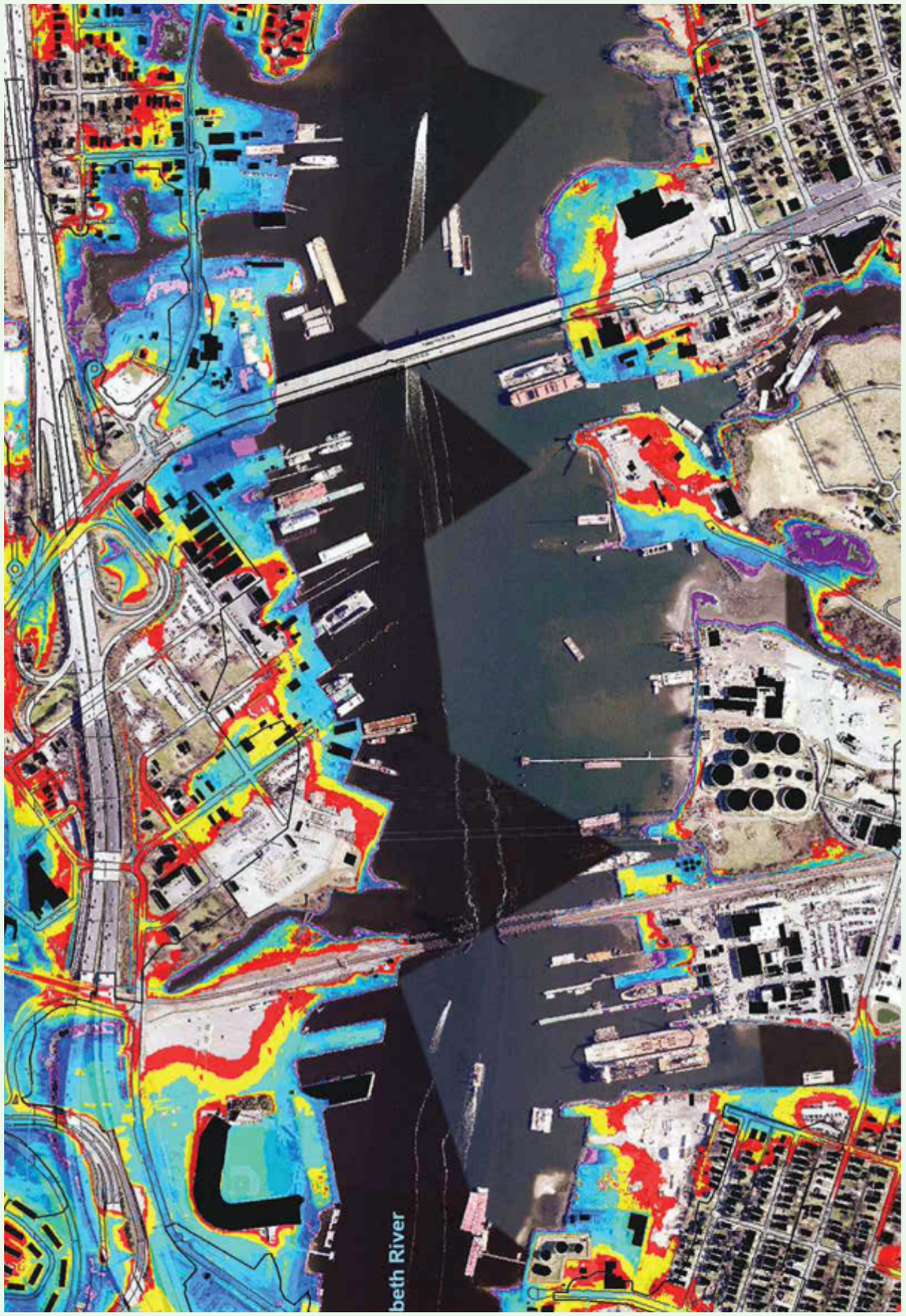
GEOG 358: Introduction to Geographic Information Systems

GIS Overview



GIS Overview

Topics

- What is GIS?
- Components of GIS
- Why use GIS?
- A brief history
- GIS in action
- GIS resources

What is GIS?

Geographic Information Systems

- Location on Earth's surface
- Occurring in space—relational

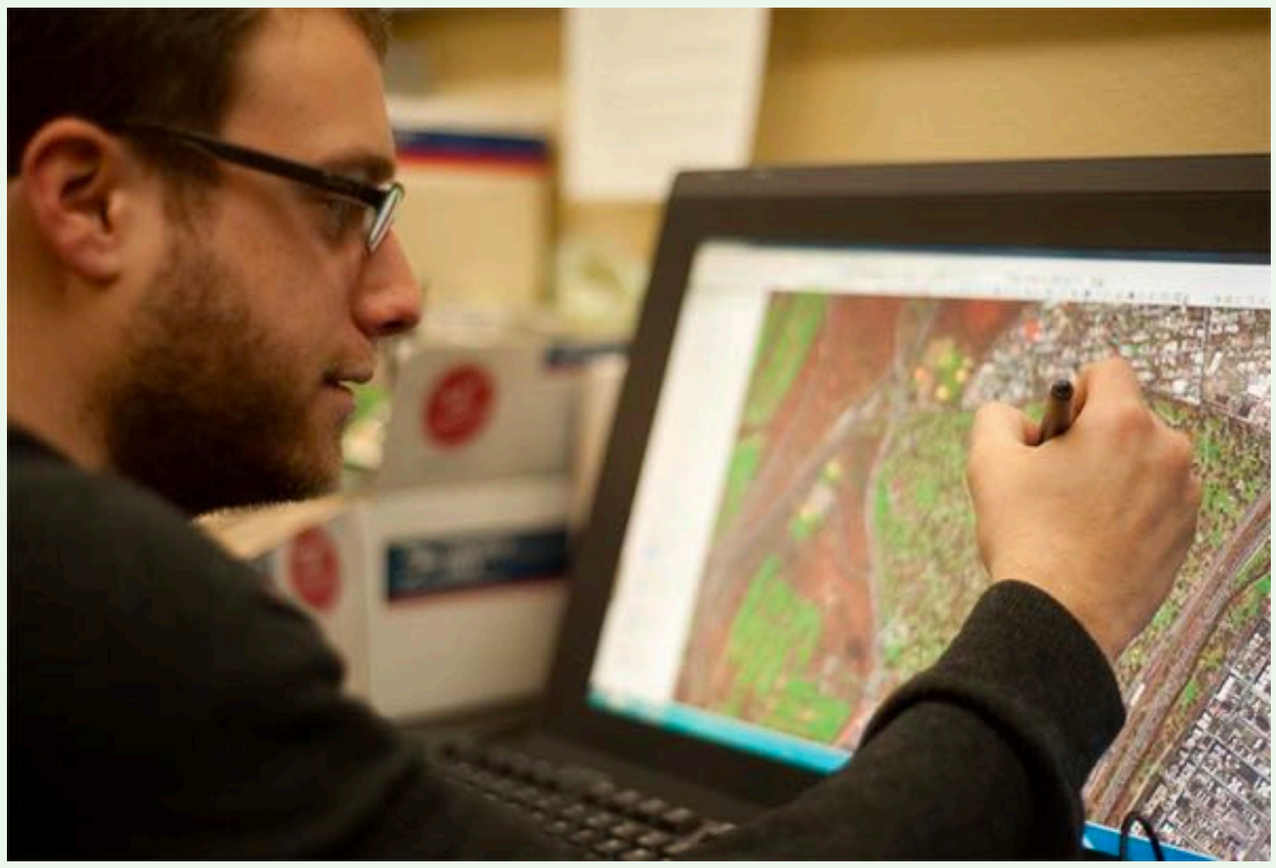
- What, **where,** when
- Knowledge derived from data

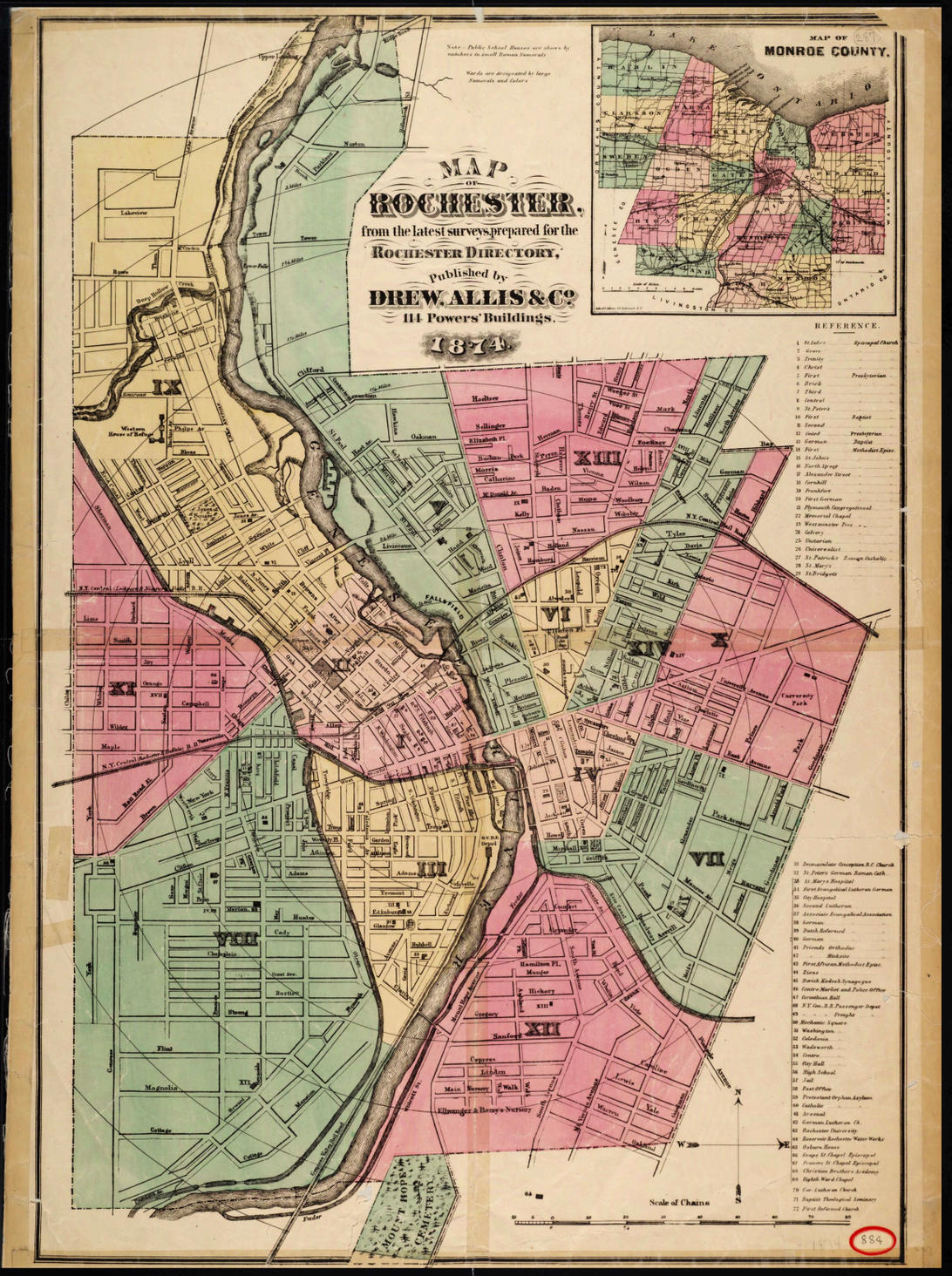
- Integrated group of elements that form a whole

What is GIS?

A computer-based system used to collect, store, analyze, display, and distribute geospatial data.

