

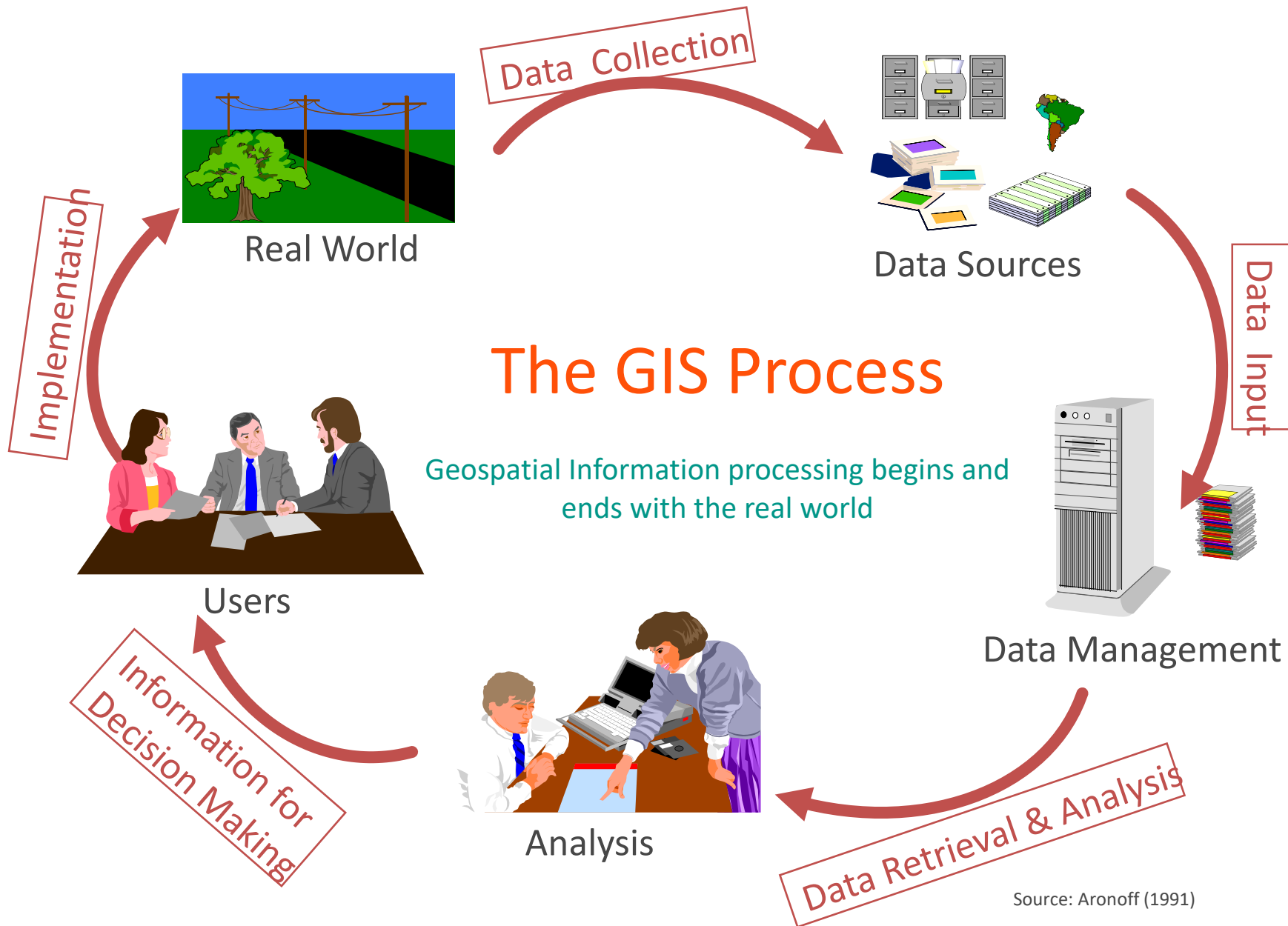
Project for the Strengthening of Spatial Data Infrastructures in Member States and Territories of the Association of Caribbean States

Capacity Building Program

Geographic Information Systems

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Ms. Valrie Grant, MSc.



Source: Aronoff (1991)

Topic 6: Spatial Query and Analysis in GIS

Topic Outline

- What is Spatial Query?
- Querying Geodatabases
- ArcGIS Spatial Tools
- What is Spatial Analysis?
- Components of Spatial Analysis
- Spatial Interpolation
- Spatial Analysis Process

Information

Data when processed will remove the level of uncertainty in a particular event.



A better understanding of our world can be achieved through the use of Spatial Queries and Spatial Analysis.

What is a Spatial Query?

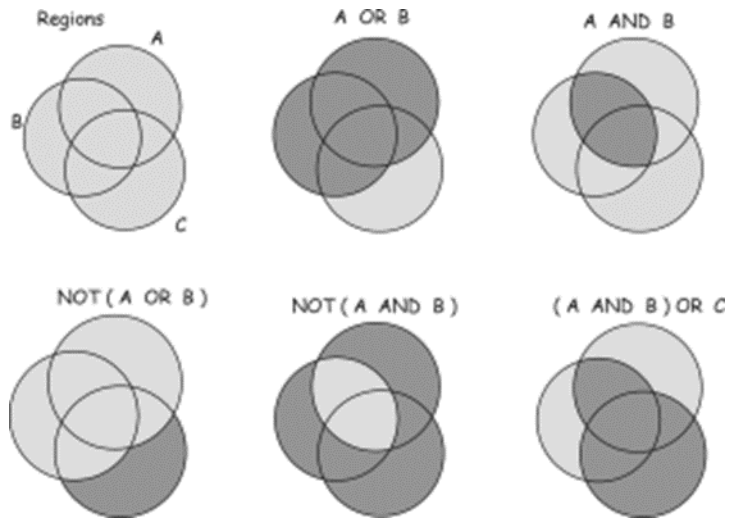
- A spatial query is a special type of database query supported by geodatabases and spatial databases.
- It allows for the use of geometry data types such as points, lines and polygons and that these queries consider the spatial relationship between these geometries.

Querying Databases

- Structured Query Language (SQL)

```
SELECT * FROM met_stations WHERE  
sensor_type = "Temperature" AND  
retrieval_method = "Automatic";
```

Querying Geodatabases



Select By Attributes

Layer: Only show selectable layers in this list

Method: Create a new selection

"FID"
"FID_"
"Easting"
"Northing"
"Name"

= <> Like
> >= And
< <= Or
_ % () Not
Is In Null Get Unique Values Go To:

SELECT * FROM AWS_Data WHERE:

Clear Verify Help Load... Save...

OK Apply Close

Querying the Geodatabase

Select By Location ✕

Select features from one or more target layers based on their location in relation to the features in the source layer.

Selection method:
select features from ▼

Target layer(s):

- Wet_Season_LTA
- AWS_Data

Only show selectable layers in this list

Source layer:
AWS_Data ▼

Use selected features (0 features selected)

Spatial selection method for target layer feature(s):
intersect the source layer feature ▼

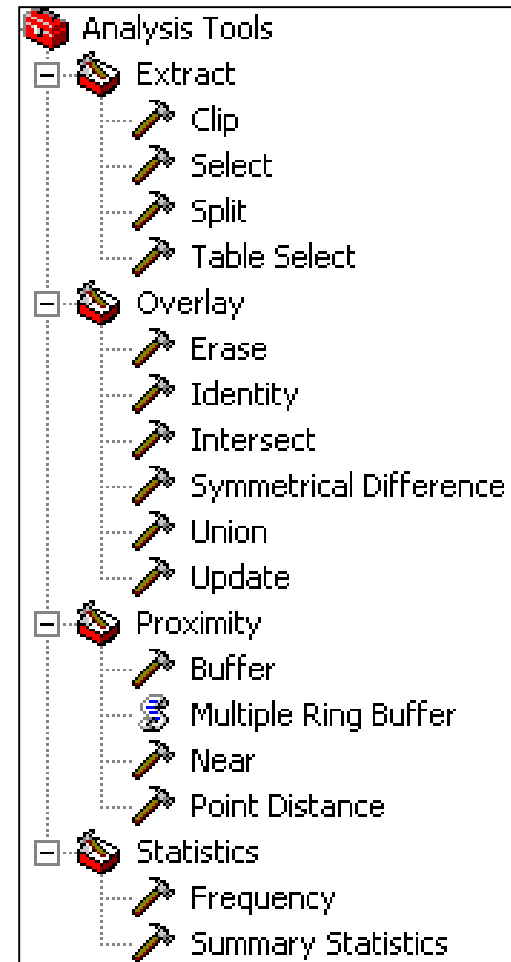
Apply a search distance
20.000000 Meters ▼

