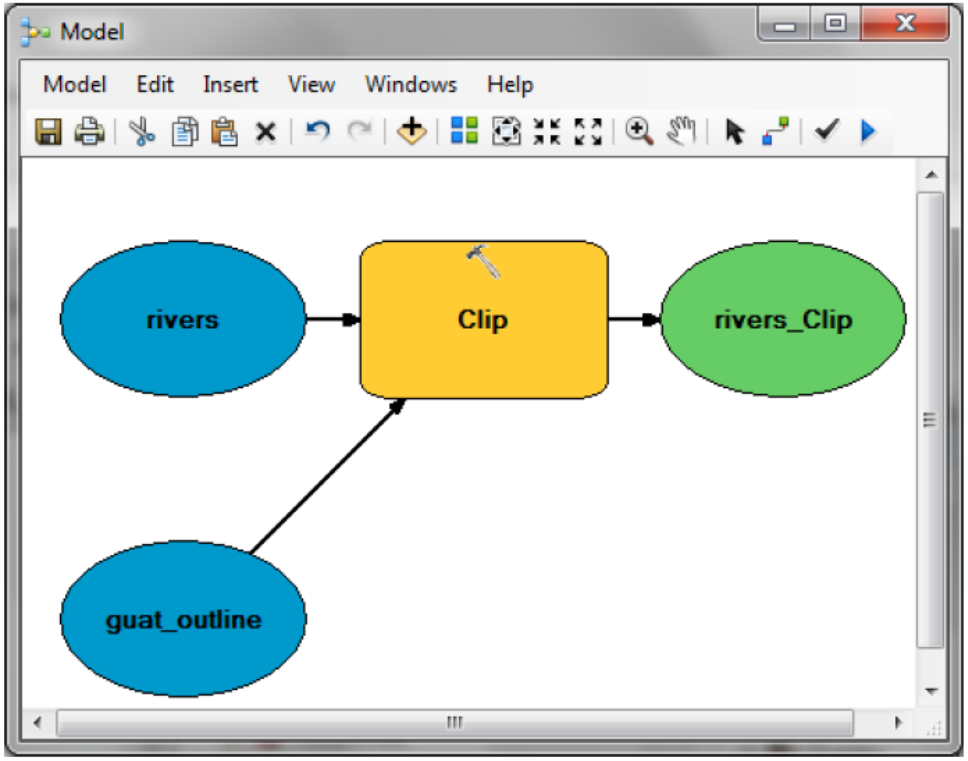
1) Zaznamenání všech **postupných kroků** v modelování;
2) Snadná **opakovatelnost** modelování a **sdílení** s dalšími uživateli;
3) Lepší **vizuální reprezentace**, která vede k lepšímu pochopení celého průběhu modelování.

Prediktivní modelování archeologického naleziště

- Prediktivní modelování v archeologii – *„nástroj pro vyjádření pravděpodobnosti výskytu archeologického naleziště kdekoliv v krajině*".
- Snaha určit pravidla a preference pro výběr lokality danou kulturou.
- Zahrnuje **deskriptivní analýzu přírodních faktorů pro známé lokality a snahu najít společné opakující se kombinace - vzorec**.
- **Příklad**: vybraná kultura (Mayové) preferovala historicky známá místa v **blízkosti** oceánu a mokřadů s **výskytem** porostů endemita Salvia apiana.
- Která místa ve zkoumané oblasti odpovídají podmínkám??

1. Omezení zkoumané oblasti

- Omezení oblasti na severní Guatemalu a oříznutí vybraných vodních toků pomocí funkce Clip.
- Vstupní a výstupní soubory + funkce.