Data collection

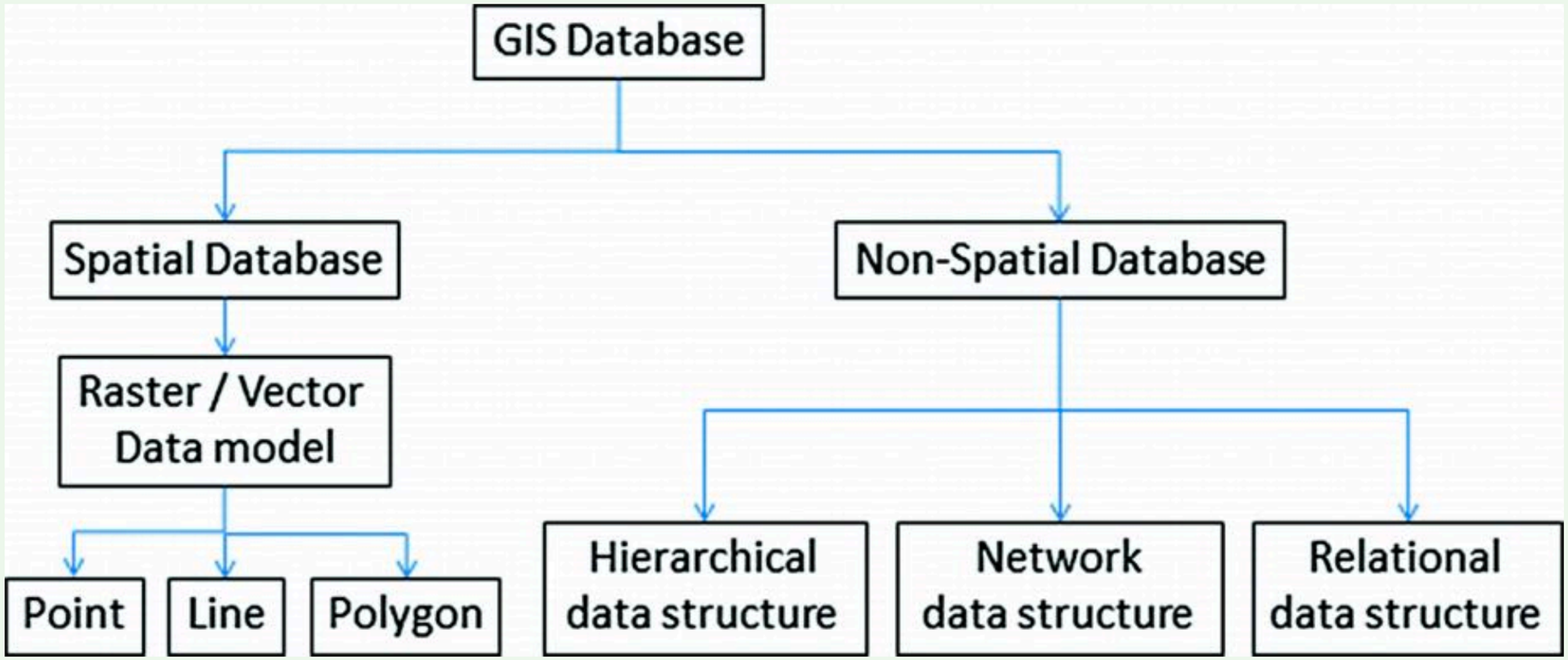


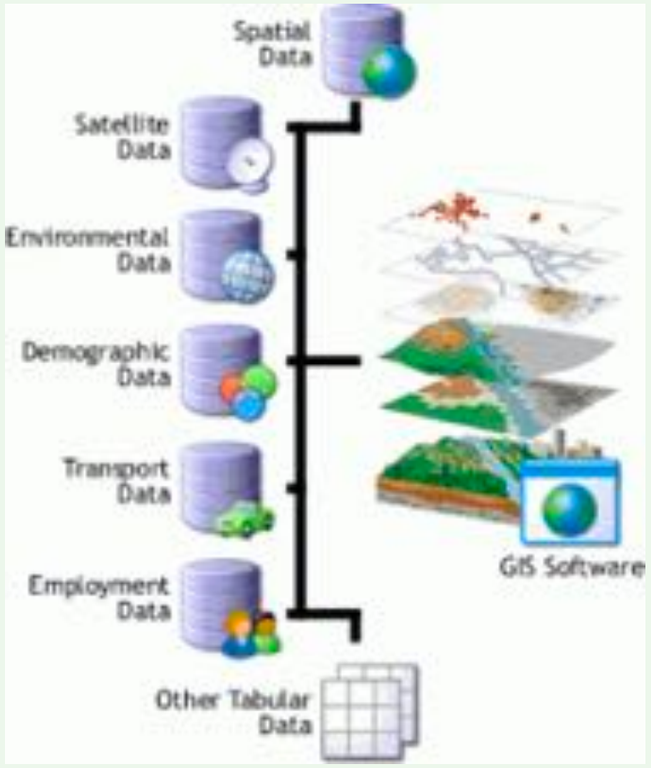


Abstract of the whole number of Persons within the division allotted to Stephen Badham. 33

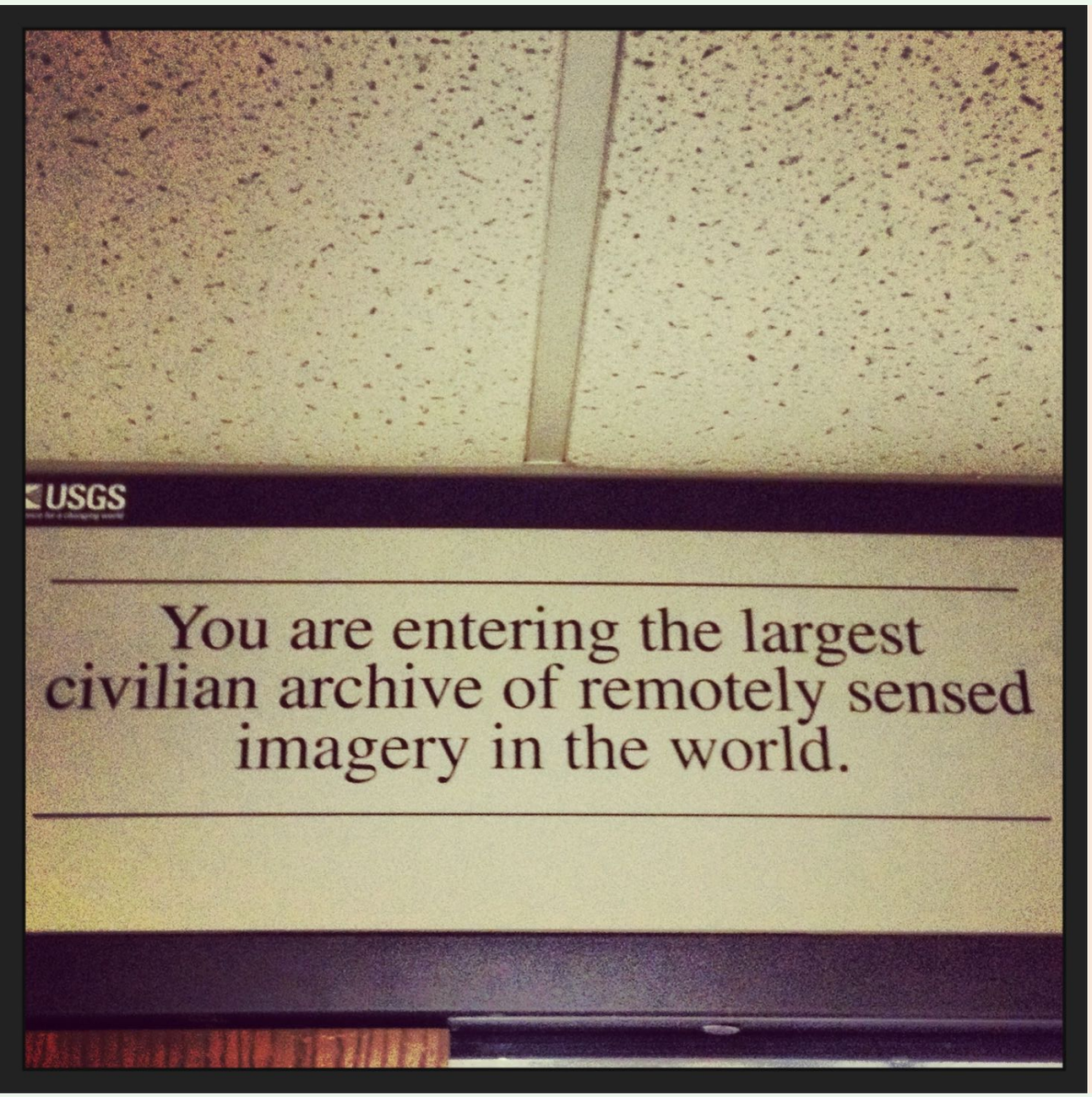
Names of Sevrs	Names of Heads of Families	Free White Males					Free White Females.					
		Under ten Years of age	Of ten & under fifteen	Of fifteen years & under twenty, including Heads of Families	Between twenty & forty five Years of age, including Heads of Families	Of forty five Years & upwards, including Heads of Families	Under ten years of age	Of ten & under fifteen	Of fifteen years & under twenty, including Heads of Families	Between twenty & forty five Years of age, including Heads of Families	Of forty five years & upwards, including Heads of Families	All other Persons except Indians not taxed
Quincy	John Adams	to 10	to 15	to 25	to 45	45 &	to 10	to 15	to 25	to 45	45	
	Esq. President											
A	of the											
	United States			5	3	1	1	1	3	1	2	
	Adams Peter B. Esq	1		2	1	1		1	2			
	Arnold Jos. N	2	1		1		2	1		1		
	Arnold Daniel	2			1		1			1		
	Adams Jedediah	2	1		1		1			1	1	
	Allen Josiah					1					1	
	Adams Micajah	2		2	1		2			1		
	Adams Eliz. Wid.				1						1	
	Adams Will.m					1				1		
	Adams Thomas		1		1		1		1	1		
110	Apthop J. H.	1	1	1			2		3	1	2	
	Adams Ben.n				1			2		1	1	
	Adams Josiah	1			1		1	2		1		

