GIS Summer 2019 Cartography and Spatial Data Display

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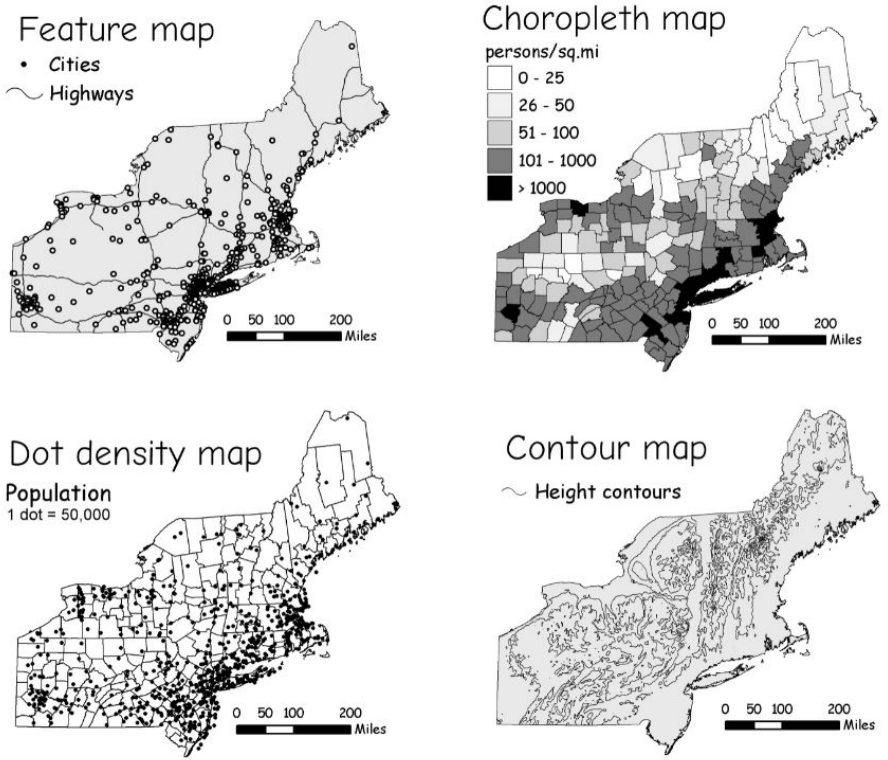
Cartography & Spatial Data Display

- Types of maps
- Spatial data layers
- Symbology
- Map design
- Demonstration
- Lab

Types of maps

- Location/Feature
- Qualitative
- Topographic maps
- Contour maps
- Thematic/Choropleth
- Density maps
- Proportional symbol
- Web maps



Source: GIS Fundamentals by P. Bolstad, 2015

Scale Discussion

Scale is used in several contexts ...

- **Spatial Resolution**: Level of spatial detail in data.
- **Geographic Extent** or scope of a project:
  - a large-scale project covers large area
  - a small-scale project covers a small area.
- **Map Scale**: The map's representative fraction (the ratio of distance on the map to the distance on the ground).
  - Large scale = Large ratio = Small extent
  - 1:1000 or 1:10,000,000
- Clear as mud?

Map Scale Example

1:10,000,000 scale

1:34,000 scale

Source: https://mgimond.github.io/Spatial/introGIS.html

Maps: Spatial Analysis

- Six categories:
  - Understanding where
  - Measuring size, shape, and distribution
  - Determining how places are related
  - Finding the best locations and paths
  - Detecting and quantifying patterns
  - Making predictions

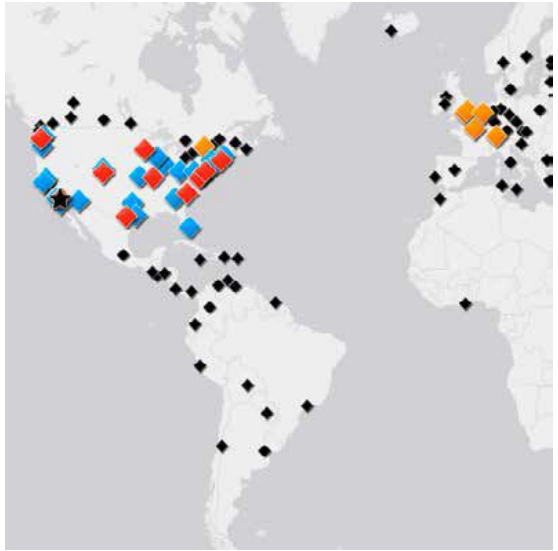
Understanding Where

If you don’t know where you are, you are lost

1. Understanding where things are
    - Location maps
2. Understanding where the variations and patterns in values are
    - Comparative maps
3. Understanding where and when things change

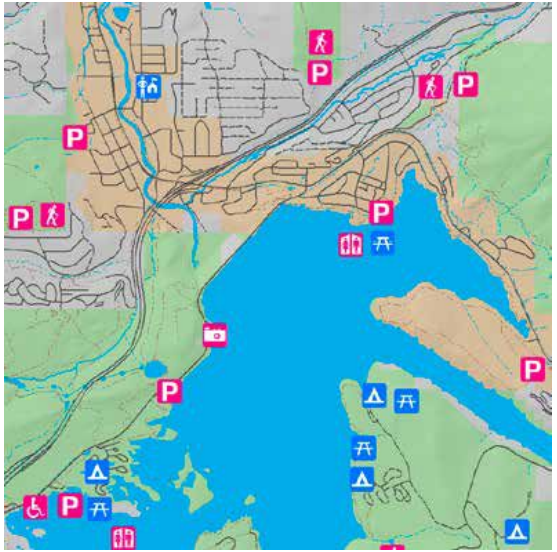
Understanding Where Things Are

Where are my offices?



Where are the delivery trucks?

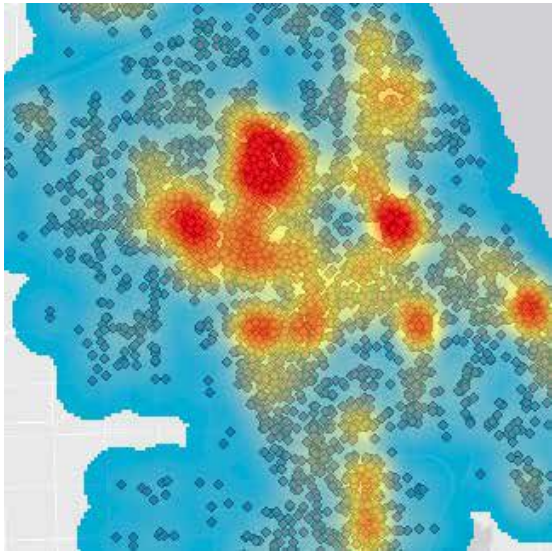
Where are the popular parks?



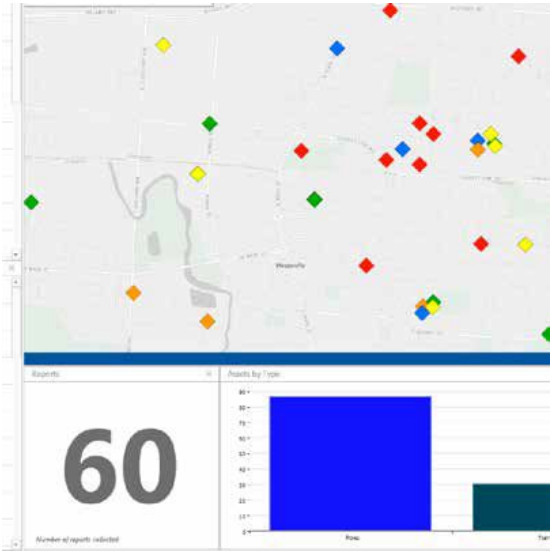
Understanding Variations and Patterns

Where are the highest levels?

Where are the high concentrations?



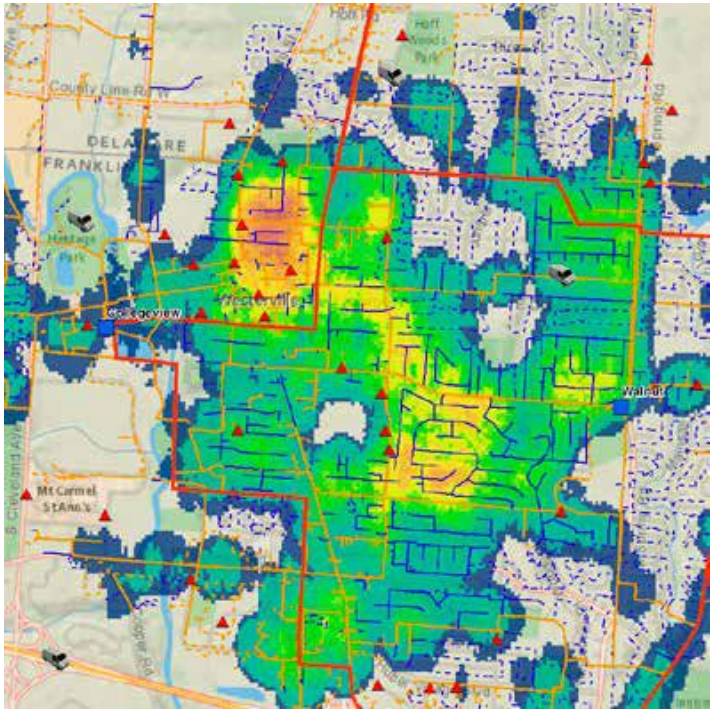
Where are the power outages?



Understanding Where Things Change

Where has the city grown?

How is weather affecting field crew safety?



Measuring size, shape, and distribution

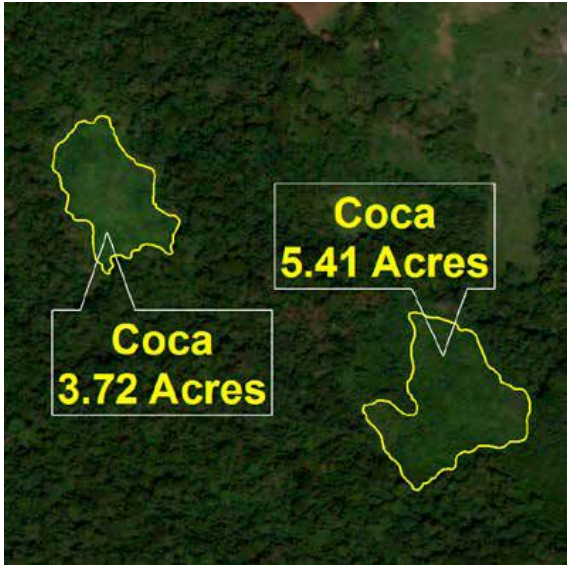
How large is the object? What is the area or length?

4. Calculating individual feature geometries

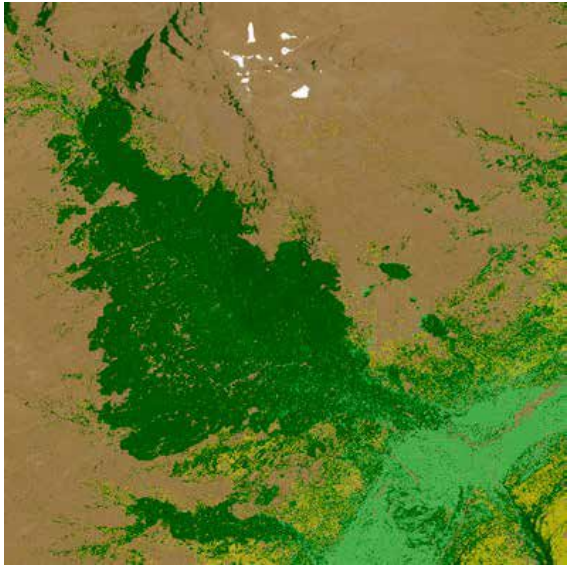
5. Calculating geometries and distributions of feature collections

Calculating individual feature geometries

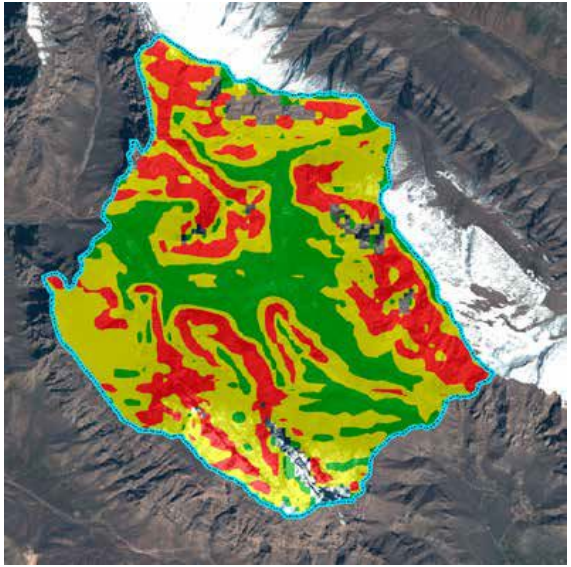
How large are the coca fields?



How many acres of forest?

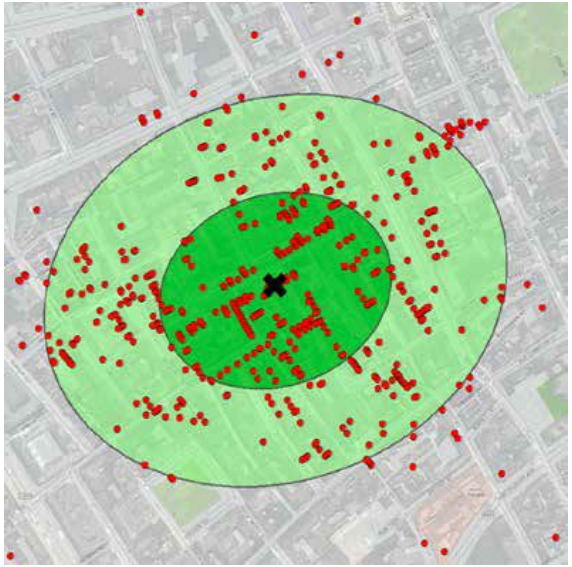


What is the slope of the terrain?

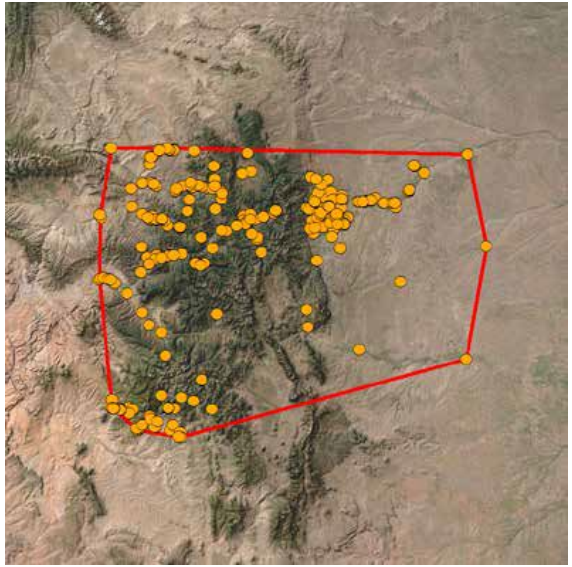


Calculating geometries and distribution

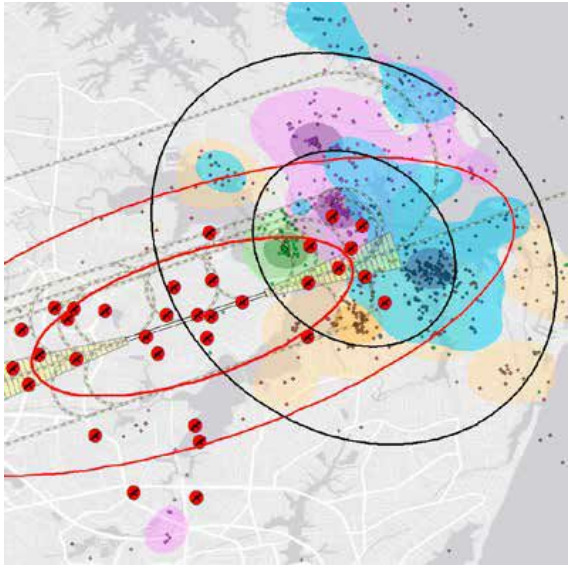
What is the center of the disease outbreak?



