



# 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



# We Need a 21<sup>st</sup> 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.**

# Geospatial Education

We live in a world where the importance and availability of spatial data are ever increasing. In just the past year the GIF has trained over 300 students from over 50 departments on campus how to acquire, analyze, visualize, and publish geospatial data.





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Cutting-Edge Mapping Technology at UC Berkeley

# WORKSHOPS

## September 2017

The GIF is pleased to offer these hands-on workshops at NO COST to UC Berkeley students, faculty, and staff. Fees are now \$150 for all non-UC affiliates. Workshop seats will be filled on a first come first serve basis.

Space is limited, so please sign up at: <http://gif.berkeley.edu/support/workshops.html>

**September 1: Intro to GIS: Environmental Science Focus**

The lecture introduces you to GIS and geospatial thinking, followed by a hands-on exercise that has been designed to acquaint you with ArcGIS Desktop software while analyzing environmental data from around Lake Tahoe. Learn how to access data in ArcGIS, query data by location and attributes, and make your own map!

**September 15: Intro to GIS: Social Science Focus**

The lecture introduces you to GIS and geospatial thinking, followed by an interactive exercise that has been designed to familiarize you with ArcGIS Desktop software while analyzing street and census data around the City of Berkeley. Learn how to access data in ArcGIS, query data by location and attributes, and make your own map!

**September 22: Intro to Remote Sensing: Understanding Digital Imagery**

This workshop introduces basic principles of understanding digital imagery, both satellite and aerial. Through a combination of lecture and interactive activities, we will explore what makes up a multi-spectral image, where to find and download them, and how to view and manipulate imagery.

**September 29: Working with Geospatial Data in R**

We will introduce attendees to methods and libraries for working with spatial data in R statistical software. We will briefly cover the basics of spatial data types and methods for importing spatial data. Participants will work through hands-on exercises exploring tools and methods for working with spatial data in R, including working with common data formats, reading and writing spatial data, and basic data visualization in R.

**Friday afternoons from 1:00 pm-4:00 pm  
124 Mulford Hall, UC Berkeley**

<http://gif.berkeley.edu>

# Community Engagement



We collaborate with domain experts on campus, partner with industry, and reach out to community organizations to bring world-class geospatial technology to UC Berkeley.

[Home](#)

[Register](#)

[Event Agenda](#)

[Speakers](#)

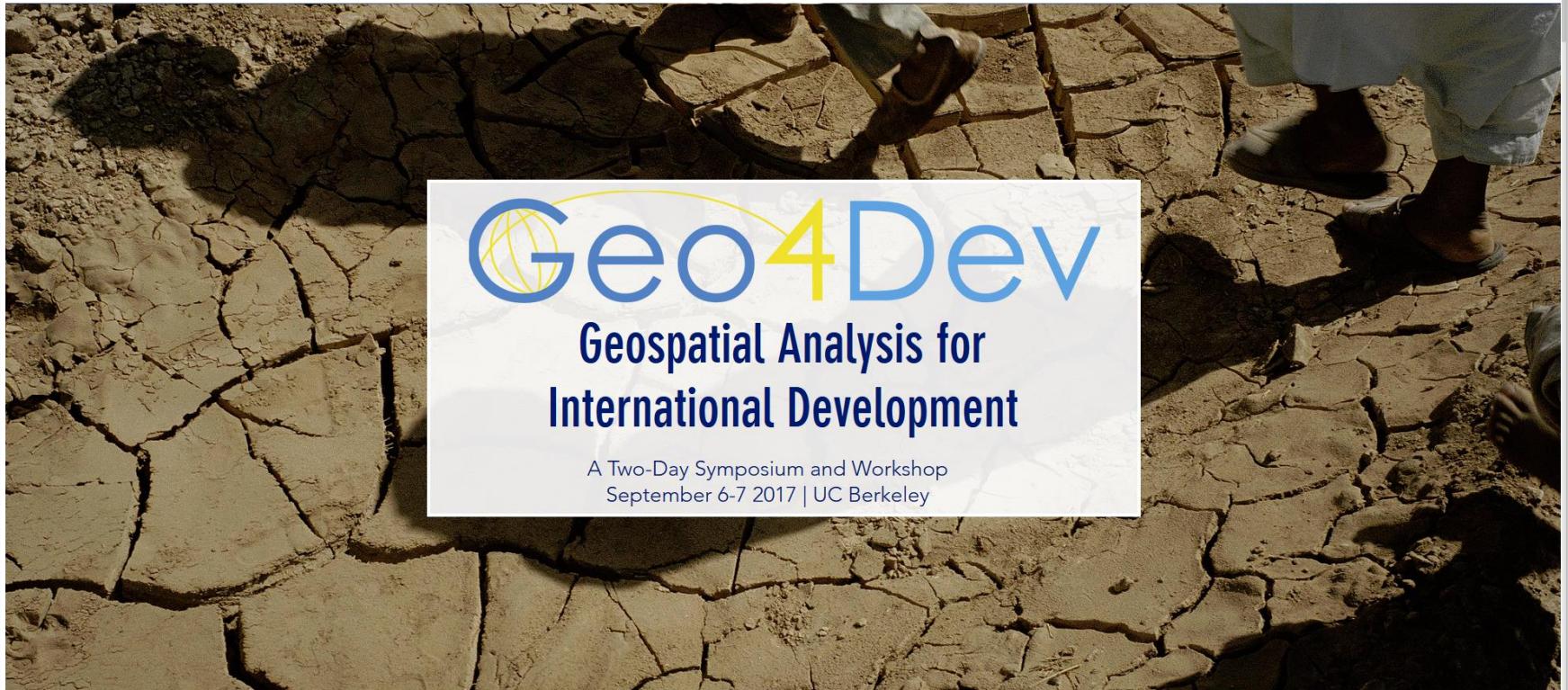
[Conference Chairs](#)

[Sponsorships](#)

[Travel](#)



BIG PIXEL  
INITIATIVE AT UC SAN DIEGO





Our research focuses on designing innovative new tools for analyzing, visualizing, and sharing complex environmental information.

# Research Projects

# 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.

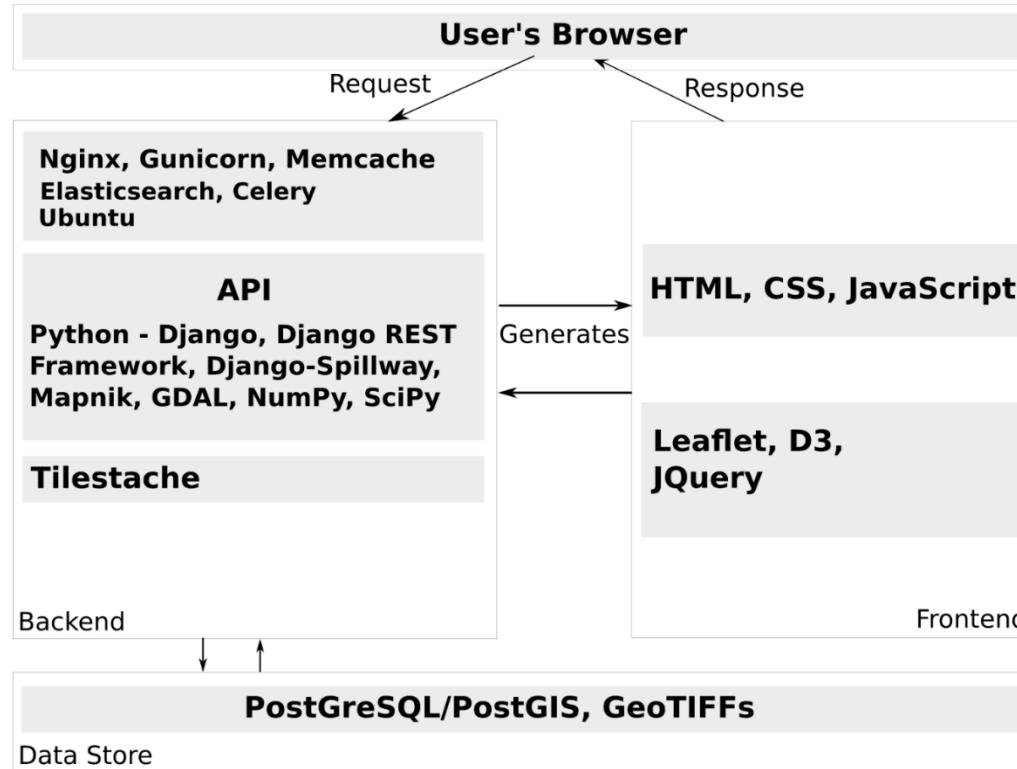
## Download Data

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.