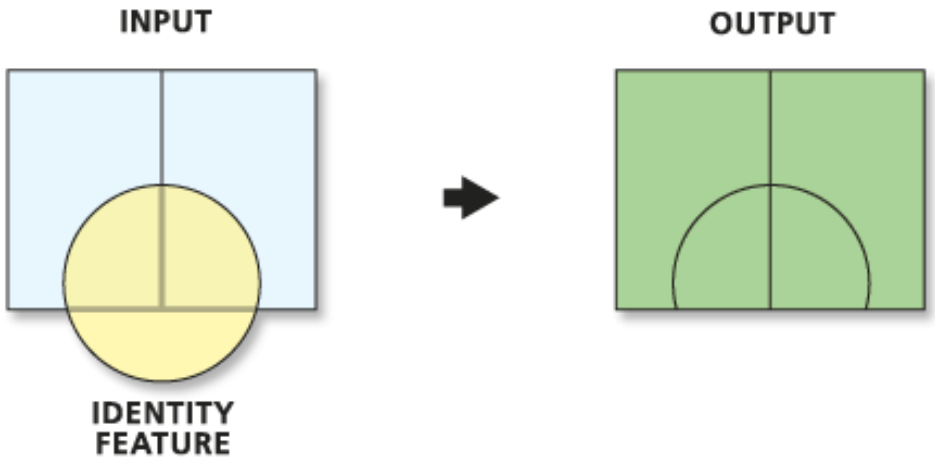


2. Změření vzdálenosti lokalit od řeky

- Říční síť nyní omezena na sledované území.
- Určení vzdálenosti potenciálních archeologických nalezišť od říční sítě – ***Near***.
- Vyhledávací vzdálenost nastaveno na 5 km (=blízko).
- Všechny lokality blíže než 5 km mají určenou přesnou (vzdušnou) vzdálenost (**NEAR_DIST)**.
- Ostatní lokality mají přiřazenu hodnotu -1.

