GEOSPATIAL INNOVATION FACILITY

Cutting-Edge Mapping Technology at UC Berkeley

Our Mission

Help people better understand the changing world through acquisition, analysis and visualization of spatial data

The GIS landscape has been changing:

- New massive data streams – from phones, from APIs, from new satellites
- Technological advances in computing- advances in database integration, cluster computing, big data, more choices in coding
- More public focus on location tech and geo

All this requires a new framework: one that is *computing-intensive, data-rich* and *collaboration-focused*.

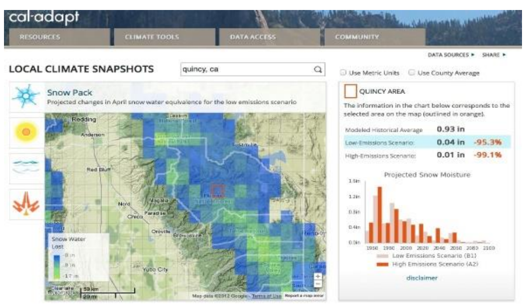
  - Broader/different scales of interest – more personal and more broad
  - New ways of analyzing and synthesizing data
  - Multiple users and collaboration
  - Agile visualization

Data in the Age of Sharing

The breadth, transparency and low comparative cost of exchanging information on the Internet provides an efficient form of communication between the public and planners, managers, and decision-makers.

Mapping makes these exchanges more powerful.

web mapping/visualization

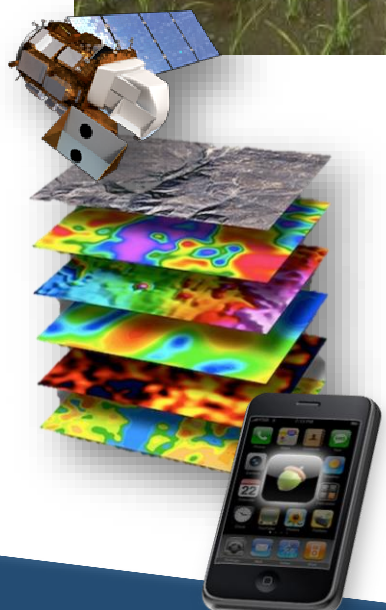


citizen involvement

disaster response

We Need a 21st Century Mapping Toolkit



Many of the global challenges that we face today – such as poverty, food and water scarcity, sustainable development, urbanization, and climate change – are large in spatial scale and impact diverse public groups.

Addressing these challenges requires a new framework: one that is ***computing intensive***, ***data-rich***, and ***collaboration-focused.***

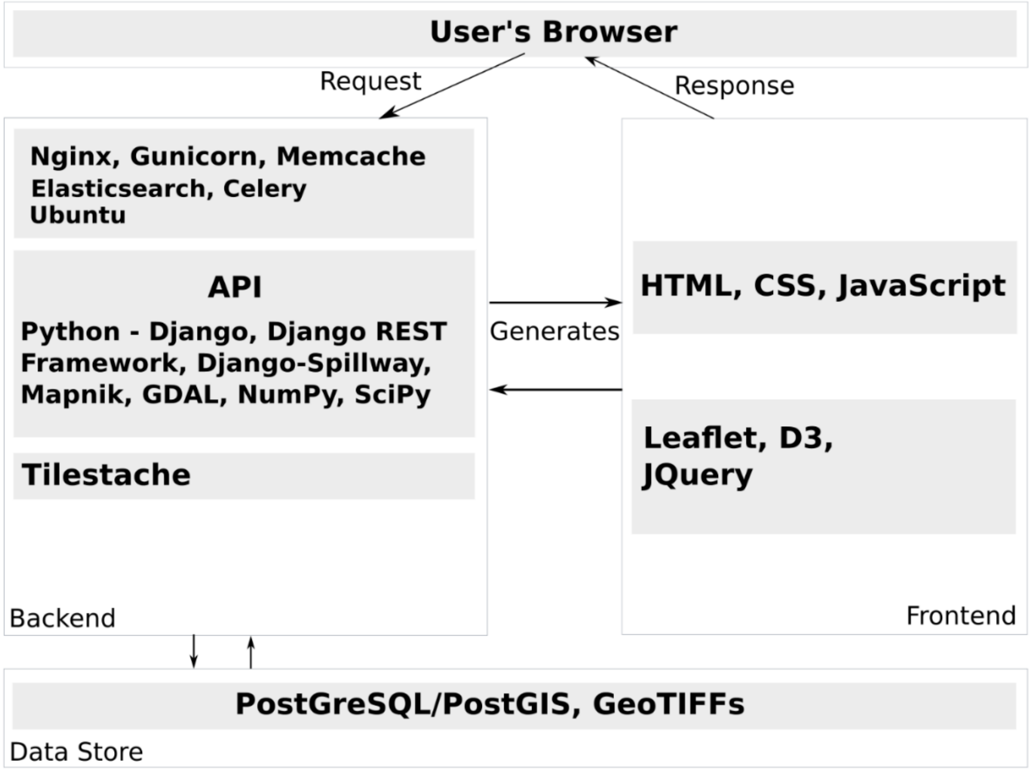
Spatial Data Science

Importance of our research being:

- Reproducible
- Repeatable
- Collaborative
- Meaningful

Open source tools allow us to achieve these goals more easily

GIF Open Source API Architecture



Spatial Data Science Bootcamp

Set Up Your Environment

- Virtual machine environments (Linux-based)
- Spatial databases (PostgreSQL/PostGIS)

Wrangle Data

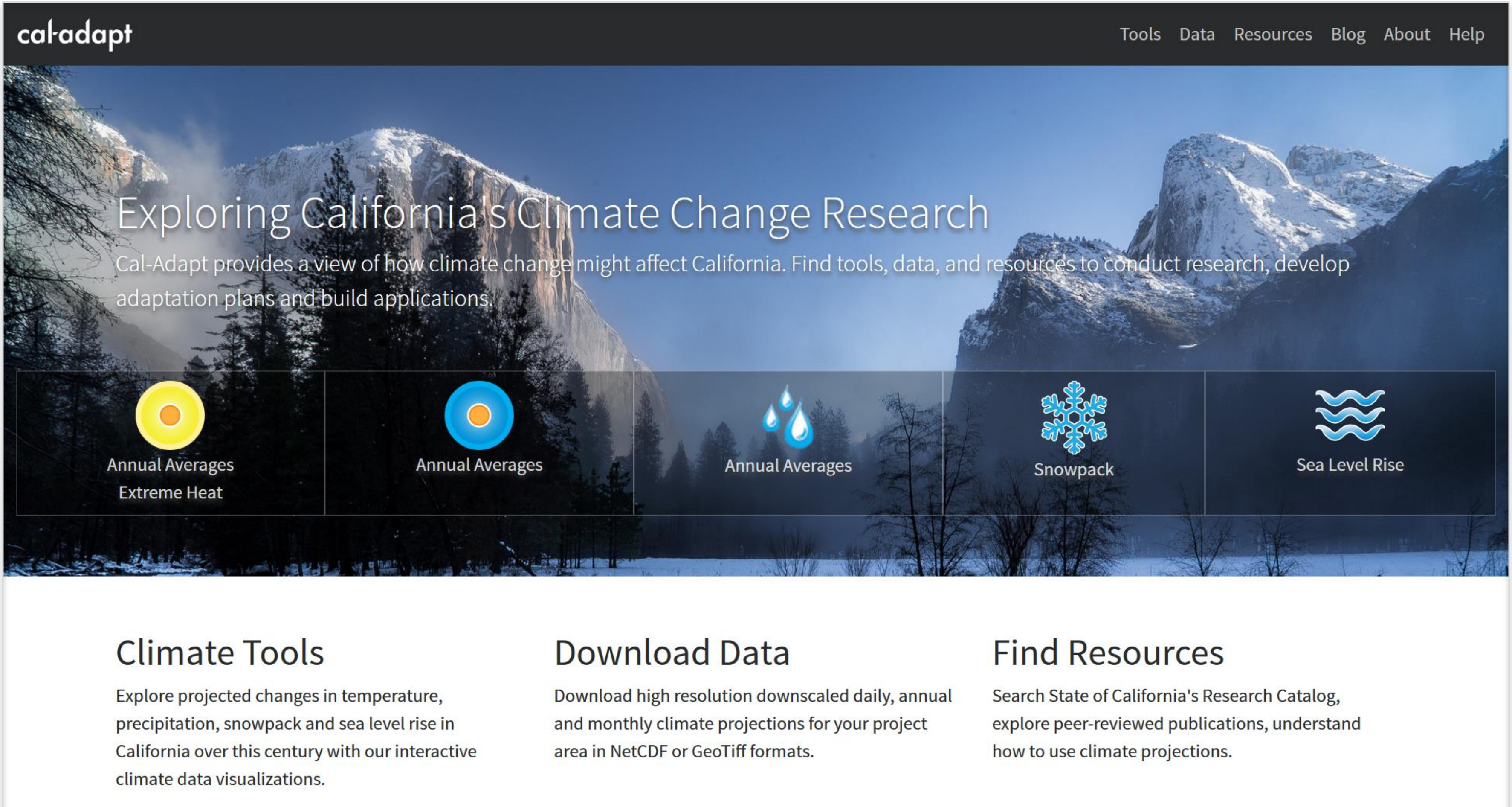
- Modern data standards and formats (GeoJSON)
- Open mapping tools (GDAL, QGIS)