What is the extent of the eagle nests?



Are there directional trends in bird strikes?



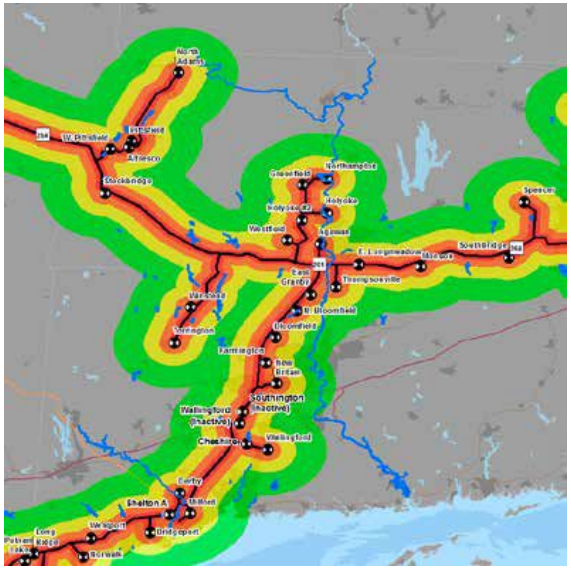
Determining how places are related

How are objects related in **both** time and space

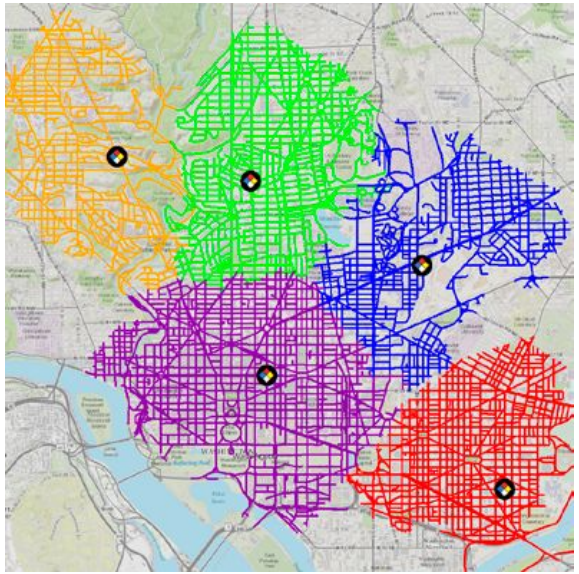
6. Determining what is nearby or coincident
7. Determining and summarizing what is within an area
8. Determining what is closest
9. Determining what is visible from a given location
10. Determining overlapping relationships in space and time

Determining what is nearby or coincident

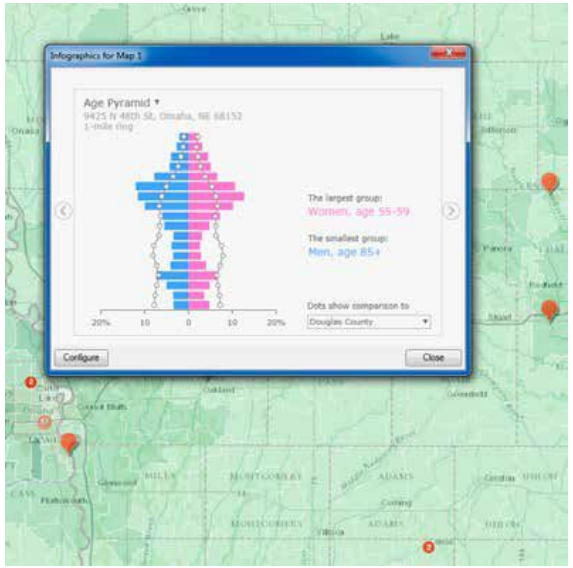
Which rivers are within 10 km of pipeline?



What locations are within driving distance?

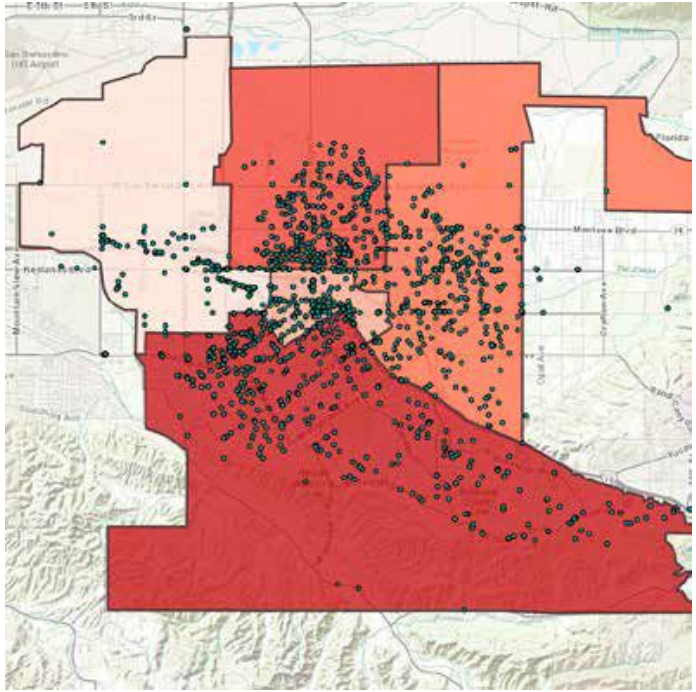


What are demographics around store?



Summarizing what is within an area

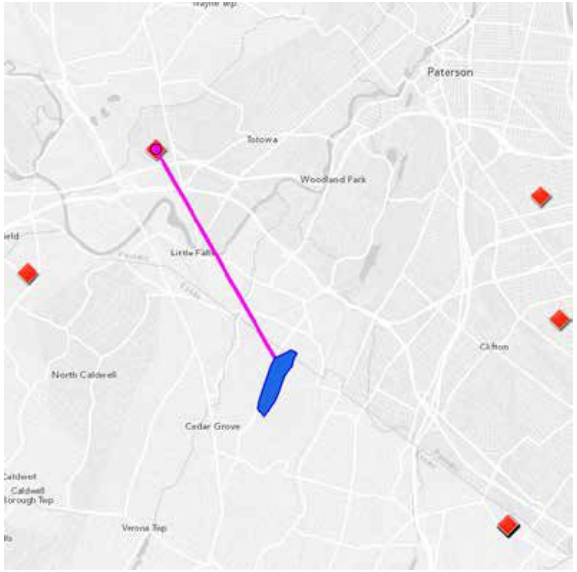
How many crimes in each police zone?



What is percent of parcel in flood plain?

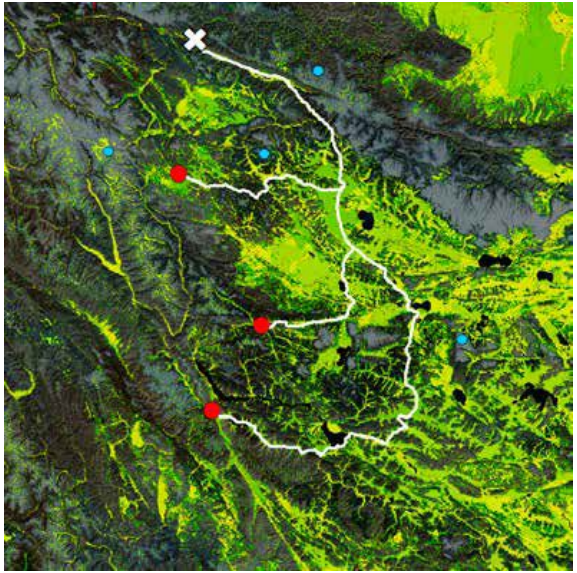
Determining what is closest

What is closest site to water reservoir?



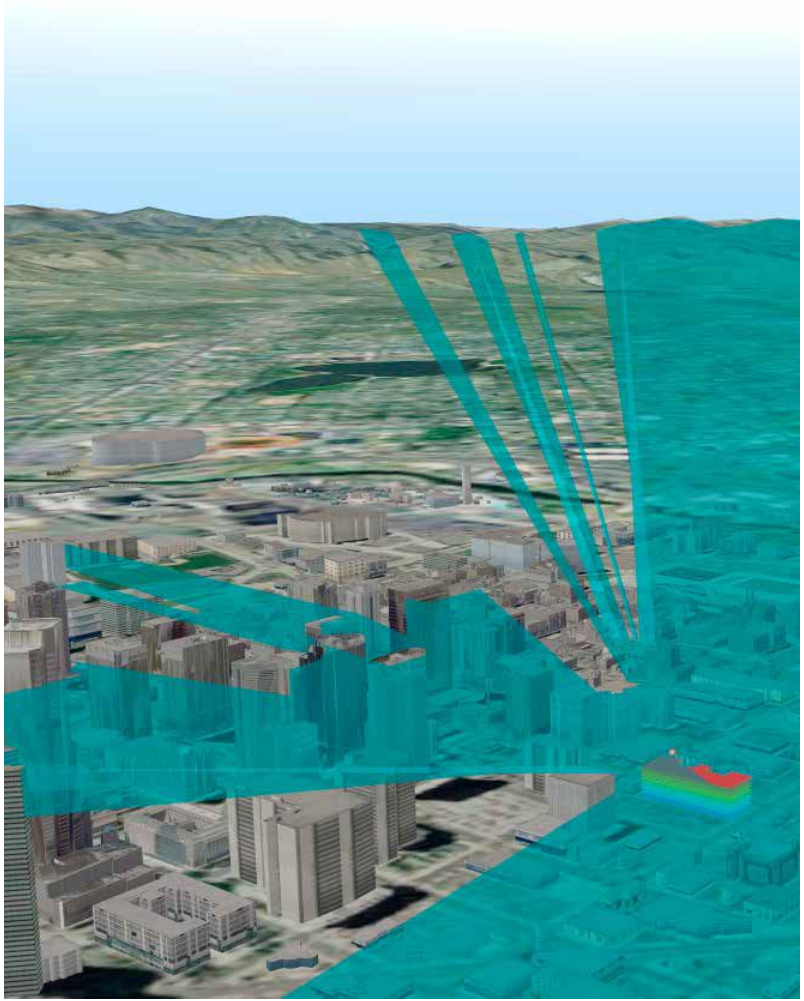
What are the three closest post offices?

Where are the three closest military units?



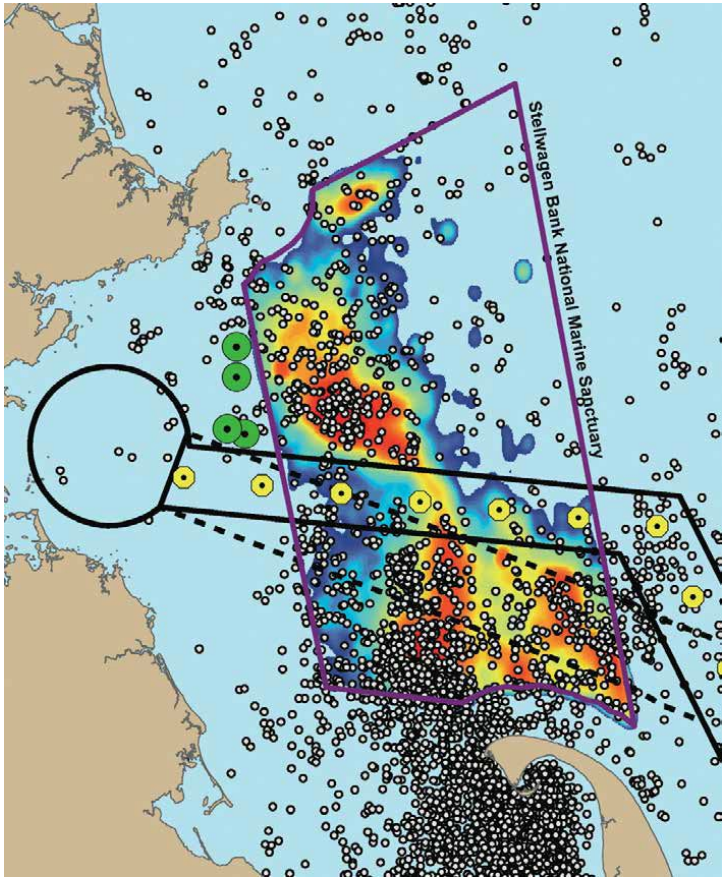
Determining what is visible from a location

What buildings have direct line of sight to a new radio tower?



Determining overlapping relationships in space and time

When and where will the whale migration paths intersect with maritime shipping routes?



