Lucy Family Institute for Data & Society

Accessible Geospatial Tools for Mapping and Sharing Medieval Information

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Outline

I. What is GIS and spatial data
   A. Data Structures
II. What can we do with spatial data?
III. Remote Sensing
IV. Spatial data formats
V. Finding spatial data
VI. Tools for working with spatial data
VII. Creating spatial data

Housekeeping

- Login to the Notre Dame ArcGIS Online Account
  - https://www.arcgis.com/
  - This account is for the workshop and will be restricted in the future.

- Materials
  - https://github.com/msisk1/workshops
  - in the DMSI folder

- Please be respectful of others, but feel free to interrupt me if something is unclear

What is GIS ?

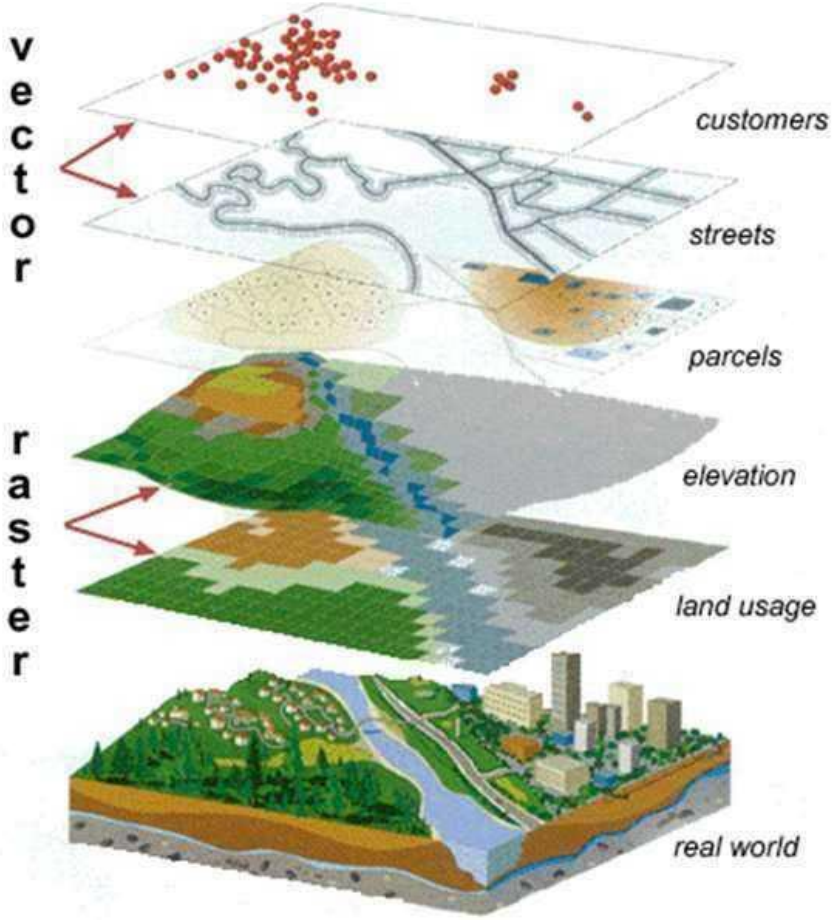
In short: “computerized mapping software”

Formal definition

A Geographic Information System (GIS) is a computerized database management system for capture, storage, retrieval, manipulation, analysis and display of spatial (i.e. locationally defined) data

Layers

- A GIS is composed of layers of spatial information
- Can be different types of data
- Everything is referenced to a coordinate system
  - e.g. latitude / longitude

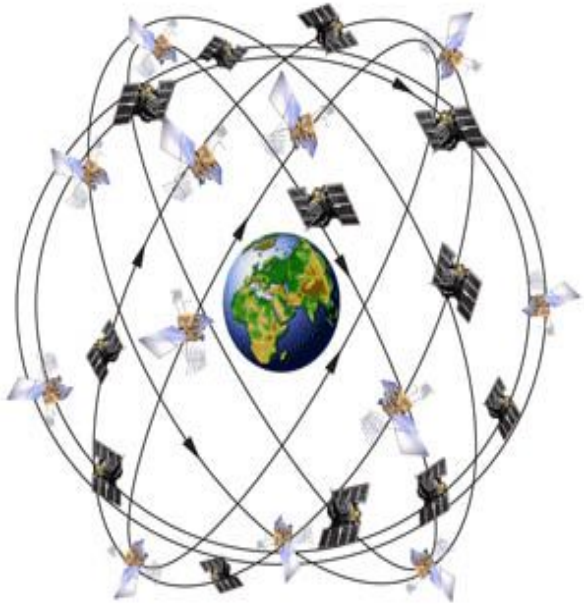


GIS and GPS

GPS: Global Positioning System

A system of 24 satellites that enabled devices can use to get a precise location on the globe

GIS frequently uses data from GPS receivers but the two are not linked



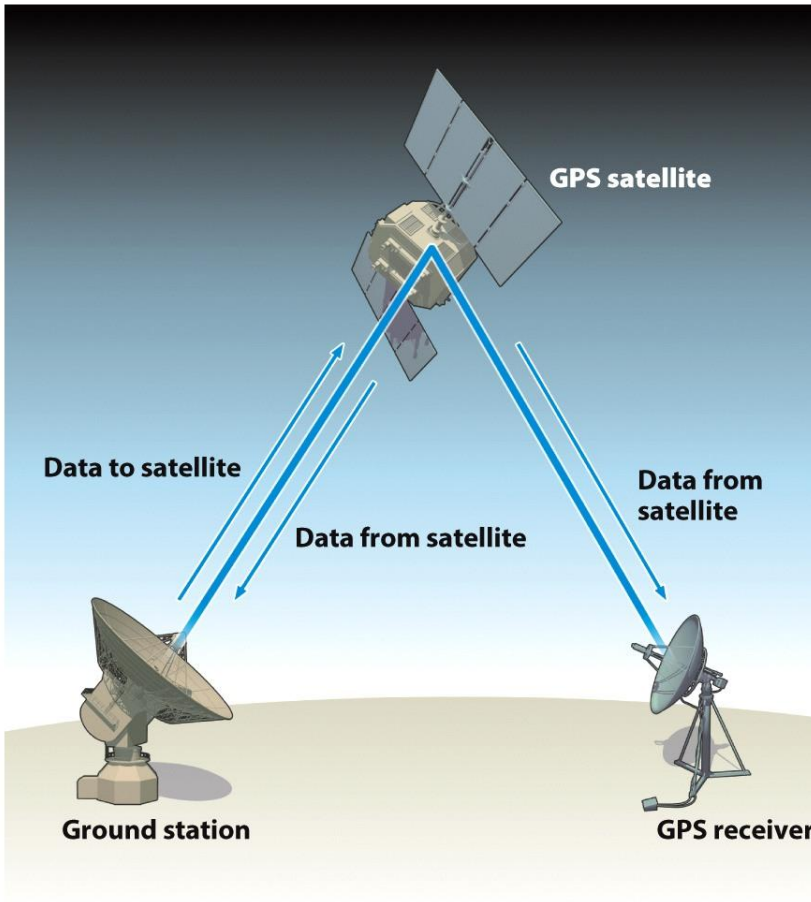
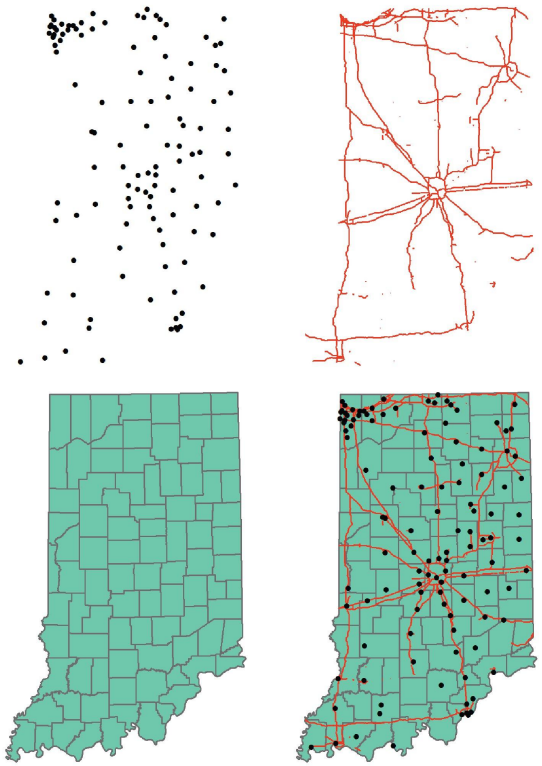


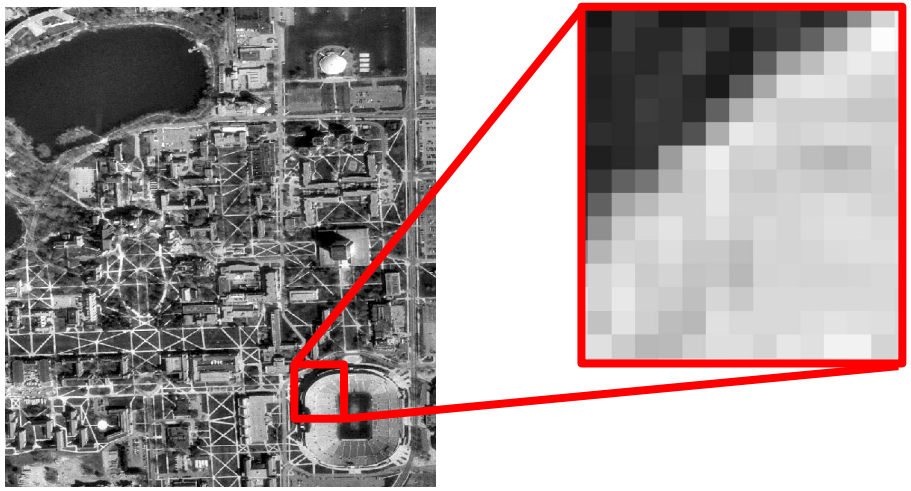
Figure 4.2
***Introduction to Geospatial Technologies*, Second Edition**

GIS digitally models the real world using:



Three types of geometry

- -Points
- -Lines
- -Areas



Cells in an image

Table

Indiana Counties

FID	Shape *	NAME_L	POP2000	MALES	FEMALES	AGE_UNDER5	AGE_5_17	AGE_18_21	AGE_22_29
0	Polygon	Steuben	33214	16771	16443	2199	6322	2241	3307
1	Polygon	Lagrange	34909	17681	17228	3432	8381	2199	3674
2	Polygon	Elkhart	182791	90848	91943	14800	37999	9881	20712
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10	Polygon	Kosciusko	74057	36982	37075	5519	15043	3728	7655
11	Polygon	Starke	23556	11660	11896	1520	4792	1142	2169
12	Polygon	Whitley	30707	15238	15469	2101	6112	1469	2853
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14	Polygon	Jasper	30043	14888	15155	2077	6157	1985	2856
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18	Polygon	Wabash	34960	16957	18003	2073	6504	2377	3234
19	Polygon	Huntington	38075	18537	19538	2536	7412	2395	3600

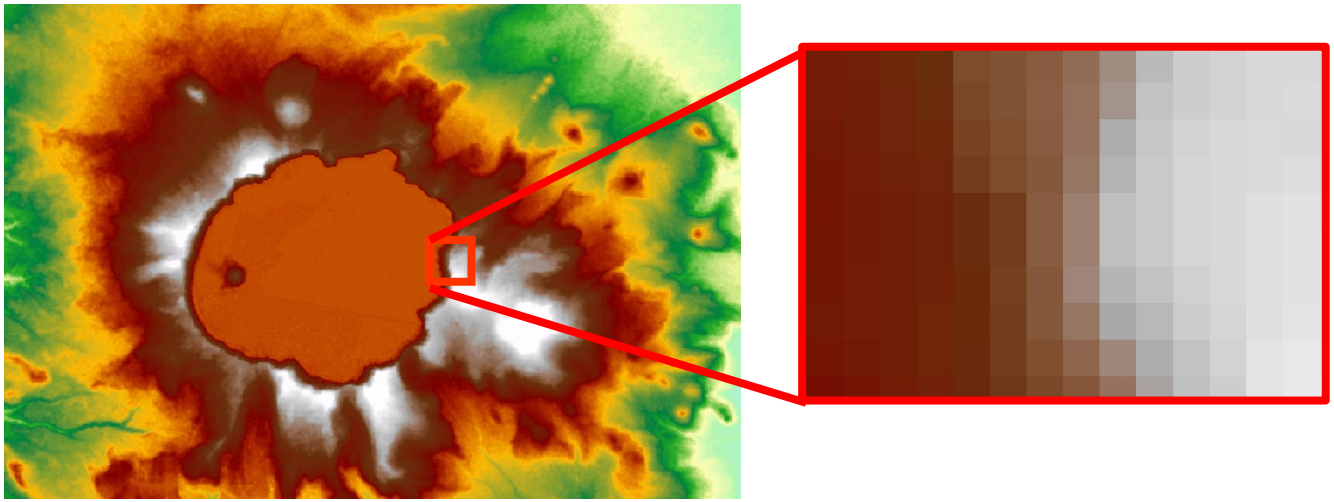
0 (0 out of 92 Selected)

Indiana Counties

Data tables

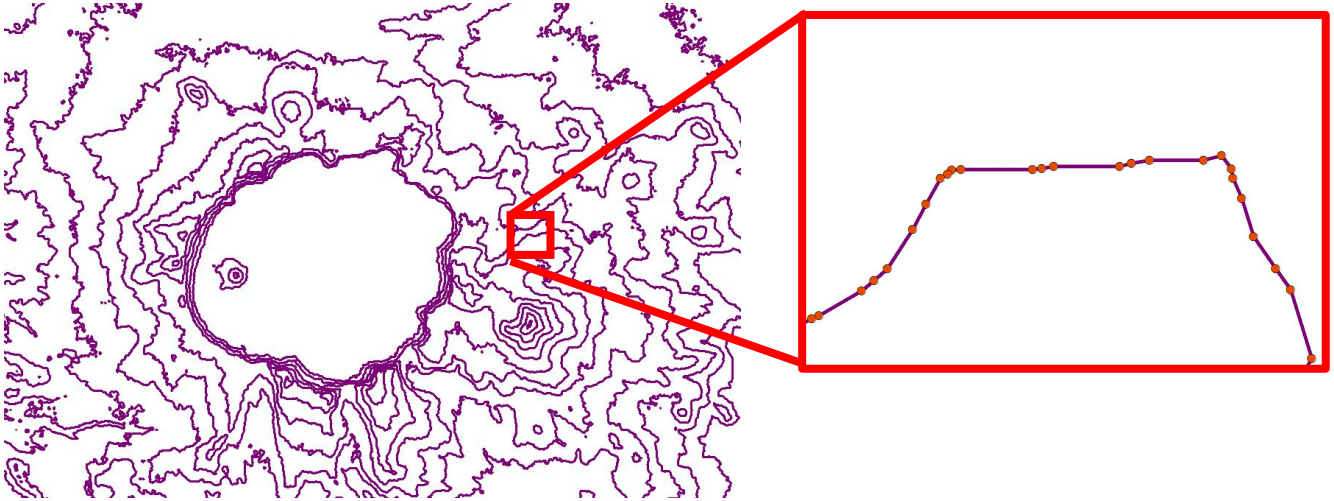
Raster Data

Based on pixel



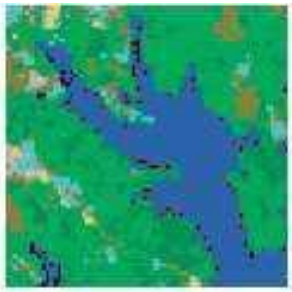
Vector Data

Based on discrete points

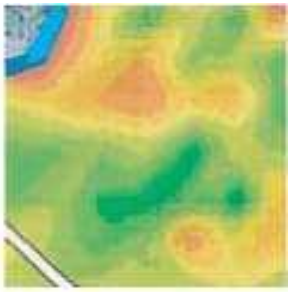


Rasters

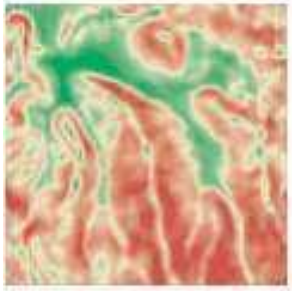
Orthophoto



Land Use

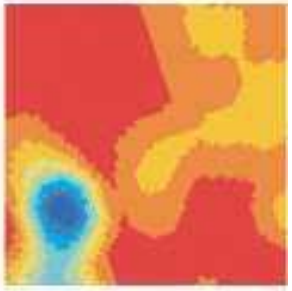


Concentration



Slope

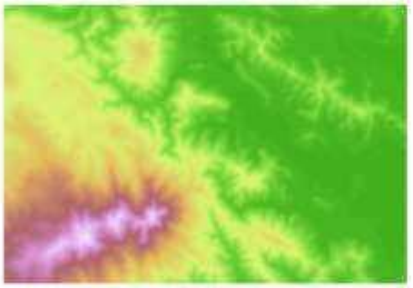
Elevation



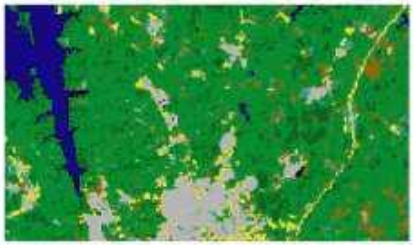
Population

Aerial Imagery

Surface Elevation



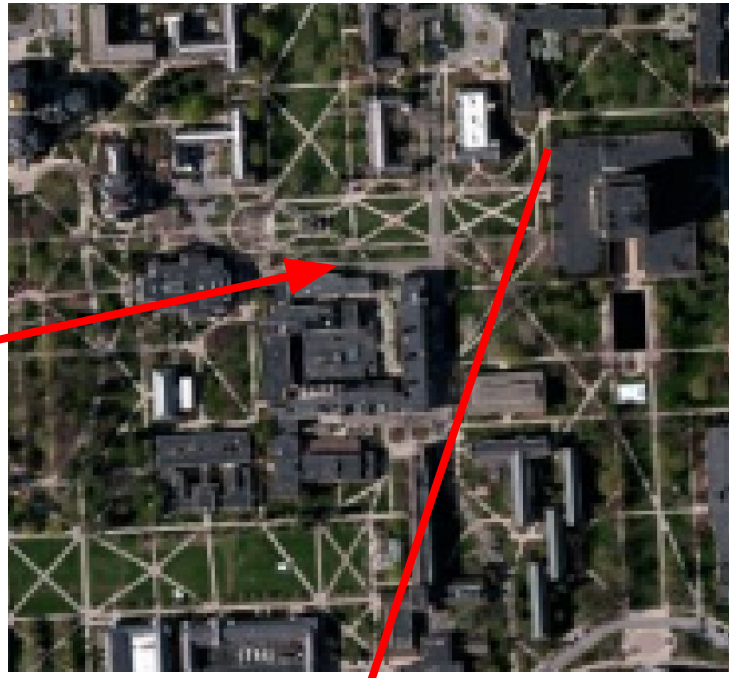
Land Use Classes



- Agriculture
- Bare ground
- Water
- Deciduous Trees
- Deciduous / Pine Mixed
- Grassland
- Pine
- Shadow
- Urban / Developed

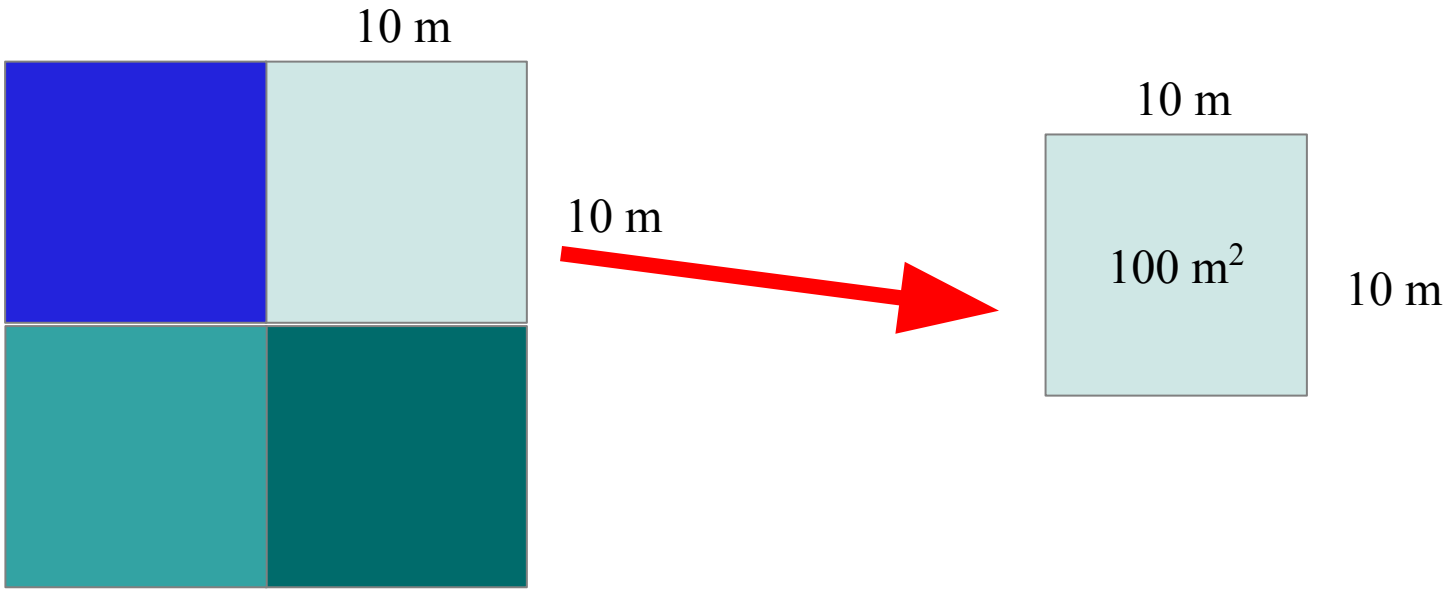
- The fundamental unit of a raster image is the pixel
- This is the same as a digital picture

The Raster Data Model

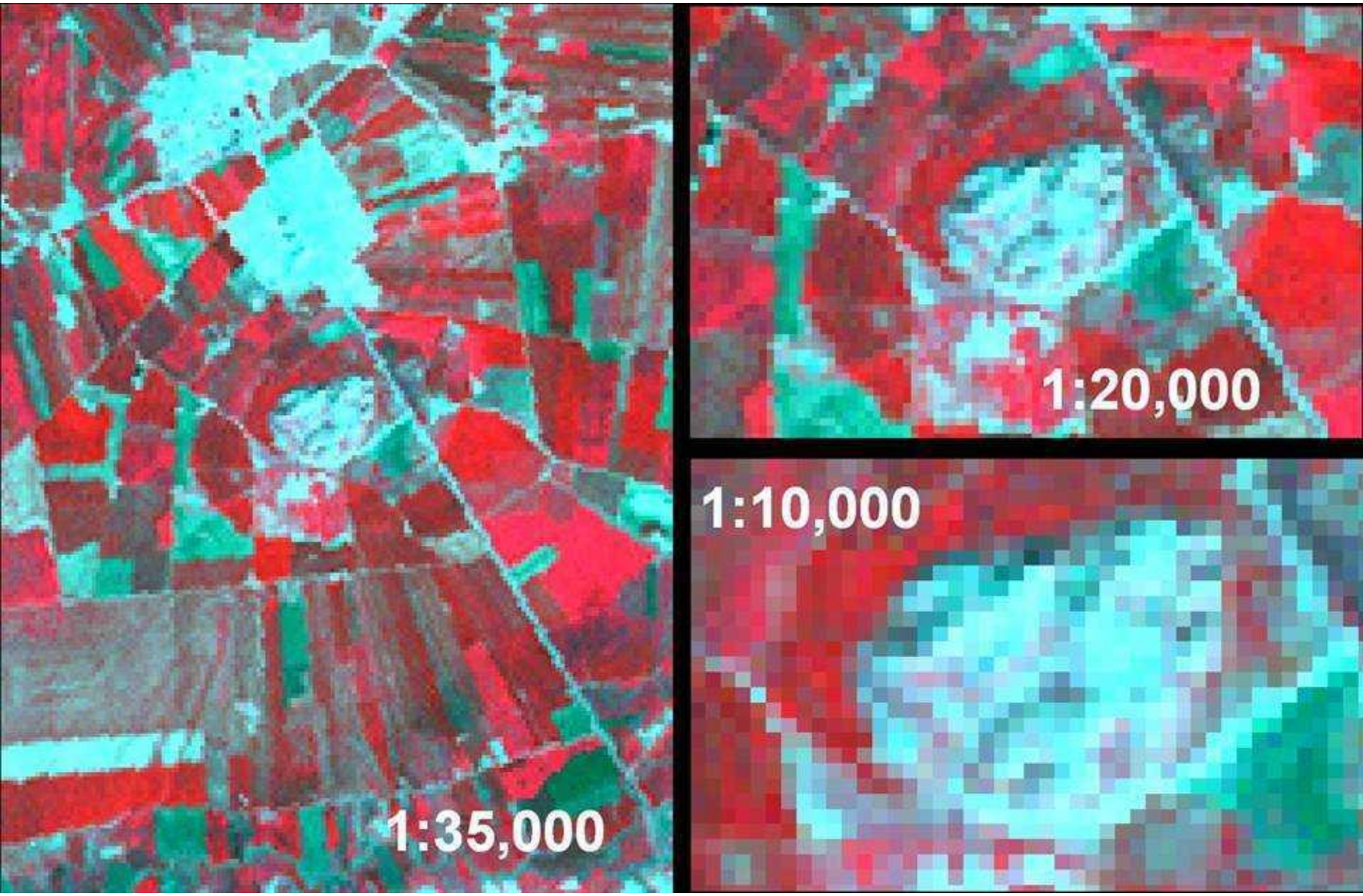


Spatial Resolution

The length, in real world measurements, of each side of a square pixel



Raster Resolution Comparison



Raster Data Model

Raster Advantages

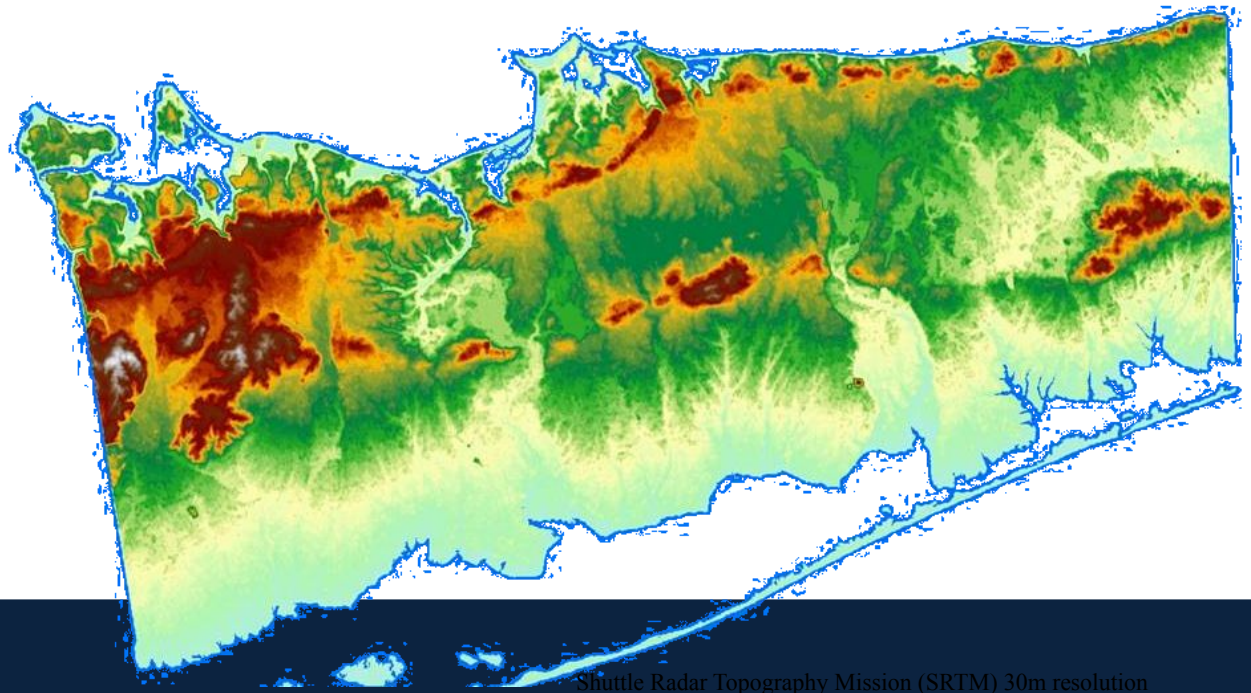
- Continuous Coverage
- Detail beyond human perception
- Easily manipulated

Raster Disadvantages

- Fixed resolution
- Large file size
- Difficult to edit individual pixels

Digital Elevation Model (DEM)

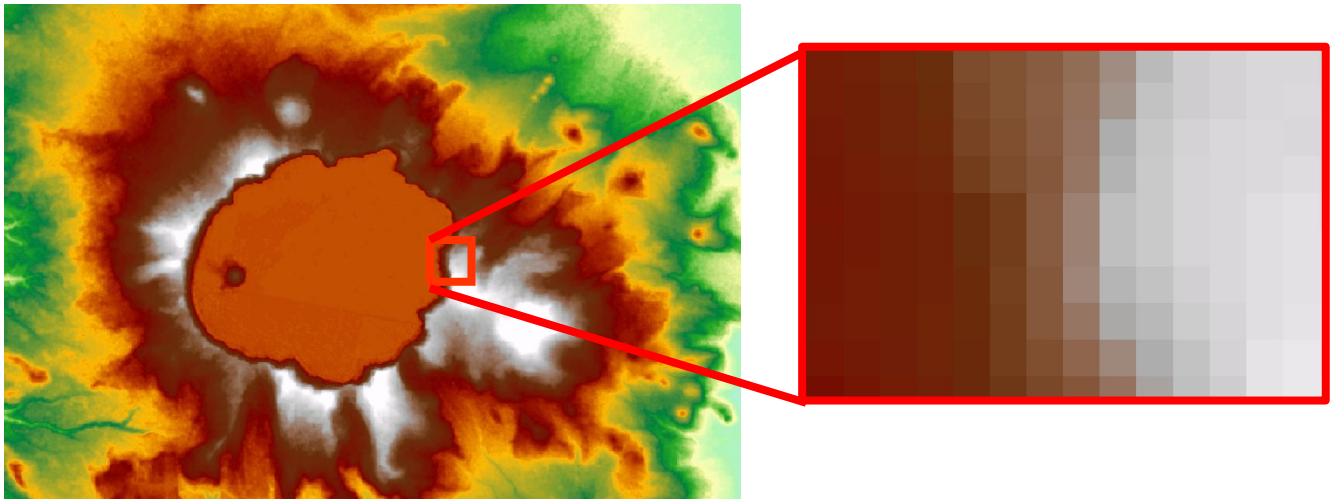
- Type of raster where the pixel value corresponds to elevation
- Used for analyzing slope, waterflow, visibility, etc.



Shuttle Radar Topography Mission (SRTM) 30m resolution

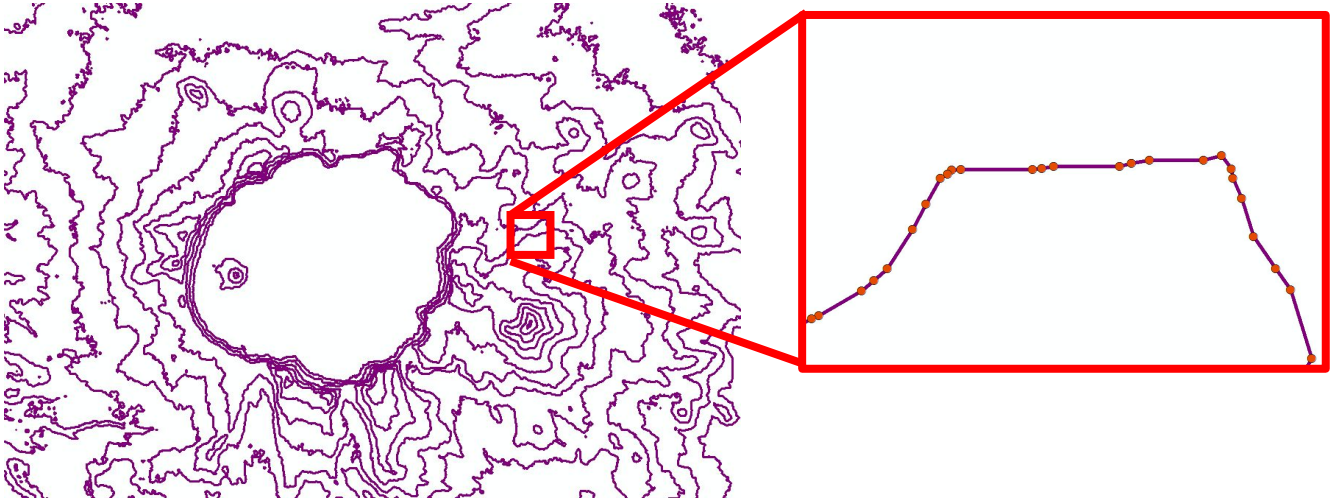
Raster Data

Based on pixel

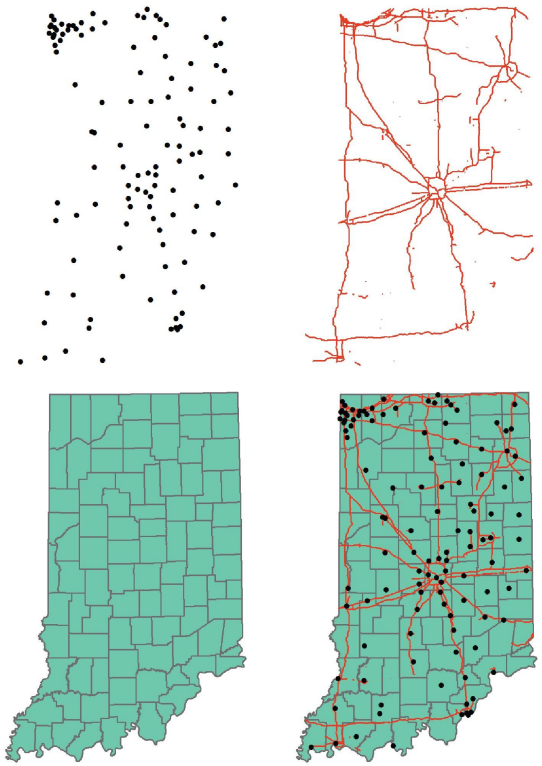


Vector Data

Based on discrete points



Vectors:



