# WEEK 02 WHAT IS GIS

# LECTURE

INSTRUCTOR: YANAN WU

FALL 2025

# 2.1
# INTRODUCTION TO GIS

# What is a **GIS**?

- Geographic Information
  - information about places on the earth's surface
  - knowledge about "what is where when"

- GIS--what's in the S?
  - Systems: the technology/tool
  - Science: the concepts and theory

# ARE THEY TECHNOLOGY OR SCIENCE IN GIS?

- ArcGIS PRO
- Drone with camera
- Coordinate system and map projection
- Web Mapping tool
- Network Analysis

# Do you think you have used GIS in your daily life?

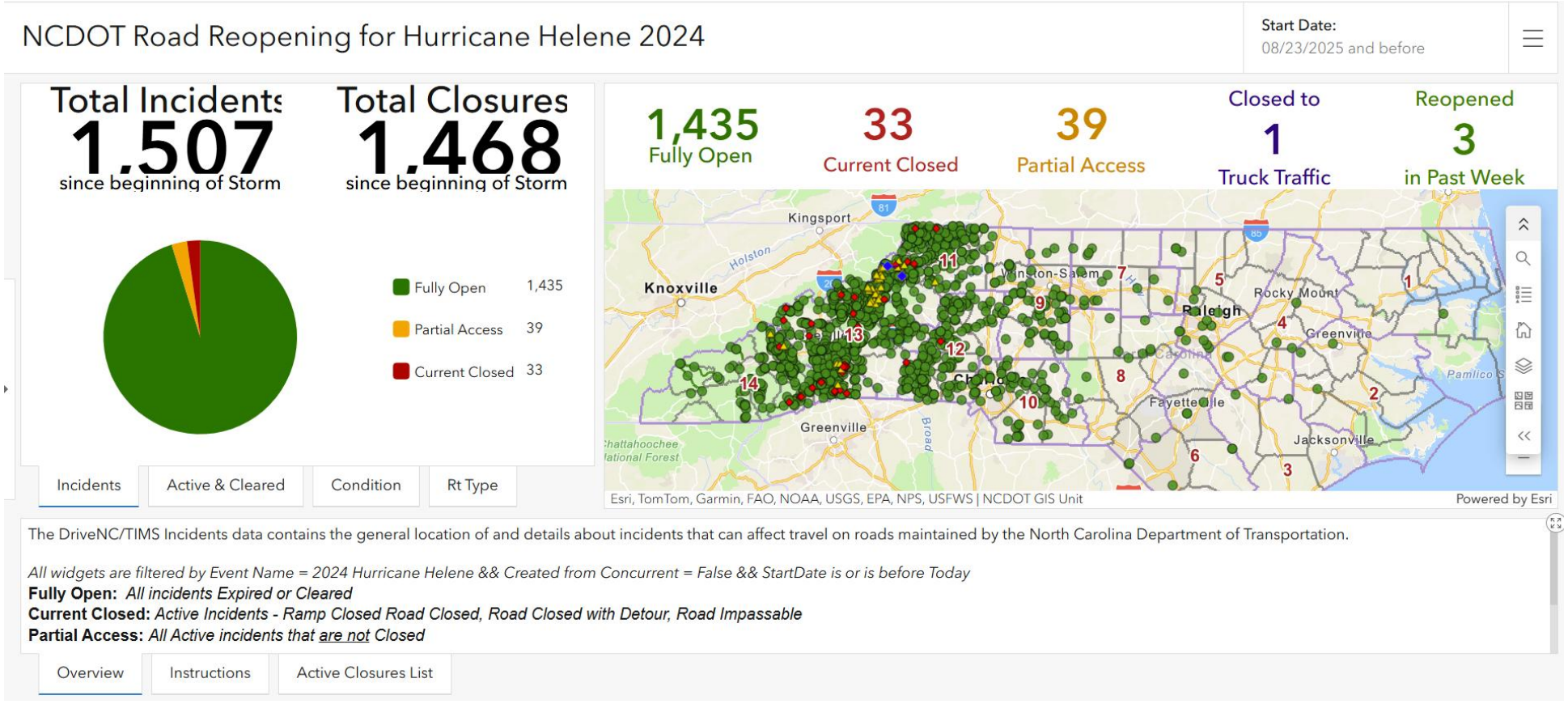

# DO THEY USE GIS?

- Fitness apps: mapping runs, biking paths
- Real estate apps: houses displayed on maps with neighborhood data
- Apple Find My iPhone
- Pokemon Go

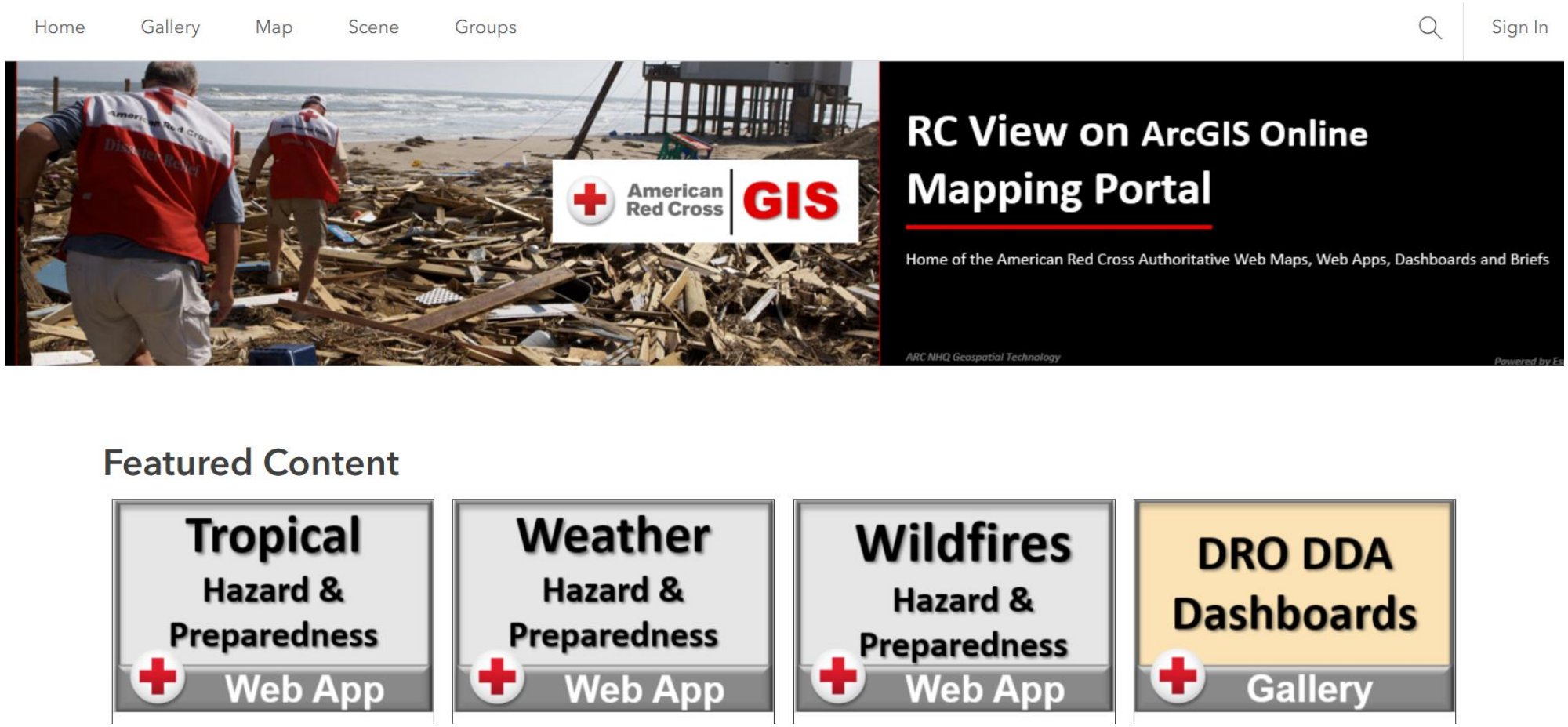
**GIS = data + location + analysis + visualization**, not just seeing a map

# GIS IN THE NEWS

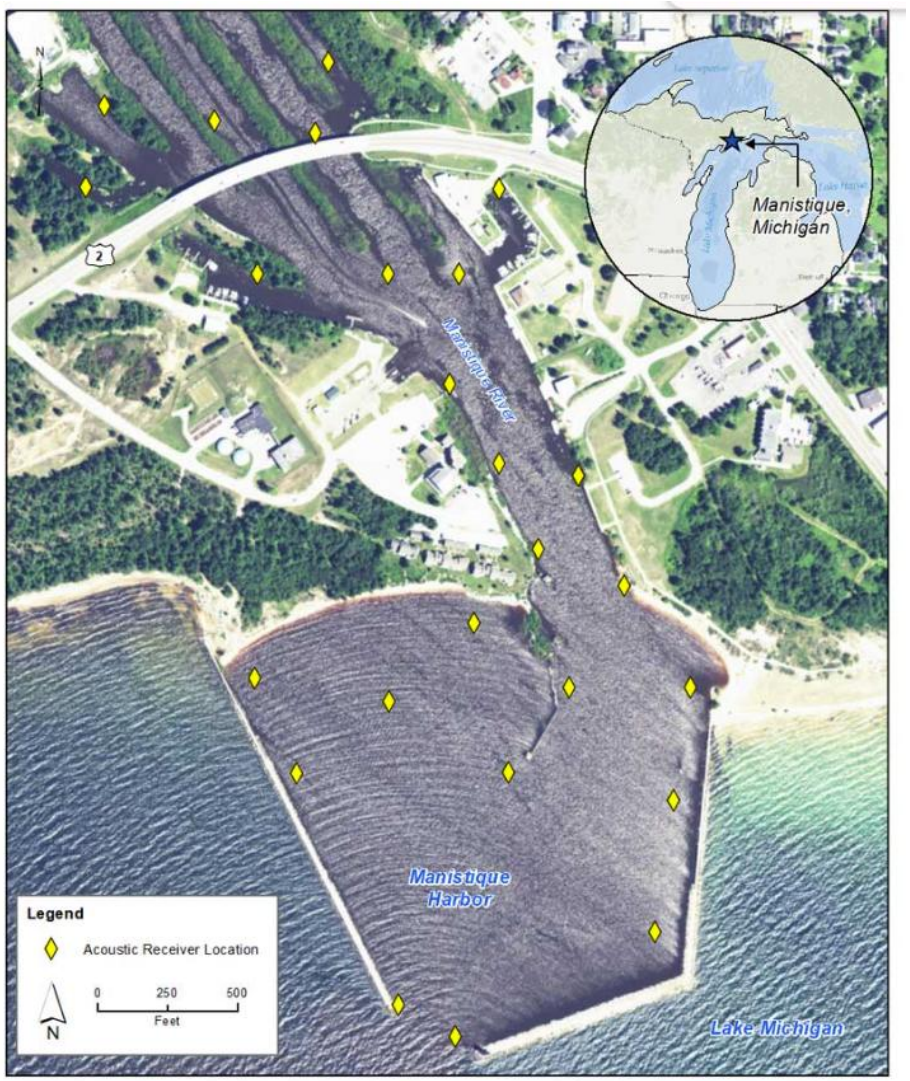
- Natural Disaster

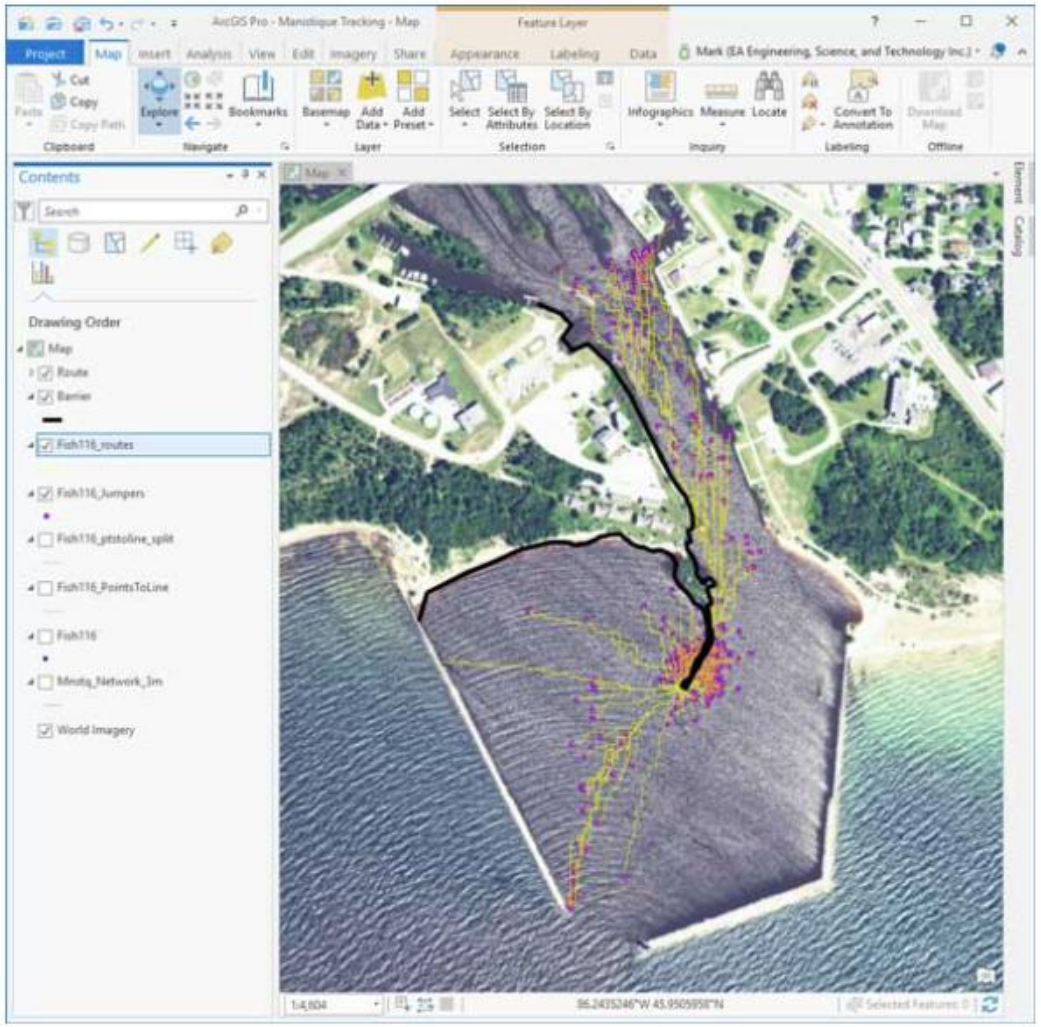


- Emergency Response and Recovery



# Tracking Fish



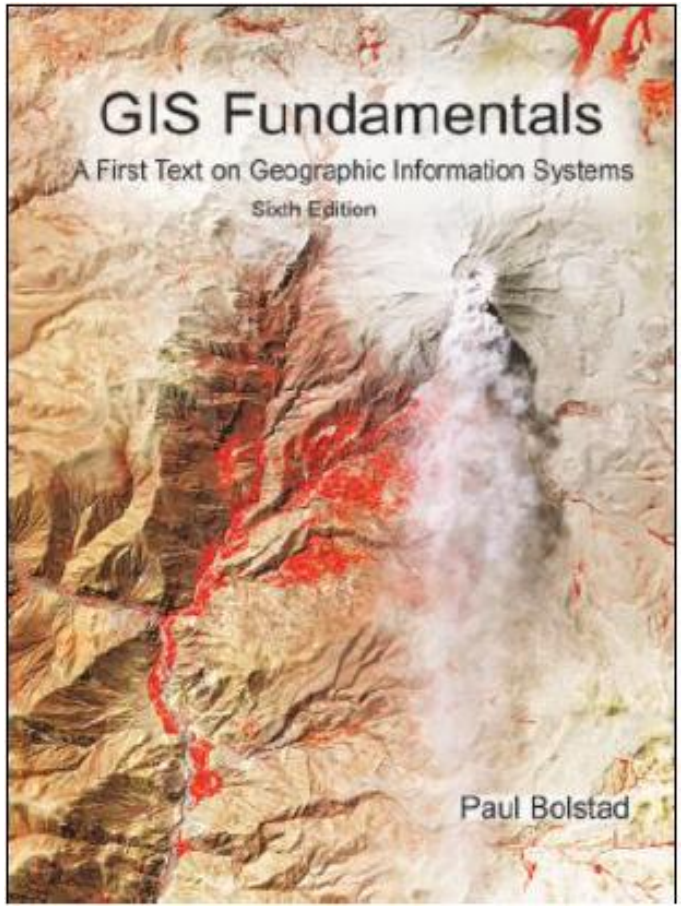




These revised line segments were generated by the Network Analyst extension.