39

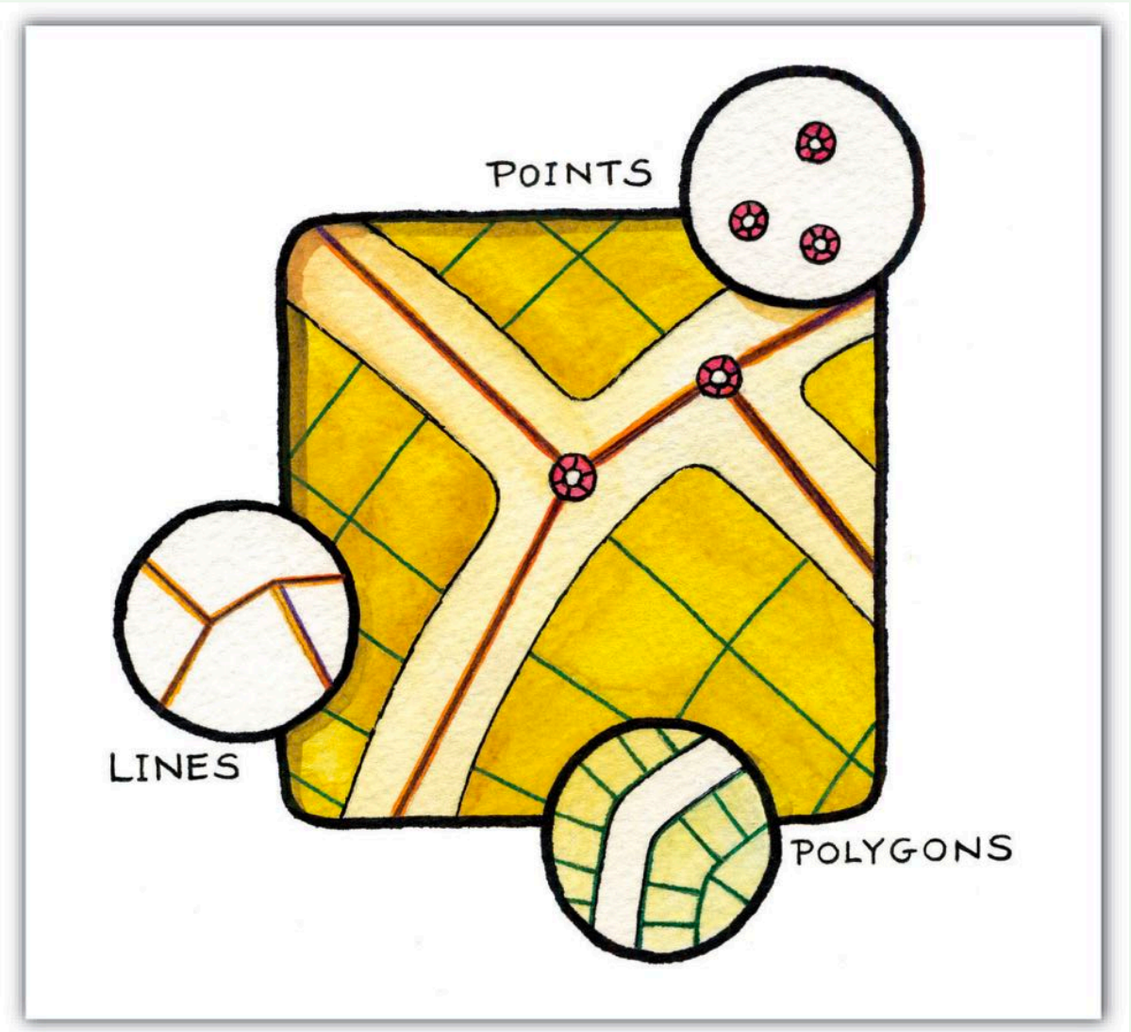




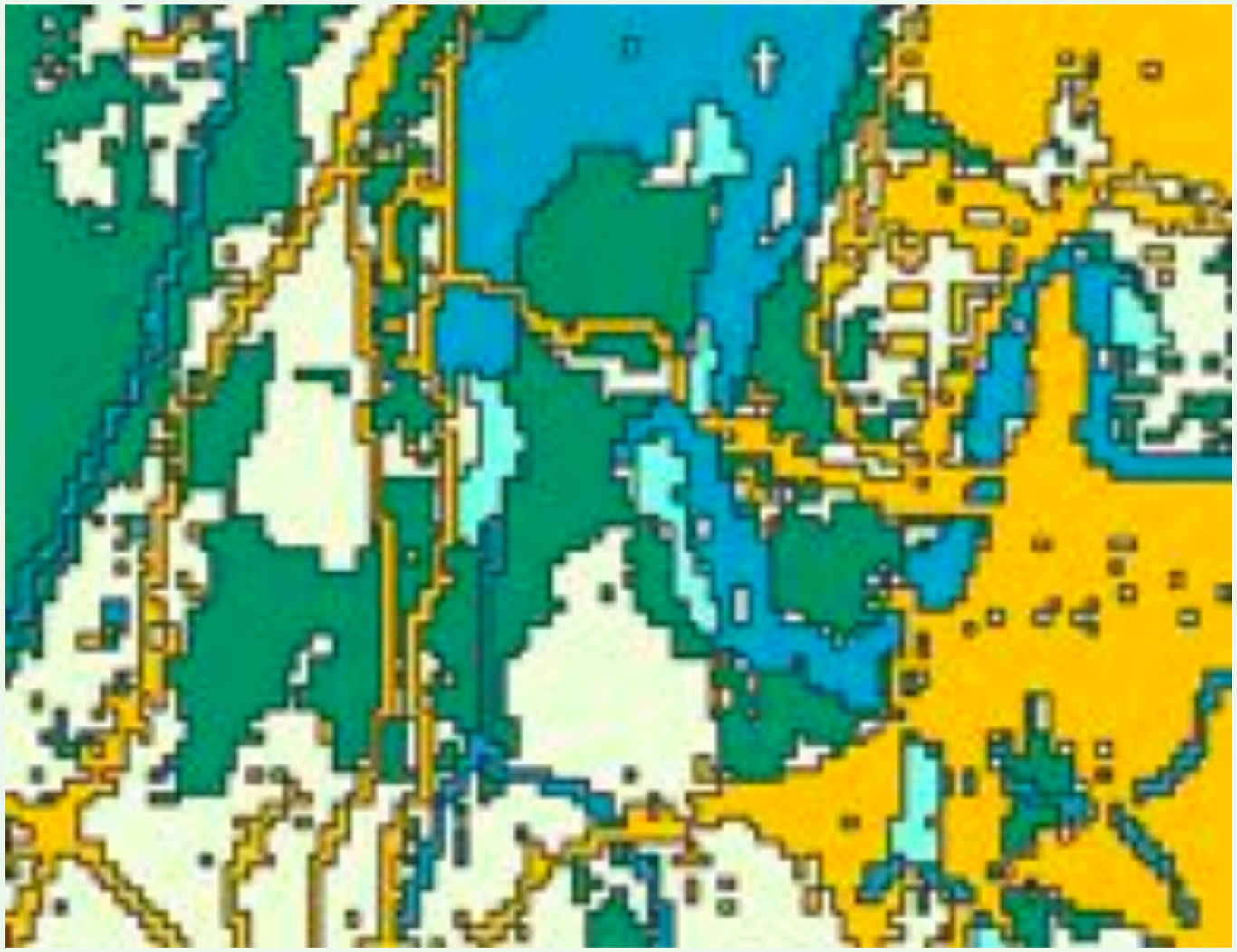
Data storage


USGS
You are entering the largest civilian archive of remotely sensed imagery in the world.

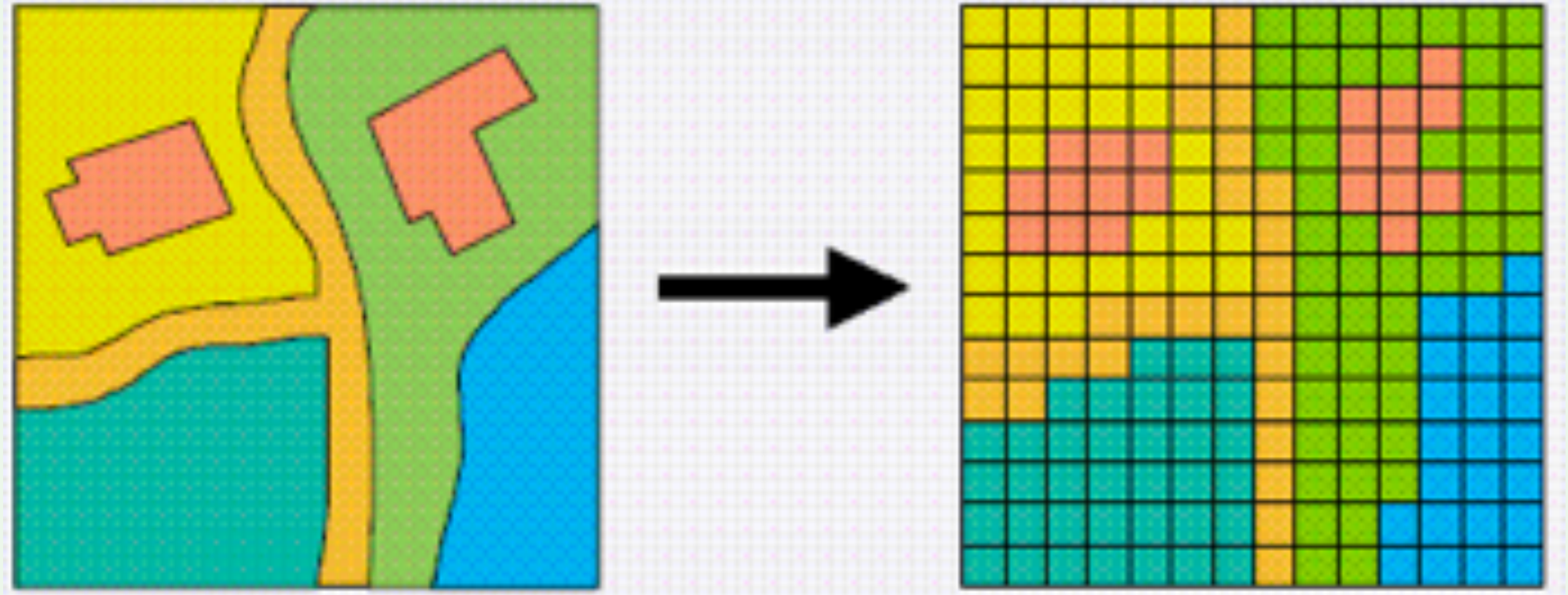
Data model



VECTOR



RASTER

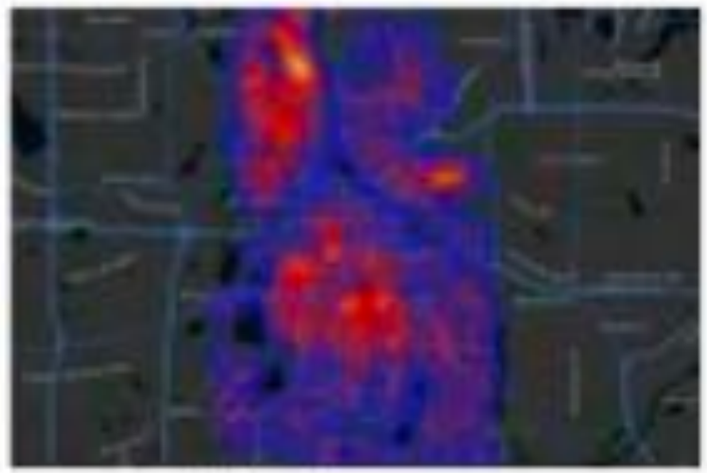


Analysis

GEOSPATIAL ANALYTICAL METHODS

Buffering

Network Analysis



Heatmaps

Route planning

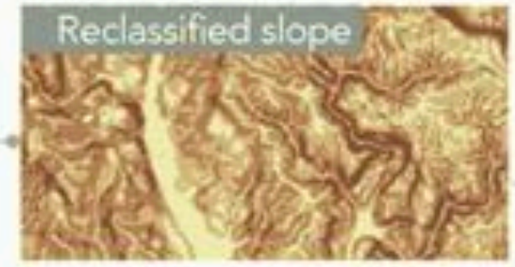
Density analysis

Interpolation/kriging

Analysis

Collect source layers

Data is first digitized into either polygon or raster layers. This housing suitability data is raster.

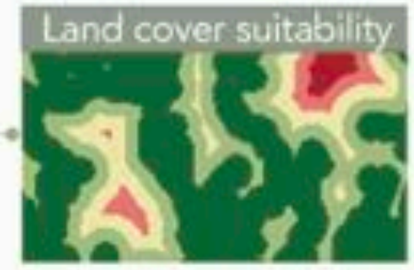


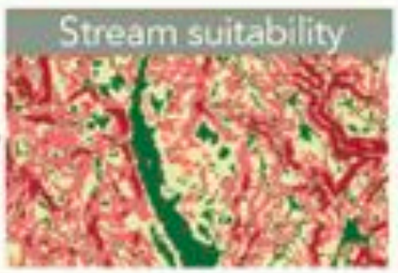
Reclassification

Source layers composed of continuous values (such as slope and distance layers) are first reclassified into meaningful ranges of values.

Create suitability layers

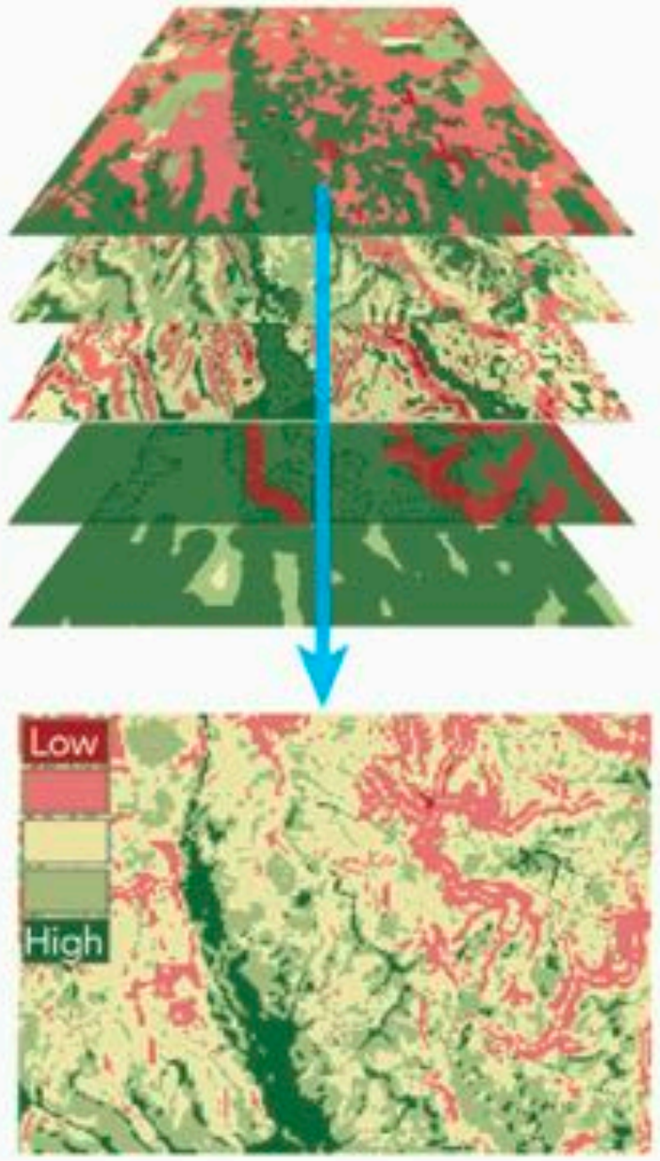
Each layer is now classified to use a common suitability scale: for example, low suitability could be assigned a value of 1 (dark red) and high suitabilty a value of 5 (dark green).