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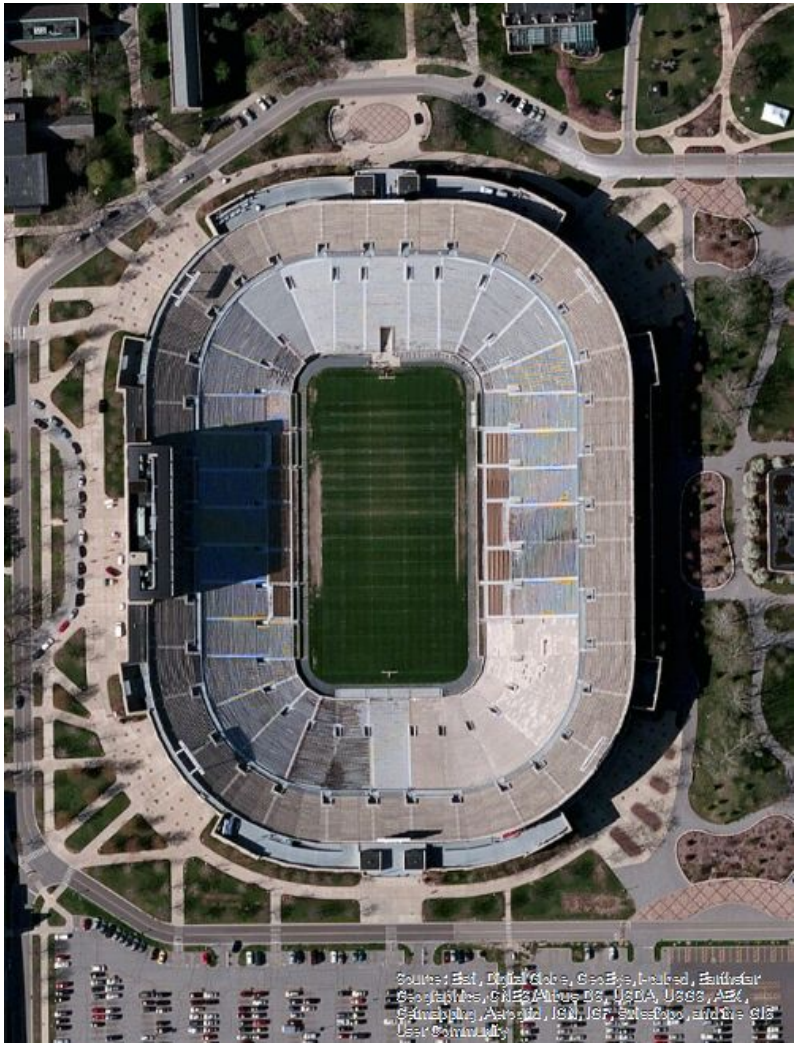
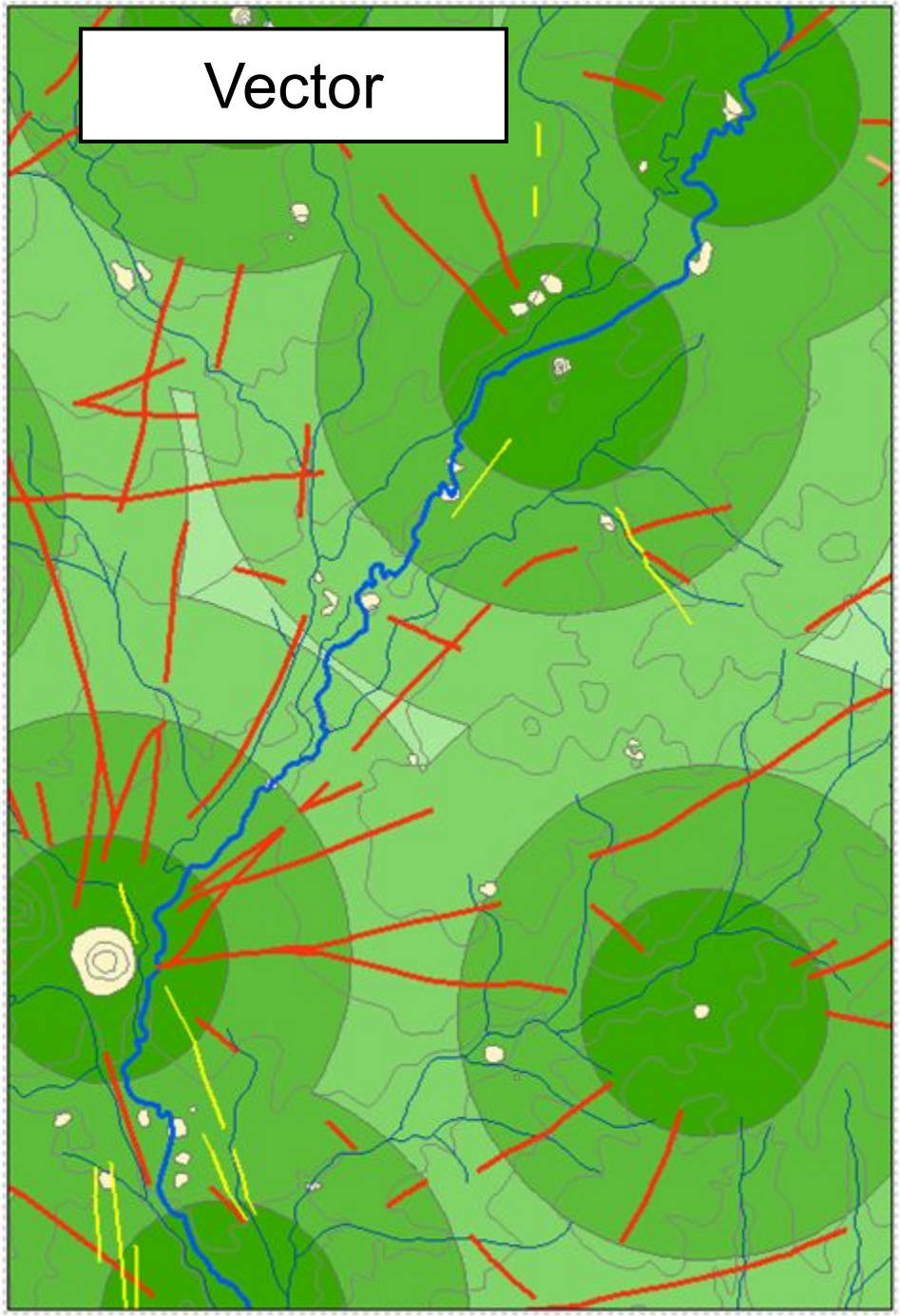
Indiana Counties

Data tables

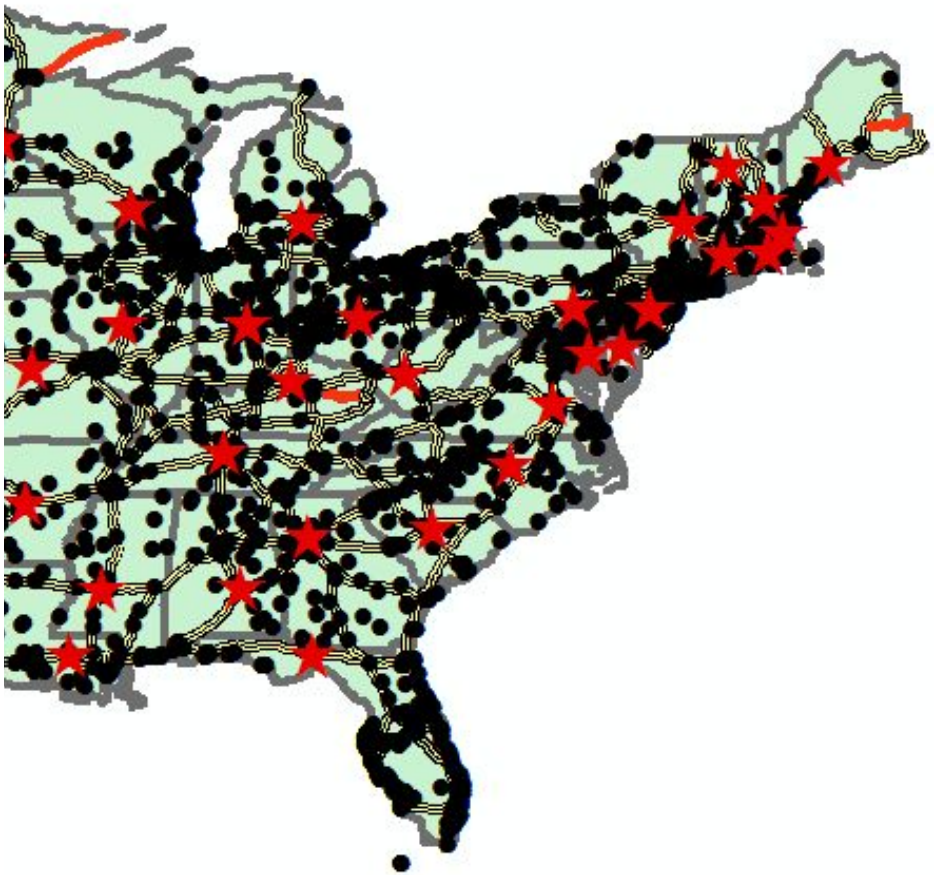
Raster and Vector



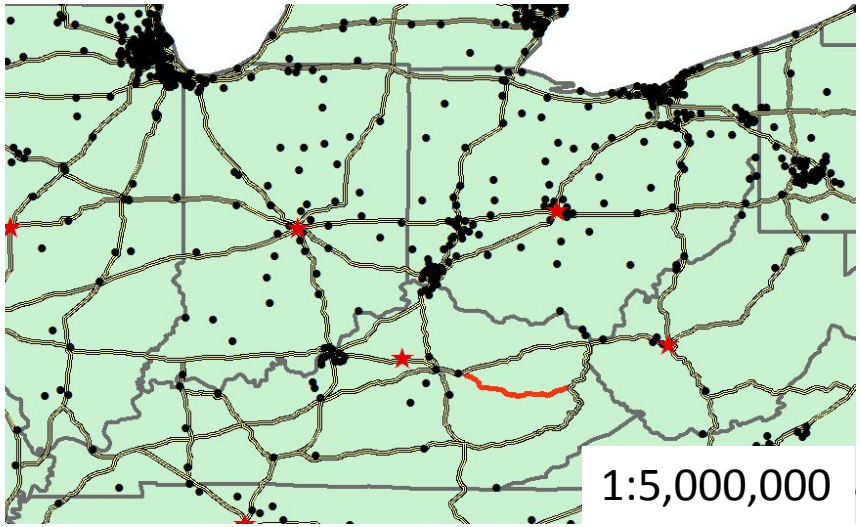

Vector


Raster
0
1
2
3
Km

Vector Resolution Comparison



1:25,000,000



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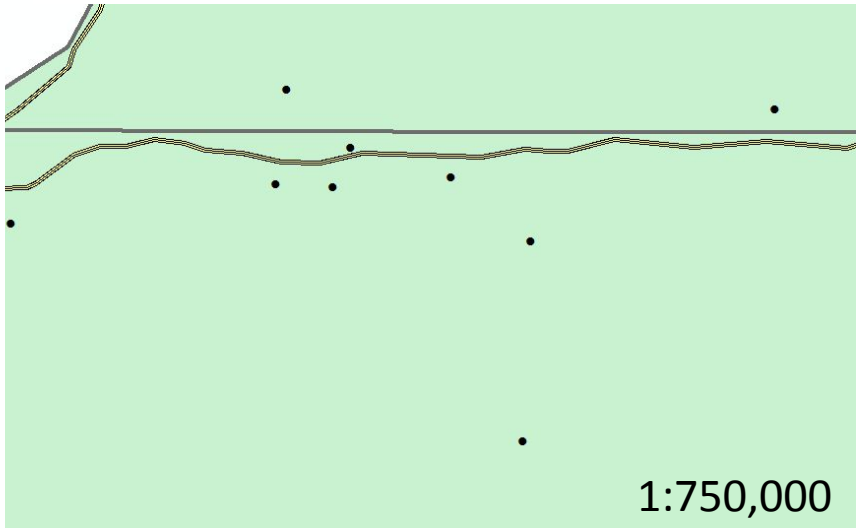


1:750,000

Vector vs. Raster

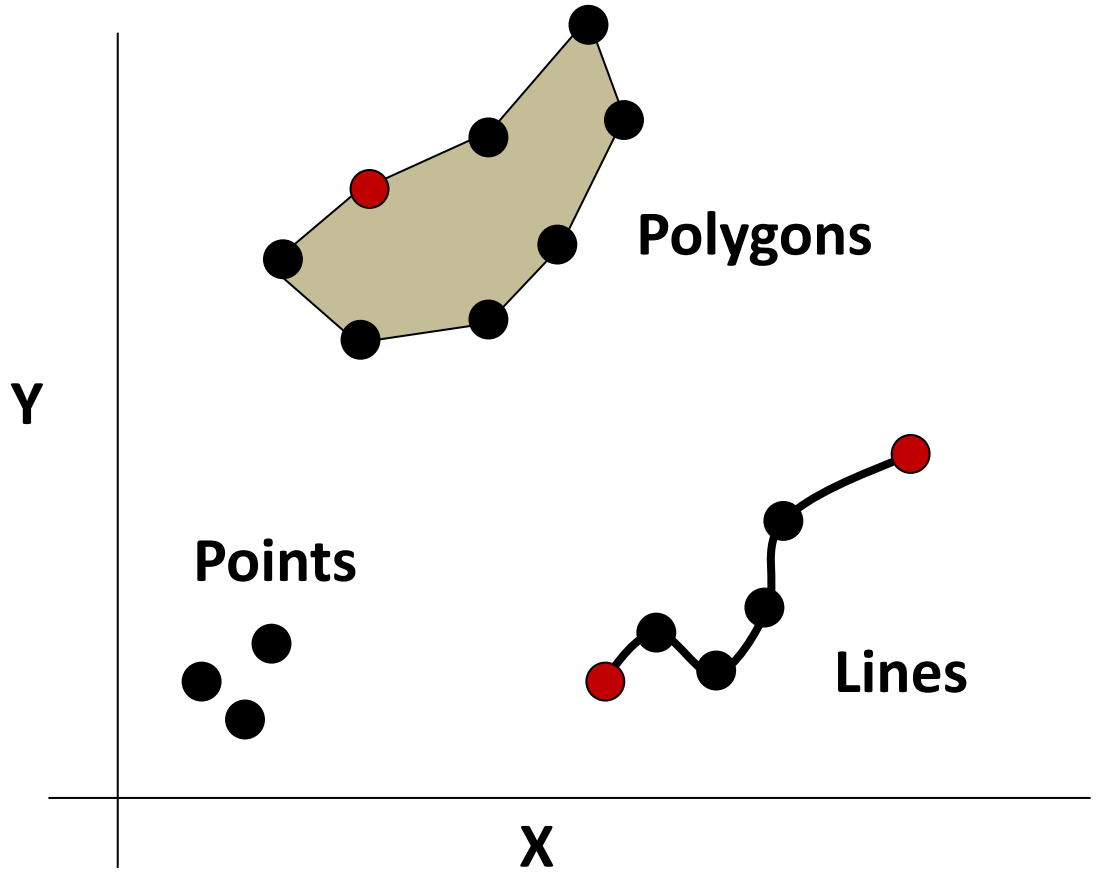
Vector Advantages

- Economical in space
- Good for discrete features
- More flexible with regard to scale

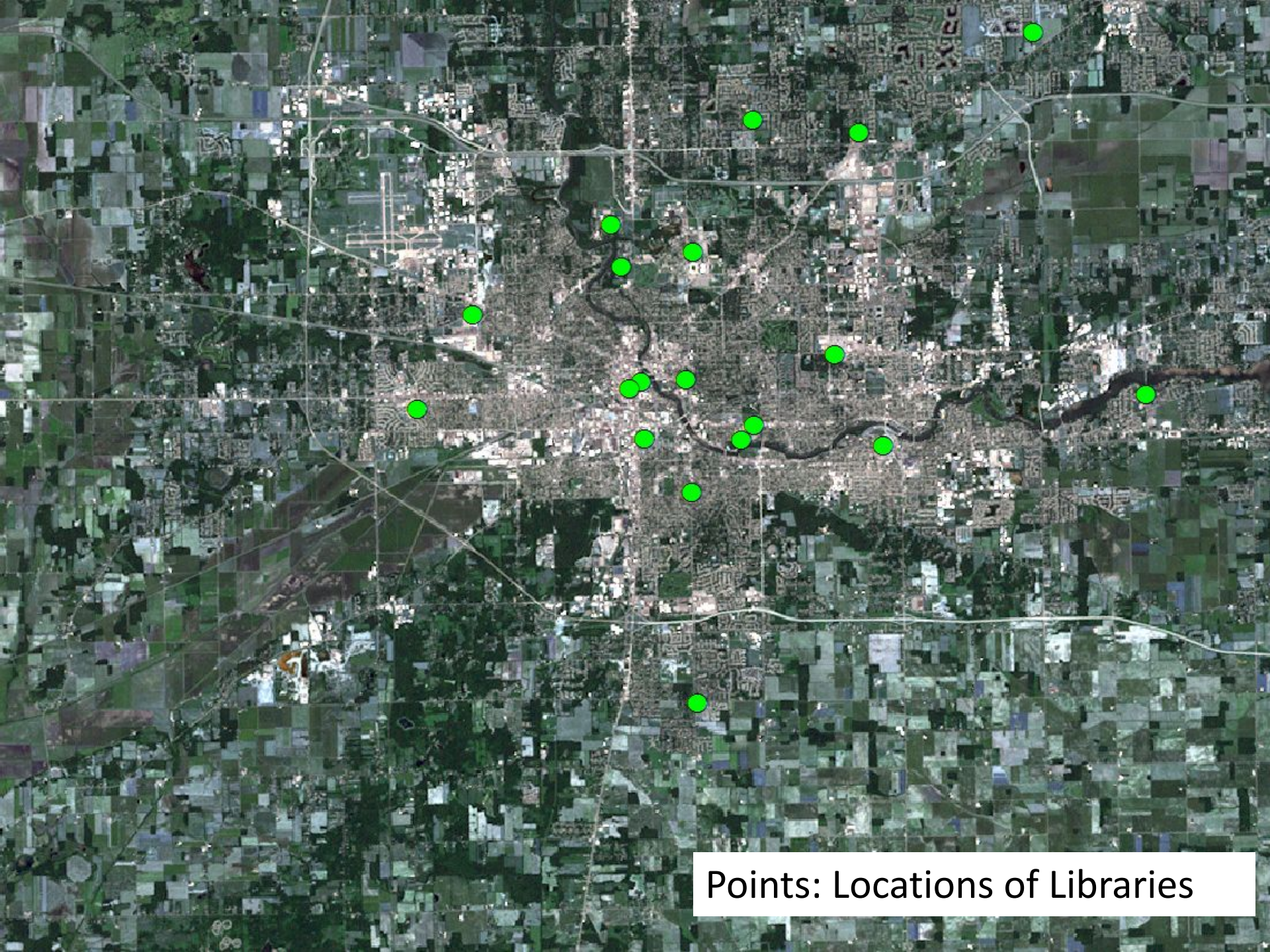
Vector Disadvantages

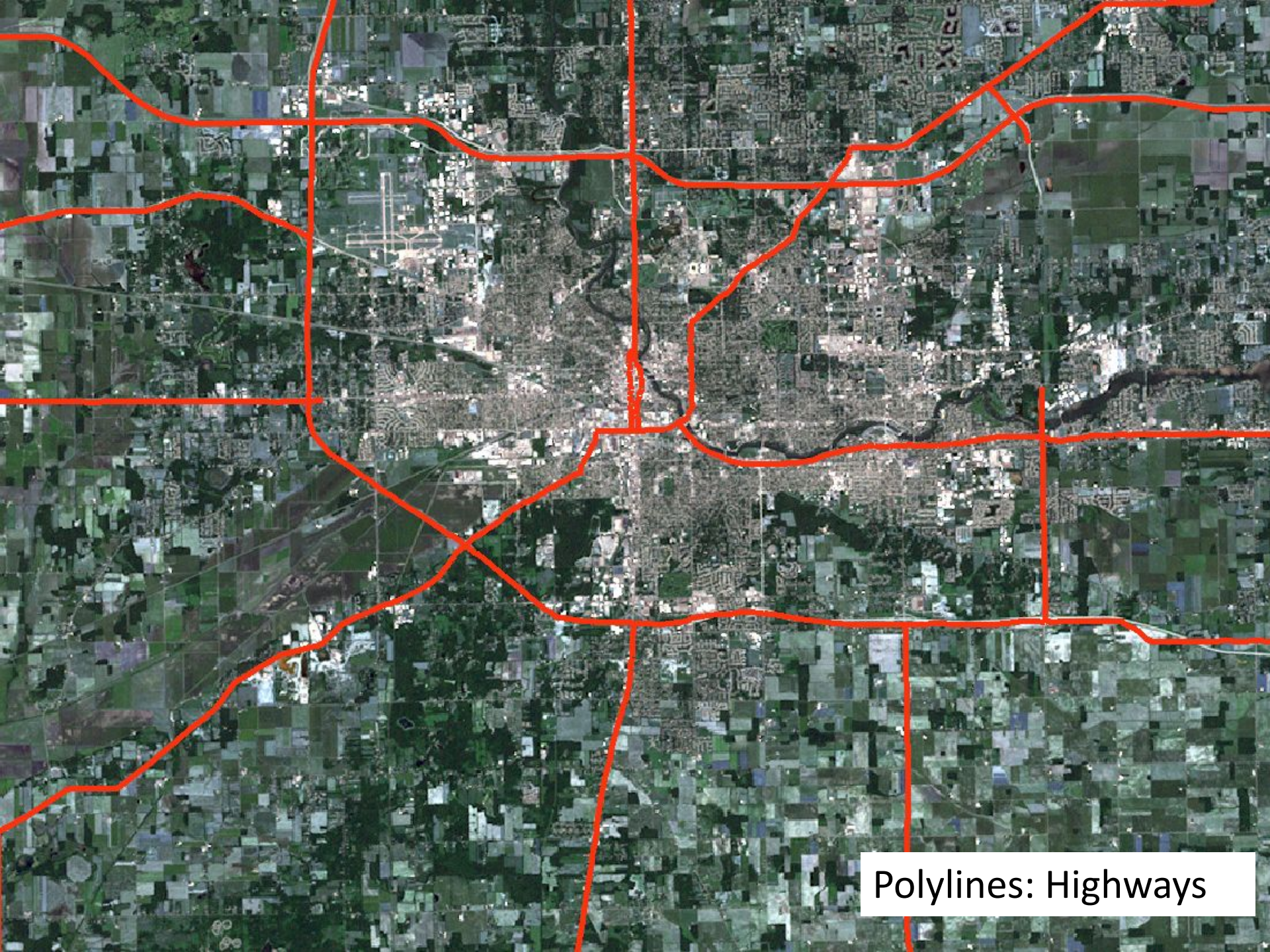
- More schematized version of reality
- Poorly suited for continuous phenomena

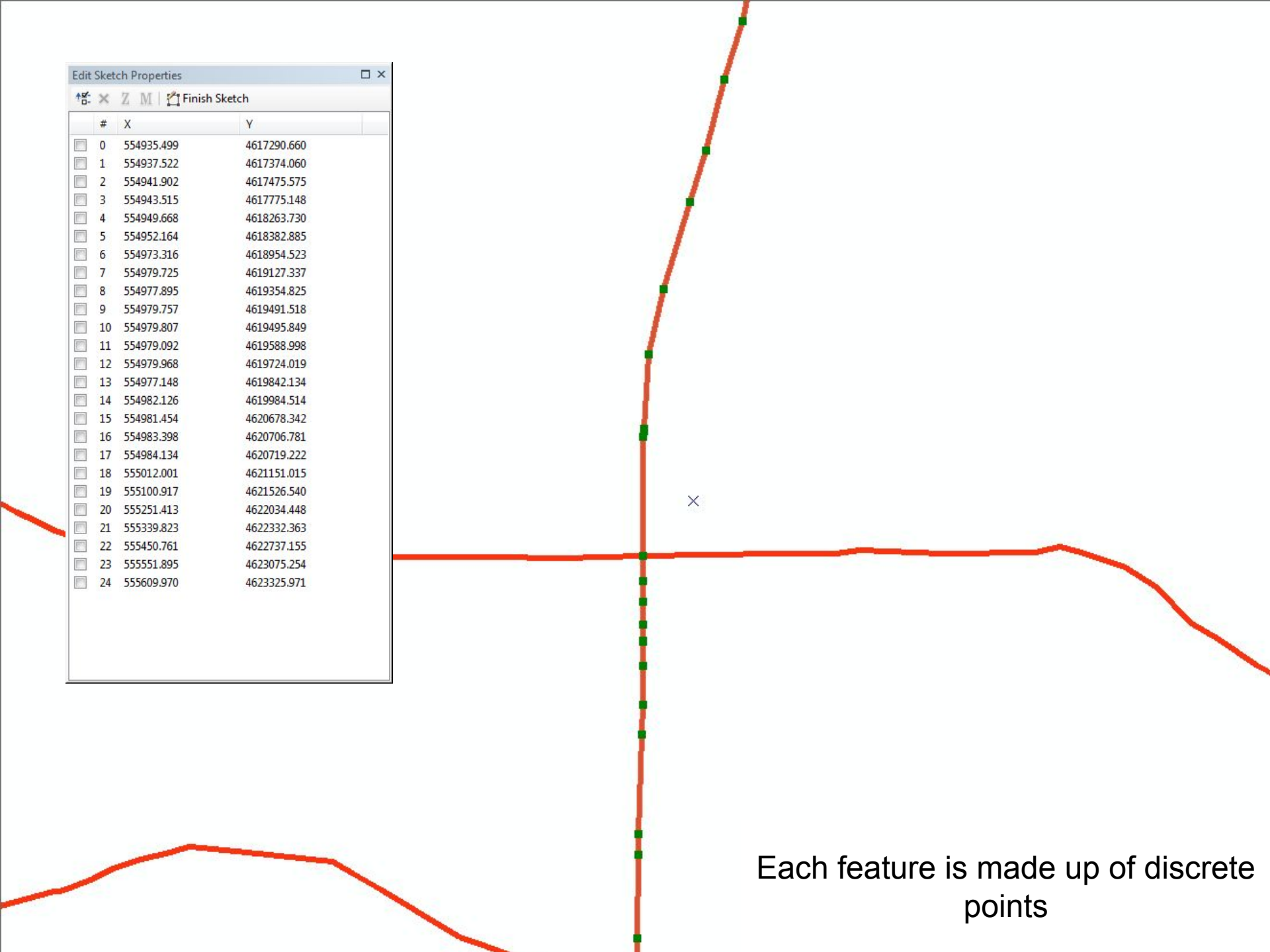
Vector model



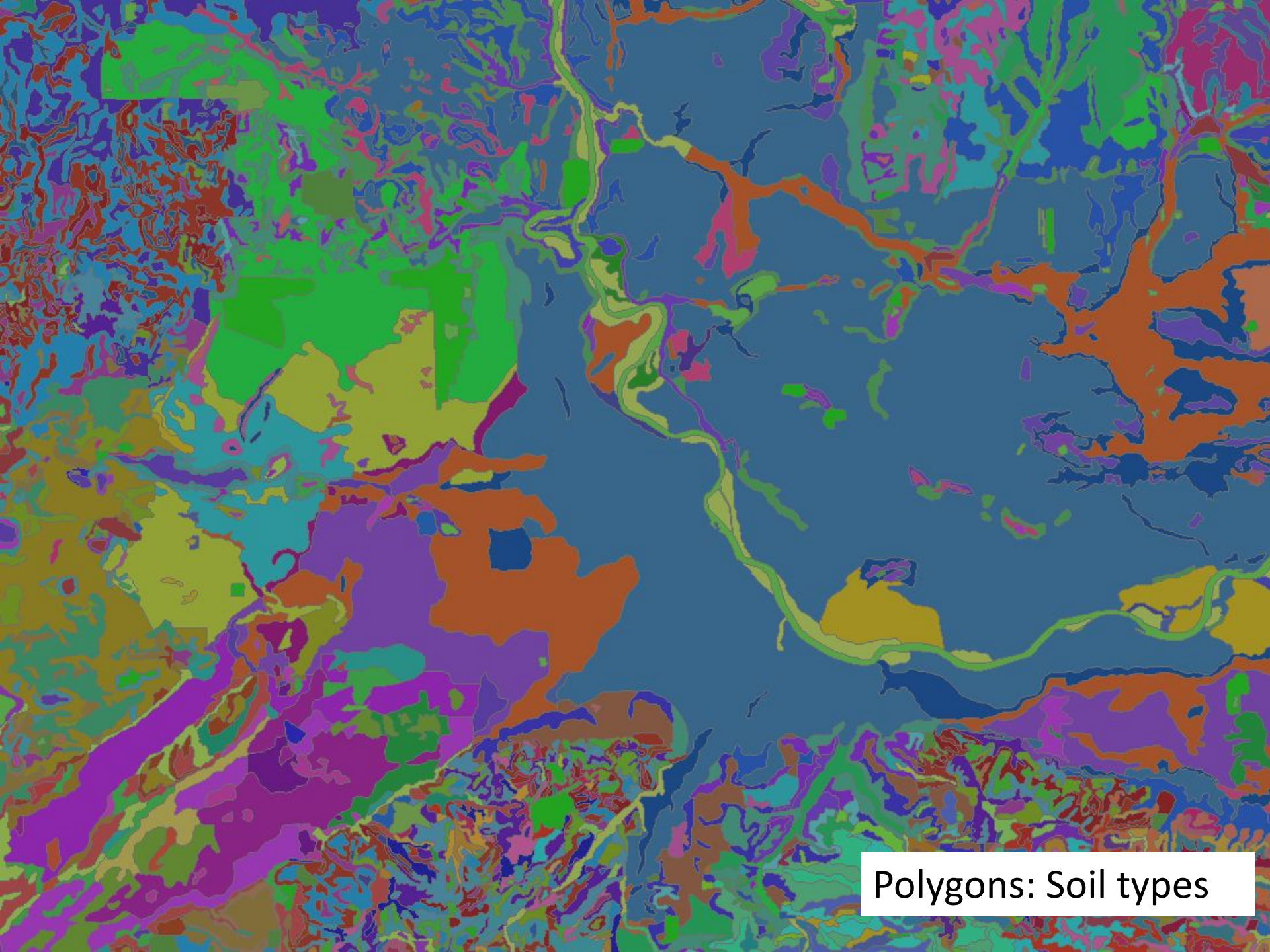
Features are stored as a series of *x-y* coordinates in a coordinate system.