# GI SYSTEMS

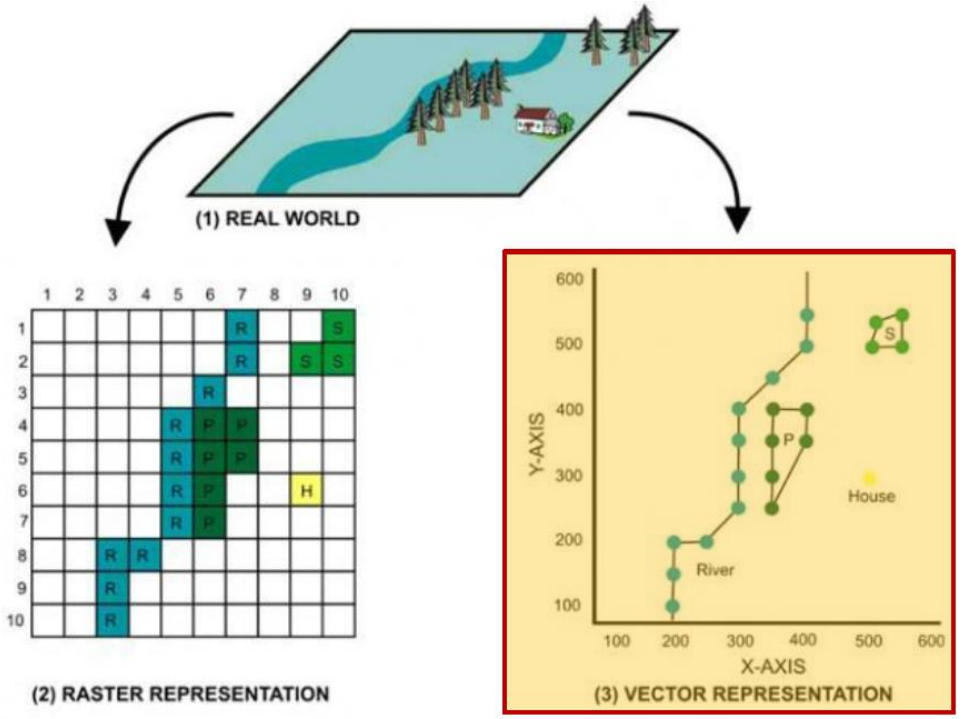
*A computer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information*

-Paul Bolstad



# GI SCIENCE

*Geographic information science is the development and use of theories, methods, technology, and data for understanding geographic processes, relationships, and patterns*




https://sqlserverrider.wordpress.com/tag/raster-graphics/

- Goodchild, M. F. (1992).

# GI technologies

## 3S

### Remote Sensing
### RS

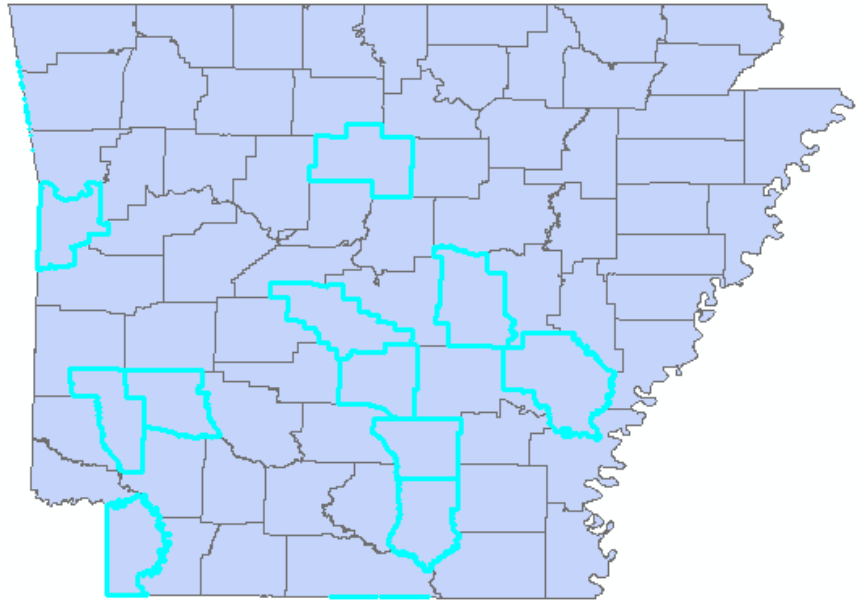
https://landsat.usgs.gov/landsat-8

### Global Positioning Systems

### GPS


https://commons.wikimedia.org/wiki/File:Bad_gdop.png

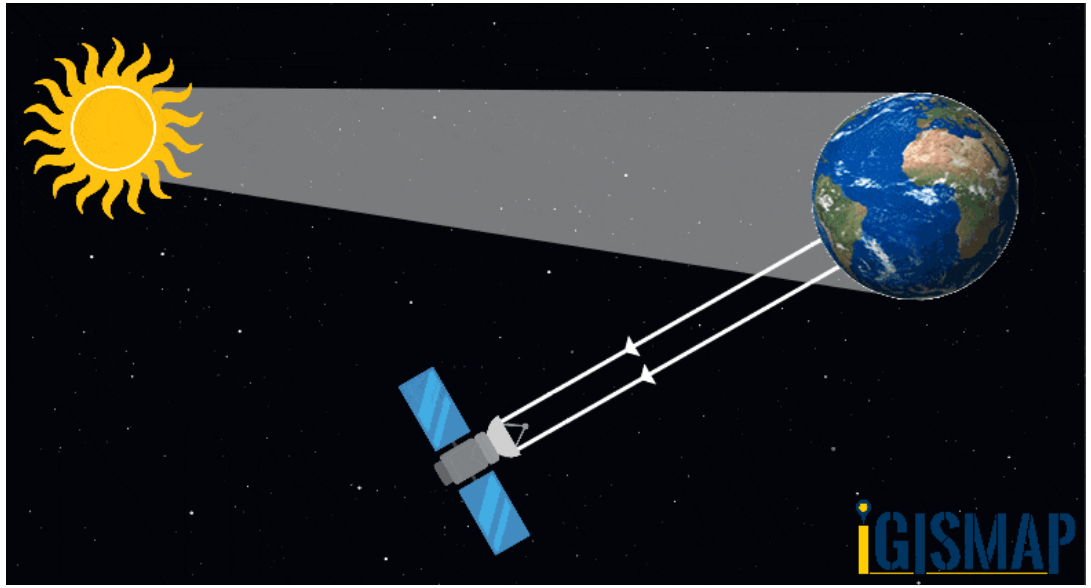
### GIS



# GI technologies

## 3S

- RS
  - use of satellites or aircraft to capture information about the earth’s surface



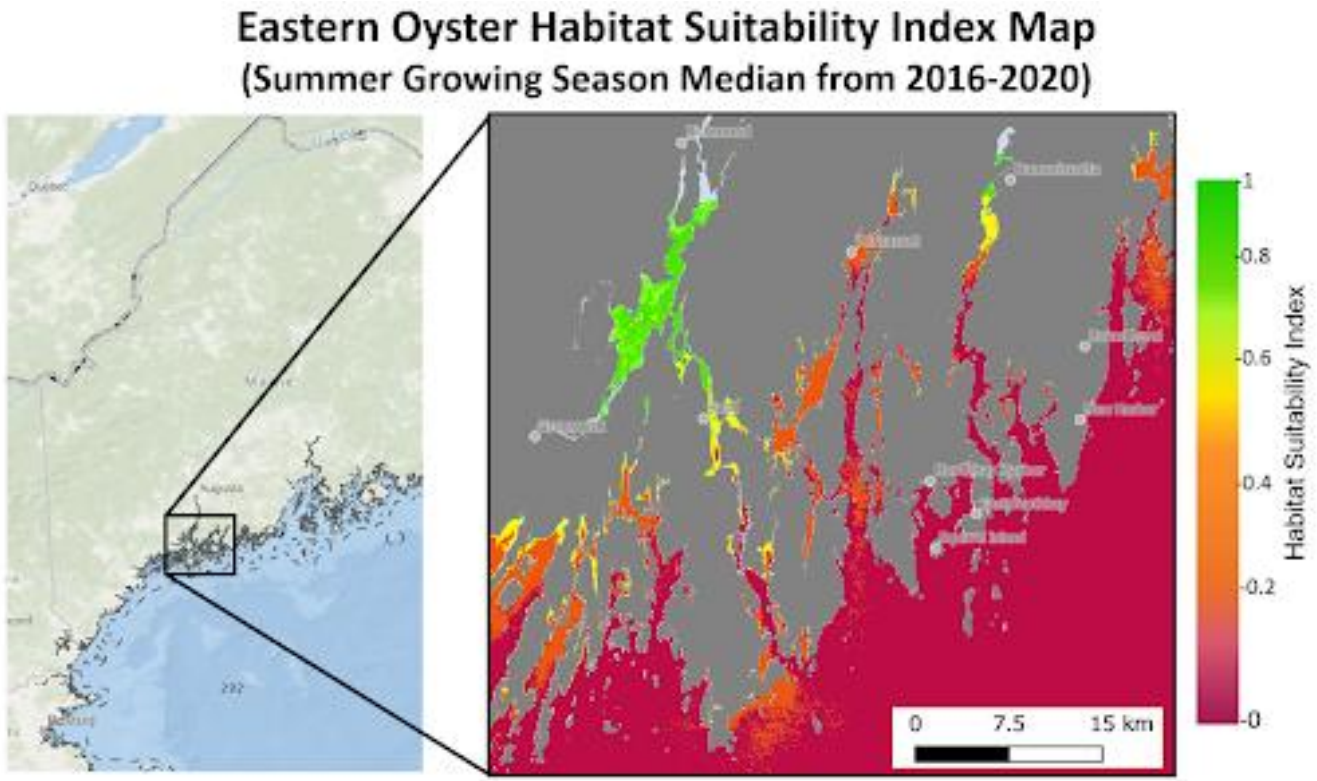
- Wildfire

*Blue Cut fire in California at 10:36 p.m. Pacific Daylight Time on August 17, 2016, as observed by the Thermal Infrared Sensor (TIRS) on Landsat 8 .*

*The image shows the amount of heat (thermal energy) radiating from the fiery landscape. Cooler areas are dark, while warmer areas are bright.*

*Image credit: Joshua Stevens, NASA Earth Observatory*

# Shellfish Suitability




*Scientists are using satellite data to support the identification of sites most suitable for oyster farming in the Gulf of Maine (Credit: NOAA).*

*The satellites measured sea surface temperature, plankton abundance, and water clarity.*

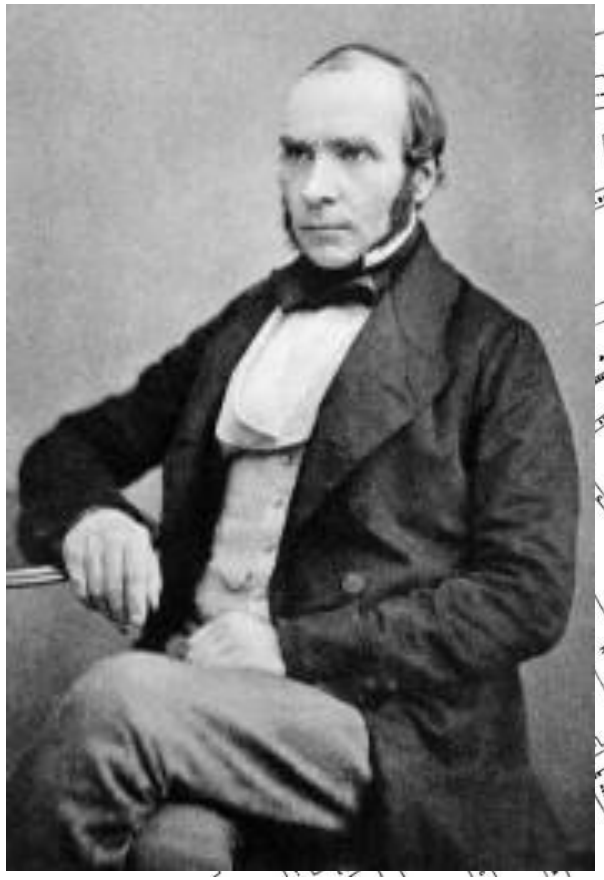
# GI technologies

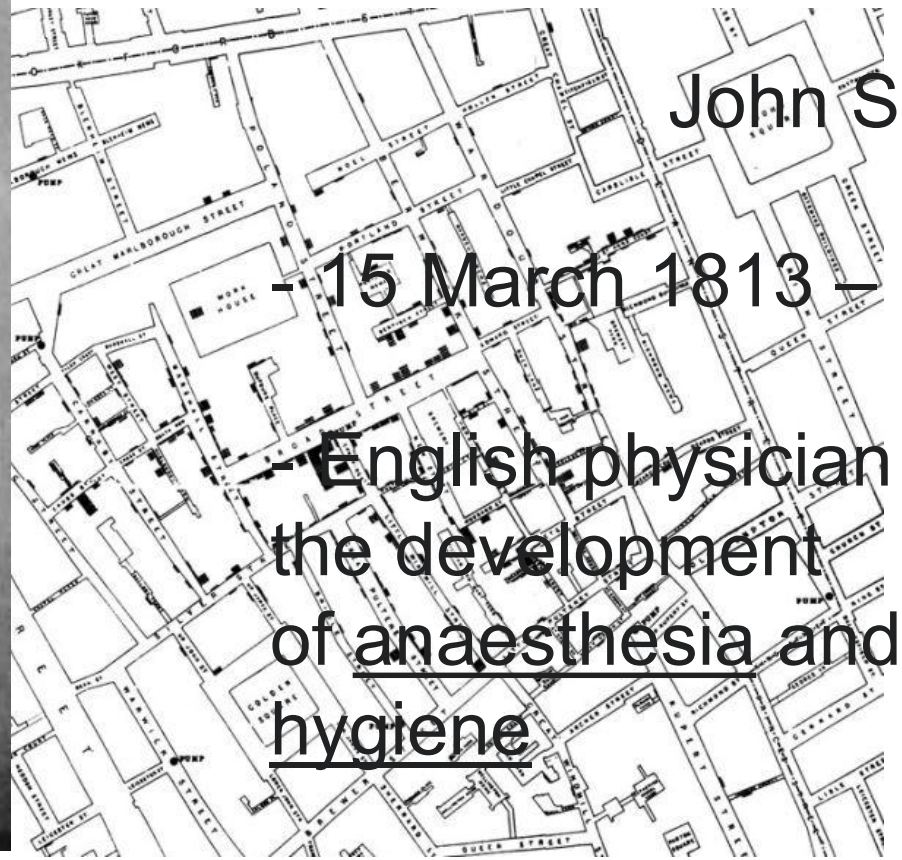
- GPS
  - a system of earth-orbiting satellites which can provide precise location on the earth's surface (in lat/long coordinates or equiv.)