[About select by location](#) OK Apply Close

ArcGIS Tools

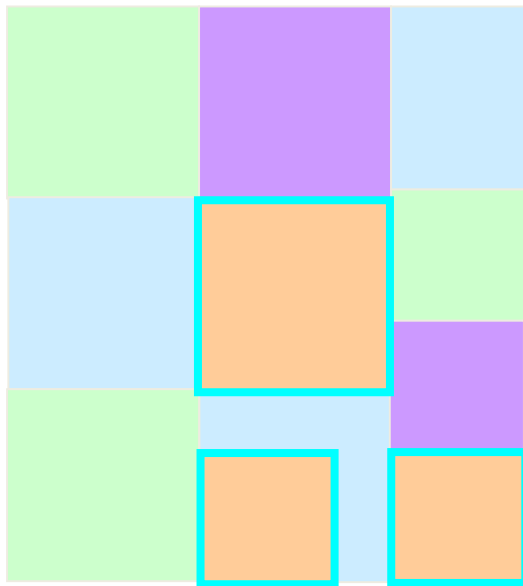
- Found in ArcToolbox
 - ArcMap, ArcCatalog, ArcScene, and ArcGlobe
- Powerful set of tools to perform analysis geoprocessing tasks
- Designed to perform vector analysis
- License determines tools

ArcGIS Advanced license level



Select

- Extracts features from a feature class or layer and stores them in a new feature class
- Output feature class optionally created using a SQL expression



Select zoning polygons designated as community shopping district



Buffer

INPUT



OUTPUT
DISSOLVE TYPE:
NONE



OUTPUT
DISSOLVE TYPE:
ALL



What is Spatial Analysis?

- Analysis is one of six GIS functions
- Process for highlighting patterns and relationships in spatial (geographic) data using spatial query
- Most people are still using GIS to only make maps
- GIS can do much more - Analysis