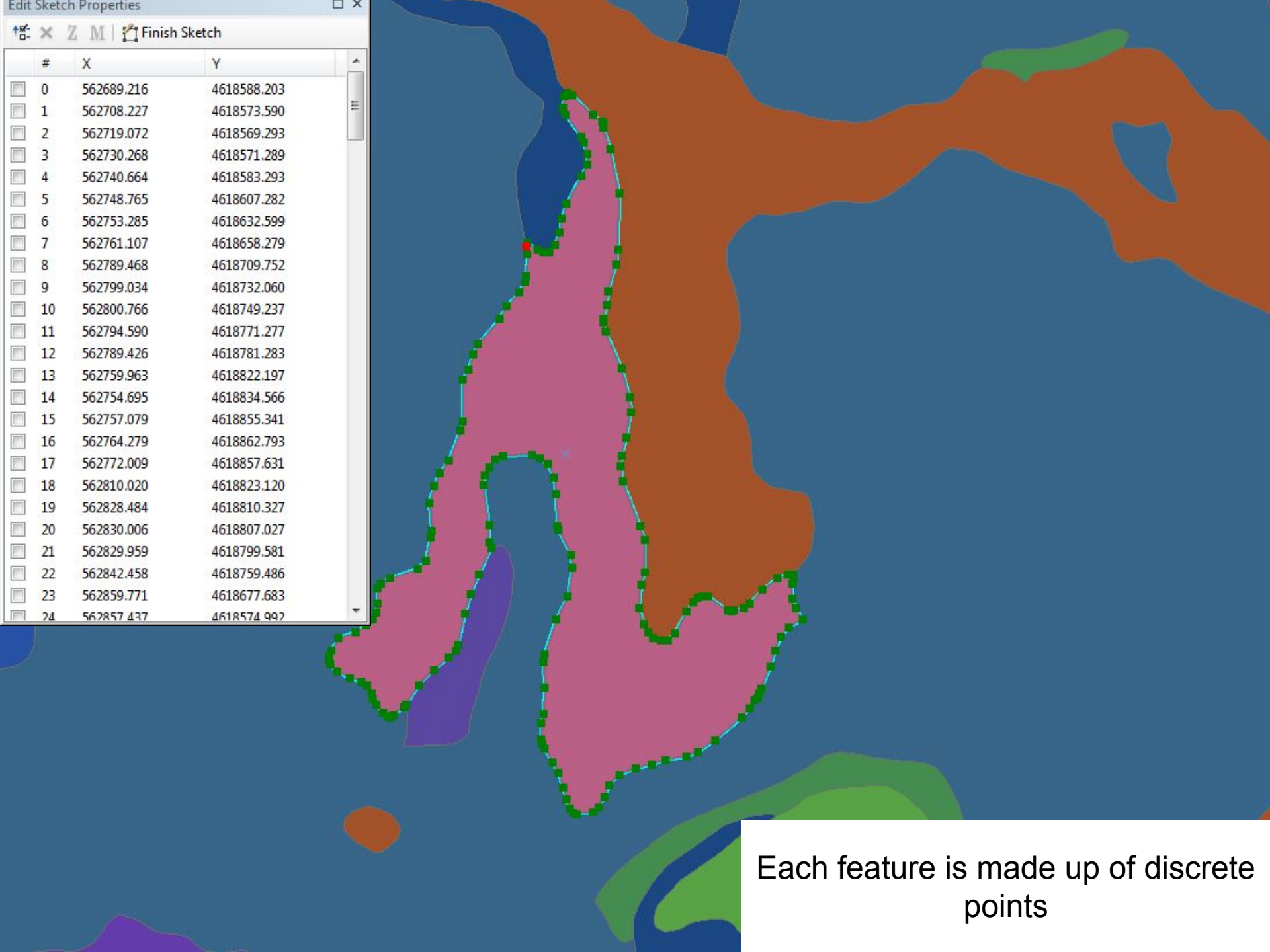

Points: Locations of Libraries

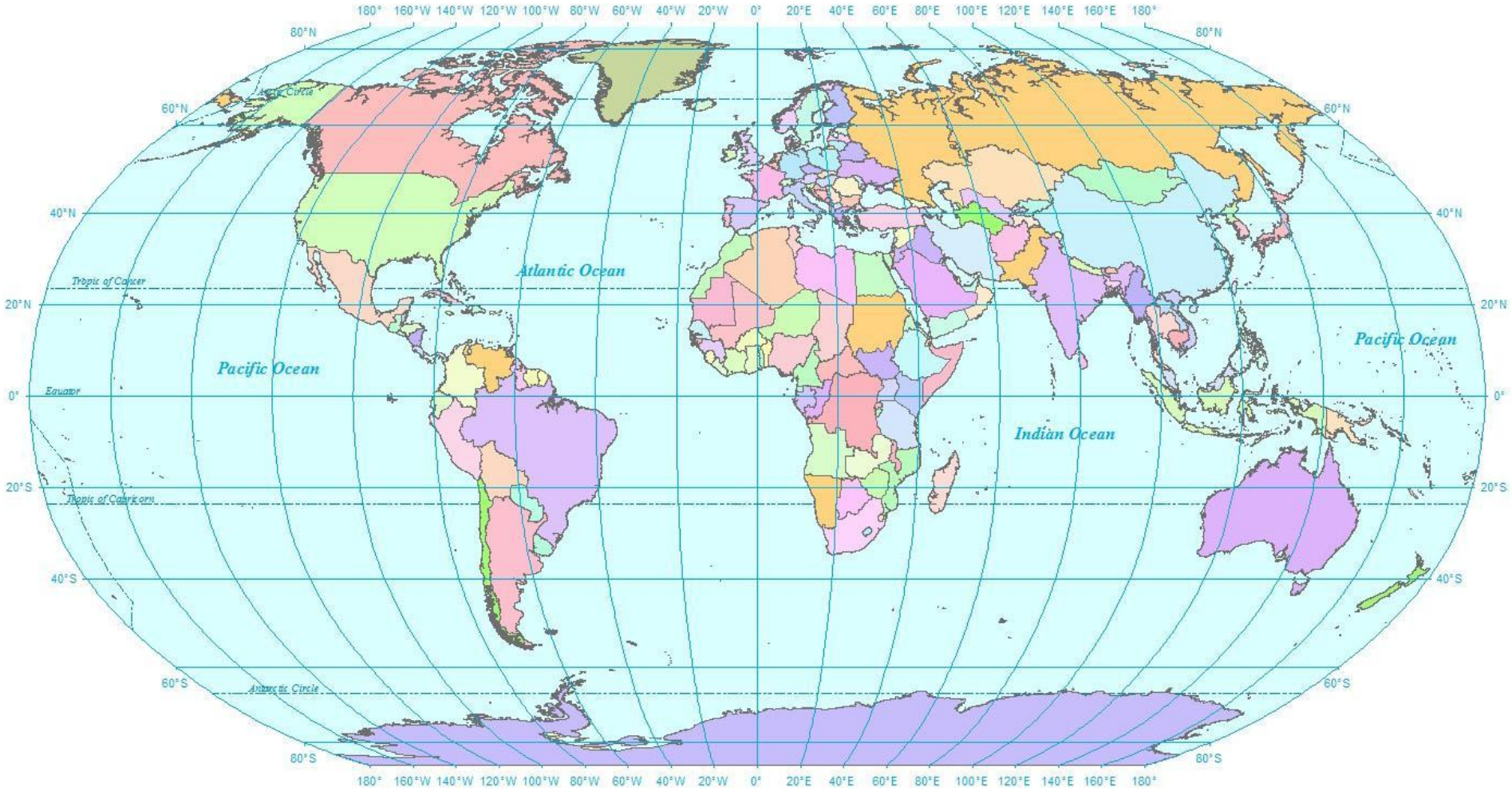

Polylines: Highways

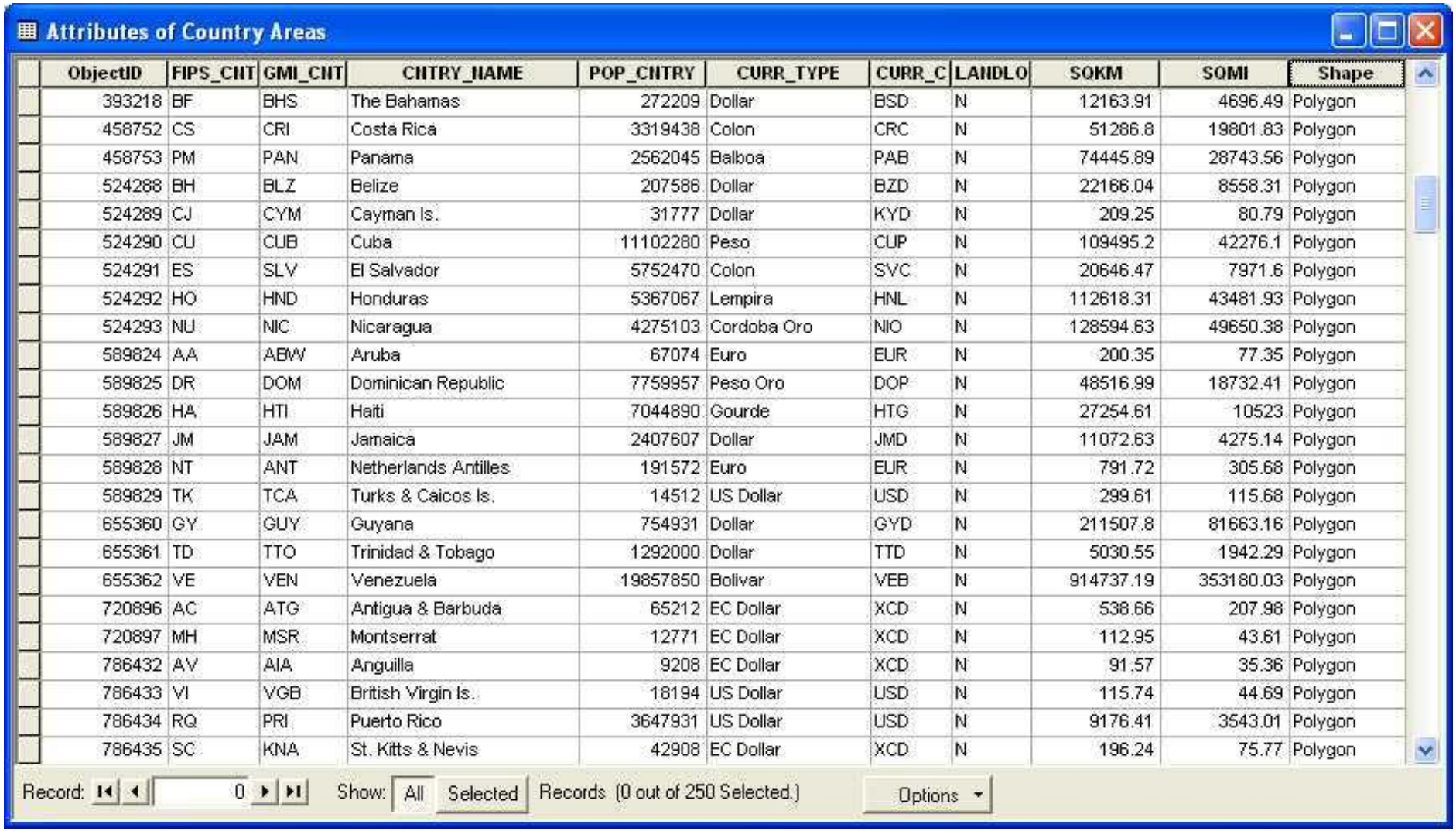


Each feature is made up of discrete points


Polygons: Soil types

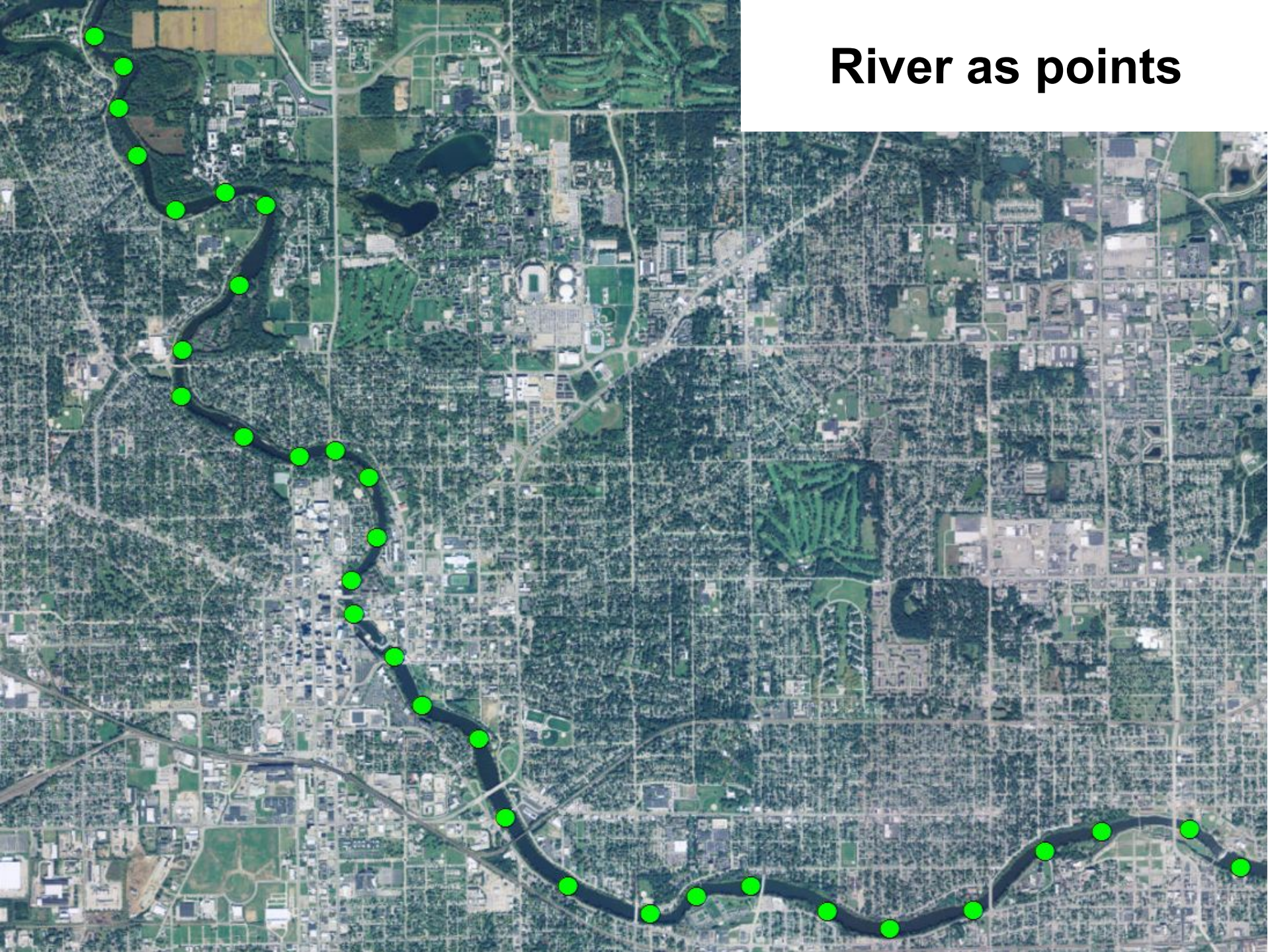

Edit Sketch Properties
Finish Sketch
X Y
0 562689.216 4618588.203
1 562708.227 4618573.590
2 562719.072 4618569.293
3 562730.268 4618571.289
4 562740.664 4618583.293
5 562748.765 4618607.282
6 562753.285 4618632.599
7 562761.107 4618658.279
8 562789.468 4618709.752
9 562799.034 4618732.060
10 562800.766 4618749.237
11 562794.590 4618771.277
12 562789.426 4618781.283
13 562759.963 4618822.197
14 562754.695 4618834.566
15 562757.079 4618855.341
16 562764.279 4618862.793
17 562772.009 4618857.631
18 562810.020 4618823.120
19 562828.484 4618810.327
20 562830.006 4618807.027
21 562829.959 4618799.581
22 562842.458 4618759.486
23 562859.771 4618677.683
24 562857.437 4618574.992
Each feature is made up of discrete points


180° 160°W 140°W 120°W 100°W 80°W 60°W 40°W 20°W 0° 20°E 40°E 60°E 80°E 100°E 120°E 140°E 160°E 180°
80°N
60°N
40°N
20°N
0°
20°S
40°S
60°S
80°S
Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
Atlantic Ocean
Pacific Ocean
Pacific Ocean
Indian Ocean

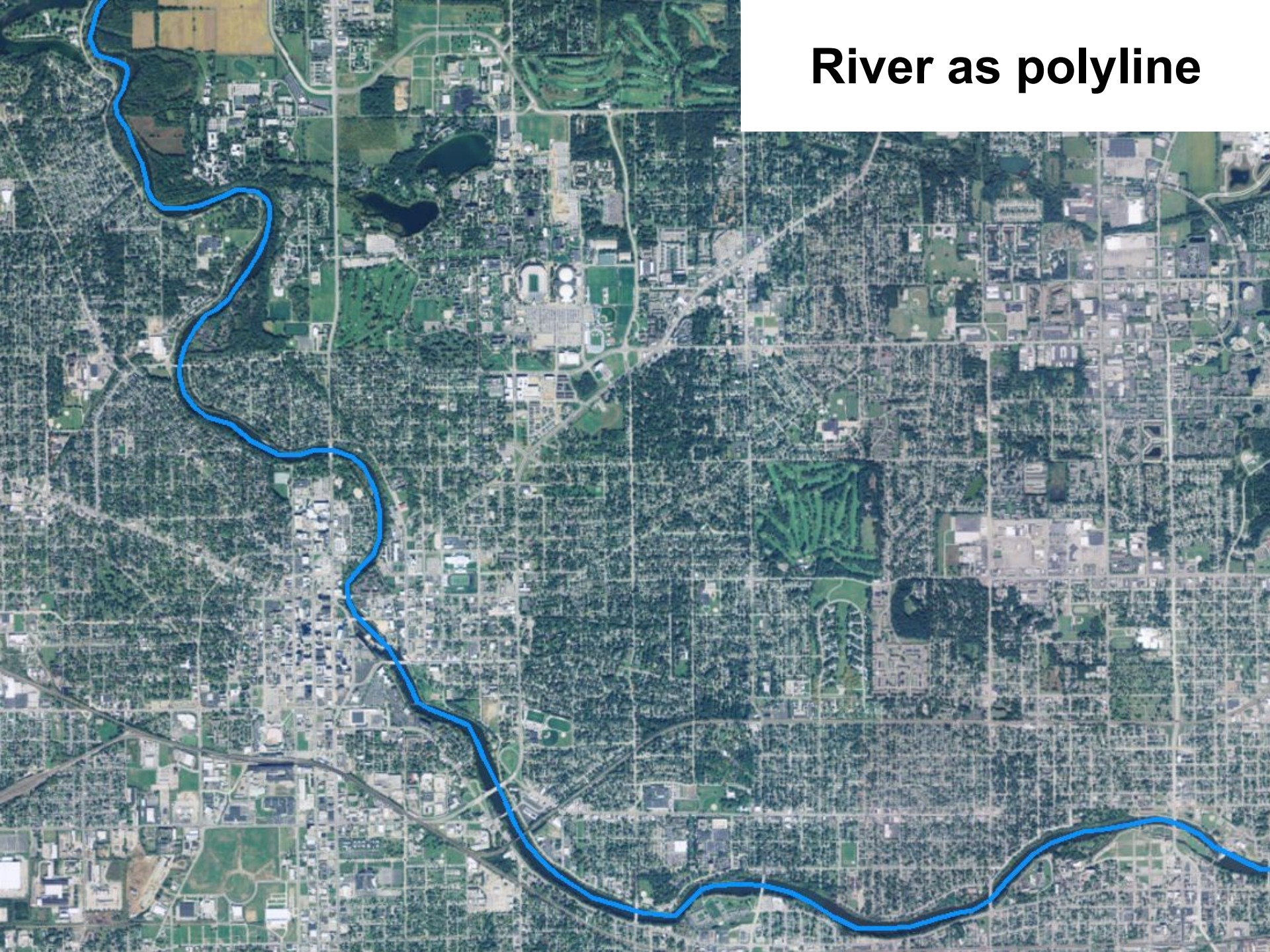


Tabular data associated with each feature

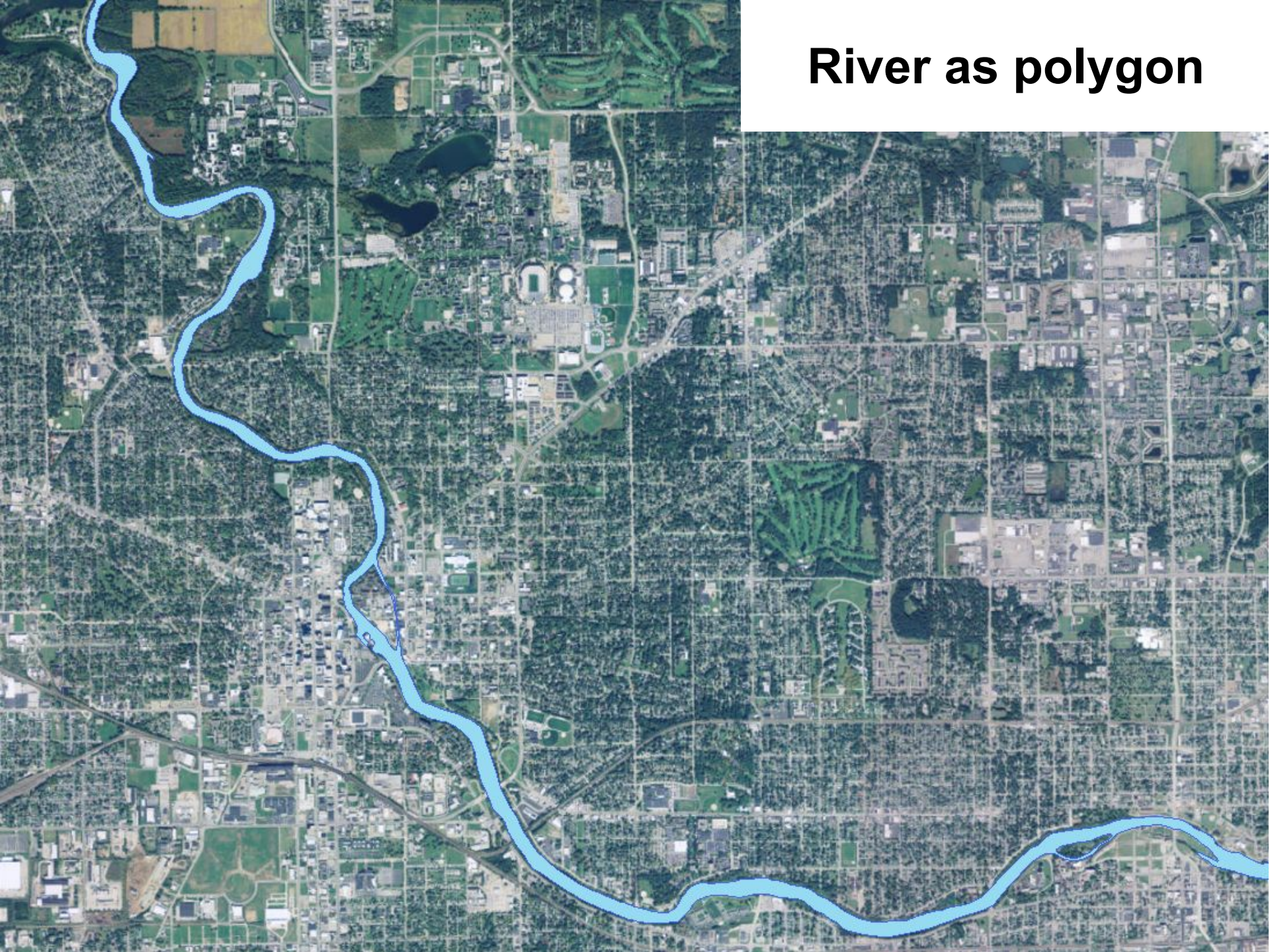
River as points



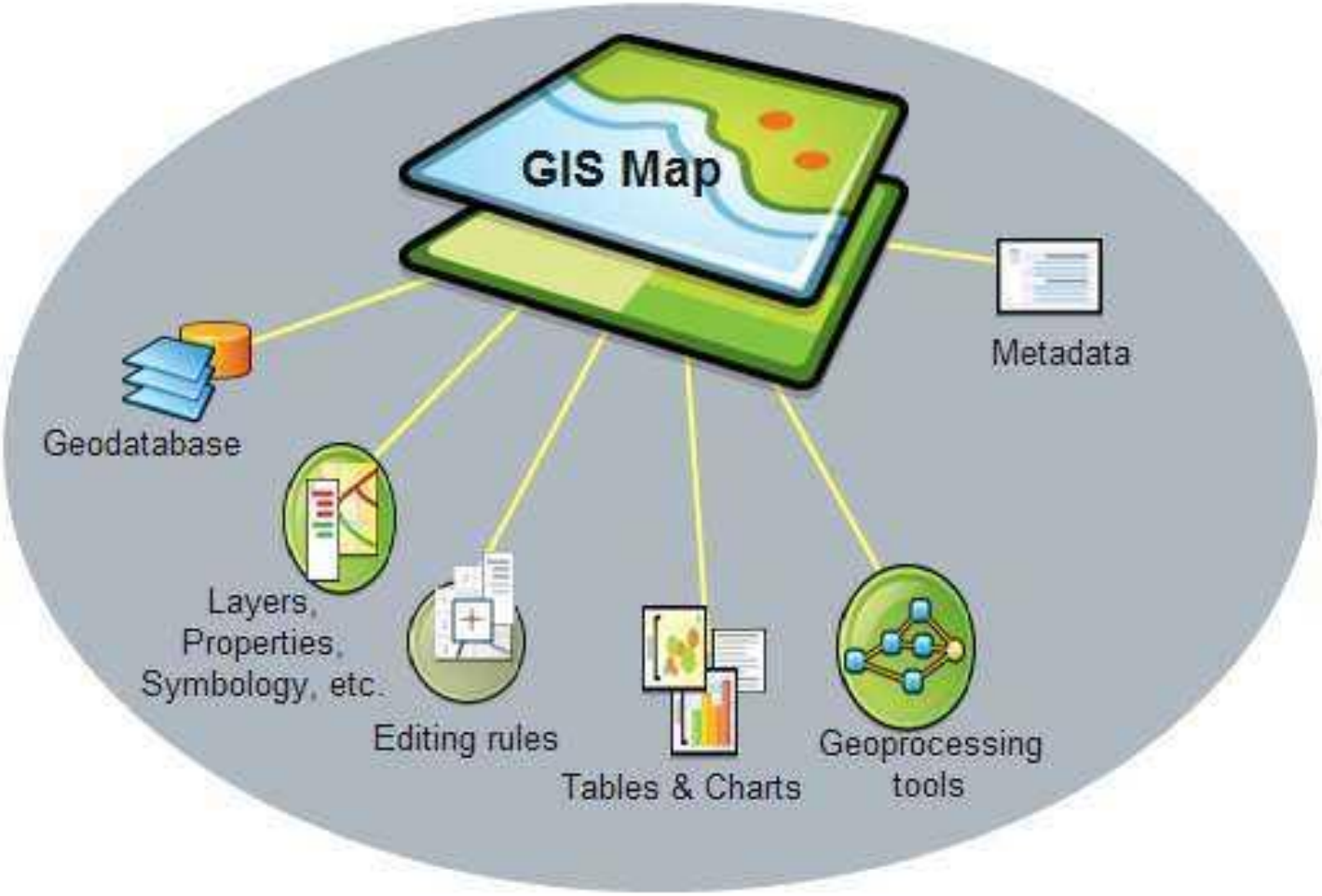
River as polyline



River as polygon

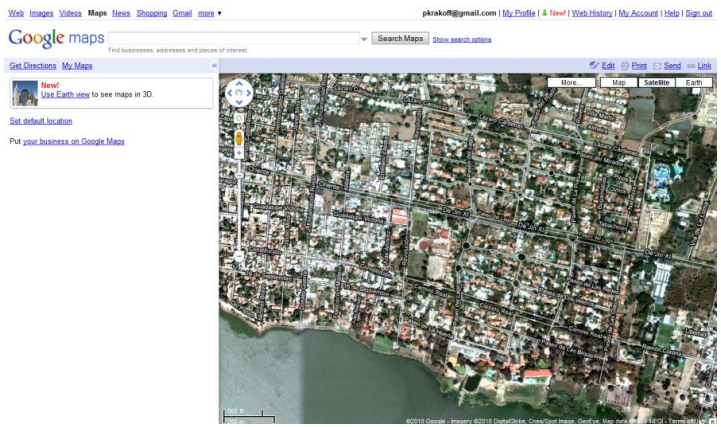


Building a GIS map

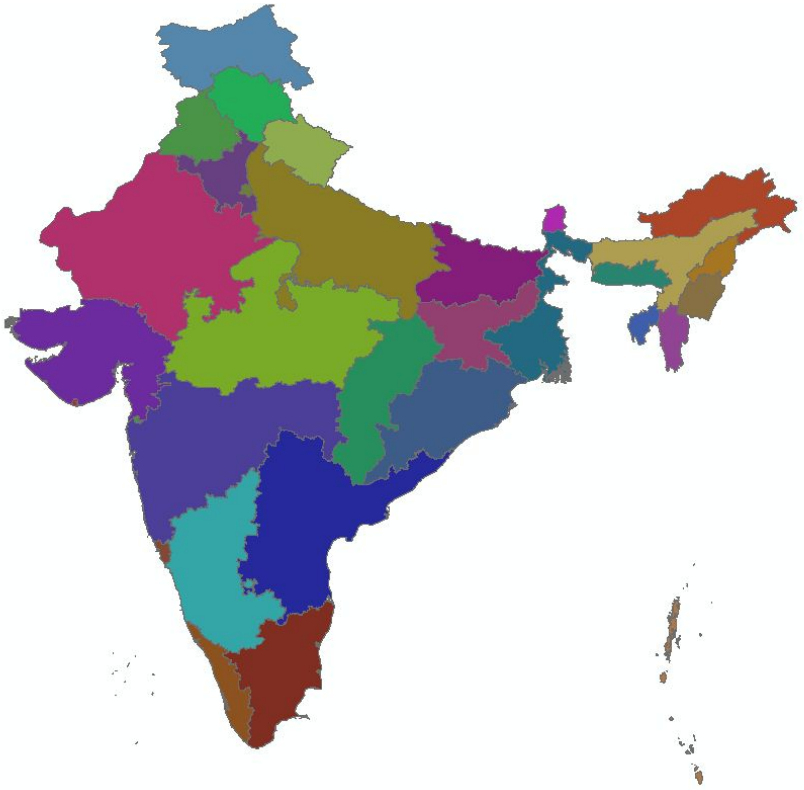


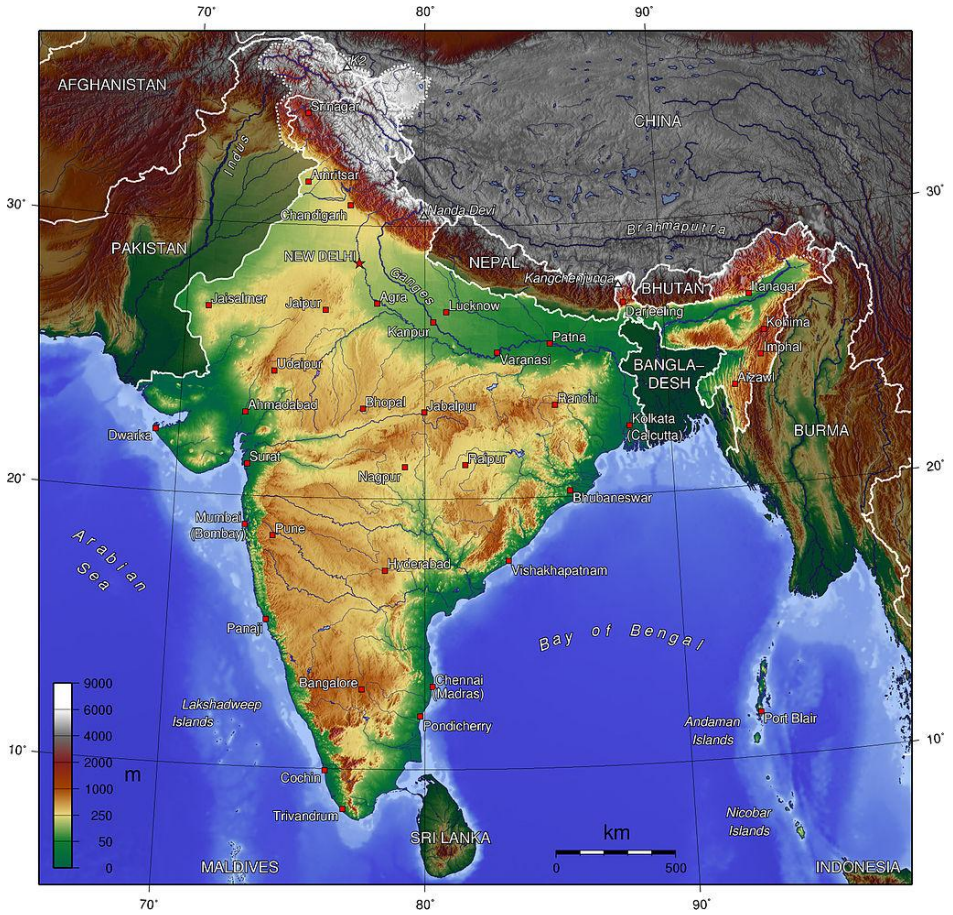
Individual data layers combine with ways of symbolizing data, charts and figures, editing rules and other tools to form a full GIS map

Not just pretty maps



- Google Maps and similar software are a type of simple GIS
- Full GIS packages usually have additional editing and analytical tools





There is very little in the GIS toolkit that cannot be done by traditional means, but it might be computationally difficult or very time consuming

What can GIS be used for?

GIS adds "space" to research dimensions

- Geographical significance & patterning
  - Does location make any difference?
    - Real estate, new business locations
  - Are there any patterns?
    - Migration patterns? How did the disease spread?
- Geographical correlations and relationships
  - Are A and B in this location related?
    - Crime rate and average income
- Prediction and predictive modeling
  - How many people will be affected by something?
  - Where are we likely to find something?

Why is GIS important?

Government

80% of **local government** activities estimated to be geographically based

- plots, zoning, public works (streets, water supply, sewers), garbage collection, land ownership and valuation, public safety (fire and police)
- natural resource management
- highways and transportation

Businesses

- retail site selection & customer analysis
- logistics: vehicle tracking & routing
- natural resource exploration
- civil engineering and construction

Military and defense

- Battlefield management
- Satellite imagery interpretation

Research:

- Hard Sciences:Geology, biology botany, epidemiology
- Social Sciences: Anthropology, sociology, economics, political science
- Humanities: History, criminology, geography, literature

Examples of how GIS can be used

Specific Examples of GIS Applications

Urban Planning, Management & Policy
- Zoning, subdivision planning
- Land acquisition
- Economic development
- Code enforcement
- Housing renovation programs
- Emergency response
- Crime analysis
- Tax assessment

Environmental Sciences
- Monitoring environmental risk
- Modeling stormwater runoff
- Management of watersheds, floodplains, wetlands, forests, aquifers
- Environmental Impact Analysis
- Hazardous or toxic facility siting
- Groundwater modeling and contamination tracking

Political Science
- Redistricting
- Analysis of election results
- Predictive modeling

Civil Engineering/Utility
- Locating underground facilities
- Designing alignment for freeways, transit
- Coordination of infrastructure maintenance

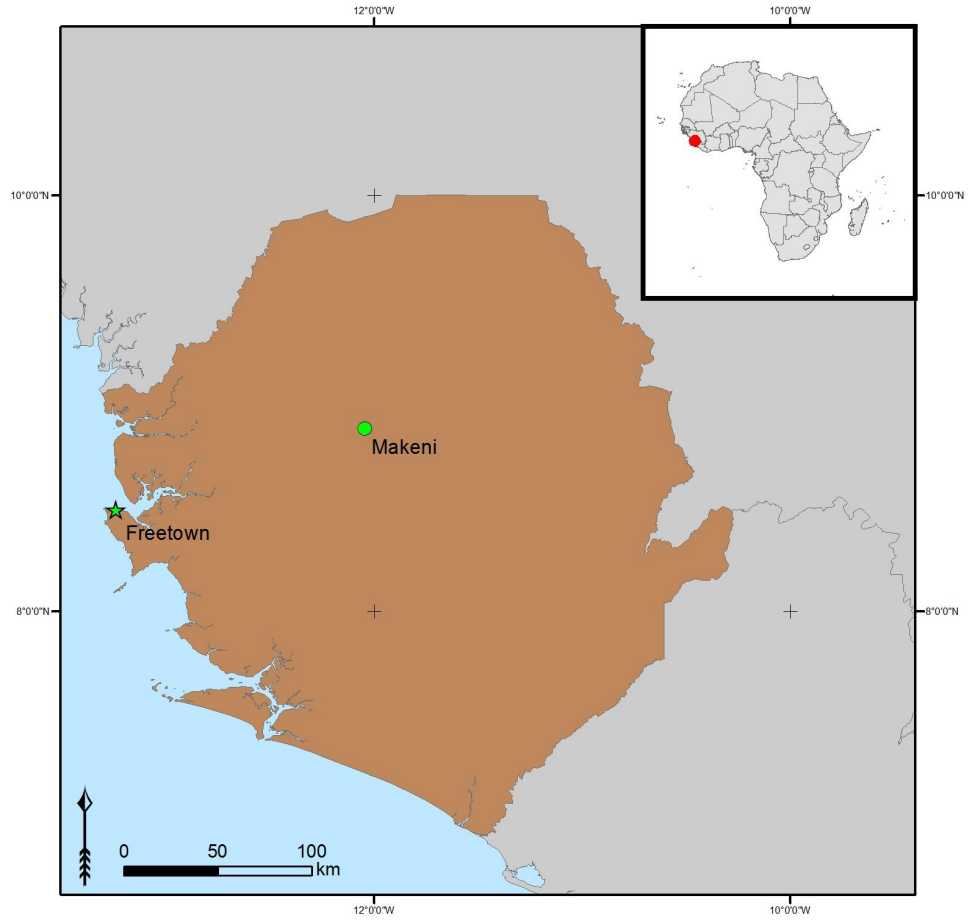
Business
- Demographic Analysis
- Market Penetration/ Share Analysis
- Site Selection

Education Administration
- Attendance Area Maintenance
- Enrollment Projections
- School Bus Routing

Real Estate
- Neighborhood land prices
- Traffic Impact Analysis
- Determination of Highest and Best Use

Health Care
- Epidemiology
- Needs Analysis
- Service Inventory

Location



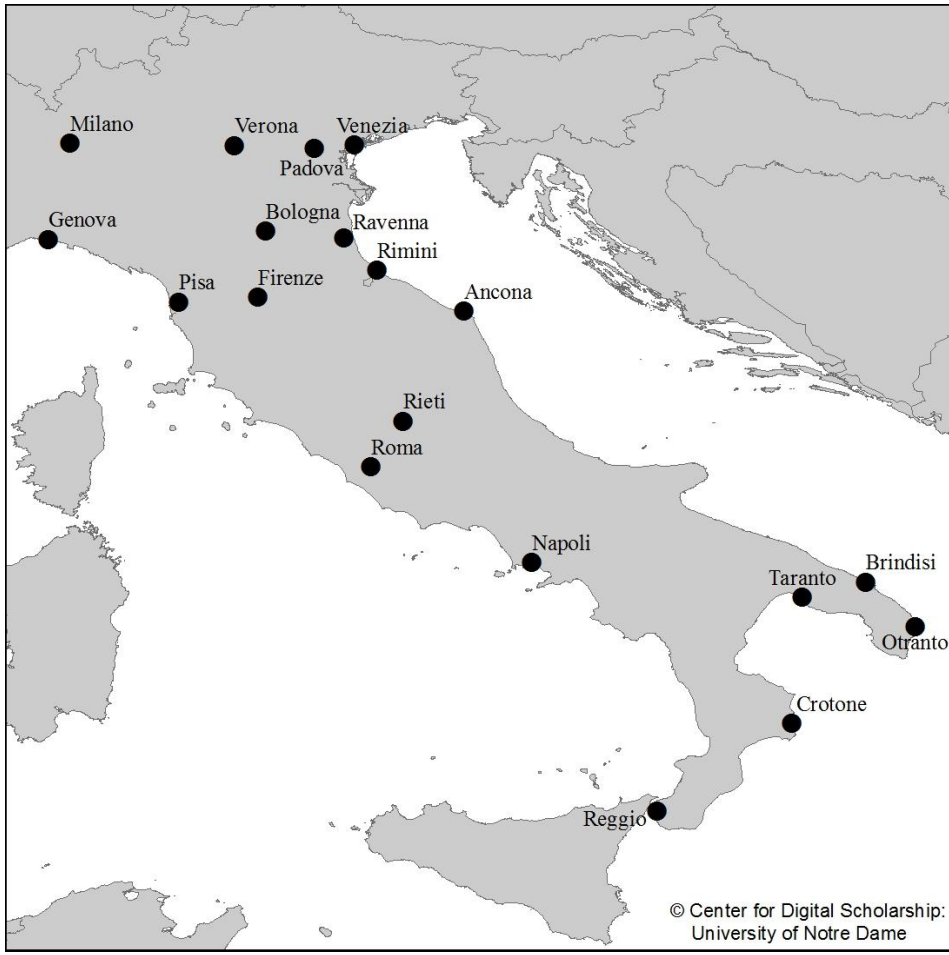
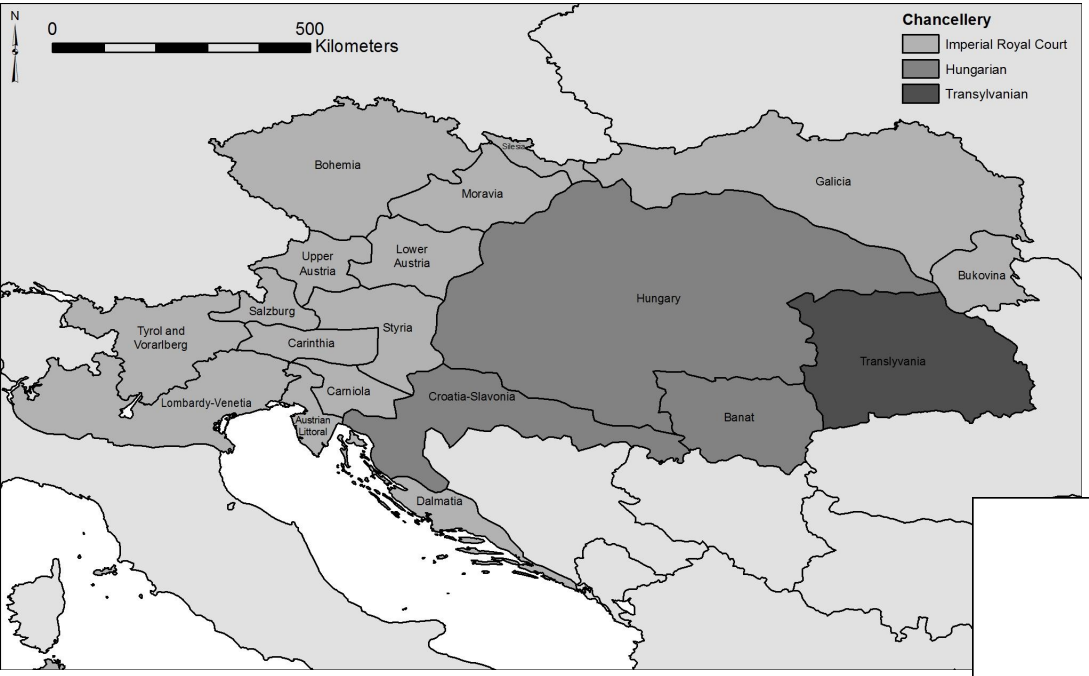
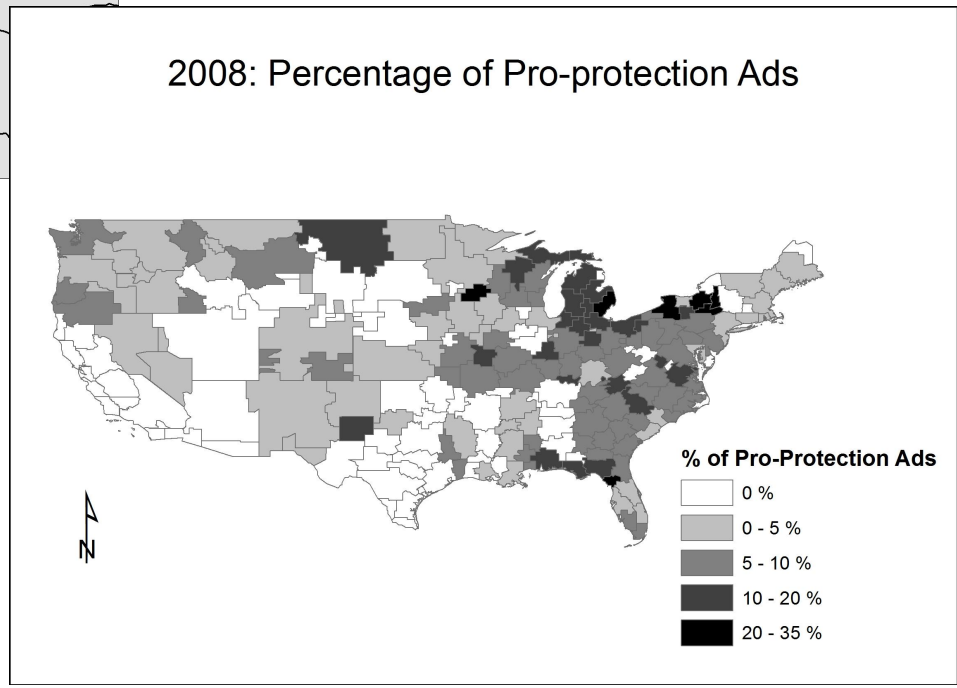