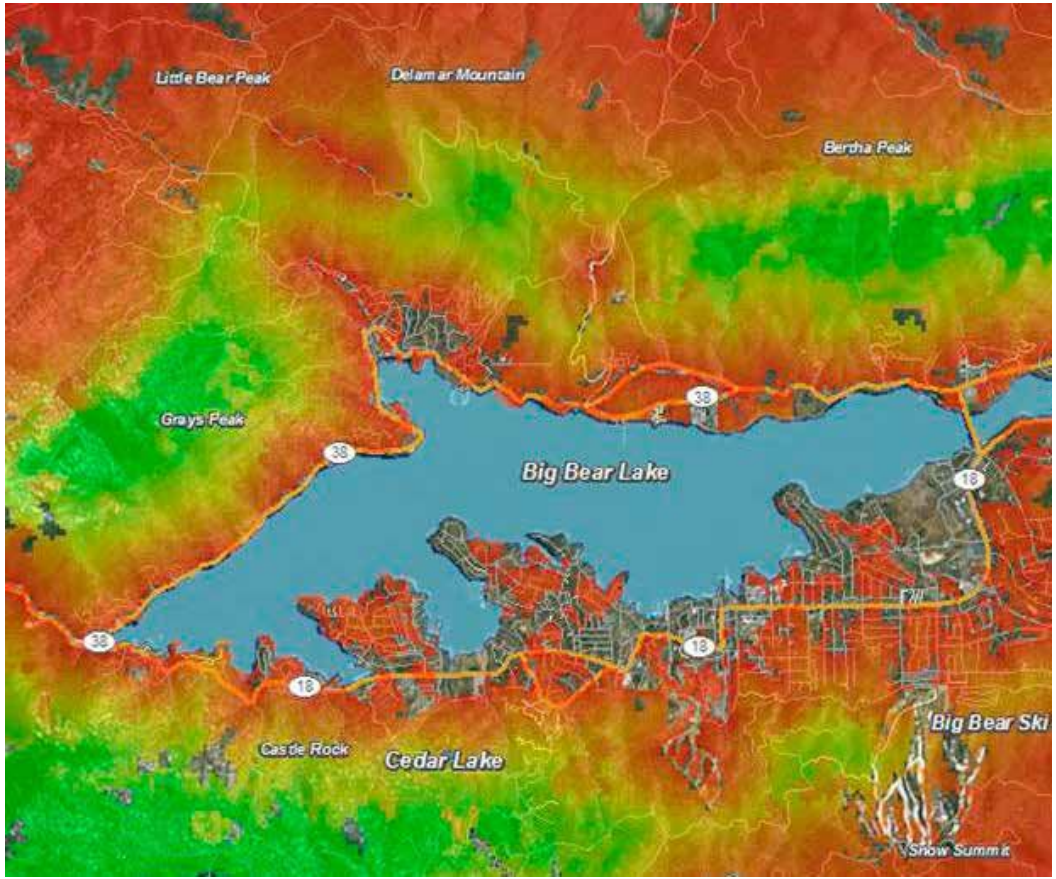
Finding the best locations and paths

Optimizing and finding the best of something

11. Finding the best locations that satisfy a set of criteria
12. Finding the best allocation of resources to areas
13. Finding the best route, path, or flow along network
14. Finding the best route, path, or corridor across terrain
15. Finding the best supply locations given known demand and travel network

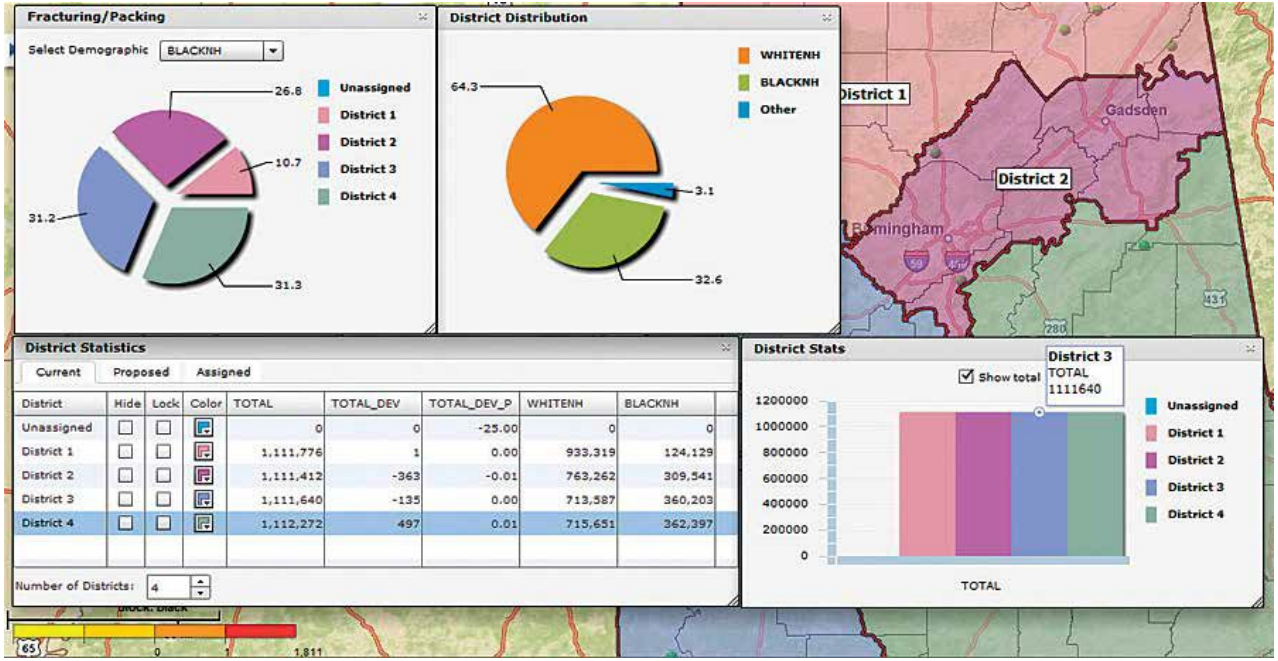
Finding the best locations that satisfy a set of criteria

Where is the best location to create a new wildfire conservation area?



Finding the best allocation of resources to geographic areas

Where should boundaries for sales territories be placed so that sales staff and opportunities are balanced?

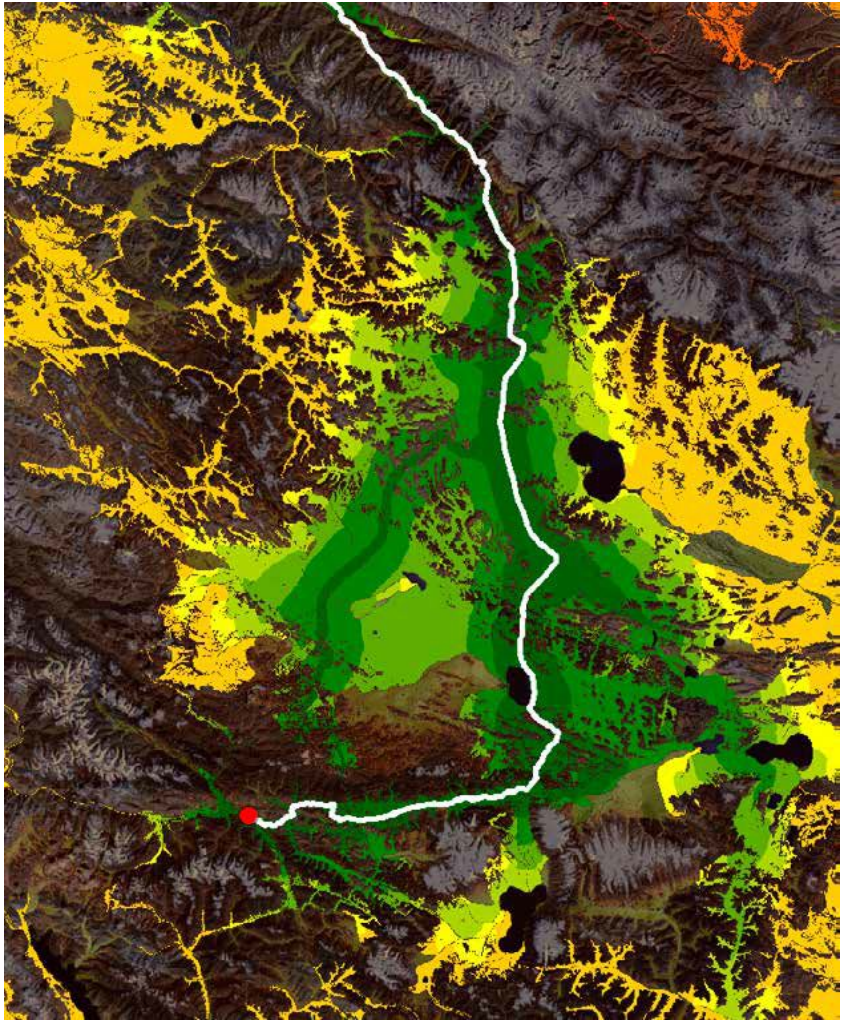


Finding the best route, path, or flow along a network

How will water flow through a sewer network?

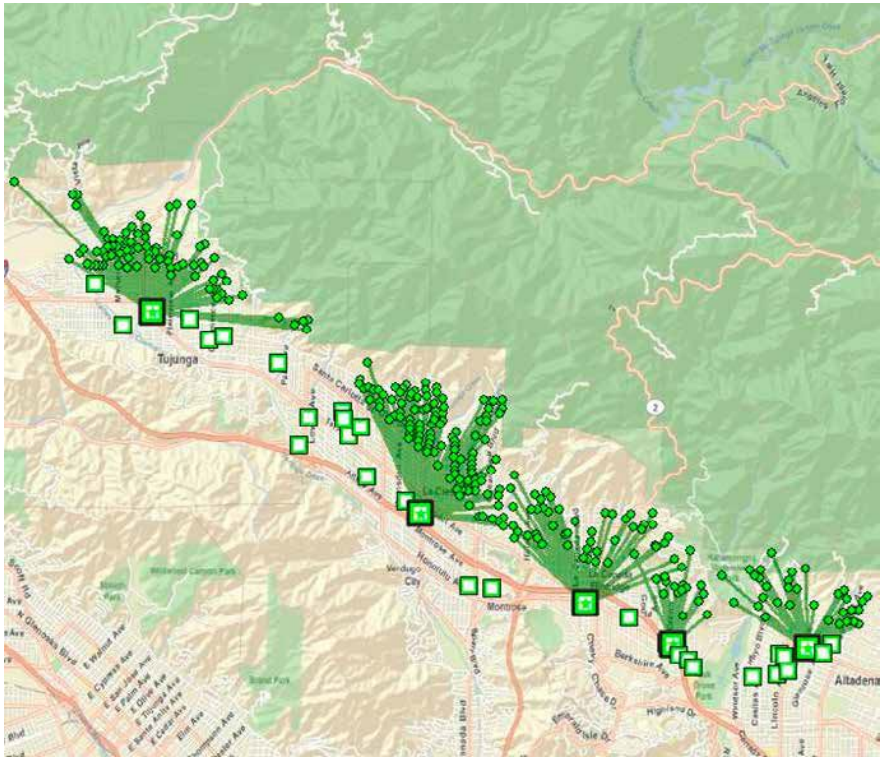
Finding the best route, path, or flow along a network

What is the best route to build a pipeline across a region?



Finding the best supply locations given known demand and a travel network

What is the best location for wildfire evacuation centers?



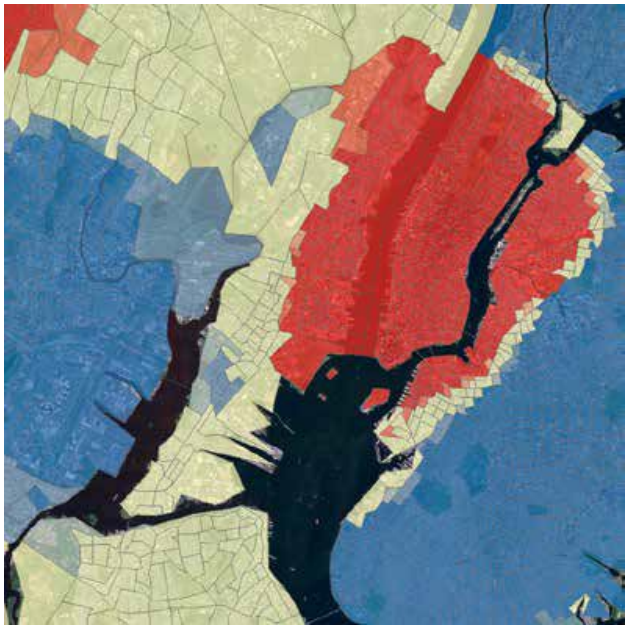
Detecting and quantifying patterns

Go beyond visualization

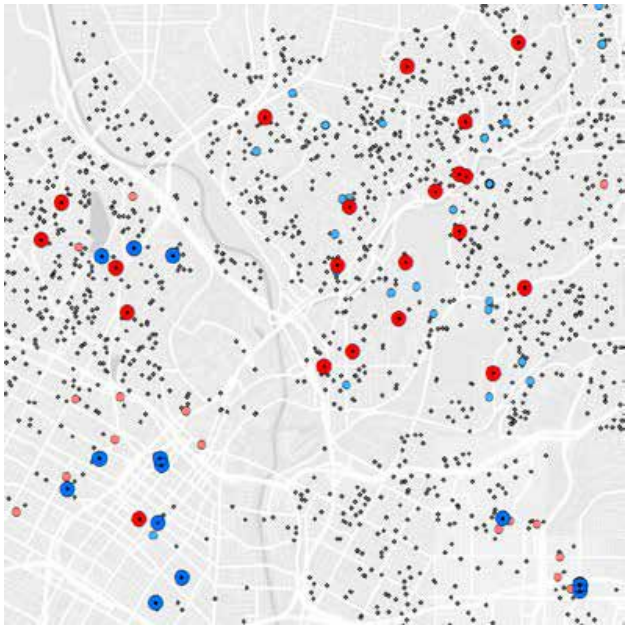
16. Where are the significant hot spots, anomalies, and outliers?
17. What are the local, regional, and global spatial trends?
18. Which features/pixels are similar, and how can they be grouped together?
19. Are spatial patterns changing over time?

Where are the significant hot spots, anomalies, and outliers?

Where are hot spots of cancer deaths?

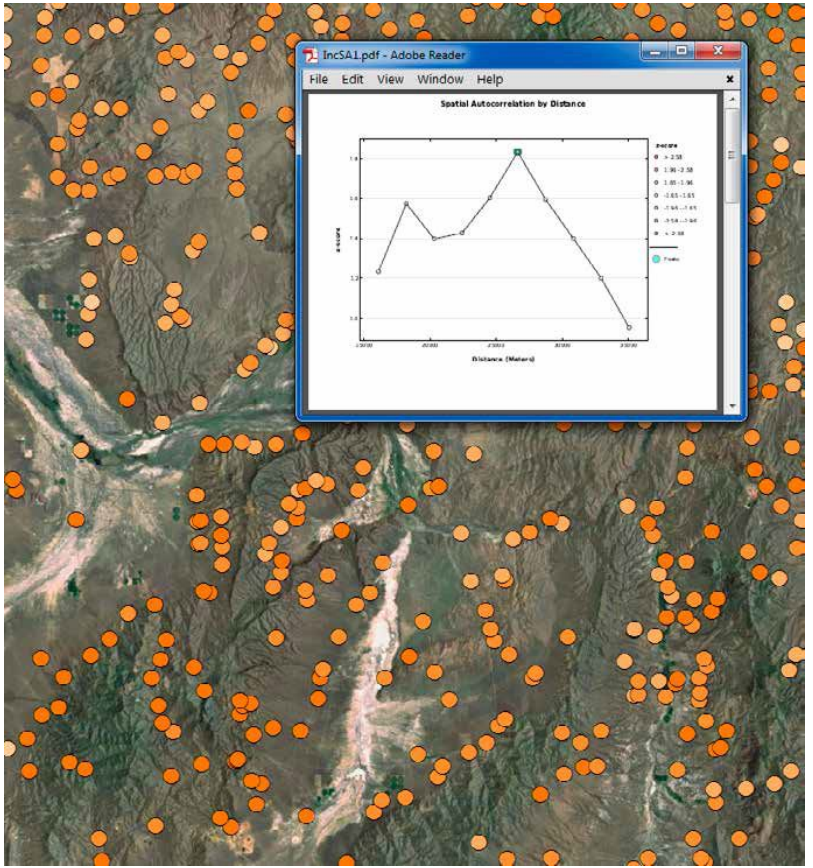


Where are homes being sold at higher prices?



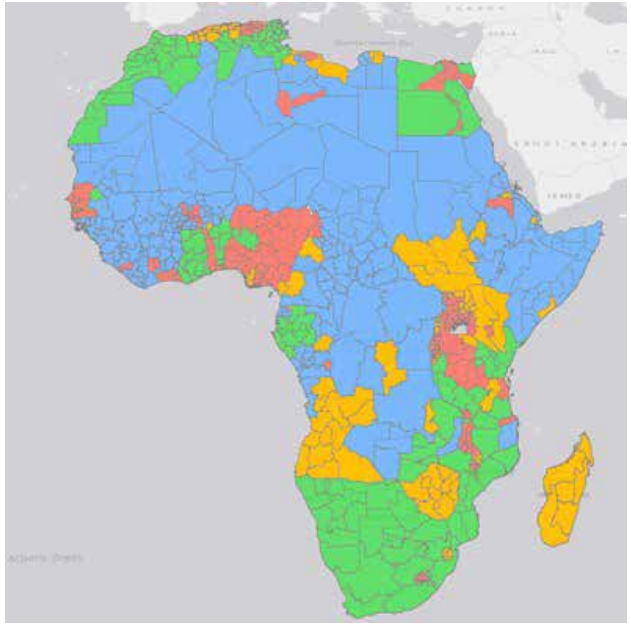
What are the local, regional, and global spatial trends?