Analyze Data

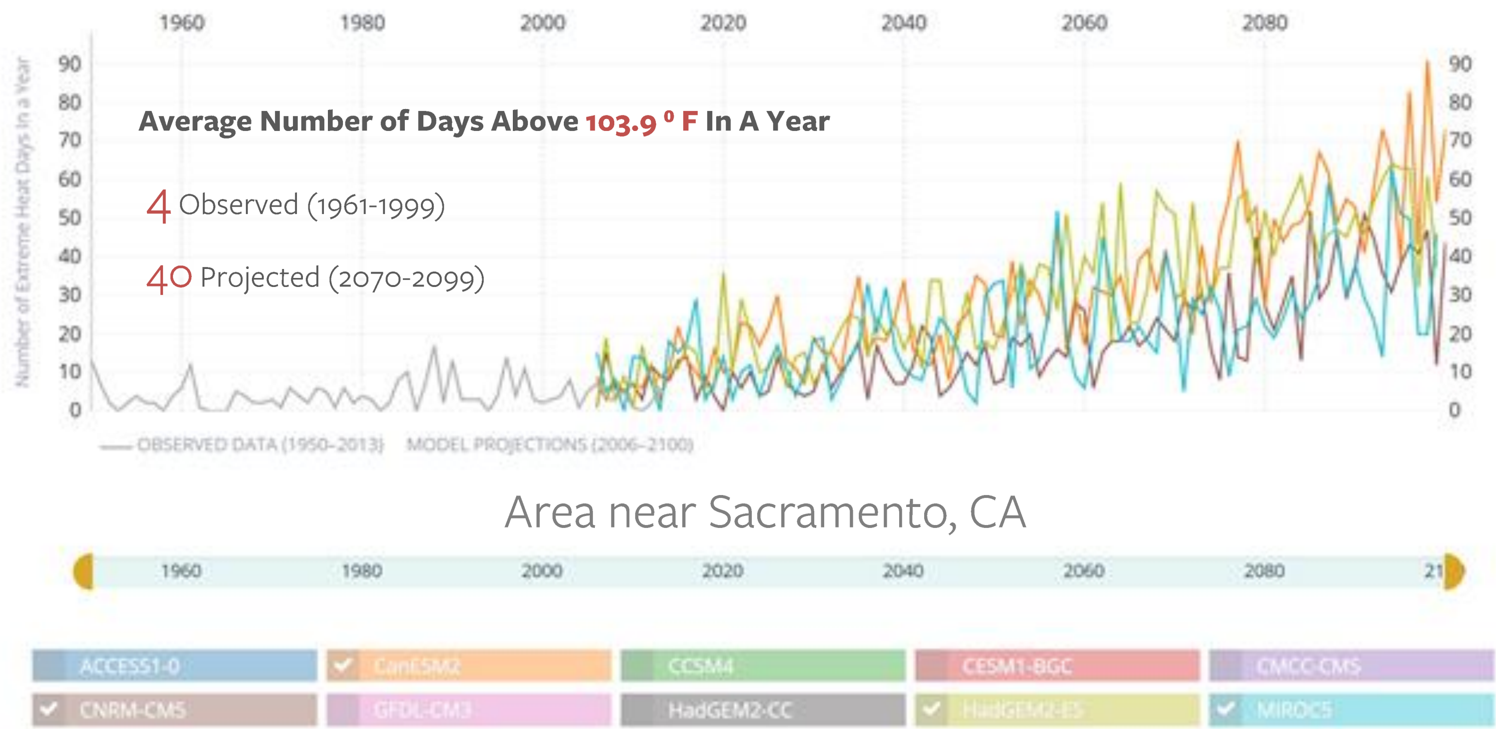
- Python (i.e. PySAL, NumPy, Pandas, Jupyter Notebook)
- R and R Studio (i.e. sp, raster, rgdal, maptools)

Visualize and Publish Data

- Web mapping and data visualizations (CARTO, Leaflet, D3)
- Data visualization in Python


cal-adapt
Tools
Data
Resources
Blog
About
Help
Exploring California's Climate Change Research
Cal-Adapt provides a view of how climate change might affect California. Find tools, data, and resources to conduct research, develop adaptation plans and build applications.
Annual Averages
Extreme Heat
Annual Averages
Annual Averages
Snowpack
Sea Level Rise
Climate Tools
Explore projected changes in temperature, precipitation, snowpack and sea level rise in California over this century with our interactive climate data visualizations.
Download Data
Download high resolution downscaled daily, annual and monthly climate projections for your project area in NetCDF or GeoTiff formats.
Find Resources
Search State of California's Research Catalog, explore peer-reviewed publications, understand how to use climate projections.

Beta.cal-adapt.org: extreme heat tool



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College of Natural Resources
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Who you are!

Today's Workshop

- Geospatial data
- Geospatial fundamentals
- Why open source?
- Intro to QGIS and hands-on exercise

LEARN HOW TO MAKE A MAP!

What is Geographic Data?

Data - descriptions collected through observation

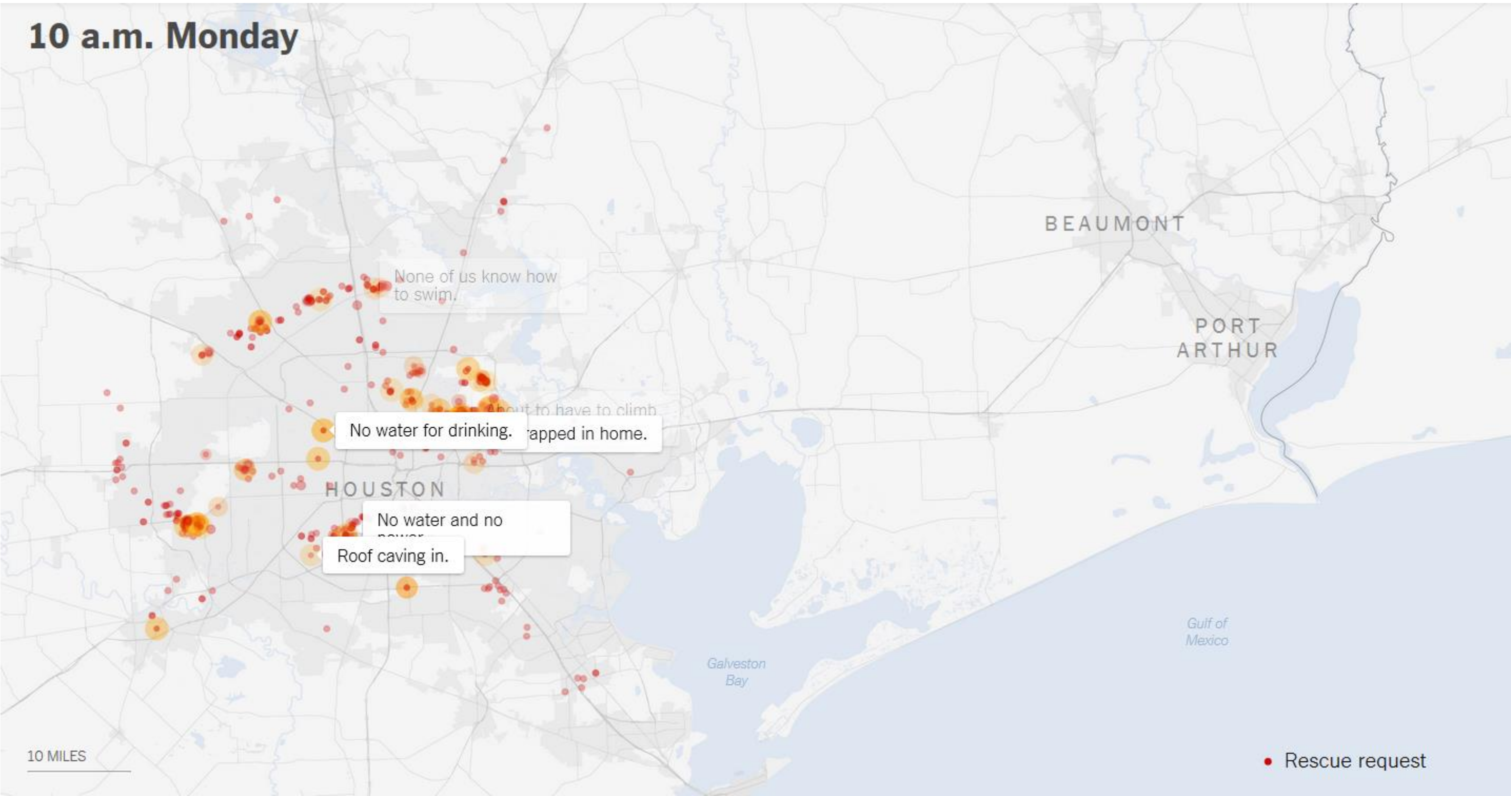
Geographic - about locations on or near the surface of the Earth

Why Geospatial?