# GIF Open Source API Architecture



# Who you are!



# Today's Workshop

- What is GIS? ... And what's its purpose?
- Geospatial Data
- Geospatial Fundamentals
- Software Domination!! Introduction to FOSS

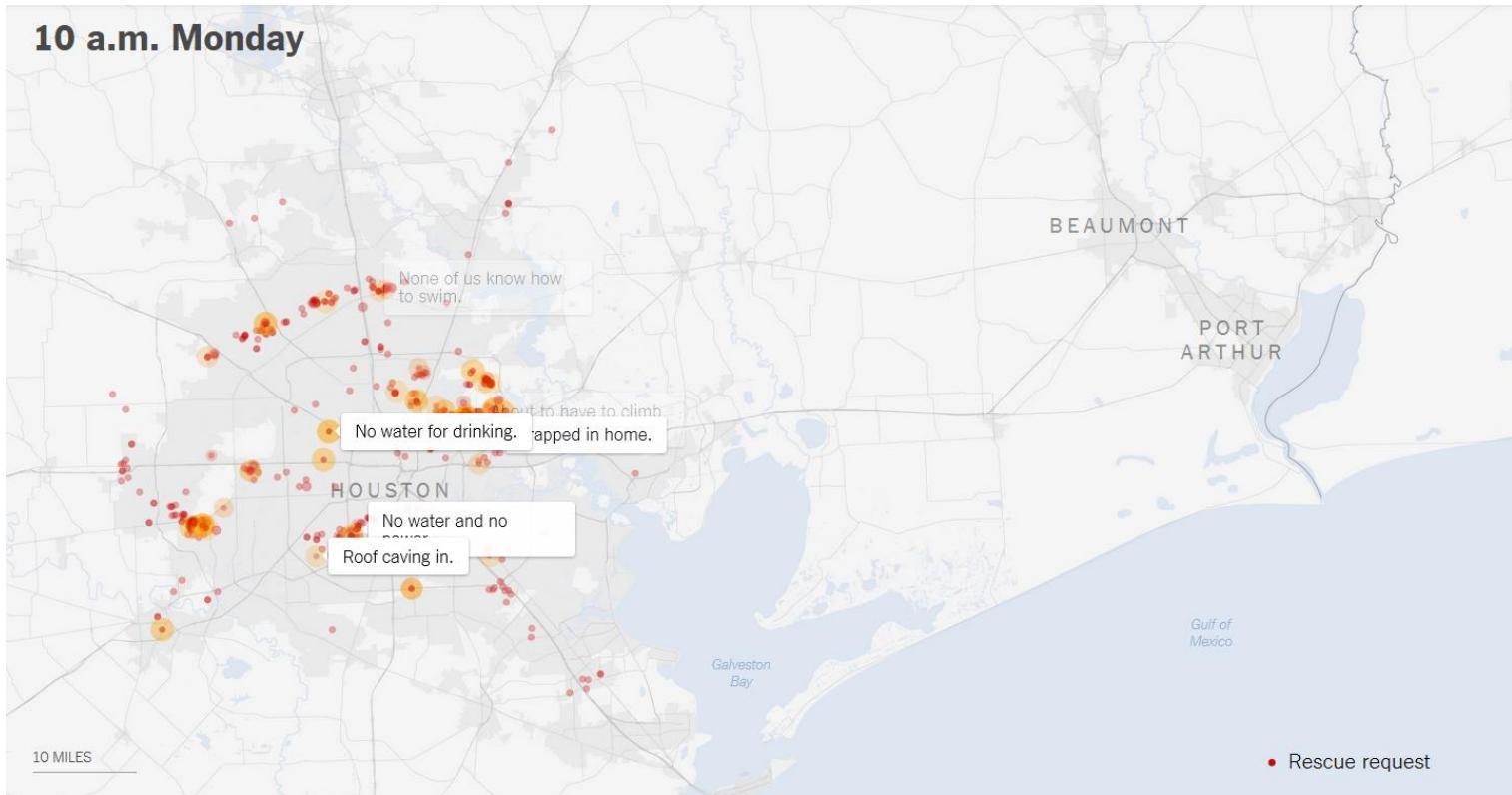
**LEARN HOW TO MAKE A MAP!**

# 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

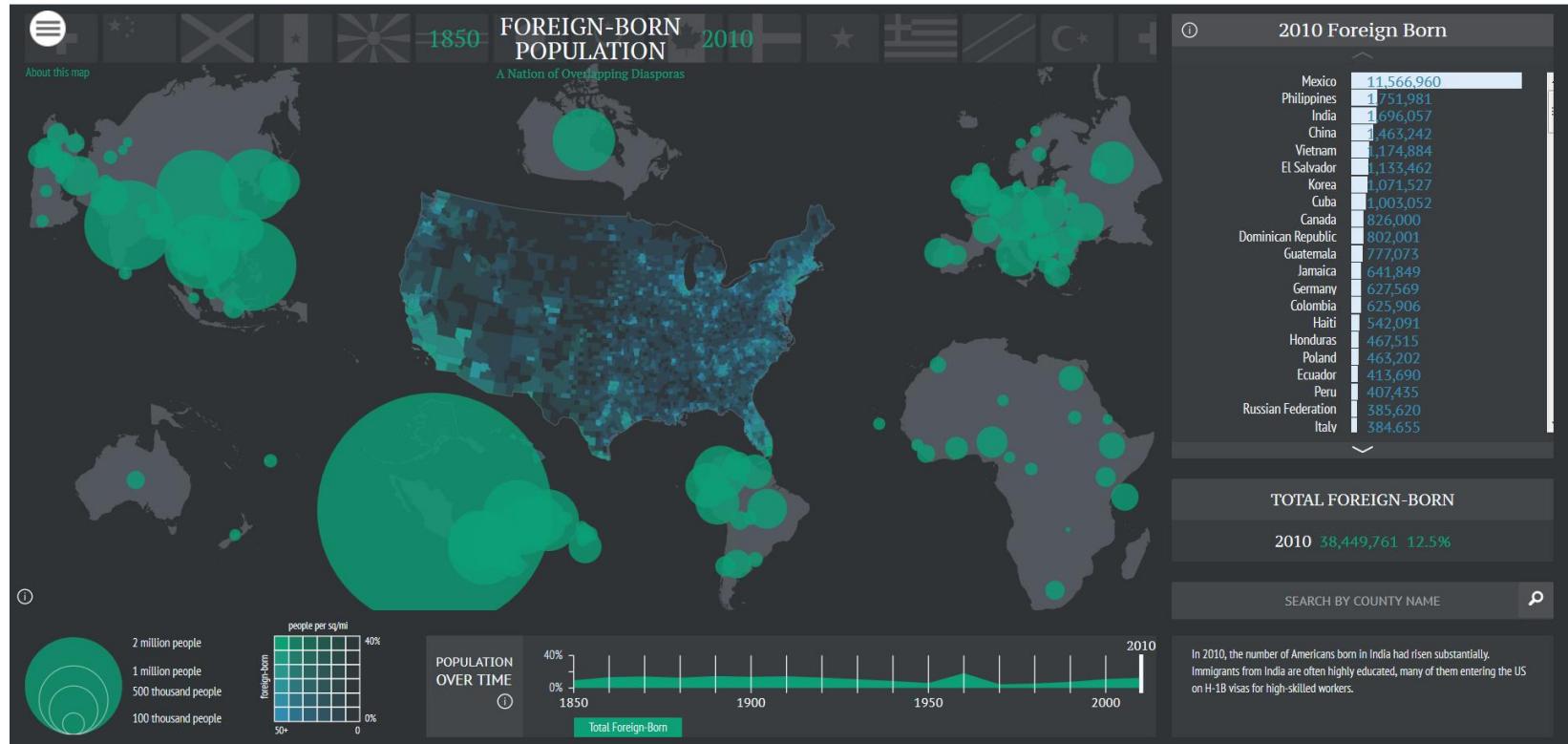


Port-au-Prince on OSM,  
January 12, 2010

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.