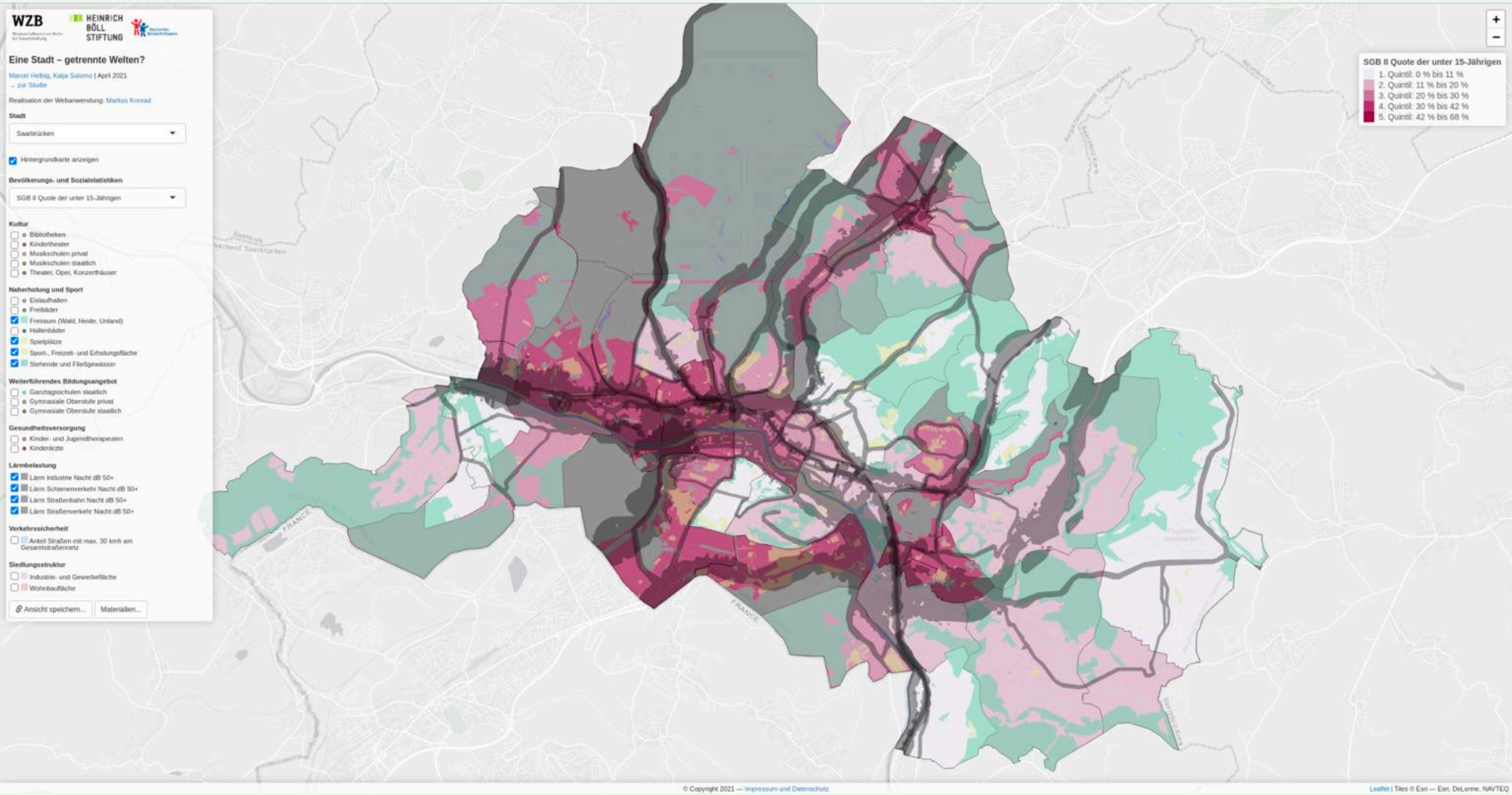


Calculate weighted overlay

Suitability layers are overlaid so that each cell gets an overall suitability rating. Weights of relative importance are assigned to each layer.



Display



https://datascience.blog.wzb.eu/2021/04/16/interactive-visualization-of-geospatial-data-with-r-shiny/

Display


Chicago Grouping Analysis
Standardized Values
Crime Count
HS Dropout Rate
Median Household Income
Unemployment Rate
Chicago Grouping Analysis
Values
Crime Counts by Group
Count
Group
HS Dropout Rate vs Crime Count
Crime Count
HS Dropout Rate
Distribution of Crime Count
Distribution of HS Dropout Rate
Median Household Income vs Crime Count
Median Household Income
Distribution of Median Household Income
Change in Crime Counts over Time
Date
Crime Counts by Type
Type
Unemployment Rate vs Crime Count
Unemployment Rate
Distribution of Unemployment

Distribution

data.boston.gov

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MENU

ANALYZE BOSTON

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Welcome to

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Analyze Boston is the City of Boston's open data hub. We invite you to explore our datasets, read about us, or see our tips for users.

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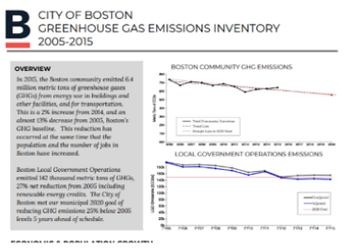
SHOWCASES

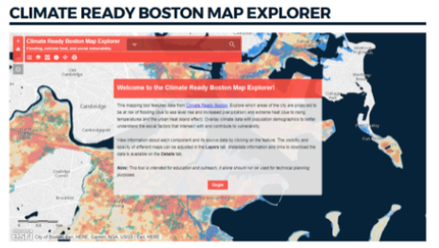
See what our users are doing with open data.