Digital maps are everywhere & changing the way we do things

Houston flooding

Disaster Response



New York Times: August 30, 2017

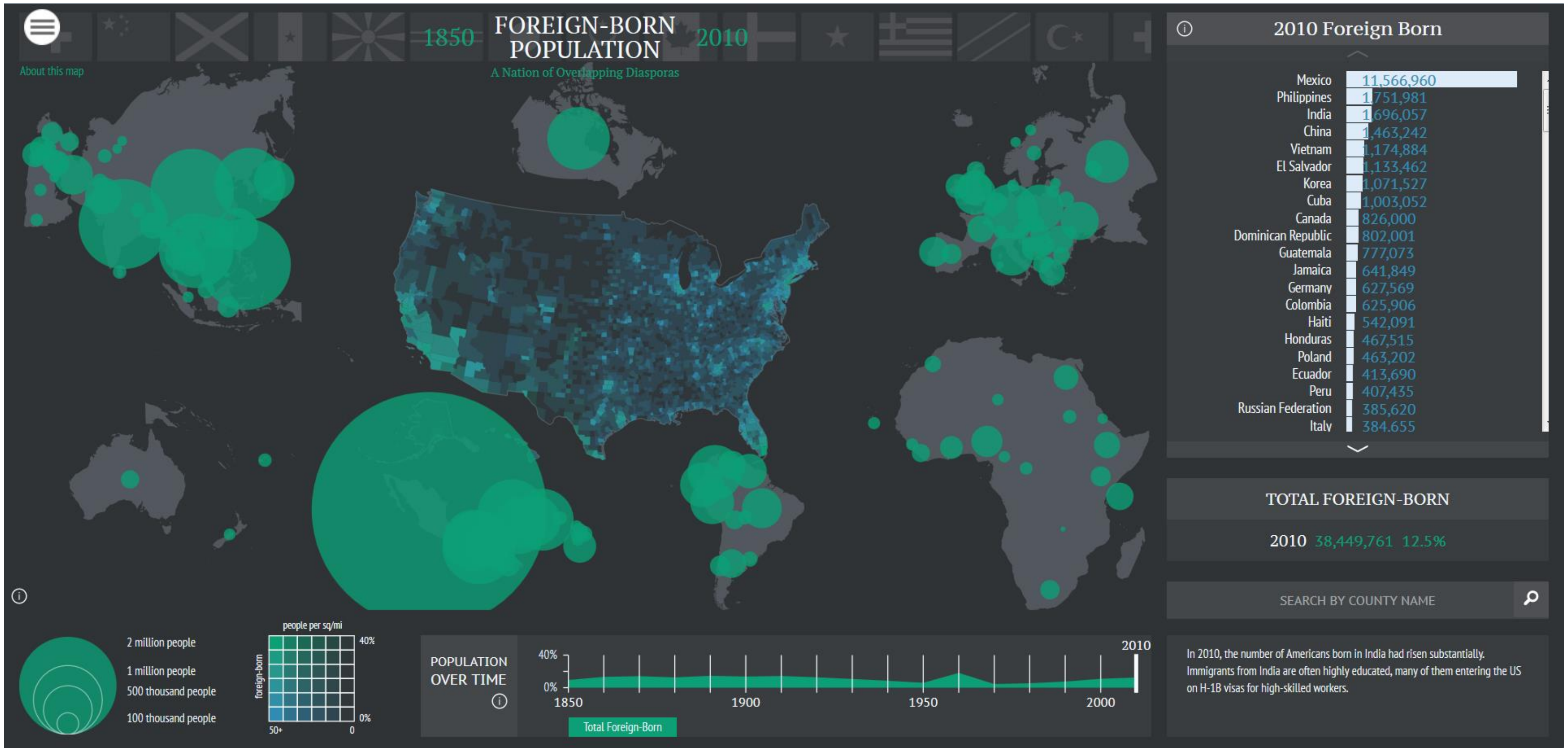
Volunteered Geographic Information

Port-au-Prince on OSM, January 12, 2010

Port-au-Prince on OSM, 28 days later

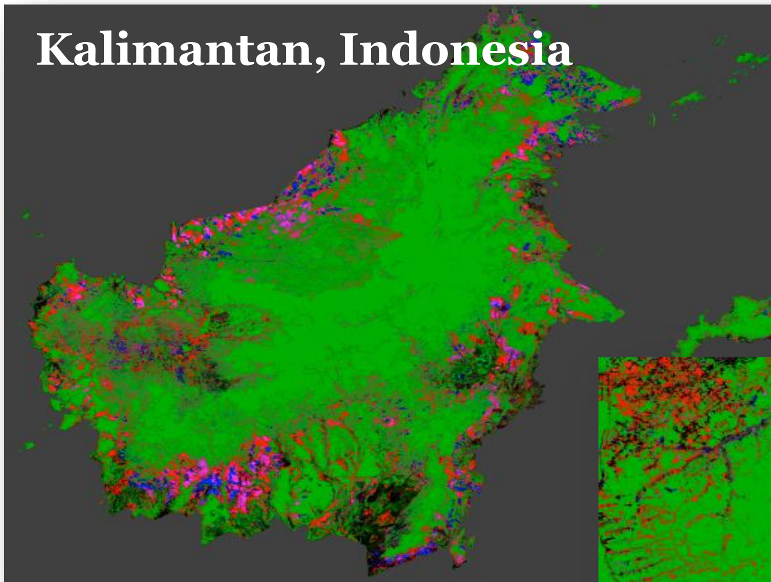
Within a few days, the response of the OSM community to map the affected areas has been intensive, as seen in this video.

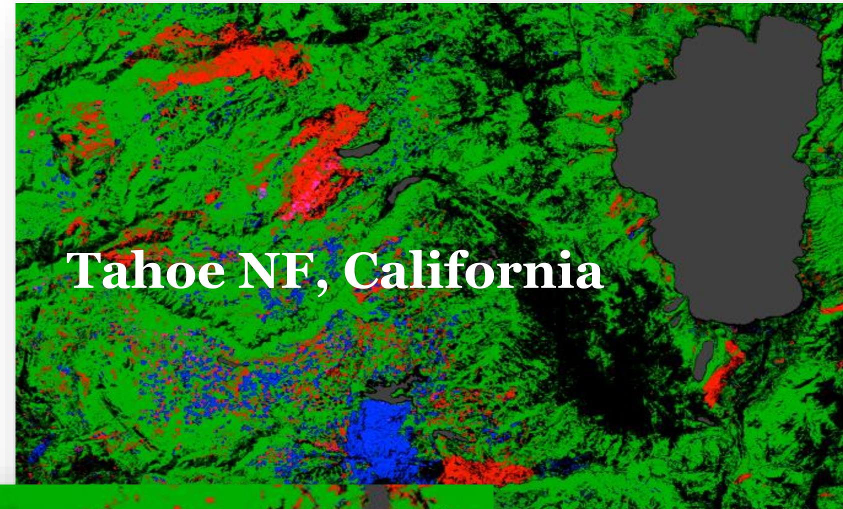
Web Mapping and Visualization



- **American Panorama:** http://dsl.richmond.edu/panorama/

Large Scale Cloud Computation: Google Earth Engine

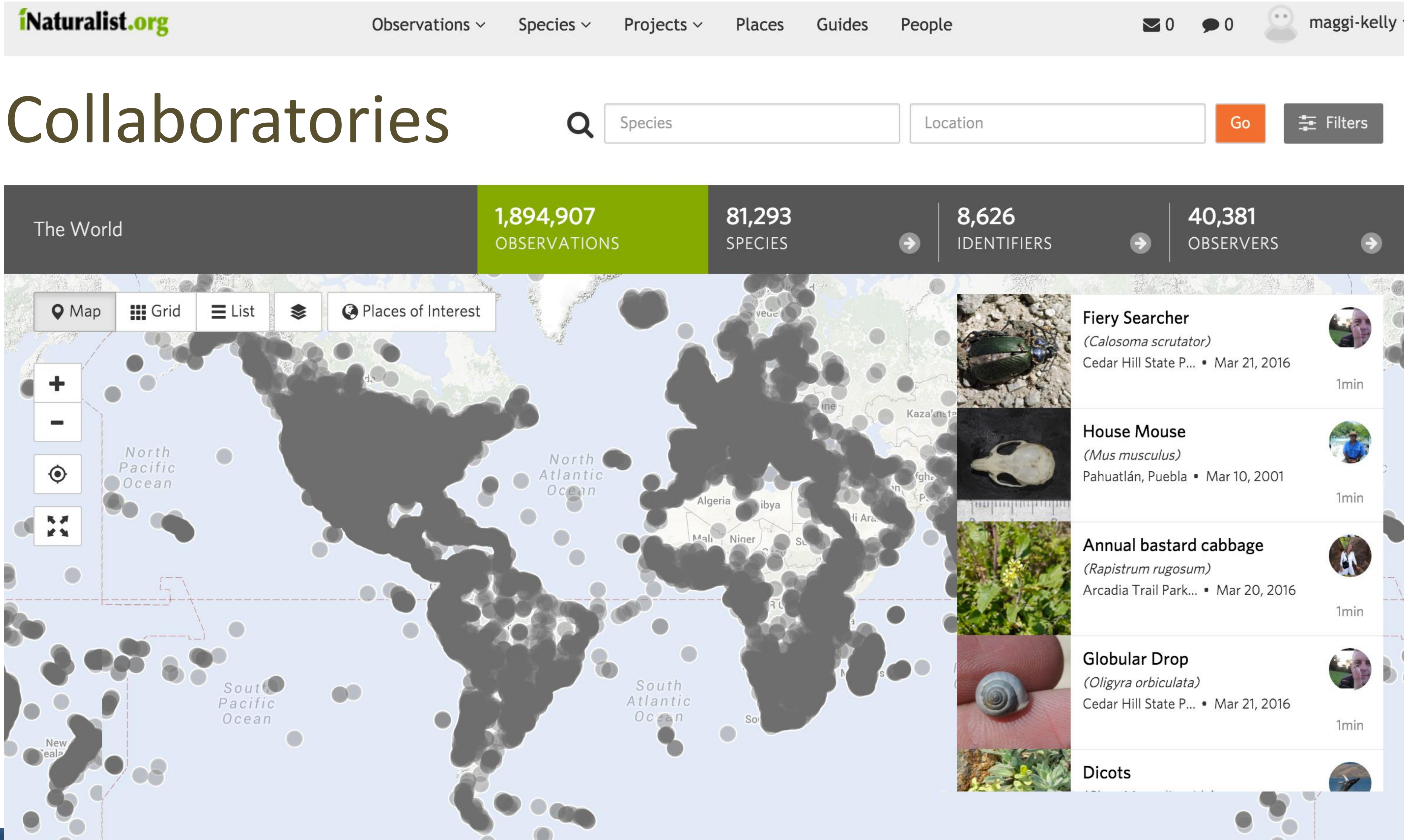




- Forest Loss 2000–2012
- Forest Gain 2000–2012
- Both Loss and Gain
- Forest Extent

10 years, 1.3M Landsat scenes, Cloud processing power

Collaboratories



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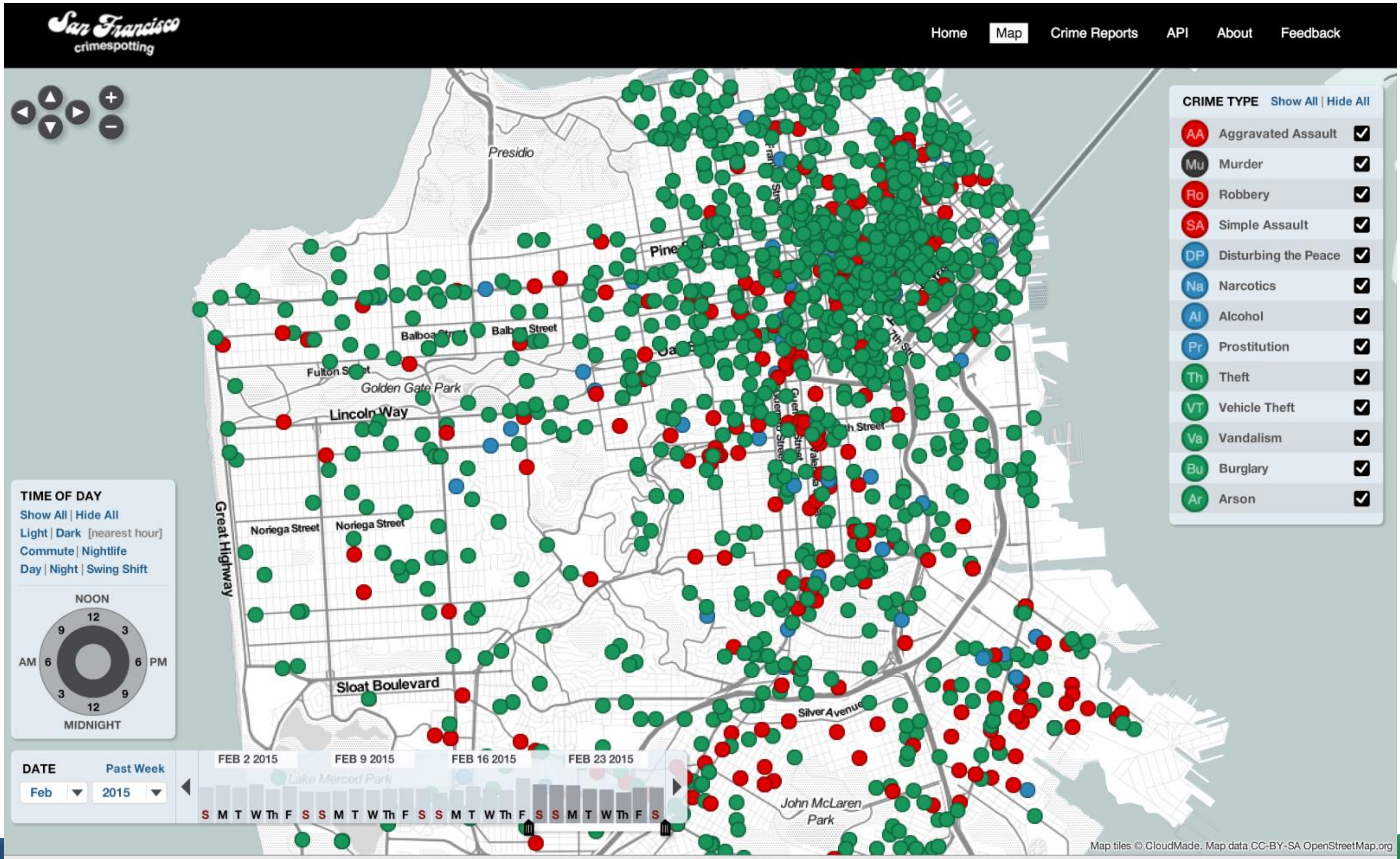
Open Government Data