Capture

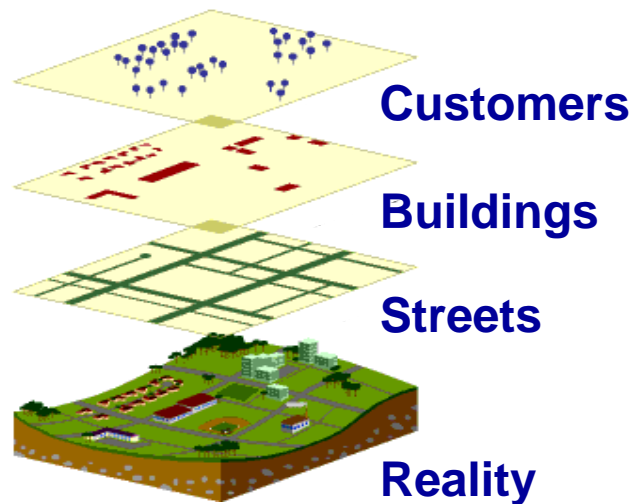
Store

Query

Analyze

Display

Output

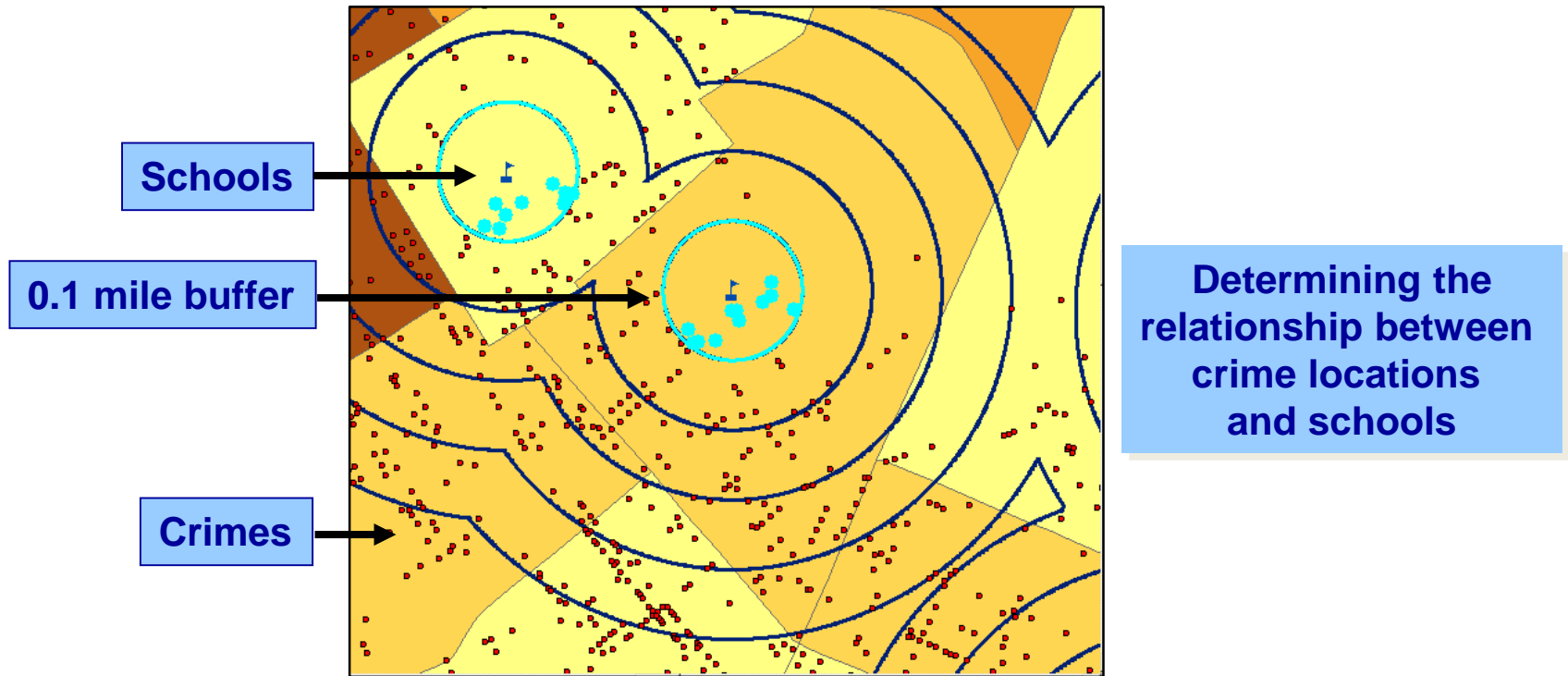


Components of Spatial Analysis

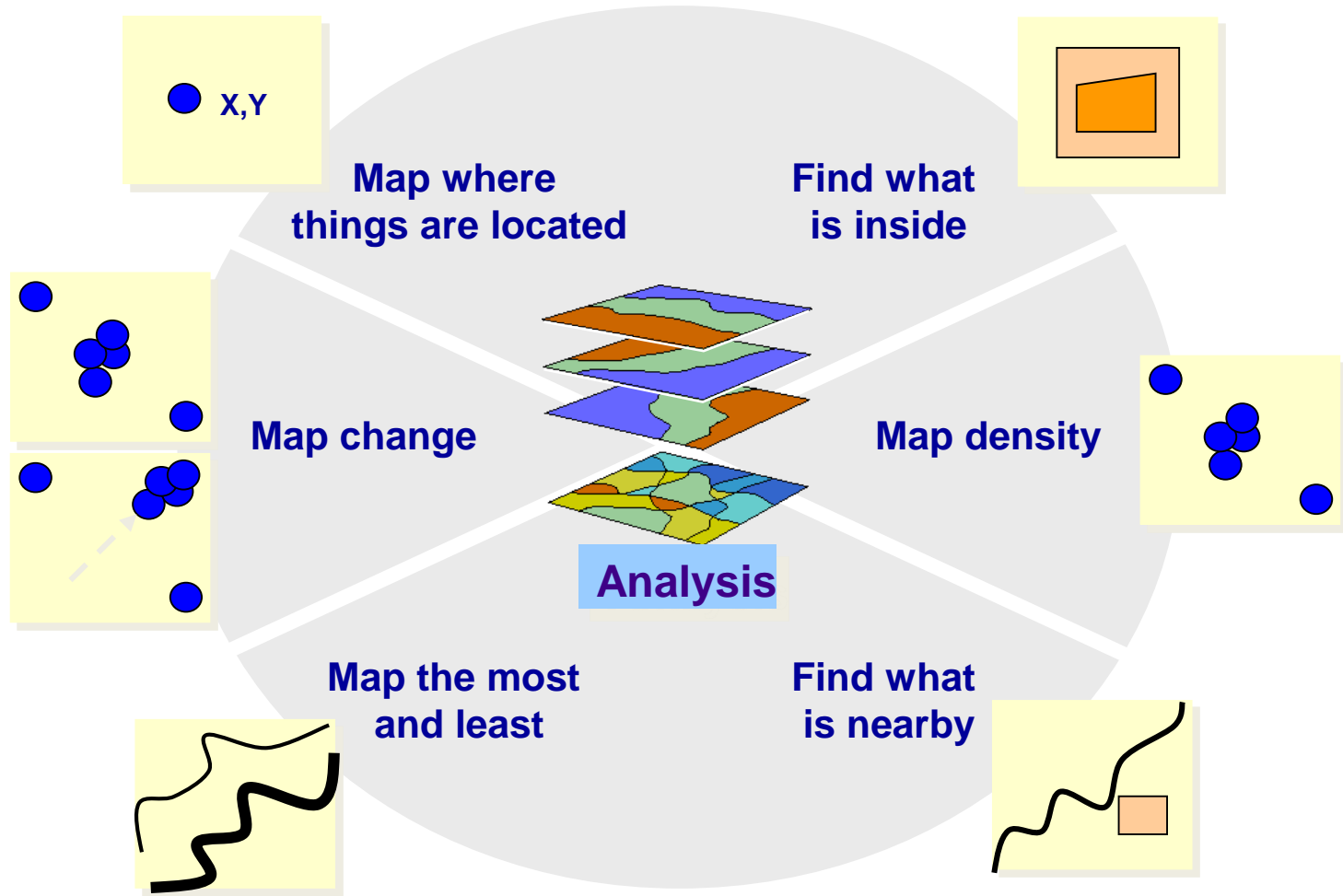
- Visualization
 - **Showing** interesting patterns
- Exploratory Spatial Data Analysis (ESDA)
 - **Finding** interesting patterns
- Spatial Modelling, Regression
 - **Explaining** interesting patterns

Why do analysis?

- Gives insight into places of interest
- Helps focus actions to choose the best option



Analysis answers simple questions

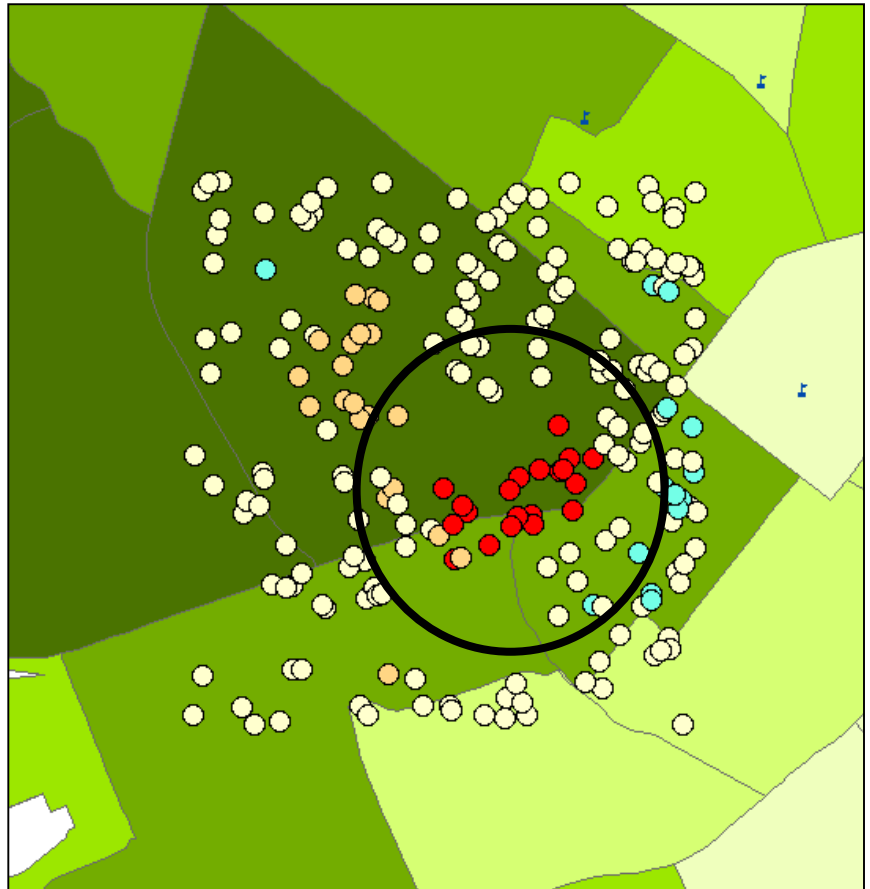


Typical Operations

- Point pattern analysis (Hotspots)
- Points in polygons
- Polygon overlay
- Spatial interpolation
- Density estimation

Point Pattern Analysis

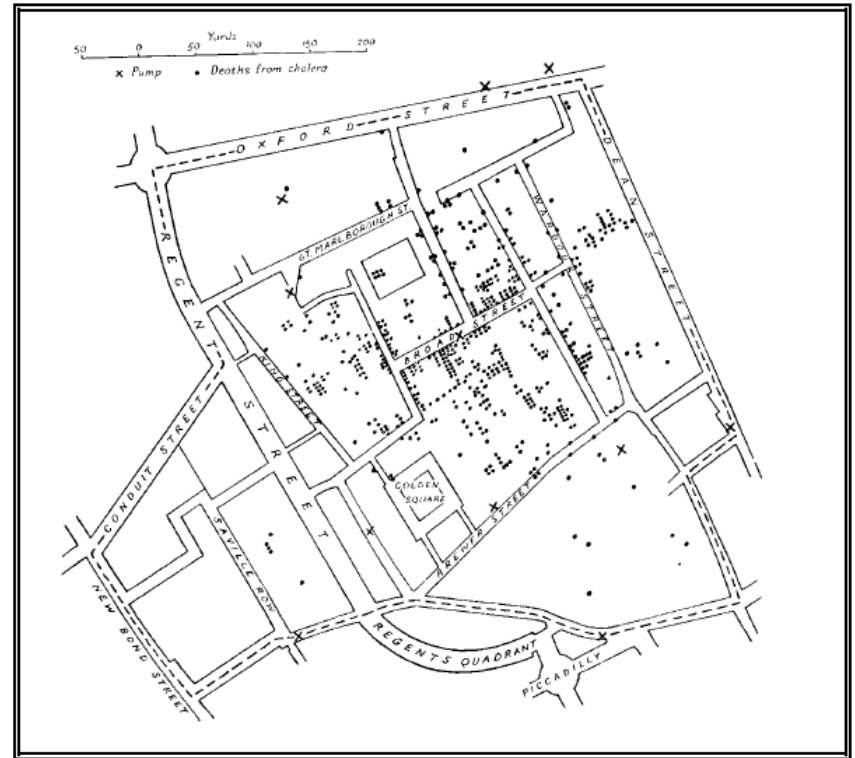
- Determine if patterns exist among point features
- Examine the spatial patterns and draw suitable conclusions
- **Example:** Crime hot spot analysis in Trinidad or Tobago



Point Pattern Analysis

For example, the work of John Snow 1865 plotting deaths from cholera on a map along with the 11 community wells.