How does the clustering of gold concentrations vary from local city , to the state, to the world?

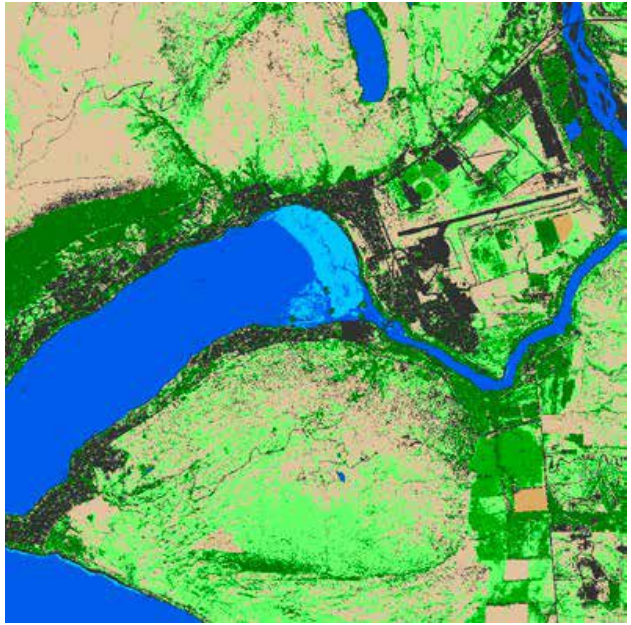


Which features/pixels are similar, and how can they be grouped together?

What areas have similar vulnerabilities based on climate?

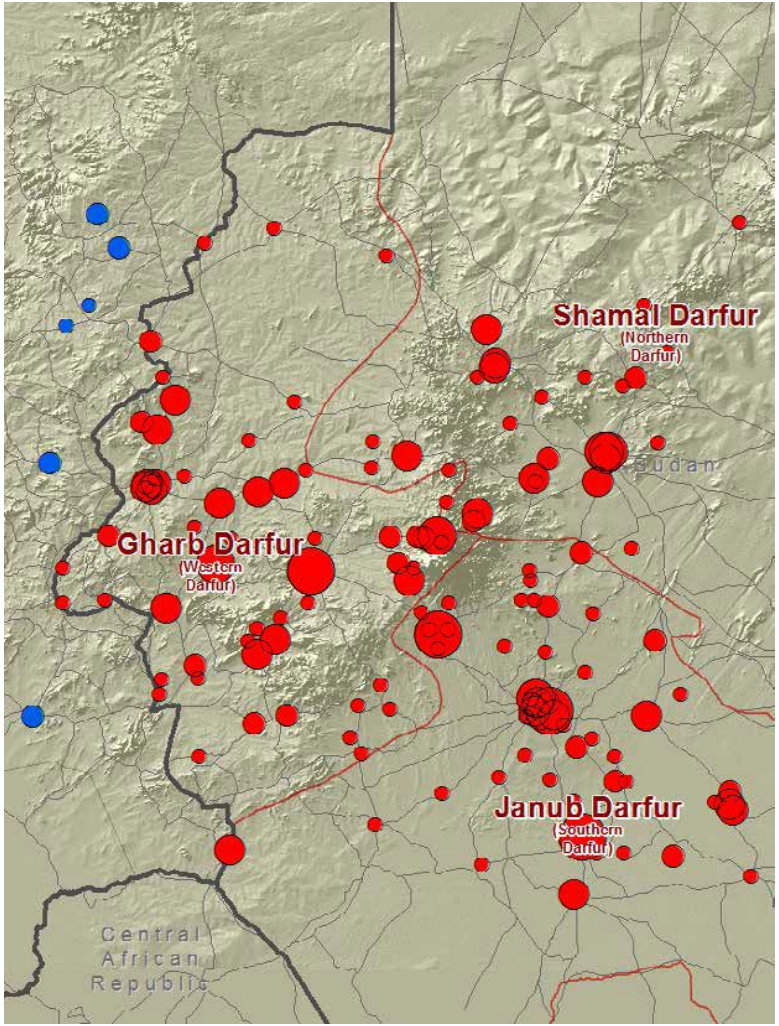


Using satellite imagery, what areas have similar land-cover?



Are spatial patterns changing over time?

Are rich and poor communities becoming more or less clustered over time?



Making predictions

Use powerful modeling techniques to aid understanding

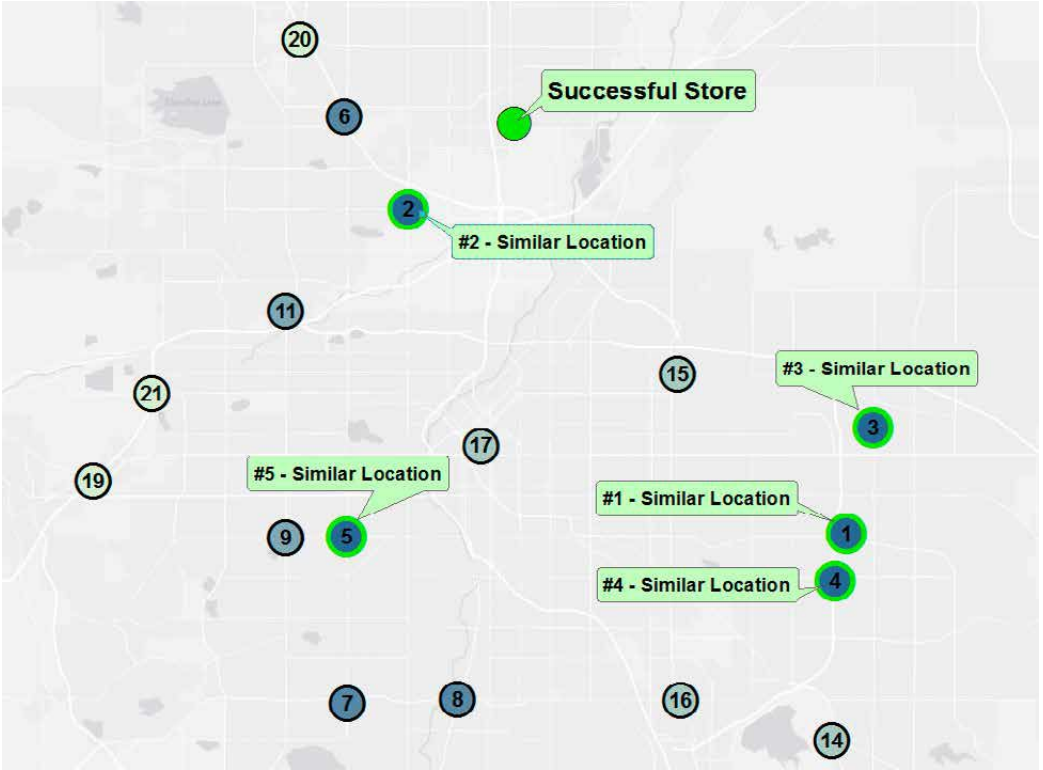
20. Given a success case, identifying, ranking, and predicting similar locations
21. Finding the factors that explain observed spatial patterns and making predictions
22. Interpolating a continuous surface and trends from discrete sample observations

Making predictions (continued)

23. Predicting how and where objects spatially interact (attraction and decay)
24. Predicting how and where objects affect wave propagation
25. Predicting where phenomena will move, flow,or spread
26. Predicting what-if

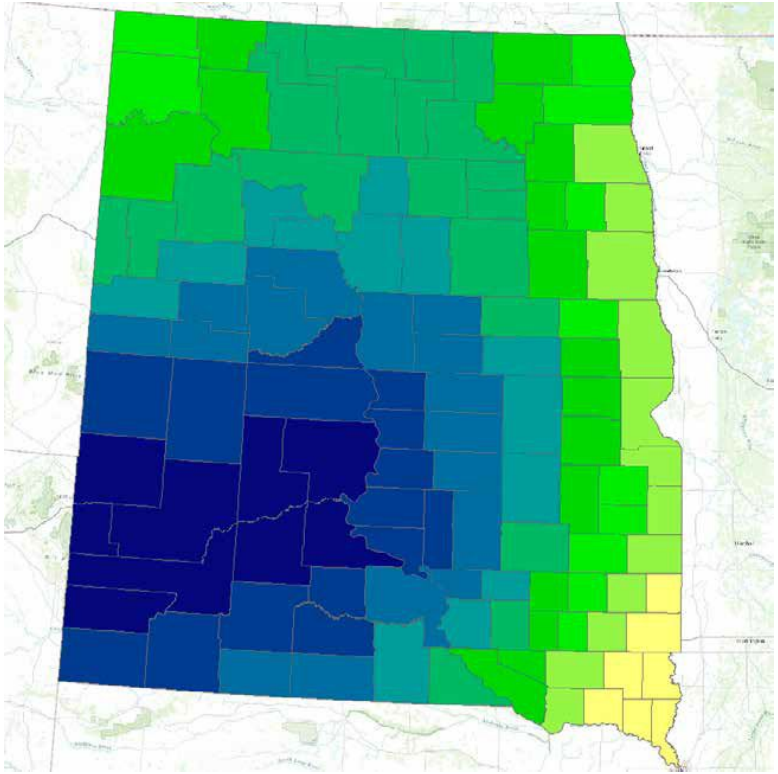
Given a success case, identifying, ranking, and predicting similar locations?

Given a successful store location, how would potential locations for a new store rank based on population, demographics, and market potentials?



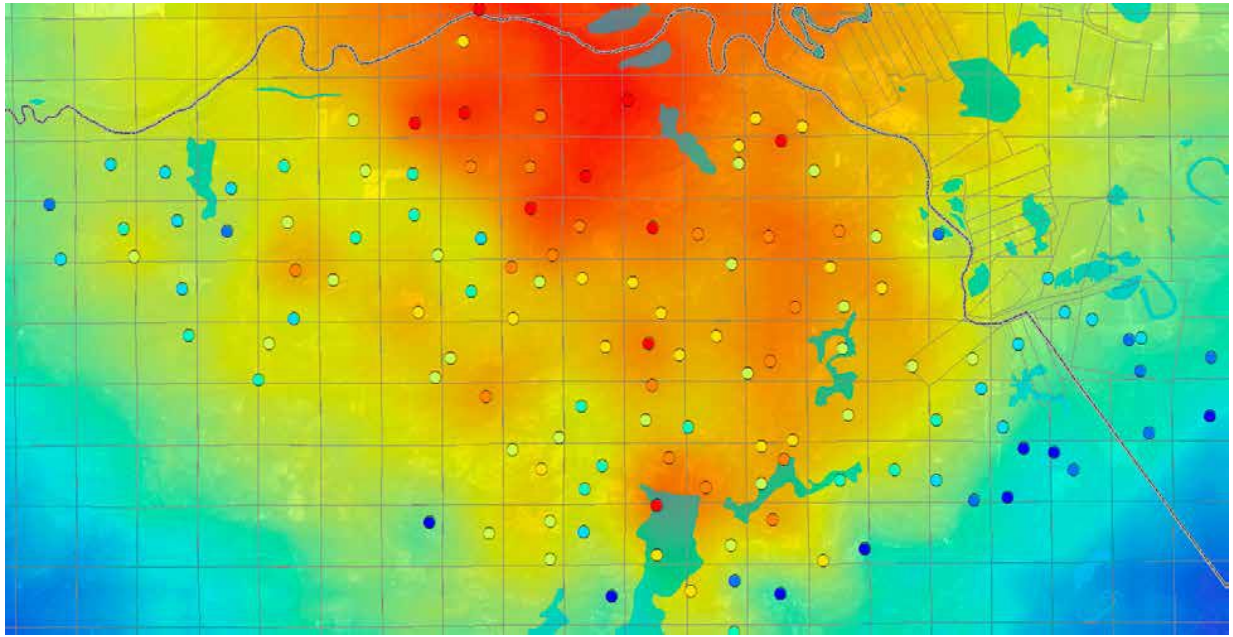
Finding the factors that explain observed spatial patterns and making predictions

What factors contribute to people dying young, where should we focus intervention, and what will the impact be?



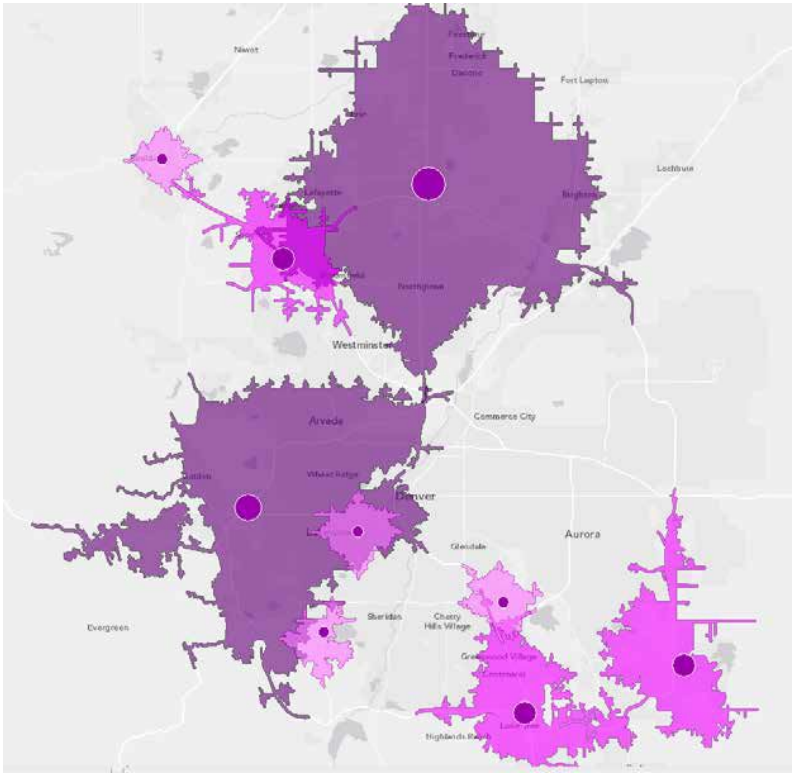
Interpolating a continuous surface and trends from discrete sample observations

Given a set of oil well production points (samples) across an area, what are the estimated production values in unmeasured locations?



Predicting how and where objects spatially interact (attraction and decay)

How will store size and travel distance attract or detract customers?