Illustration 3: La mappa dell'Italia di Petrarca, Epistola metrica, 2.11

Classification



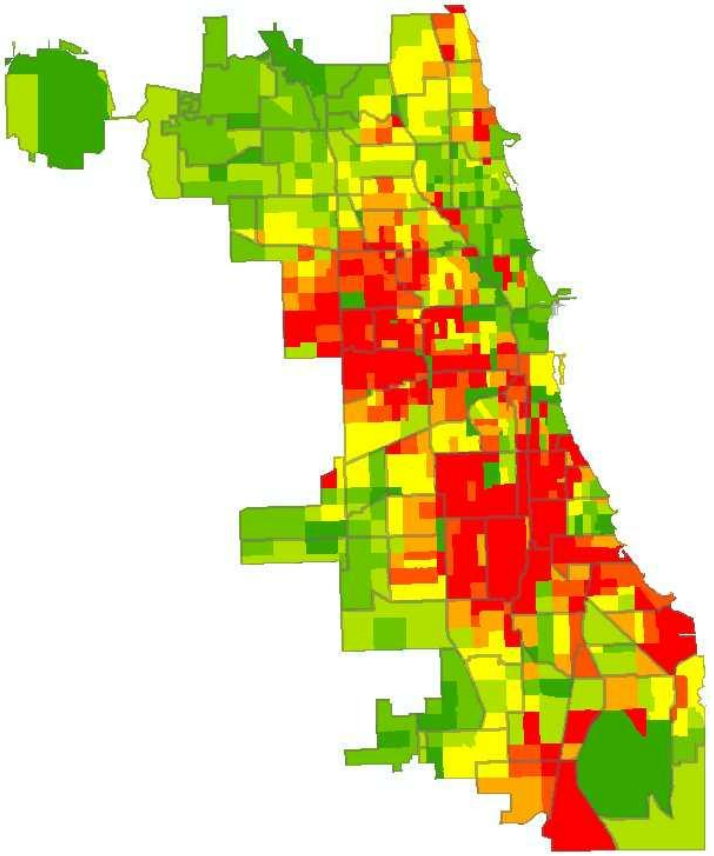


Example: Patterns

Socio-economic

2000 Census data
Unit – Census Tract
Over the community area boundaries

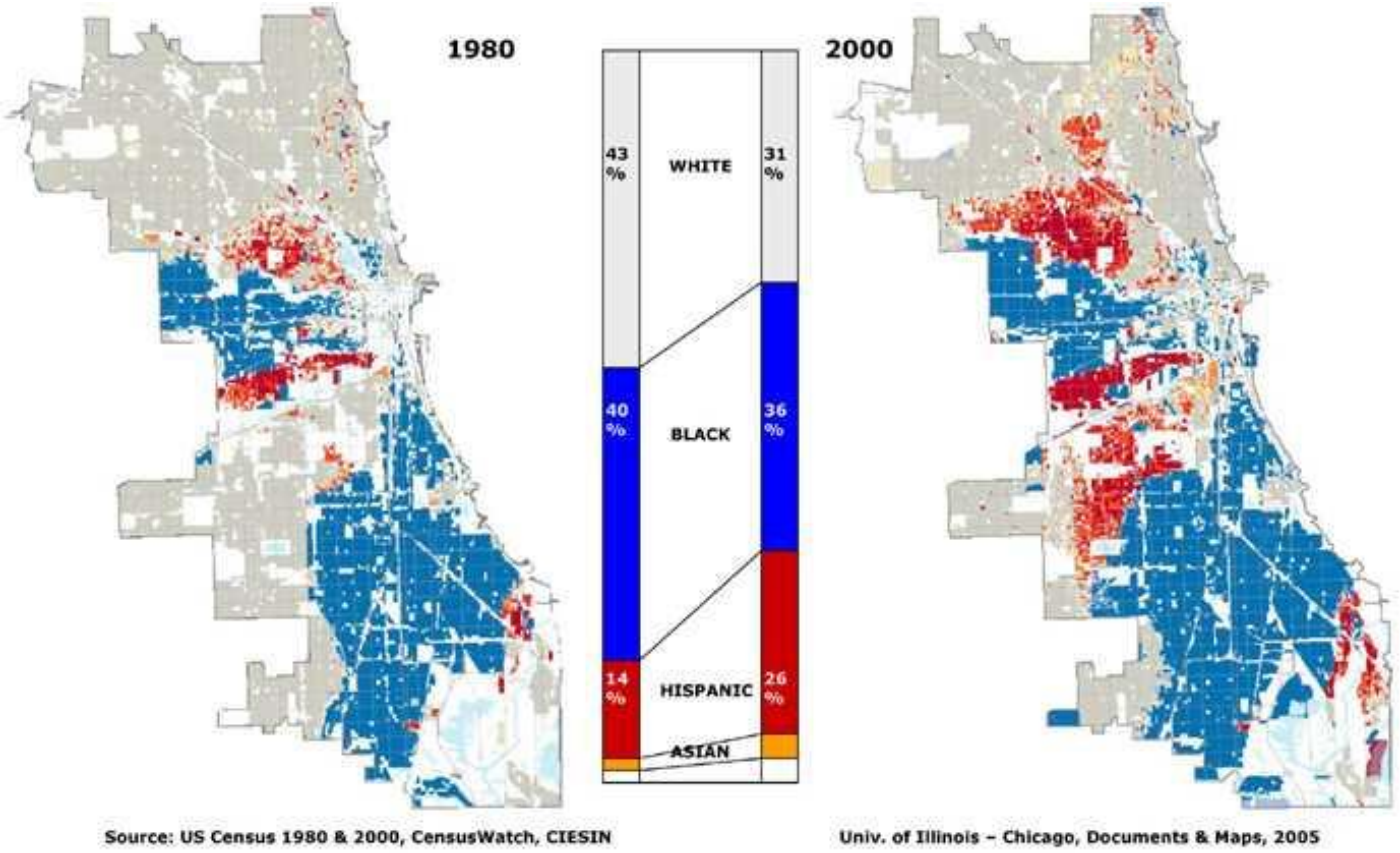
% families below poverty level



Example: Trends

Trends

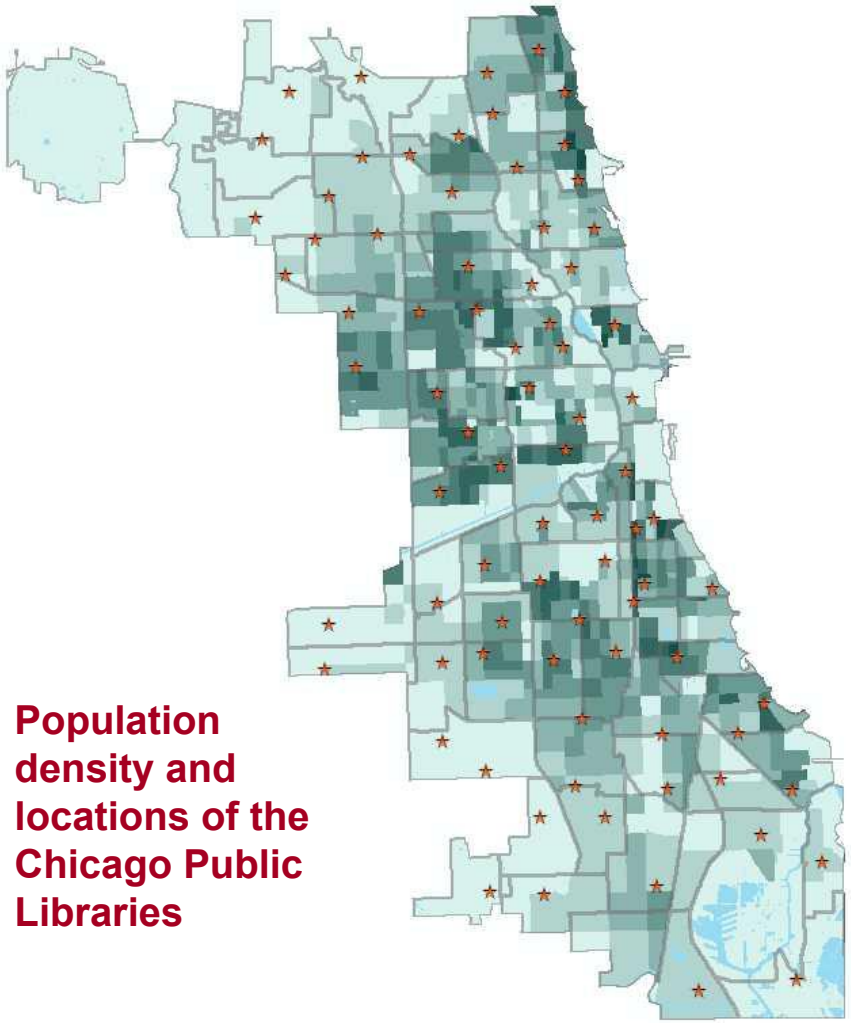
Changes over time using historical (time-series) data



Example: Relationship

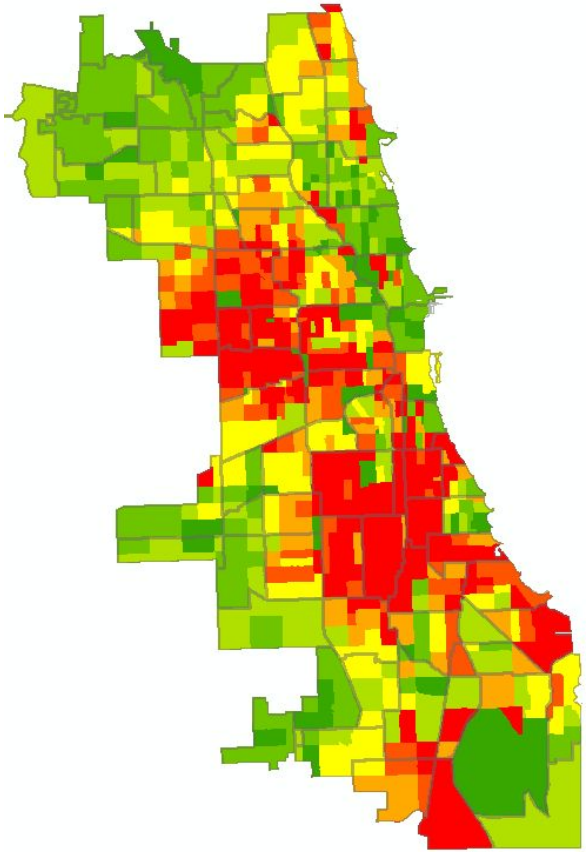
Association

- Demography and Libraries
- Are there enough libraries to serve local residents?

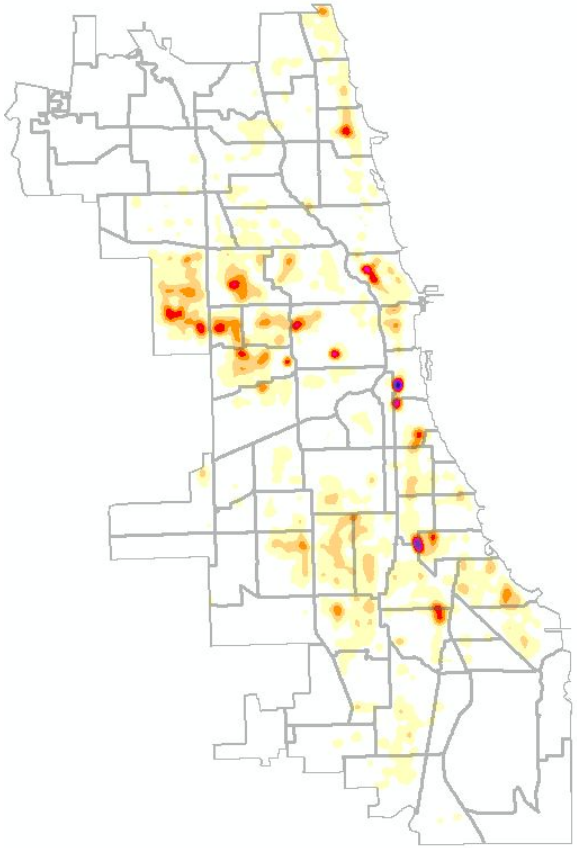


Population density and locations of the Chicago Public Libraries

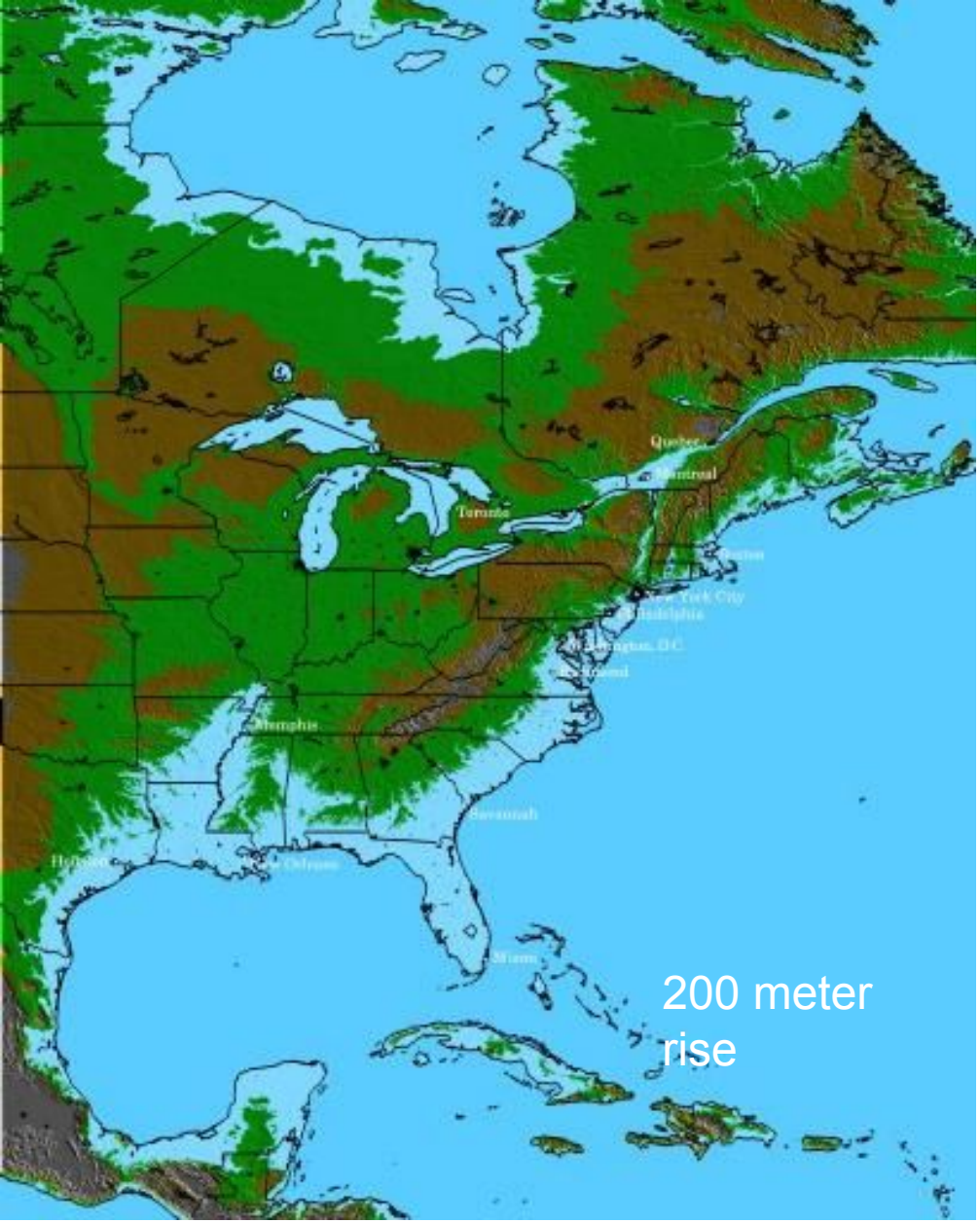
Example: Associations

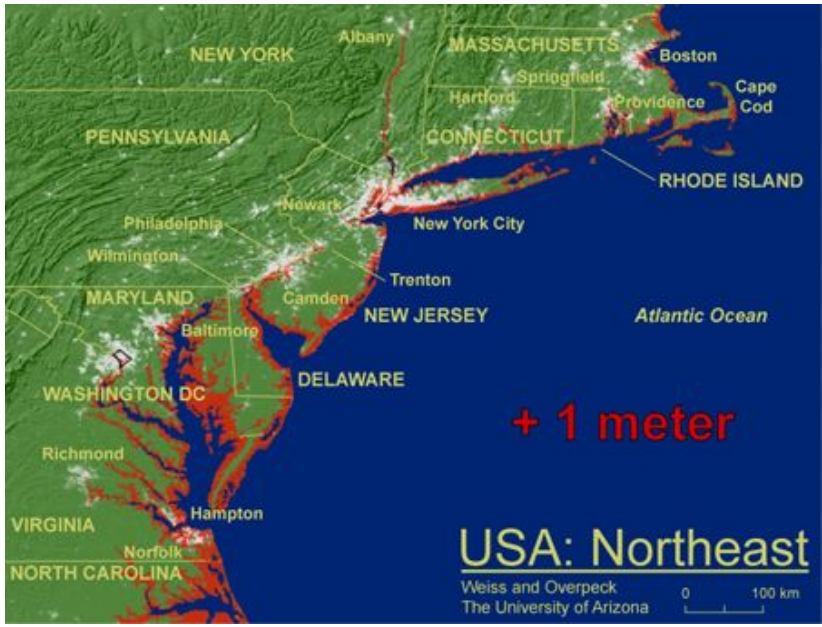


% families below poverty level

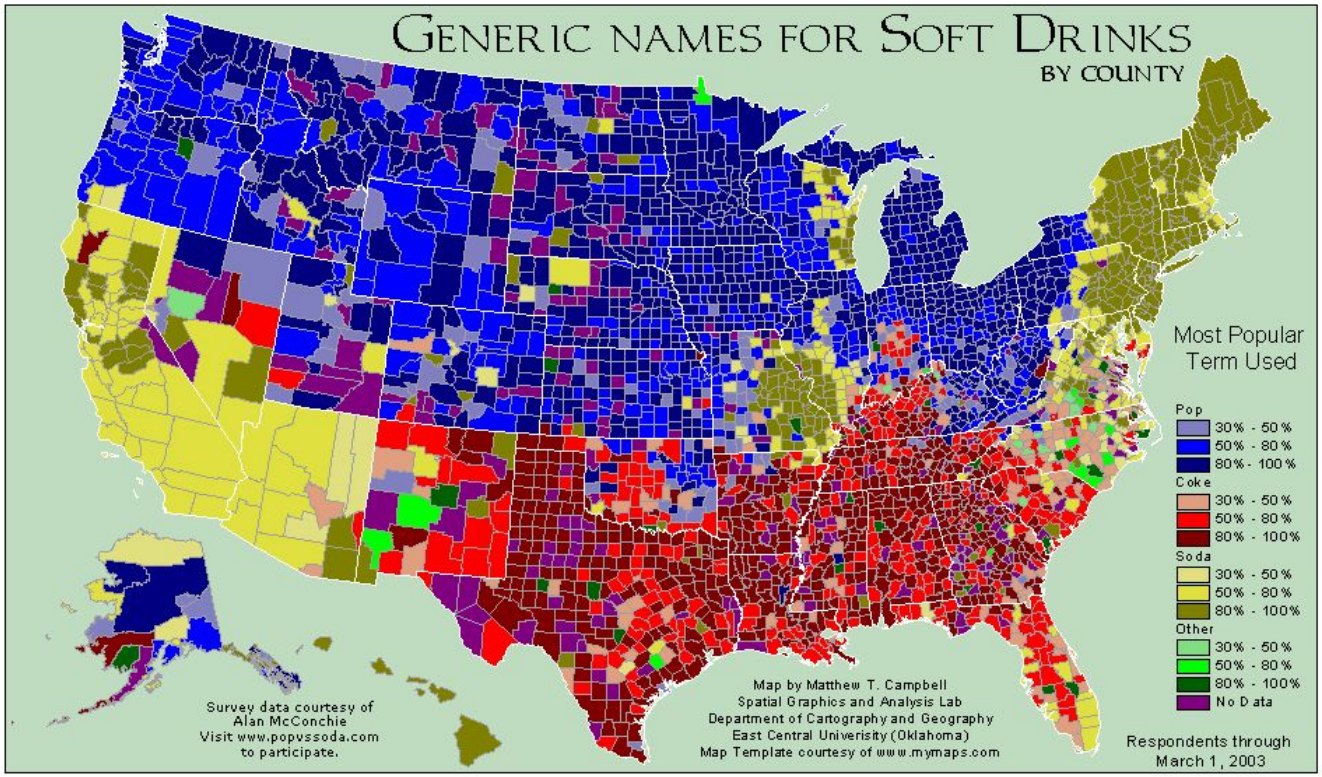


Crime hotspots





Areas impacted by sea-level rise

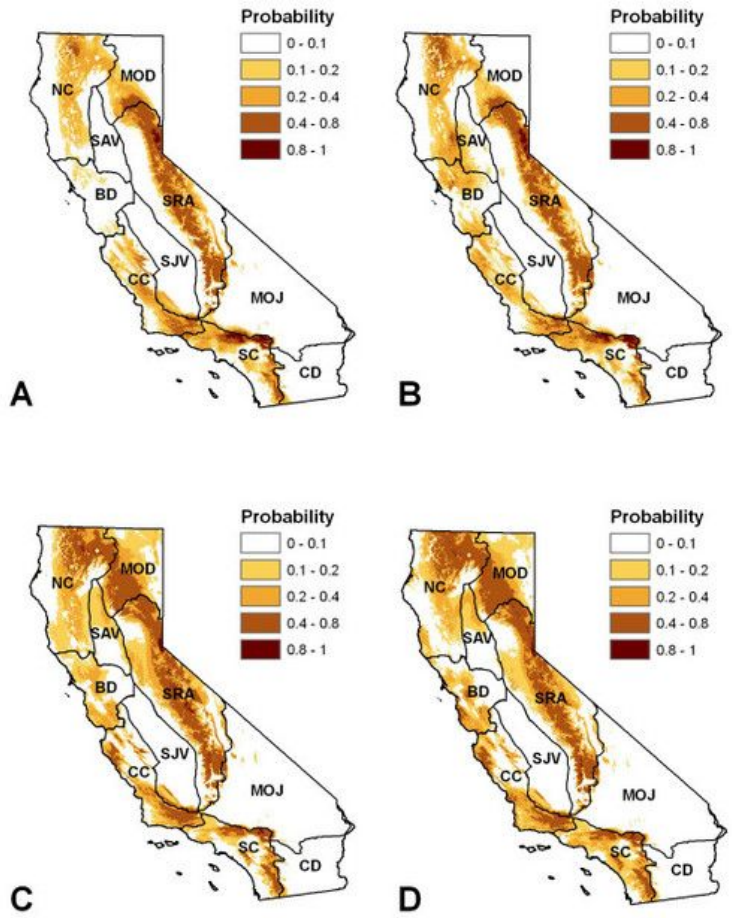


Geographers have even analyzed the distribution of generic names for soft drinks by US county

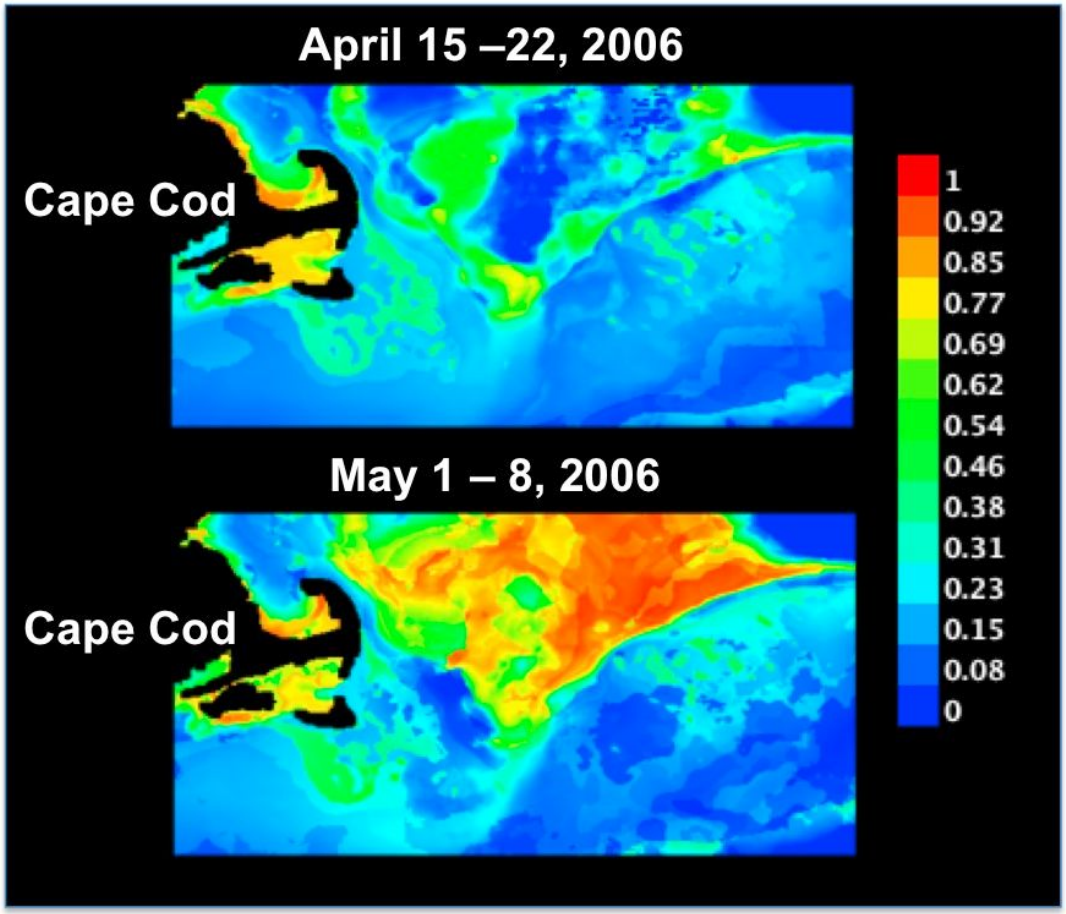
Same analysis, but done via geotagged tweets mentioning one of the key words

MODELLING AND PREDICTION

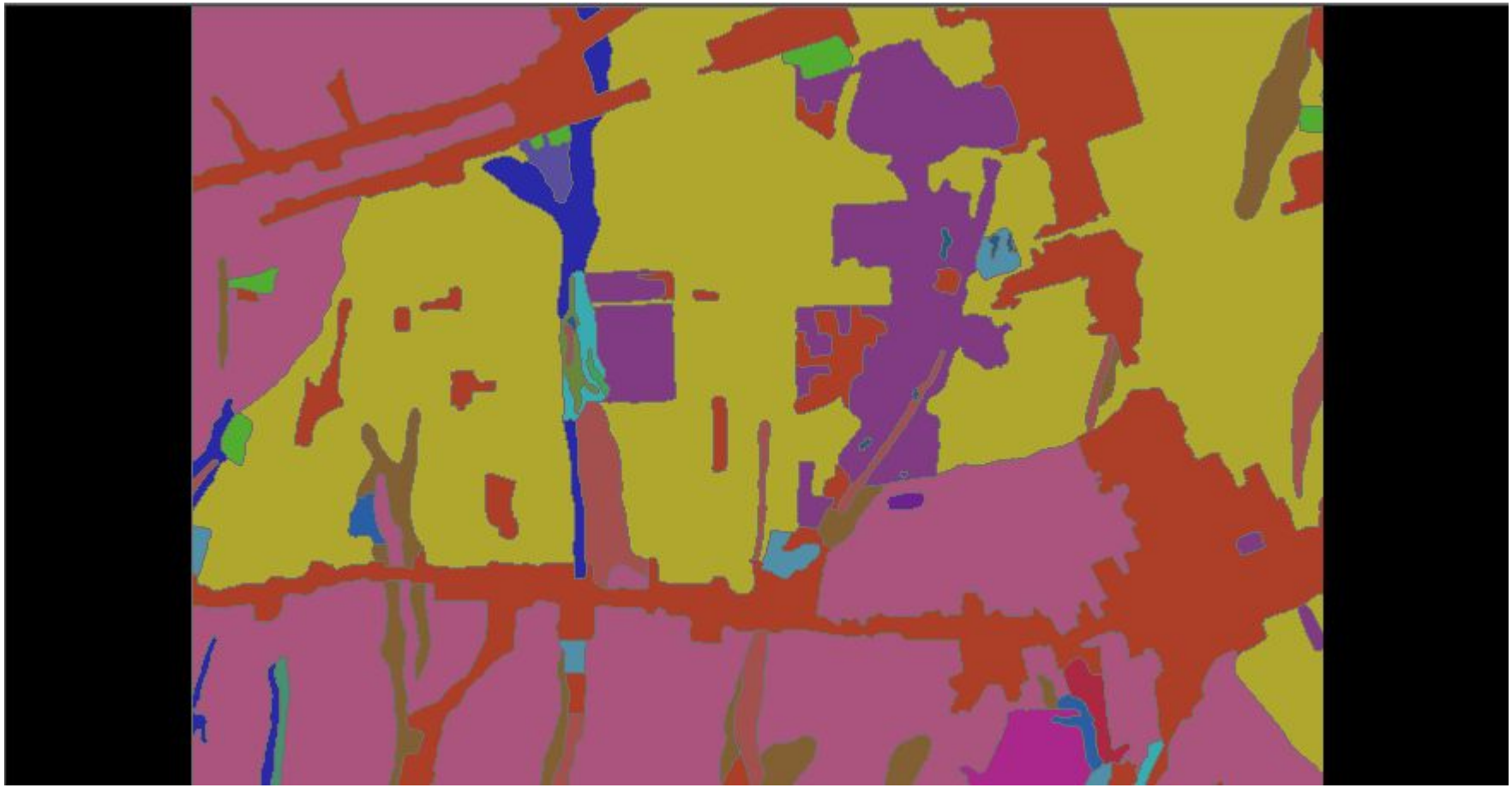
Predictive Modeling



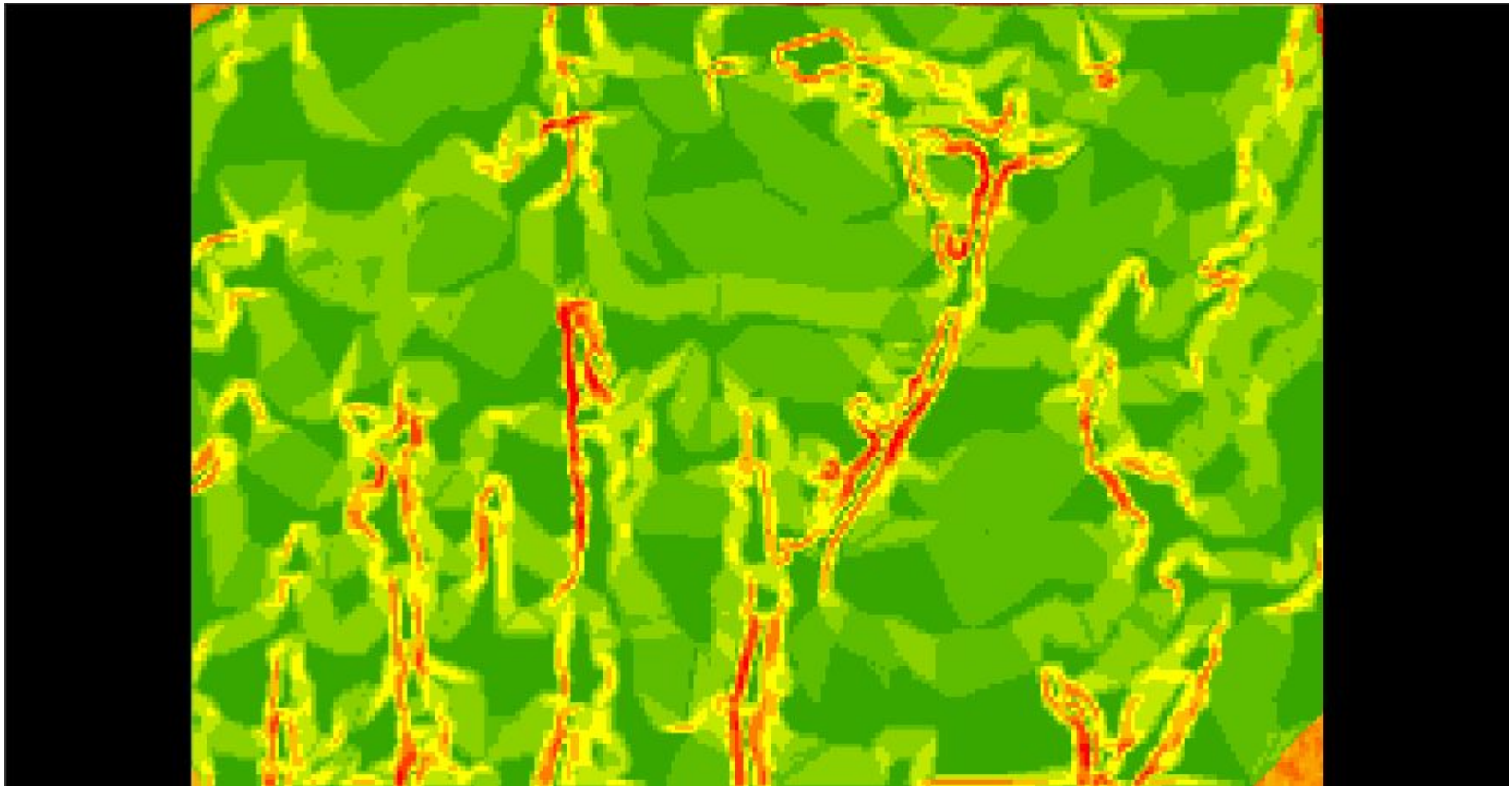
Models of plague activity in California ground squirrels
Used to identify potential plague risk areas based on future climate scenarios



Prediction of likely right whale locations off of Cape Cod



Input Data 1. Soils

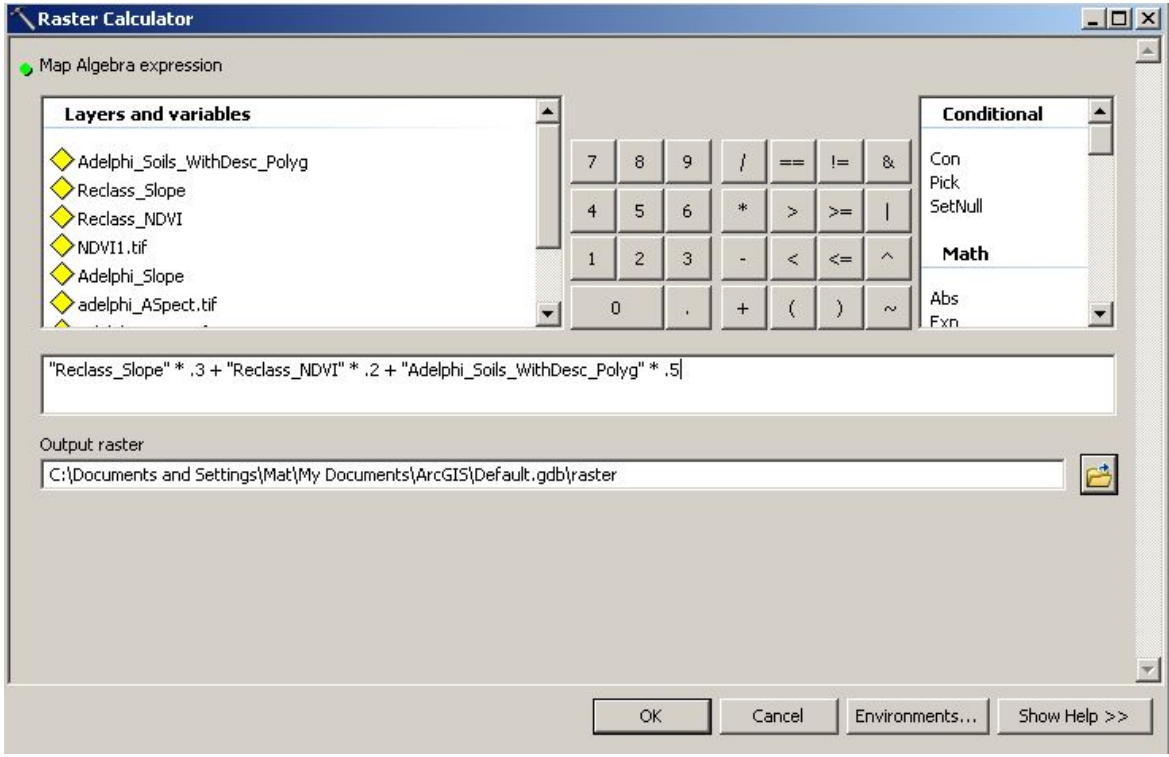


Input Data 2. Slope

Input Data 3: Vegetation Density (NDVI)

Erosion risk model

30 %: Slope
20 %: Vegetation
50 %: Soils



Use GIS tools to weight each factor and create a single layer representing erosion risk

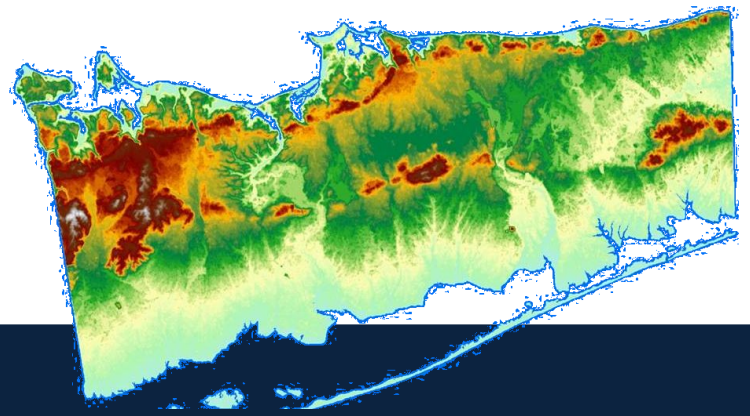
Final map: Erosion risk is ranked from 1 – 10

T

TERRAIN MODELS

What is a Digital Elevation Model (DEM)?