The map revealed an association between cholera and the broad street pump



Point Pattern Analysis

PPA relies heavily on *Tobler's First Law of Geography*

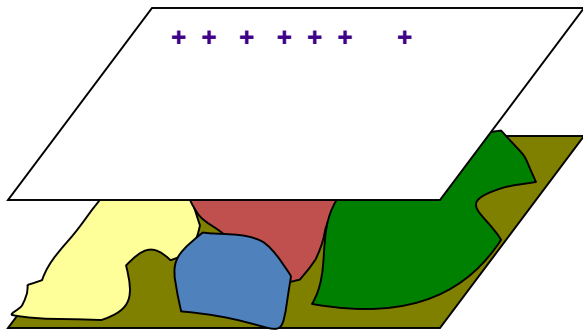
“Everything is related to everything else, but nearby things are more related than distant things”

Foundation of the fundamental concept of spatial dependence which is at the core of spatial analysis

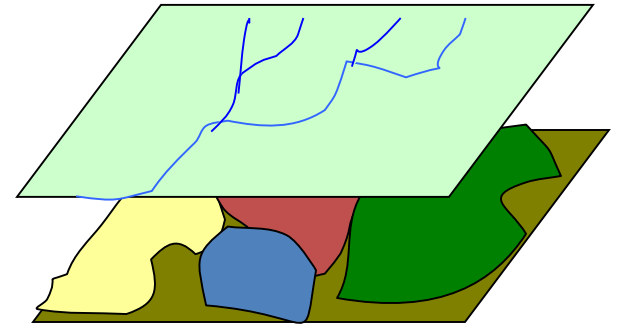
Waldo R Tobler



Overlay Analysis

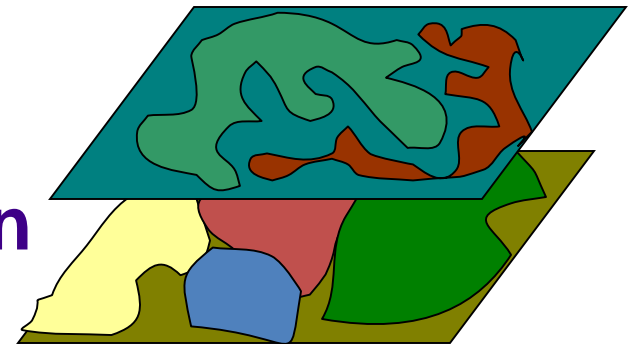


Point on
Polygon



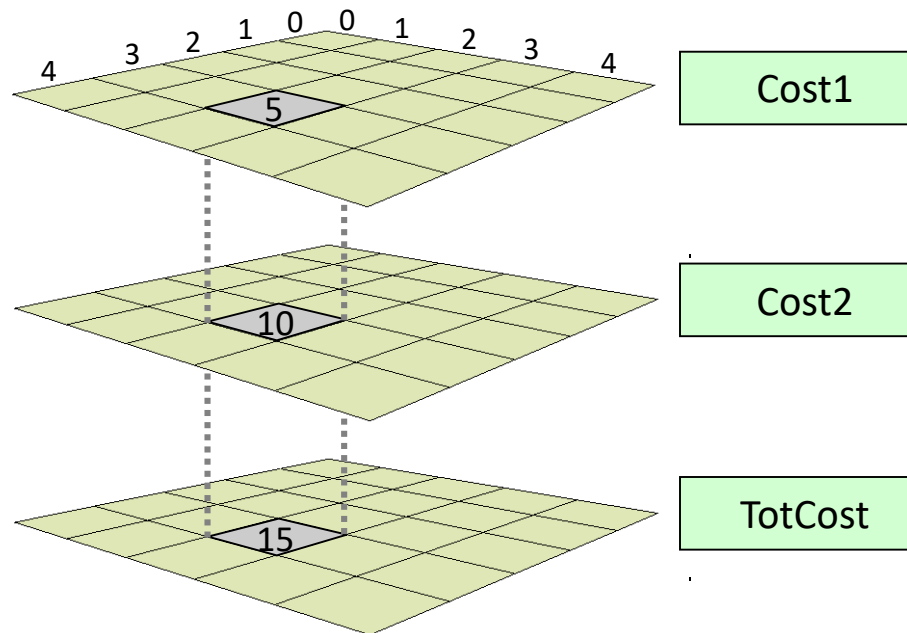
Line on Polygon

Polygon on
Polygon



Raster cell coincidence

- Analysis between rasters compares values for cells
 - Rasters must be registered to a common coordinate system



$$\begin{array}{rcccc} \text{TotCost} & (3,2) & = & \text{Cost1} & (3,2) & + & \text{Cost2} & (3,2) \\ 15 & & = & 5 & & + & 10 & \end{array}$$

Spatial Interpolation

- Traditionally, data collected in the field comprise of point measurements at discrete locations. Today it is usual to have automated system, like weather station, that collect vast amounts of data
- These datasets are still samples and would not represent a continuous surface over the area of interest
- **Spatial interpolation** methods are used to estimate values at unsampled locations using measurements at sampled locations
- Effectively fills in the unknown information using the known information

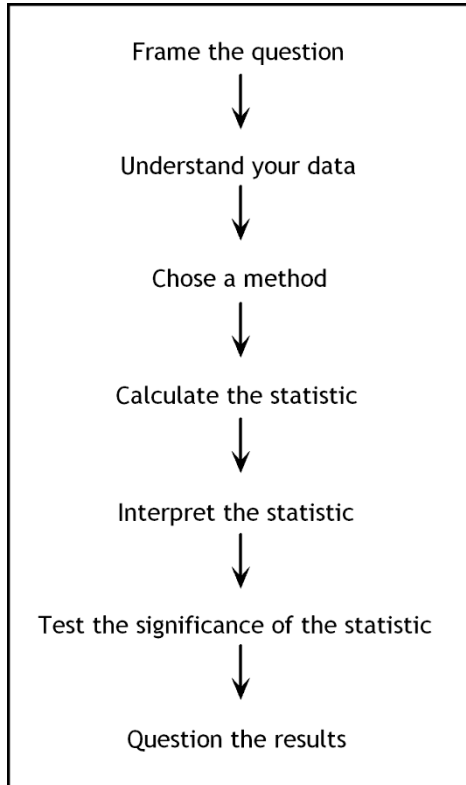
Spatial Interpolation

- Methods include
 - Inverse Distance Weighted
 - Spline
 - Kriging

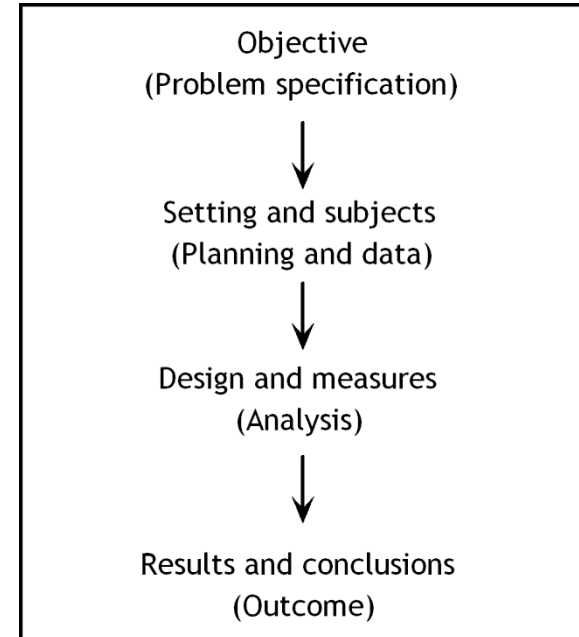


Spatial Analysis Process

- Mitchell (2005)

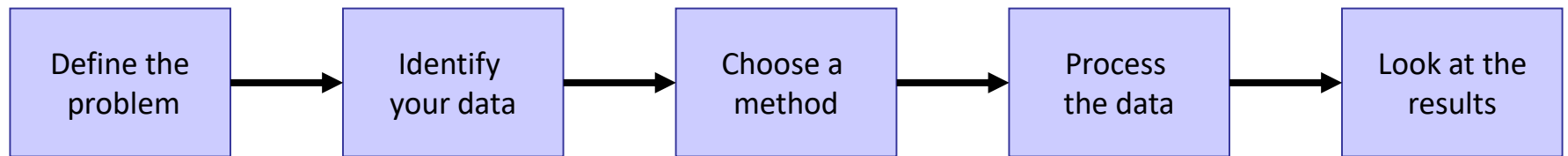


- Draper et al (2005)