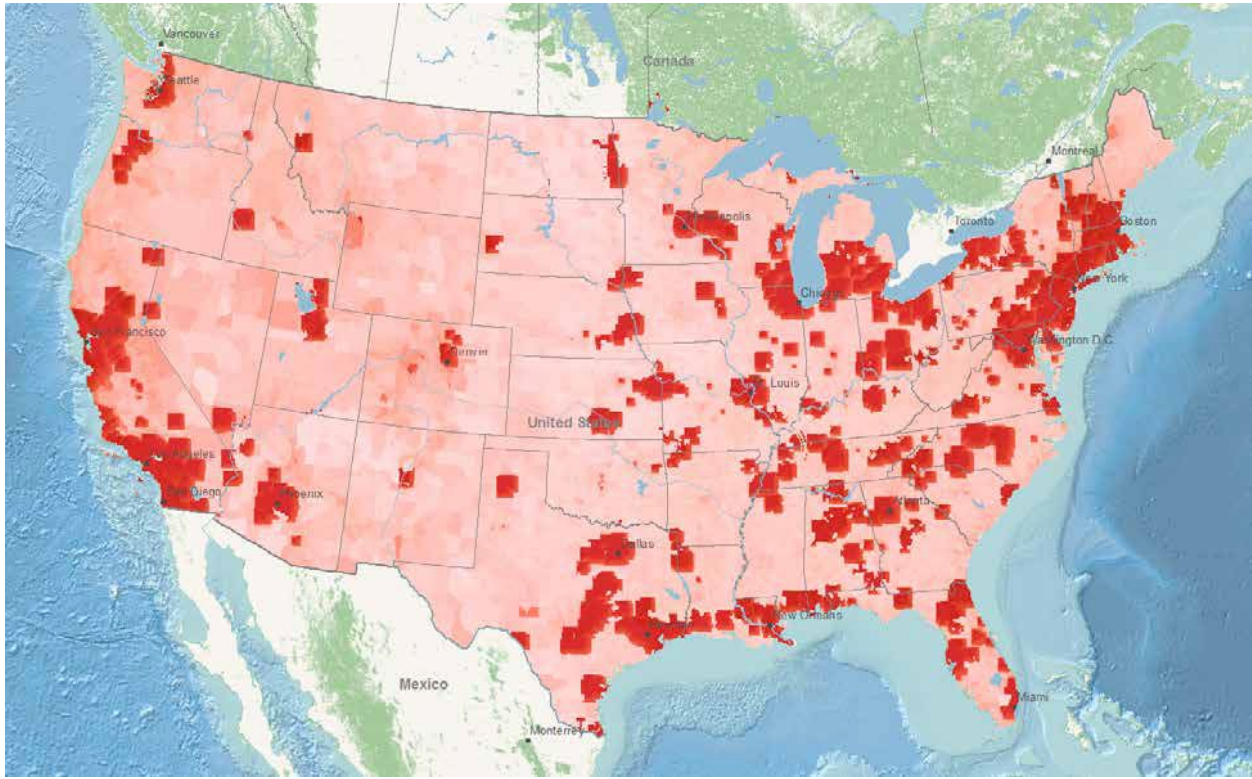


Predicting how and where objects affect wave propagation

How will buildings cast shadows or reflect sunlight?

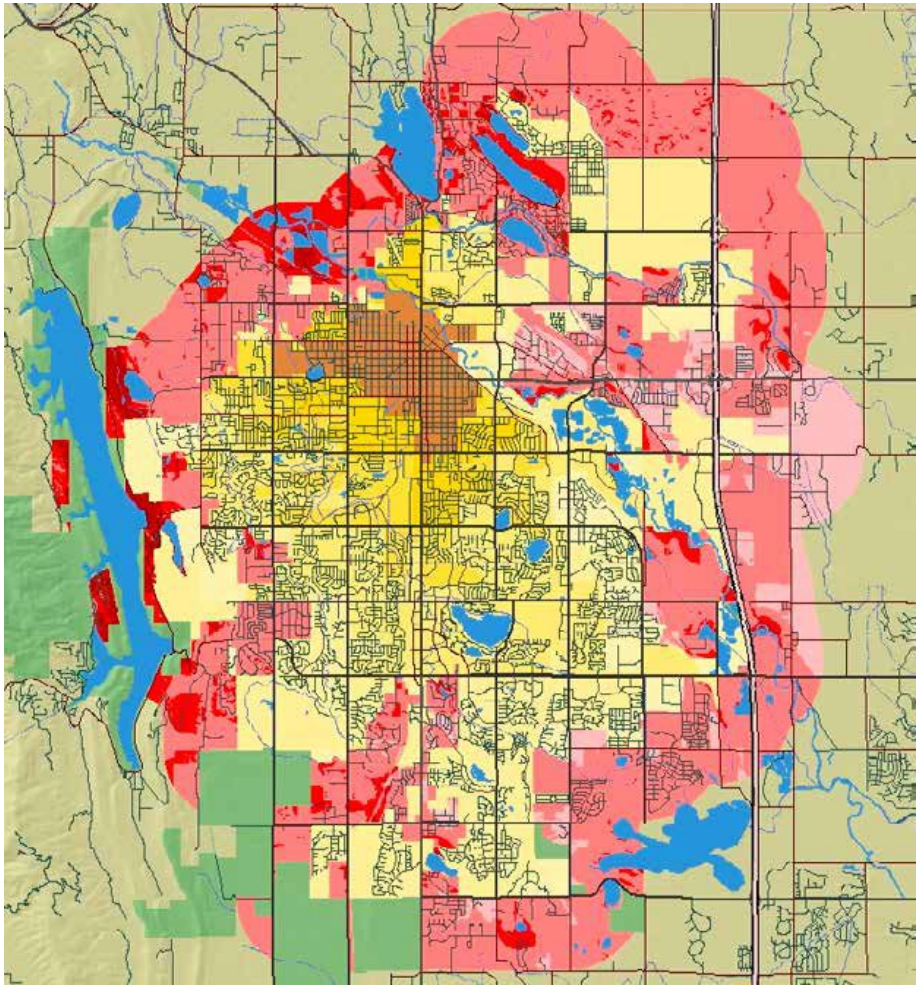
Predicting where phenomena will move, flow, or spread

How will illegal drug use grow and spread?

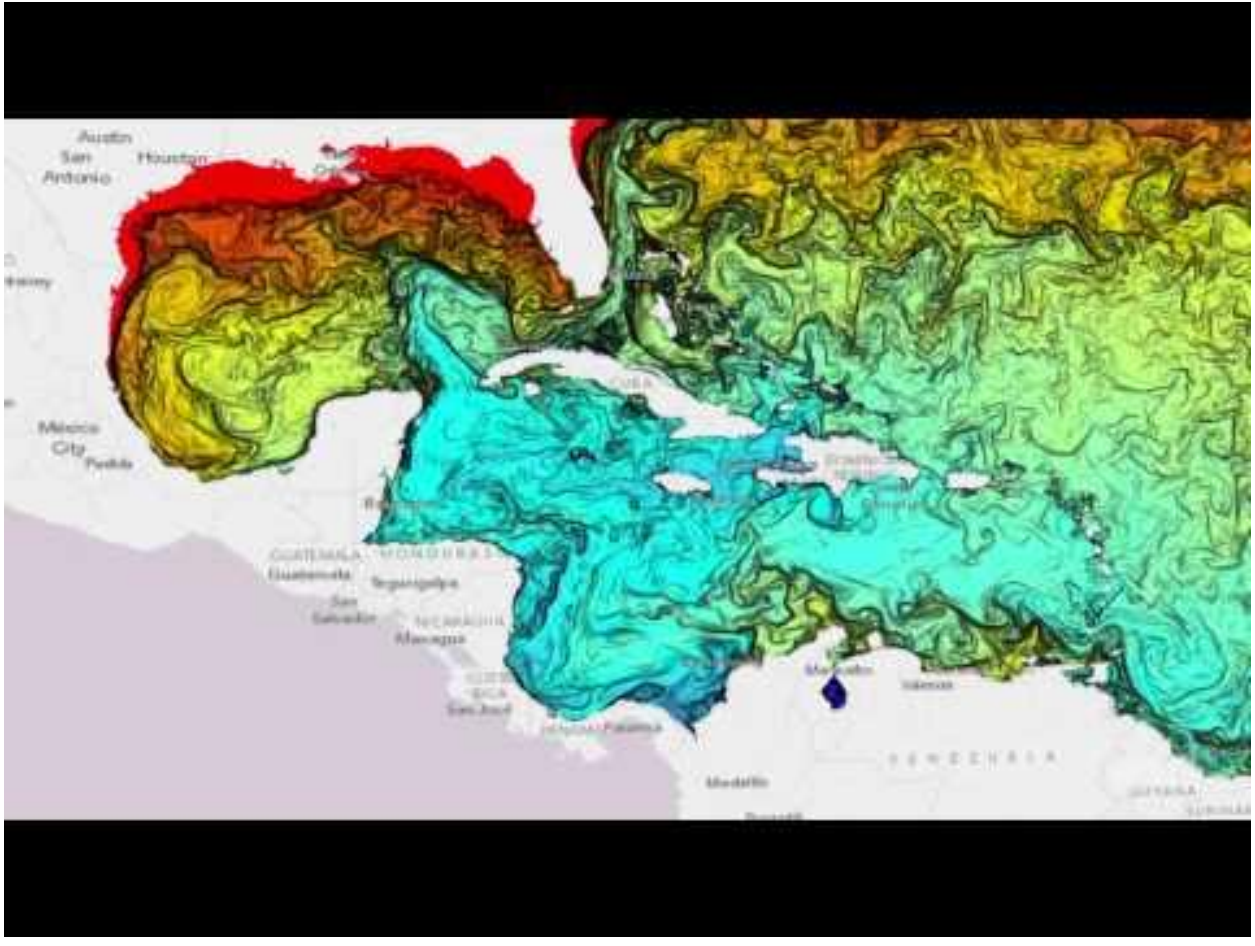


Predicting what-if

How will different urban development scenarios impact sprawl?



The Importance of Maps



Web Maps: Not Just a Pretty Picture

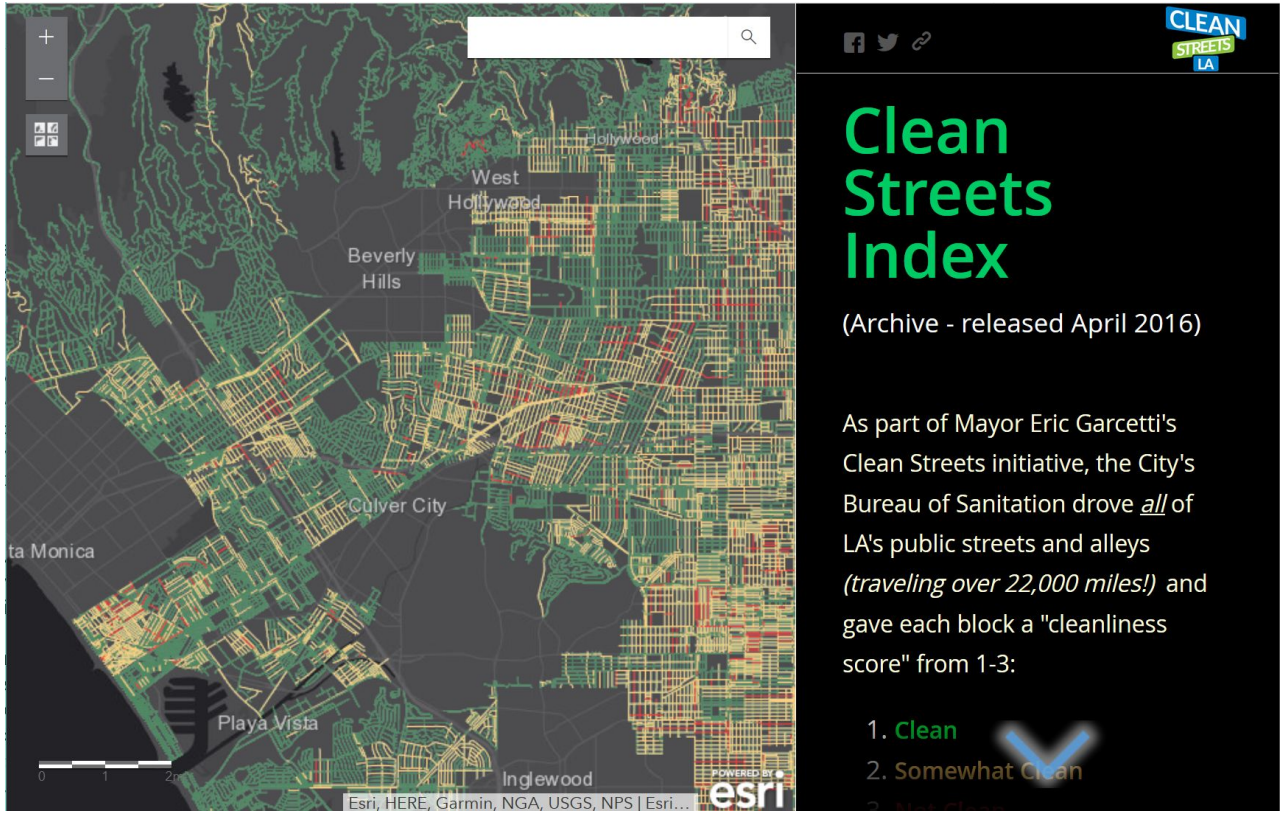
- Continuous and multiscale
- Pop-ups
- Real-time feeds
- Mashup culture
- Reach large audiences
- Easy to produce

Los Angeles Clean Streets Web Map

Web Map Example:

L.A. Clean Streets

- Maps we love
- Story map

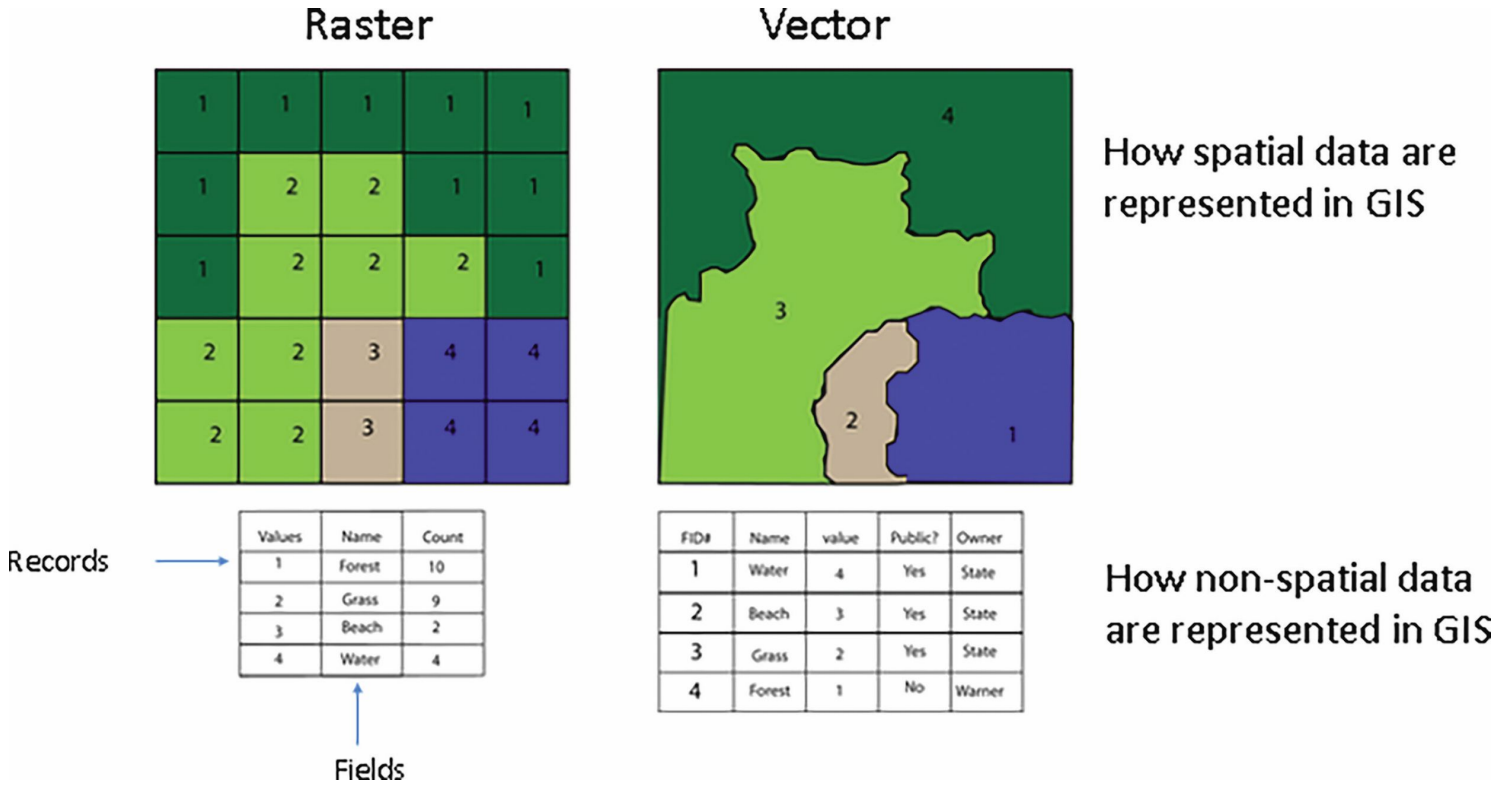


Cartography & Spatial Data Display

- Types of maps
- Spatial data layers:
  - Vector layers
  - Raster layers
  - Basemap layers
- Symbology
- Map design
- Demonstration