- Digital representation of topography
- Typically, a raster dataset
  - Each cell has a single value (elevation) which represents the entire area covered by the cell
- Advantages
  - Easy to use
  - Importance of terrain in hydrology and environmental modeling
  - Visualization of landscapes



Uses of Digital Elevation Models

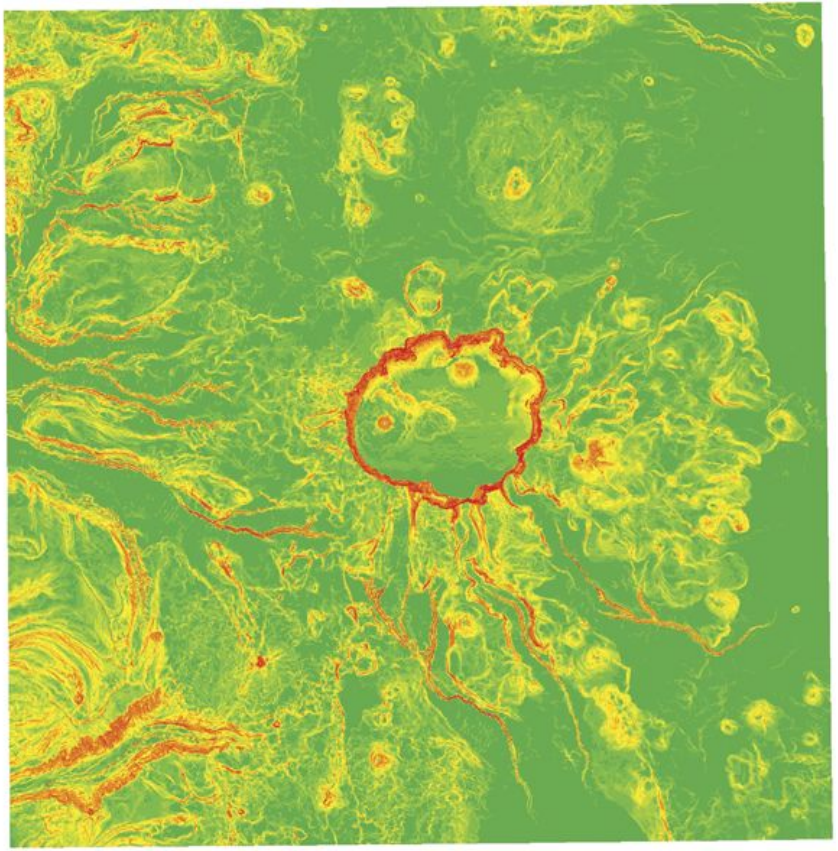
- Determine characteristics of terrain
  - Slope, aspect, spot elevations
  - Source for contour lines
- Finding terrain features
- Modeling of hydrologic functions
  - Watersheds, drainage networks, stream channels

Crater Lake DEM

Elevation (m)

2323.7

945.4



Slope Degrees

- 0 - 4
- 4.0 1- 8
- 8.01 - 12
- 12.01 - 18
- 18.01 - 24
- 24.01 - 30
- 30.01 - 40
- 40.01 - 50
- 50.01 - 85

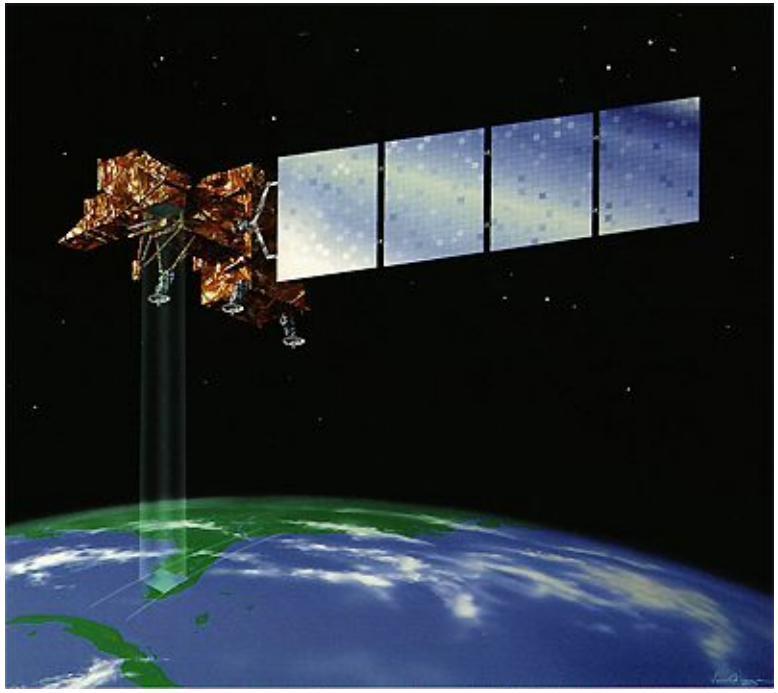
REMOTE SENSING

Satellite Imagery

Remote sensing is the science of acquiring, processing and interpreting information/data collected by remote sensors.

Often, these are Earth Observing Satellites

- Record visible and non-visible wavelengths of light



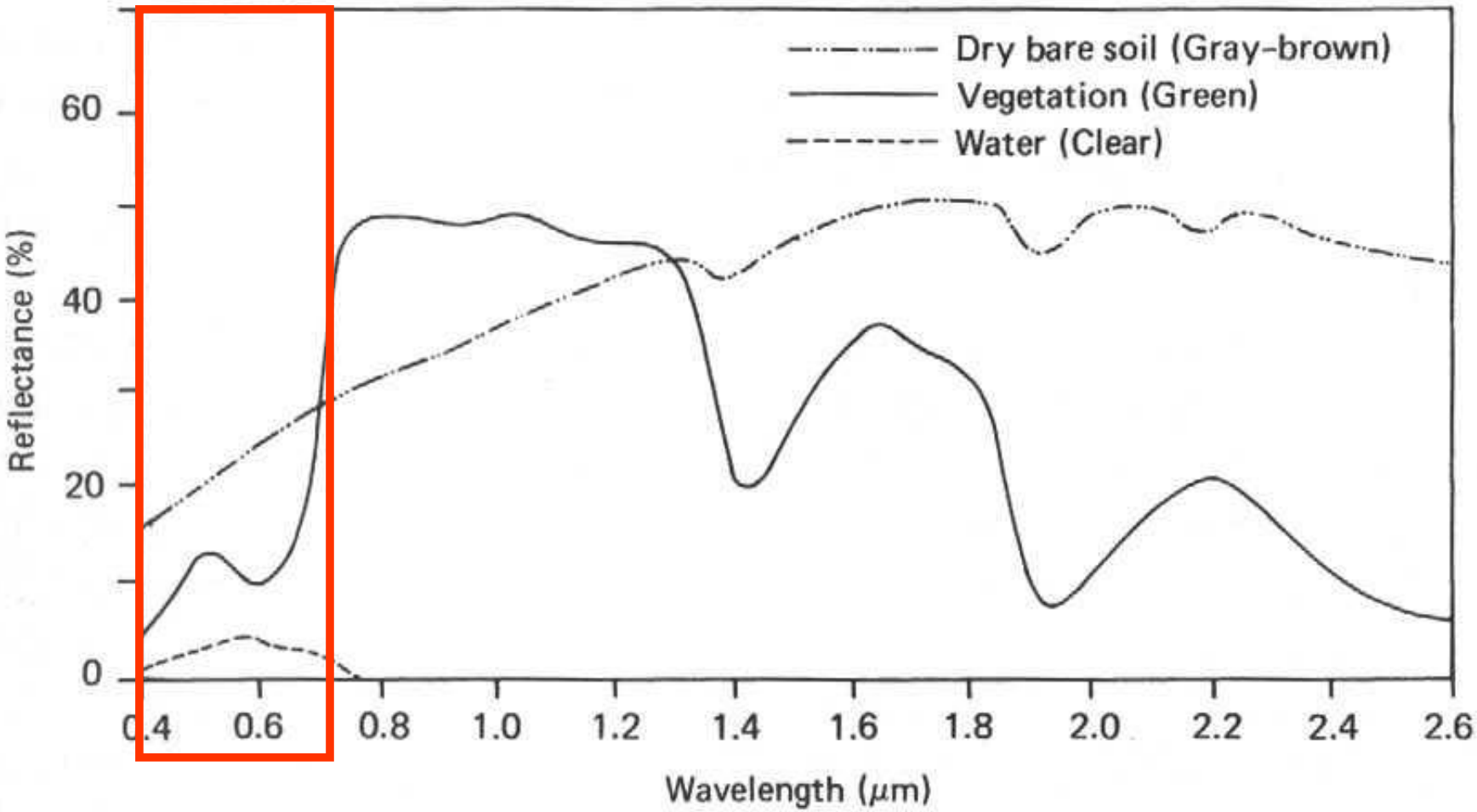


Figure 1.10 Typical spectral reflectance curves for vegetation, soil, and water. (Adapted from Swain and Davis, 1978.)

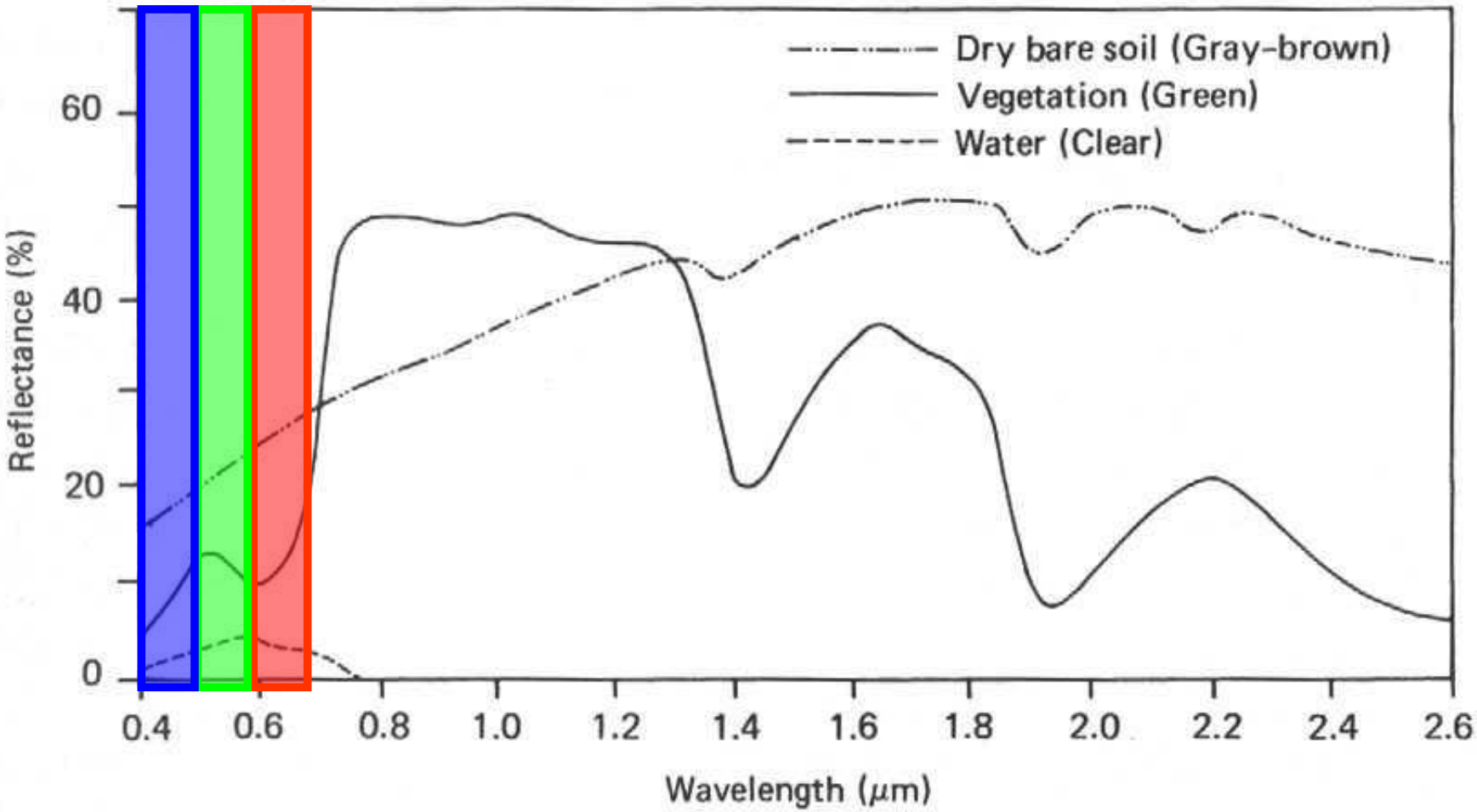
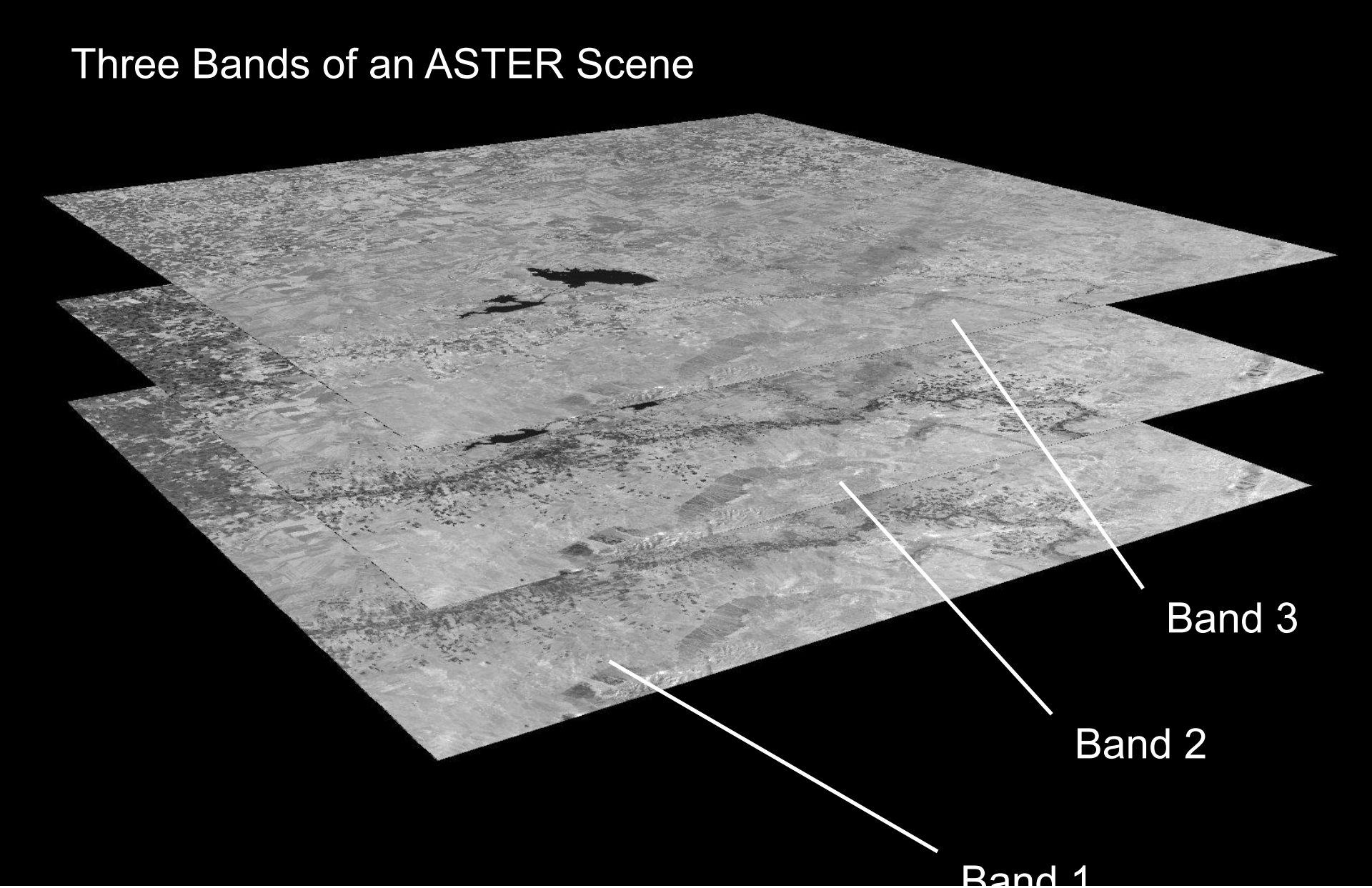
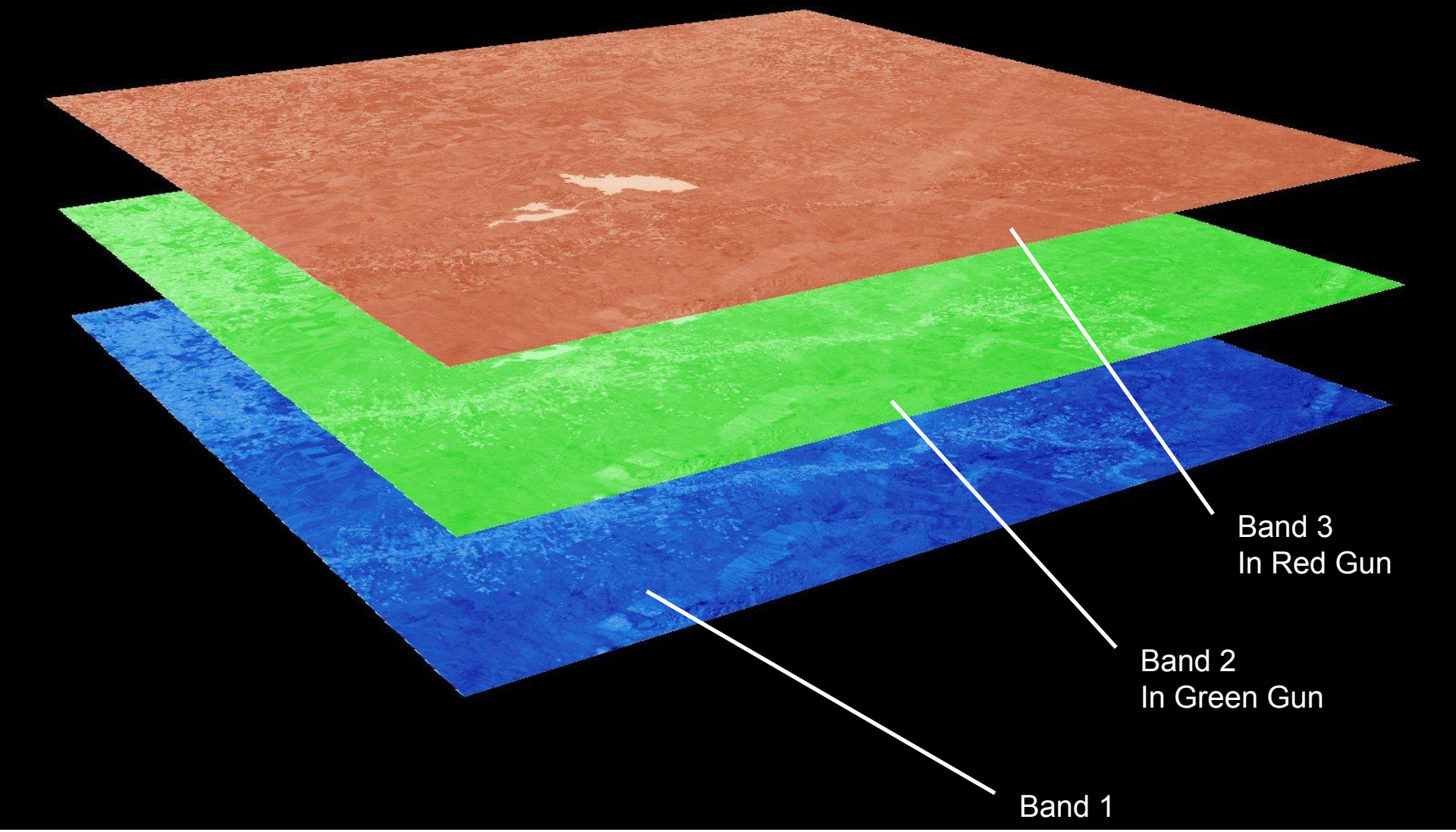


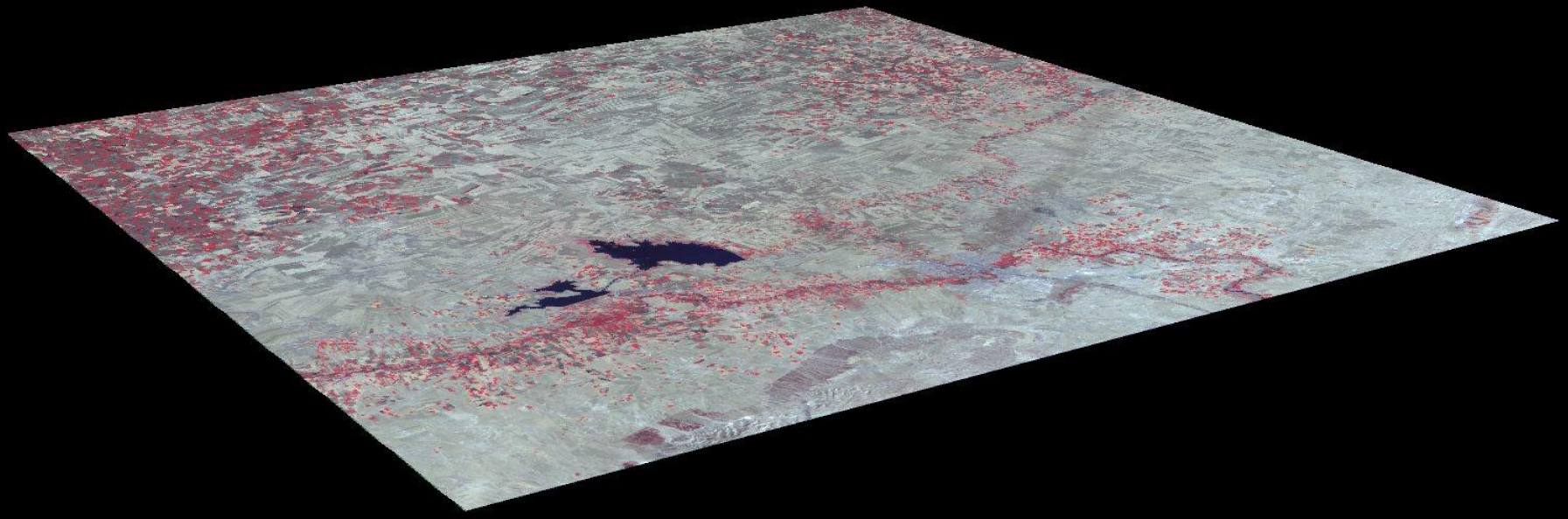
Figure 1.10 Typical spectral reflectance curves for vegetation, soil, and water. (Adapted from Swain and Davis, 1978.)

Three Bands of an ASTER Scene

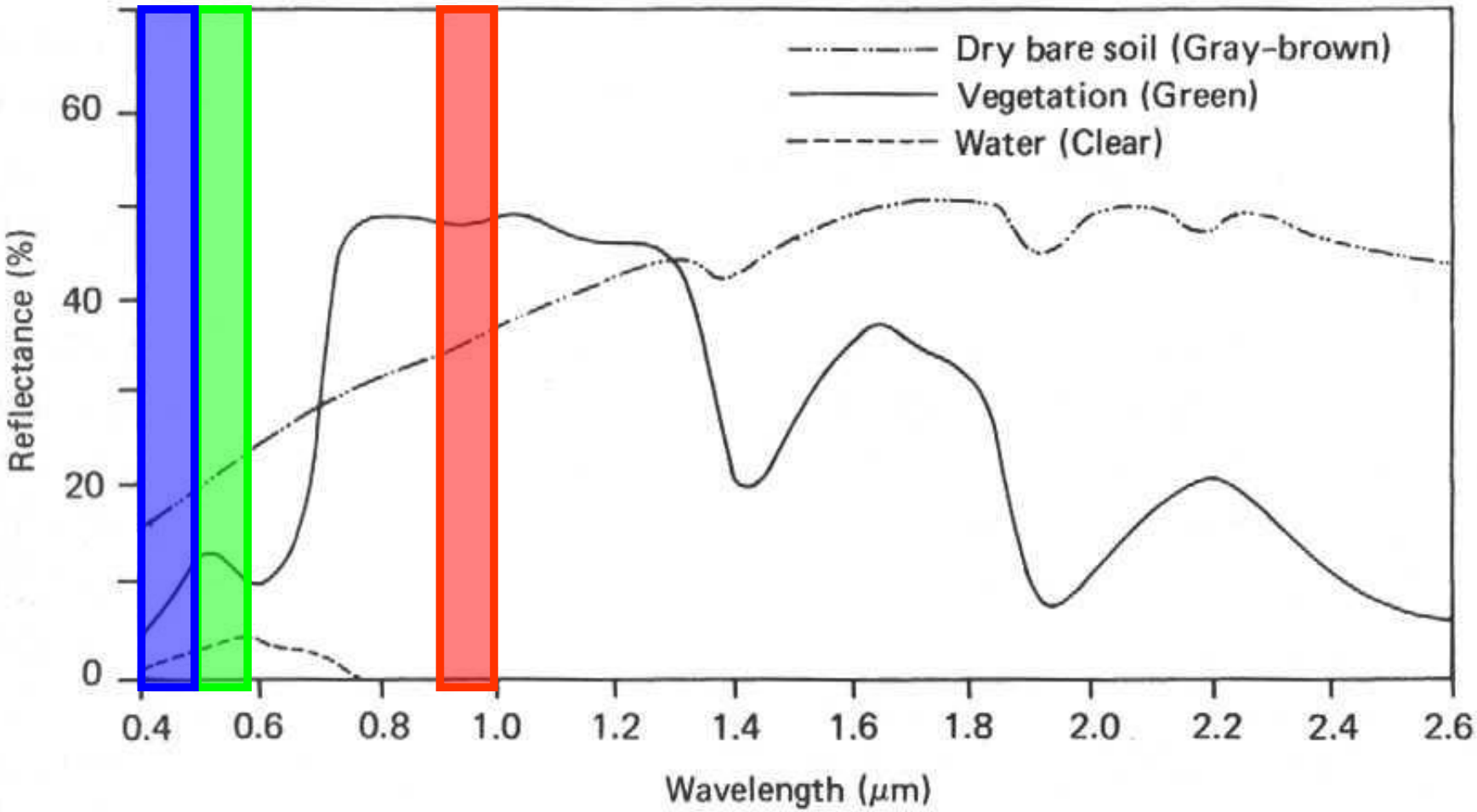


Three Bands of an ASTER Scene





ASTER Scene
Red: Band 3
Green: Band 2
Blue: Band 1



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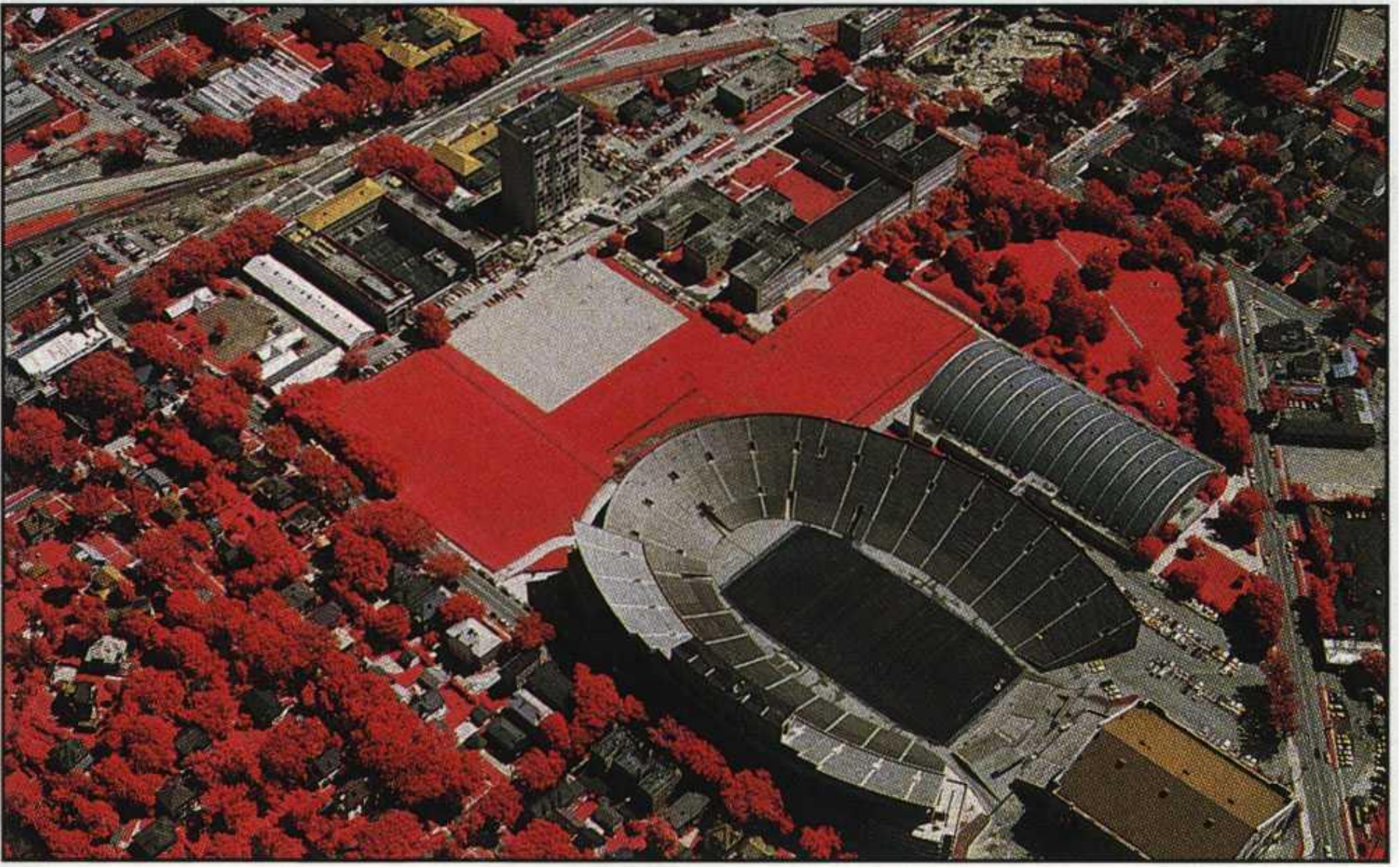
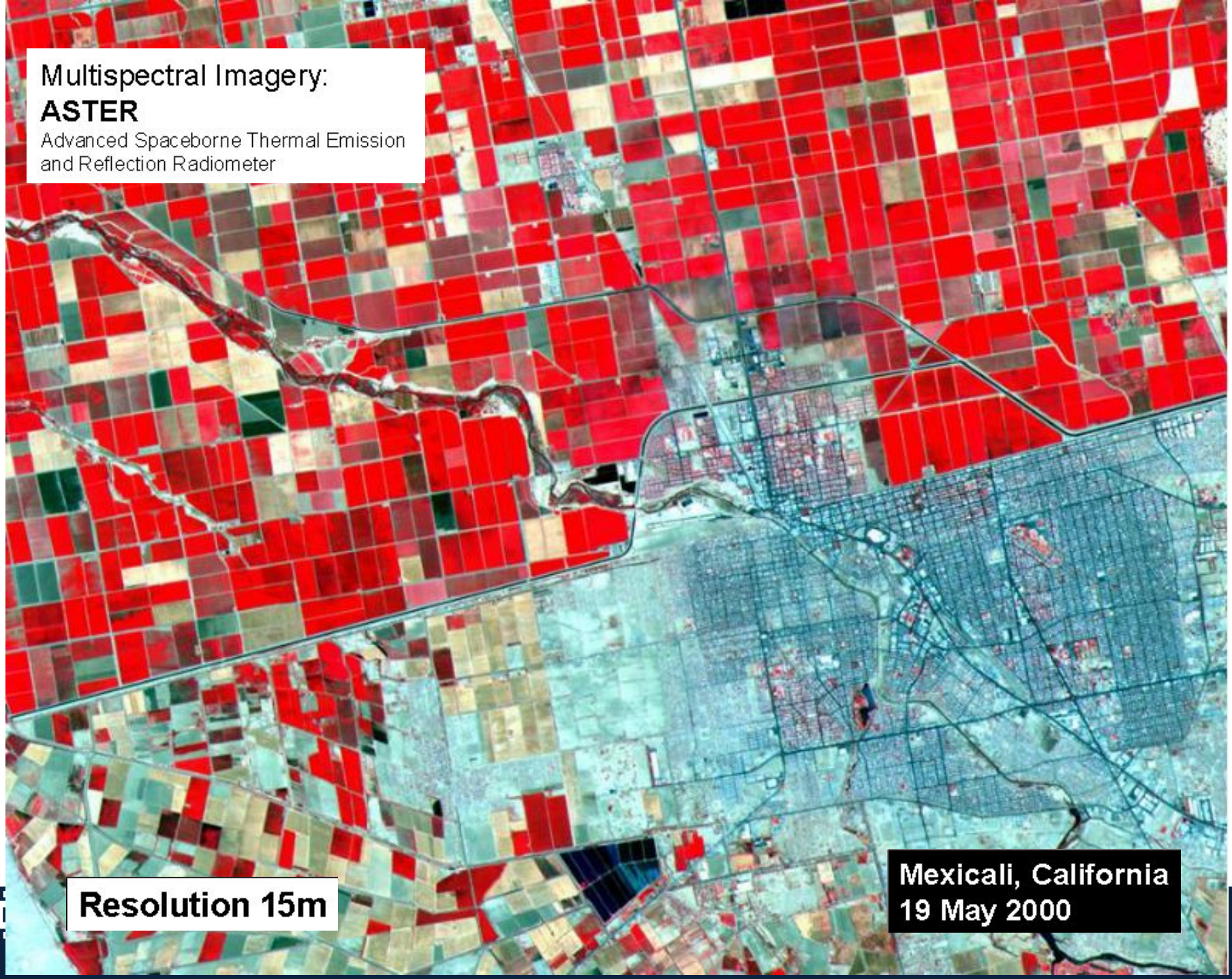



Multispectral Imagery:
ASTER
Advanced Spaceborne Thermal Emission and Reflection Radiometer
Resolution 15m
Mexicali, California
19 May 2000

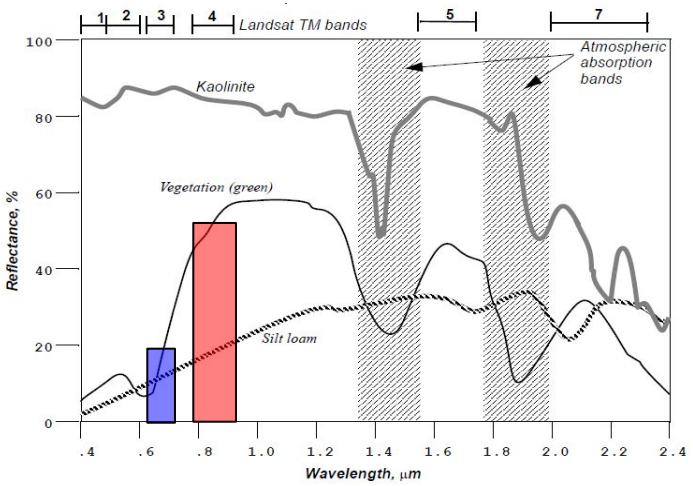
Vegetation Indices

Based on the ratio of Near Infrared to Red
- **Chlorophyll reflects strongly in Infrared**
- **Red measure removes some error**

Measures vegetation density and health

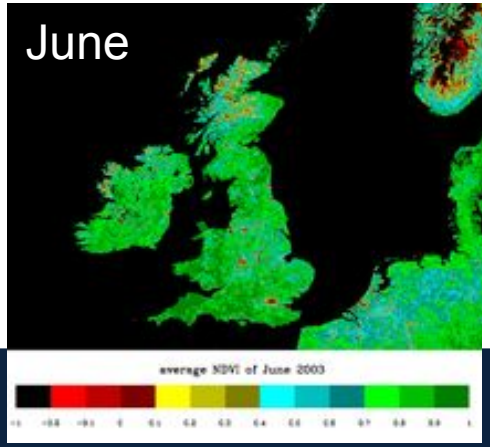
Several possible measures

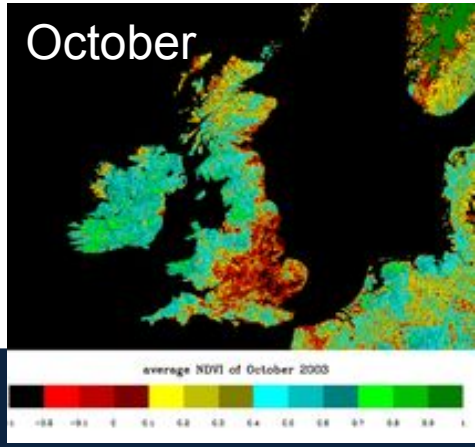
Normalized Difference Vegetation Index (NDVI)