*GPS and RS are sources of input data for a GIS*

# PRECURSOR TO GIS

- John Snow's Cholera Map

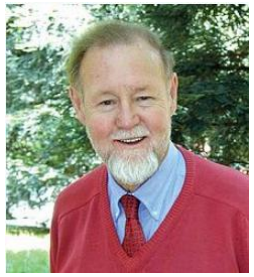




John Snow

- 15 March 1813 – 16 June 1858
- English physician and a leader in the development of anaesthesia and medical hygiene

# HISTORY



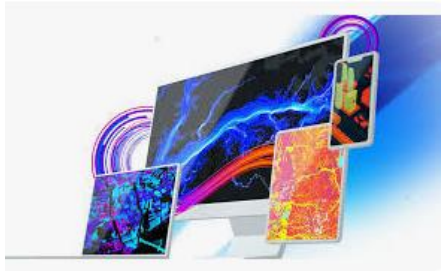
U.S. Census Bureau
Harvard Lab developed key tools that advanced GIS

**1960s**
Dr. Roger Tomlinson
Canada GIS

**1969**
Mr. Jack Dangermond

**1970s**


Arc/info, MapInfo



Desktop GIS


Web GIS

**1970s**

**1980s**

**1990s**

**2000s**

https://www.esri.com/en-us/what-is-gis/history-of-gis

https://en.wikipedia.org/wiki/Geographic_information_system

# FUNCTIONS OF A GIS

1. Capture
2. Store
3. Query
4. Analyze
5. Display

# Functions: *Capture*


https://landsat.usgs.gov/landsat-8

Volunteered Geographic Information

Mapathon

https://commons.wikimedia.org/wiki/File:Interspect_UAV_B_3.1.png

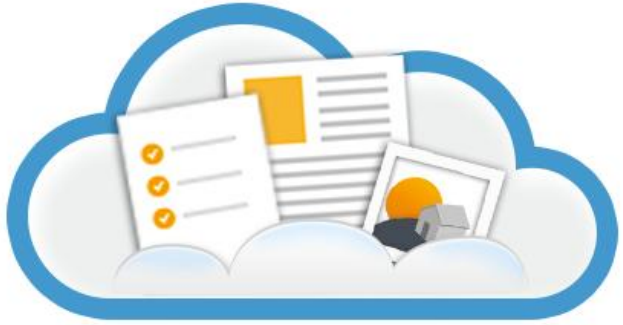

https://commons.wikimedia.org/wiki/File:Bad_gdop.png

# Functions: *Store*


Local disk

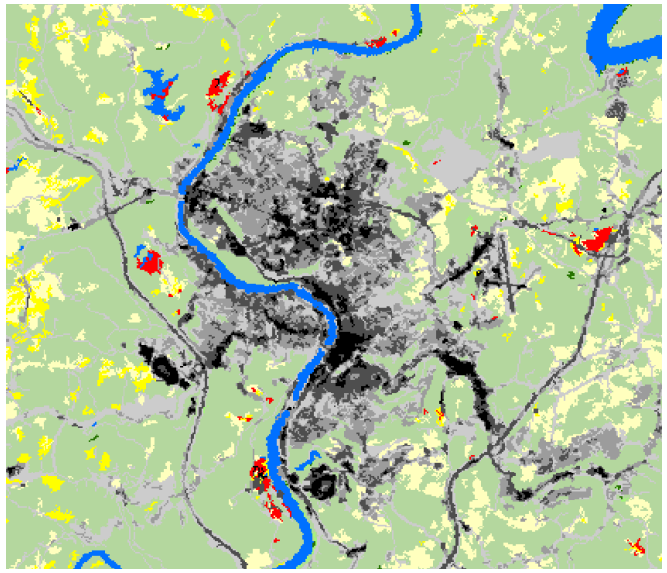
Server

amazon cloud drive

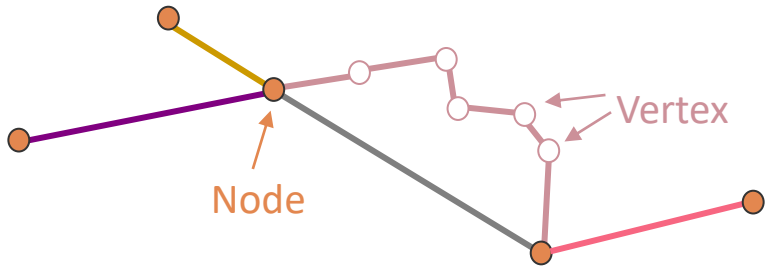


Cloud

# Functions: *Store*



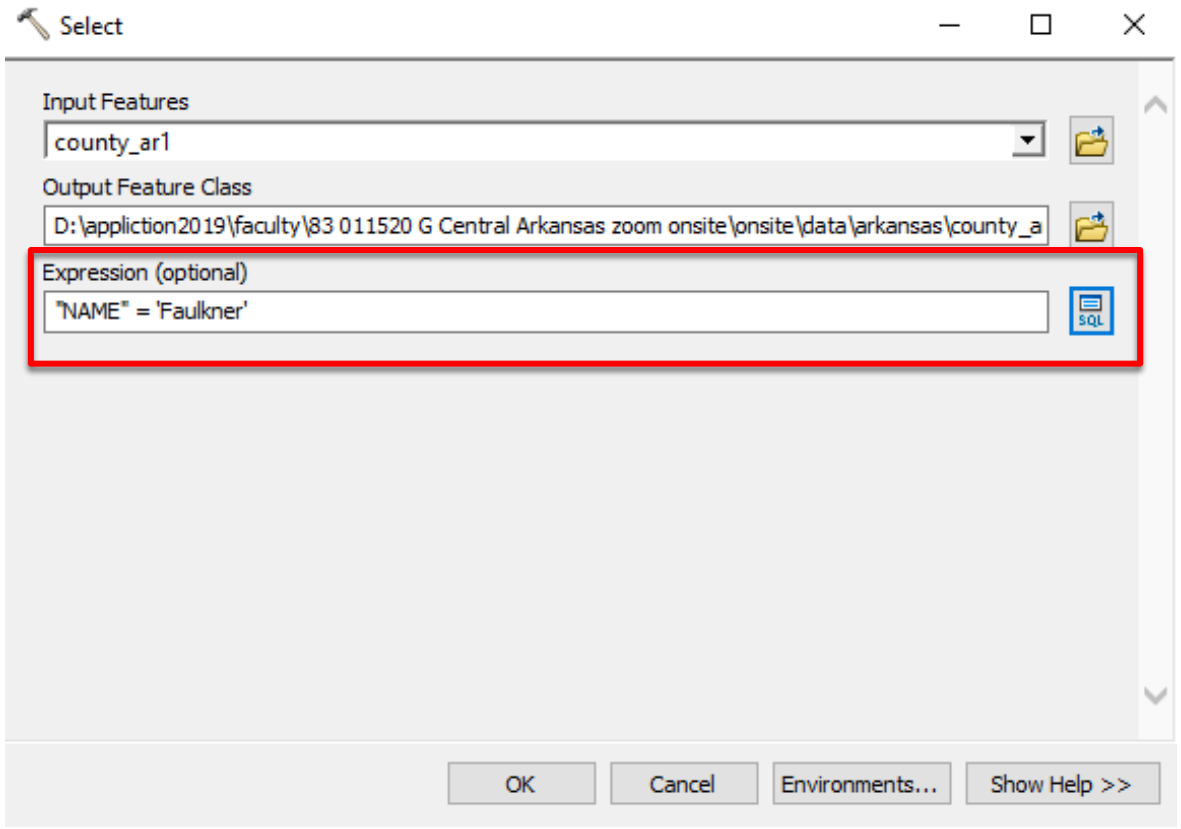
Raster

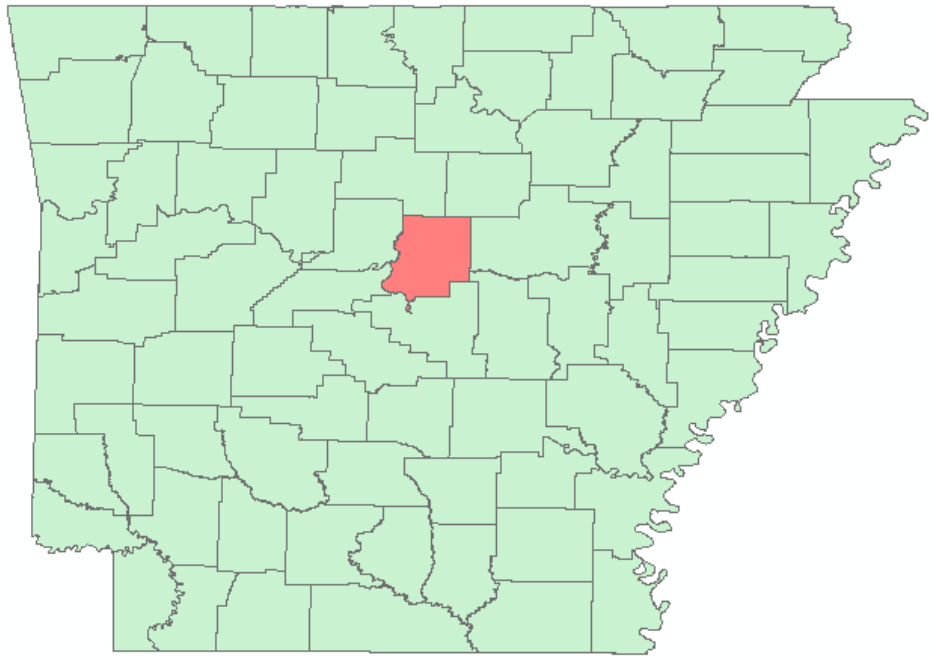



Vector

# Functions: *Query*

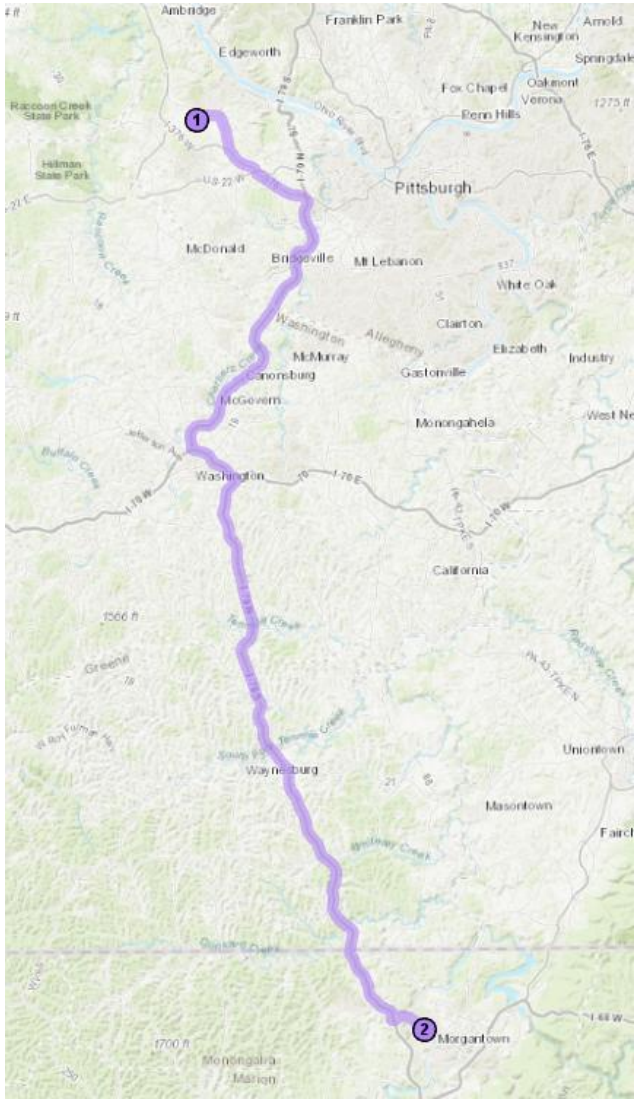
## Structured Query Language (SQL)