Spatial Data Layers

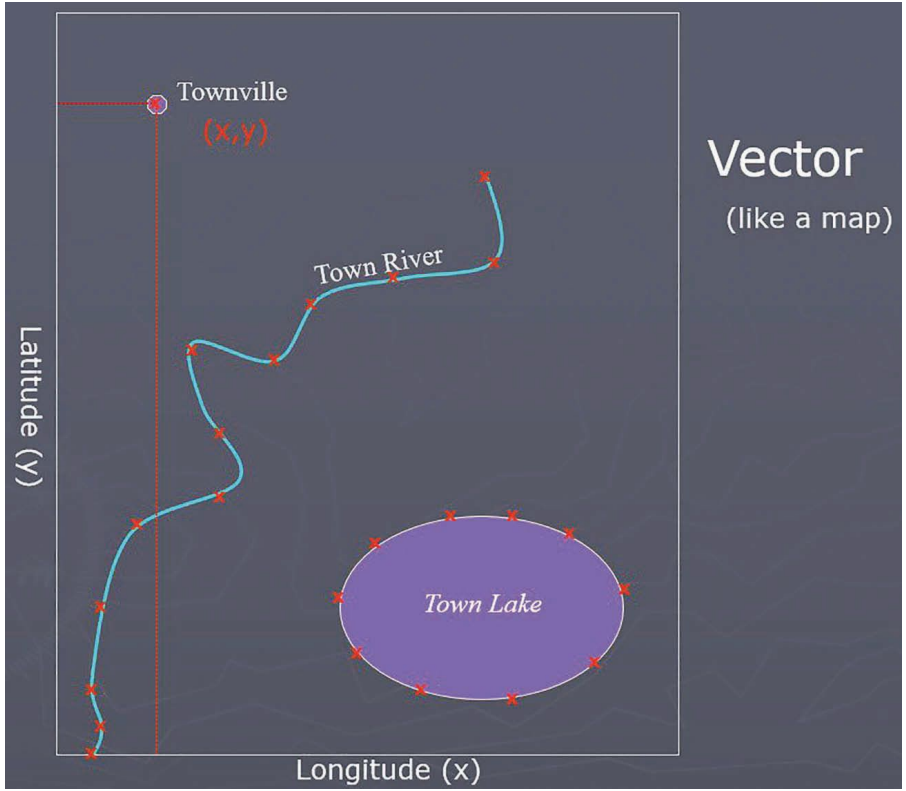
- Raster
- Vector



Source: GIS - An Introduction (McHaffie, 2019)

Vector Data Model

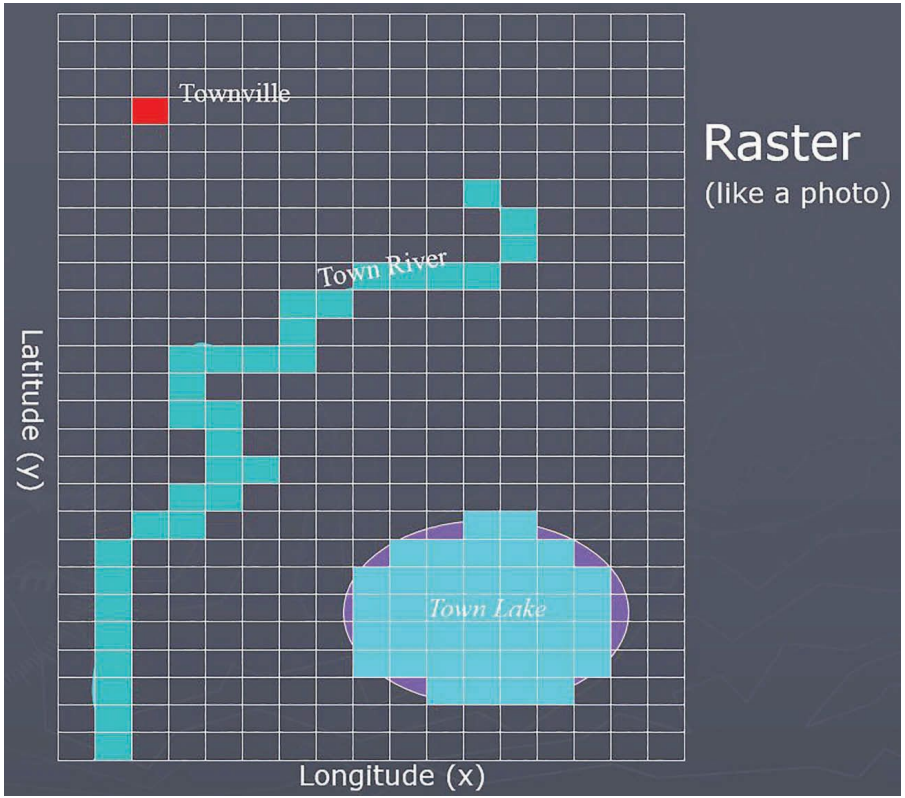
- Points
- Lines
- Polygons



Source: GIS - An Introduction (McHaffie, 2019)

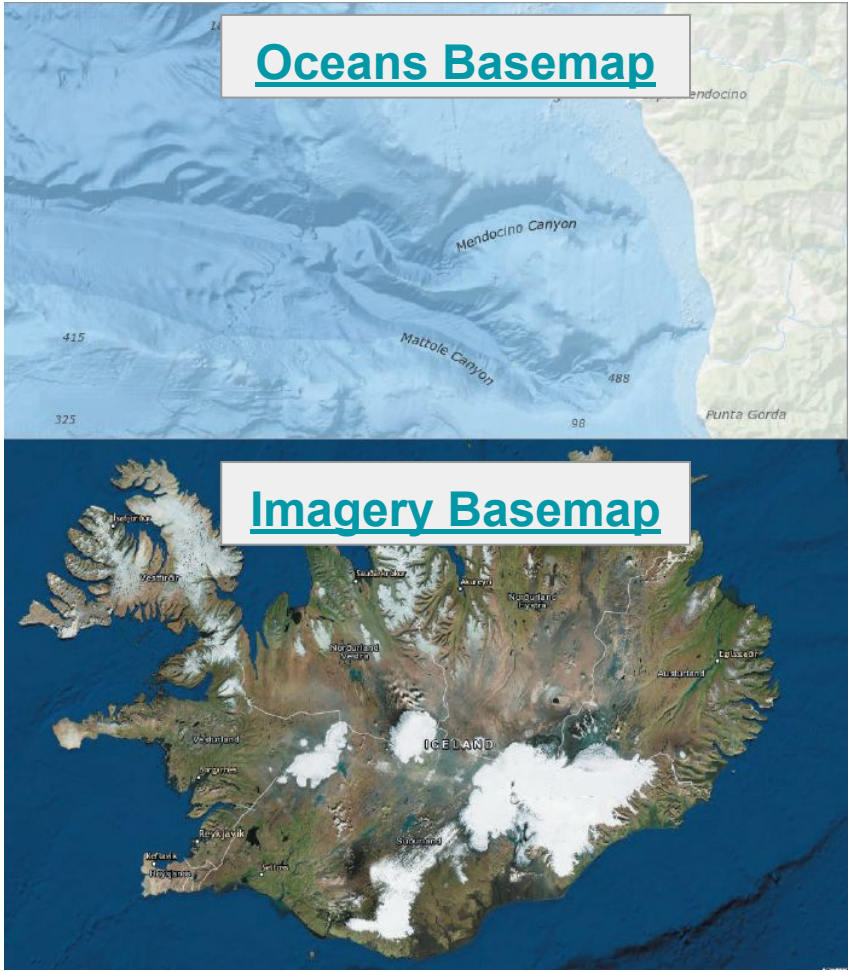
Raster Data Model

- Grid based
- Equal sized cells
- Like an image

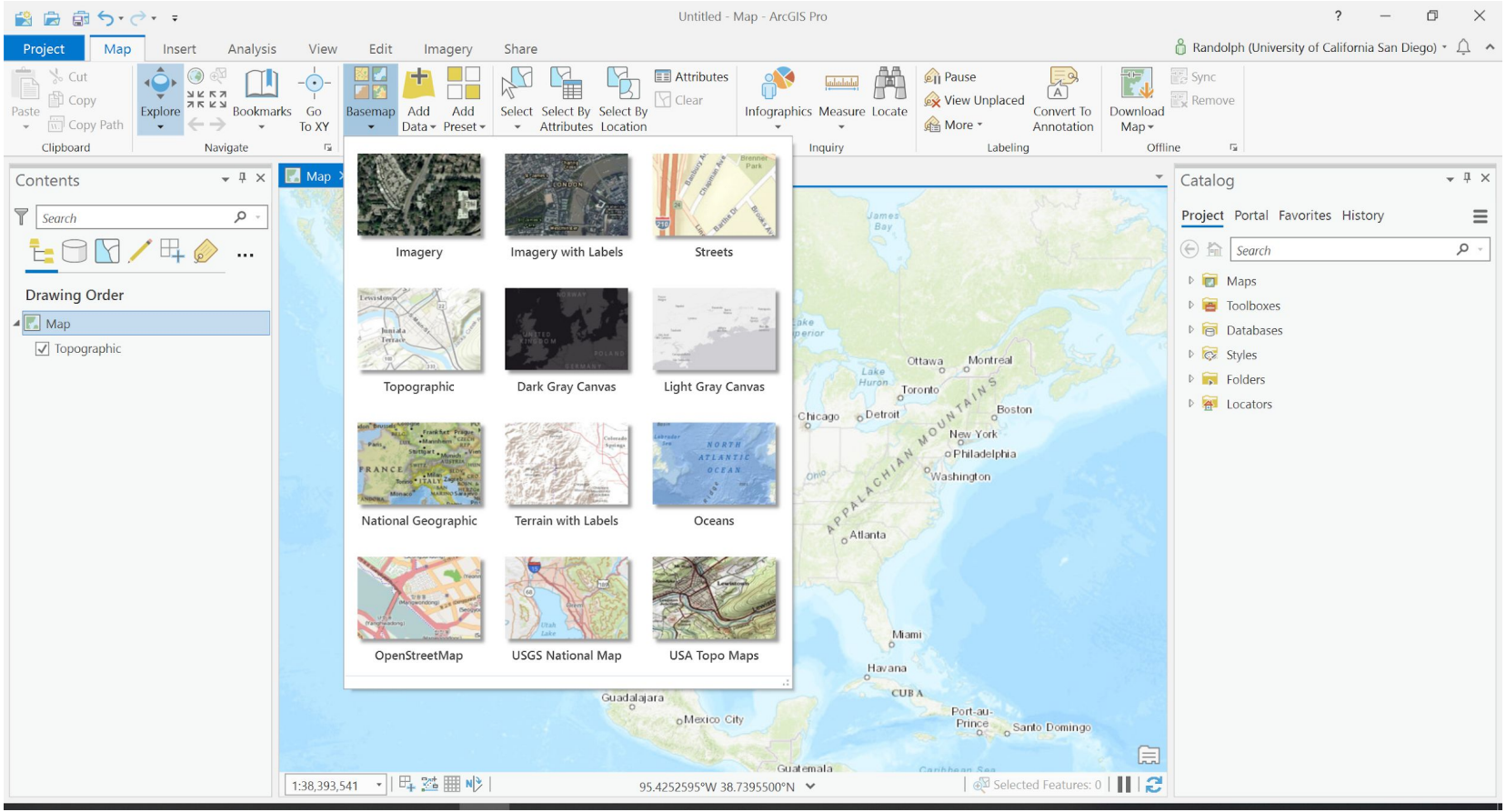


Basemaps

- Provide digital canvas
- Each has a theme:
  - Terrain
  - Roads
  - Oceans
  - Imagery
- Multiple zoom levels
- Global scales