NDVI values range between -1 and 1
- 1 – 0.1 : Clouds, water, rock, sand, snow.
0.2 – 0.4 : Shrub and grasslands
0.5 – 0.8 : Dense forest

In ArcGIS NVDI is scaled to 0 – 200:
0 – 110 : Not vegetation
120 – 140 : Shrub and grasslands
150 – 200 : Dense forest

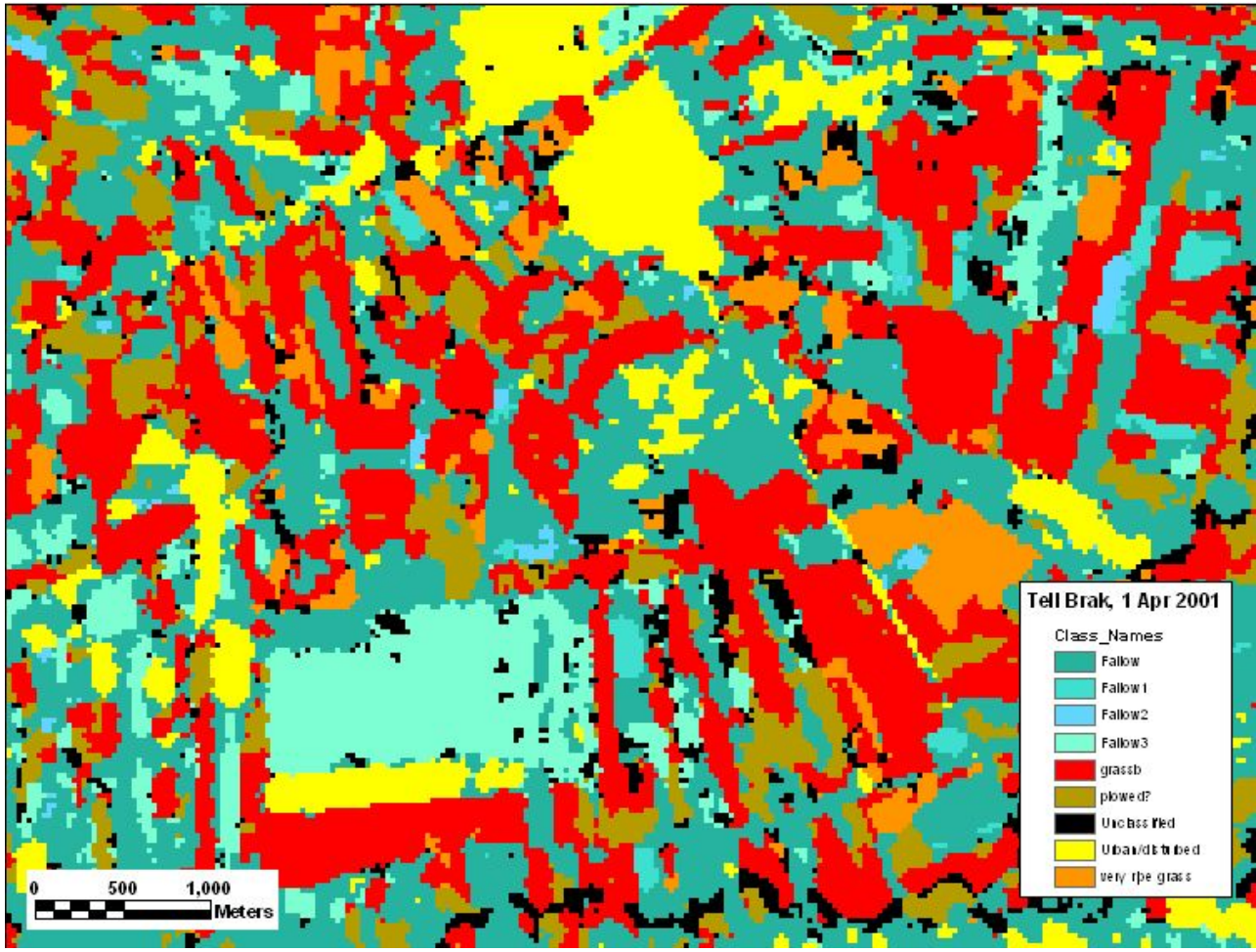




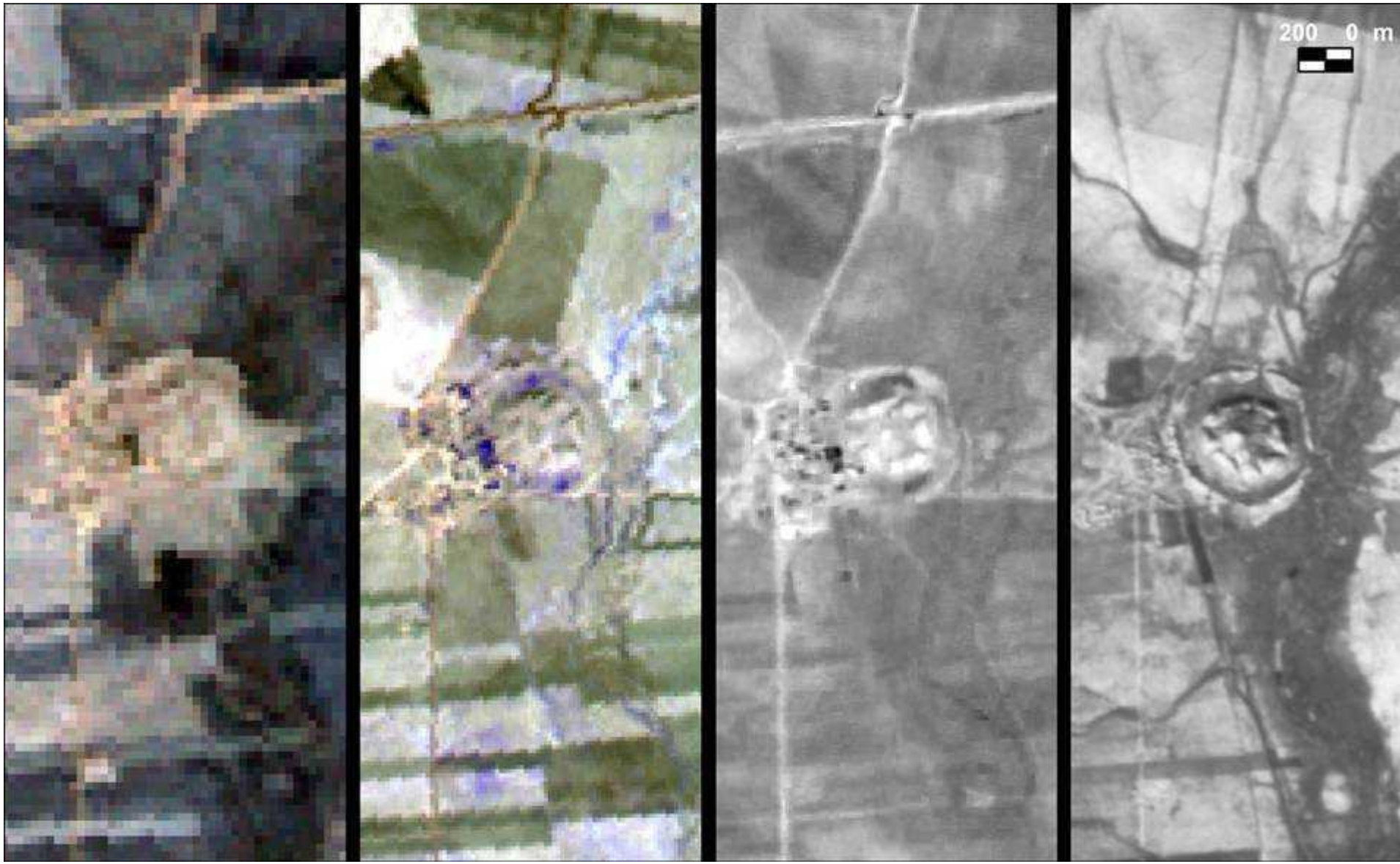
Landcover

Using all of the spectral information to classify each pixel into discrete classes representing landcover types

- Can be done in ArcGIS
- Many pre-made, global, classifications are available
  - Global Land-cover Facility



Spatial Resolution Comparison among four data sources (Tell Beydar, NE Syria)



LANDSAT (30m) **ASTER (15m)** **SPOT (10m)** **CORONA (2m)**


©Google Earth™ 2005

Uses of Satellite Imagery

- Determining Features
- Classification of Landcover
- Vegetation Indices
- Geologic Indices
- Principal Components Analysis

Accessible Geospatial Tools for Mapping and Sharing Medieval Information

Spatial Data Formats

File Formats for Vector Spatial Data

Shapefile: vector data format introduced with *ArcView in 1993*

- openly published specs so other vendors can create shape files

Geodatabase: new format introduced with ArcGIS 8.0 in 2000

- Multiple layers saved in a singe .mdb (MS Access-like) file
- Proprietary, “next generation” spatial data file format

Shapefiles are the simplest and most commonly used format and will generally be used in the class exercises.

The Shapefile

Each shapefile is made up of several different files

- For example, a shapefile called “example” on your computer would have at least three different files
  - example.shp: shape format
    - the actual points for each feature
  - example.shx: shape index format
    - positional index of the feature geometry to allow seeking forwards and backwards quickly
  - example.dbf: attribute table
    - Columns with the attributes for each shape, in dBase format
- And possibly up to 4 more

GeoJSON

- GeoJSON is a format for encoding a variety of geographic data structures.
- Based on Java data objects
- Common in web applications
- Can mix vector types

```
{
  "type": "Feature",
  "geometry": {
    "type": "Point",
    "coordinates": [125.6, 10.1]
  },
  "properties": {
    "name": "Dinagat Islands"
  }
}
```

KML / KMZ files

- File format for Google Earth / Google Maps
- Often used in mapping software
- Can mix vector types
- Not all analysis GIS software can read

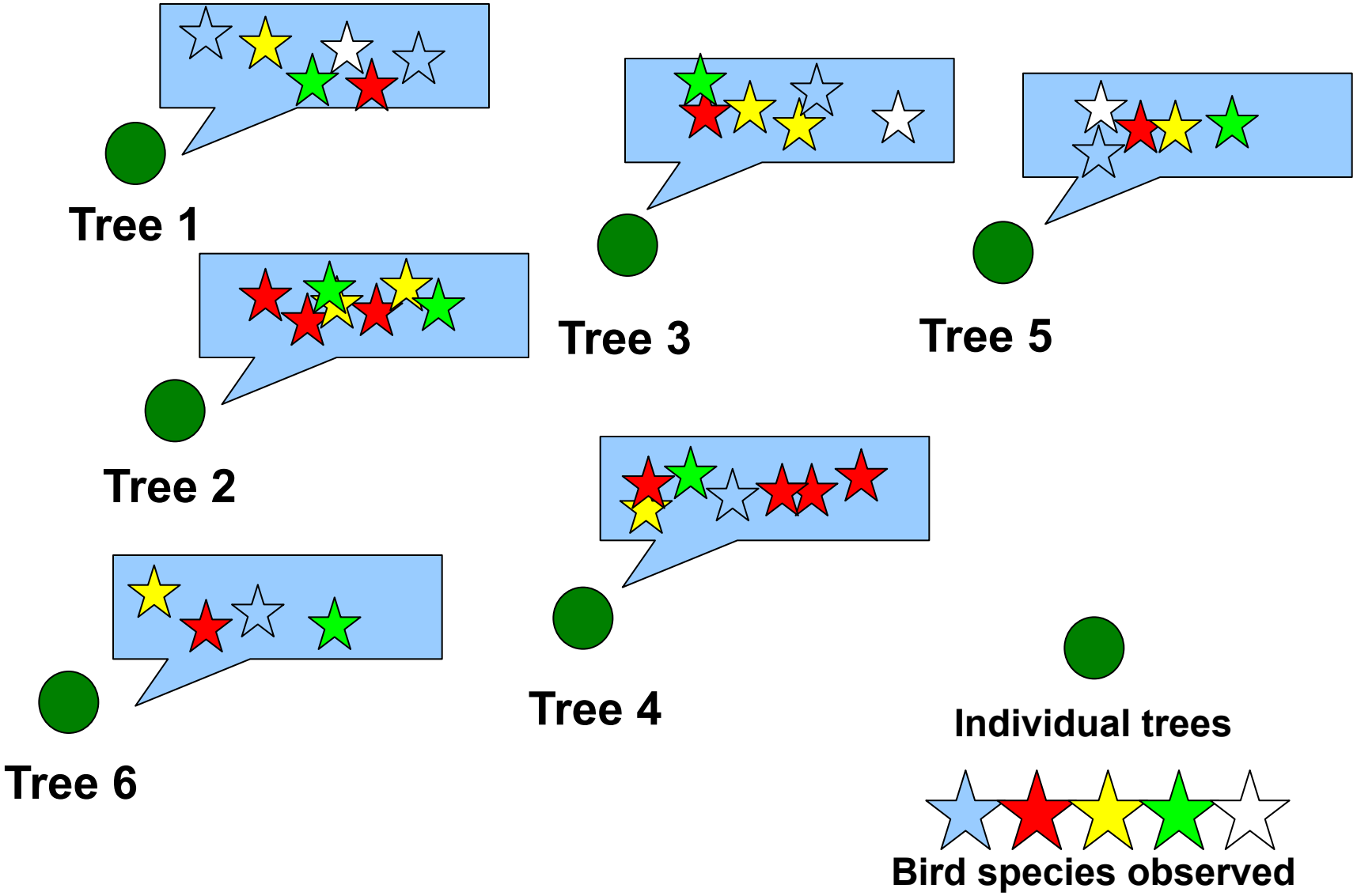
```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
  <Placemark>
    <name>Simple placemark</name>
    <description>Attached to the ground. Intelligently places itself
       at the height of the underlying terrain.</description>
    <Point>
      <coordinates>-122.0822035425683,37.42228990140251,0</coordinates>
    </Point>
  </Placemark>
</kml>
```

Tables

- Usually created in programs like excel or google sheets
- Only work well for points
- A Comma-Separated-Value (CSV) files is usually the most versatile
- Organization can be important

```
id,Name,POINT_X,POINT_Y
13773,¿Detumo 1?,-5.100619000000000,37.801108999999997
13775,¿Detumo 2?,-5.110923000000000,37.782581000000000
3708,Abdera,-3.022522000000000,36.748069999999998
10833,ABDERA - ?ßd??a,24.973631000000001,40.931190000000001
10834,Abila Dekapoleas,35.869793000000001,32.681418999999998
18099,Abuneiteichos-Ionopolis,33.763728999999998,41.978546000000001
10828,ABYDOS,31.919100000000000,26.184849000000000
18311,Abydus,26.409669999999998,40.171138999999997
3737,Acci,-3.134636000000000,37.300308000000001
10829,ACCO,35.087704000000002,32.920859999999998
10830,ACERRAE,14.371335999999999,40.945926999999998
```

Data Organization Example



Organization of data tables

Horizontal:

Tree	Bird A	Bird B	Bird C	Bird D	Bird E
1	2	0	14	3	35
2	0	0	1	0	2
3	12	0	0	4	1
4	0	4	0	0	0
5	22	1	13	8	12
6	1	0	1	0	1

Organization of data tables

Vertical:

Birds	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6
A	2	1	12	0	22	1
B	0	0	0	4	1	0
C	14	1	0	0	13	1
D	3	0	4	0	8	0
E	22	2	1	0	12	1

Tables

- Sometimes tables have coordinates where something happened (e.g. latitude and longitude), but sometimes they just have a street address or the name of a city
- Often you can just look up the coordinates using a search engine or map
- But in the case of many, you need to do a process called *geocoding*

Geocoding

- **Geocoding** is the process of looking up the geographic coordinates of a street address
  - **Reverse geocoding** is the inverse, looking up the address for coordinates
- In order to create a map from a list of addresses, you will need to geocode them
- Everytime you ask Google (or Apple) maps to find a nearby address, this is what is happening behind the scenes.

Geocoding

- The actual process of geocoding takes a lot over overhead to develop a model for where all addresses (or at minimum how they are distributed along a road network) and then using special software to lookup the location of a given address.

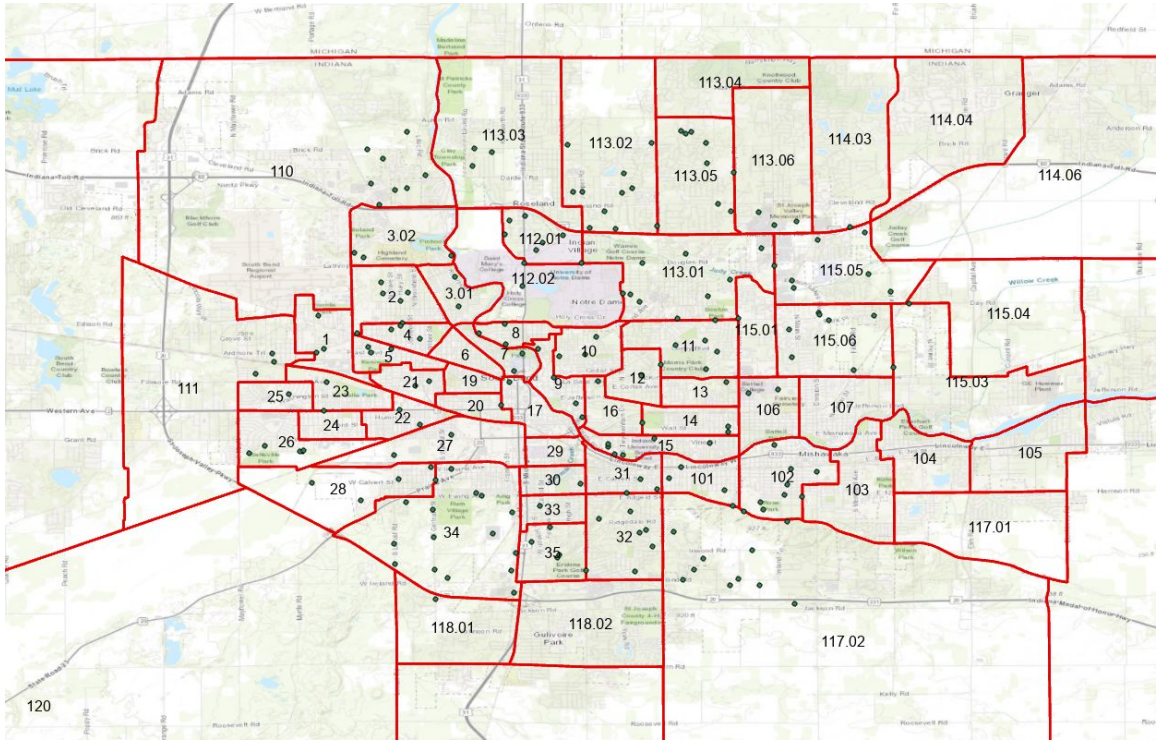
- Fortunately, many large companies (like ESRI, Google Maps, Apple Maps, Mapquest or Bing Maps) have already done this for most of the world, so it is almost always more efficient to use these pre-built services to perform geocoding and routing

Geocoding

Things to watch out for:

- The process is never perfect.
- If the data come from people, there will always be mistakes (misspelled road names, inverted number, totally fake addresses)
- Sometimes this means the geocoder will fail. Other times it may find an incorrect address or only know that this address is in particular city

Geocoding


MICHIGAN
INDIANA
113.04
113.03
113.02
113.06
114.03
114.04
113.05
114.06
110
3.02
112.01
112.02
3.01
113.01
115.05
115.04
115.01
115.06
115.03
111
106
107
104
105
103
117.01
118.01
118.02
117.02
120
1
2
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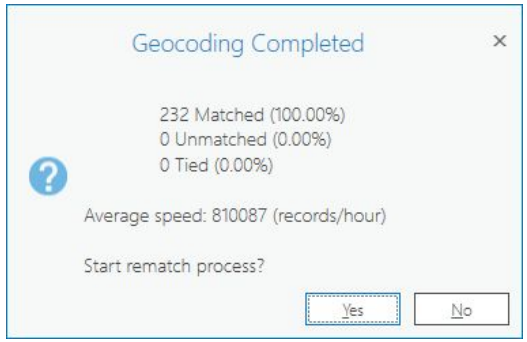
Geocoding Completed
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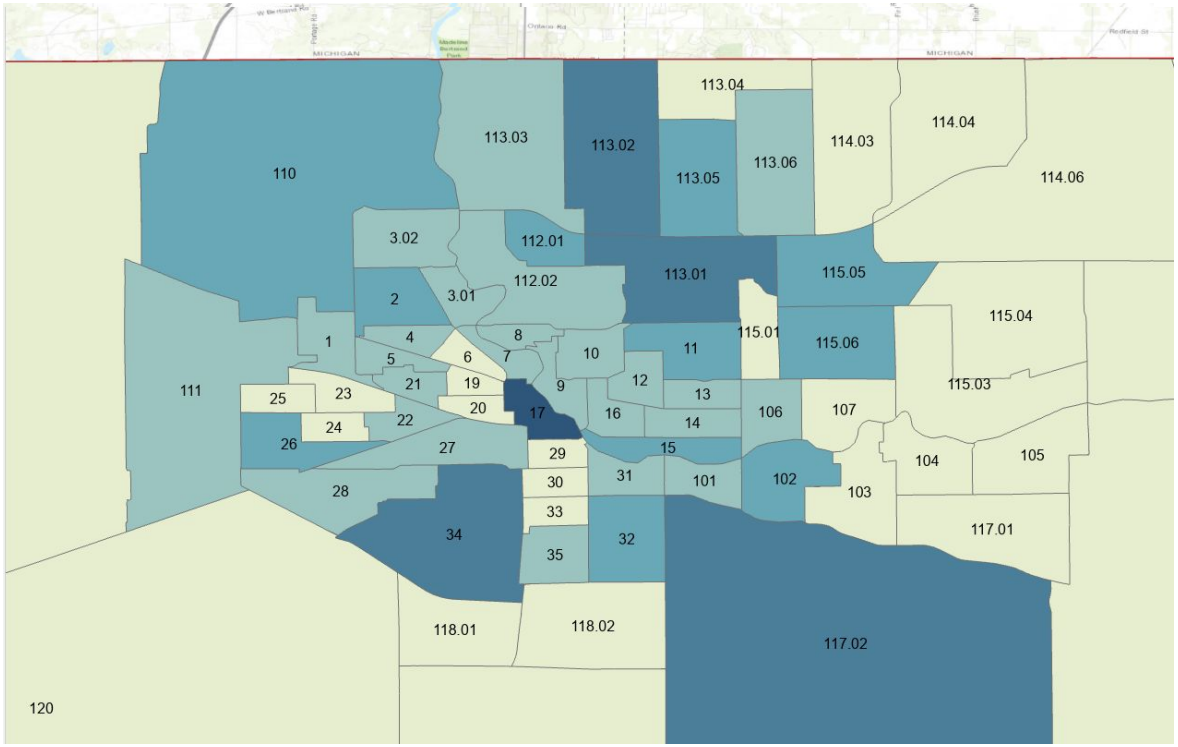
0 Unmatched (0.00%)
0 Tied (0.00%)
Average speed: 810087 (records/hour)
Start rematch process?
Yes
No

Geocoding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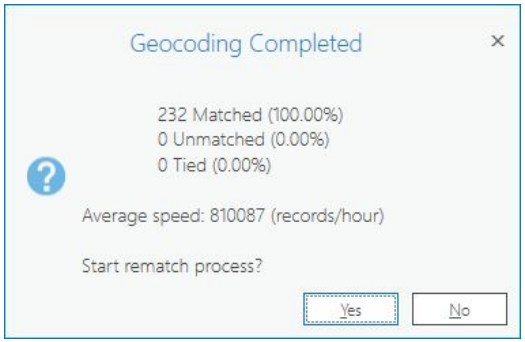
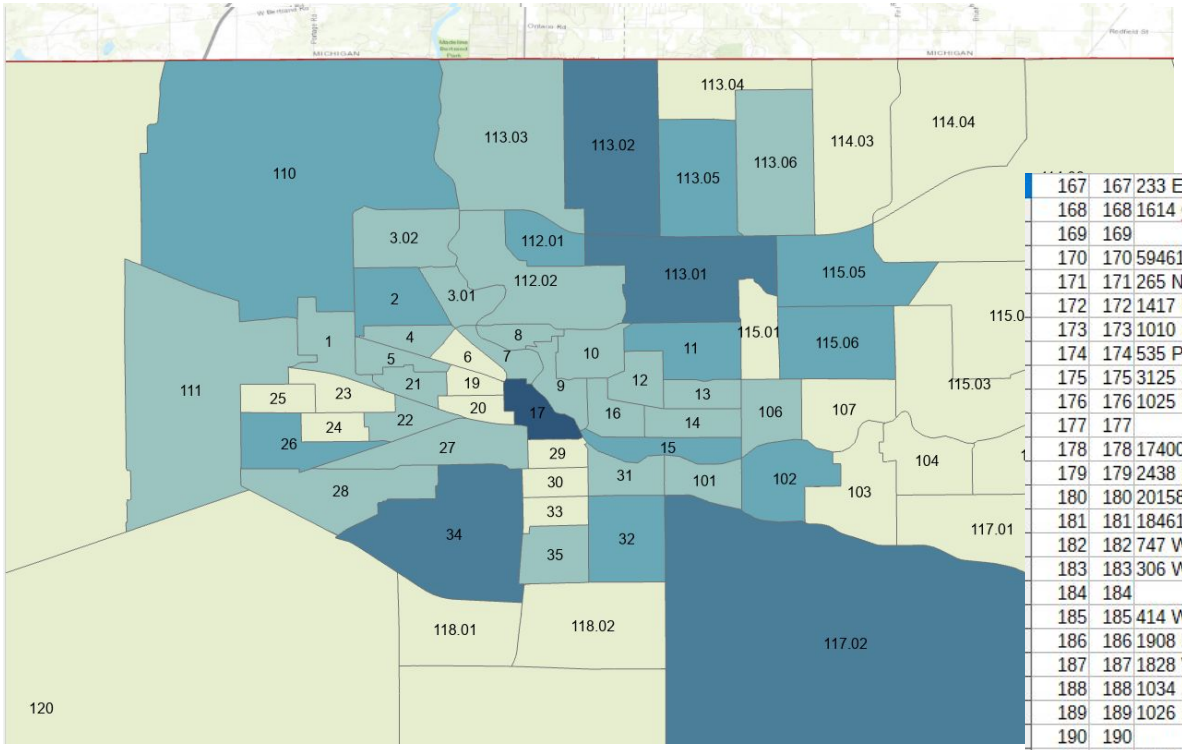
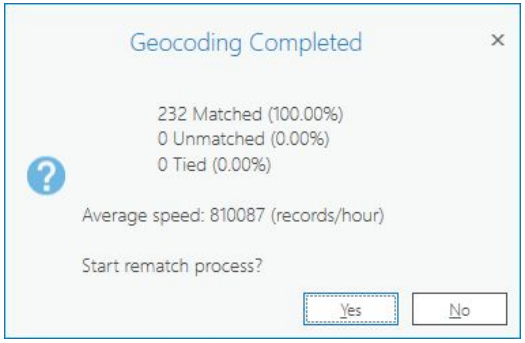

Geocoding Completed
232 Matched (100.00%)
0 Unmatched (0.00%)
0 Tied (0.00%)
Average speed: 810087 (records/hour)
Start rematch process?
Yes
No

Geocoding





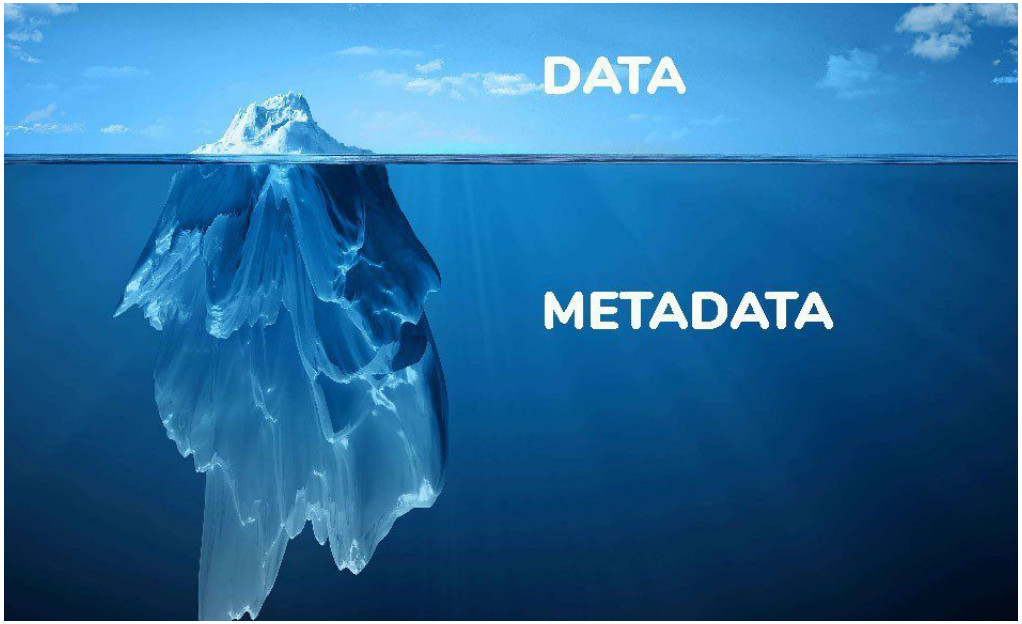
167	167	233 E Fairview Ave	South Bend	Indiana		99	2	
168	168	1614 Galway Dr	South Bend	Indiana	46614	55	2	
169	169		South Bend	Indiana	46637	77	1	
170	170	59461 Keria Trl	South Bend	Indiana		85	2	
171	171	265 N Wellington St	South Bend	Indiana	46619	39	1	
172	172	1417 N Hickory Rd	South Bend	Indiana	46635	31	2	
173	173	1010 E Bowman St	South Bend	Indiana	46613	42	1	
174	174	535 Parry St	South Bend	Indiana	46617	27	1	
175	175	3125 S Gertrude St	South Bend	Indiana	46614	29	2	
176	176	1025 Emerson Ave	South Bend	Indiana	46615	71	2	
177	177		South Bend	Indiana	46614	96	3	
178	178	17400 Inwood Rd	South Bend	Indiana	46614	77	2	
179	179	2438 Eisenhower Ave	South Bend	Indiana	46615	62	2	
180	180	20158 Richard St	South Bend	Indiana	46637	14	1	
181	181	18461 Greenleaf Dr	South Bend	Indiana	46637	4	1	
182	182	747 W North Shore Dr	South Bend	Indiana	46617	29	2	
183	183	306 W Angela Blvd	South Bend	Indiana	46617	86	1	
184	184		South Bend	Indiana	46614	58	3	
185	185	414 W 13th St	Mishawaka	Indiana	46544	53	2	
186	186	1908 N Liberty Dr	Mishawaka	Indiana	46545	51	3	
187	187	1828 Winston Dr	South Bend	Indiana	46635	16	3	
188	188	1034 S Edison Ave	South Bend	Indiana	46619	27	2	
189	189	1026 Parkway St	South Bend	Indiana	46619	98	3	
190	190		Mishawaka	Indiana	46544	99	2	
191	191	325 W North Shore Dr	South Bend	Indiana	46617	53	2	
192	192	1722 E Calvert St	South Bend	Indiana	46613	26	2	
193	193	1609 N Chicago St	South Bend	Indiana	46628	94	1	

Accessible Geospatial Tools for Mapping and Sharing Medieval Information

Finding spatial data

Metadata

- Data about your data



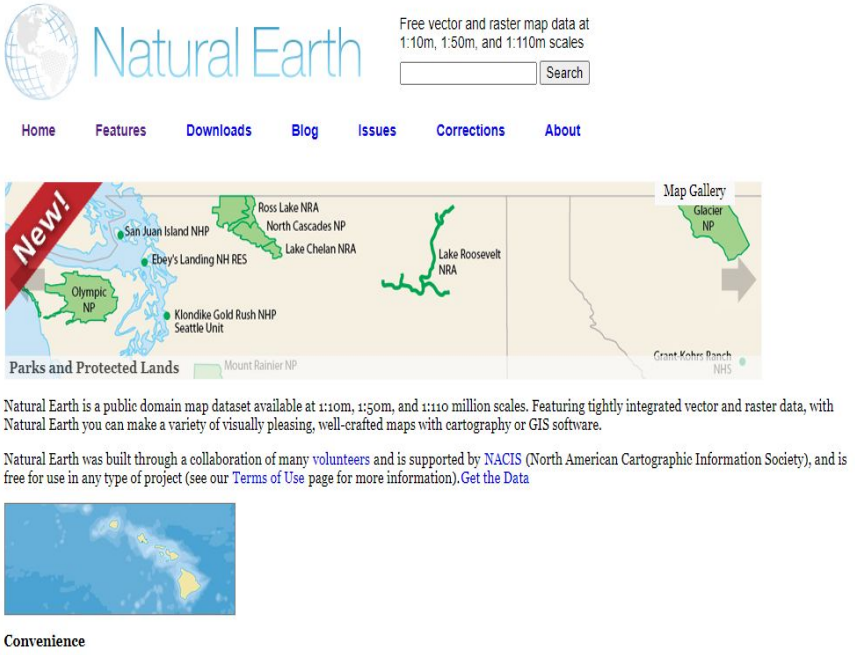
Data

Metadata

- Filename: Kitten.jpg
- It is a picture of a black kitten sitting on a blanket looking at the camera
- Taken with an iphone 10X
- March 23, 2022
- The kitten is female
- Her name is Princess Beatrice Buttercup
- She may actually be evil

Geospatial Data Sources

- Natural Earth
  - https://www.naturalearthdata.com/
  - High quality geographic and cultural background layers
- GADM
  - https://gadm.org/
  - Modern country boundaries at a variety of levels



Raster Data Sources

Old Maps Online (https://www.oldmapsonline.org/)

- Clearinghouse of scanned maps held in libraries throughout the world.
- Not all georeferenced or usable in GIS

Medieval data sources

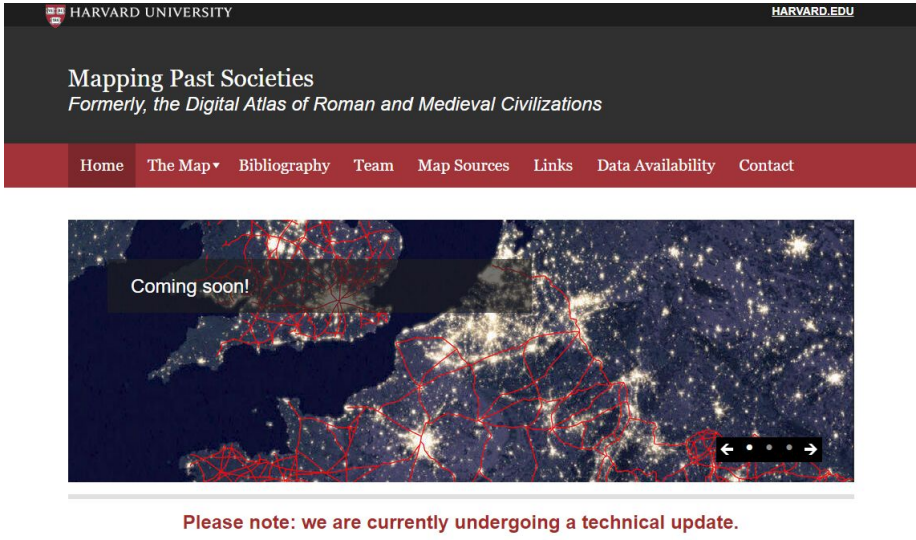
Ancient World Mapping Center

- https://awmc.unc.edu/
- UNC Chapel Hill
- Many layers in geoJSON format
- Map tiles

Medieval data sources

Mapping Past Societies

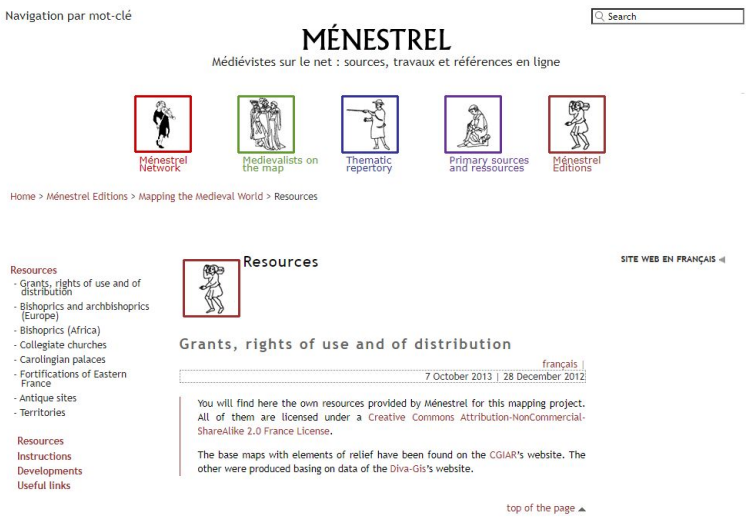
- https://darmc.harvard.edu/
- Many digitized maps and online platforms
- Not all data is directly accessible
- Some is available but not easy to find