Spatial Analysis Process

Based on ESRI



Spatial Analysis Process

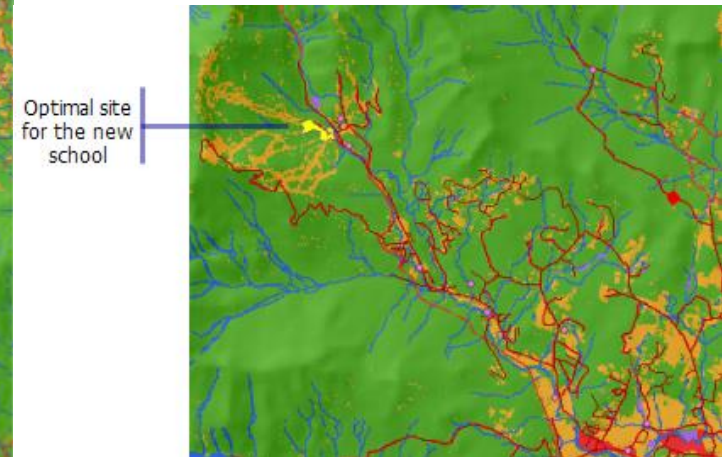
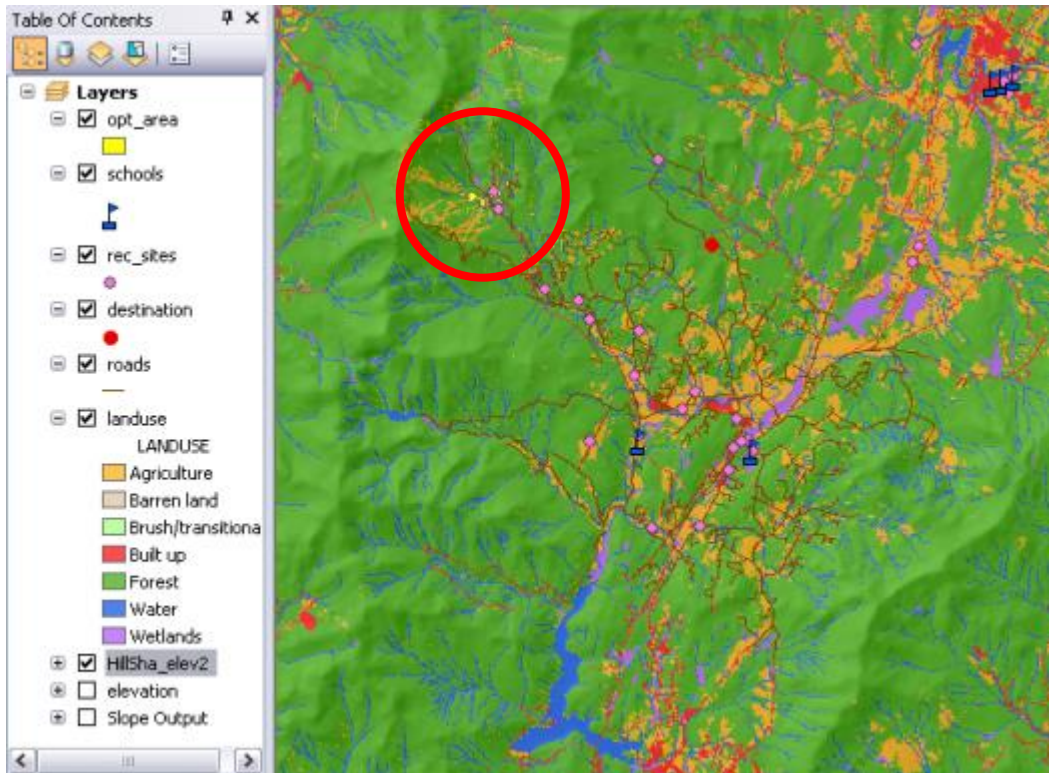
- Problem formulation
- Planning
- Data gathering
- Exploratory analysis
- Hypothesis formulation
- Modelling and testing
- Consultation and review
- Reporting and/or implementation



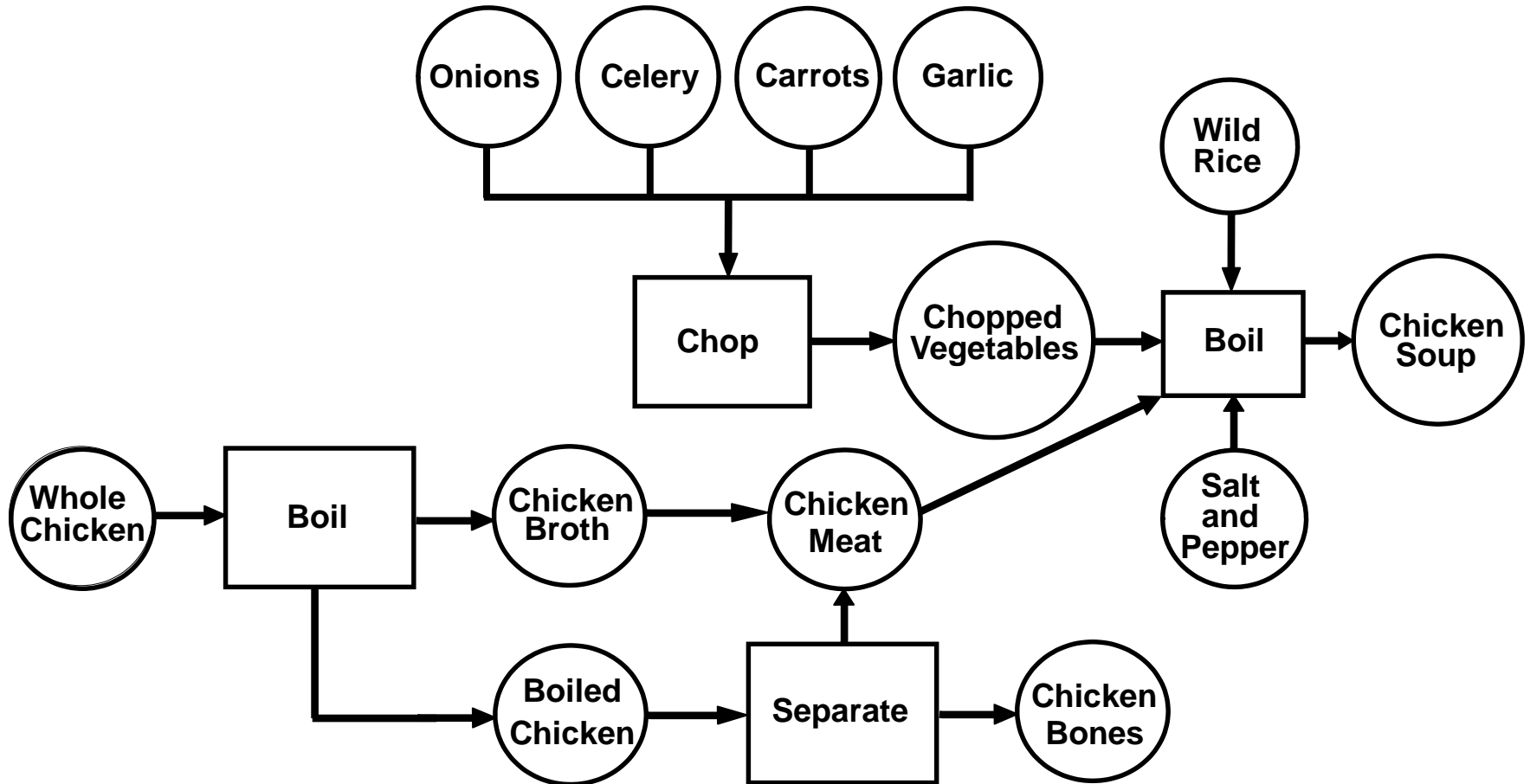
Problem – Site Suitability

- Phrase the problem as a question
 - Where would be a suitable location for a new school?
- Desk study / literature review
 - How have others dealt with this in the past?
 - What are the possible models?
- Criteria for selection
 - Close to recreation areas
 - Not close to existing schools
 - Gently sloping ground
 - Close to residential areas