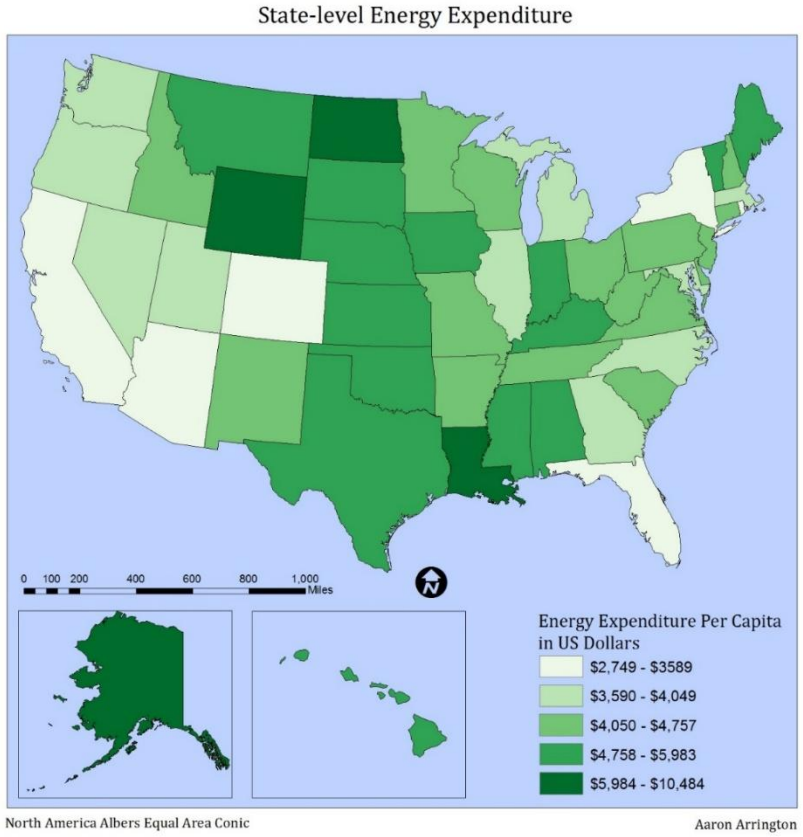



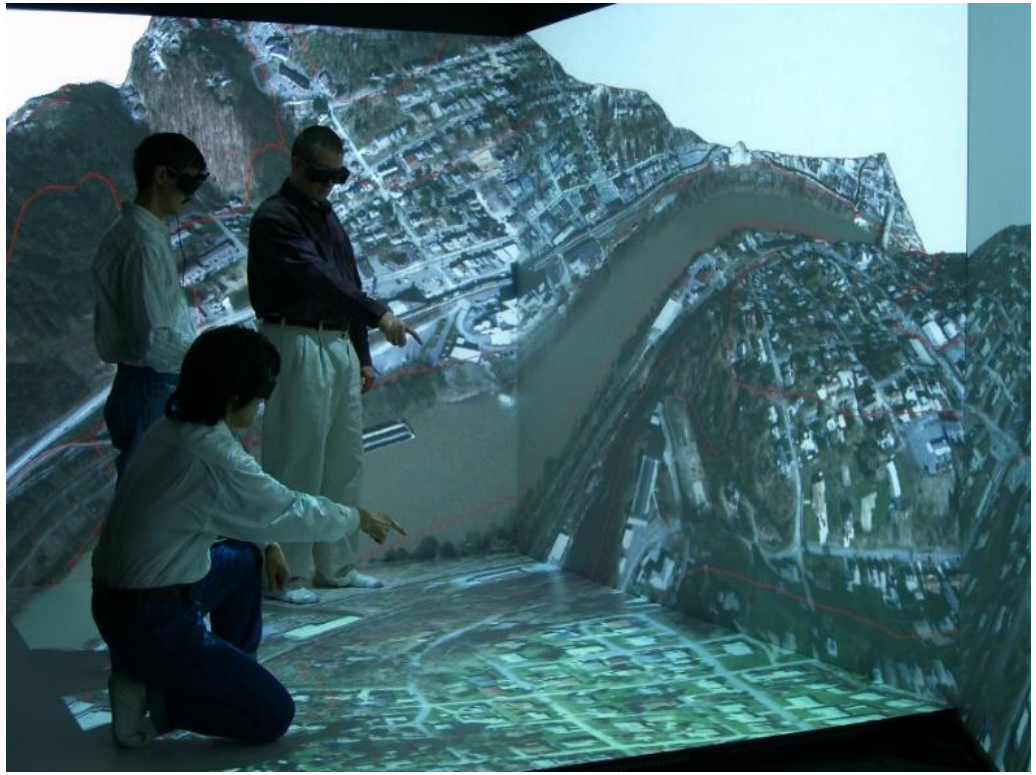
# Functions: *Analyze*

1. Directions
2. Buffer
3. Proximity
4. Suitability
5. Likelihood
6. Best locations
7. Worst locations
8. Etc.



# Functions: *Display*



Virtual Reality

# Components of a GIS

1. People
2. Data
3. Hardware
4. Software
5. Methods/Protocol


https://www.rst2.org/ties/GENTOOLS/comp_gis.html

# Components: *People*


https://www.argisusers.org/


http://www.aag.org/


https://www.asprs.org/


https://www.gisci.org/


https://www.esri.com/training/

Logos were obtained from organization websites

# Components: *People*

- Department of Geography @UCA

## Programs

**Undergraduate Majors**

Geography

Geospatial Concentration

Environmental Science – Planning & Administration

**Undergraduate Minors**

Geography

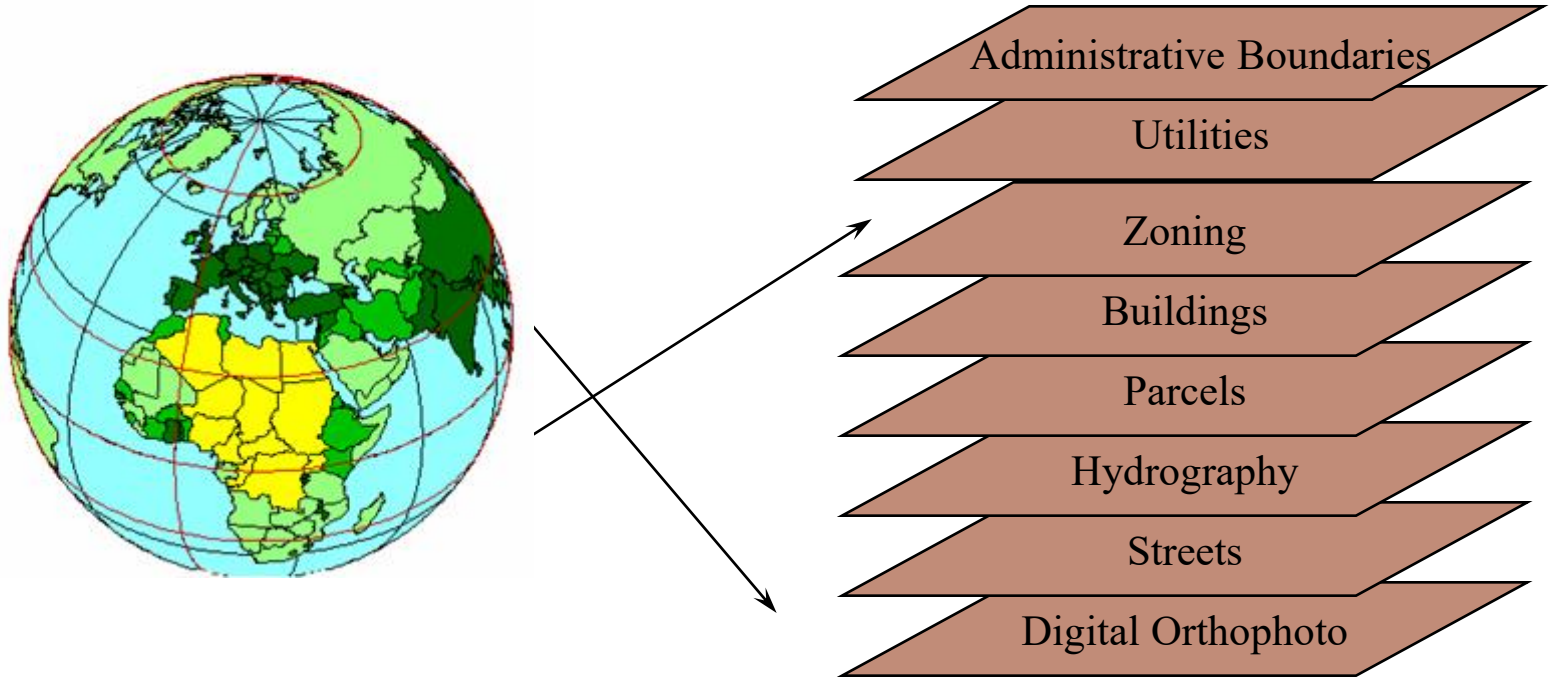
GIS

**Graduate**

Master of GIS

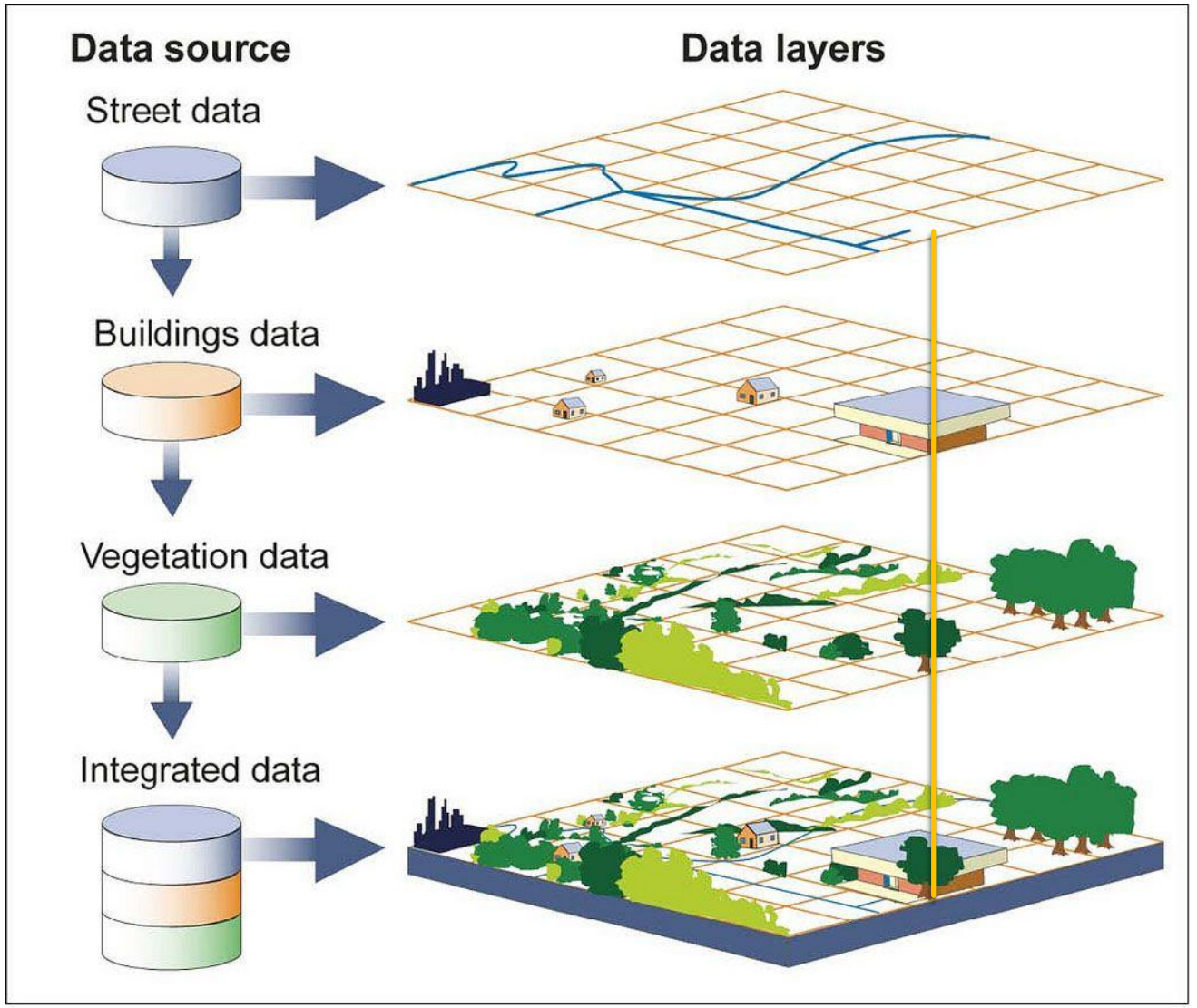
GIS Certificate

# Components: *Data*




- Data is organized by layers, coverages or themes*, with each layer representing a common feature.*
- Layers are integrated using explicit location on the earth's surface, *thus geographic location is the organizing principal*.

# Components: *Data*




Source: GAO.

# GROUP DISCUSSION

- If we were to build an indoor GIS for our campus buildings to help students find classrooms, what kinds of layers would be useful?

- Divide into small groups 3 -4 students

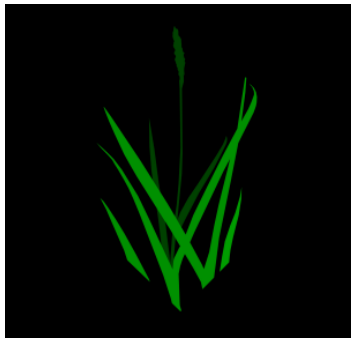
- Choose one representative from your group to share your discussion results

# Components: *software*







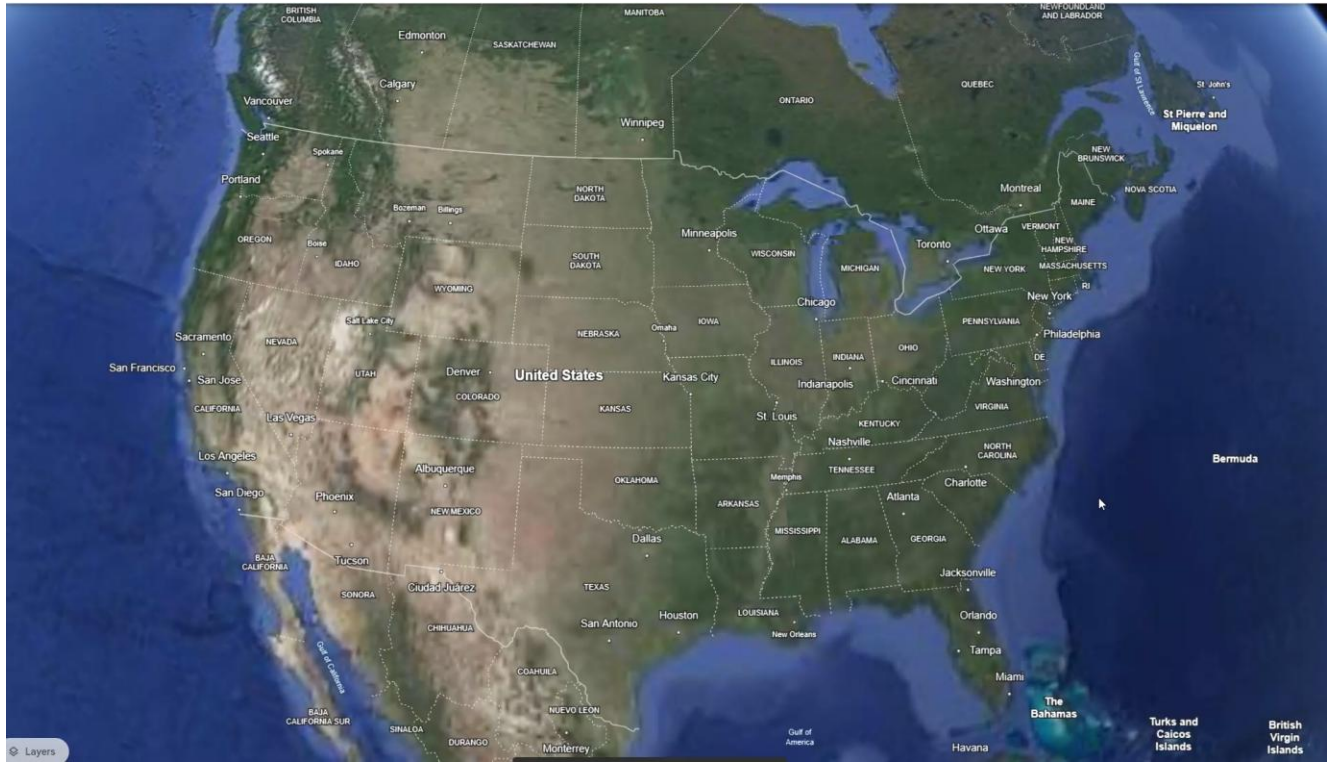




Logos were obtained from organization websites

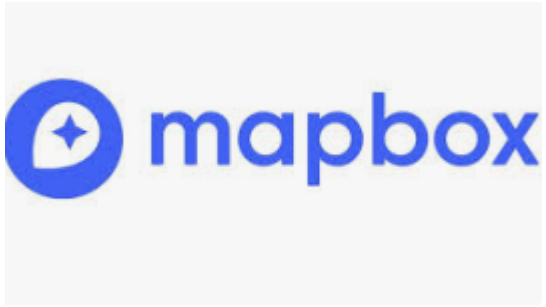
# TYPES OF GIS & MAPPING SOFTWARE

| Type | Analysis Power | Example(s) |
|---|---|---|
| **Geobrowser** | **Weak**<br>mainly only to display data) | Google Maps, Google Earth, Apple Maps, Waze, etc. |



# TYPES OF GIS & MAPPING SOFTWARE

| Type | Analysis Power | Example(s) |
| --- | --- | --- |
| **Web-based** | **Medium**<br>able to upload additional data, customize display, and perform basic analyses) | Carto, ArcGIS Online, Mapbox, Google MyMaps, etc. |





# TYPES OF GIS & MAPPING SOFTWARE

| Type | Analysis Power | Example(s) |
|---|---|---|
| **Desktop** | **Strong**<br>installed locally, provides full control of map creation, and perform advanced analyses) | ArcGIS Pro, QGIS |


# Which desktop software should we use today?

ArcGIS Pro

1. Commercial (expensive, requires license)
2. Windows only
3. Powerful, but heavy on computer resources
4. Strong integration with ArcGIS Online
5. Excellent training & official support
6. Full professional toolkit

QGIS

1. Free, open-source
2. Works on Windows, Mac, Linux
3. Lightweight, runs smoothly on most computers
4. Many tools available (though some functions less polished)
5. Community tutorials & forum support
6. Flexible (anyone can develop tools, but documentation varies)