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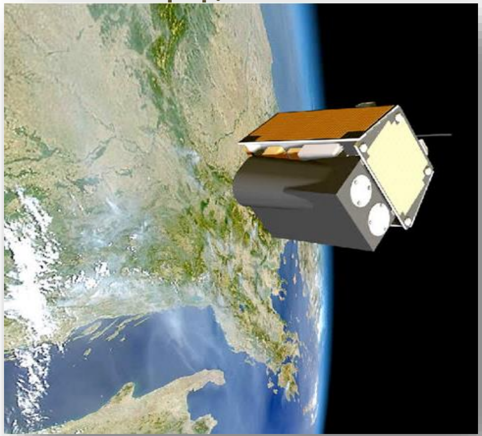
Sensor Trends: Drones, Micro Satellites

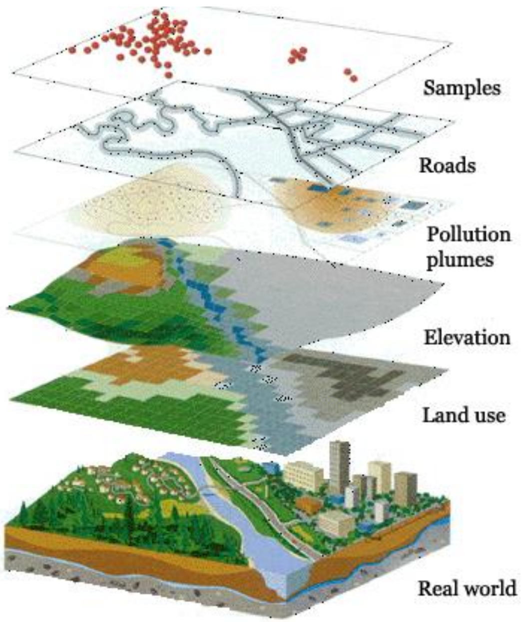
New sensors, smaller



Fundamentals of Geospatial Data & Analysis

What is GIS?

A geographic information system (**GIS**) is a computer-based tool that **links geographic information** (where things are) with **descriptive information** (what things are).



GIS Layers

Real World

Monitoring Wells

Well ID	Date Sampled	Concentration
C-6A	5/8/94	300
C-8A	5/8/94	20
C-13A	5/8/94	120
C-17A	5/8/94	560

Industries

Facility	Address
Acme	3029 Convington Dr.
Fox	742 West Lake St.
TPC	90 Aspen Dr.

Population

Family Name	Occupants	Addresss
Blake	6	79 Circuit St
Hernandez	2	148 Plain St.
Joy	4	18 Webster St.
Smith	5	4321 Tecumseh Dr.

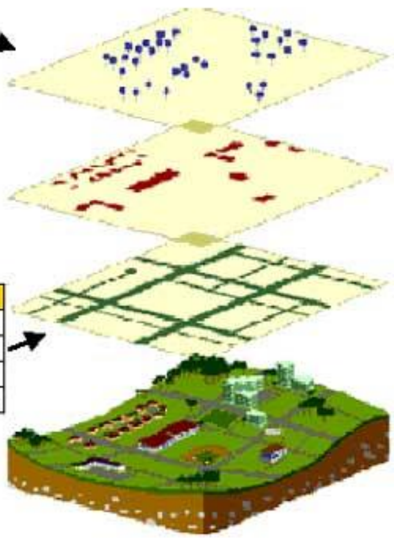
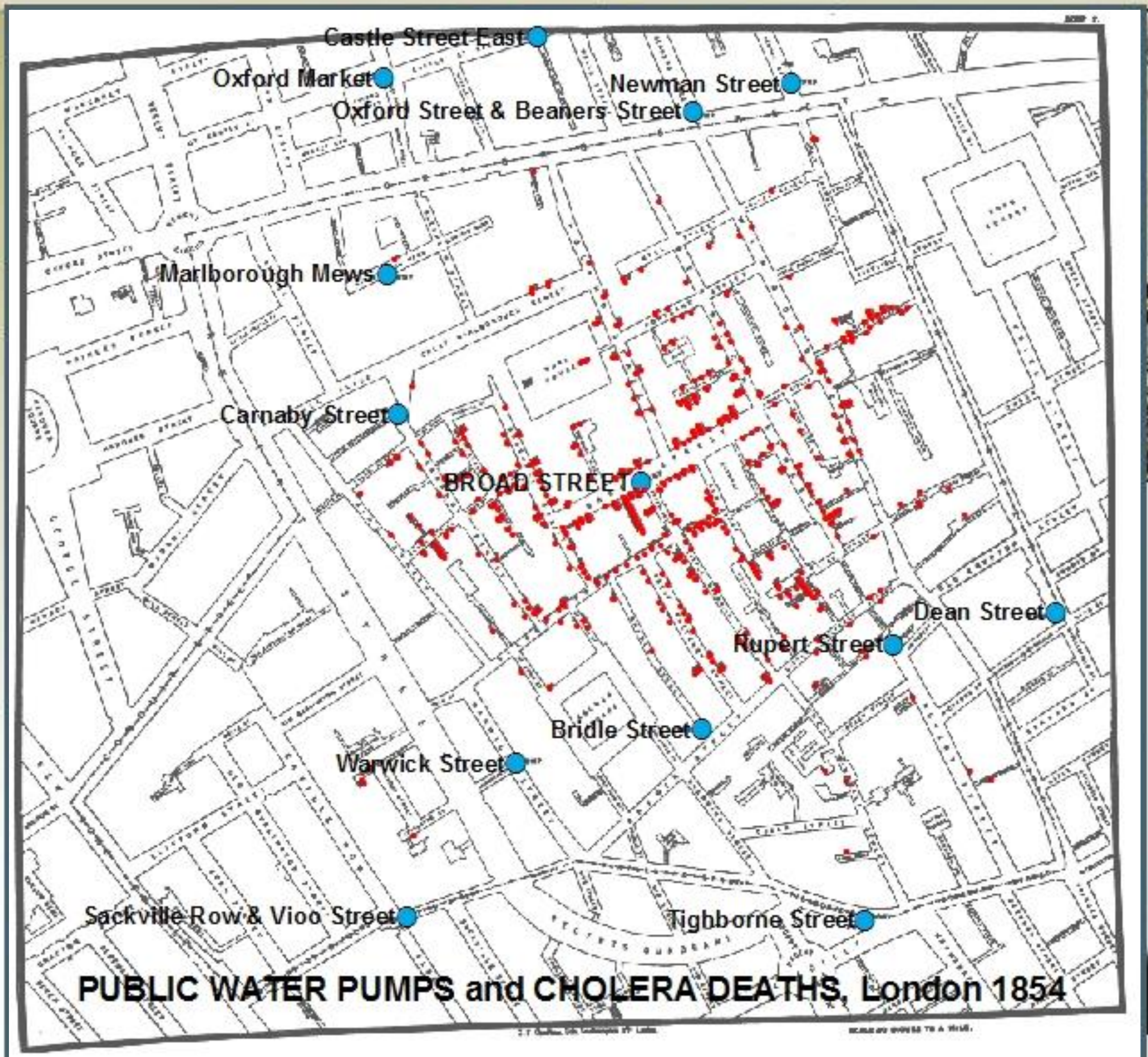