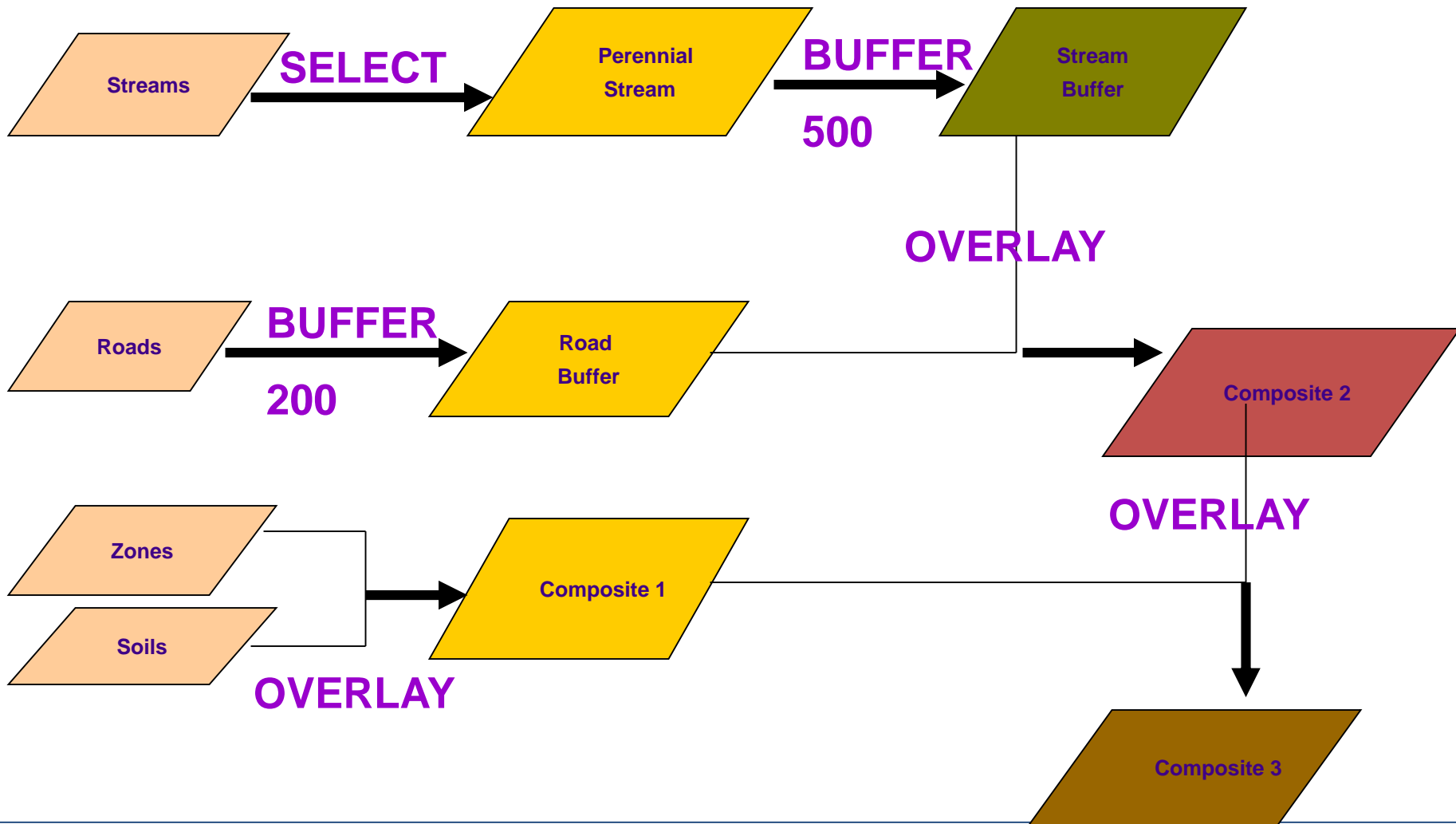
Possible Result - Optimal Site



A Simple Model



A Cartographic Model



Cartographic Modelling with Model Builder

The screenshot displays the ArcMap interface with a map of Portland, Oregon, showing schools and roads. A cartographic model titled "SchoolsCloseToFreeways" is open in the foreground. The model workflow is as follows:

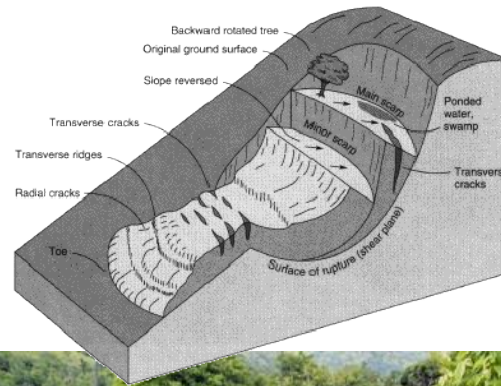
- Major Roads (Input) → Select Highways (Process) → Highways (Output)
- SCHOOLS (Input) → Near (Process) → SCHOOLS (2) (Output)
- Select Schools (Process) → Multiple Ring Buffer (Process) → School_Zones (Output)

The "Near" process is currently executing, as shown by the progress bar and the "SchoolsCloseToFreeways" dialog box. The dialog box displays the following information:

```
1 of 4 processes executed  
Executing Next...  
 Close this dialog when completed successfully  
\\GIS_data\Portland.mdb\Highways  
"2700.000000 Feet" NO_LOCATION  
NO_ANGLE SCHOOLS  
Start Time: Thu Mar 25 09:55:08  
2004
```


Modelling Susceptibility to Landslides

- Precipitation
- Elevation
- Slope
- Aspect
- Curvature
- Earthquake zones
- Landcover
- Soil/Geology
- Human activities
- etc