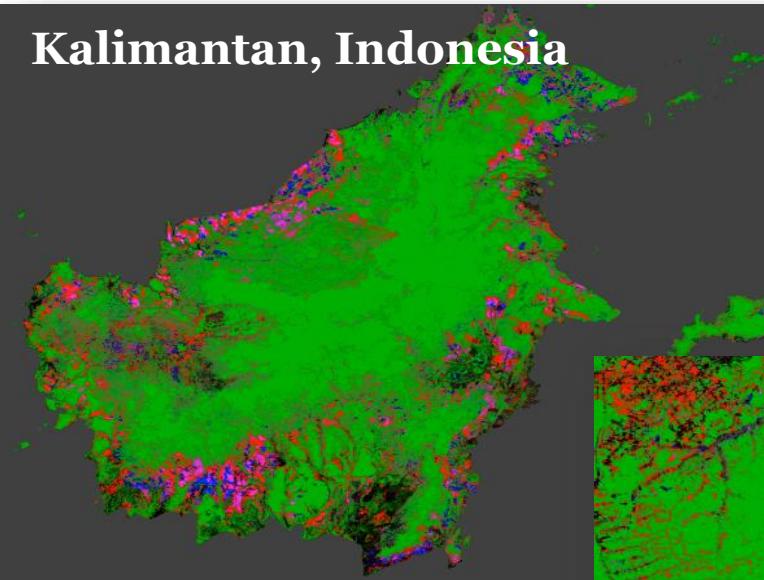
# Web Mapping and Visualization



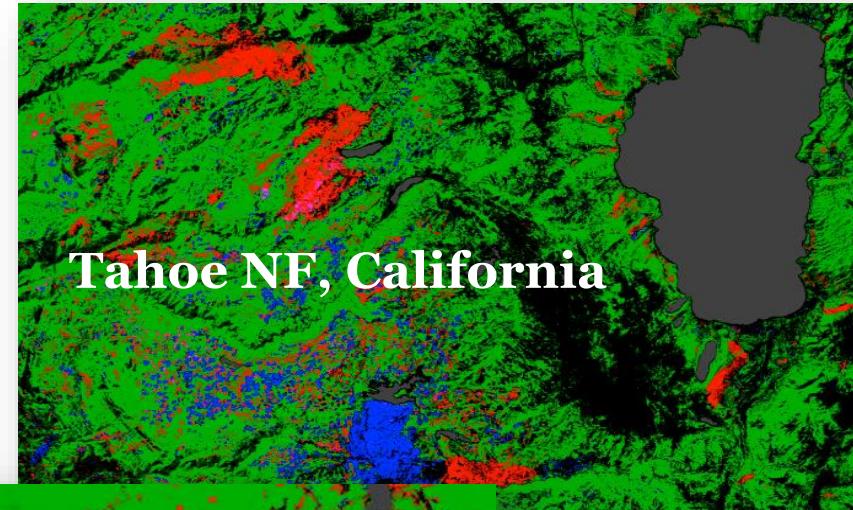
- American Panorama: <http://dsl.richmond.edu/panorama/>

# Large Scale Cloud Computation: Google Earth Engine

Kalimantan, Indonesia



Tahoe NF, California



State of Para, Brazil



10 years,  
1.3M Landsat  
scenes,  
Cloud processing  
power

# Collaboratories



Species

Location

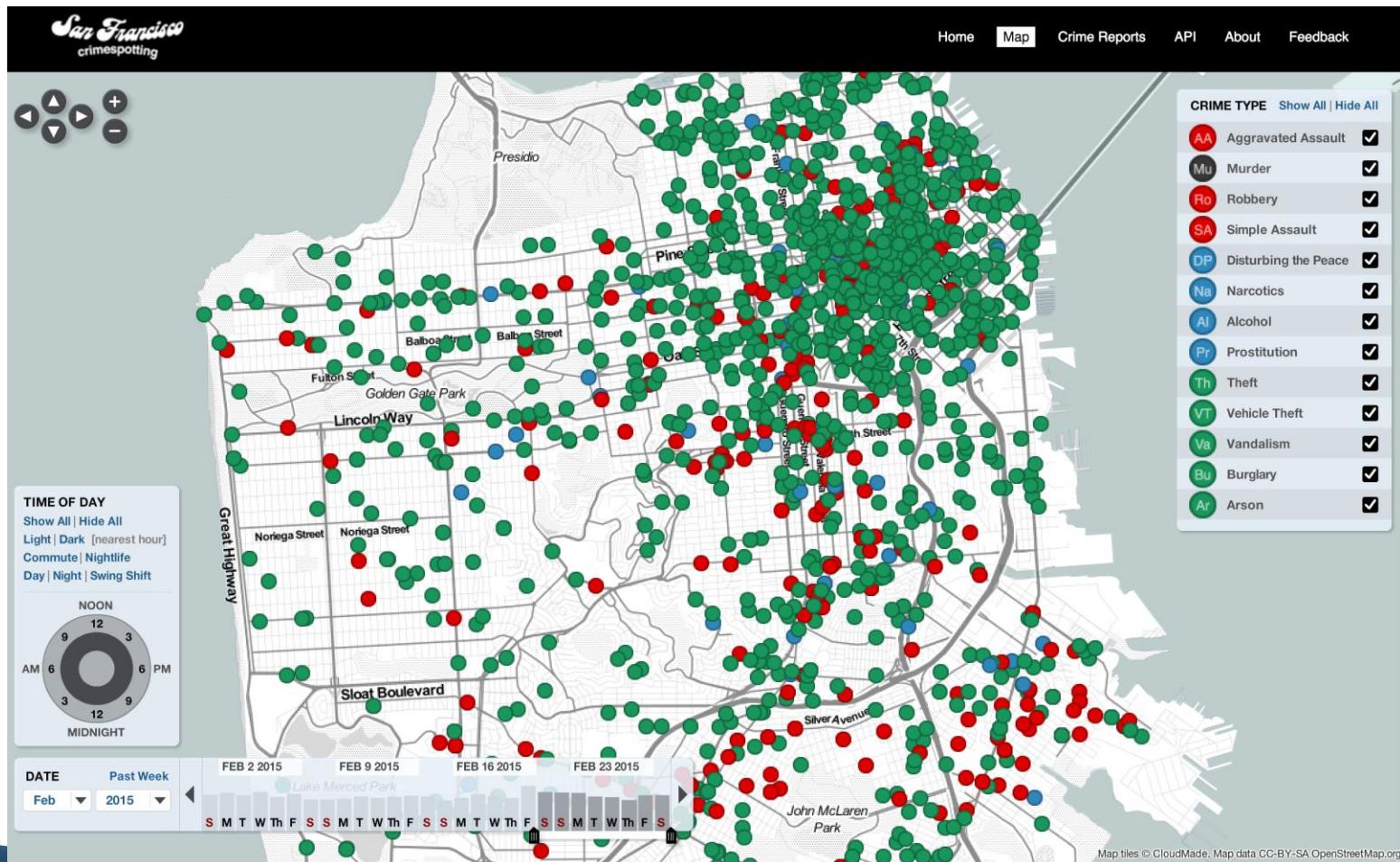
Go

Filters

The World

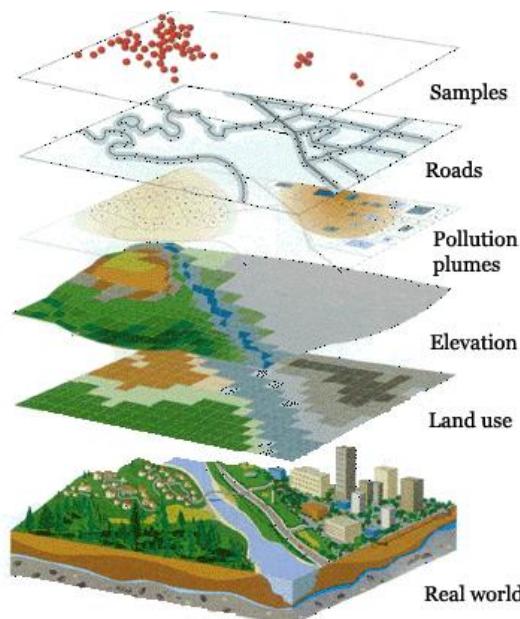
1,894,907  
OBSERVATIONS81,293  
SPECIES8,626  
IDENTIFIERS40,381  
OBSERVERS