Medieval data sources

Mapping Past Societies

- https://www.menestrel.fr/?-Ressources-&lang=en#4411
- Many digitized atlases of geospatial data for France
- Some used in our sample exercises

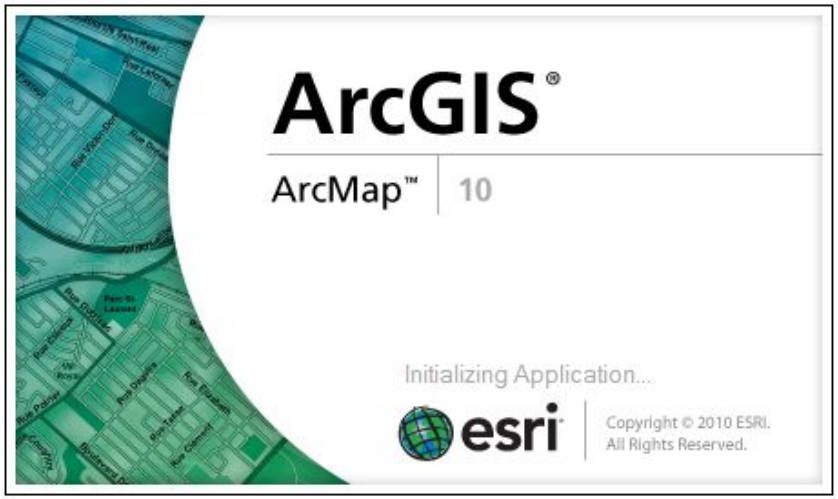


Accessible Geospatial Tools for Mapping and Sharing Medieval Information

GIS software and analytical tools

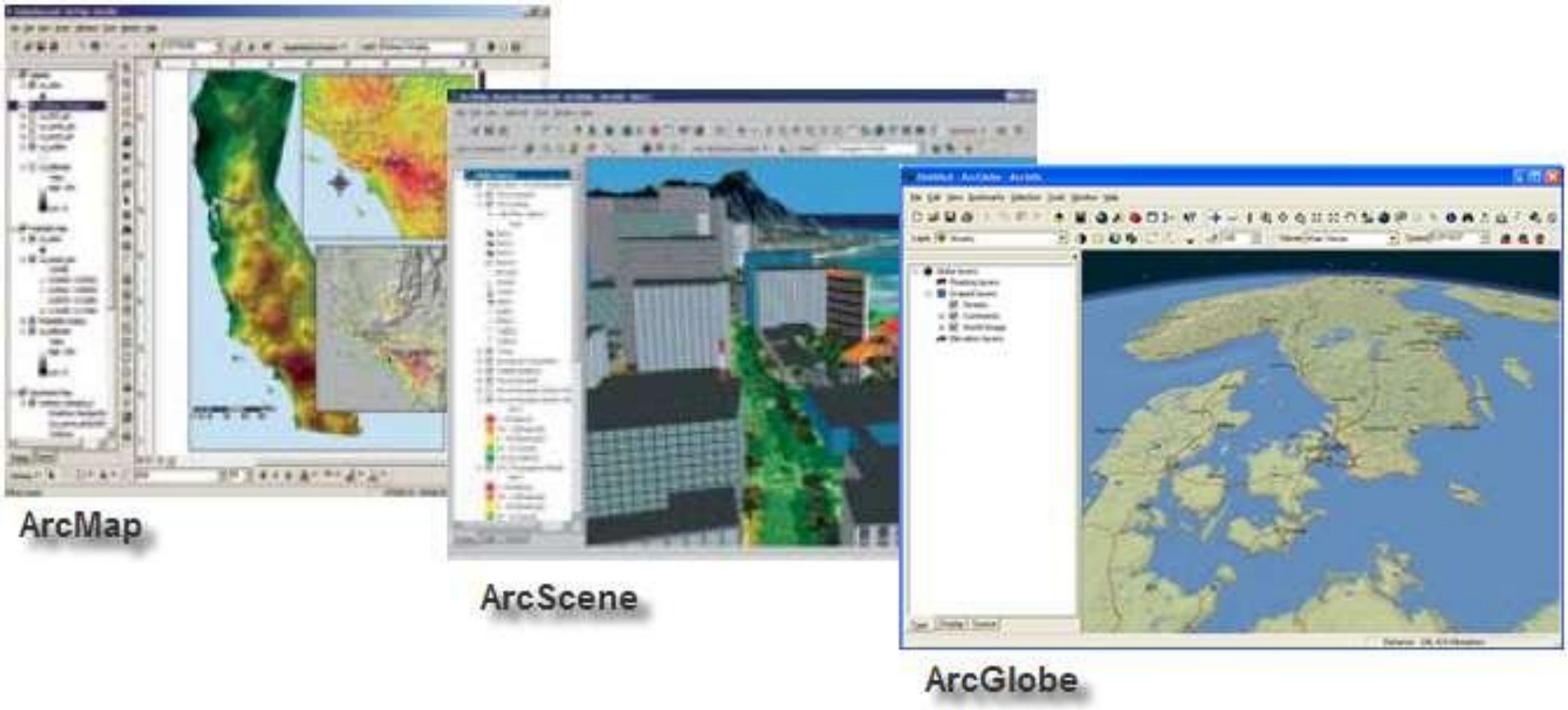
GRASS:
Open source GIS

Quantum GIS:
Open source GIS

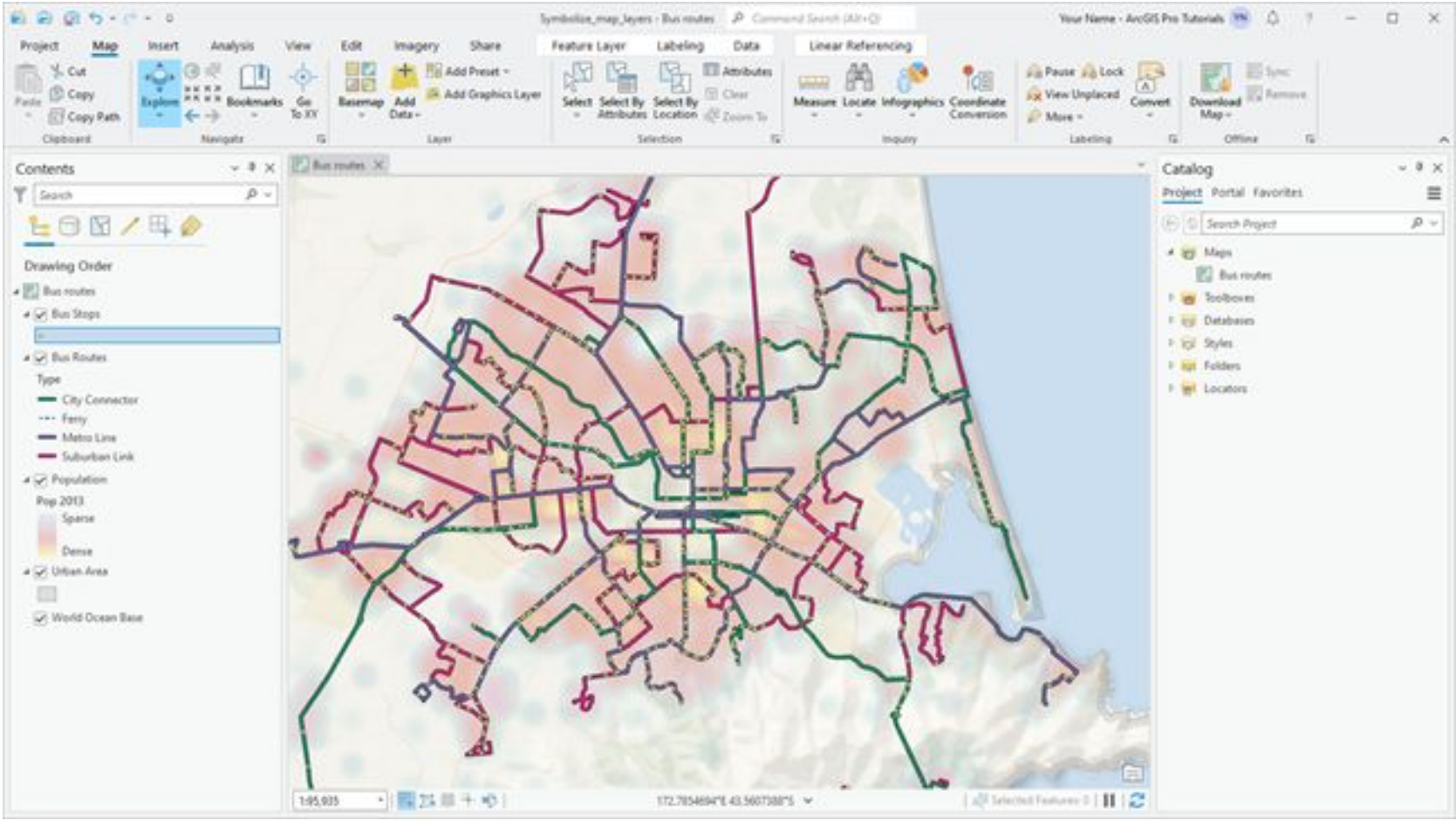


ArcInfo GIS:
Proprietary, industry standard, GIS package

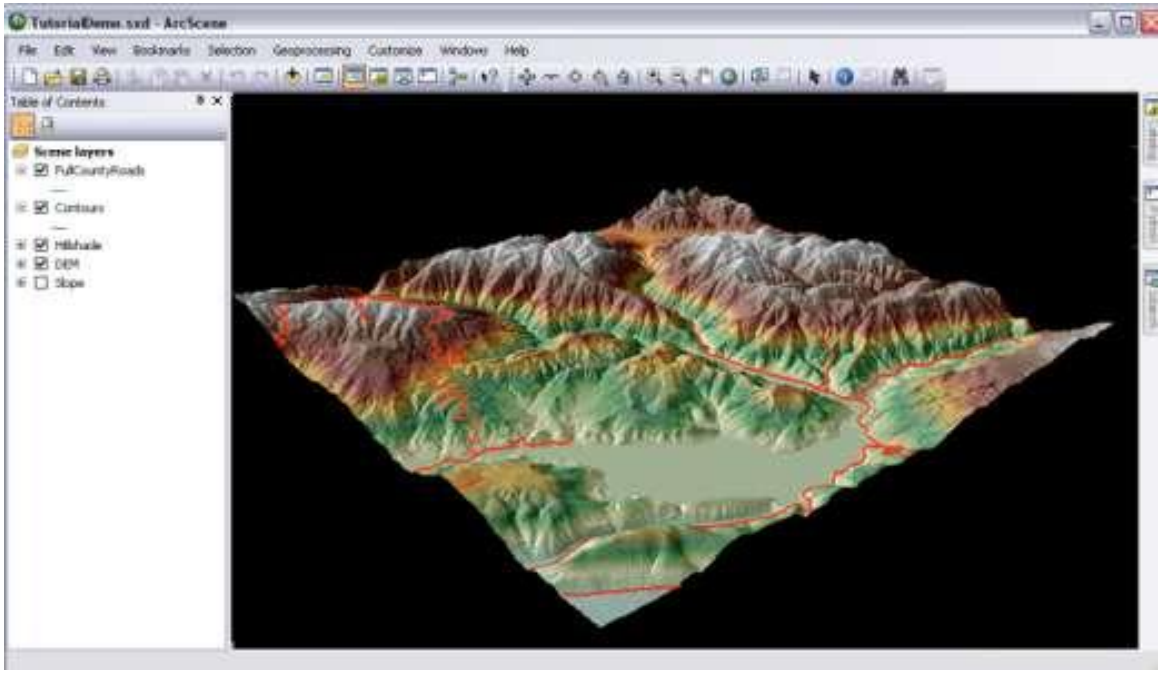
ArcGIS



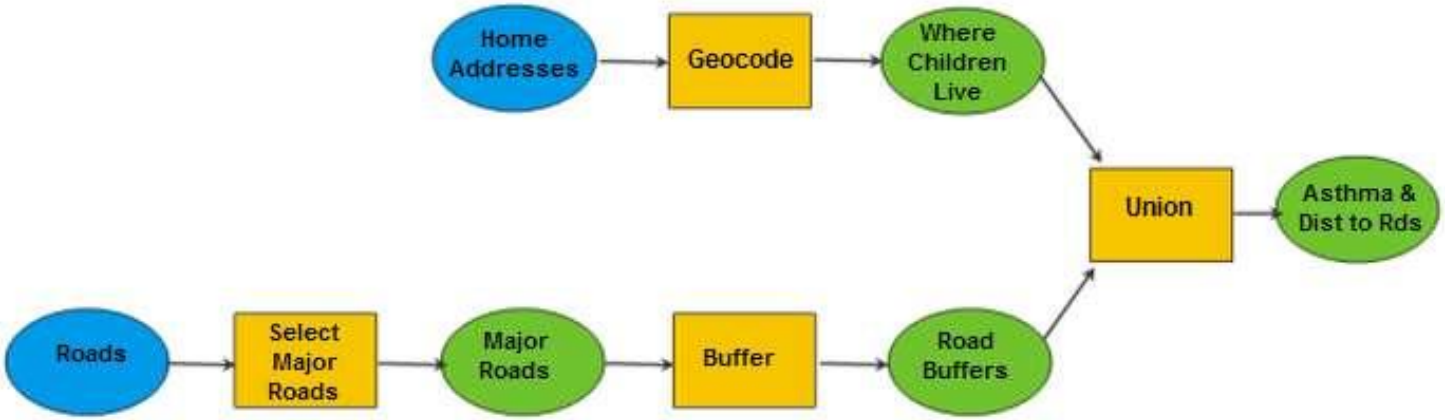
ArcGIS Pro


Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Feature Layer
Labeling
Data
Linear Referencing
Contents
Drawing Order
Bus routes
Bus Stops
Bus Routes
Type
City Connector
Ferry
Metro Line
Suburban Link
Population
Pop 2013
Sparse
Dense
Urban Area
World Ocean Base
Catalog
Project
Portal
Favorites
Maps
Bus routes
Toolboxes
Databases
Styles
Folders
Locators

3d Visualization
ArcScene and ArcGlobe



Model building and Scripting



python™

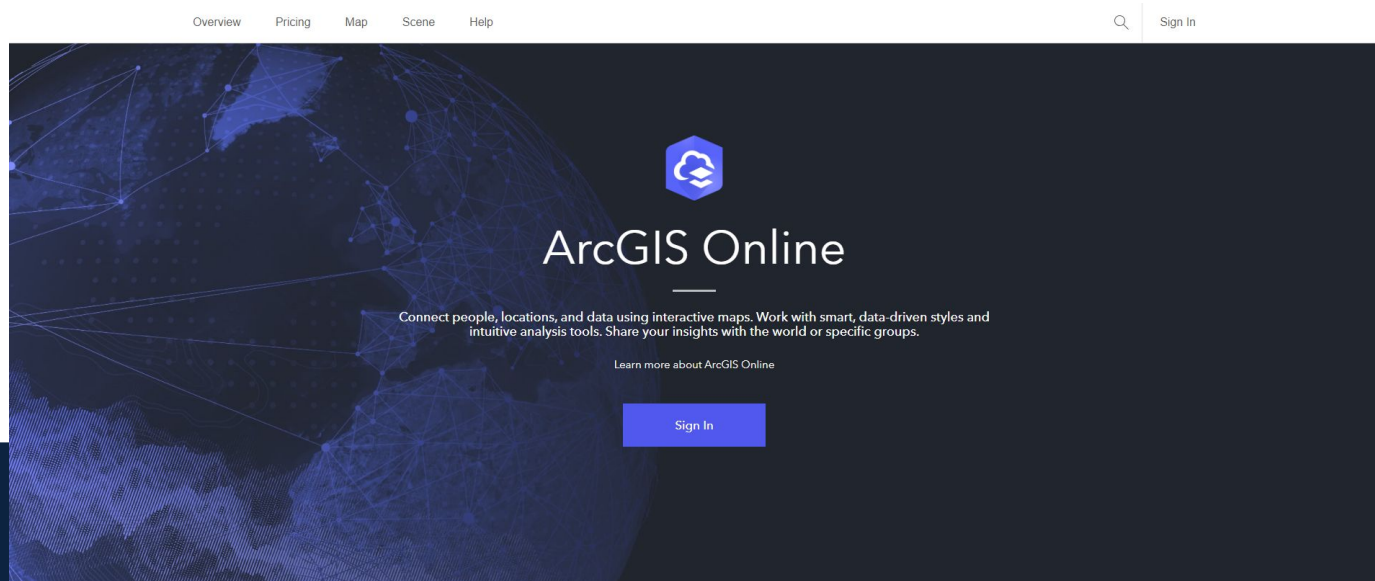
reproject.py - C:\Documents and Settings\Mat\Desktop\reproject.py

File Edit Format Run Options Windows Help

```
# ---------------------------------------------------------------------------
# reproject.py
# Created on: Thu Aug 19 2010 10:50:06 AM
#   (generated by ArcGIS/ModelBuilder)
# ---------------------------------------------------------------------------

# Import system modules
import sys, string, os, arcgisscripting

# Create the Geoprocessor object
gp = arcgisscripting.create()

# Load required toolboxes...
gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Data Management Tool


# Local variables...
output = "Y:\\OpenProjects\\Dissertation\\GISData\\DataSourceBackups\\RandyScans
inputS = "Y:\\OpenProjects\\Dissertation\\GISData\\DataSourceBackups\\RandyScans
gp.ProjectRaster_management(inputS, output, "PROJCS['WGS_1984_UTM_Zone_31N',GEOG
```

ArcGIS Online

- Interface between desktop environment and online data
- Quick and easy ways of making web-based maps and data collection apps
  - http://arcg.is/2eXCr6g
  - http://arcg.is/2eyFx6w



ArcGIS Storymaps

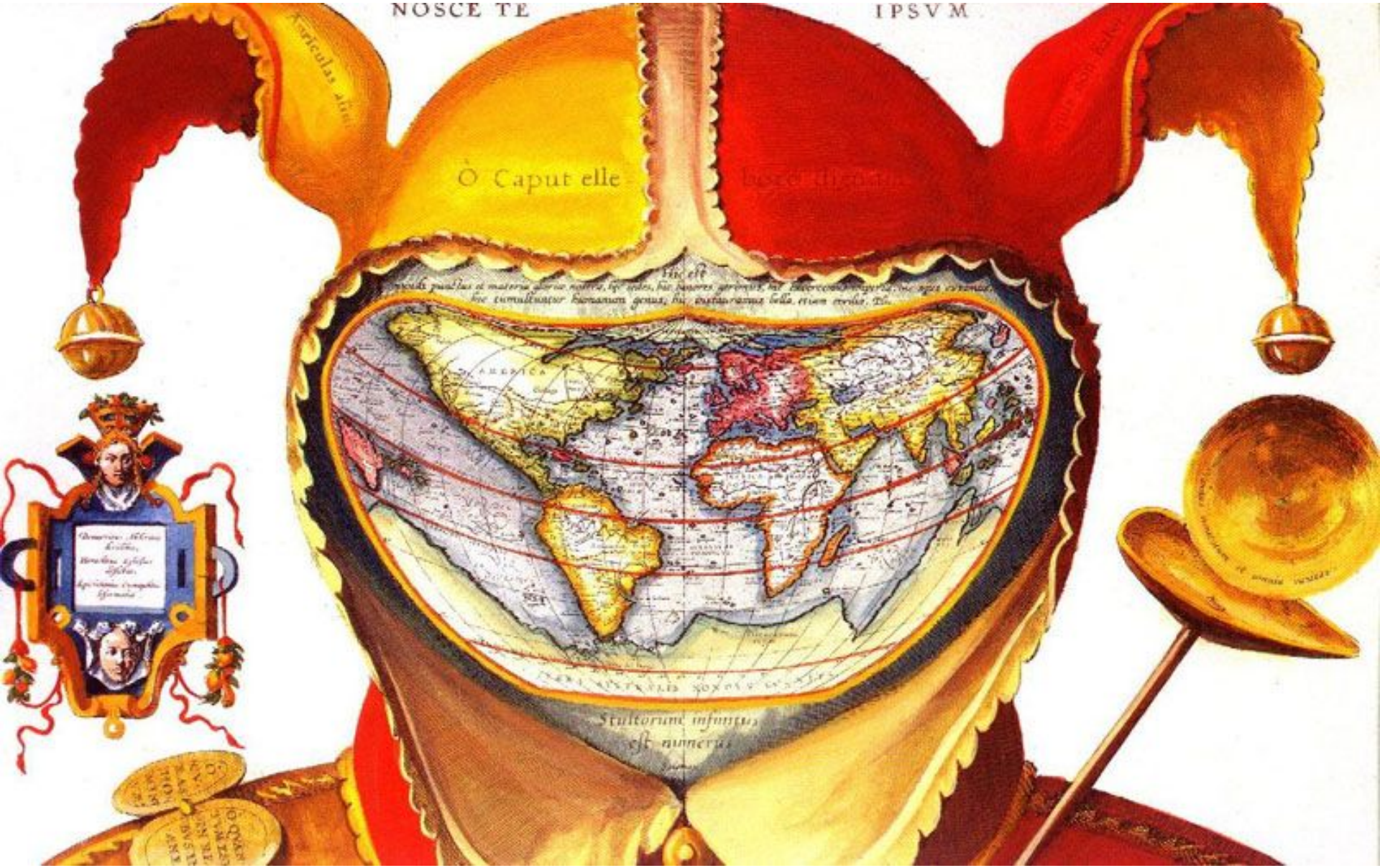
- Platform for sharing long form narratives with embedded geospatial content.
- https://storymaps.arcgis.com/
- Tutorials

Google MyMaps

- Additional capabilities beyond Google Maps / Earth
- Allows editing of vector data

Accessible Geospatial Tools for Mapping and Sharing Medieval Information

Visualizing Data on Maps



The fool's cap world map. ca 1590

Necessary components of a good map

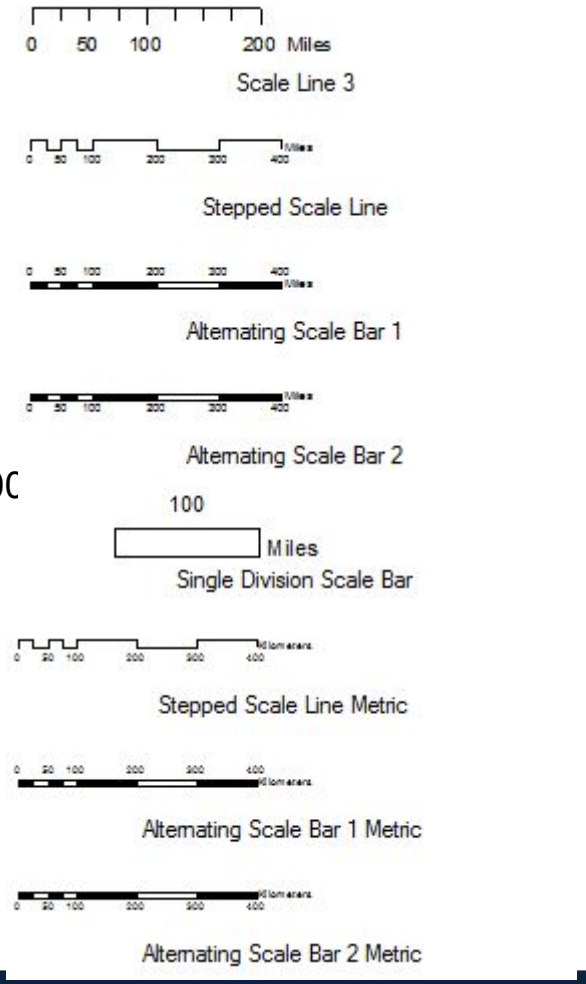
Scale

Legend

North Arrow (or other indication of direction)

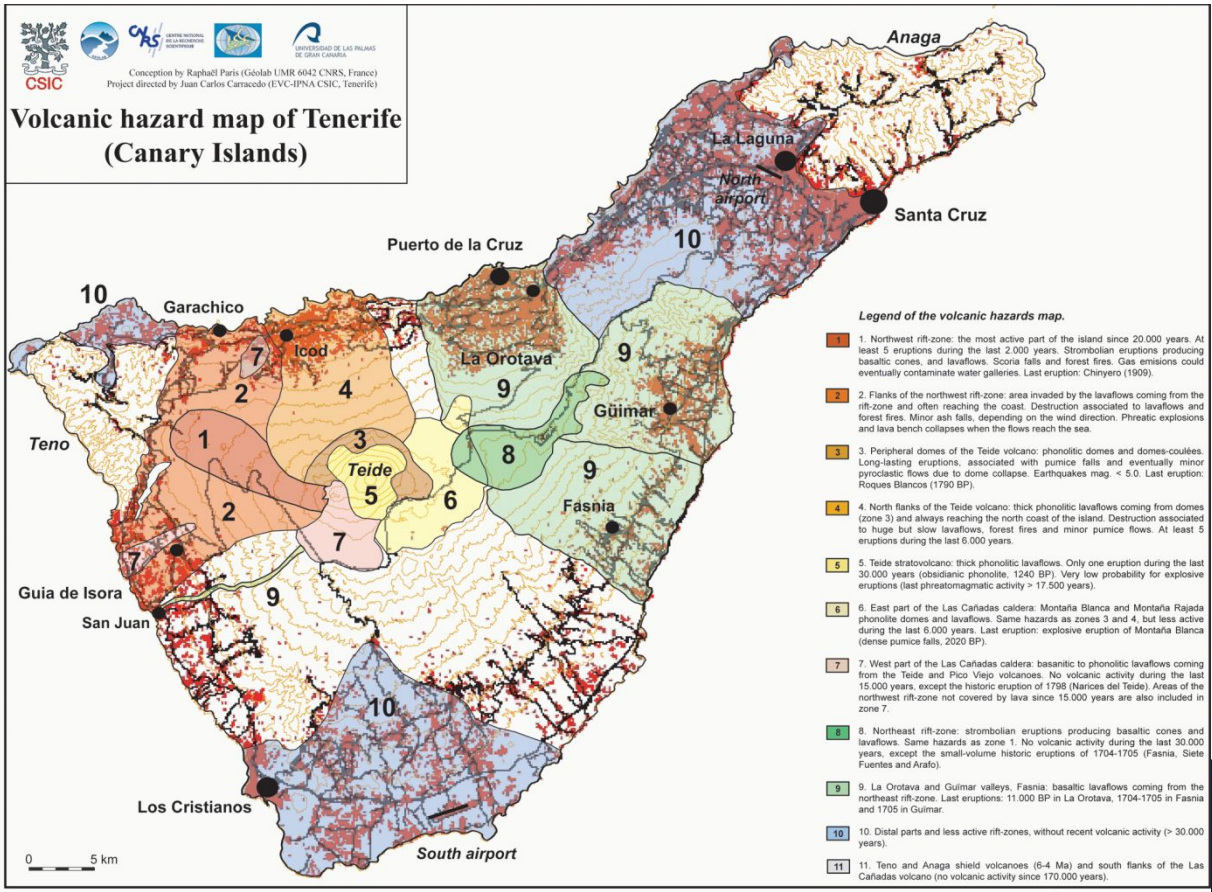
Necessary components of a good map

- Scale
  - Verbal
    - One inch equals 20 miles
    - Inaccurate if map is resized
  - Representative Fraction:
    - 1:24,000: one unit on the map equals 24,000 units in the real world
  - Graphic or Bar Scale:
    - Like representative fraction



Necessary components of a good map

- Legend
  - Explains the symbols used on the map



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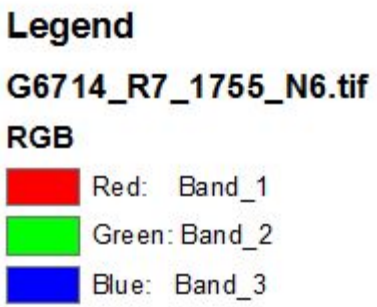
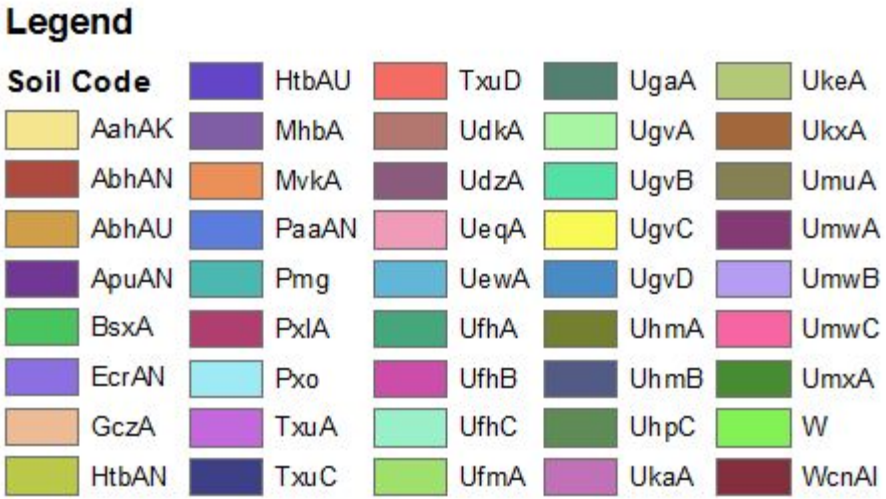




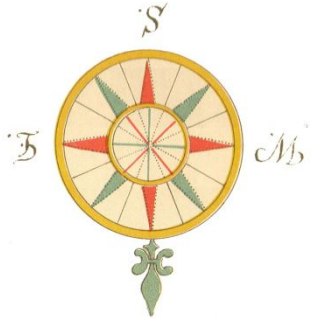
Choosing symbols

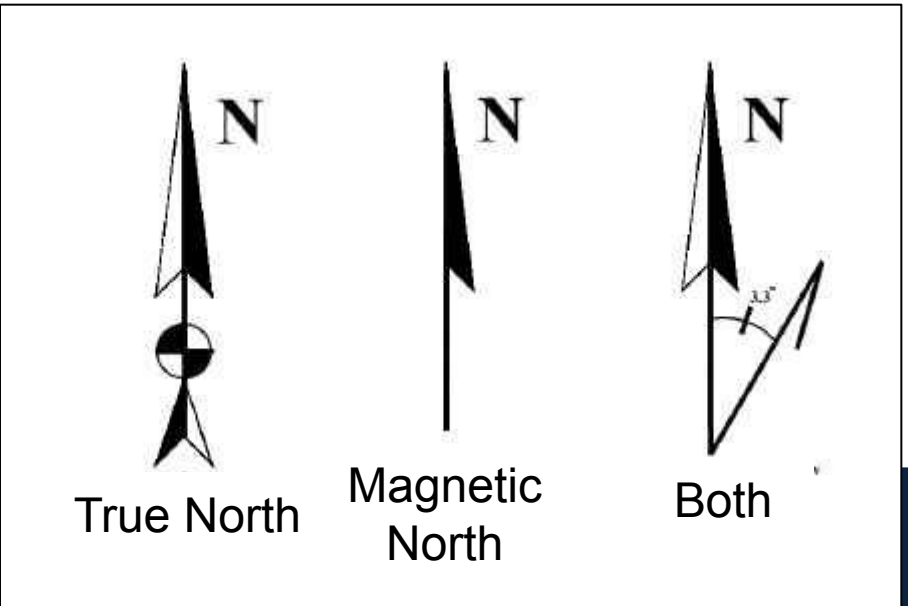
- Avoid clutter
  - Use as few layers as possible to make your point
  - Use size, color, shape to distinguish important elements
  - Polygons especially need to have clear boundaries
  - Try to match colors and symbols to the items being represented
    - Water should be blue
    - Though it you are distinguishing between visually similar things (e.g. crows and ravens) use more abstract symbols
- Use standard color ramps
  - Elevation, slope, aspect, etc.