# Components: *hardware*

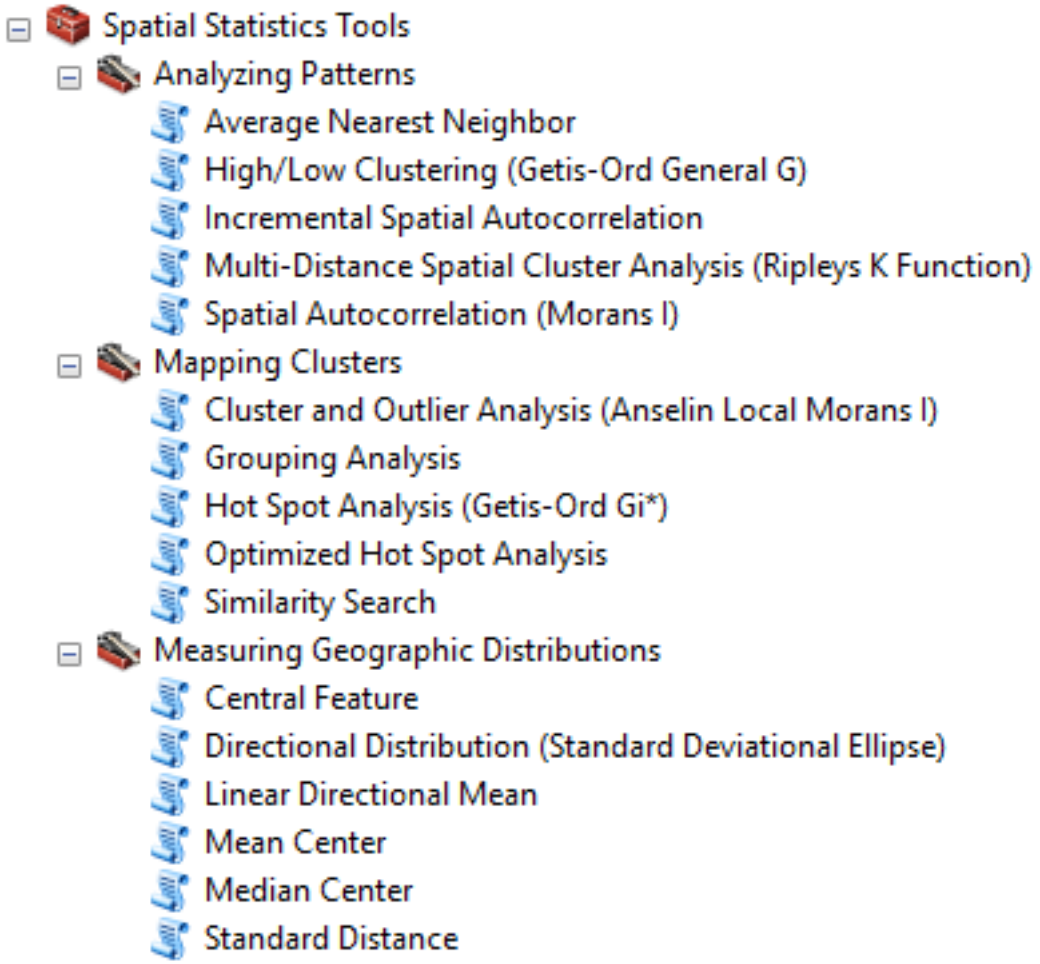
https://commons.wikimedia.org/wiki/File:Interspect_UAV_B_3.1.png

https://www.microsoft.com/en-us/p/surface-laptop-3/8VFGGH1R94TM/F29J?activetab=overview&source=googleshopping&OCID=AID2000022_SEM_mRUxj5Qp

http://geospatialfieldmethodstanner.blogspot.com/2014/04/field-activity-9-surveying-with-topcon.html

# Components: *Method*

- ✓ Table Query
- ✓ Map design
- ✓ Digitizing
- ✓ Georeferencing
- ✓ Resampling
- ✓ Vector spatial analysis
- ✓ Raster spatial analysis
- ✓ Digital terrain analysis
- ✓ Geospatial modeling
- ✓ ArcGIS Model Builder
- ✓ Weighted overlay
- ✓ Spatial statistical analysis
- ✓ Spatial interpolation



# GIS

# MORE THAN MAPS

# Applications

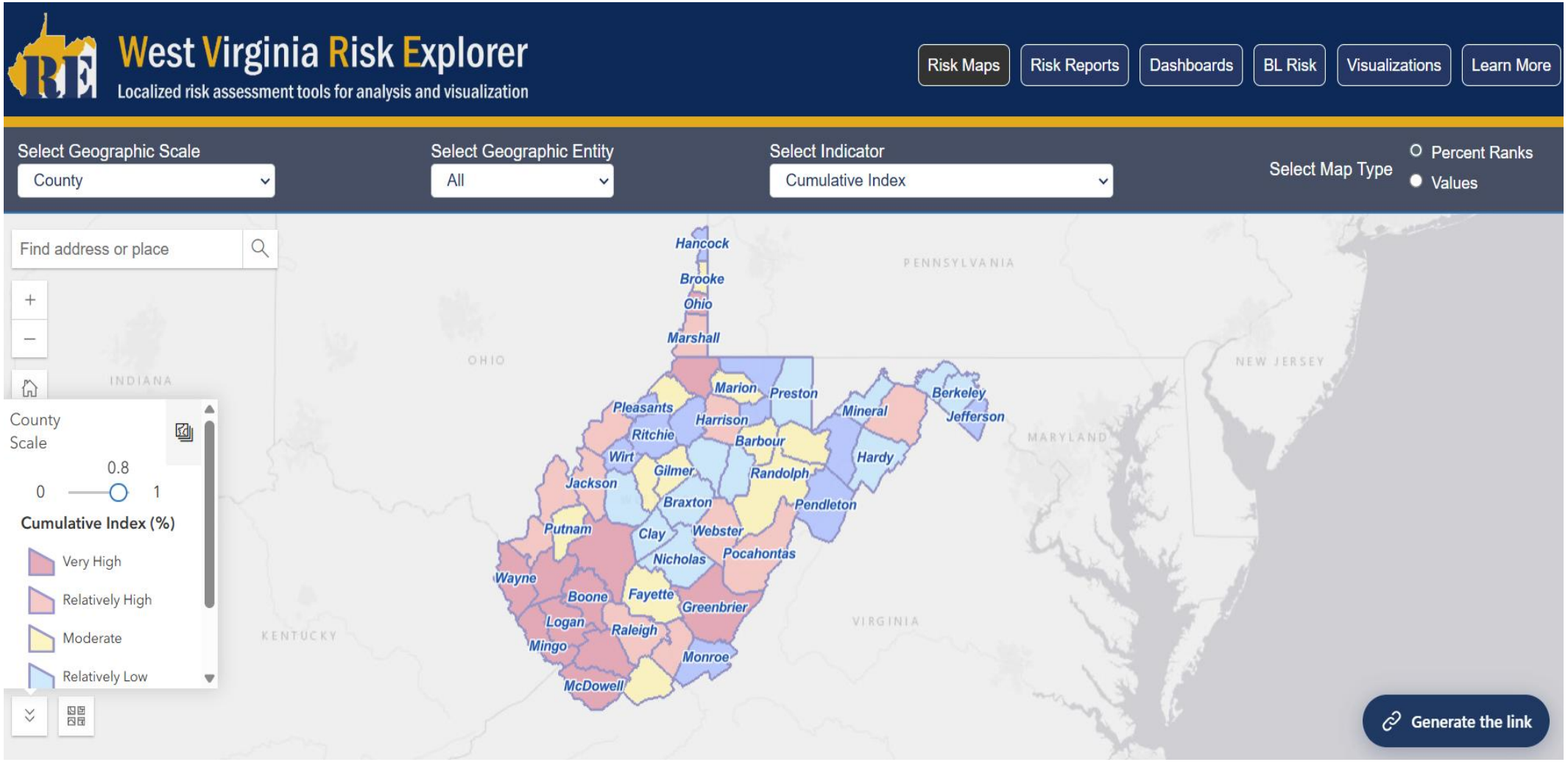
- **Urban Planning, Management & Policy**
  - Land acquisition
  - Housing renovation programs
  - Emergency response
  - Tax assessment
- **Environmental Sciences**
  - Monitoring environmental risk
  - Modeling stormwater runoff
  - Management of watersheds, floodplains, wetlands, forests, aquifers
  - Groundwater modeling and contamination tracking
- **Political Science**
  - Redistricting
  - Analysis of election results
  - Predictive modeling

# Applications

- **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

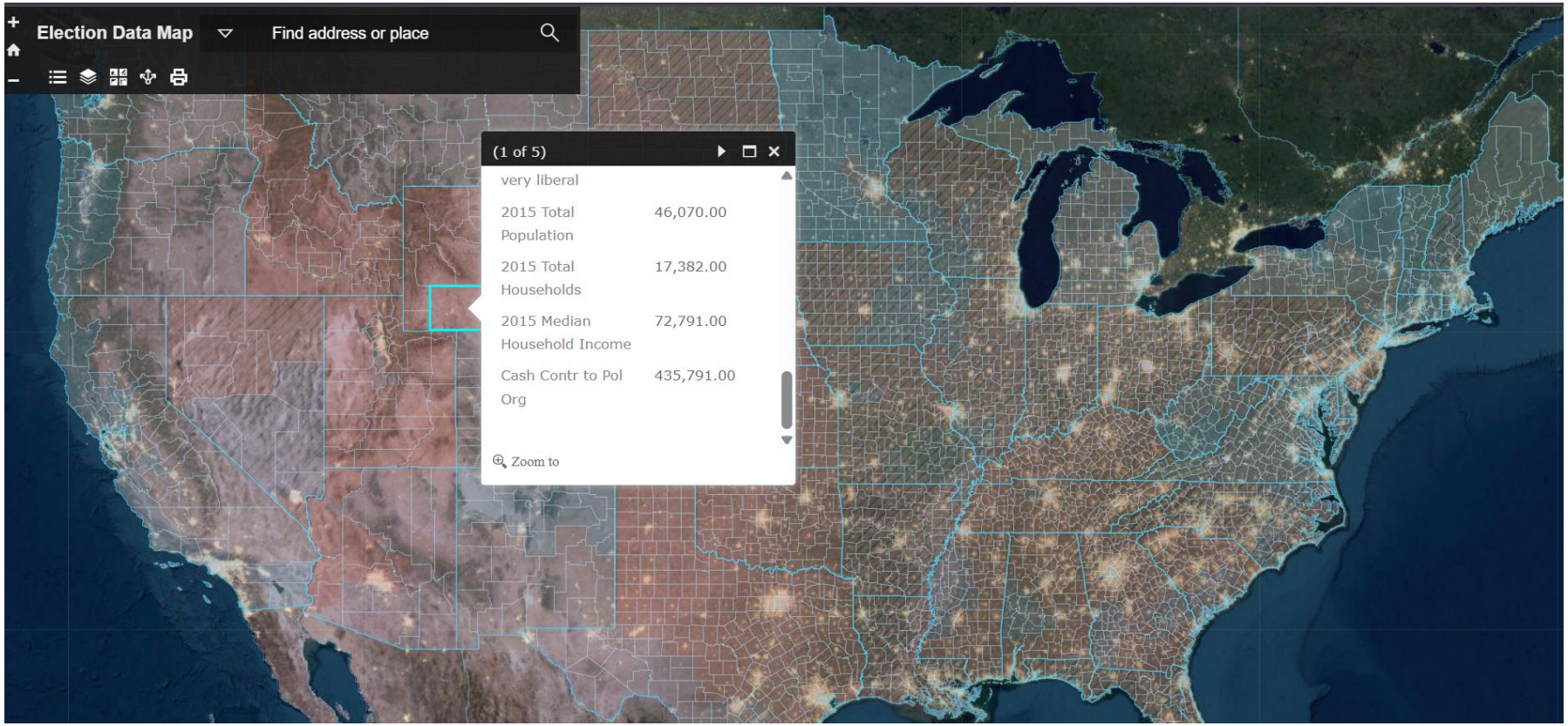
# Example: *GIS in Environmental Science*

## West Virginia Risk Explorer



# Example: *GIS in Political Science*

## 2020 Presidential Election




Election Data Map

# Example: *GIS in Health Care*

Traveling during early stage of COVID-19 period

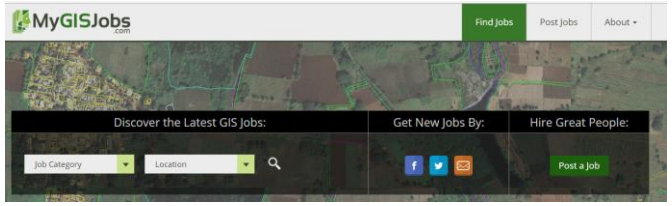

https://geods.geography.wisc.edu/

# GIS Application in Modern World

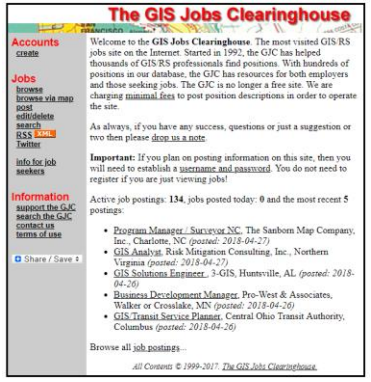
# GISer Job Market

- **Local Government**
  - Planning and environmental management
  - property records and appraisal
- **Real Estate and Marketing**
  - Retail site selection, site evaluation
- **Public safety and defense**
  - Crime analysis, fire prevention, emergency management, military/defense
- **Natural resource exploration/extraction**
  - Petroleum, minerals, quarrying
- **Transportation**
  - Airline route planning, transportation planning/modeling
- **Public health and epidemiology**
- **The Geospatial Industry**
  - Data development, application development, programming