Canopy Change Assessment: 2014-2019



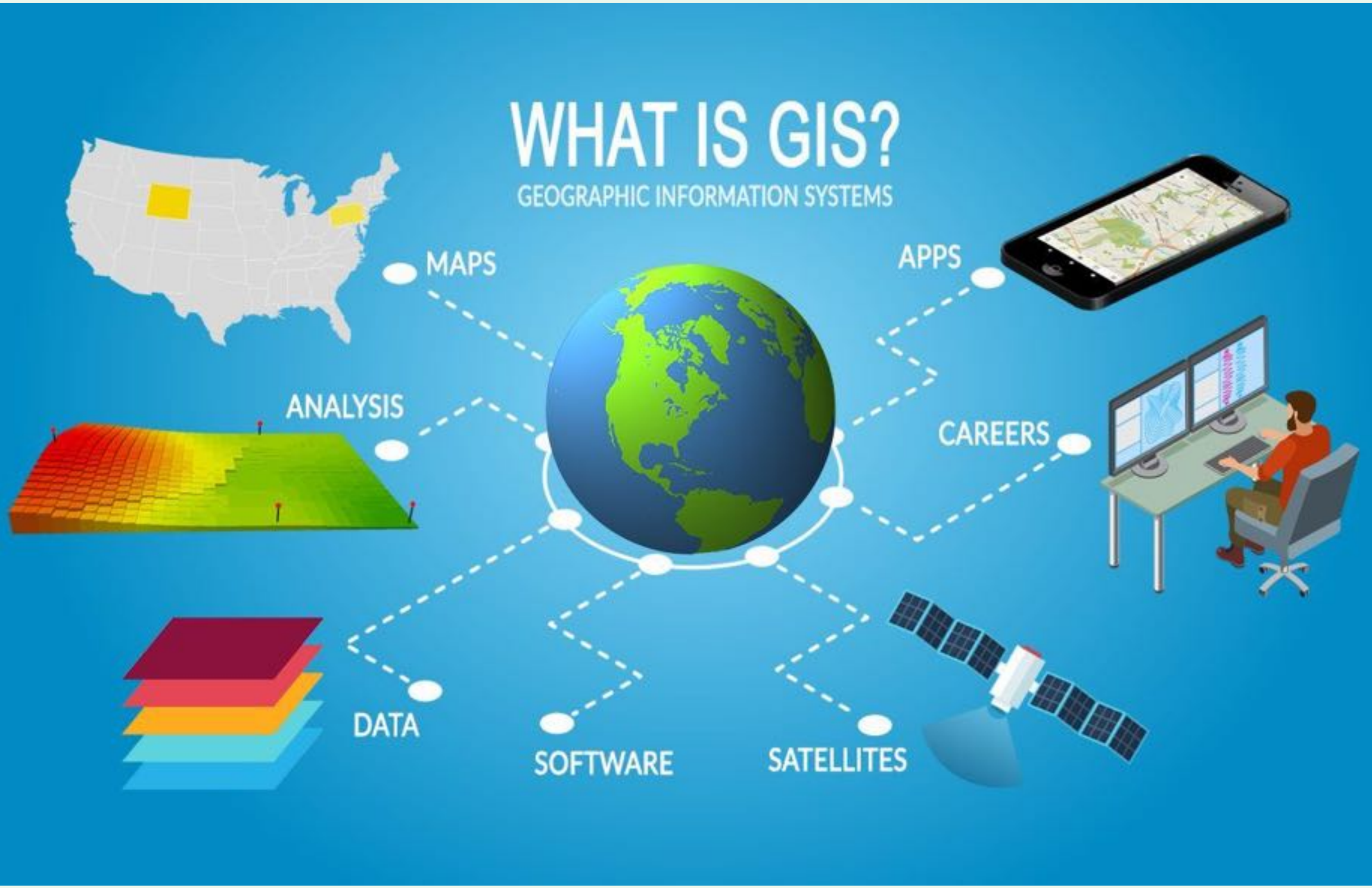
Our Progress Toward Carbon Neutrality

Beantown Solar



Climate Ready Boston Map Explorer

Components of a GIS

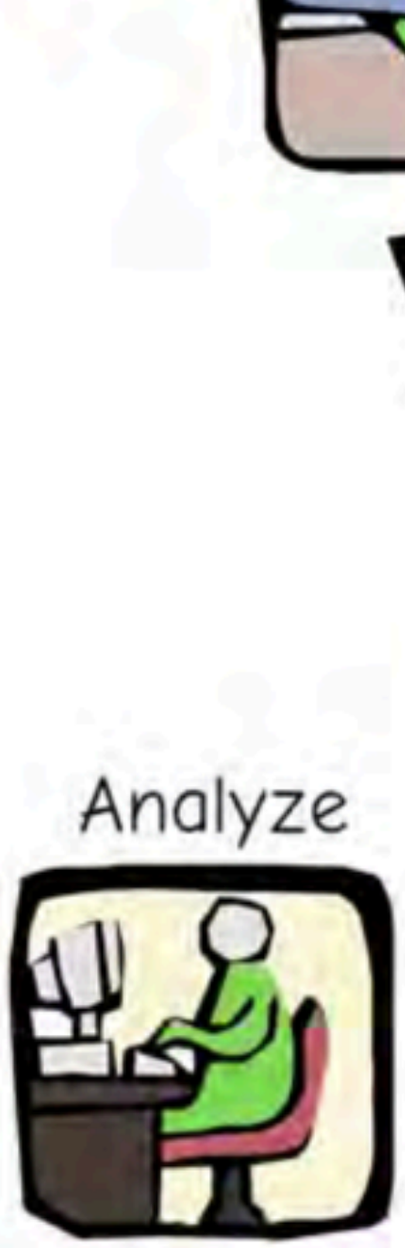


The physical world

Define protocols

Collect and edit spatial data

Analyze



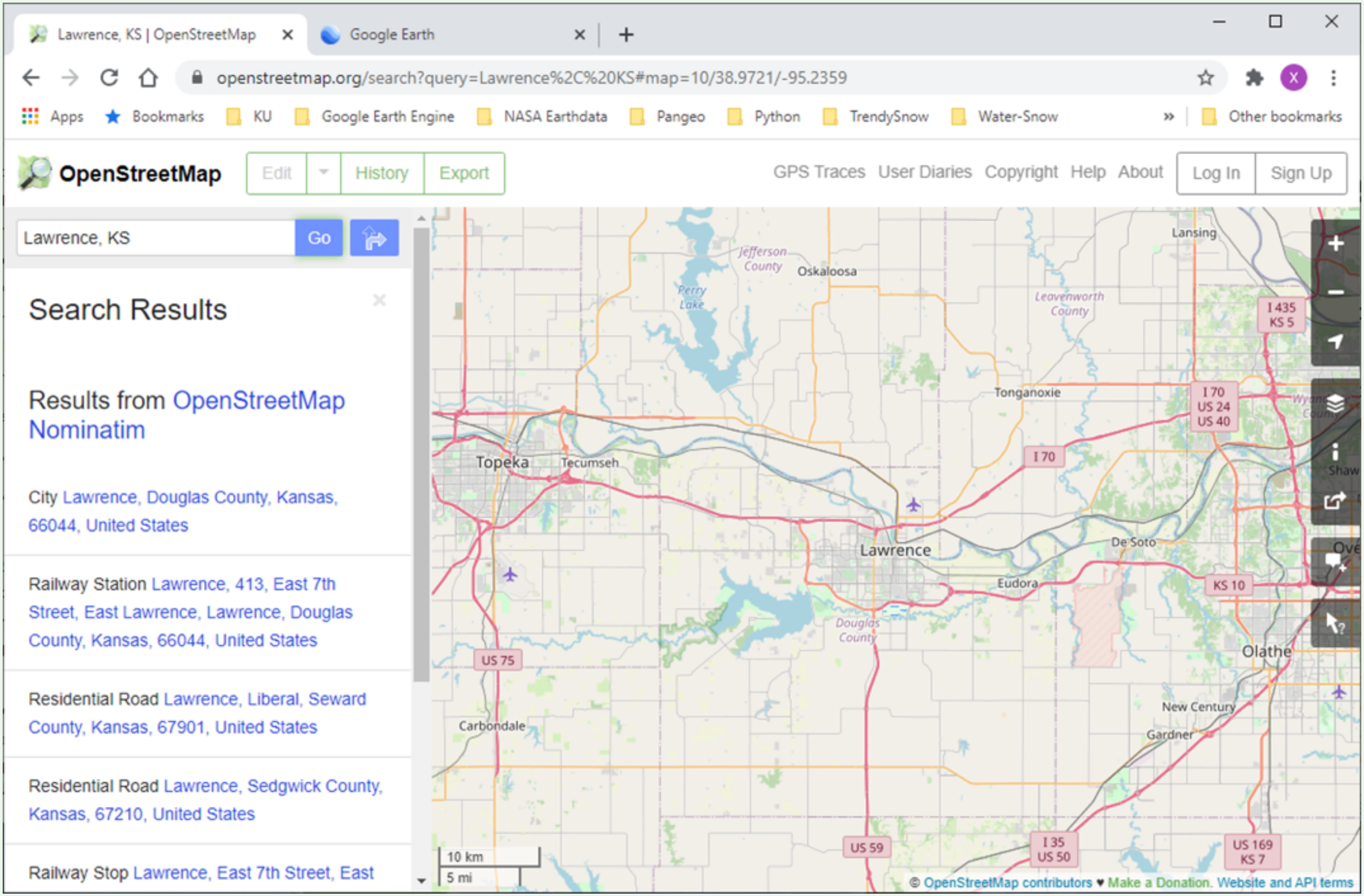
Report results

Decide and act

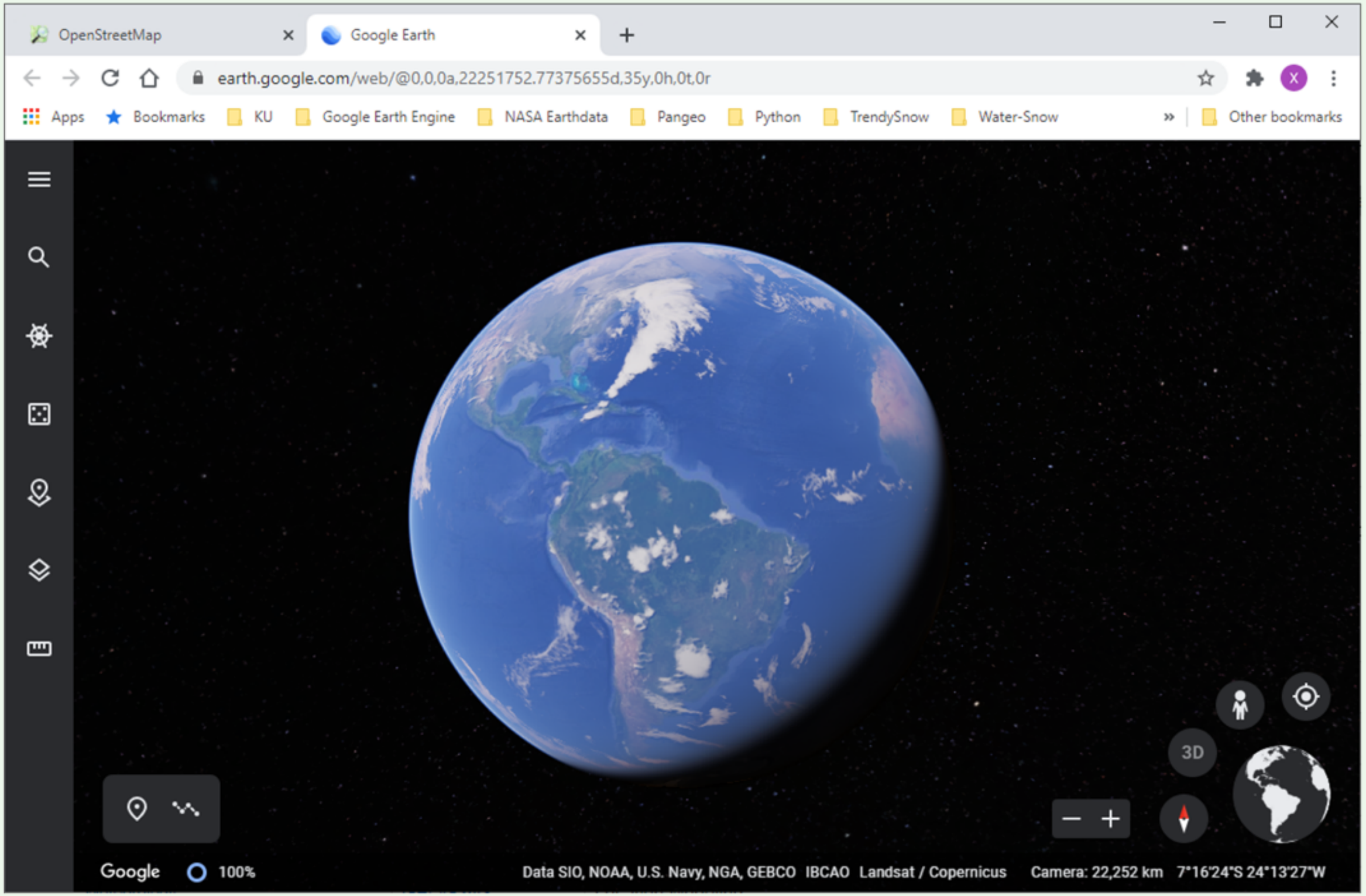
Software

- **ESRI—Environment System Research Institute, Redlands, California**
    - **ArcGIS Pro, ArcGIS Desktop, ArcGIS Online…**
    - **The largest GIS company**
- **Many others**
    - **GeoMedia, Mapinfo, AutoCAD Map, IDRISI, Manifold, Microimages, …**
- **Remote sensing software with certain GIS functions**
    - **ERDAS, ENVI, …**
- **Free and Open Source Software (FOSS)**
    - **QGIS, GRASS (raster)**
    - **Google Map, Open Street Map, Google Earth**
    - **Libraries (APIs)—application programming interfaces**
        - **R, Python, Javascript**
        - **Google Earth Engine**