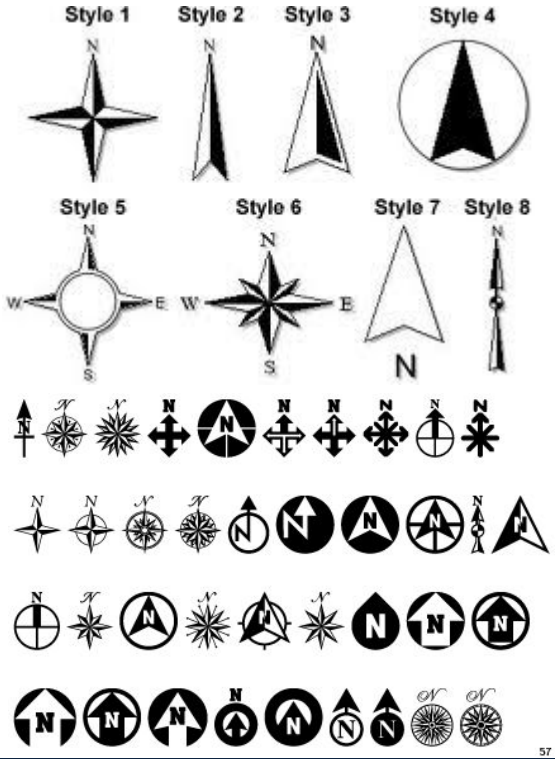
Necessary components of a good map

North Arrow

- Orients the map
  - North is customarily the top of the map
  - Form has some conventions
  - Not strongly enforced







Sample of ArcGIS North Arrows

Other elements

- **Coordinates / Tic Marks**
  - Indicates the location of geographic coordinates
- **Inset Maps**
  - Shows the area of interest within a broader context
- **Tables, charts, etc**
  - Used to present information not on the map

3 Types of Coordinates

Reference Grid

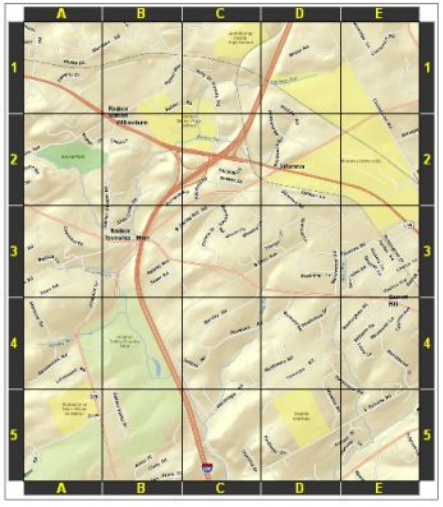
Divided into zones

Graticule

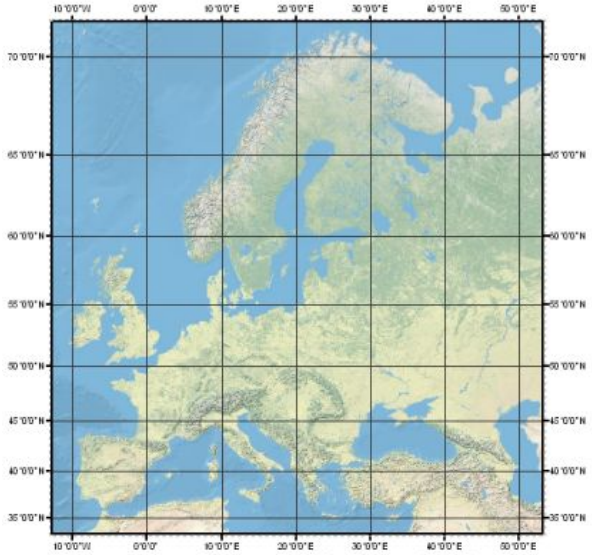
Divided based on Lat / Long

Measured Grid

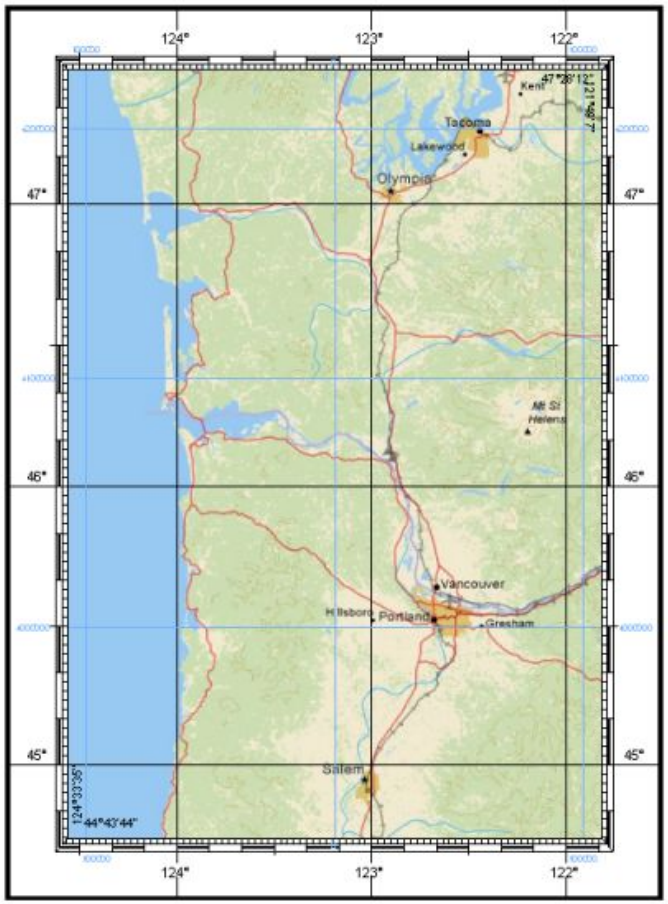
Divided based on a projected grid



Reference Grid

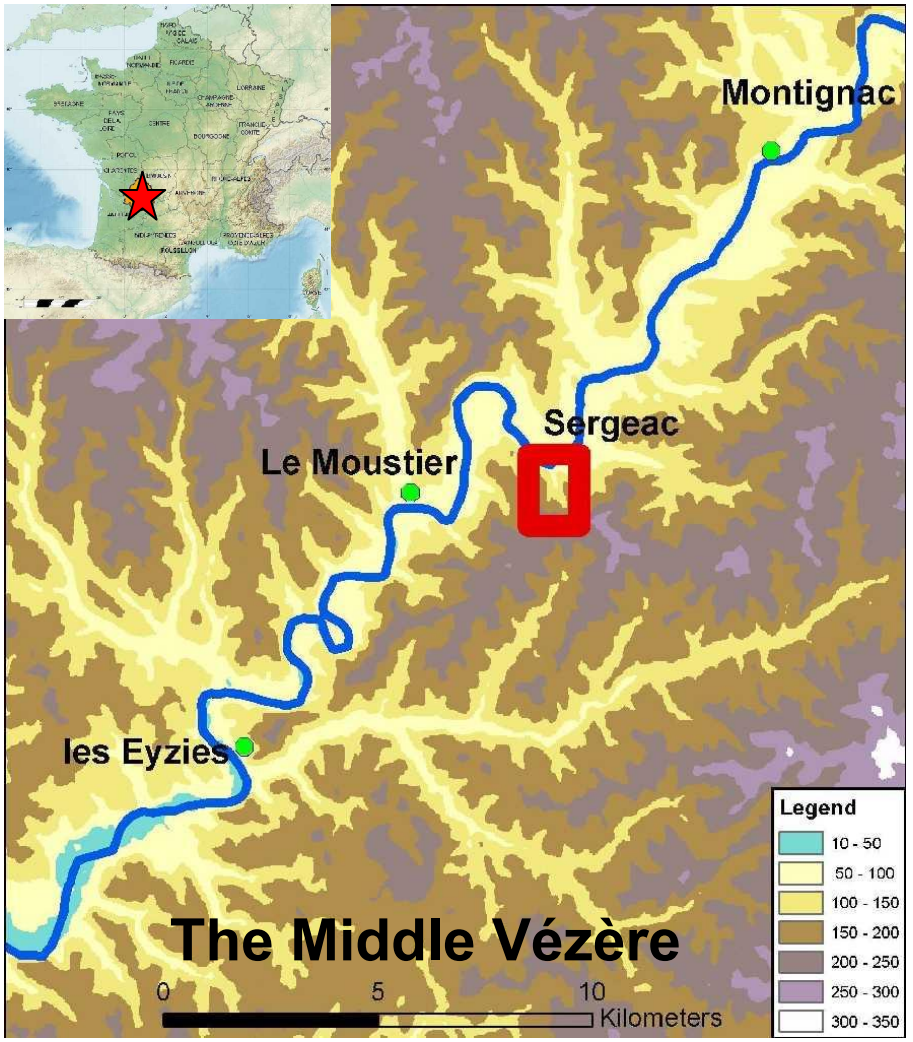


Graticules



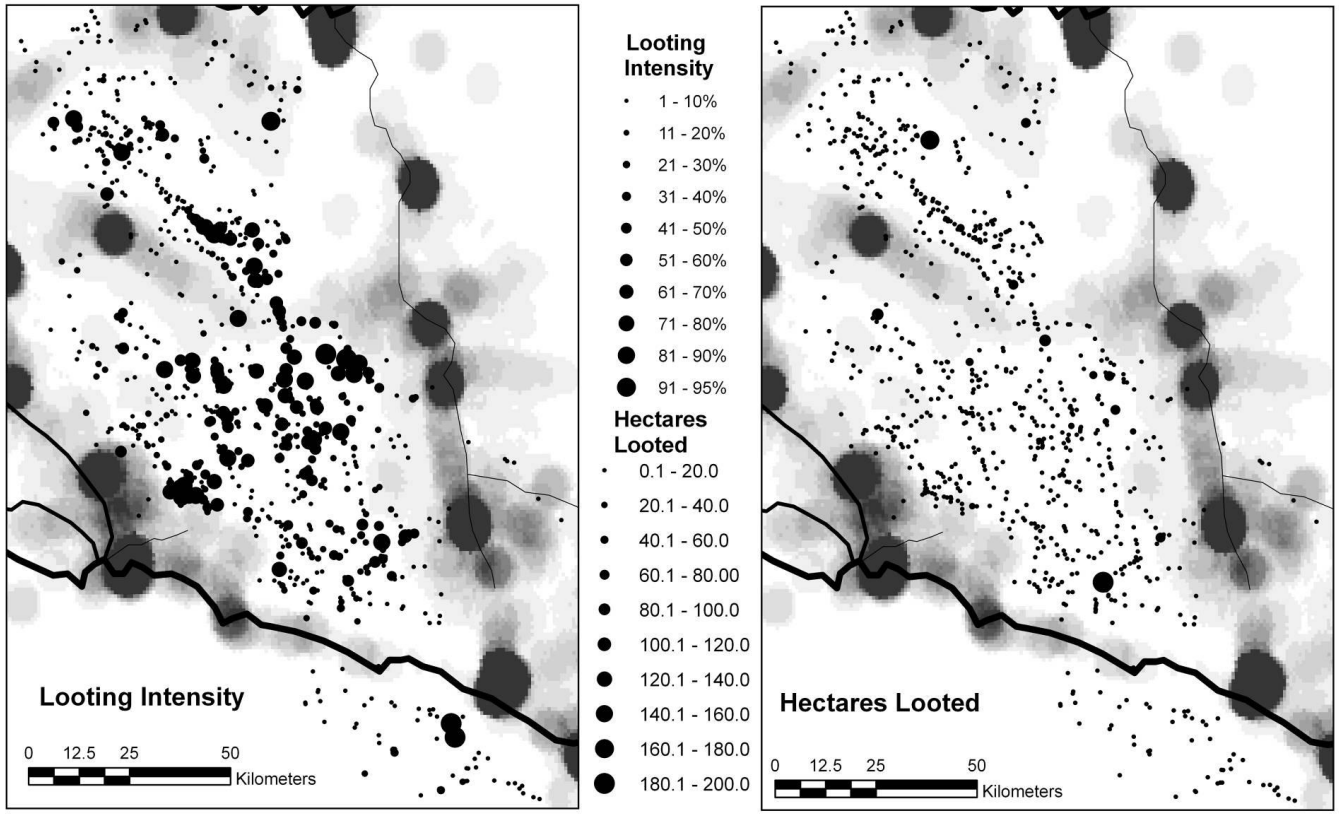
Map insets

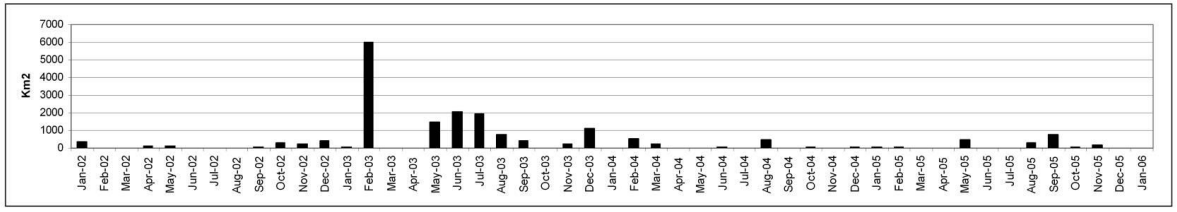
Detail of important area



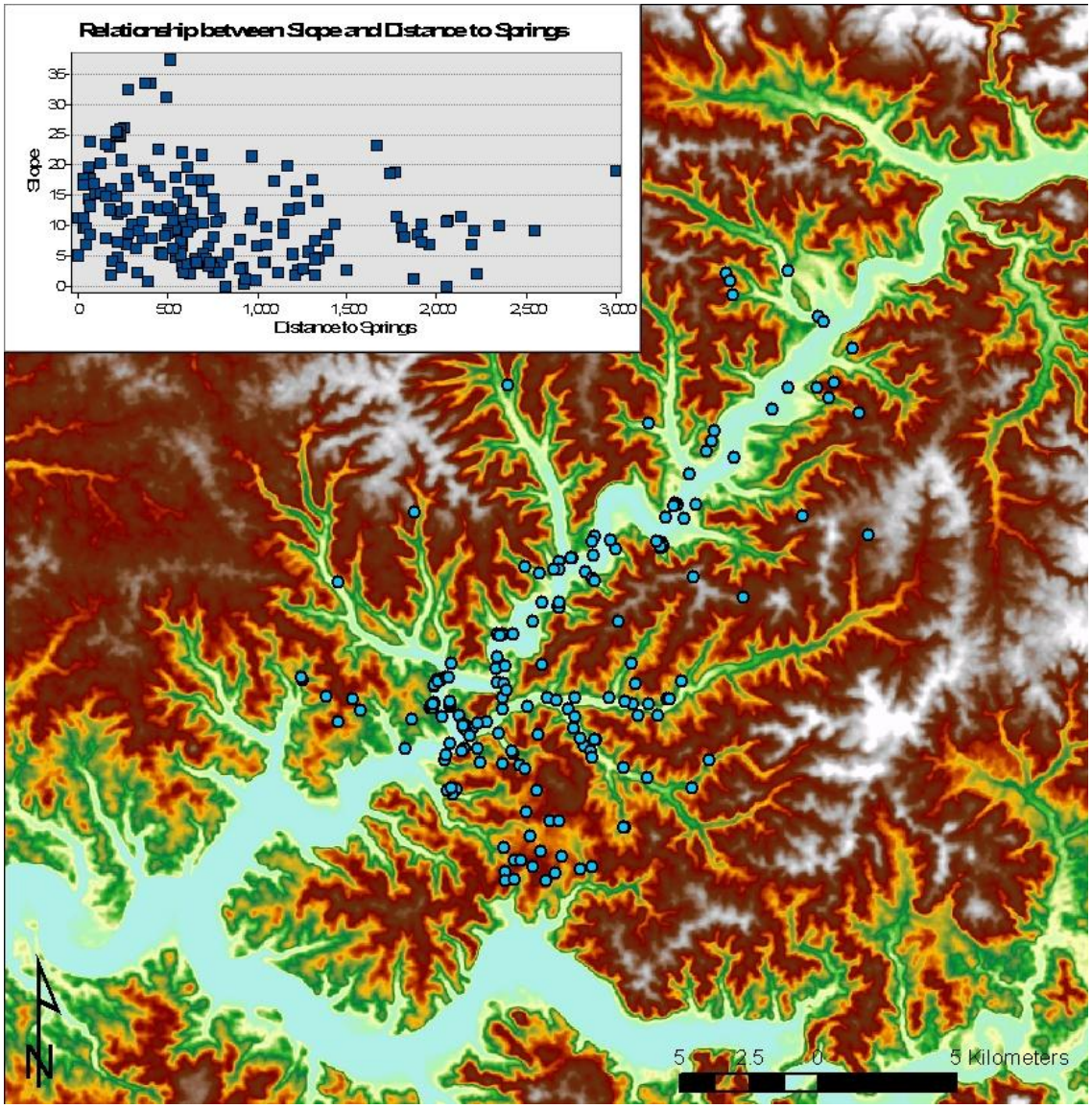
Broader location

Tables and charts



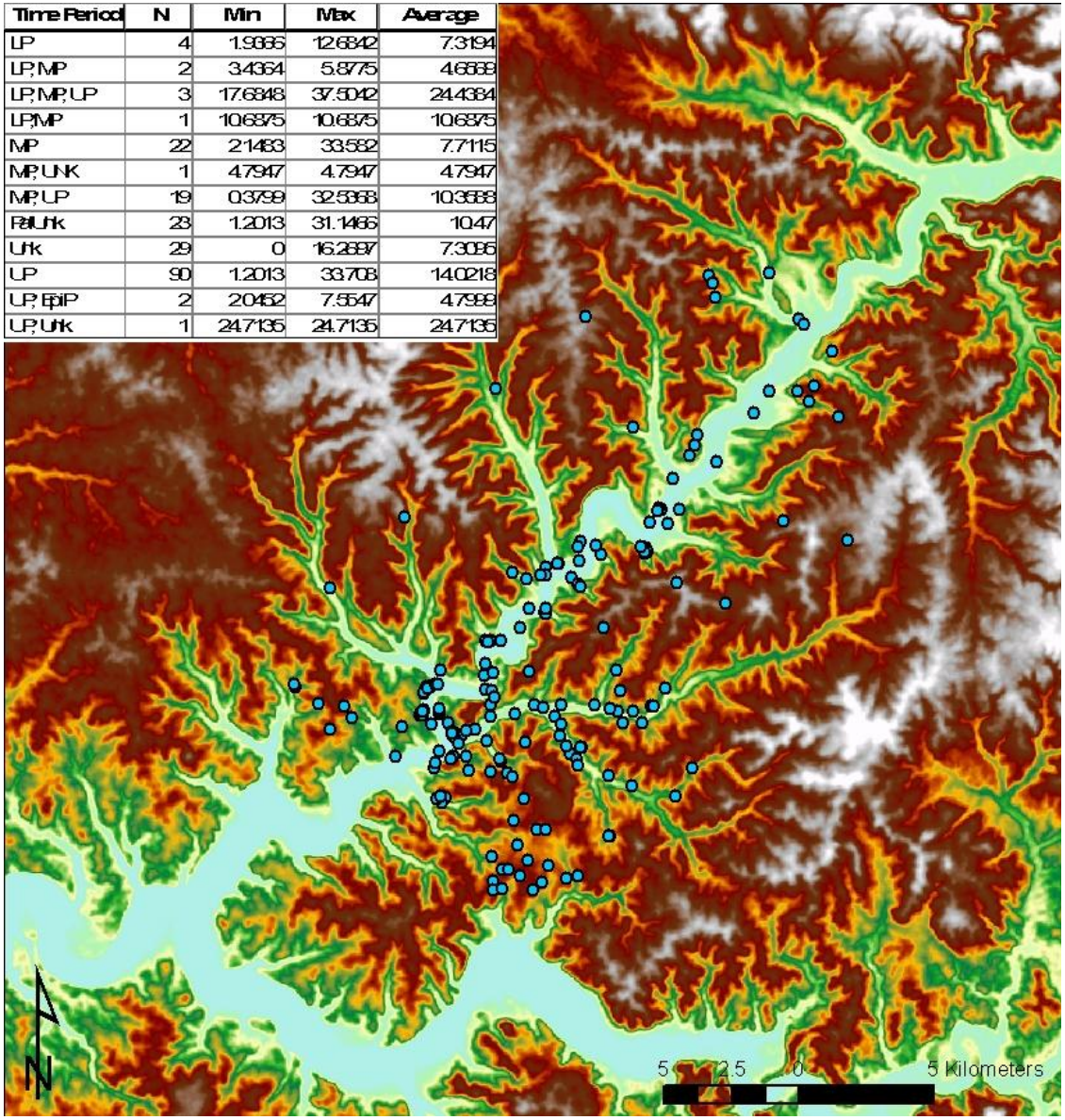


Tables and charts



Tables and charts

Time Period	N	Min	Max	Average
LP	4	1.9665	12.6842	7.3194
LP; MP	2	3.4364	5.8775	4.6569
LP; MP; LP	3	17.6848	37.5042	24.4384
LP; MP	1	10.6875	10.6875	10.6875
MP	22	2.1483	33.582	7.7115
MP; UNK	1	4.7947	4.7947	4.7947
MP; UP	19	0.3799	32.5868	10.3668
PalUnk	23	1.2013	31.1466	10.47
Unk	29	0	16.2897	7.3095
UP	90	1.2013	33.708	14.0218
UP; EpiP	2	2.0452	7.5547	4.7999
UP; Unk	1	24.7135	24.7135	24.7135



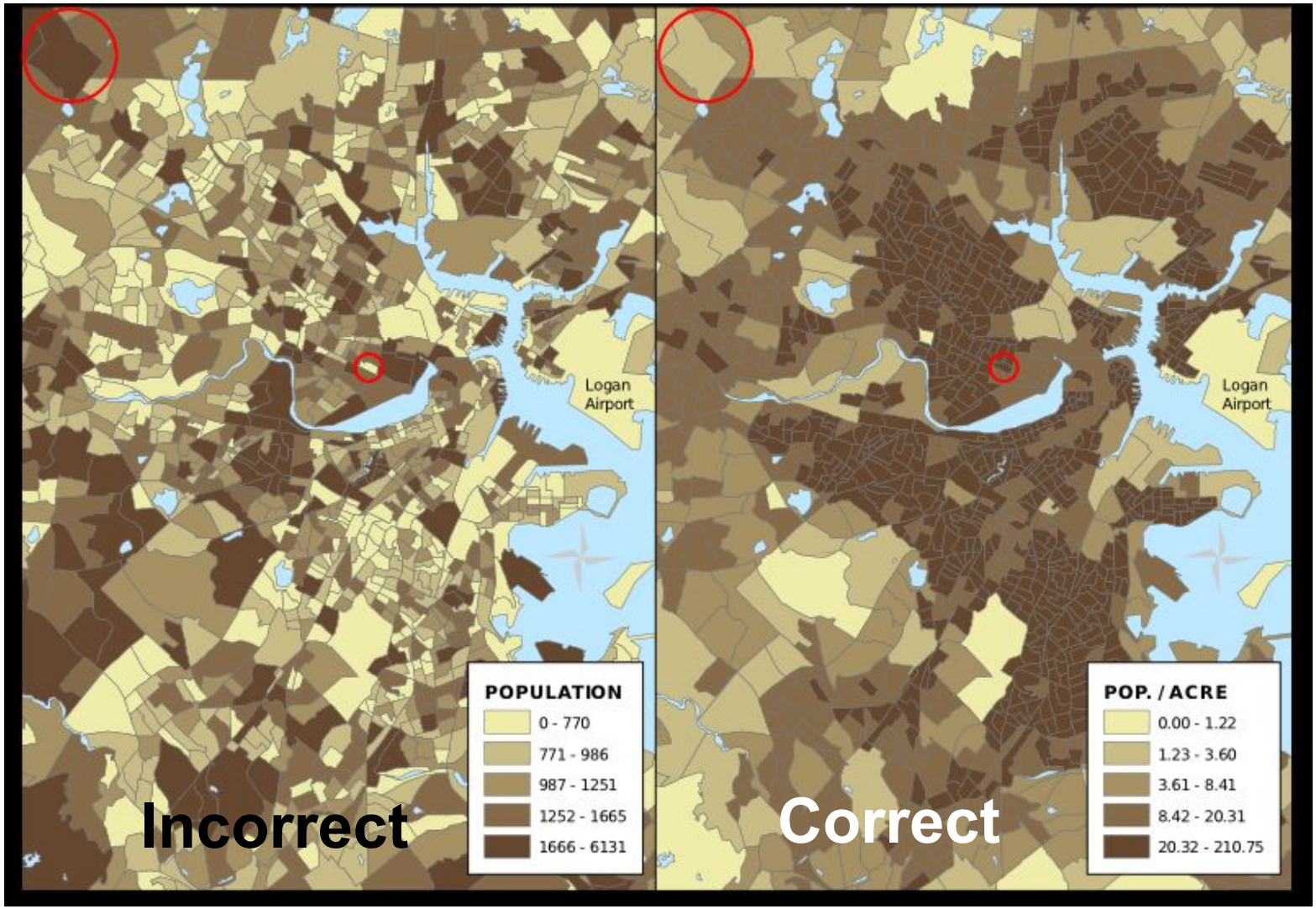
Adapt the map to your audience

- General
  - Everything should be annotated
    - Legends, scale, north arrow
- Publications / Reports
  - Grayscale is usually better than color
  - Everything should be annotated
    - Legends, scale, north arrow
- Presentations
  - Keep it simple. Clutter makes it difficult to interpret
  - Choose high-contrast colors
  - Black backgrounds work well

Choropleth Maps

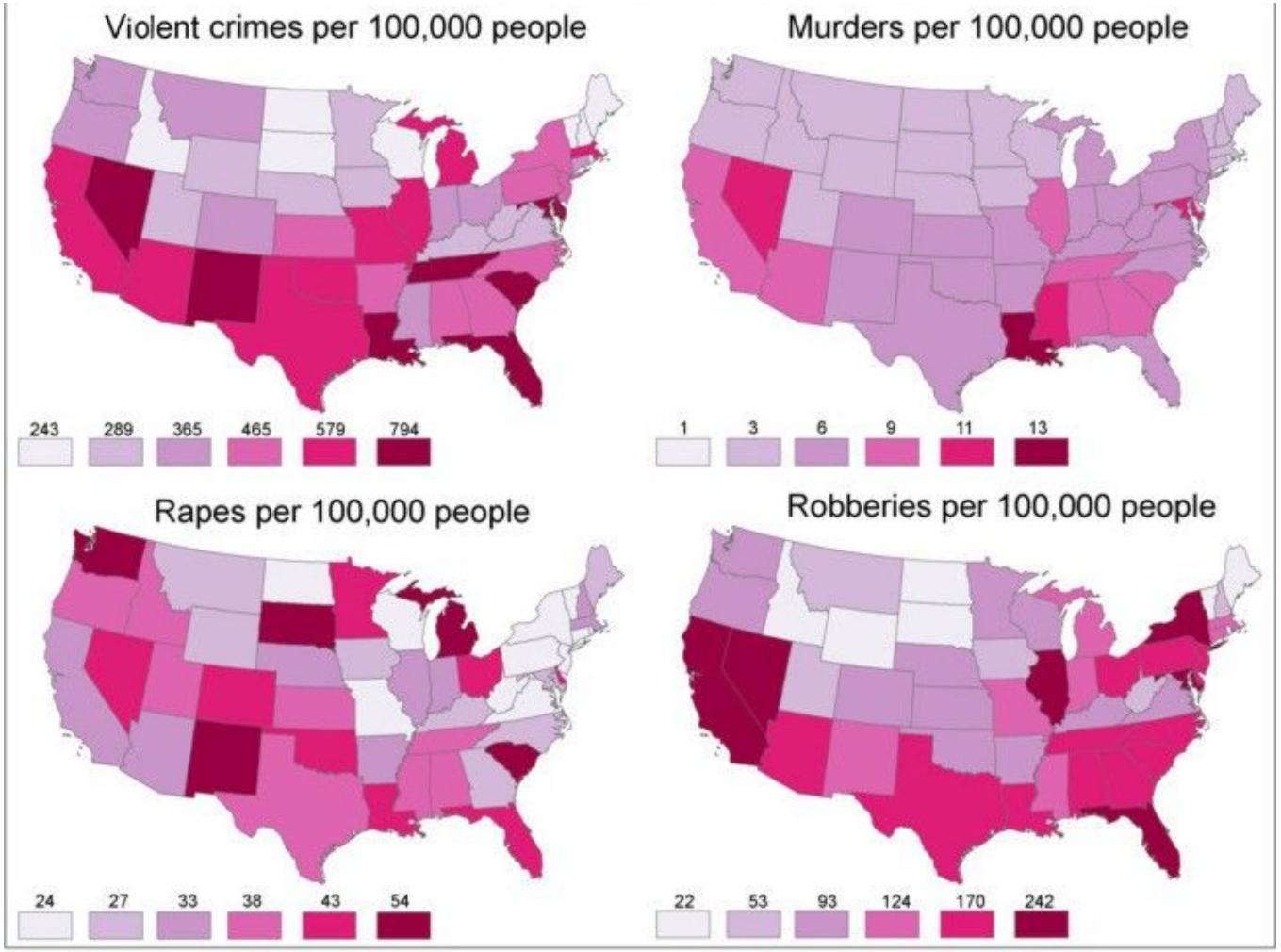
- Thematic maps with areas shaded or patterned in proportion to a measurement
  - e.g. population density or per-capita income.
- Not just a total value but standardized to some unit
  - e.g. population vs. population density
- An easy visualization of how the measurement varies spatially
- Can highlight the level of variability within a region.

Example: Choropleth Maps



Population density per census block

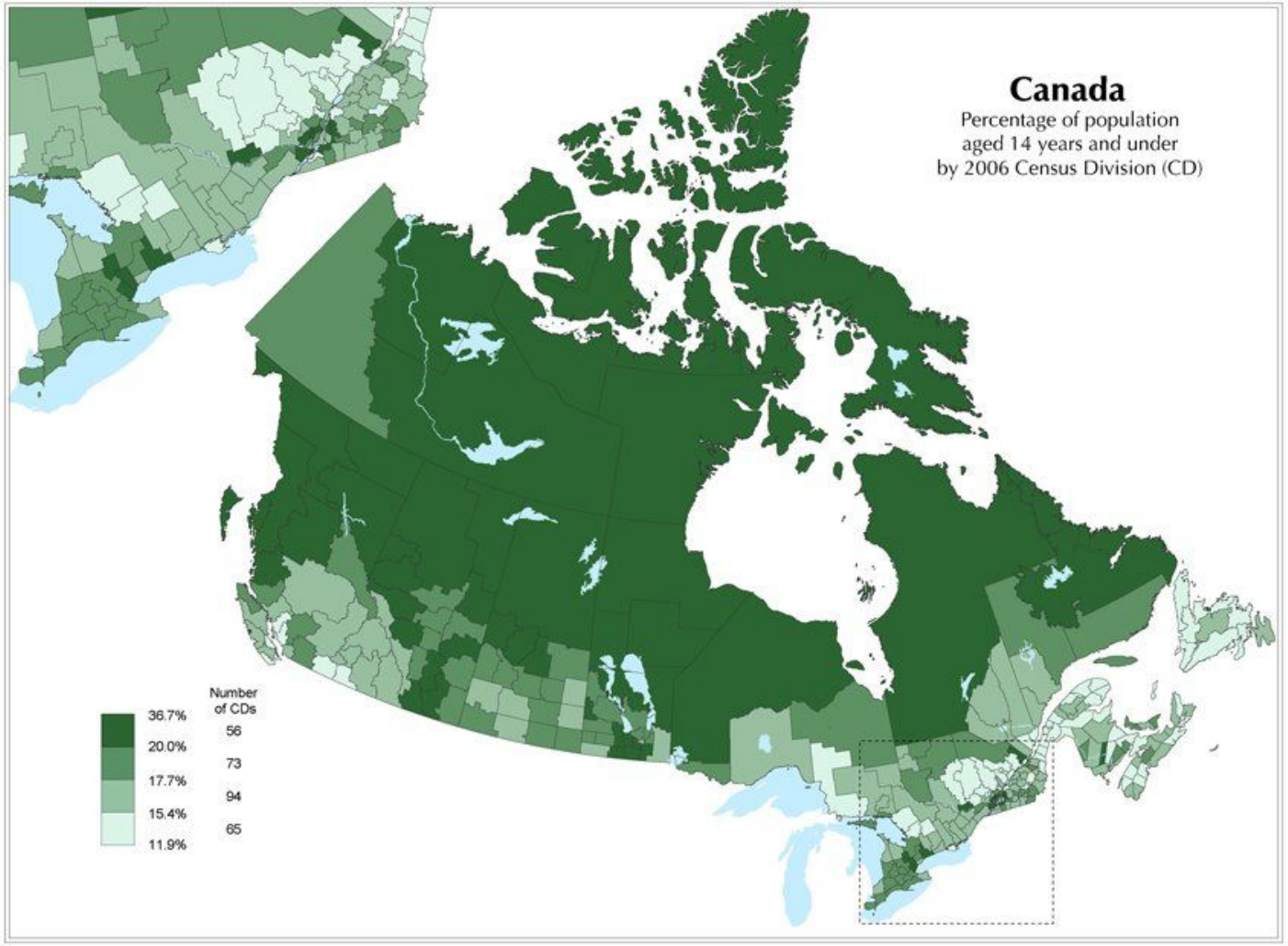
Example: Choropleth Maps



Source: Crime in the United States, 2003, FBI, Uniform Crime Reports

Crime rates by state

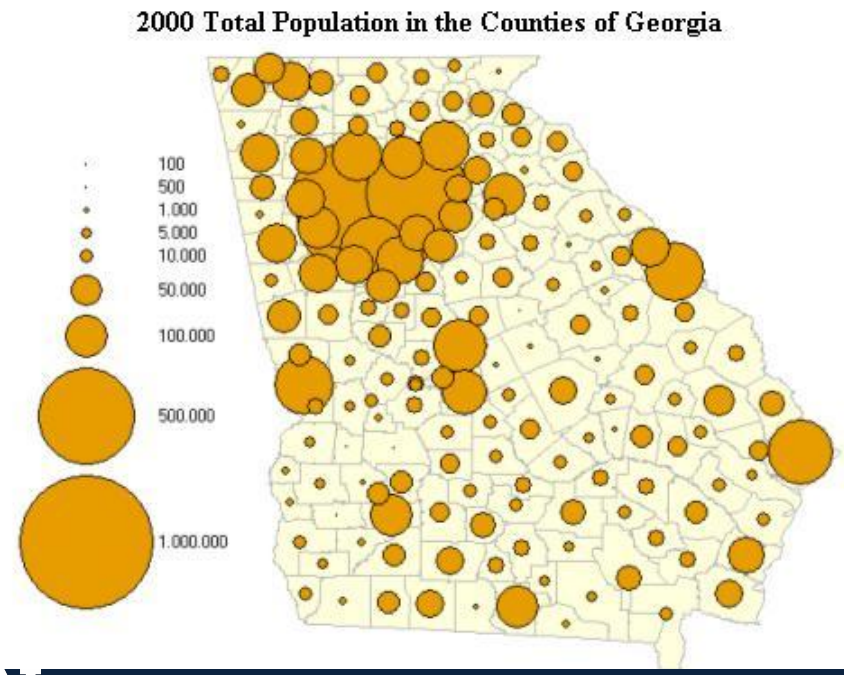
Example: Choropleth Maps

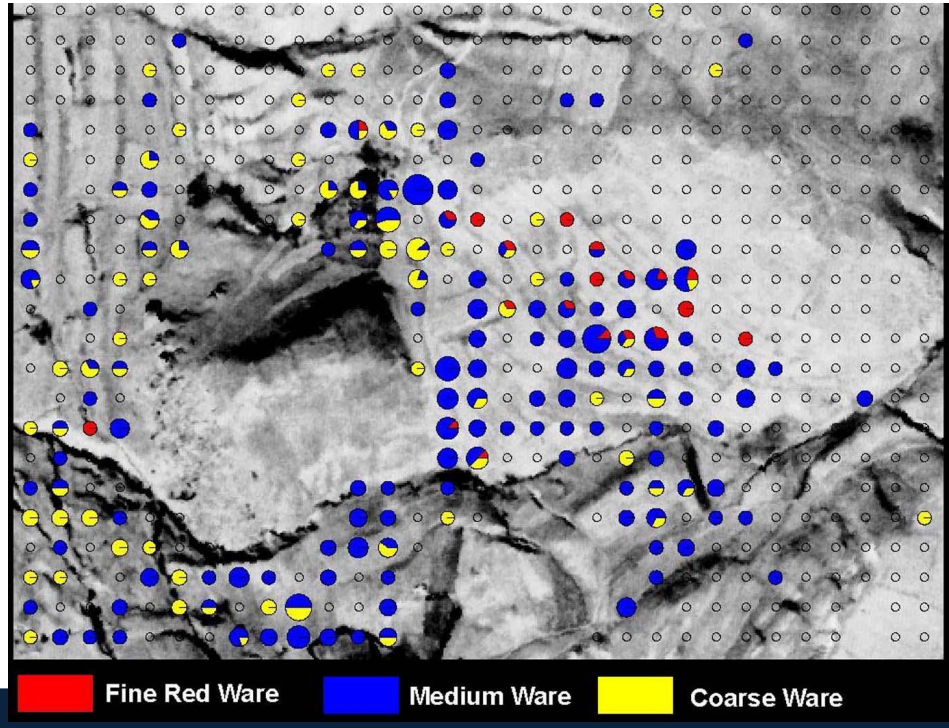


Water use by area

Proportional Symbols

The size or nature of a symbol represents something about its measurements

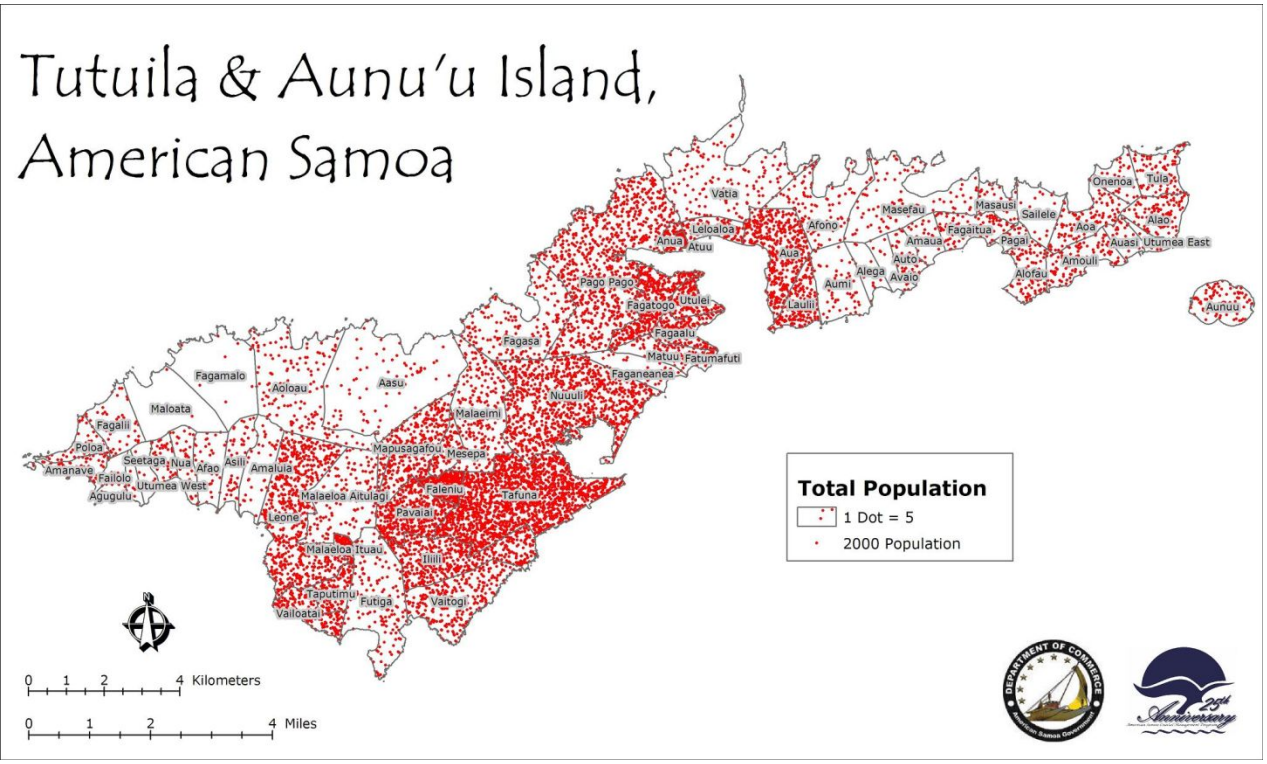


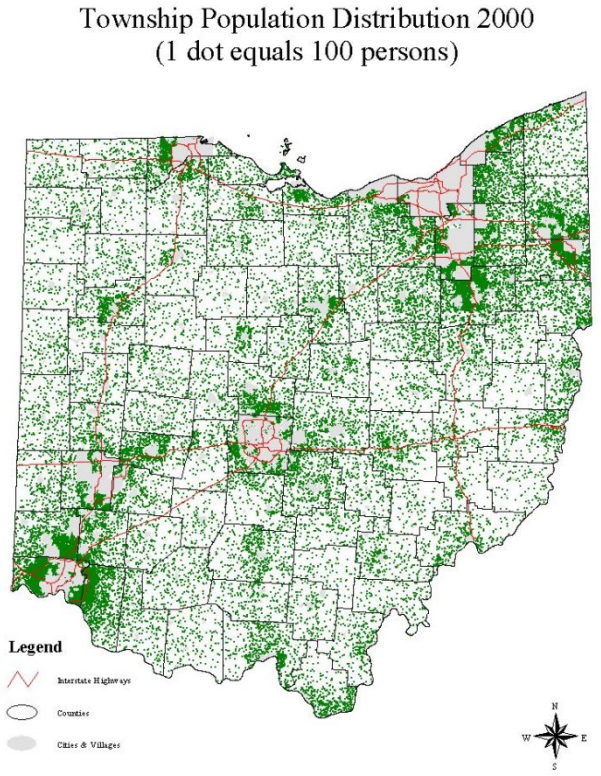


Dot density

- Presents spatial density information without hiding other data
- Each dot represents the same quantity (e.g. 500 people)
- Dots are randomly places within known boundaries (e.g. counties)
- Often used for population

Example: Dot density maps





Online Modules

- Beta version of modular sections from credit bearing class
  - https://libguides.library.nd.edu/gis