# Open Government Data



# 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

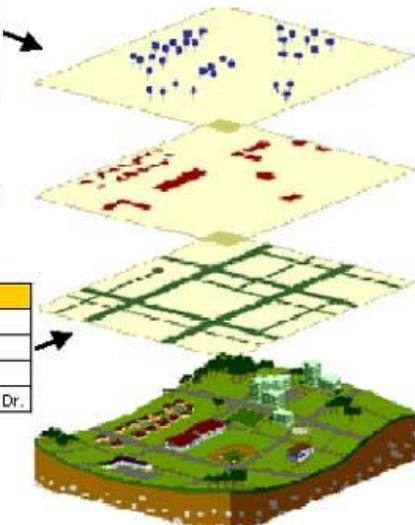


Real  
World

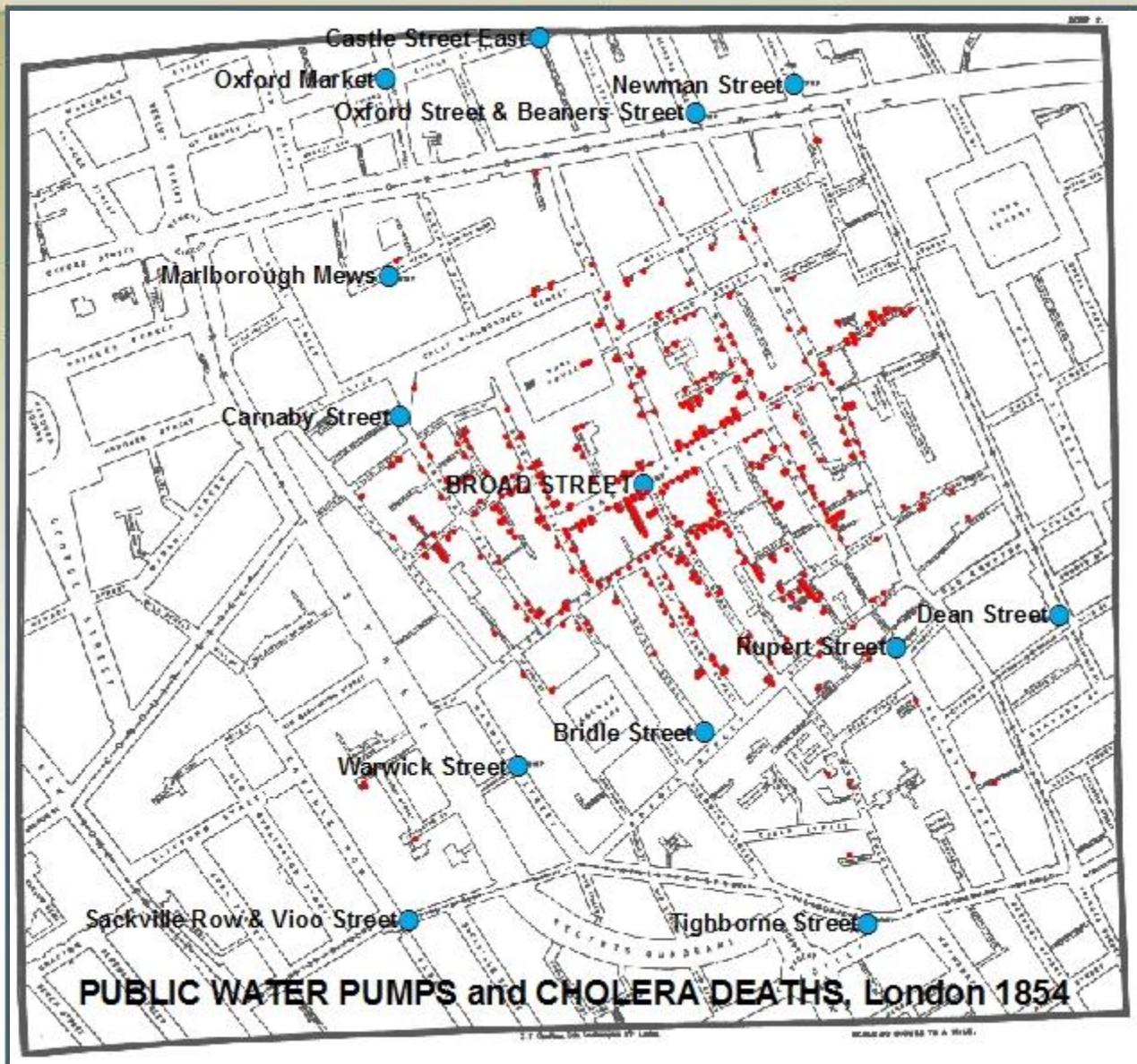
| Monitoring Wells |              |               |
|------------------|--------------|---------------|
| Well ID          | Date Sampled | Concentration |
| C-6A             | 5/8/94       | 300           |
| C-8A             | 5/8/94       | 20            |
| C-13A            | 5/8/94       | 120           |
| 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 | Address           |
| Blake       | 6         | 79 Circuit St     |
| Hernandez   | 2         | 148 Plain St.     |
| Joy         | 4         | 18 Webster St.    |
| Smith       | 5         | 4321 Tecumseh Dr. |

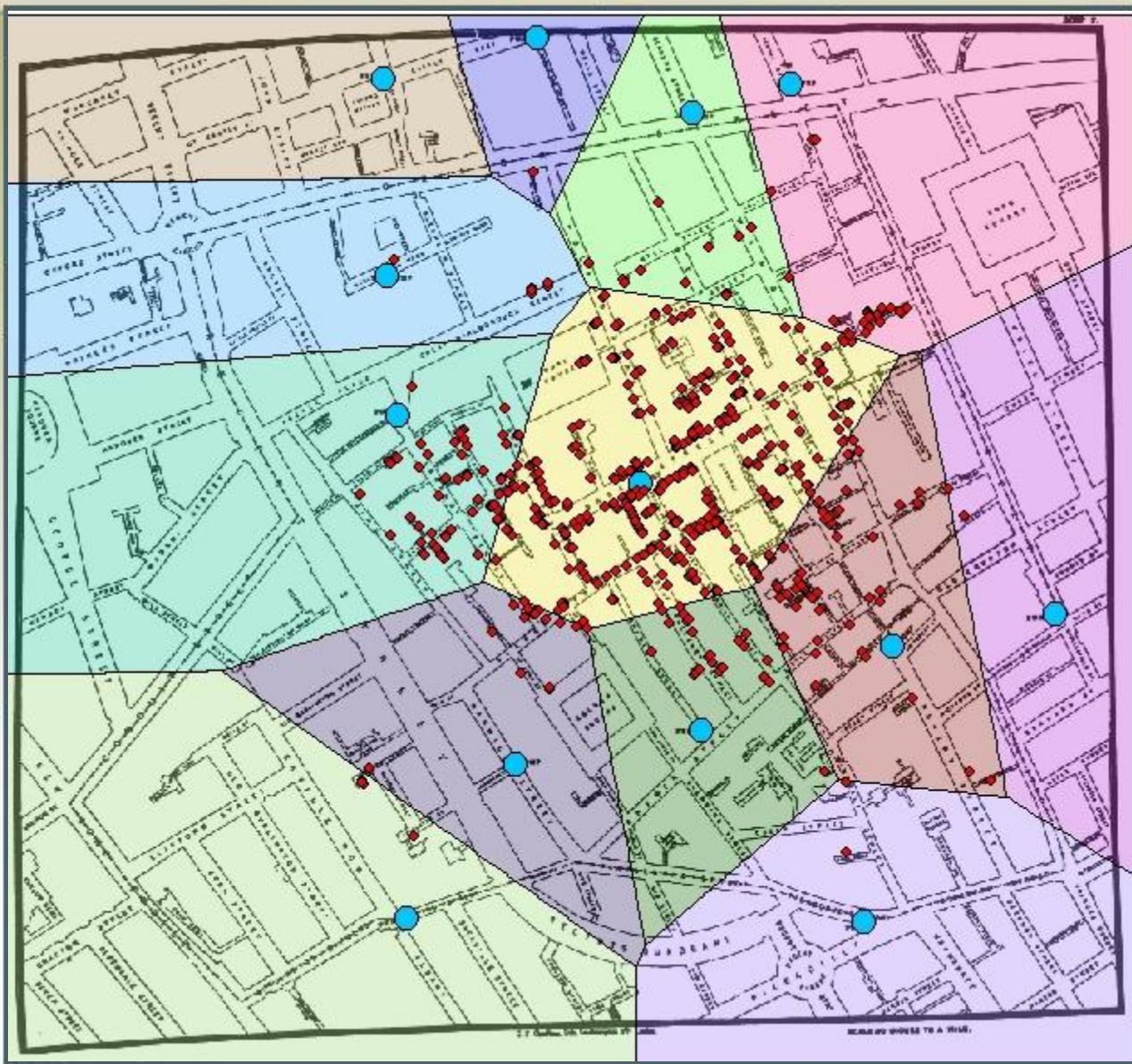


# Beginnings of GIS – Snow Map



**"Miasma"**

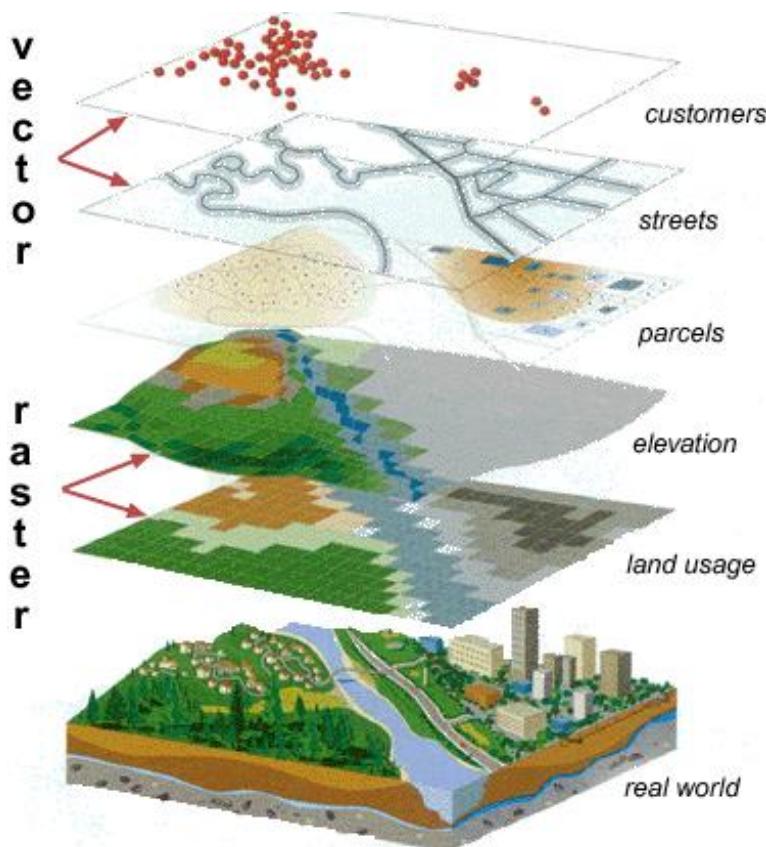
# Beginnings of GIS – Snow Map



“Miasma”