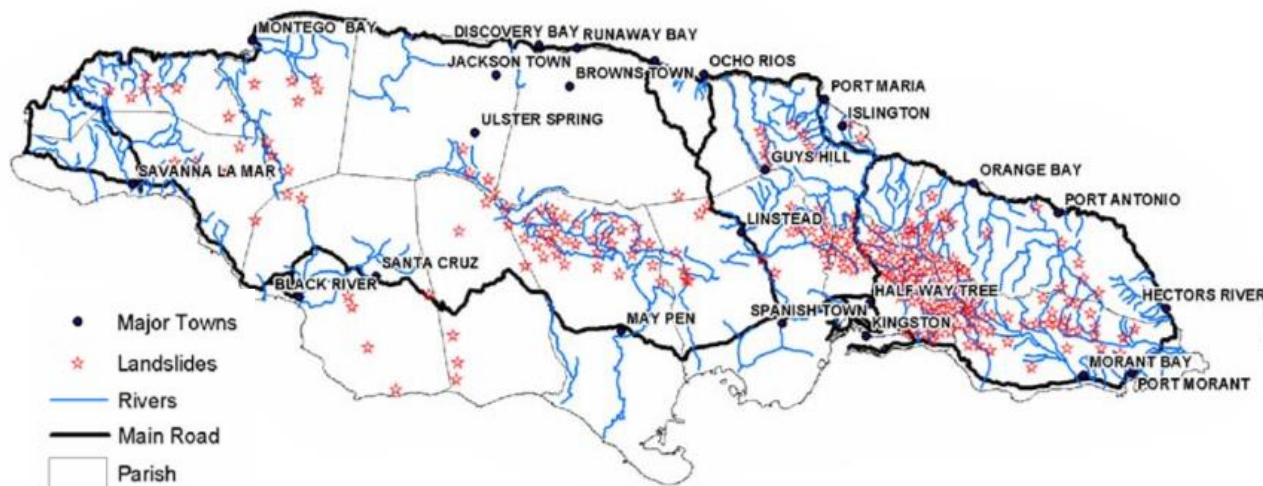


Source: USGS



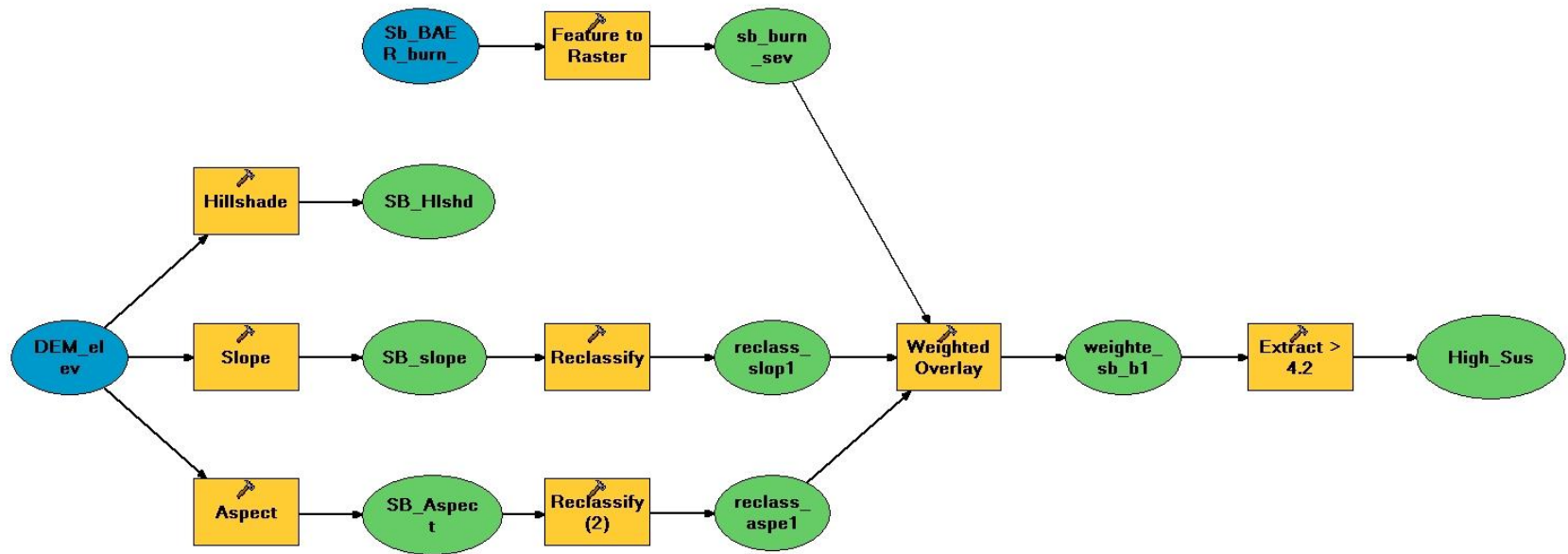
Source: Jamaica Gleaner

Historical Landslides

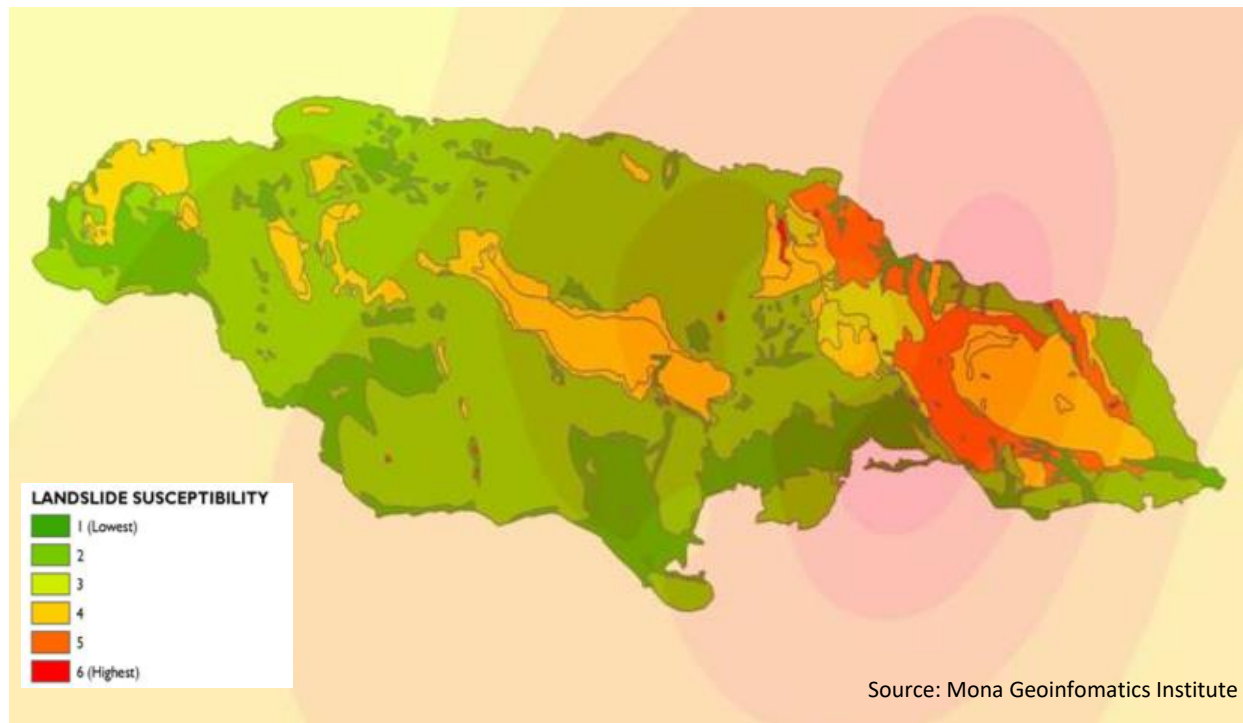


Source: Dr Rafi Ahmad, UWI Mona

Landslide Susceptibility Model



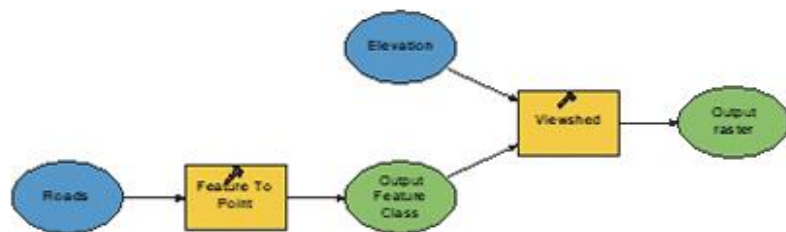
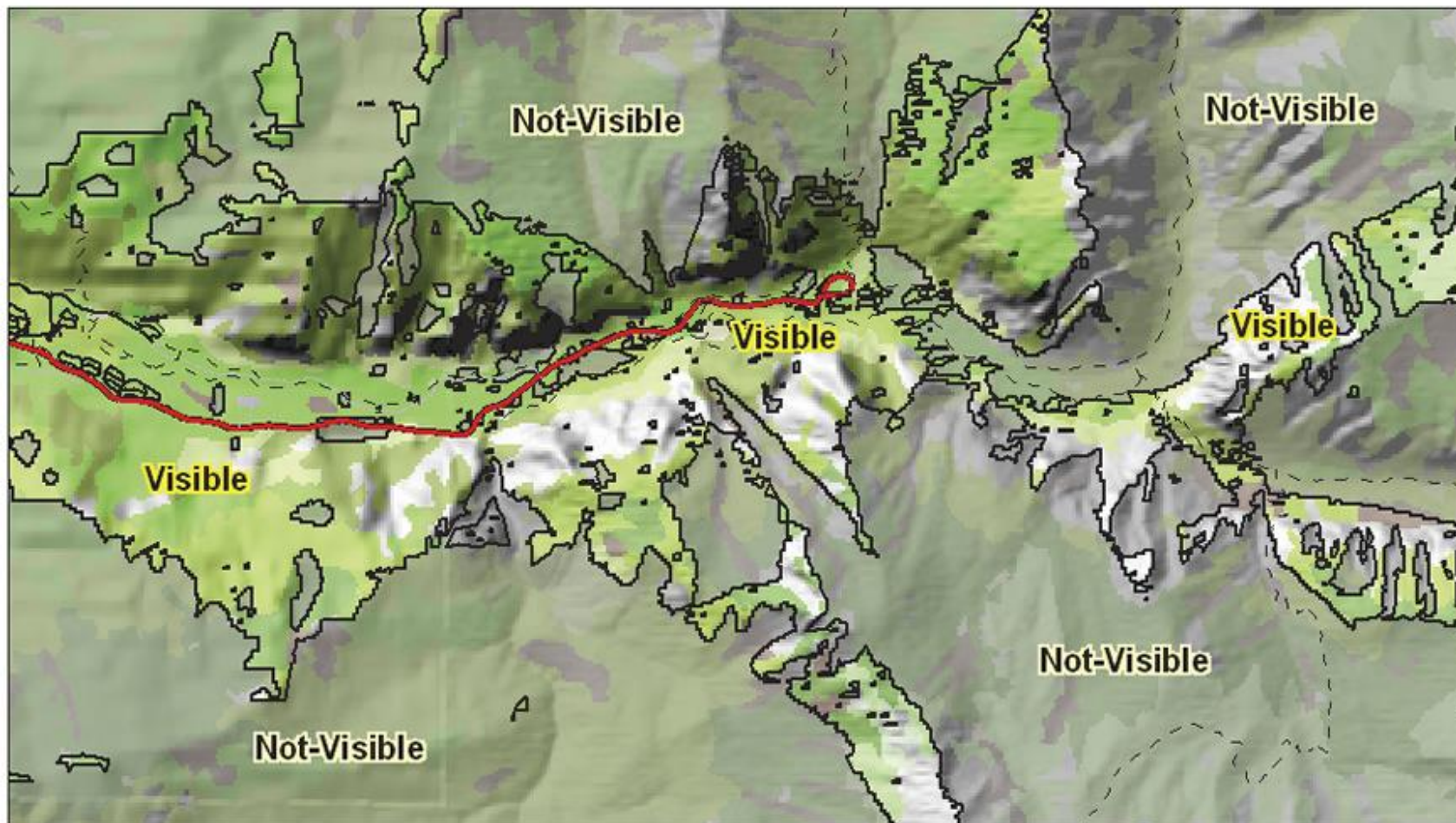
Landslide Susceptibility Zones



Other Analysis Examples

- Determination of visibility
 - line-of-sight
 - view sheds
- Site Suitability Analysis
 - Finding the best site for a school
- Network Analysis
 - optimal routes
 - allocation of resources