Image credit: ESRI

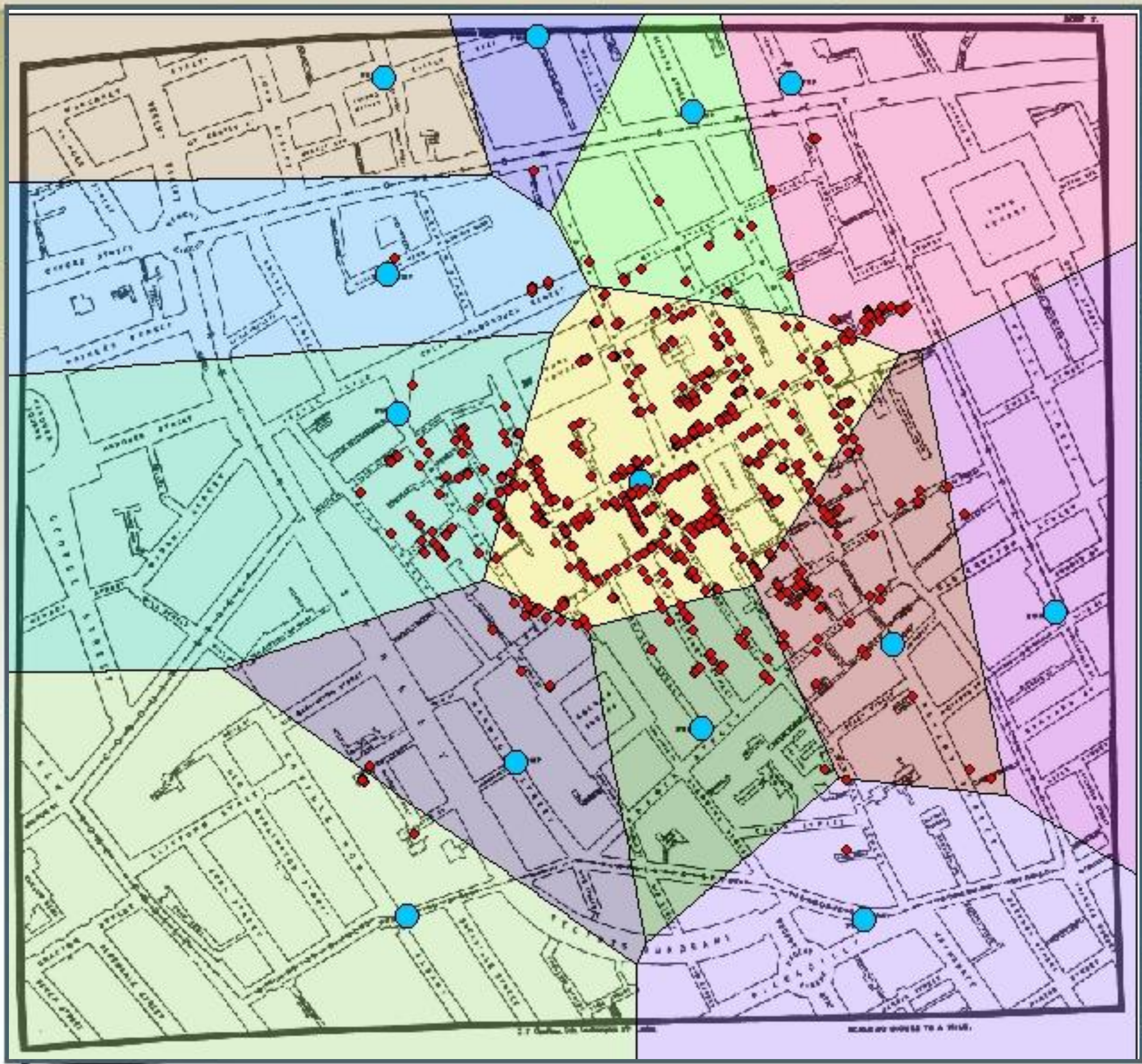
Beginnings of GIS – Snow Map



"Miasma"

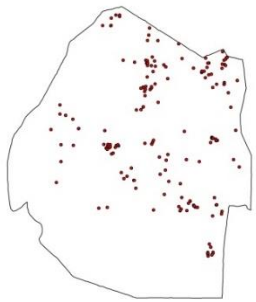
http://www.udel.edu/johnmack/frec682/cholera/cholera2.html

Beginnings of GIS – Snow Map

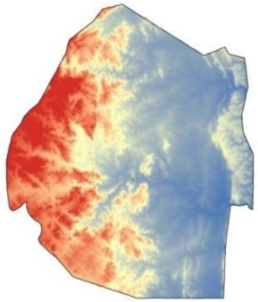


"Miasma"

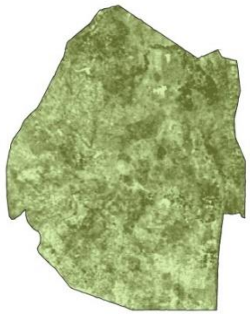
Public Health: Hugh Sturrock (UCSF) Risk Mapping



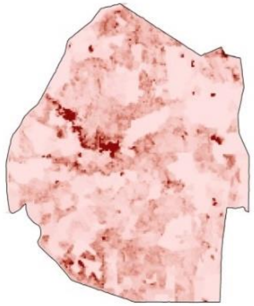
Malaria cases



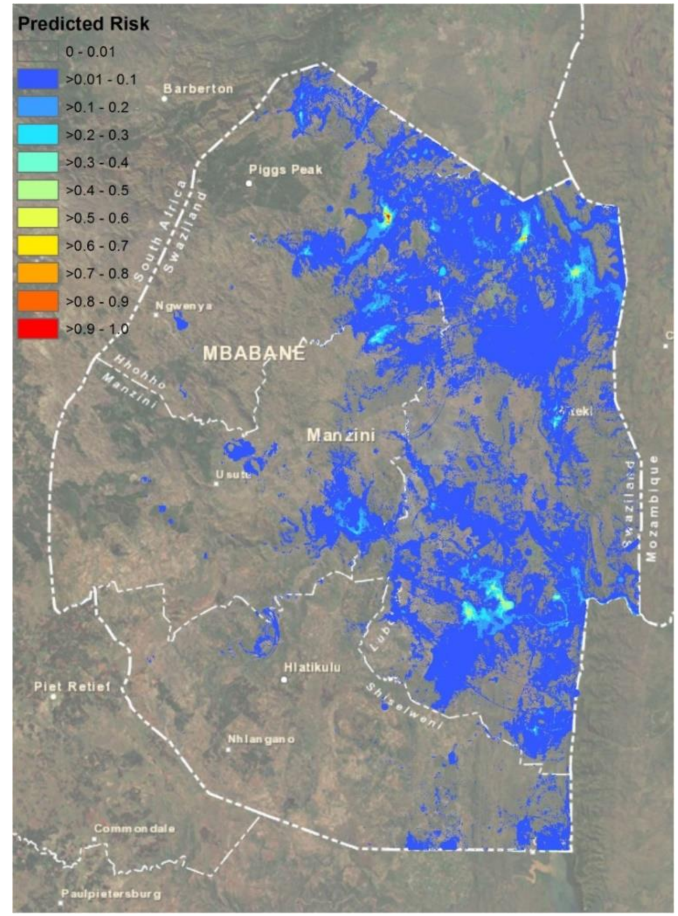
Elevation



Vegetation



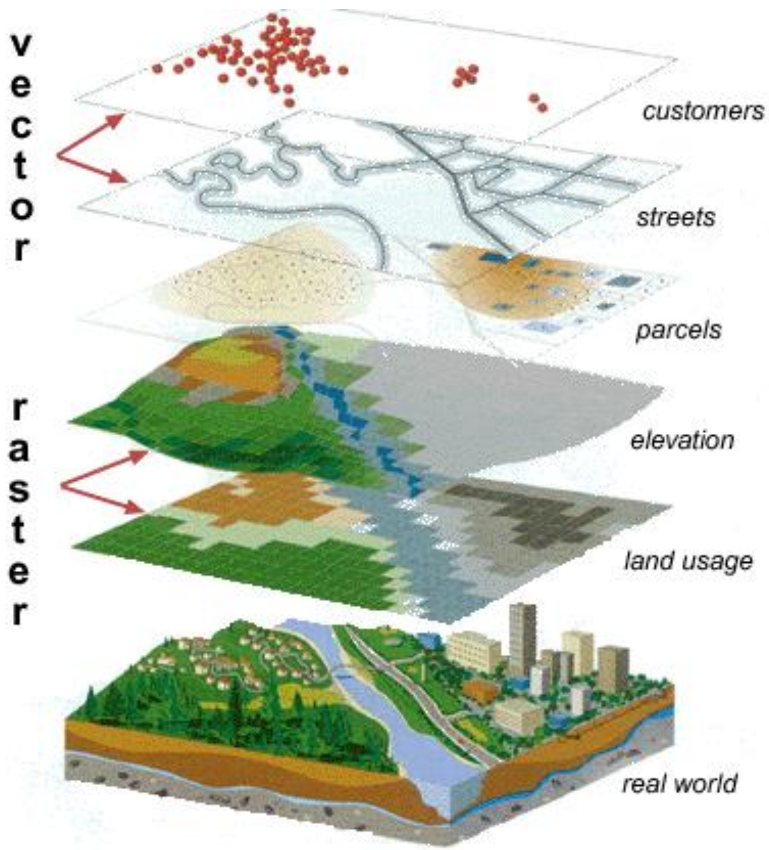
Population density



Malaria in Swaziland in 2011
Cohen et al. (2013) Malaria Journal, 12:61

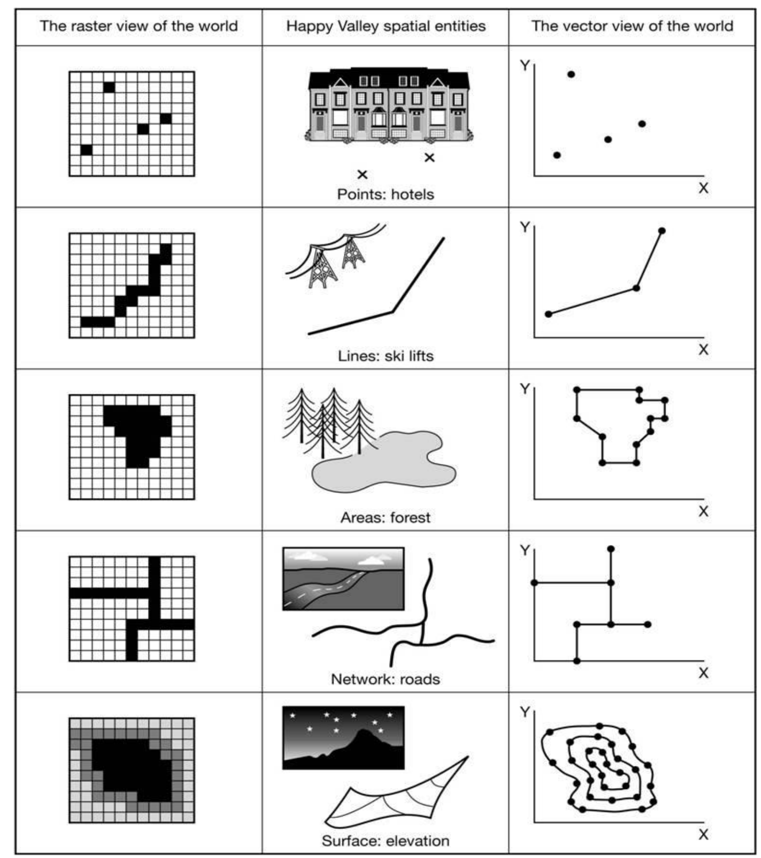
How GIS Works

A GIS stores information about the world as a collection of thematic layers that can be linked together by geography



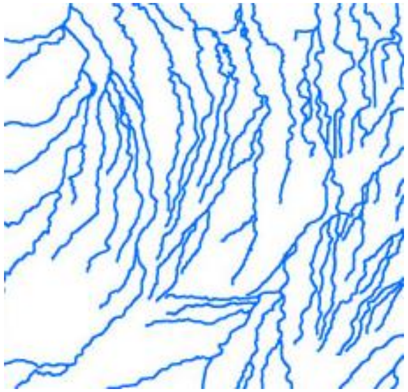
There are 2 basic spatial data types representing the real world:

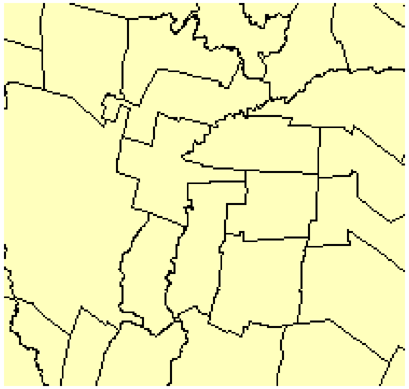
Raster **Vector**

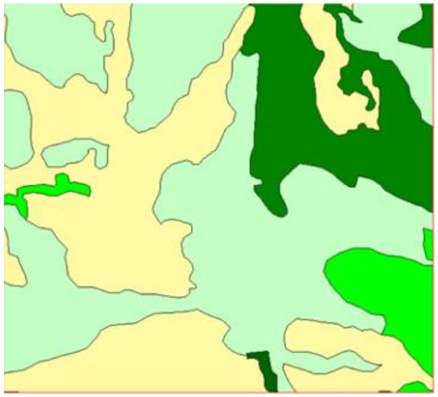


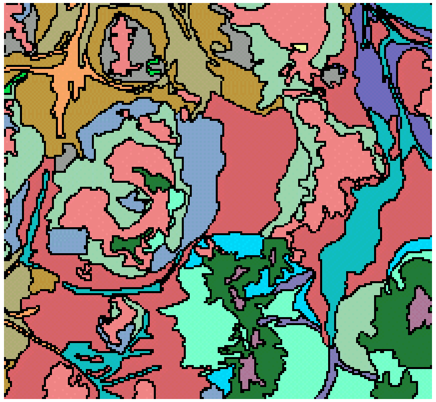
Vector data examples
(points, lines, and polygons)

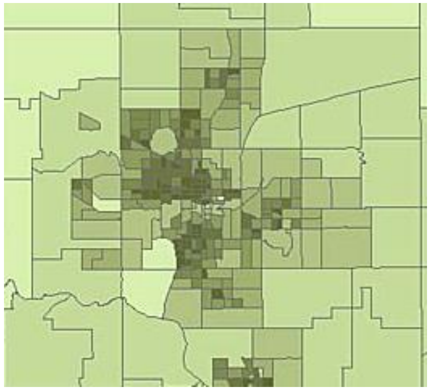

GPS data


Rivers


Counties


Habitat boundaries


Soil type

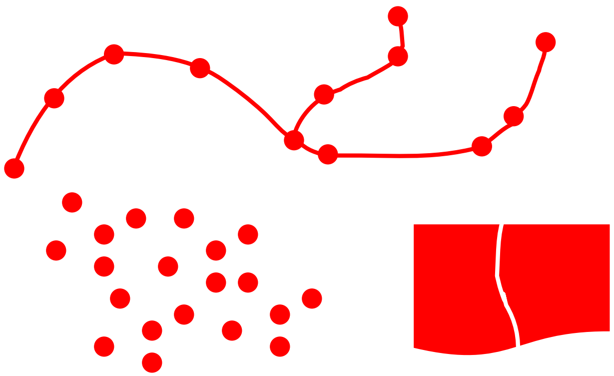

Census data

GIF

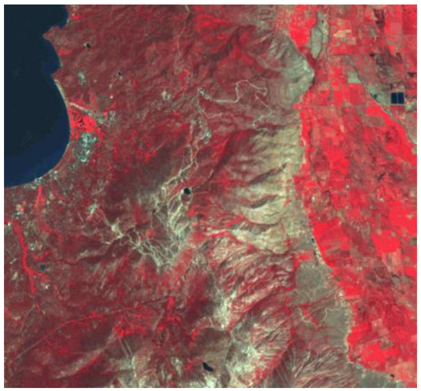
Shapefiles

File type extension	*What it is*	*Description*	*Example*
.shp	Main file	Stores each shape with a list of its vertices	counties.shp
.shx	Index file	Each record contains the offset of the corresponding main file record from the beginning of the main file	counties.shx
.dbf	dBASE table	Contains feature attributes with one record per feature	counties.dbf
.prj	Projection file	Stores projection information; doesn't define the data projection, only describes it. Recommended, but not mandatory.	counties.prj
.xml	Metadata file	Stores metadata information created by data creator/editor/distributor. Recommended, but not mandatory	counties.xml
.sbn	Unnecessary file, created automatically, doesn't need to be moved/copied/renamed		counties.sbn
.sbx	Unnecessary file, created automatically, doesn't need to be moved/copied/renamed		counties.sbx

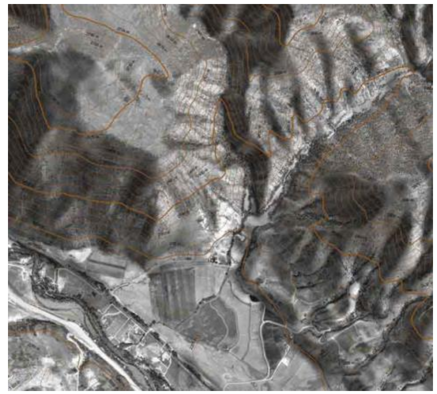
- Vector Data type
- Features: points, lines & polygons
- Attributes: size, type, length, etc.



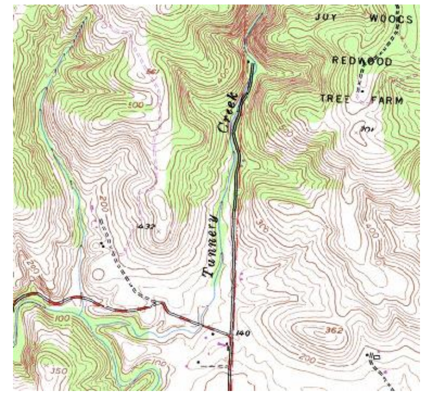
Raster data examples



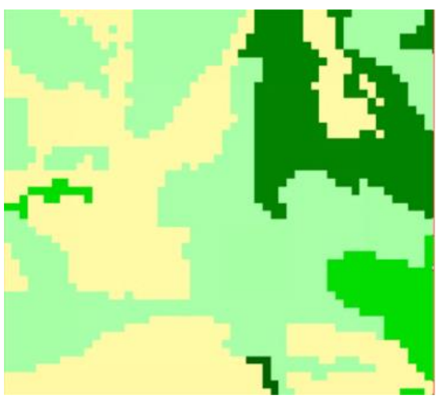
Satellite imagery



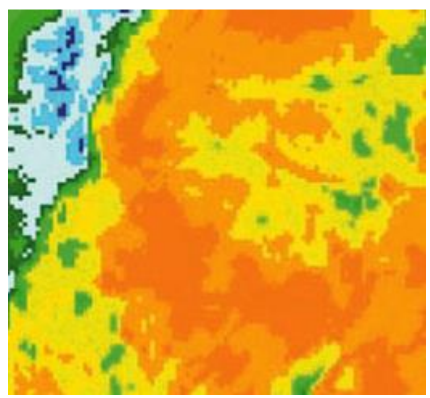
Elevation



Digital USGS
topo map



Landcover/landuse



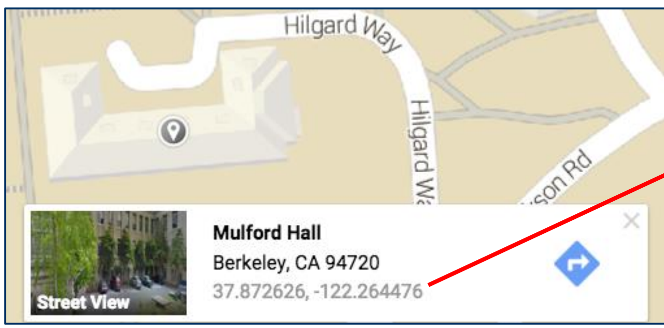
Precipitation

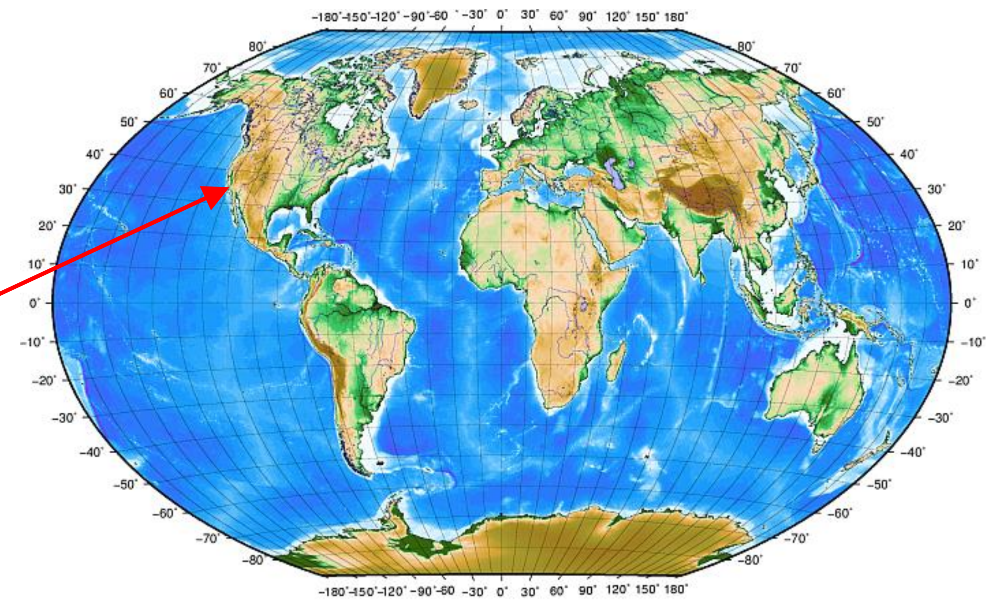
Aerial photography

Coordinate Systems & Projections

Geographic Coordinate Reference System (CRS)

Specifies precise locations as **longitude** and **latitude** values.