https://www.gisjobs.com/




https://www.mygisjobs.com/




http://www.gjc.org/

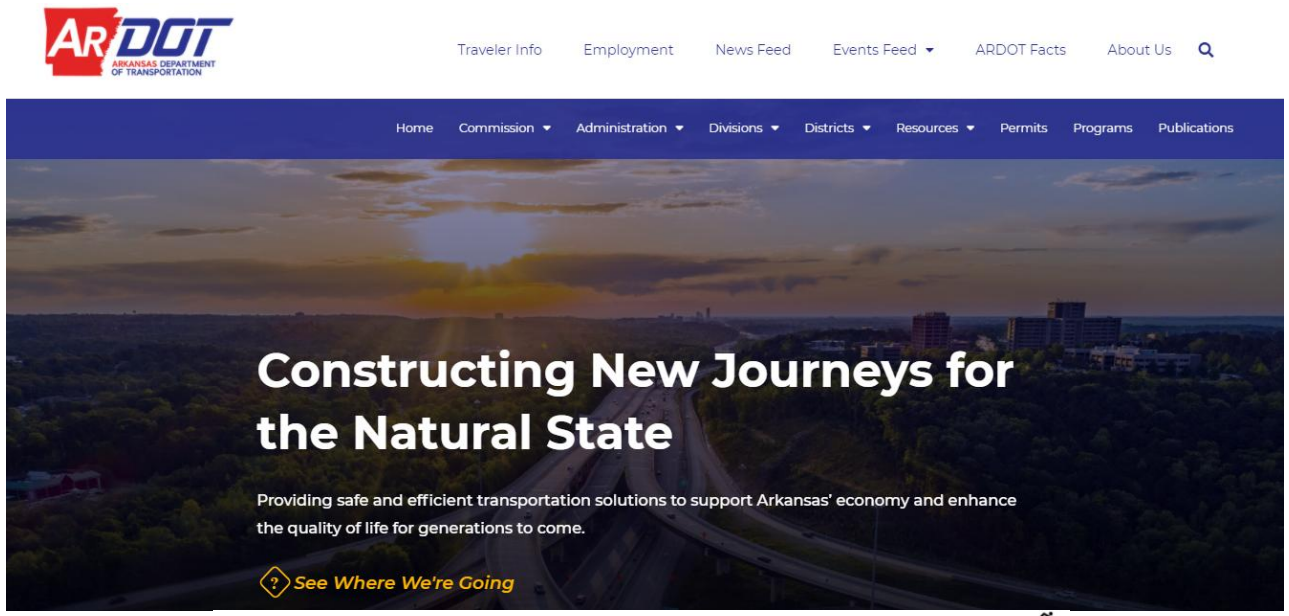
# Geography Students placement @UCA

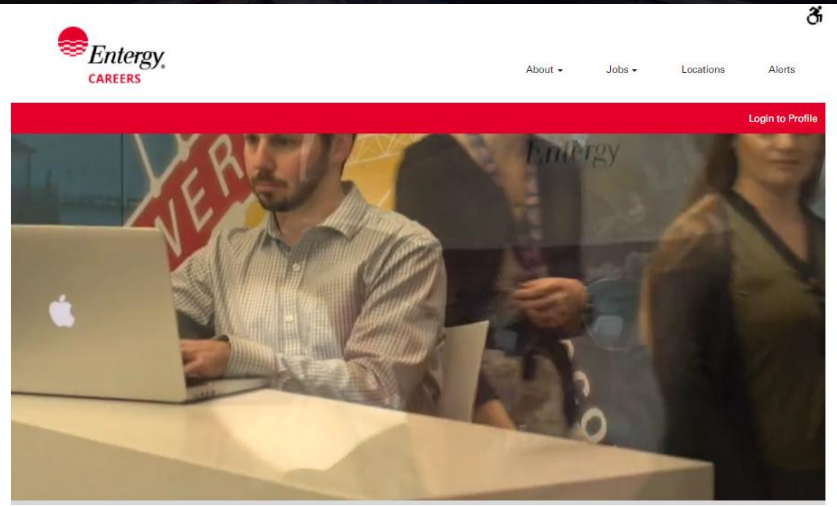
2020-2021

1. Four students worked as full time at ARDOT
2. Three students in master GIS program @UCA (One student is supported by Arkansas Space Grant Consortium project)

2022

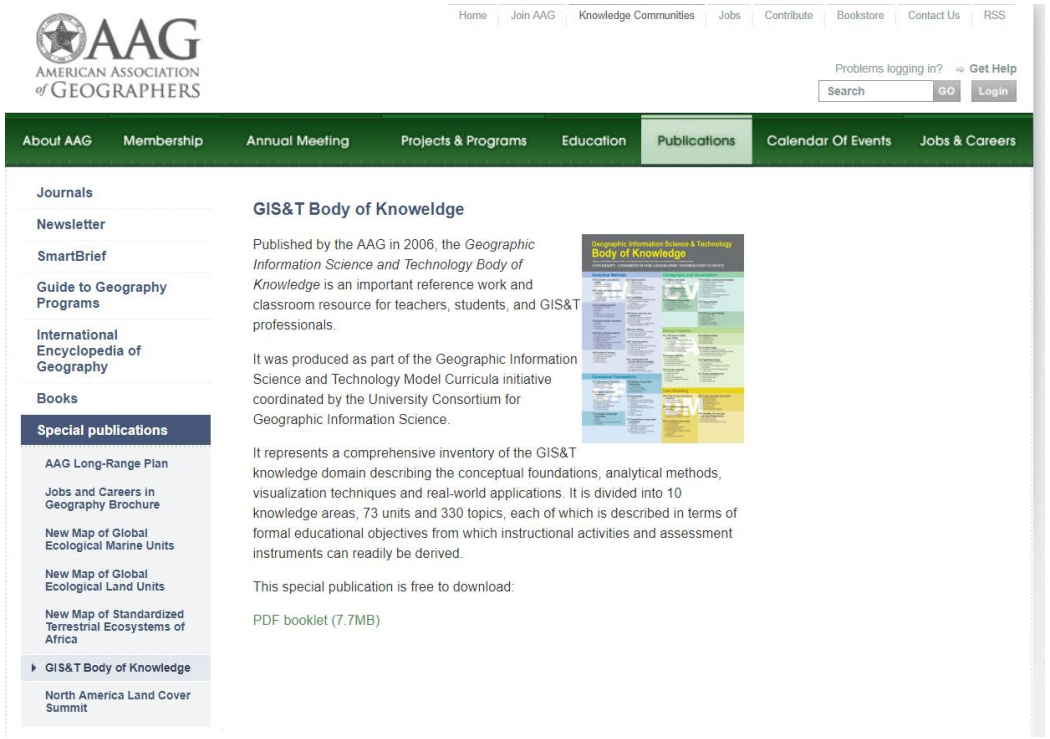
1. Two current students worked as part-time at ARDOT



# Geospatial Skillsets

1. Spatial problem solving
2. Spatial analysis
3. Software troubleshooting
4. Statistics
5. Spatial predictive modeling
6. Database management
7. Web GIS
8. Python scripting
9. Cartography/Map design
10. Graphic design
11. Image interpretation
12. GPS tracking




http://www.aag.org/cs/publications/special/gist

# Esri Summer Internship

12-WEEK SUMMER INTERNSHIP

## Innovation and collaboration

**Real work. Real experience.**

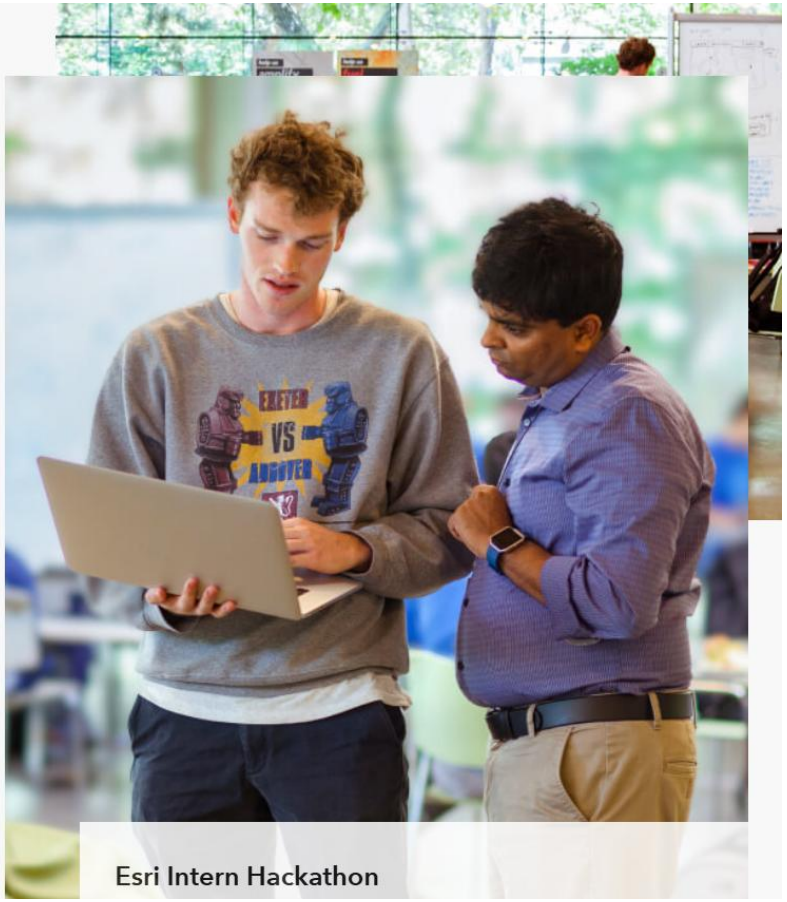
Work on projects that matter, such as creating an app to speed emergency aid or conducting research for a marketing campaign.

**Work hard and play hard**

Participate in daily events and programs, including Monday Meetups, Tech Tuesday, What's Next Wednesday, Training Thursdays, and Fun Friday.

**Accelerated personal growth**

One-on-one mentoring, professional development workshops, and various networking opportunities provide valuable tools to jump-start your career.




Esri Intern Hackathon

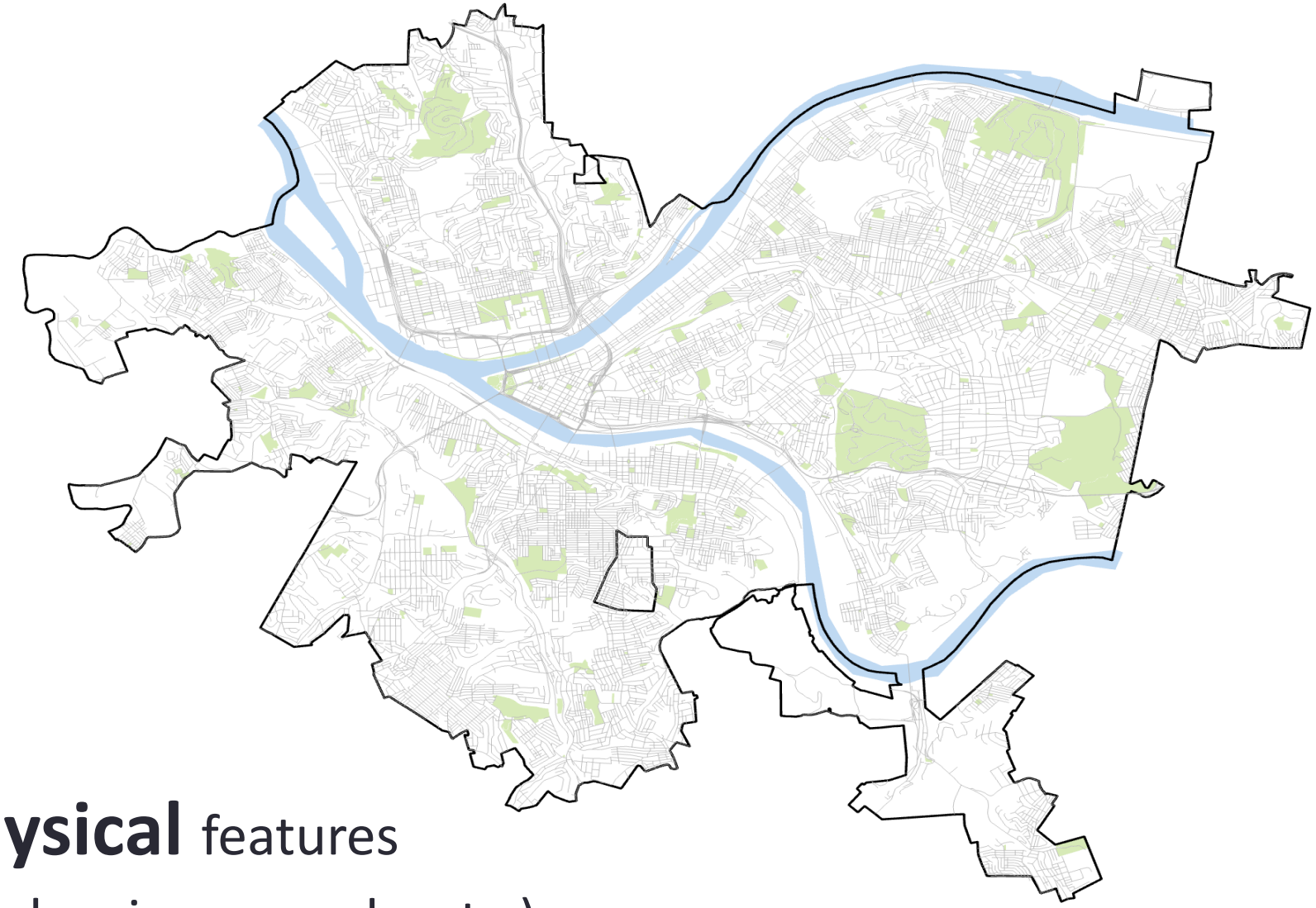
# 2.2
# FEATURE CLASSES AND MAP LAYERS

GIS stores related geographic features as separate collections of files called **feature classes**

1. can be easily reused, assembled into any number of map compositions, and overlaid for analysis
2. are associated with attribute tables of data

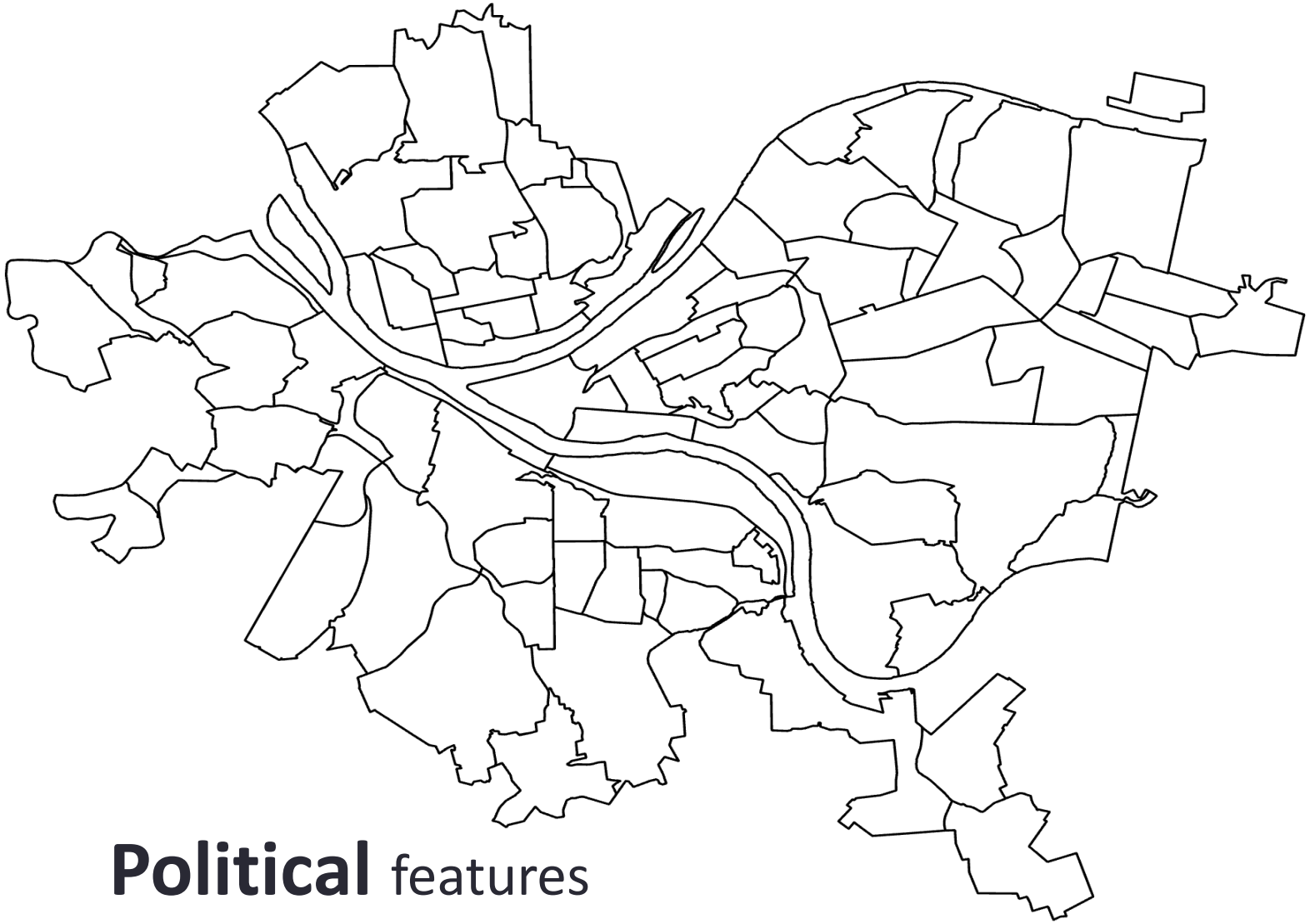
When symbolized and displayed as part of a map, a feature class is called a **map layer**