Road Corridor Visibility Analysis Model

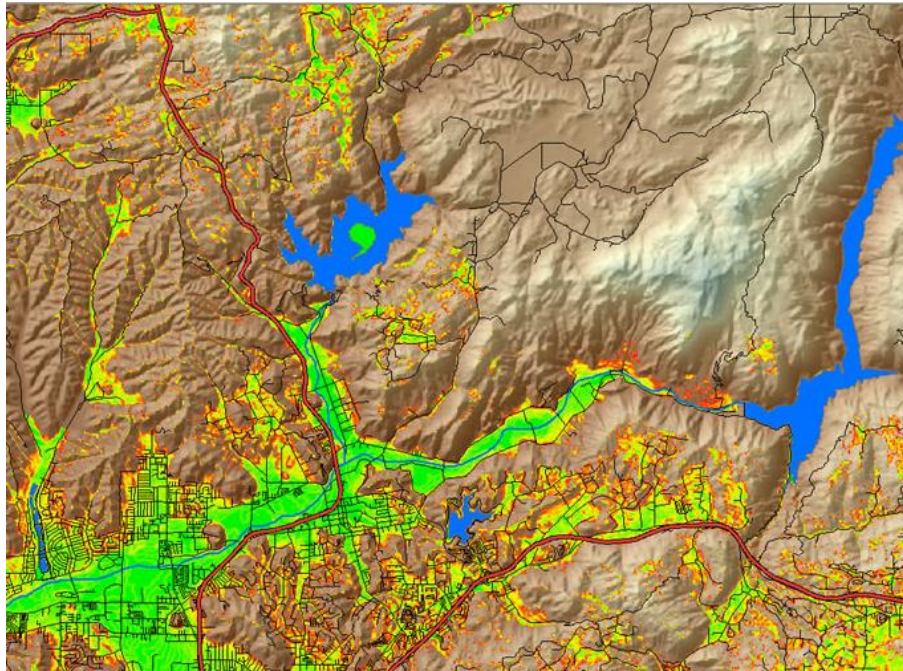


Site Suitability

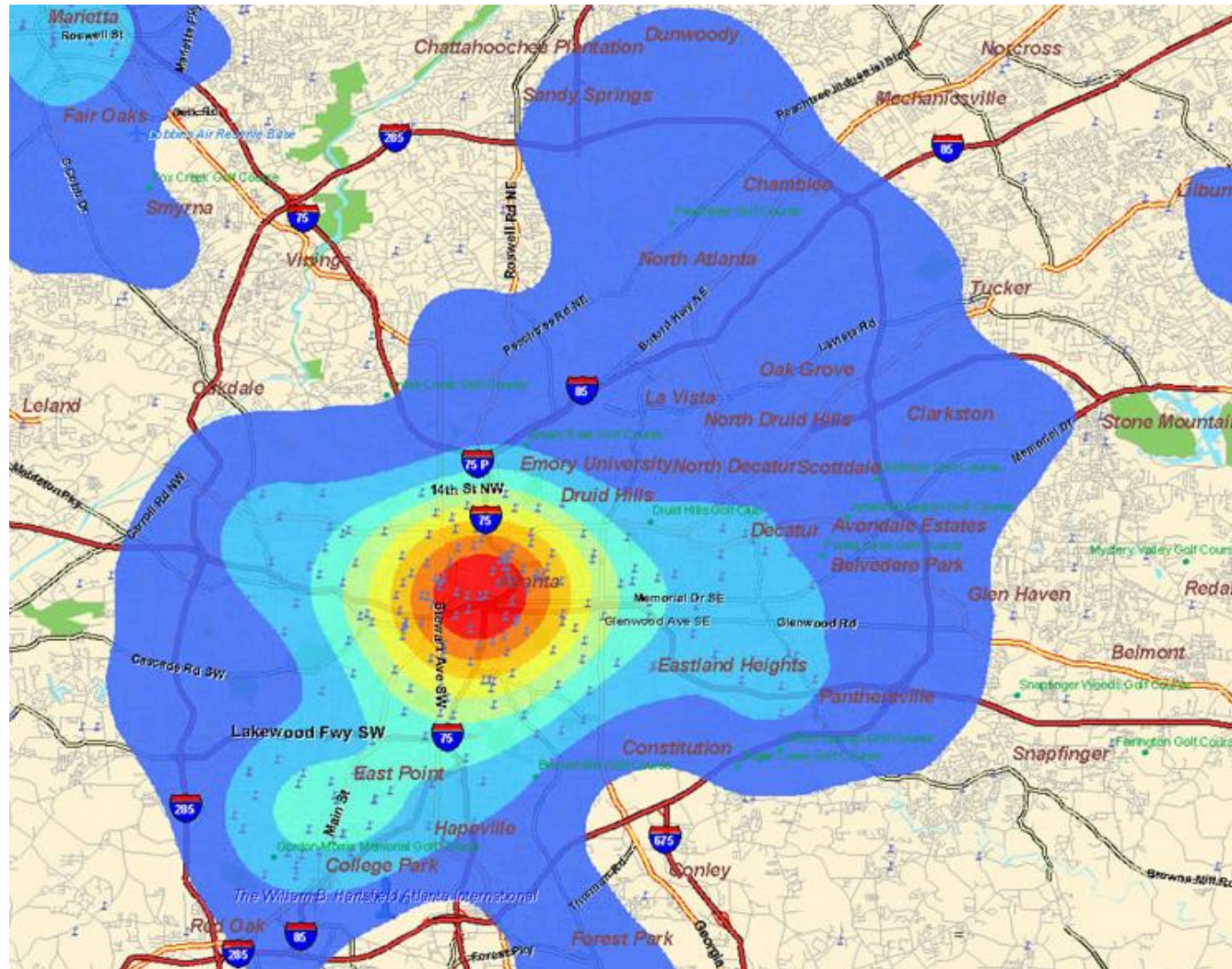
A suitability model typically answers the question, Where is the best location?—whether it involves finding the best location for a new road or pipeline, a new housing development, or a retail store.

For instance, a commercial developer building a new retail store may take into consideration distance to major highways and any competitors' stores, then combine the results with land-use, population density, and consumer spending data to decide on the best location for the store.

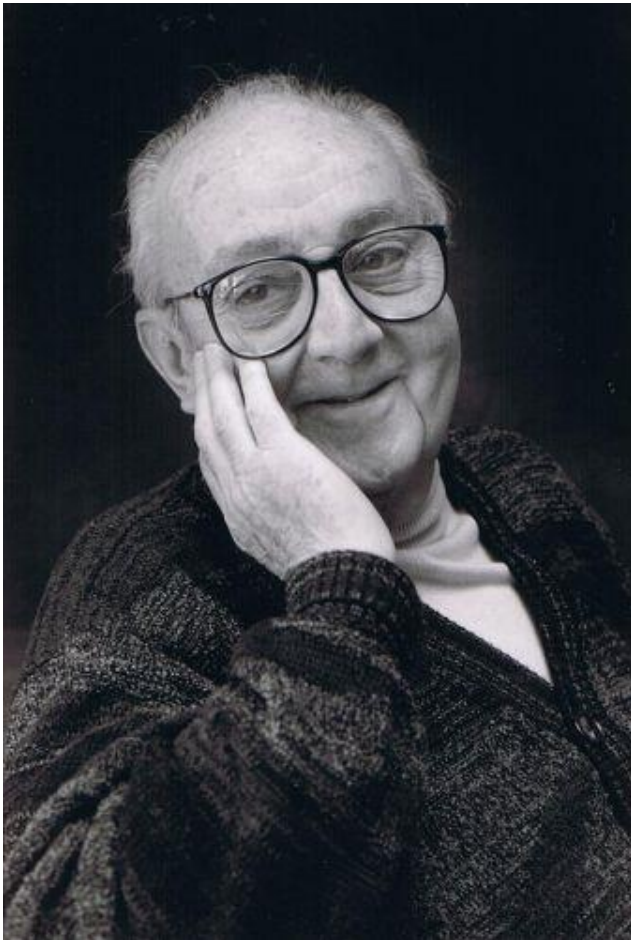
ArcGIS Spatial Analyst derives new information from the overlay of multiple layers, which can then be used to determine the best location.



Density Analysis



**British statistician
George E. Box**



“Essentially all
models are wrong,
but some are useful”

UP NEXT

Activity: Conducting Spatial Query and Analysis in ArcGIS

Acknowledgement

Except where stated, images used in this presentation were acquired from multiple sources on the world wide web.