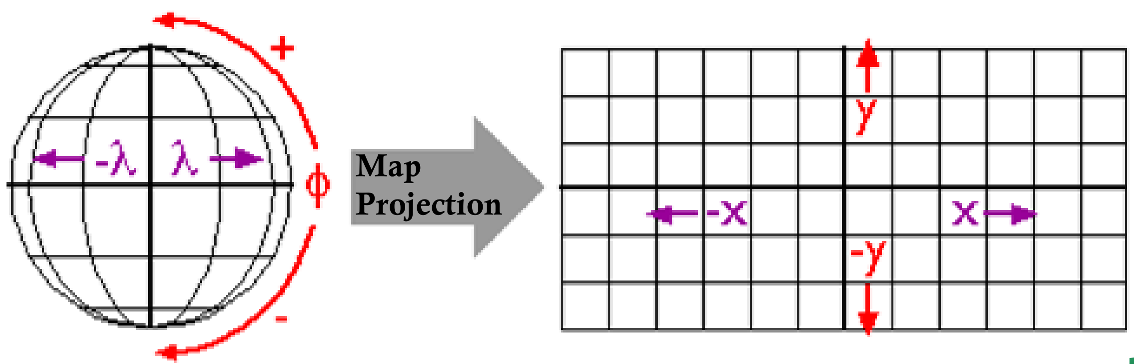


Map Projection

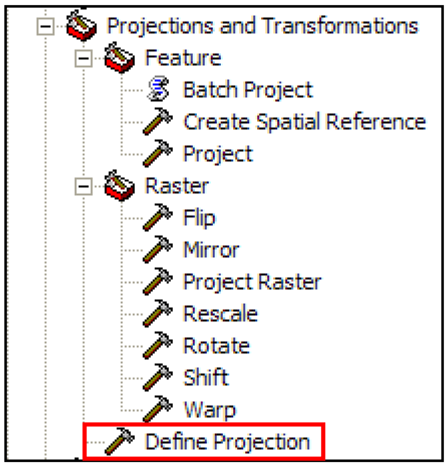
- **Map** = flat representation of the non-flat Earth
- **Map projection** = mathematical transformation from 3D surface to 2D plane.

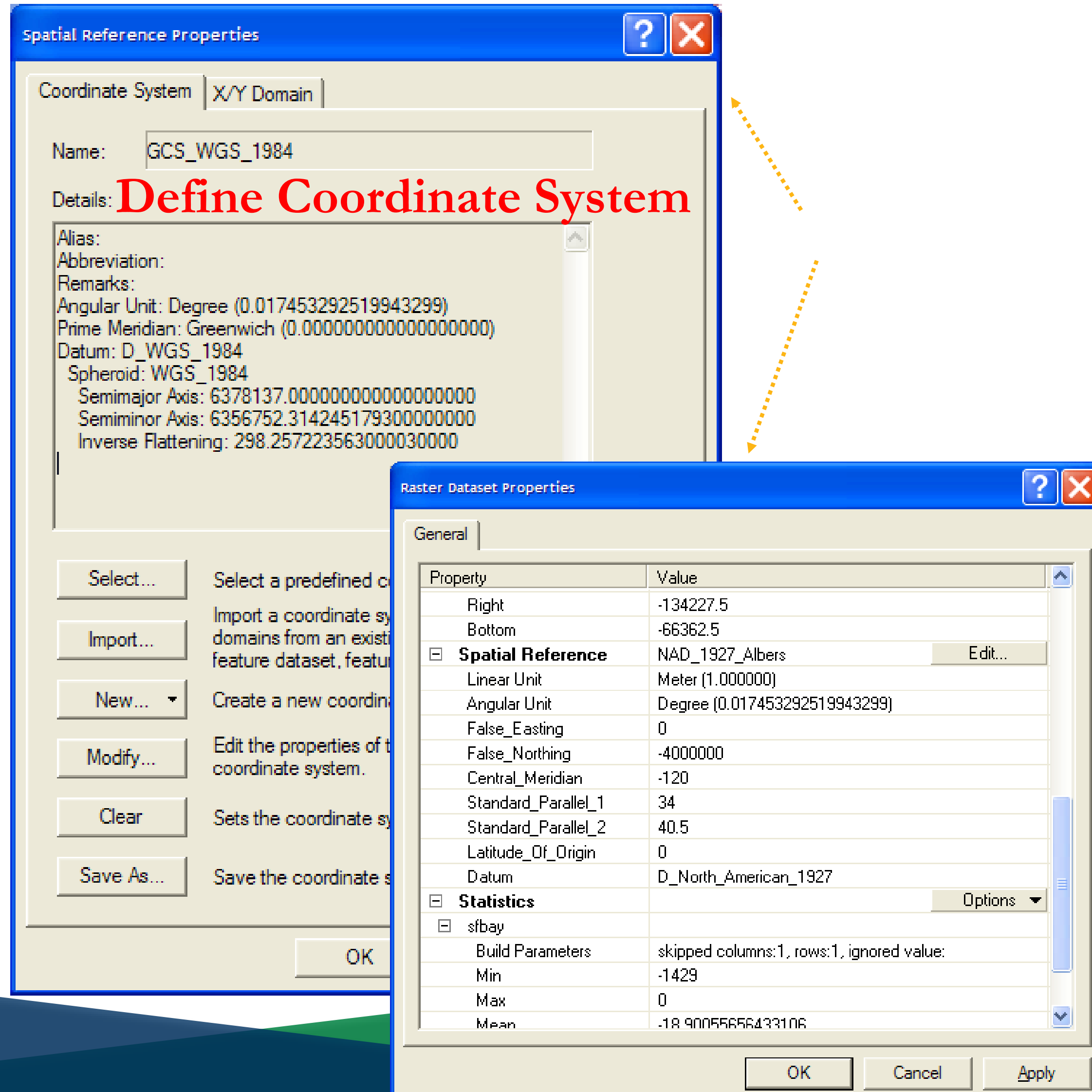
Longitude λ > X

Latitude ϕ > Y



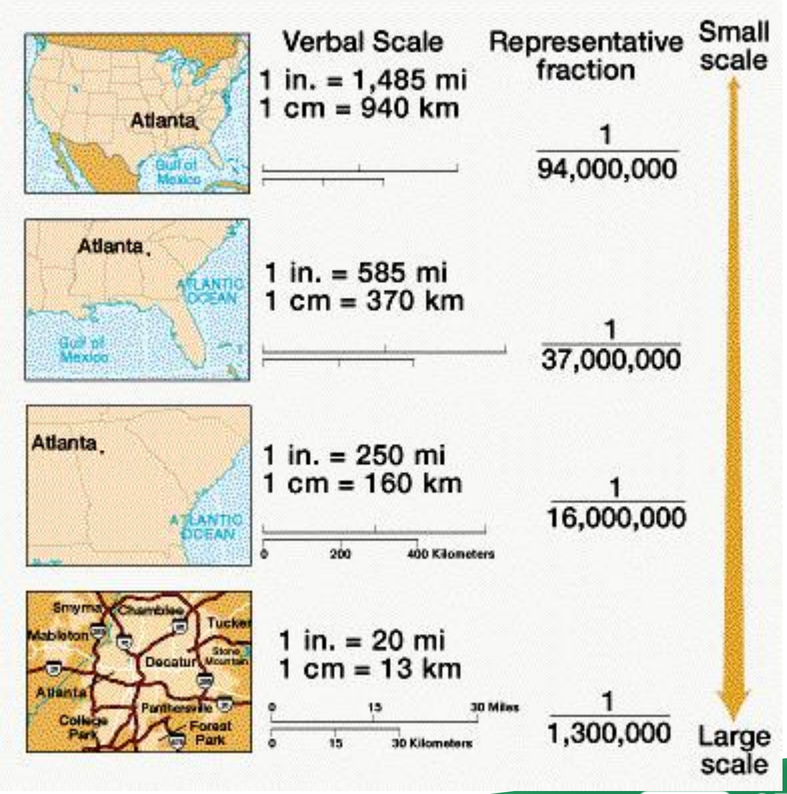
Spatial Reference Properties





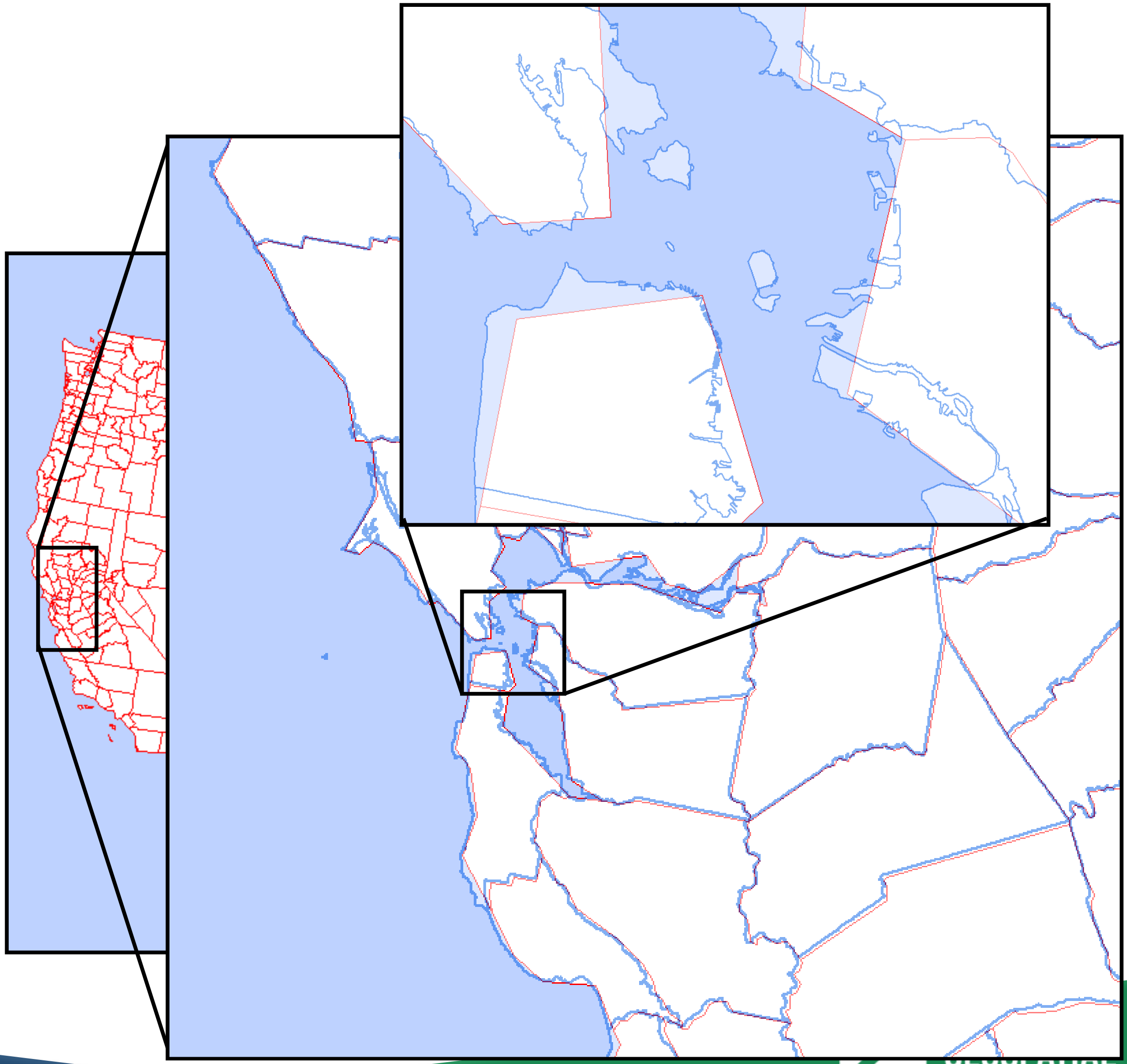
Scale

- 1 inch on the map is how many on the ground?
- Relationship between the map and the Earth
  - Which is the largest scale:
    - 1:24,000
    - 1:100,000
    - 1:250,000
- Using an appropriate scale matters