51



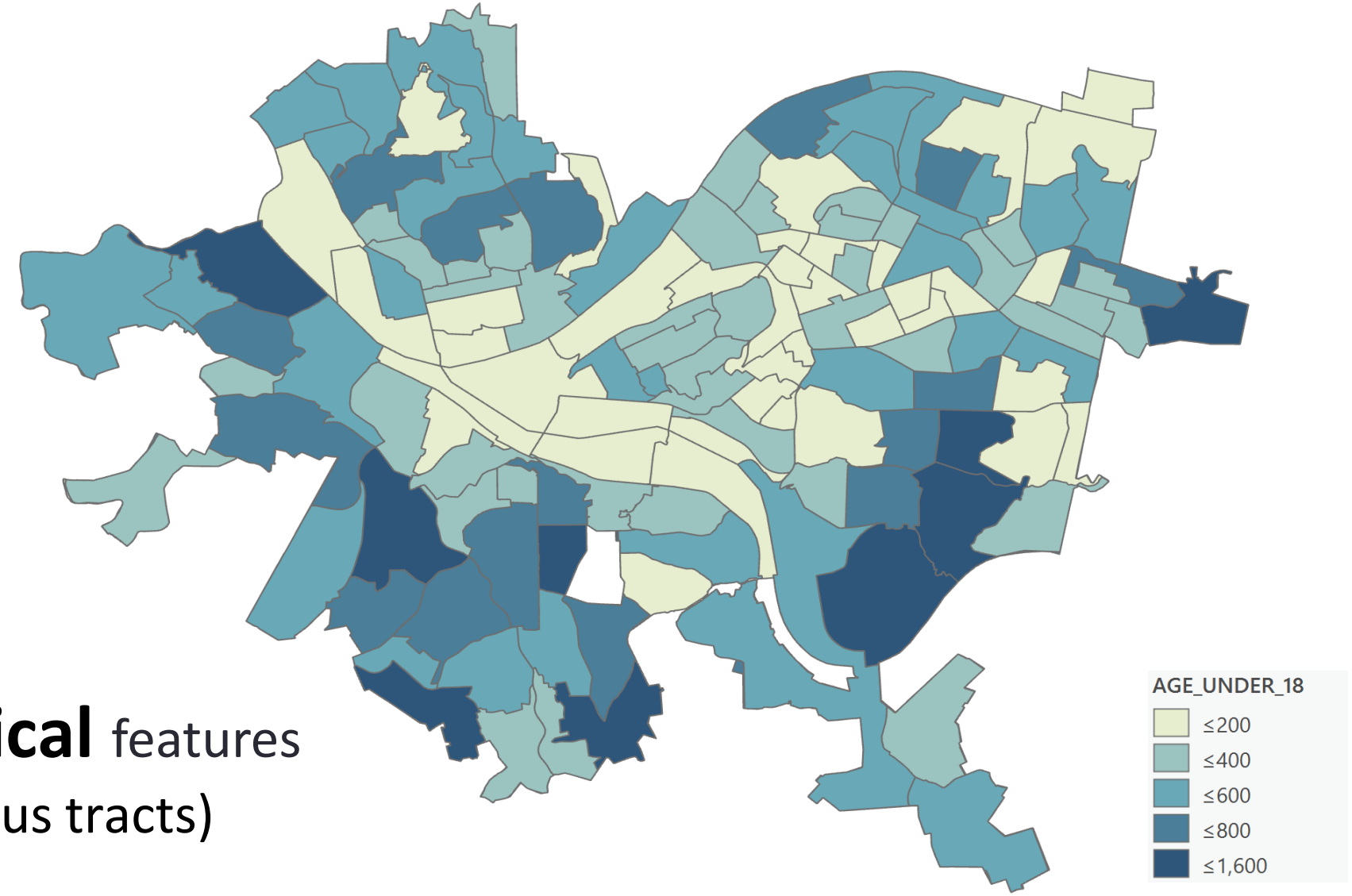
**Physical** features

(lakes, parks, rivers, roads, etc.)



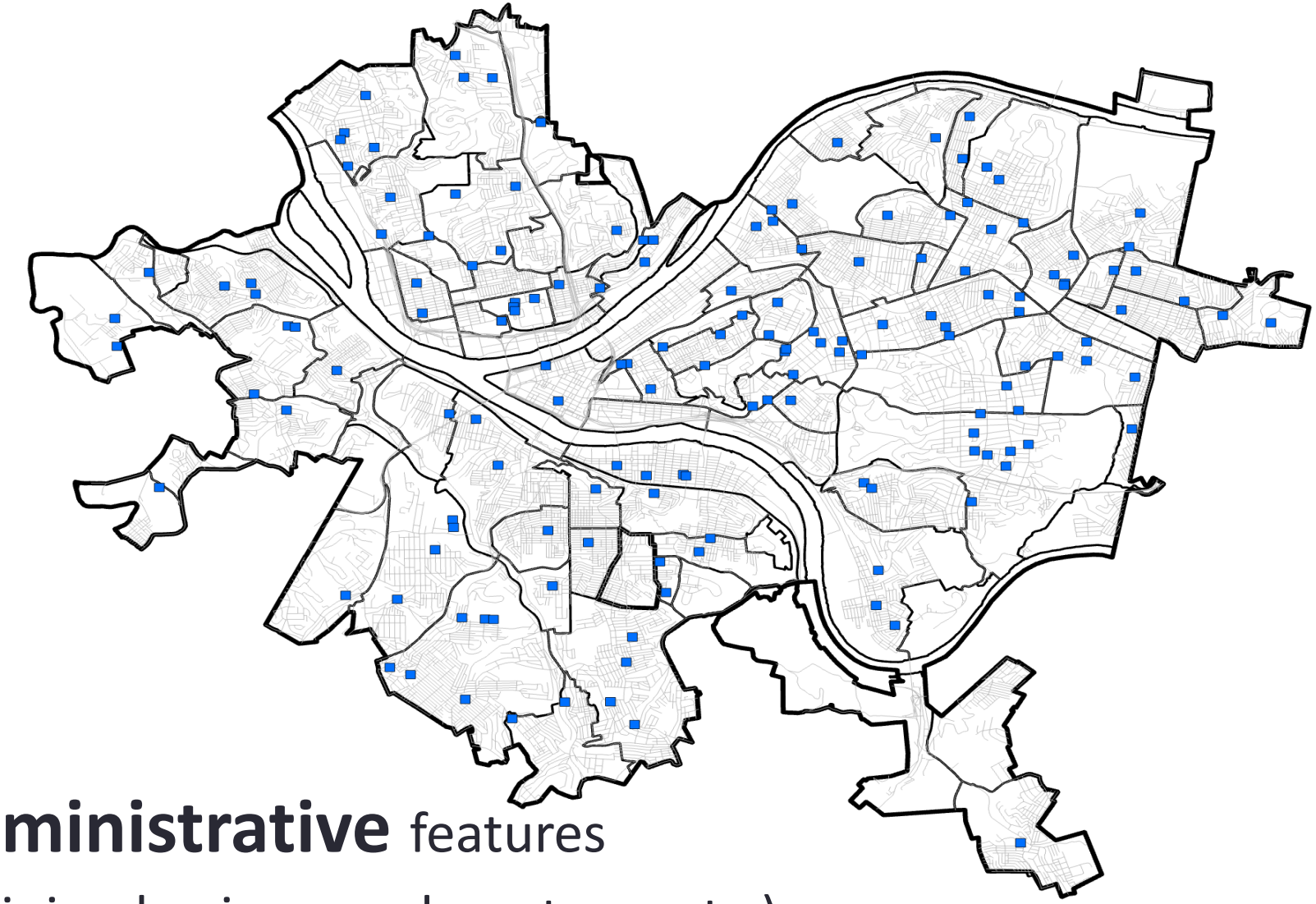
**Political** features

(states, provinces, municipalities, neighborhoods)




**Statistical** features

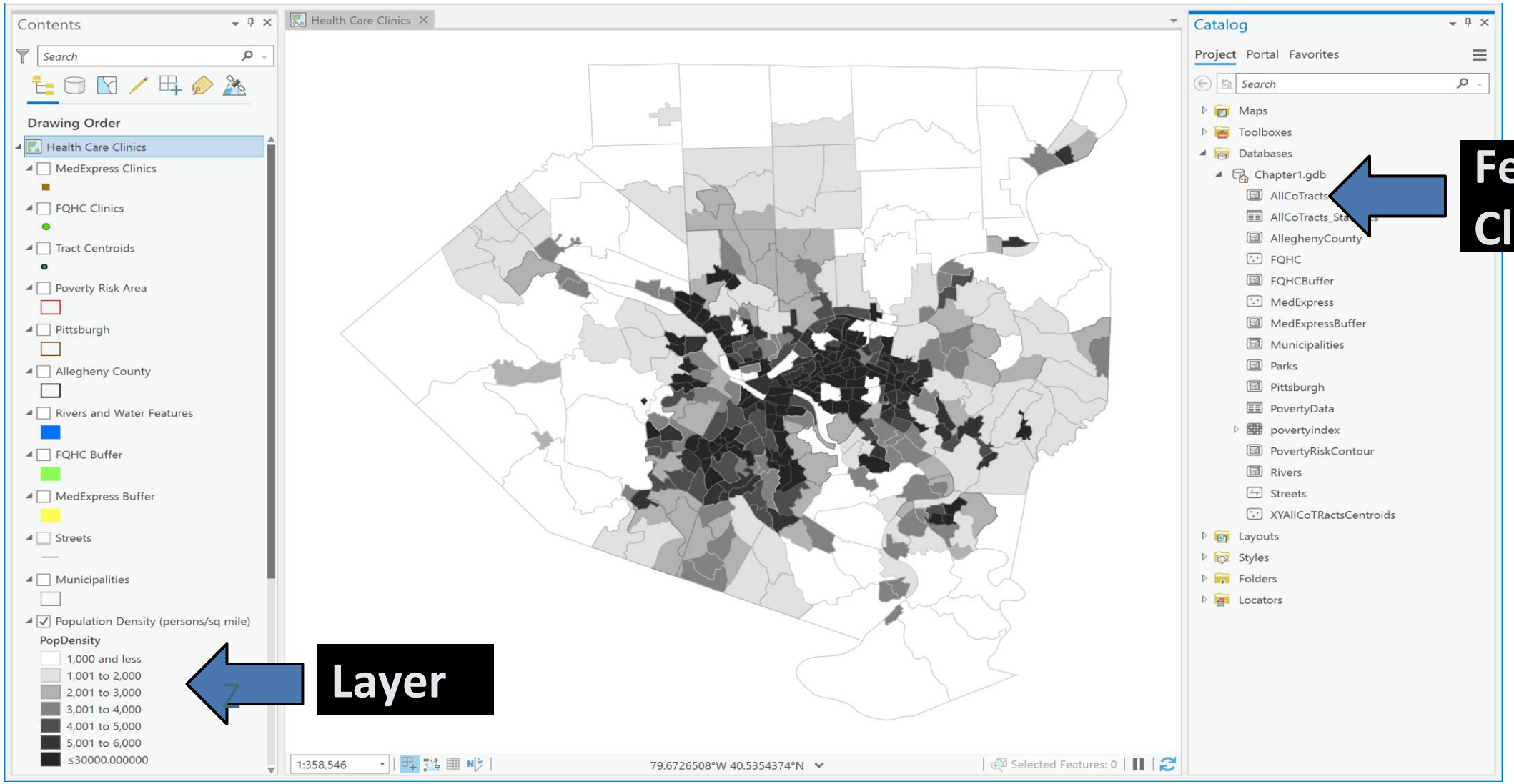
(Census tracts)



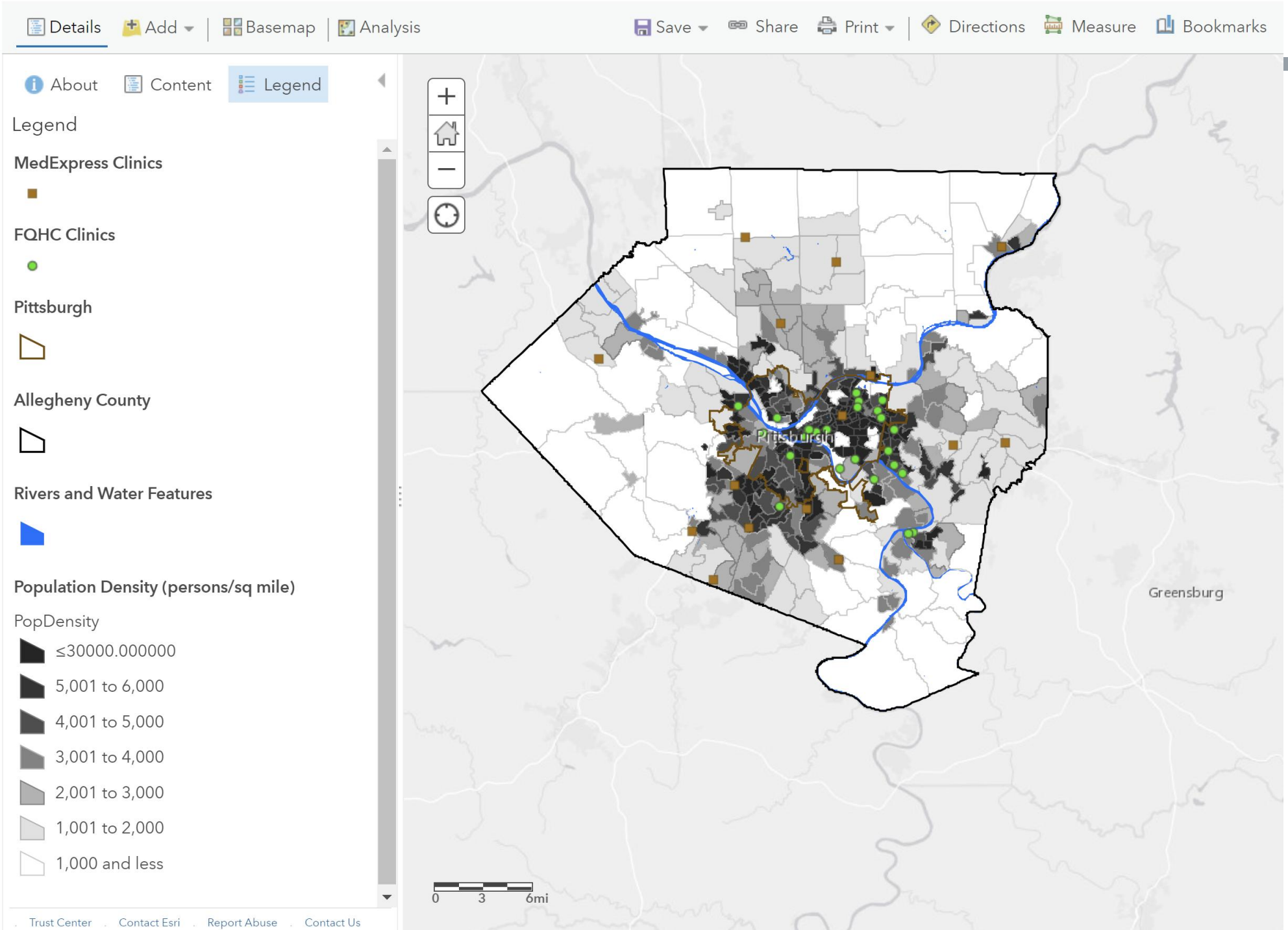
**Administrative** features

(schools, clinics, businesses, bus stops, etc.)