# How GIS Works

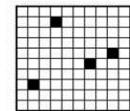
**A GIS stores information about the world as a collection of thematic layers that can be linked together by geography**



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

Raster

The raster view of the world



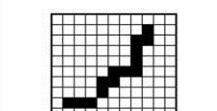
Happy Valley spatial entities



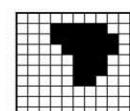
Points: hotels

Vector

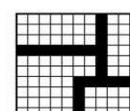
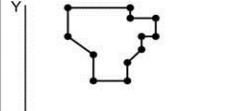
The vector view of the world



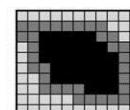
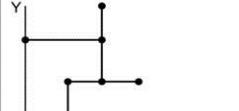
Lines: ski lifts



Areas: forest



Network: roads

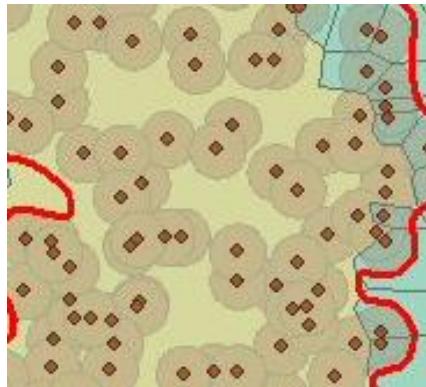


Surface: elevation

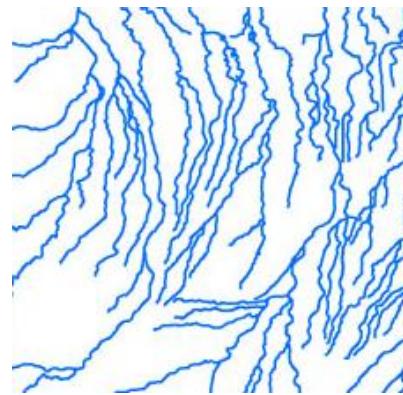


# Vector data examples

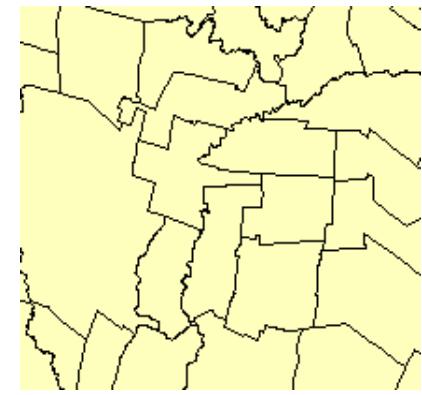
(points, lines, and polygons)