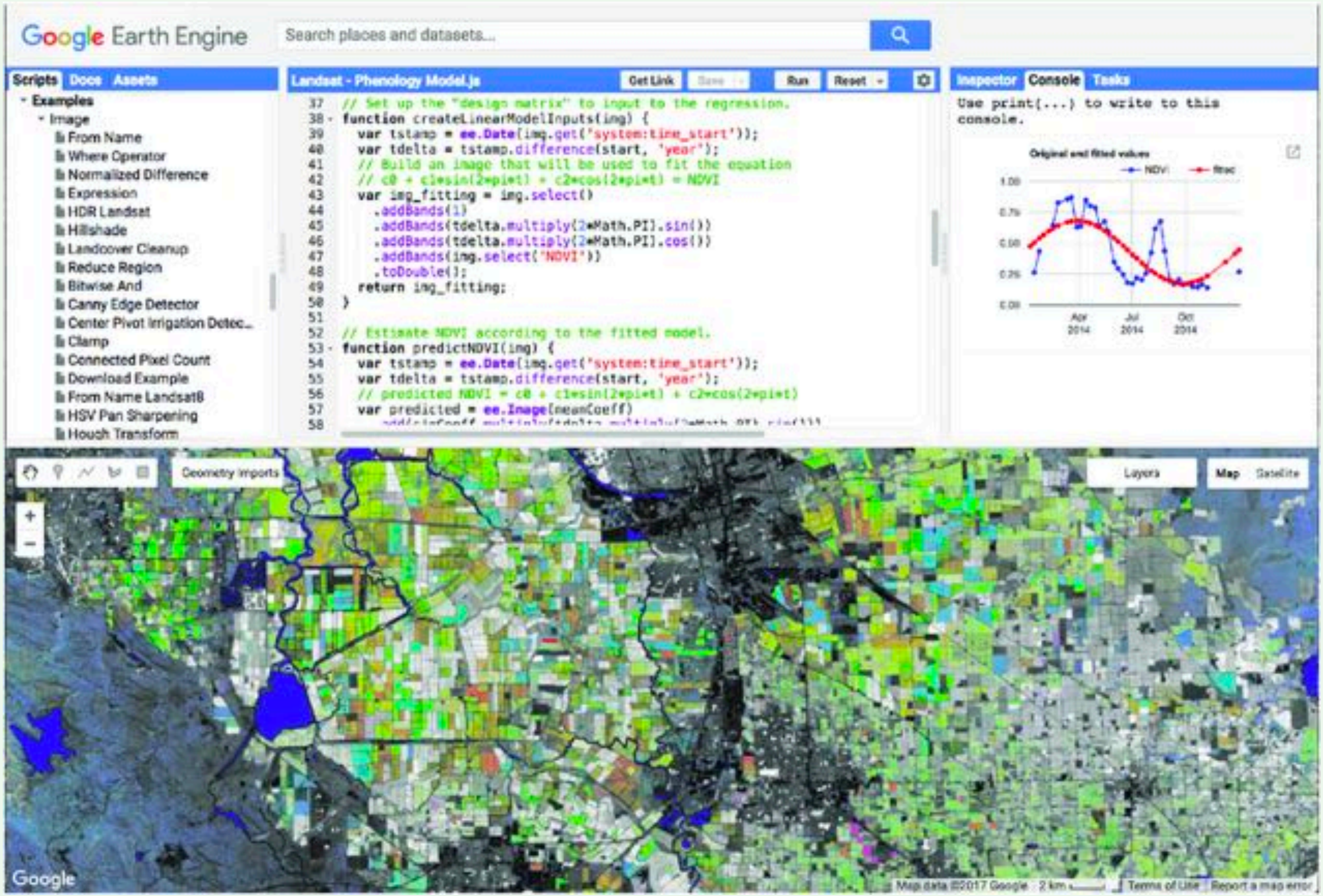
Open Street Map



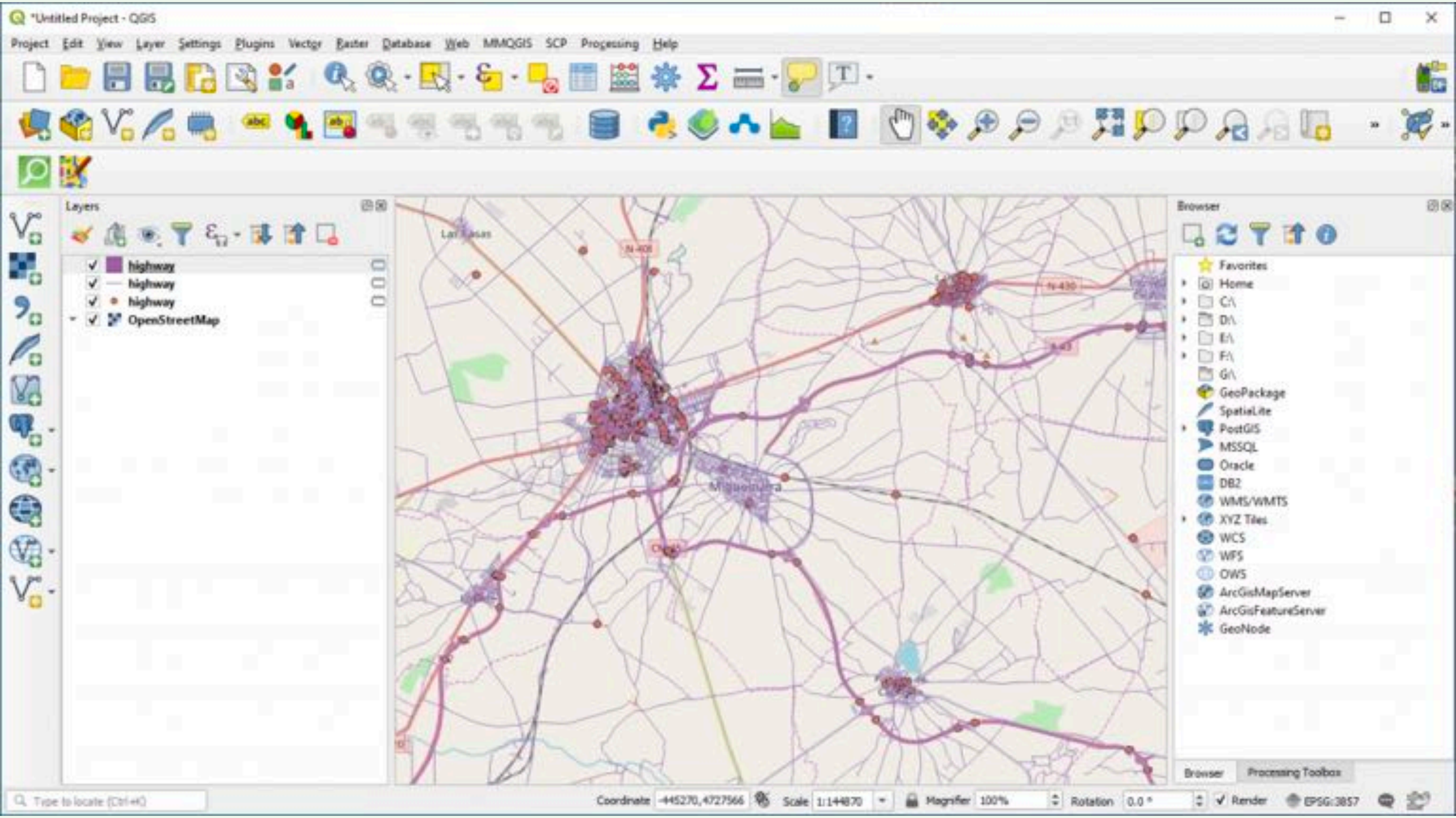
Google Earth



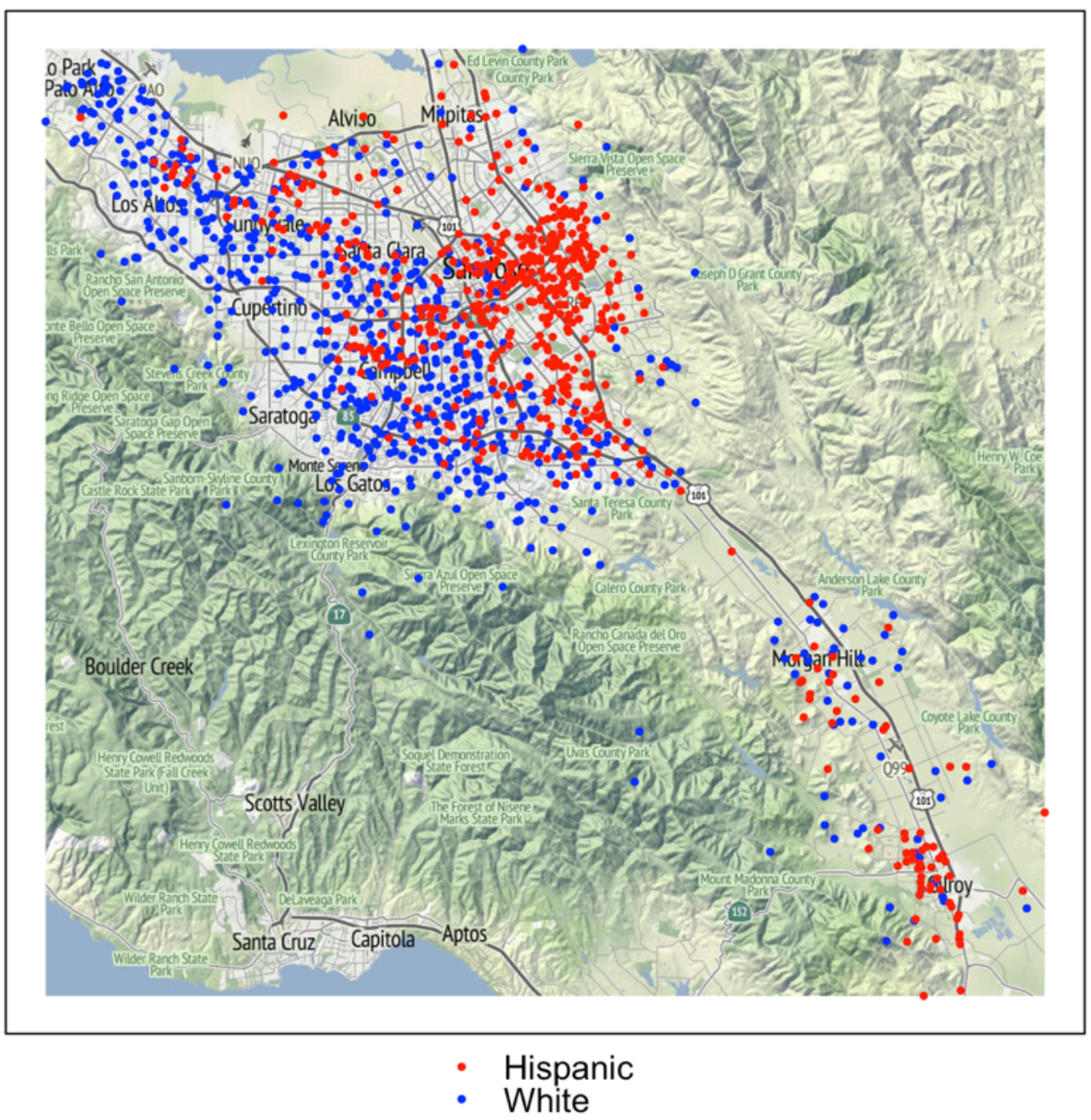
Google Earth Engine



QGIS


*Untitled Project - QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web MMQGIS SCP Processing Help
Layers
highway
highway
highway
OpenStreetMap
Browser
Favorites
Home
C:\
D:\
E:\
F:\
G:\
GeoPackage
SpatiaLite
PostGIS
MSSQL
Oracle
DB2
WMS/WMTS
XYZ Tiles
WCS
WFS
OWS
ArcGisMapServer
ArcGisFeatureServer
GeoNode
Browser
Processing Toolbox
Type to locate (Ctrl+K)
Coordinate -445270,4727566
Scale 1:144870
Magnifier 100%
Rotation 0.0 °
Render
EPSG:3857

R

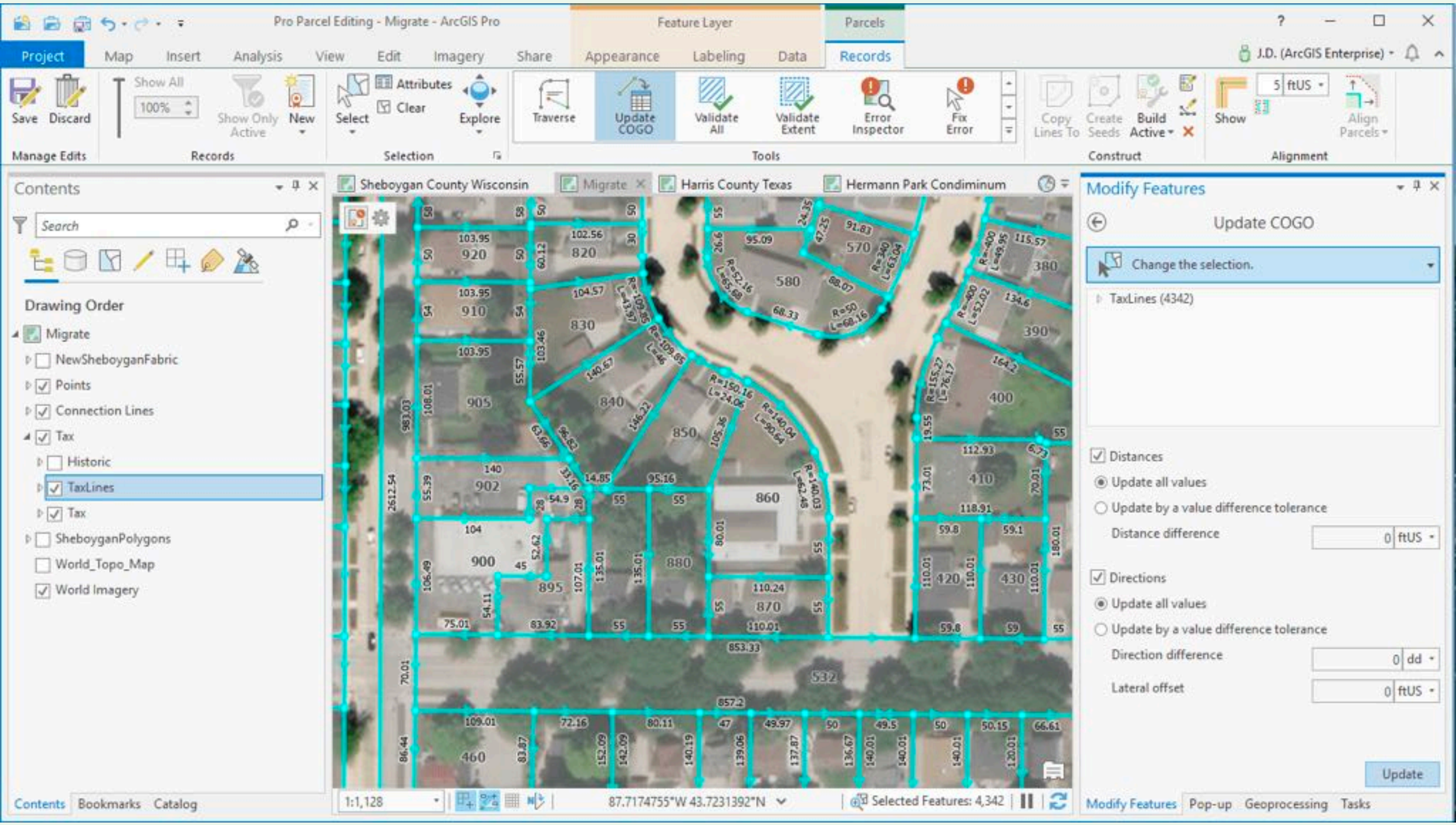



```r
library(ggmap)
# REPROJECT YOUR DATA TO EPSG 3857
to.plot.web.merc <- spTransform(dots.all, CRS("+init=EPSG:3857"))


# COPY AND PASTE SEGEMENT 1 Series of weird conversions to deal with
# inconsistencies in units for API.
box <- to.plot.web.merc@bbox

midpoint <- c(mean(box[1, ]), mean(box[2, ]))
left.bottom <- c(box[1, 1], box[2, 1])
top.right <- c(box[1, 2], box[2, 2])

boundaries <- SpatialPoints(rbind(left.bottom, top.right))
proj4string(boundaries) <- CRS("+init=EPSG:3857")
boundaries.latlong <- c(t(spTransform(boundaries, CRS("+init=EPSG:4326"))@coords))

# END COPY-PASTE SEGMENT 1


# SET MAP TYPE HERE, LEAVE OTHER PARAMETERS AS THEY ARE
gmap <- get_map(boundaries.latlong, maptype = "terrain", source = "stamen",
    crop = TRUE)

# COPY-PASTE SEGMENT 2 Create object that sp.layout likes.
long.center <- midpoint[1]
lat.center <- midpoint[2]
height <- box[2, 2] - box[2, 1]
width <- box[1, 2] - box[1, 1]

sp.raster <- list("grid.raster", gmap, x = long.center, y = lat.center, width = width,
    height = height, default.units = "native", first = TRUE)
# END COPY-PASTE SEGMENT 2


# NORMAL PLOTTING TRICKS - HAVE FUN HERE!

# Housecleaning and set colors
to.plot.web.merc$ethnicity <- as.factor(to.plot.web.merc$ethnicity)

my.palette <- c("red", "blue")
point.size <- 0.5

# Plot!

spplot(to.plot.web.merc, "ethnicity", sp.layout = sp.raster, col.regions = my.palette,
    cex = point.size, main = "Demographic Distribution of Santa Clara County")
```