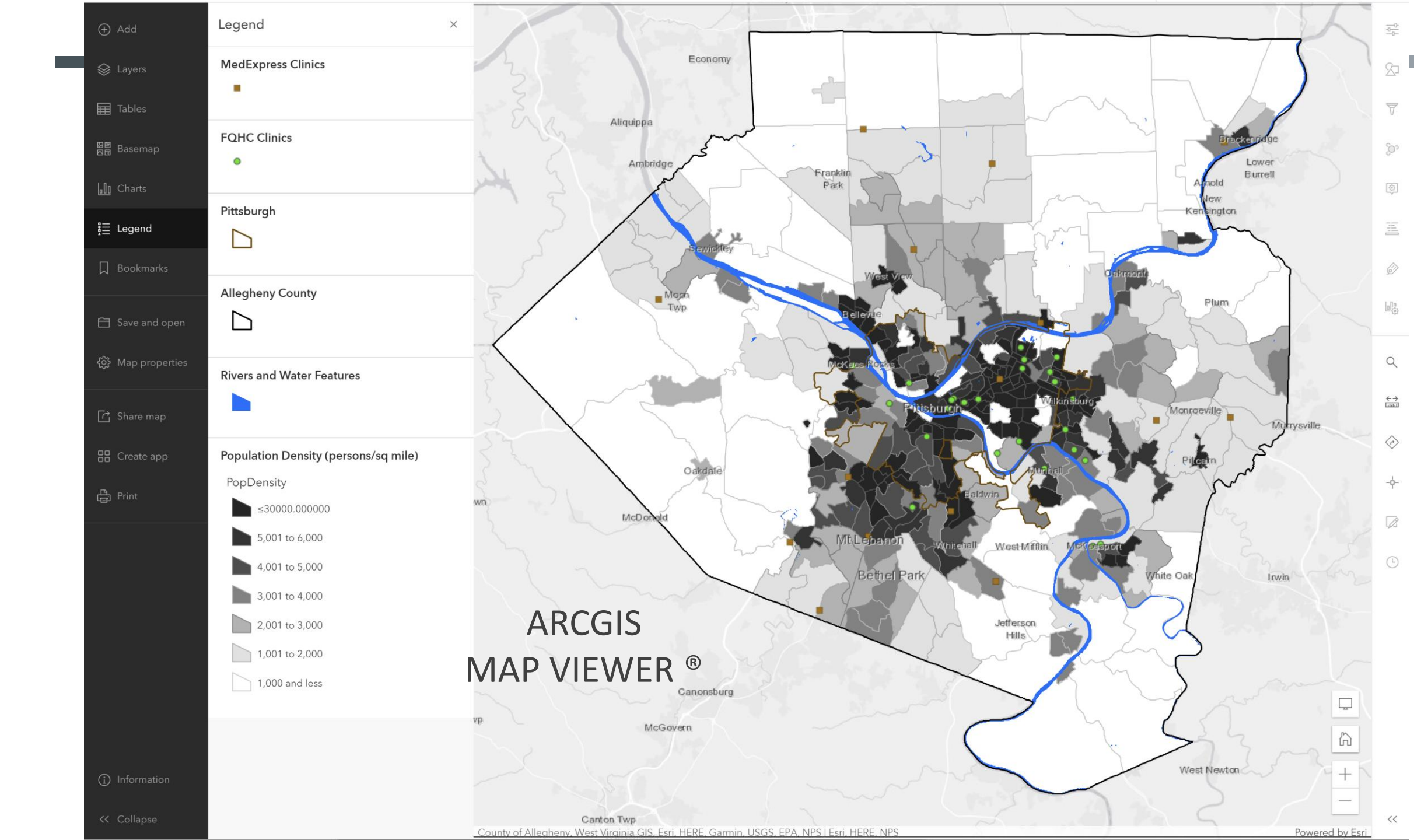
# **Layers and features** as viewed in ArcGIS Pro

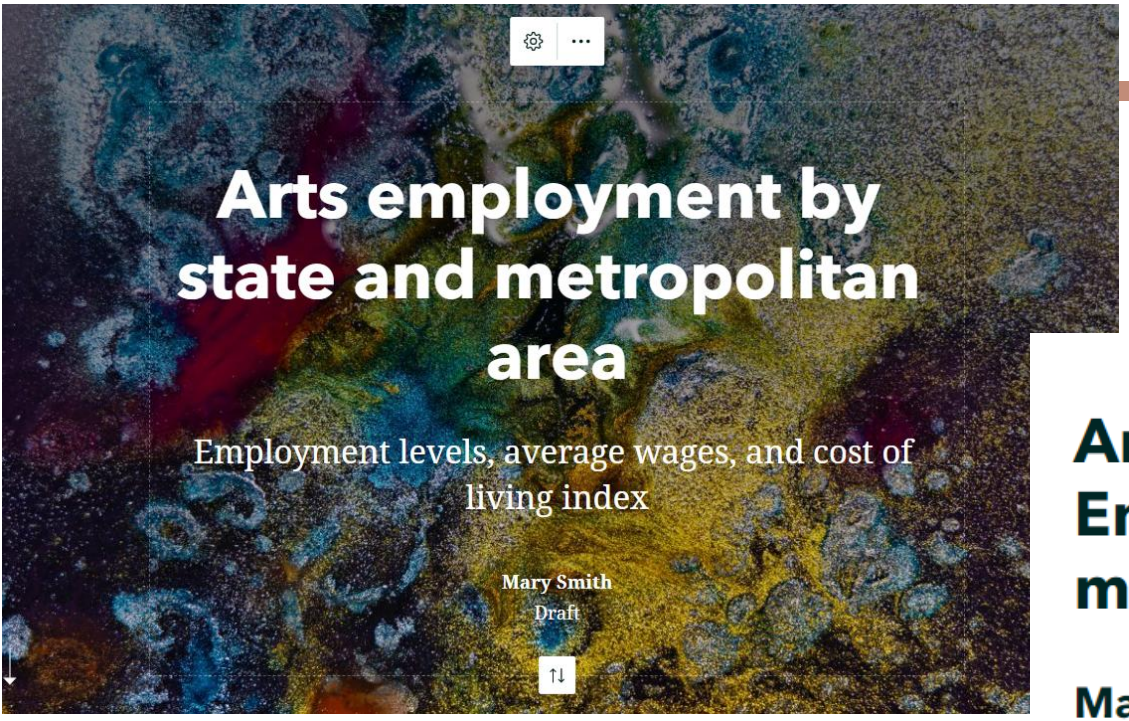


# 2.3
# ARCGIS ONLINE




# ARCGIS ONLINE®
## (MAP VIEWER CLASSIC)


Add
Layers
Tables
Basemap
Charts
Legend
Bookmarks
Save and open
Map properties
Share map
Create app
Print
Information
Collapse
Legend
MedExpress Clinics
FQHC Clinics
Pittsburgh
Allegheny County
Rivers and Water Features
Population Density (persons/sq mile)
PopDensity
≤30000.000000
5,001 to 6,000
4,001 to 5,000
3,001 to 4,000
2,001 to 3,000
1,001 to 2,000
1,000 and less
Economy
Aliquippa
Ambridge
Franklin Park
Sewickley
Moon Twp
West View
Bellevue
McKees Rocks
Pittsburgh
Oakdale
McDonald
Canonsburg
McGovern
Canton Twp
Mt Lebanon
Bethel Park
Baldwin
Whitehall
West Mifflin
Jefferson Hills
Brackenridge
Lower Burrell
Arnold
New Kensington
Oakmont
Plum
Wilkinsburg
Monroeville
Murrysville
Pitcairn
Munhall
McKeesport
White Oak
Irwin
West Newton
ARCGIS
MAP VIEWER ®
County of Allegheny, West Virginia GIS, Esri, HERE, Garmin, USGS, EPA, NPS | Esri, HERE, NPS
Powered by Esri



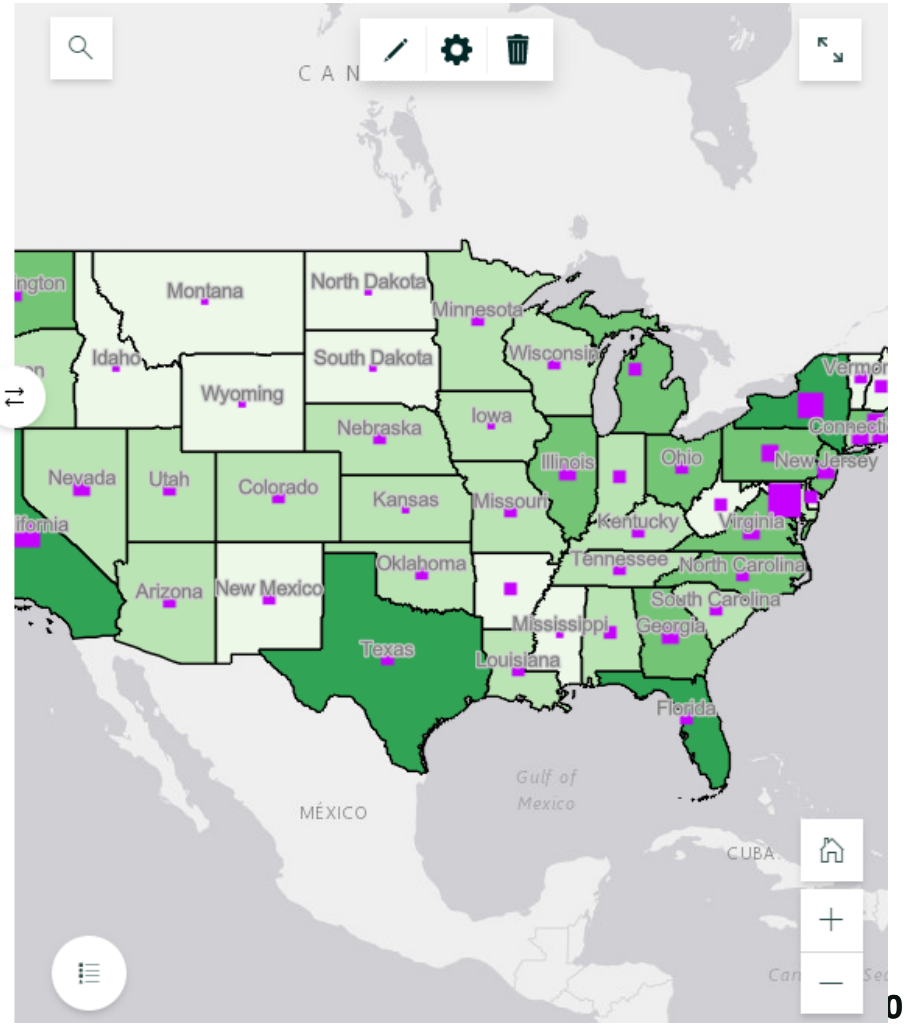

# ArcGIS Story Maps®

[Competition]

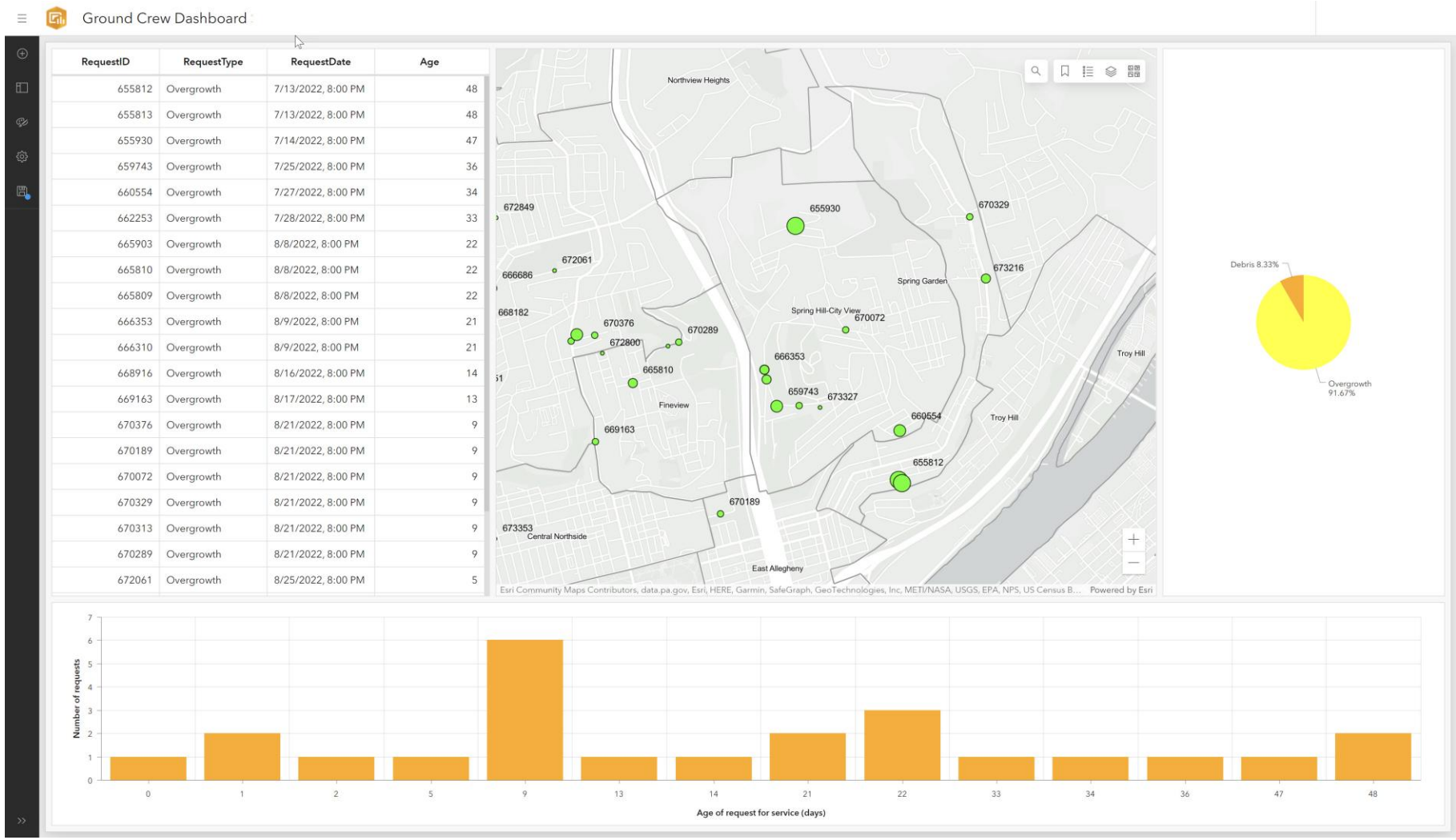
## Arts Employment map

### Map use and navigation

- Hover over the legend icon (lower left of map) to see the map legend.
- Click the magnifying glass icon (upper left of map) to search for an address or place.
- Click the + to zoom in, - to zoom out, and house icon to zoom to the whole map.
- Zoom in far enough and



# ArcGIS Dashboard®



# 2.4
# LAB SESSION

# LAB 01: INTRODUCTION TO ARCGIS PRO

DUE BY MIDNIGHT
(11:59 PM) ON
MONDAY, SEP 1, 2025

SUBMIT A WORD
DOCUMENT ONLY INCLUDE
QUESTION AND ANSWER