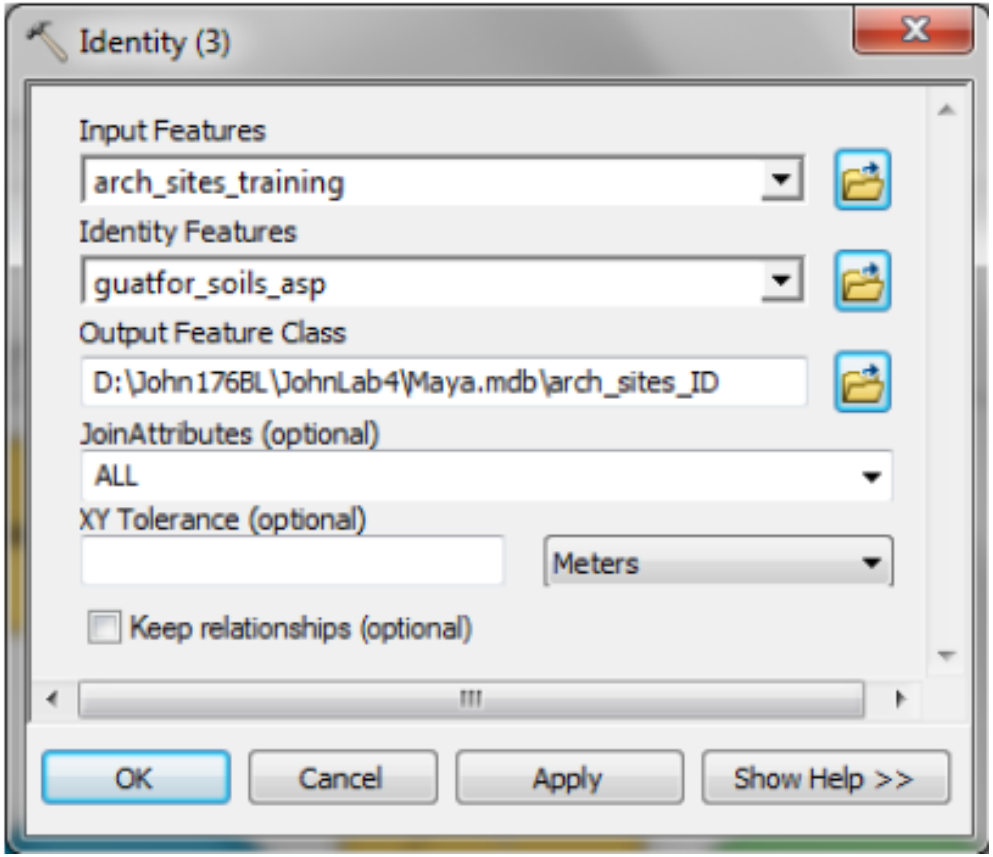
3. Kombinace přírodních podmínek

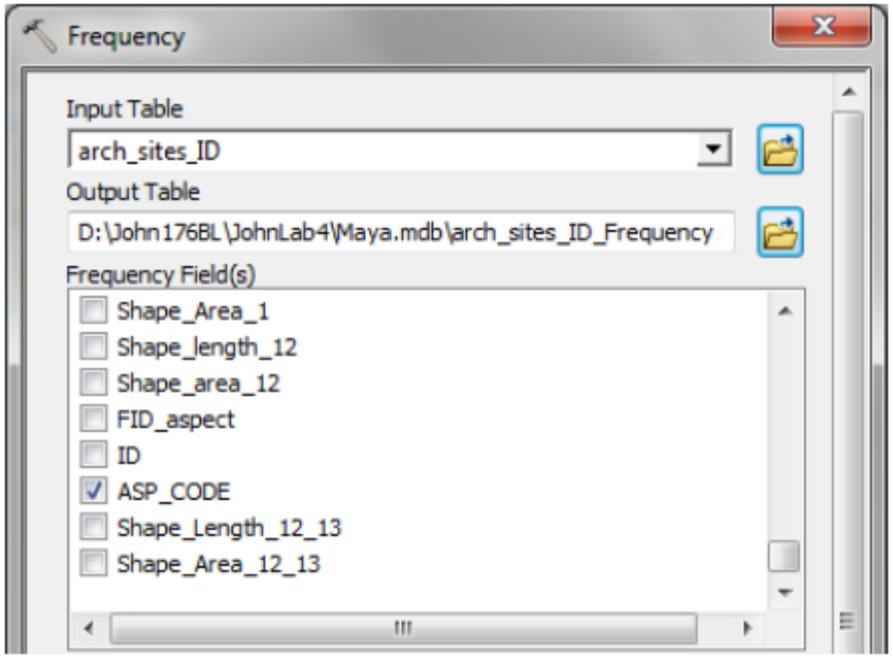
- Zjištění jaké přírodní podmínky obklopují naše archeologické lokality.
- **Vegetace – půdy – orientace svahu.**
- Nutná postupná analýza přírodních podmínek v několika krocích a postupné rozšíření atributové tabulky o přírodní ukazatele.
- Použití nástroje ***Identity***.
- Vegetace +půdy= PP1
- PP1 + orientace=PP2



4. Přírodní podmínky pro archeologické lokality

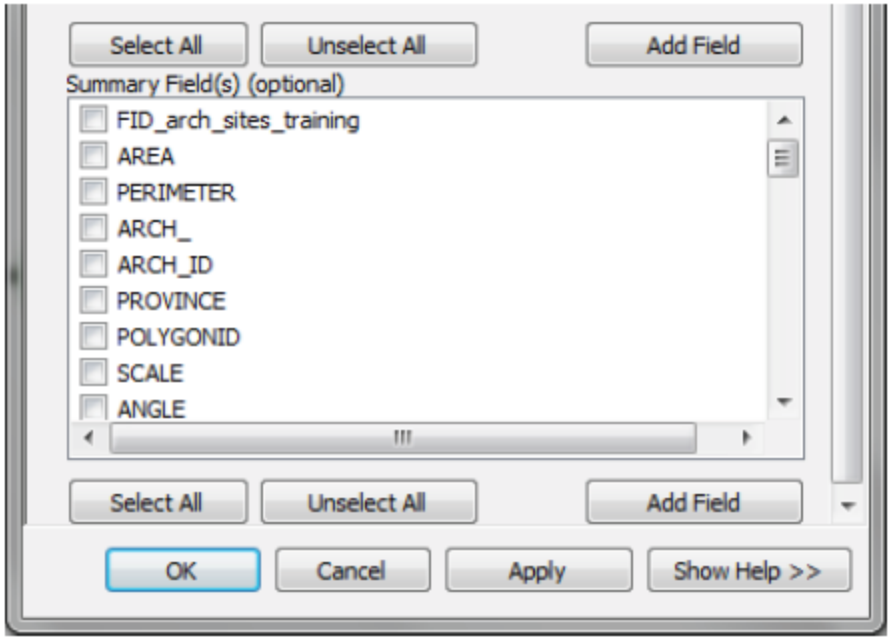
- Spojení dat o archeologických lokalitách a PP2 pomocí nástroje ***IDENTITY.***
- Následný výběr potřebných atributů z tabulky – nástroj Idnetity zachovává všechny atributy a vytváří další.
- Využití nástroje ***Frequency.***