ESRI ArcGIS Software

- ArcGIS Pro
    - Latest desktop GIS software
    - Replacing the ArcGIS Desktop suite
- ArcGIS Desktop
    - ArcMap, ArcCatalog
- ArcGIS Online
    - Web data and maps accessible to desktop applications (ArcGIS Pro or Desktop)
    - Maintained by ESRI
- ArcGIS Server
    - Web GIS maintained by organizations

ArcGIS Pro


Pro Parcel Editing - Migrate - ArcGIS Pro
Feature Layer
Parcels
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Appearance
Labeling
Data
Records
J.D. (ArcGIS Enterprise)
Save
Discard
Manage Edits
Show All
100%
Show Only Active
New
Records
Select
Attributes
Clear
Explore
Selection
Traverse
Update COGO
Validate All
Validate Extent
Error Inspector
Fix Error
Tools
Copy Lines To
Create Seeds
Build Active
Construct
Show
5 ftUS
Align Parcels
Alignment
Contents
Search
Drawing Order
Migrate
NewSheboyganFabric
Points
Connection Lines
Tax
Historic
TaxLines
Tax
SheboyganPolygons
World_Topo_Map
World Imagery
Sheboygan County Wisconsin
Migrate
Harris County Texas
Hermann Park Condiminum
Modify Features
Update COGO
Change the selection.
TaxLines (4342)
Distances
Update all values
Update by a value difference tolerance
Distance difference
0 ftUS
Directions
Update all values
Update by a value difference tolerance
Direction difference
0 dd
Lateral offset
0 ftUS
Update
1:1,128
87.7174755°W 43.7231392°N
Selected Features: 4,342
Contents
Bookmarks
Catalog
Modify Features
Pop-up
Geoprocessing
Tasks

Why use GIS?

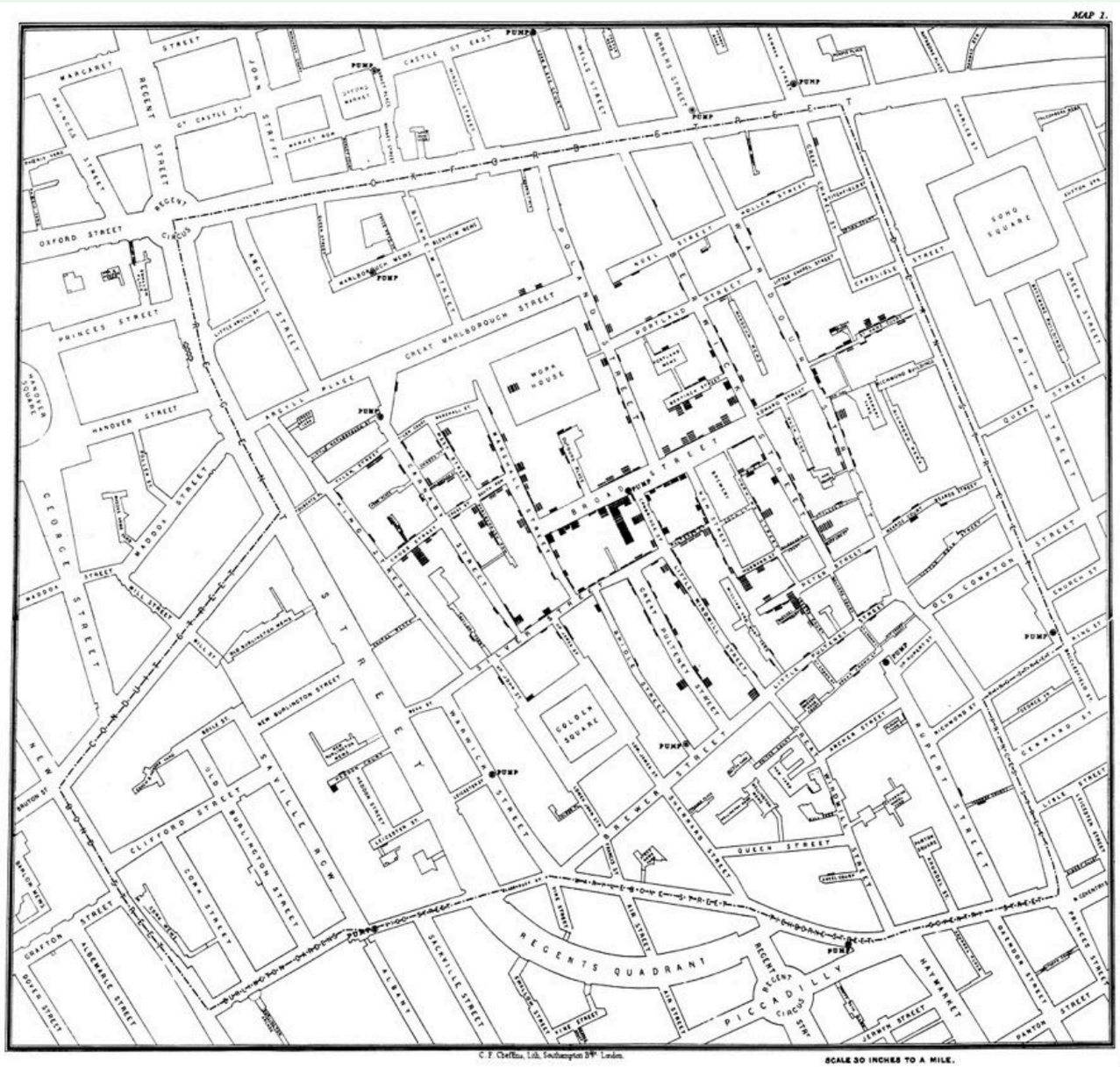
Why use GIS?

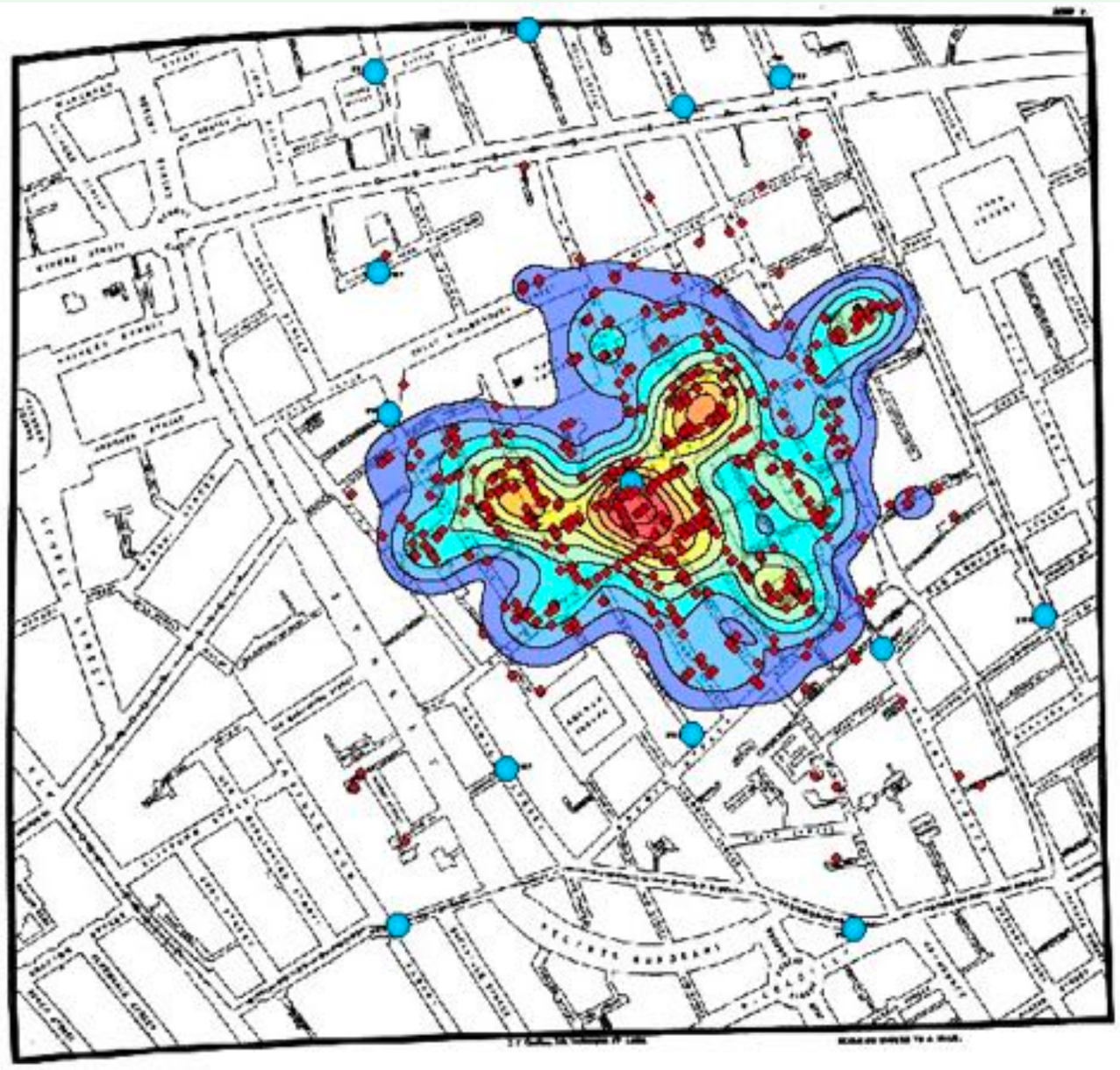
- Geographic data is important
    - Life is spatial—geographic information is essential in day-to-day activities
    - Essential for the management of water, food, and energy
- Everything happens somewhere
    - Most information has location associated
- Spatial variation is ubiquitous
    - Knowledge of what is where and when it occurs is important for understanding the world and global change

Manage & Process Geospatial Data

- Mental maps
    - Our brains are geographic information systems
    - Maps of the environment stored in our brains
- Paper maps
    - Printing
    - Preserve and distribute geographic knowledge
- GIS
    - Digital
    - Revolutionize the handling of geographic data (at fingertips)