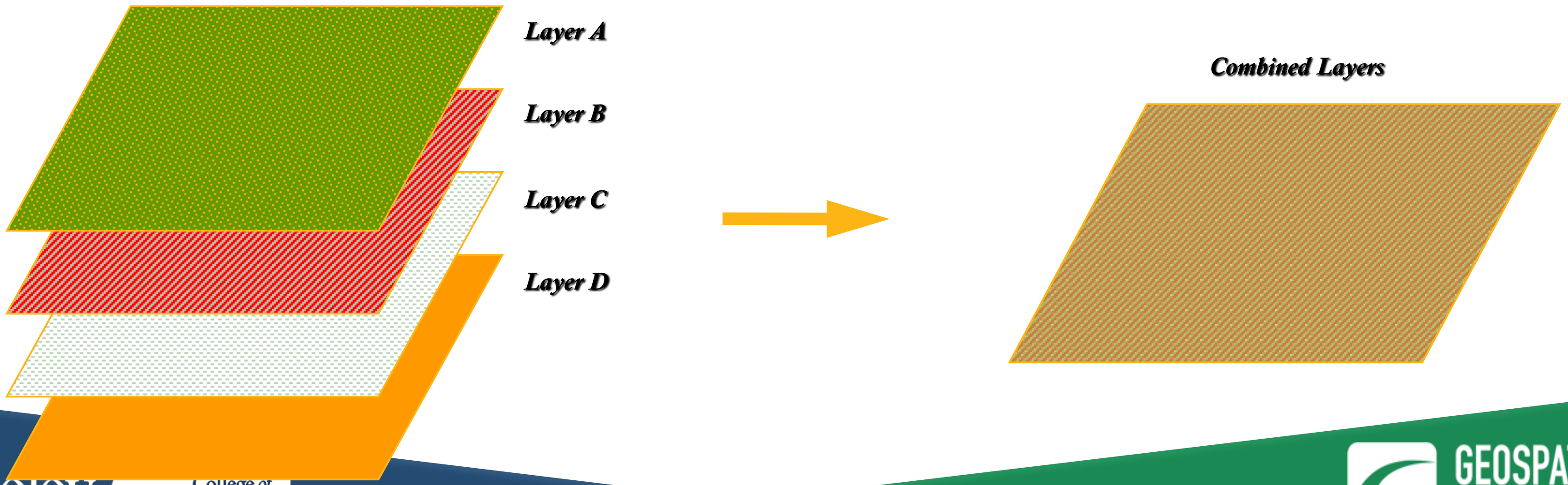
Geospatial Data Considerations: Scale

- Zooming in on a small scale map <u>does not</u> increase its level of accuracy or detail.
- Map detail is determined by the data's <u>source scale</u>.



Spatial Analysis

- A critical function in GIS analysis is the integration of datasets
  - determining where different geographic phenomena are coincident
- Overlay tools are powerful analysis tools for this
  - vertical stacking and merging of spatial data
  - combine, erase, modify features from multiple datasets



Spatial Relationship Queries

How we reason & communicate about space

Key Concepts:

Proximity, Nearness, Adjacency, Connectivity, Containment, Arrangement

The spatial aspects of an environment…

(e.g. *location, amount, distance, adjacency, isolation, fragmentation, pattern*)

…impact ecological/human/environmental function.

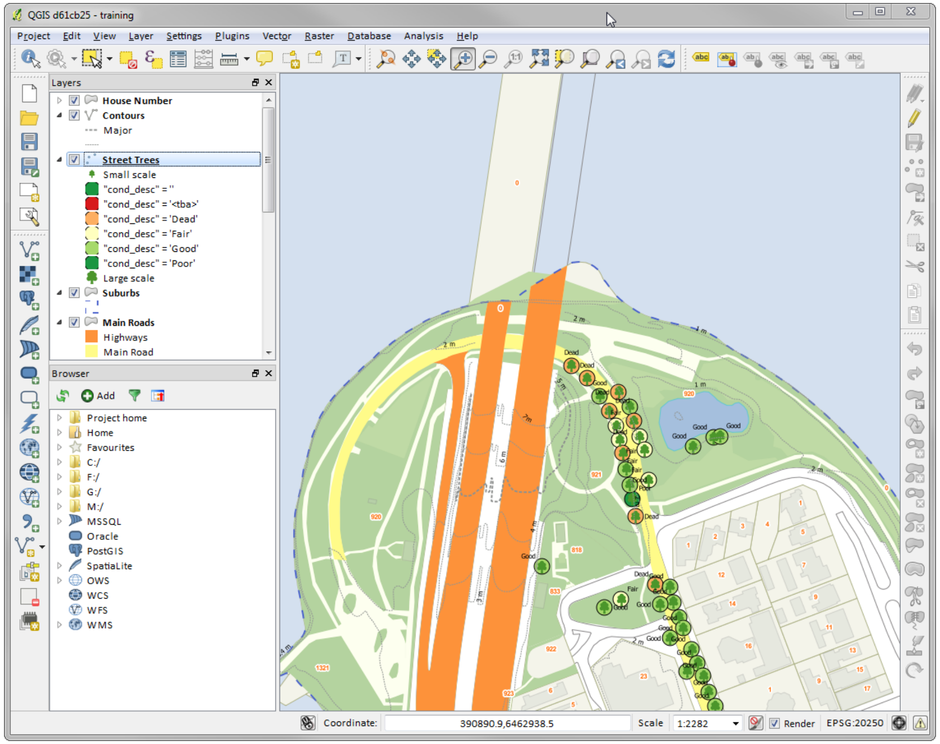
Open Source Tools for Geo

Open Source Software

- Source code freely available, and modifiable
- Open source geospatial includes
  - Spatial databases
  - Web map servers
  - Desktop applications
- Strength comes from a strong community of users
- Participate by
  - Providing programming help
  - Writing documentation
  - Simply by providing feedback

QGIS

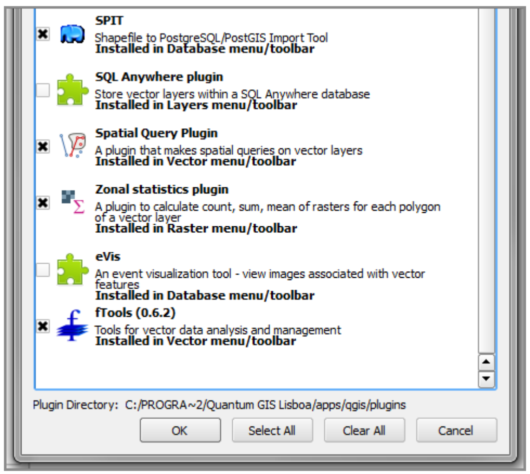
- Free and Open Source
- Easily Translatable
- Plugin Environment
- Easy to use/learn
- Powerful
- Multiplatform
  - Windows
  - Mac
  - Linux

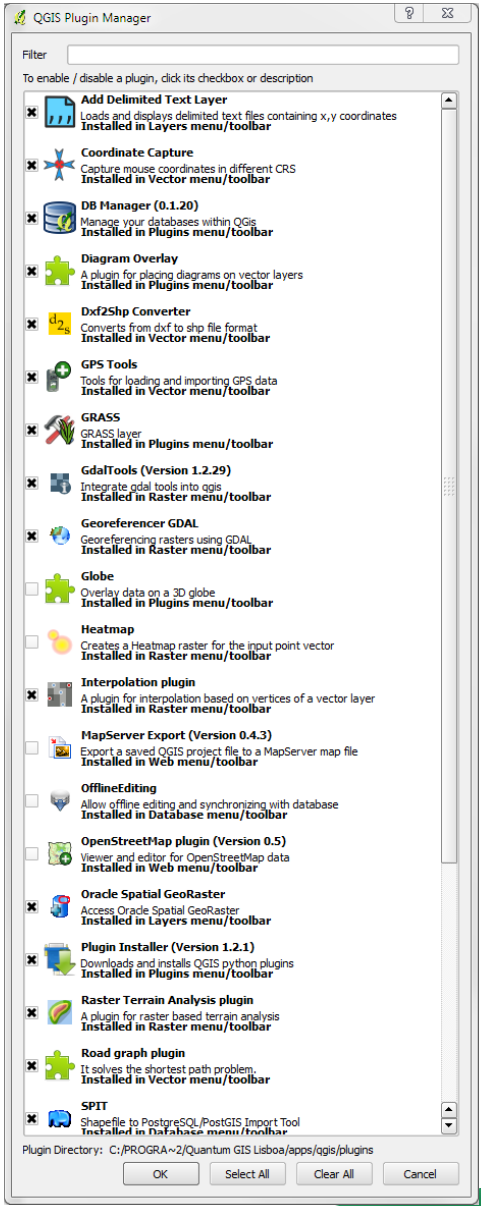


QGIS Features

- Growing Core Functionality
  - Vector Support
  - Raster Support
  - Projection Support
  - Vector editing
  - Map Composition

- Plugins!





GitHub

Code management and storage web-based platform with a focus on:

1. Versioning (tracking changes)
2. Collaboration (ability to clone and add to existing repositories)

All repositories are publicly available, unless you create it with a paid (upgraded account) that can create private repositories.

"GitHub is the largest code host on the planet with over **22.8 million** repositories."

If you haven't already, create your free account: https://github.com/join

Hands-on exercise

https://github.com/nethomas-geo/QGIS-Training