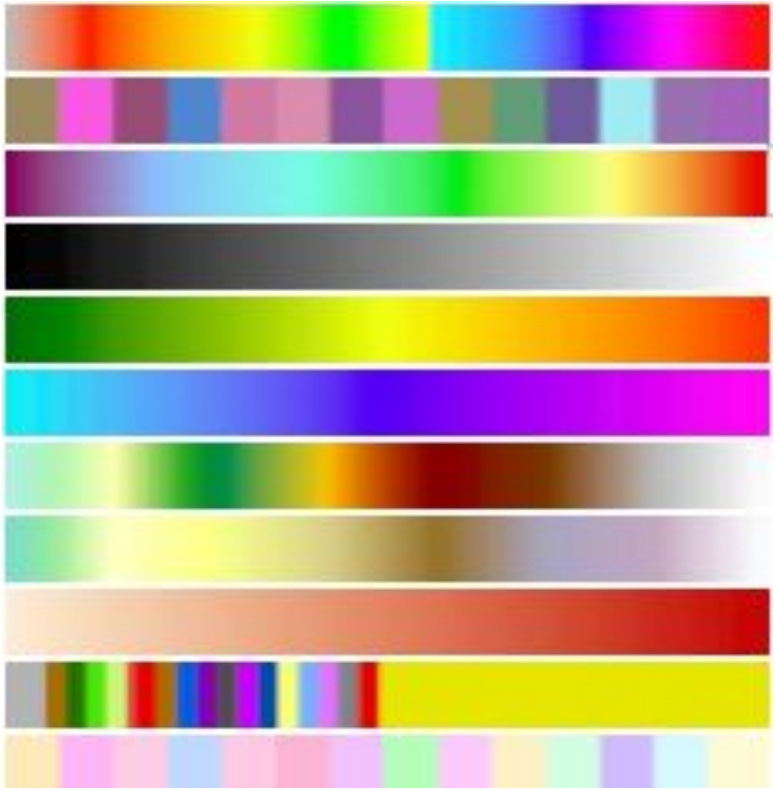


ArcGIS Basemaps



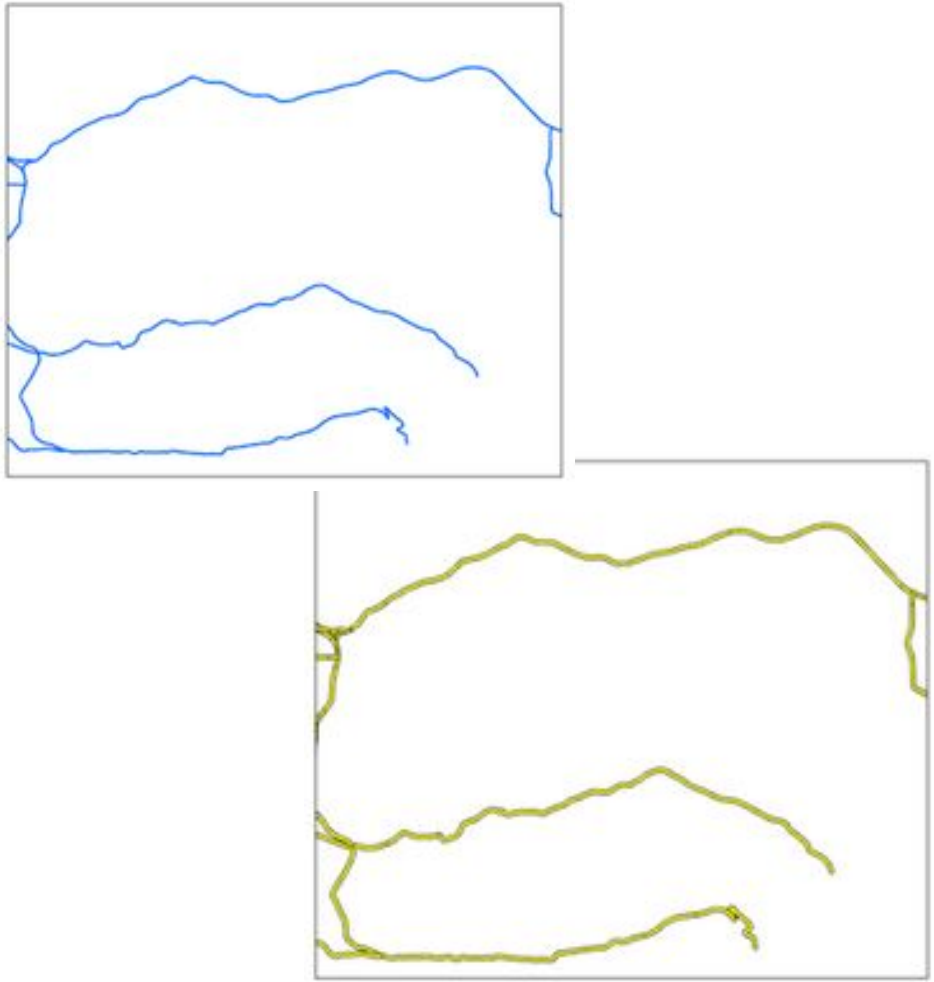
Cartography & Spatial Data Display

- Types of maps
- Spatial data layers:
- Symbology
  - Qualitative data
  - Quantitative data
  - Classification methods
- Map design
- Demonstration



Symbology

- Symbols give meaning in maps
- Choosing appropriate symbols make map:
  - More useful
  - Easier to interpret



Symbology: Qualitative Data

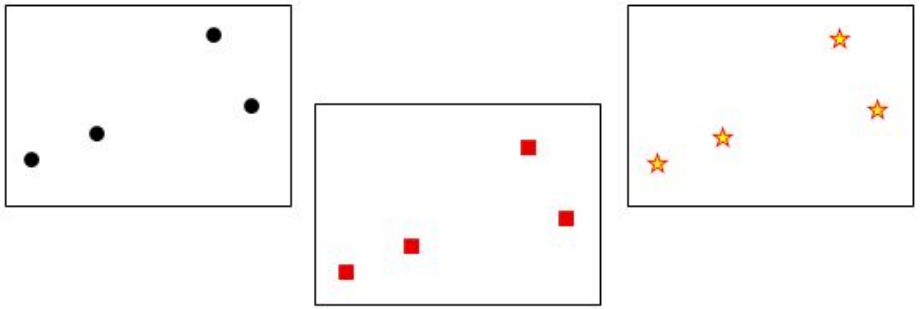
Symbolize **qualitative** data in two ways:

- Single symbols: shows spatial distribution
- Unique values: shows categories

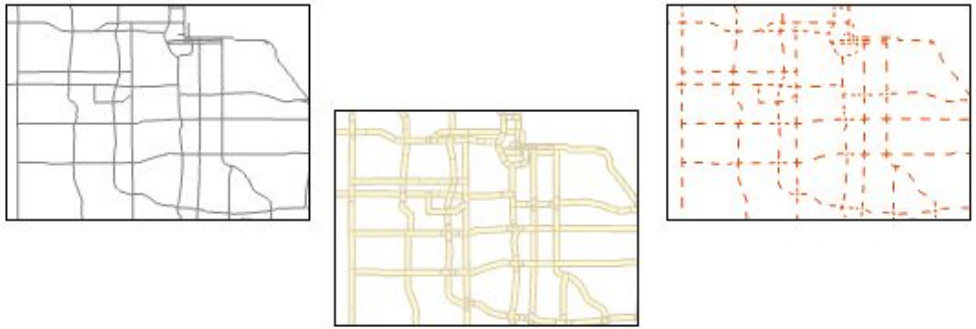
Roads in Utah symbolized using unique values. The attribute used for symbology categorizes roads as: Highway, State, or County

Symbology: Single Symbols

Points: alter shape, size, inner fill color, outline color, and angle



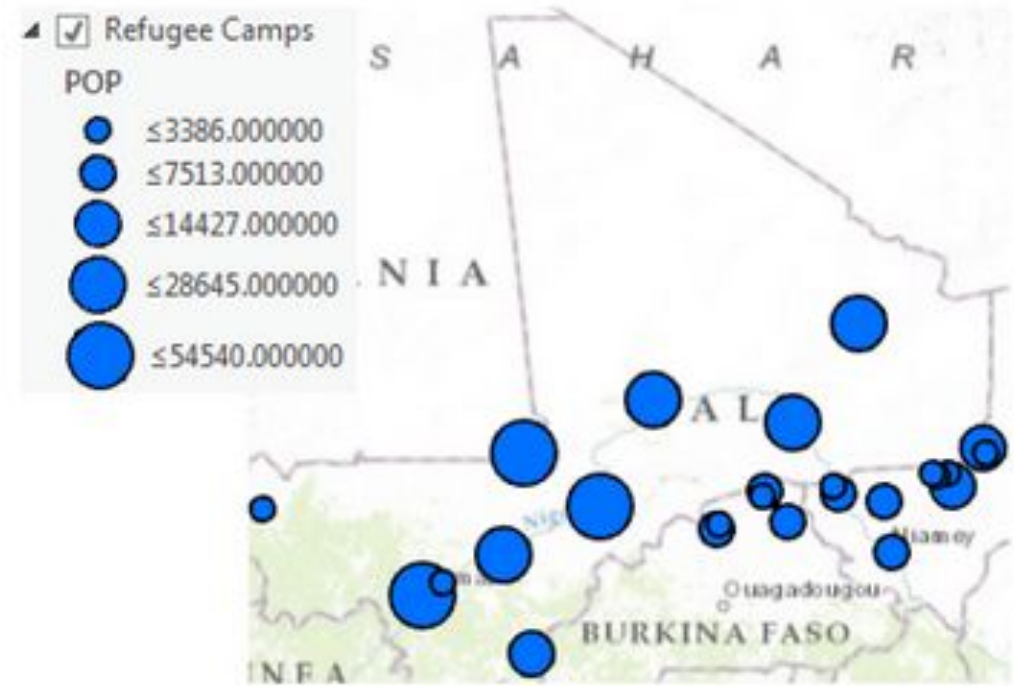
Lines: adjust color and width. Line effects, such as dashes, are also alternatives to the standard solid line



Symbology: Quantitative Data

Symbolize **quantitative** data by showing relative size or color between classes

- Graduated symbols
- Graduated color



Graduated symbols show the relative population of refugee camps

Symbology: Demo

Nepal Earthquakes

- Symbolize by graduated symbols
- Symbolize by graduated colors

Symbology: Classification Introduction

When displaying features by value there are two methods:

1. Use a different symbol for each value
    - All data are shown
2. Group values together for display
    - Patterns easier to visually discern
    - Not all values are shown

Symbology: Classification Introduction

- When using graduated symbols or colors, there are several classification methods available.
- Factors to consider when choosing:
  - Data Type
  - The variability across attributes values
  - The number of values in each class

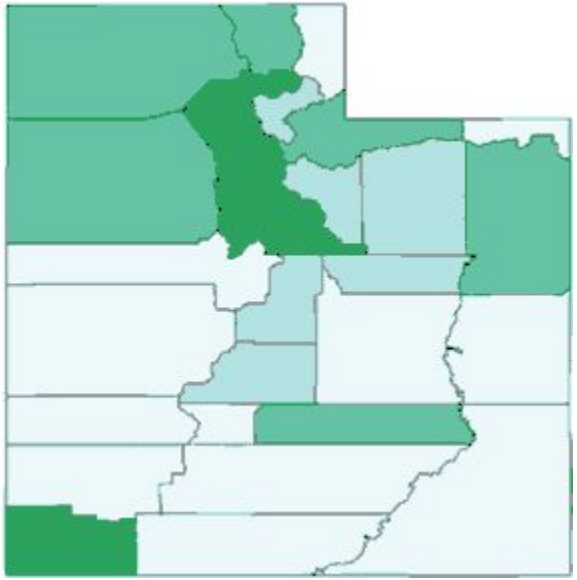
Symbology: Classification Methods

Same data, but different display

Natural Breaks (Jenks)