A Brief History of GIS





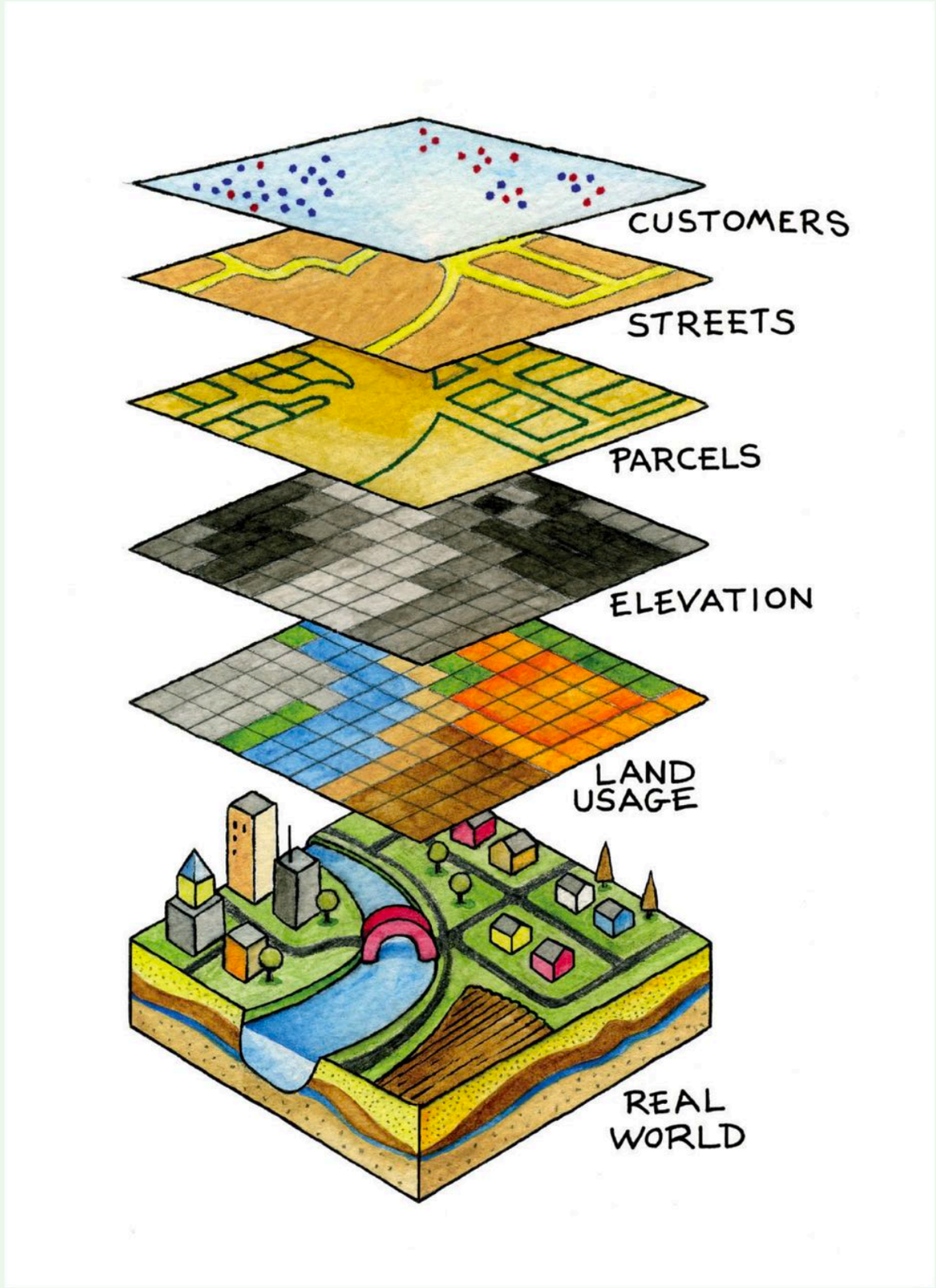
A Brief History of GIS

- Necessity is the mother of any invention
    - Planners, cartographers, resource managers involved in site selection projects (suitability analysis)
    - Computerizing manual processes
- GIS started at universities as research tools
    - Harvard, Minnesota, Yale, Clark University in late 60s and early 70s
- GIS benefit from the development of computing and data collection and distribution technologies
    - Computer hardware (CPU, memory, storage) and software (programming language, operating system, graphic user interface, database)
    - Advancement in sensor technology and availability of geographic data (government and private industries)
    - The Internet and the Internet of Things

GIS in Action

How does GIS answer spatial questions?

GIS allows us to abstract information from the physical world and display it in layers or themes.



How is climate change projected to affect my community?

https://gisclimatechange.ucar.edu/

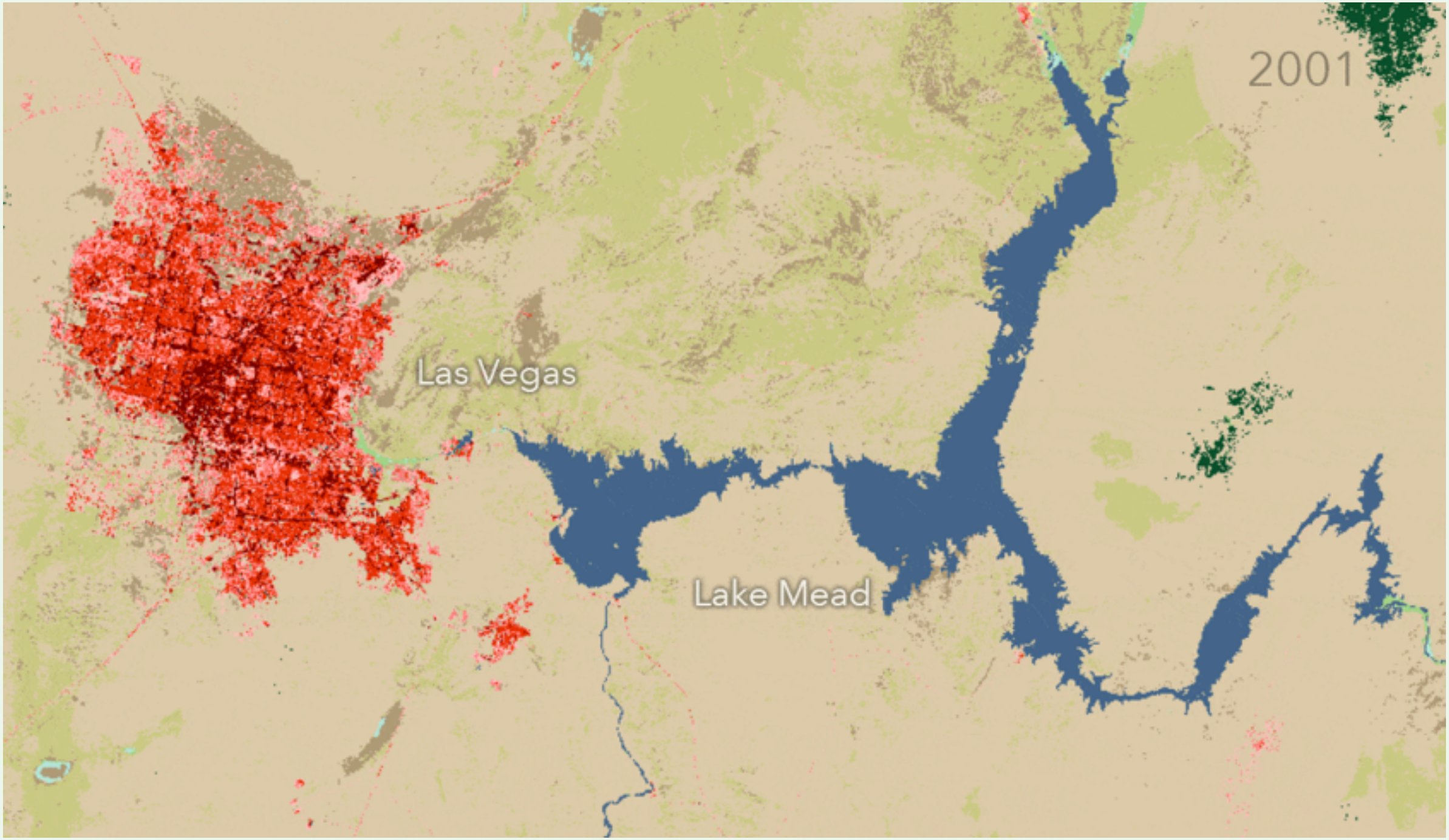
What areas of a community are high risk for children?

The New York Times

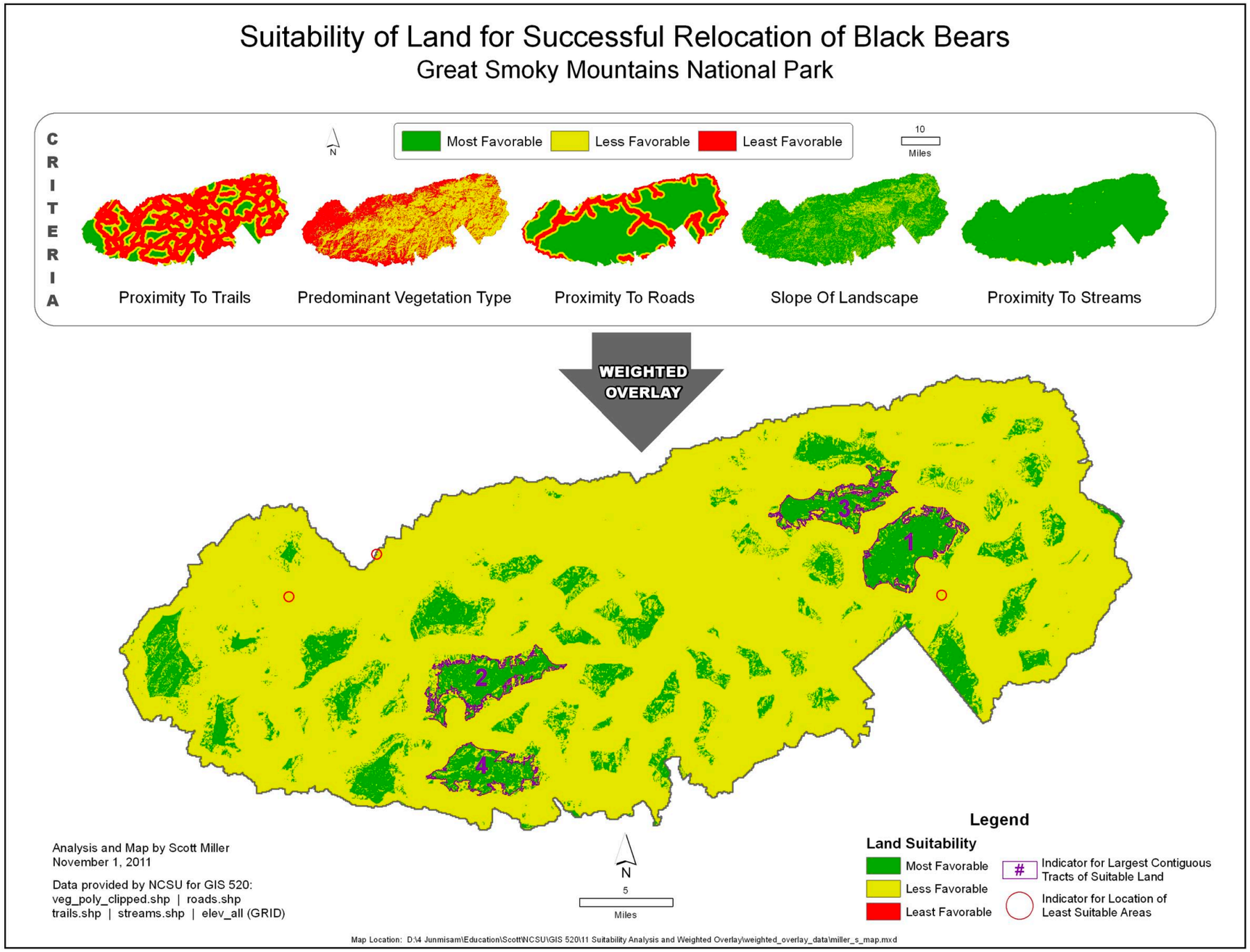
Living Near a Major Highway Tied to Developmental Delays in Children

Exposure to air pollution could be a factor, experts suggest.

How is urbanization affecting water resources?



What habitat is suitable for a species of interest?



How is agriculture impacting global forests?

Changing Forests

Resources

GIS Degrees & Programs at KU

- B.S., M.S., and PhD degree in geography with a concentration in geospatial analytics
- B.S. and M.S degrees at KU geography are designated as STEM degree
- Undergraduate and graduate GIS certificate program
    - https://catalog.ku.edu/liberal-arts-sciences/geography/geographic-information-science-ucert/
    - https://catalog.ku.edu/liberal-arts-sciences/geography/geographic-information-science-gradcert/

Jobs in GIS

- Federal Government
    - Federal Agencies – USGS, EPA, USFS
- State or Local Government
    - Natural Resources, Public Works, Tax
        - Public works/infrastructure management (roads, water, sewer)
        - 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

GIS Organizations

- **GITA**—Geospatial Information & Technology Association
- **USGIF**—U.S. Geospatial Intelligence Foundation
- **UCGIS**—The University Consortium for Geographic Information Systems (www.ucgis.org)
- **ASPRS**—American Society for Photogrammetry and Remote Sensing (www.asprs.org)
- **URISA**—Urban and Regional Information Systems Association
- **AAG**—The Association of American Geographers (www.aag.org)
- **MAGIC**—MidAmerican GIS Consortium (https://www.magicgis.org/)

Trade Magazines

- GeoSpatial World
- GIS Lounge
- Imaging Notes
- ESRI ArcNews
- ESRI ArcUser

Academic Journals

- International Journal of Geographical Information Systems
- Transactions in GIS
- Cartography and Geographic Information System
- GIScience and Remote Sensing
- Photogrammetric Engineering and Remote Sensing

GIS Conferences

Software User Conferences

- ESRI
- Intergraph
- MapInfo

Professional Conferences

- AAG Annual Conference
- URISA Annual Conference
- ASPRS Annual Conference
- GITA Annual Conference
- UCGIS Annual Symposium
- GIScience (bi-annual)

Readings

- Chapter 2: Introduction
- Chapter 3: Introduction