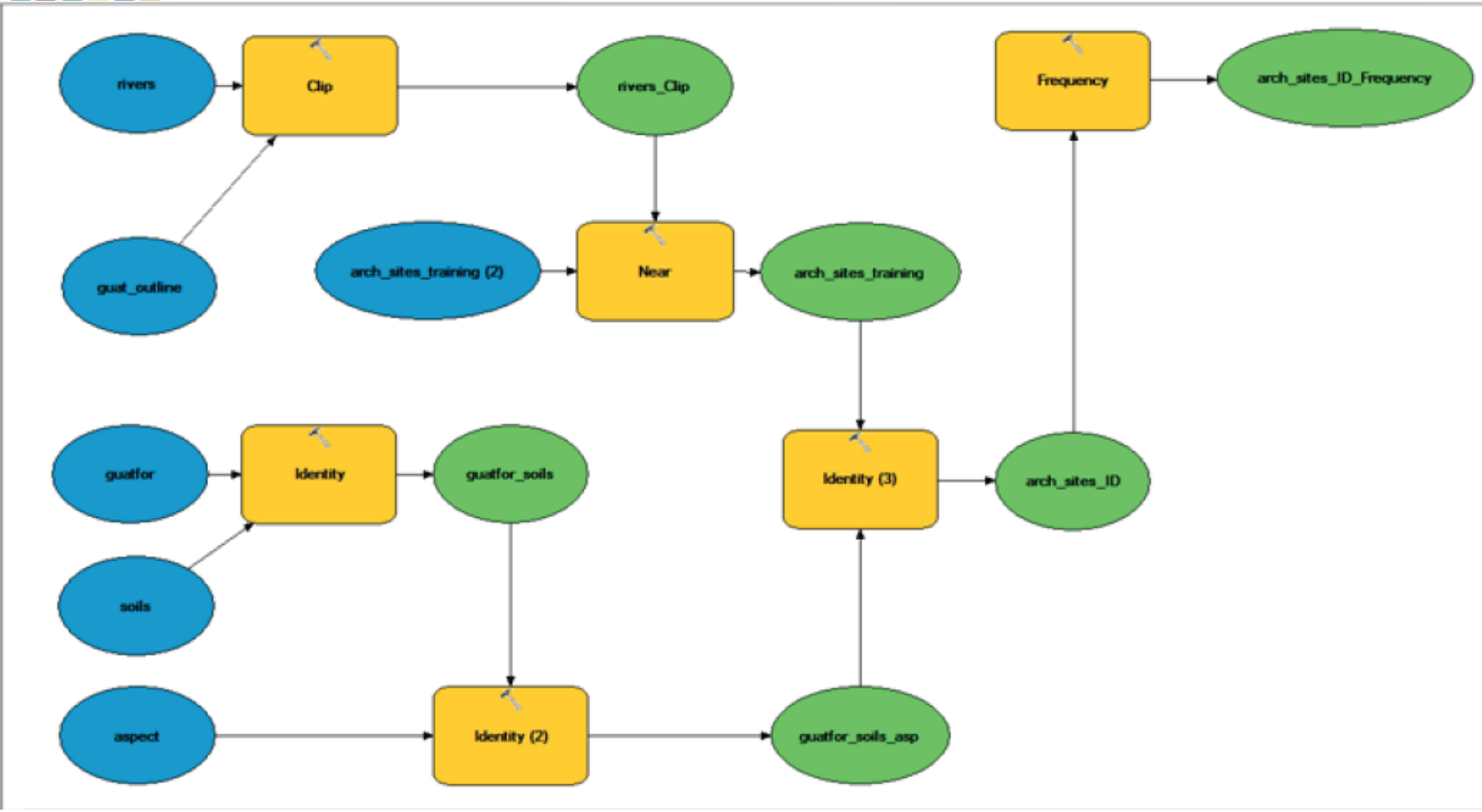


Výběr atributů

- **Nutno zachovat:**
  - NEAR_DIST - blízkost
  - DESC_ vegetace
  - R_FERT - půda
  - ASP_CODE - orientace



Finální model



6. RUN a prozkoumání výsledků

- Určení hlavních shluků přírodních podmínek.
- Stanovení pracovních predikční hypotézy pro vybraná místa.
- Ověření hypotézy.

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