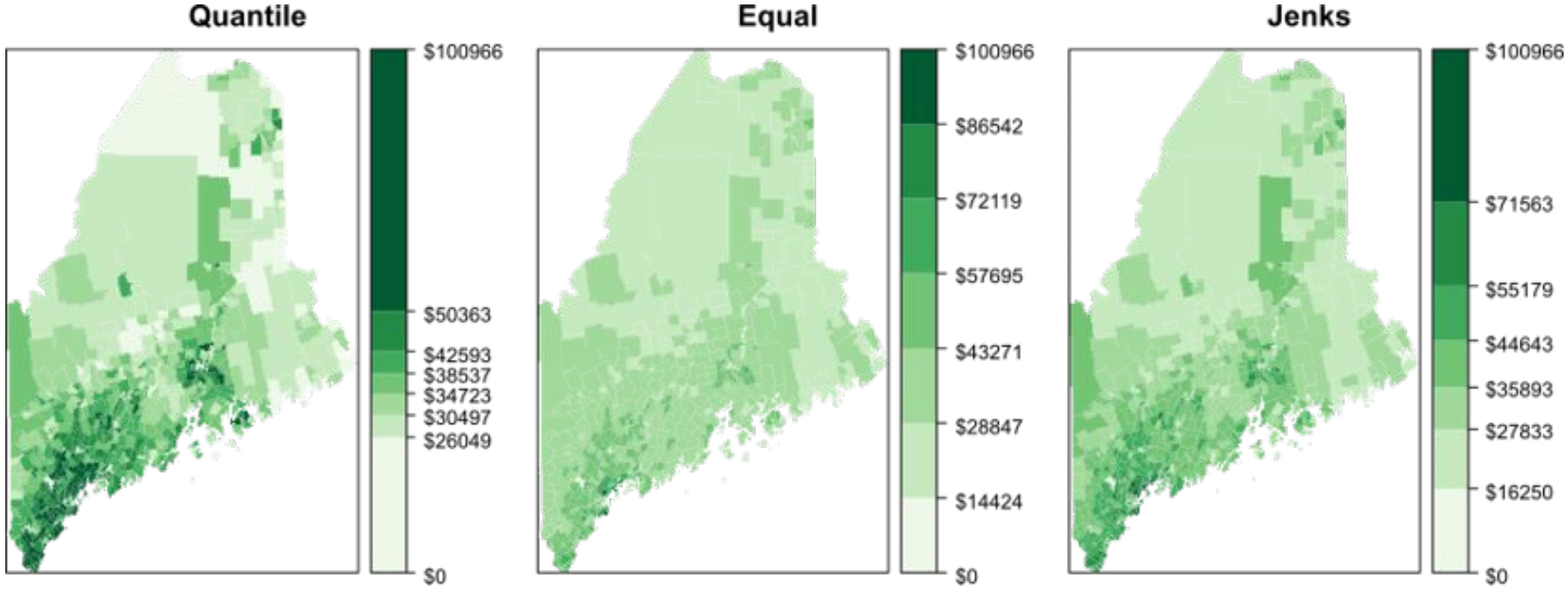
Equal Interval

Quantile



Symbology: Classification Example

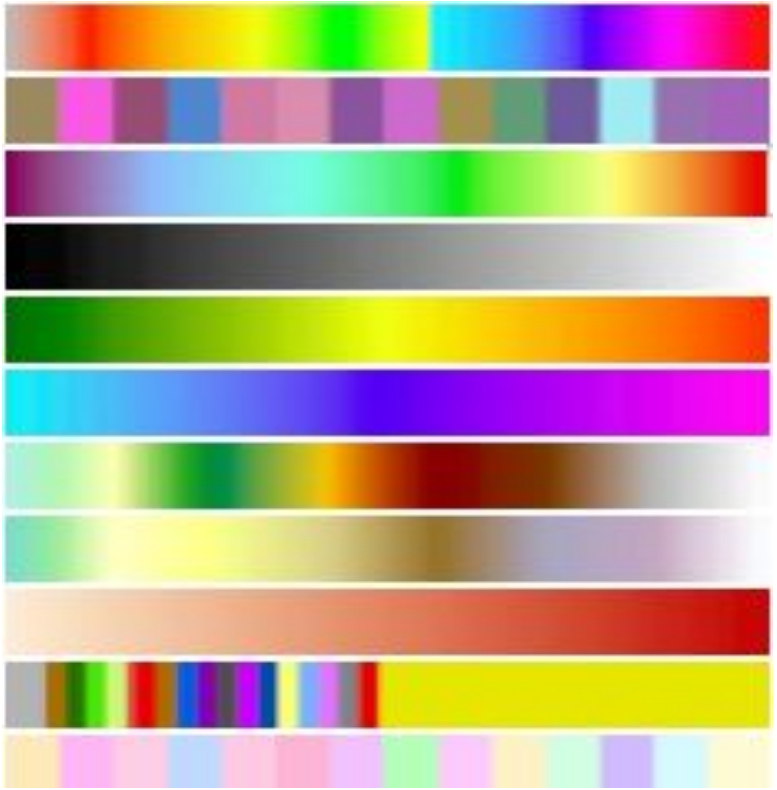
Household Income, North East USA



Source: https://github.com/mgimond/Spatial

Cartography & Spatial Data Display

- Types of maps
- Spatial data layers
- Symbology
- Map design
- Demonstration



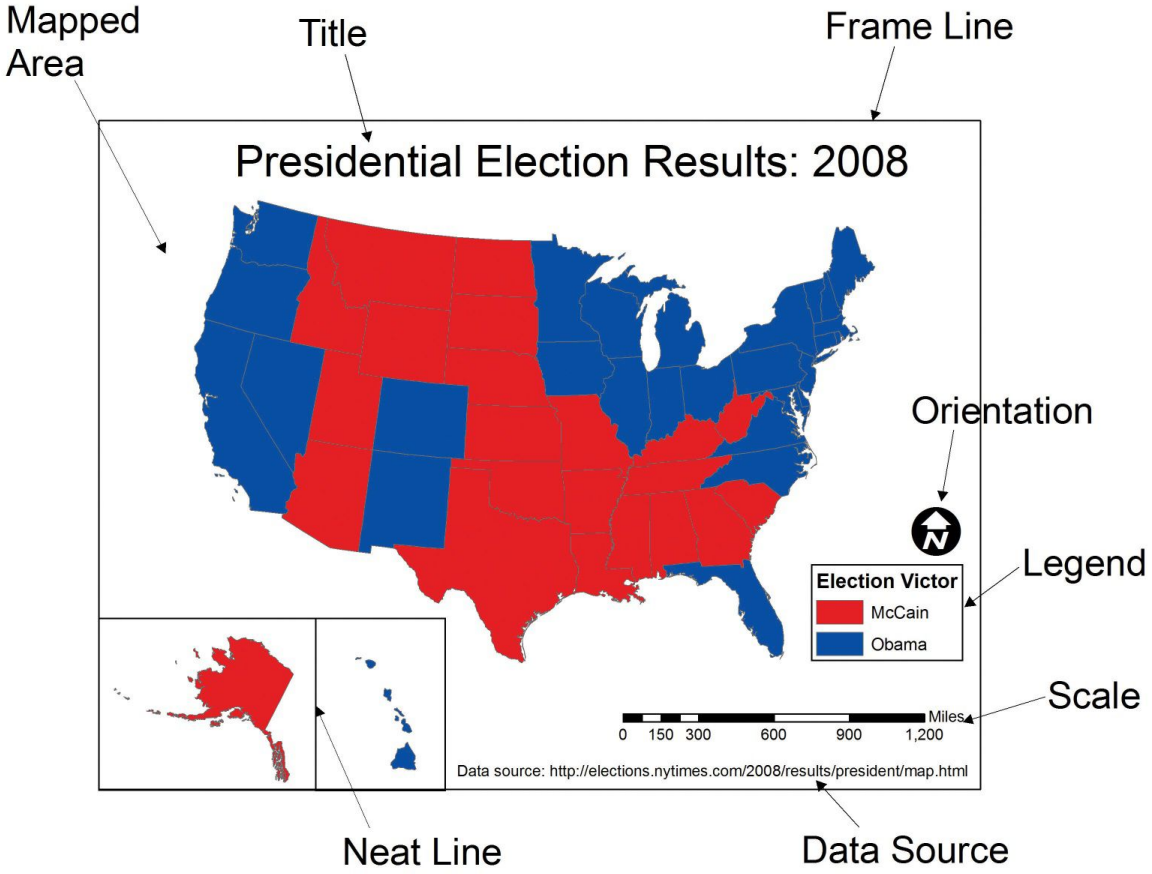
Good Map Design

Elements of a map:

- Map body
- Legend
- Title
- Scale
- Inset map
- Source information
- Author/Contact info

Source: https://mgimond.github.io, 2018

Map Elements

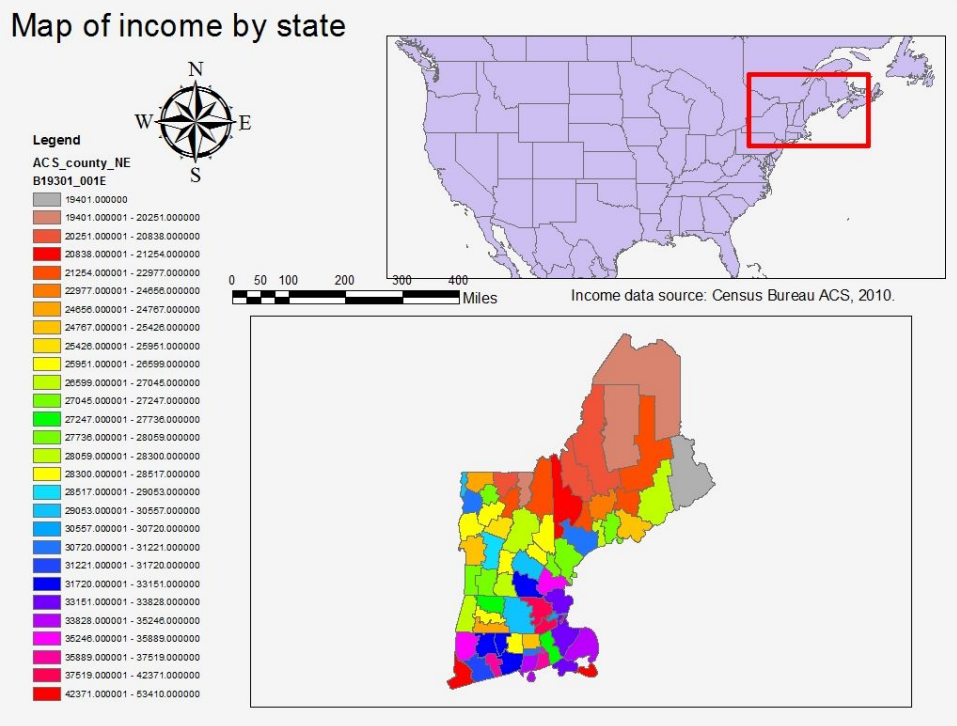


Source: Essentials of GIS (Campbell, 2011)

Bad Map Design

Example of “bad” map

- Legend: less classes, format numbers
- Inset map: too big
- Scalebar is confusing: which map?
- Too many colors
- etc ...

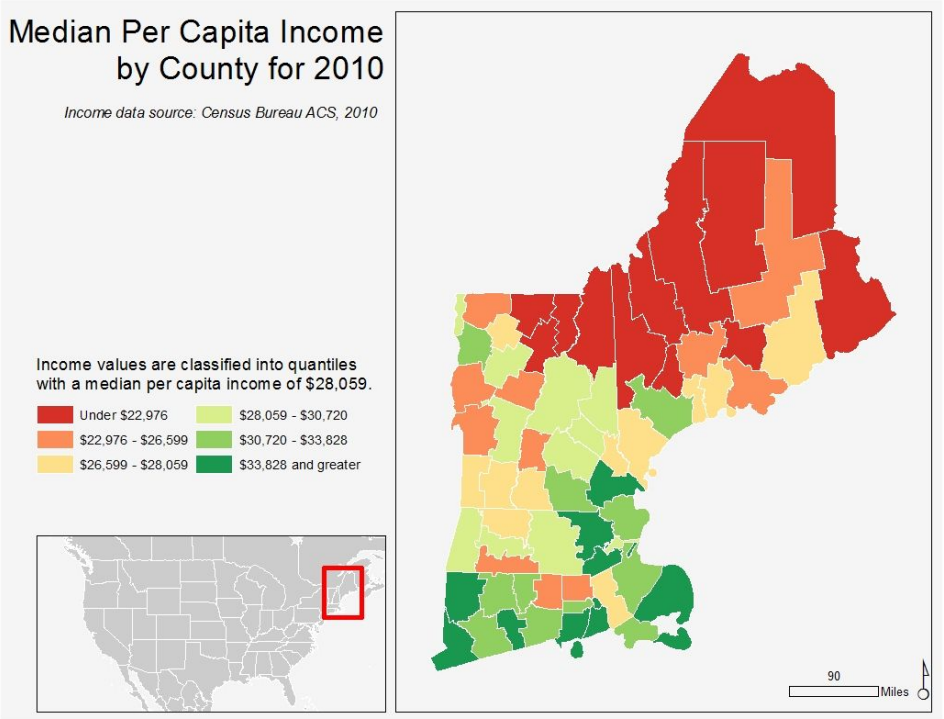


Source: https://mgimond.github.io, 2018

Good Map Design

Good Practices:

- Visual hierarchy: top-to-bottom
  - Top elements: main map body, title and legend
- Limit colors
- Use logical classification scheme
- Scale bar size: keep simple
- Title: concise



Source: https://mgimond.github.io, 2018

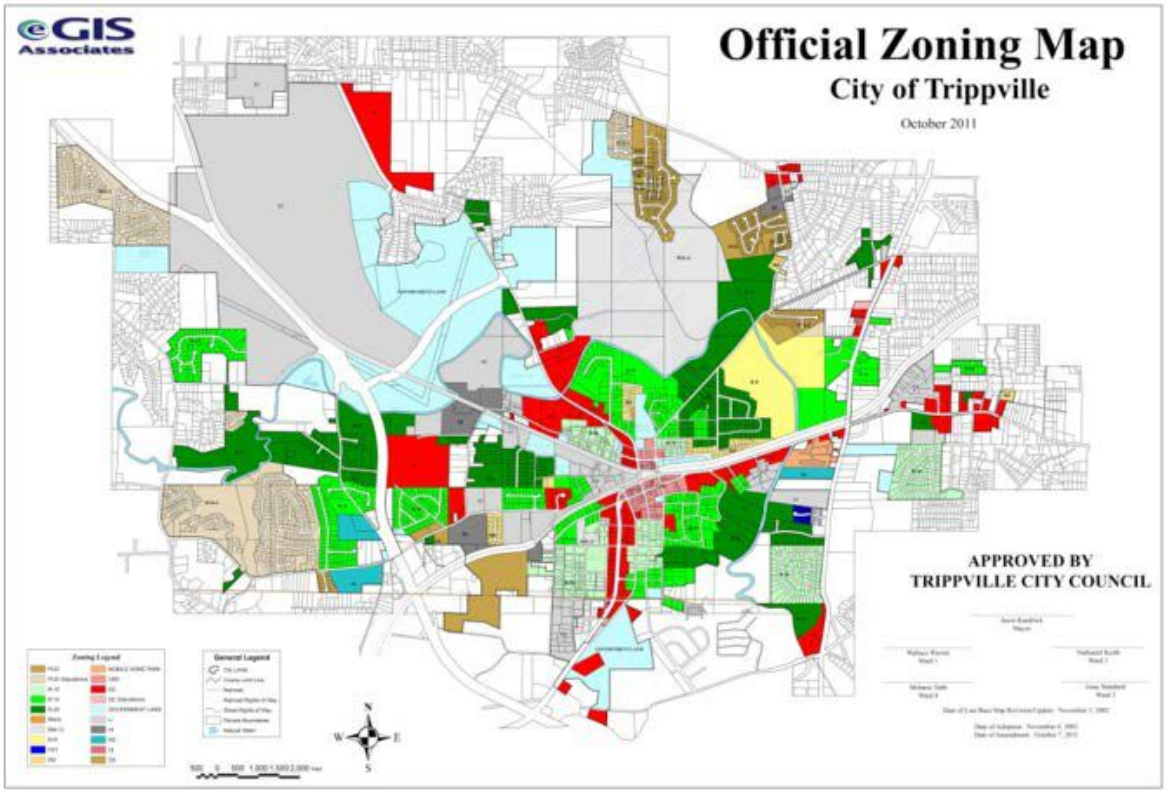
Considerations When Designing Layout

- Layout frames all the hard analysis work in GIS
- Important to put thought and planning into layout creation
- Three basic factors to address:
  - Purpose
  - Audience
  - Usage

Purpose of Map

- The purpose defines the overall theme of the map
- Helps determine what content to be included
- Common purposes may include:
  - Show location of features
  - Highlight specific attributes associated with features
  - Show spatial relationships
  - Present the results of the analysis
  - Meet legal requirements (e.g. Tax Map or Land Use)

Map Purpose: Meet Legal Requirements

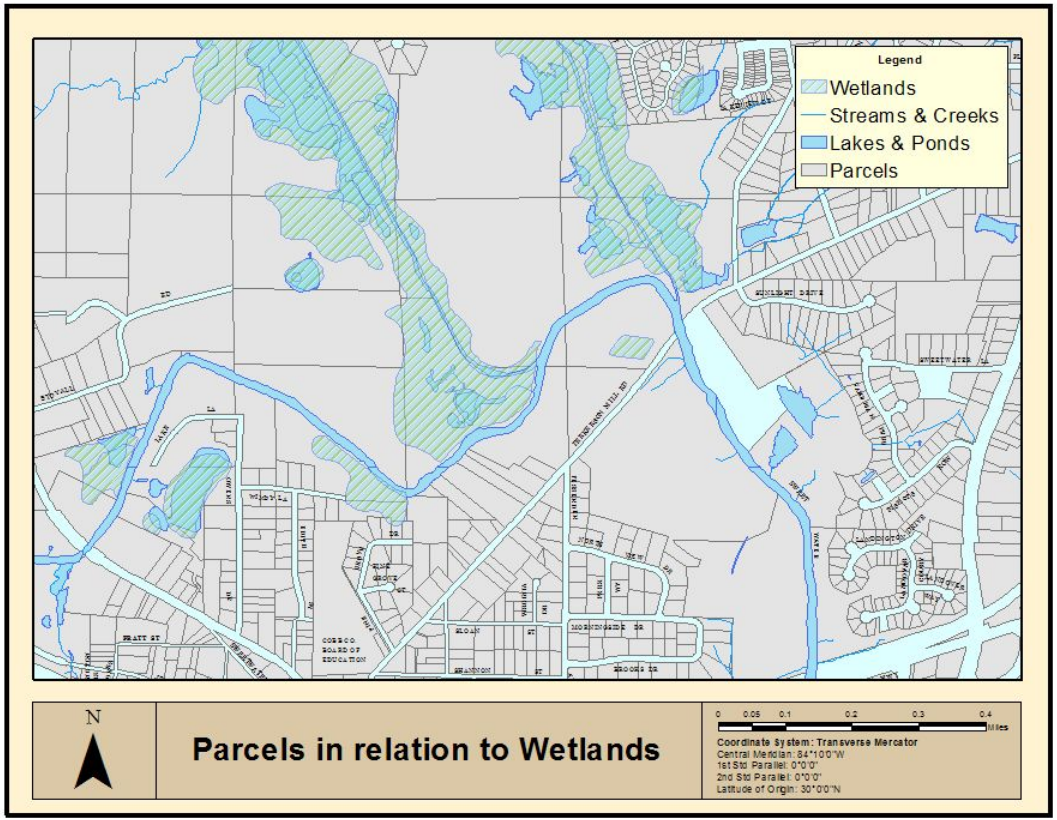


Source: Learning ArcGIS Pro (Corbin, 2015)

Map Purpose: Location Map

Source: Learning ArcGIS Pro (Corbin, 2015)

Map Purpose: Show Spatial Relationship



Source: Learning ArcGIS Pro (Corbin, 2015)

Map Intended Audience

- The intended audience will impact map design
- Considerations:
  - Age
  - Education or knowledge level
  - Physical abilities or disabilities

Map Intended Usage

- How will map be presented and used
  - Digital or printed?
  - Used in presentation or hung on wall or taken into field?
  - Is it a legal document?

Activity: Map Book Gallery

Explore Map Book Gallery

- Published annually
- By GIS users worldwide
- Choose 3 maps and record:
  - Author or Organization
  - Reason or problem
  - Layers included