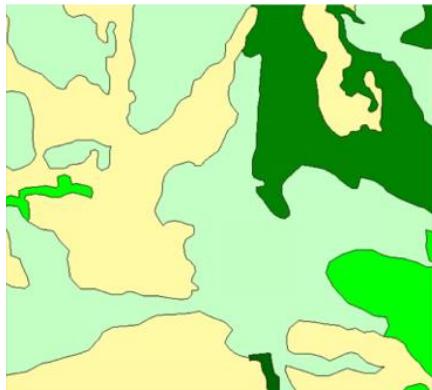
GPS data



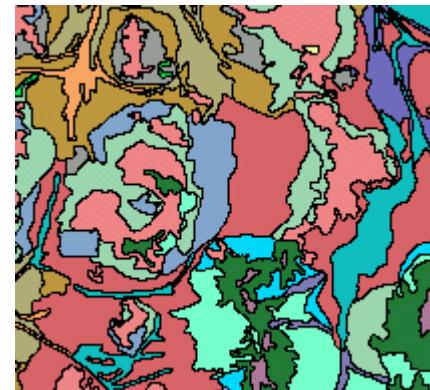
Rivers



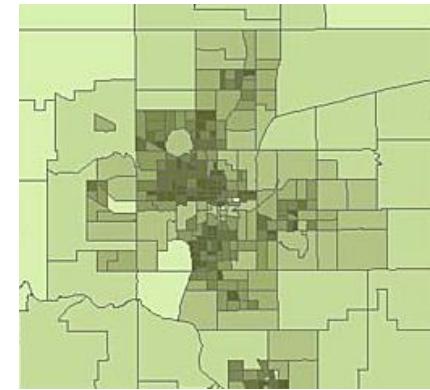
Counties



Habitat boundaries



Soil type

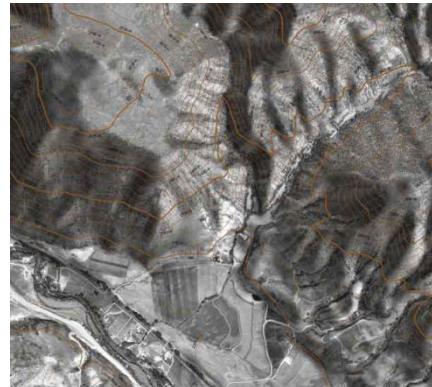


Census data

# Raster data examples



Satellite imagery



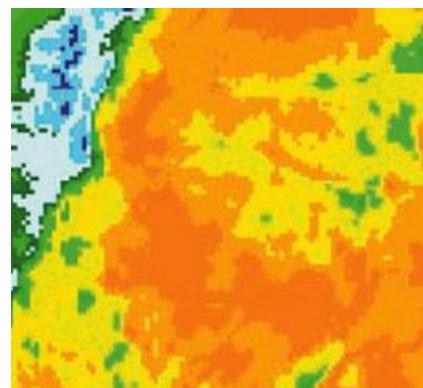
Elevation



Digital USGS  
topo map



Landcover/landuse



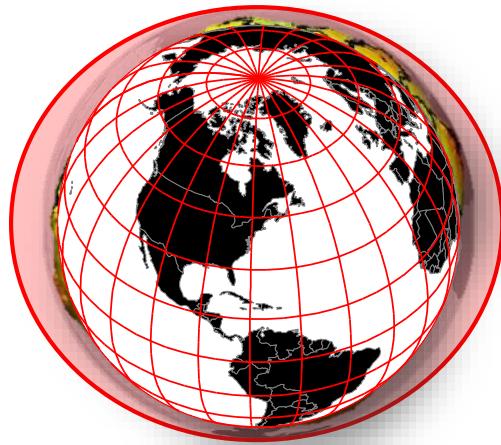
Precipitation



Aerial photography

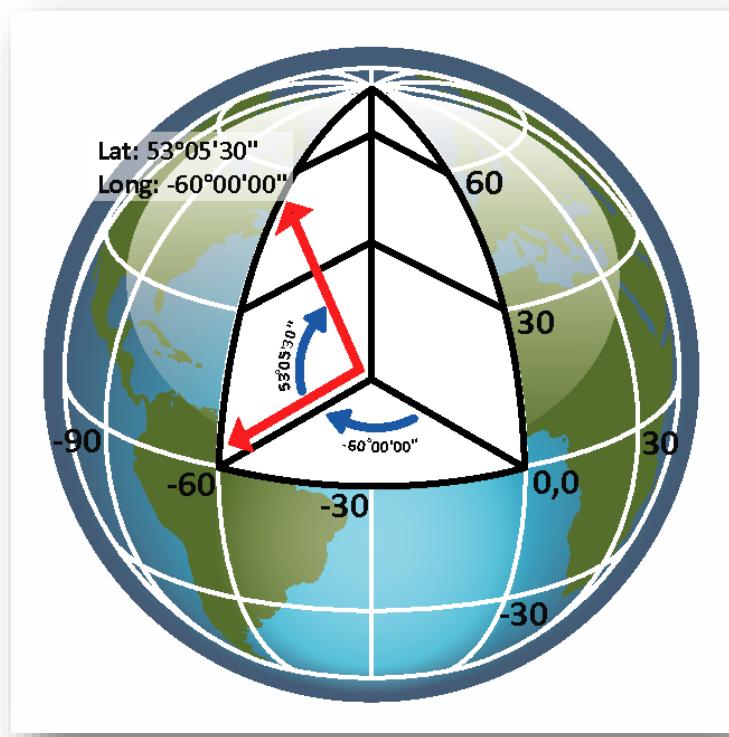


# Coordinate Systems & Projections



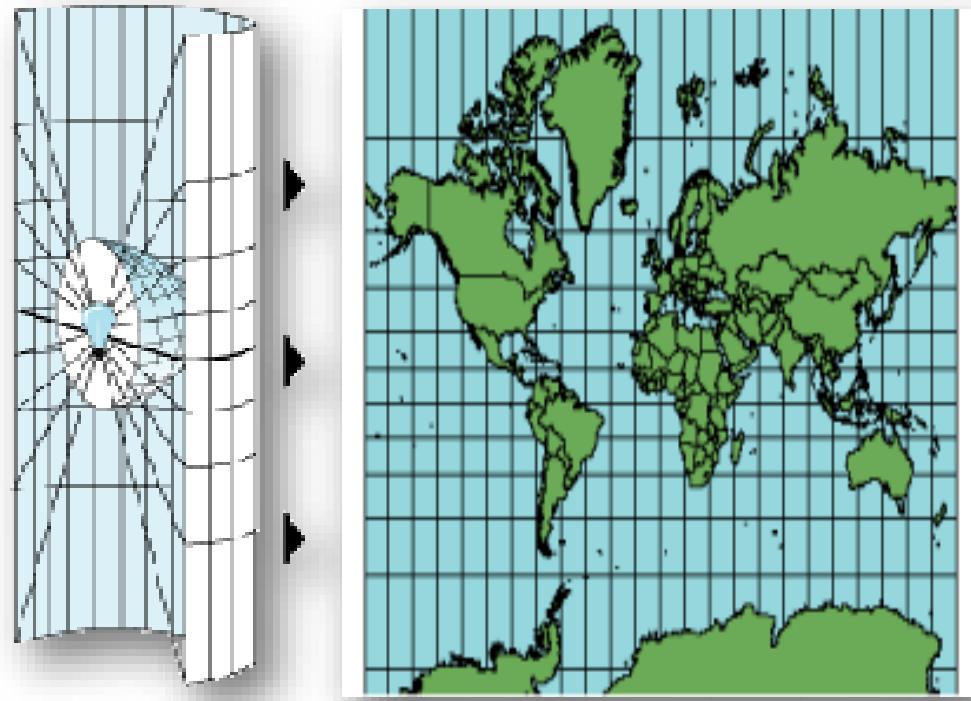
# Earth Reference Systems

## Geographic Coordinate Systems



Latitude, Longitude:  
Always ask for the **Datum!**

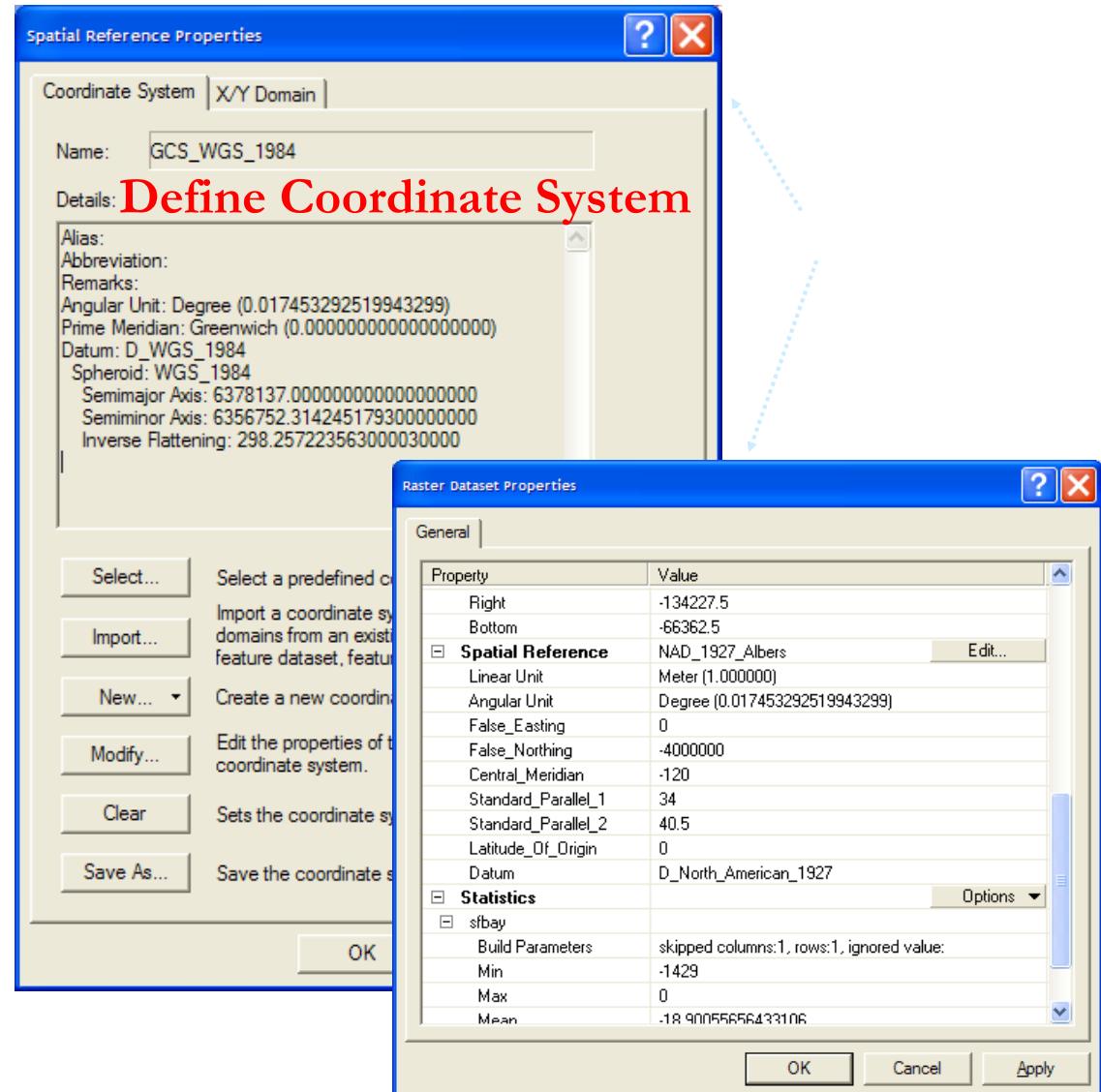
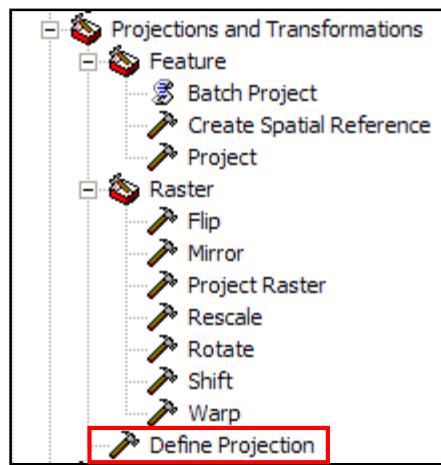
## Projected Coordinate Systems



Mercator, UTM, State Plane,  
Albers Equal Area, Equidistant

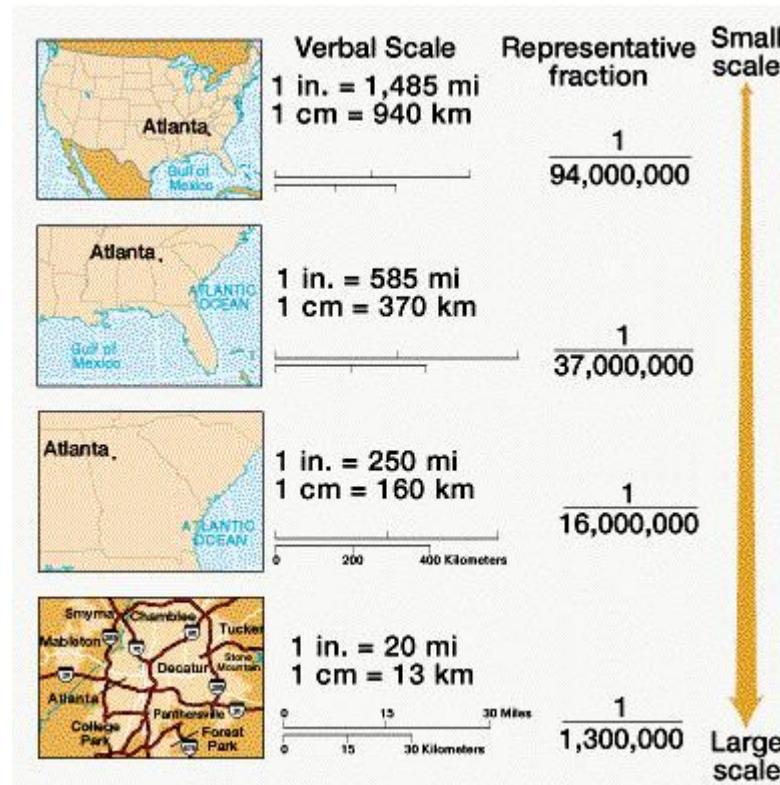


# Spatial Reference Properties



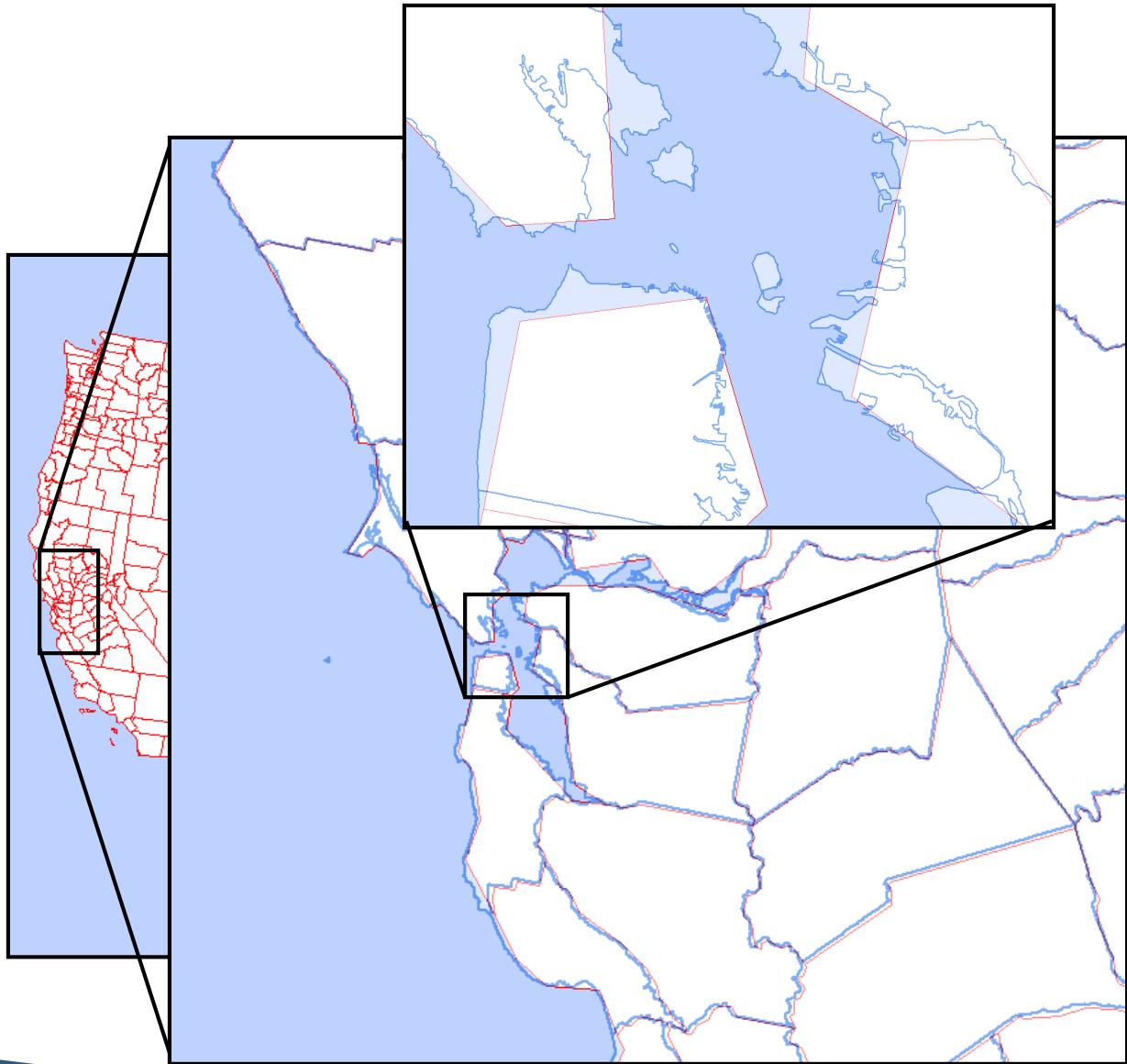
# Scale

- 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 does not increase its level of accuracy or detail.
- Map detail is determined by the data's source scale.

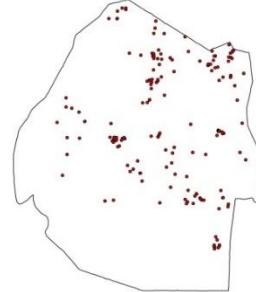


# Spatial Analysis

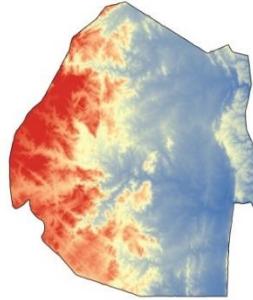
- A critical function in GIS analysis is the integration of datasets
  - determining where different geographic phenomena are coincident
- Overlay tools are powerful analysis tools for this
  - vertical stacking and merging of spatial data
  - combine, erase, modify features from multiple datasets



# Public Health: Hugh Sturrock (UCSF) Risk Mapping



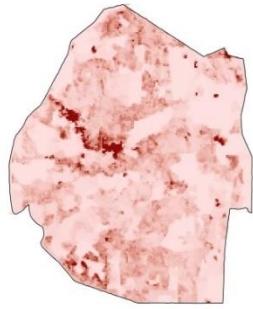
Malaria cases



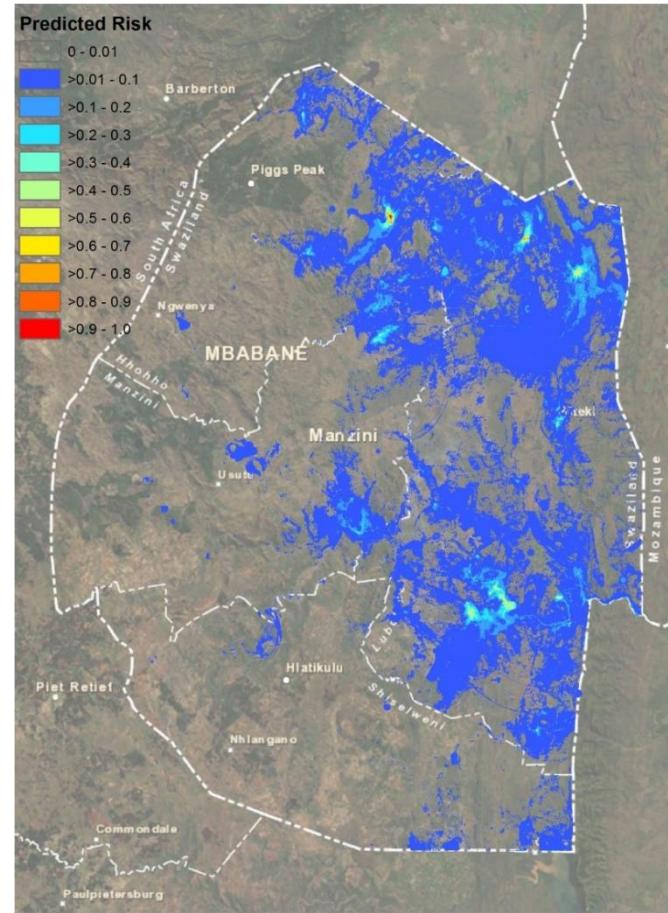
Elevation



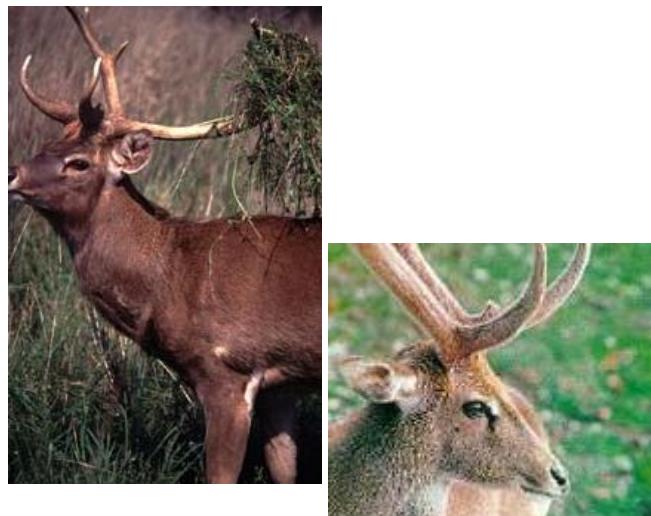
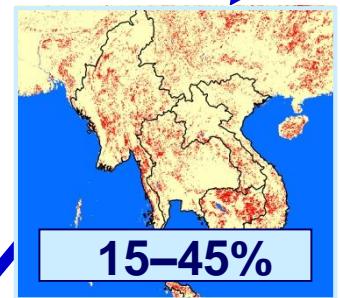
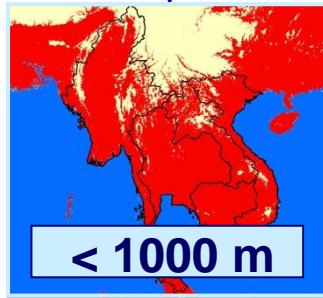
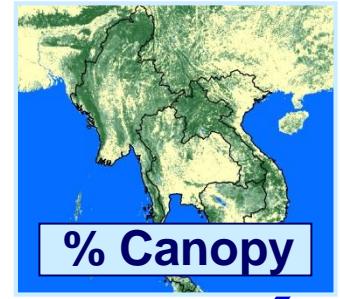
Vegetation



Population density



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



Eld's deer  
habitat  
suitability  
analysis

# 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.

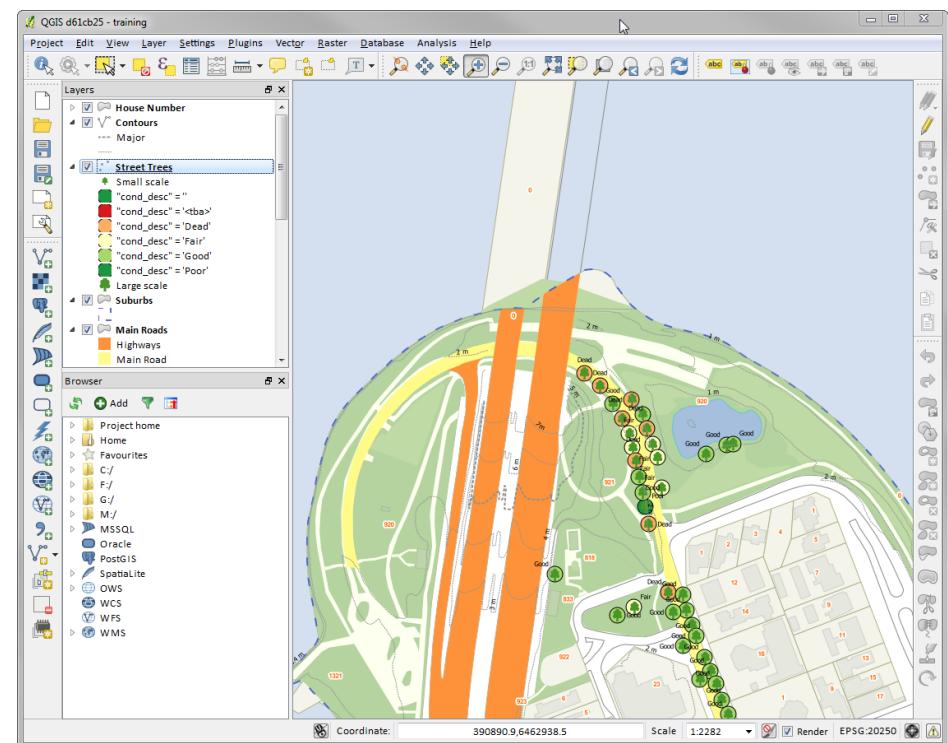
# Open Source Tools for Geo

# 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

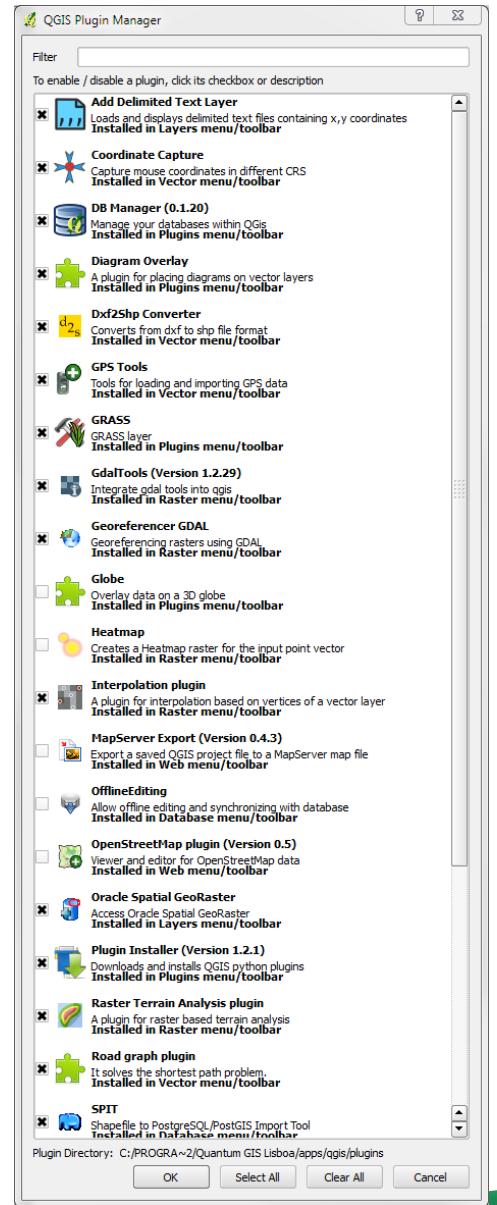
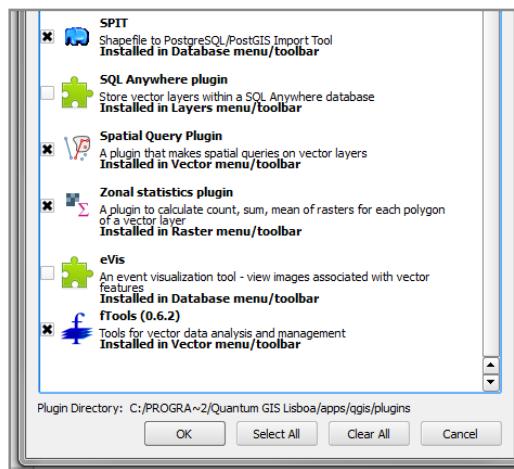
# QGIS

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



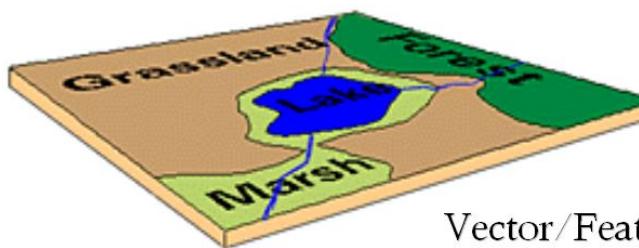
# QGIS Features

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

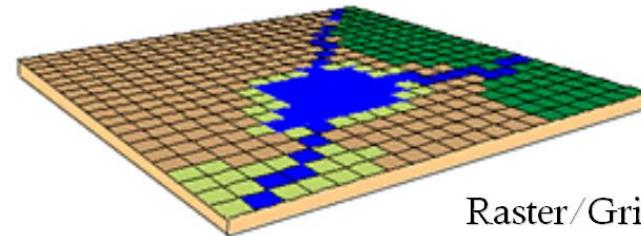


# GIS Data Types

- Vector
  - ESRI Shapefile
  - ESRI Coverage
  - Kml
  - GeoJSON
  - .csv file (x,y coordinates)
- Raster
  - ESRI Grid
  - Erdas images
  - GeoTiff



Vector/Feature data

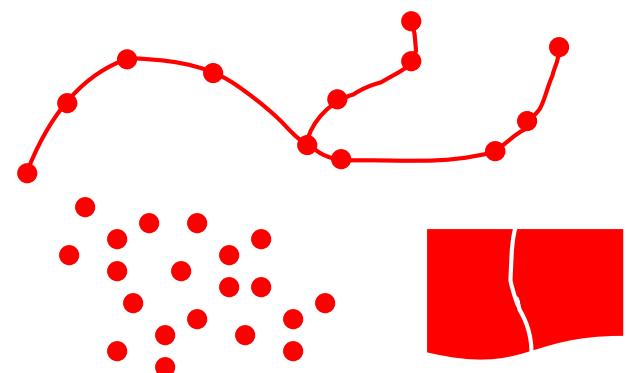


Raster/Grid data

# Shapefiles

| <i>File type extension</i> | <i>What it is</i>  | <i>Description</i>  | <i>Example</i> |
|----------------------------|--|---|----------------|
| .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.



Hands-on exercise

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