Geospatial Technology, Data, Spatial Thinking, and National Standards

GEOSTAC

NSF-ATE 0903330   11/11/09

Geospatial “Technology”

Geomatics is the TECHNOLOGY used for visualization, measurement, and analysis of features or phenomena…

(Today)Geospatial technology includes:

- **GPS** (global positioning systems)
- **GISci** (geographical information science)
- **RS** (remote sensing)

http://en.wikipedia.org/wiki/Geospatial_technology

Geospatial Technology

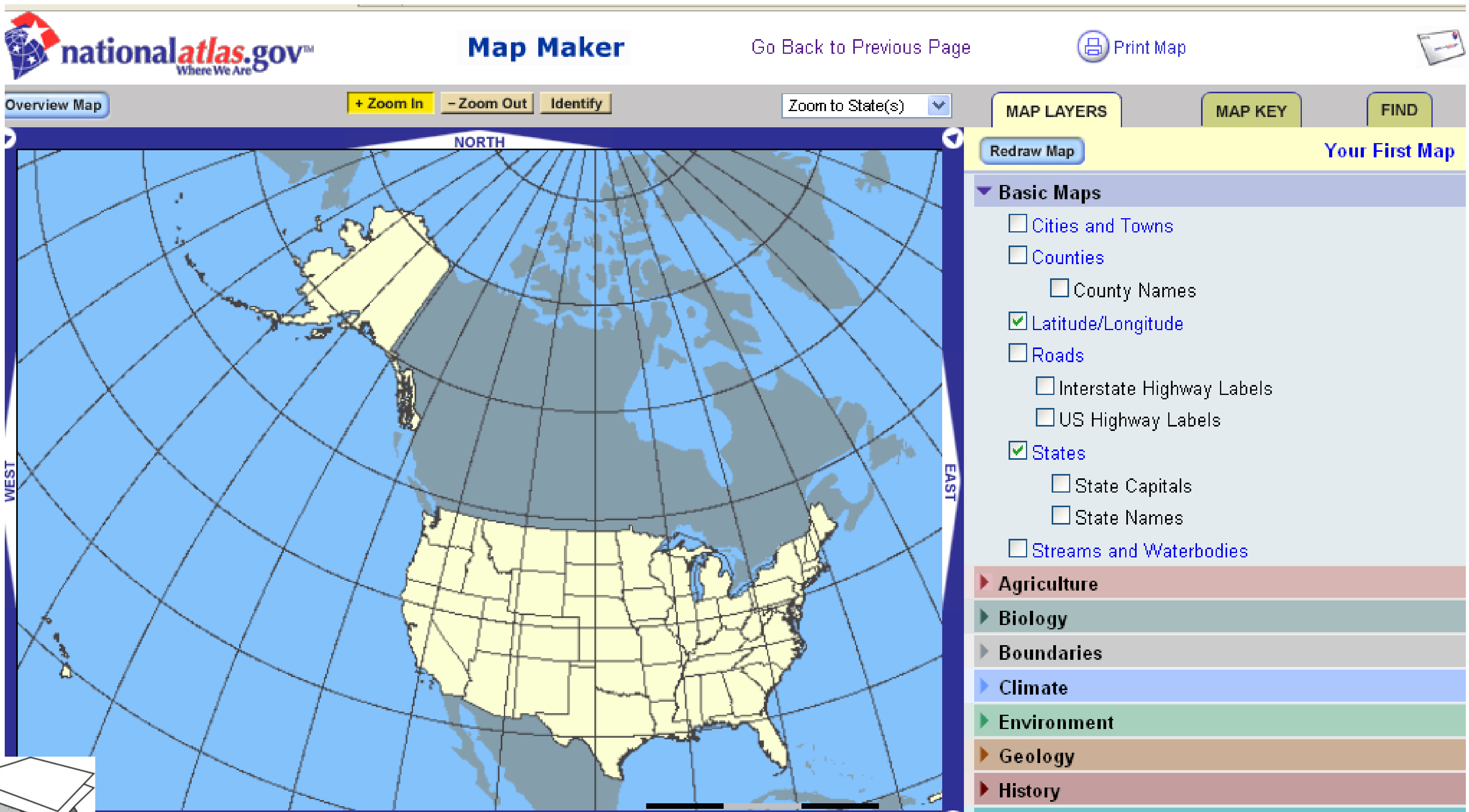
Digital Maps
Virtual Globes
Web-based GIS
Desktop GIS

simple

complex

The end products are rapidly merging in terms of availability and function.

Digital Map


nationalatlas.gov
Where We Are
Map Maker
Go Back to Previous Page
Print Map
Overview Map
+ Zoom In
- Zoom Out
Identify
Zoom to State(s)
MAP LAYERS
MAP KEY
FIND
NORTH
WEST
EAST
Redraw Map
Your First Map
Basic Maps
Cities and Towns
Counties
County Names
Latitude/Longitude
Roads
Interstate Highway Labels
US Highway Labels
States
State Capitals
State Names
Streams and Waterbodies
Agriculture
Biology
Boundaries
Climate
Environment
Geology
History

Digital Maps [Dynamic Maps]

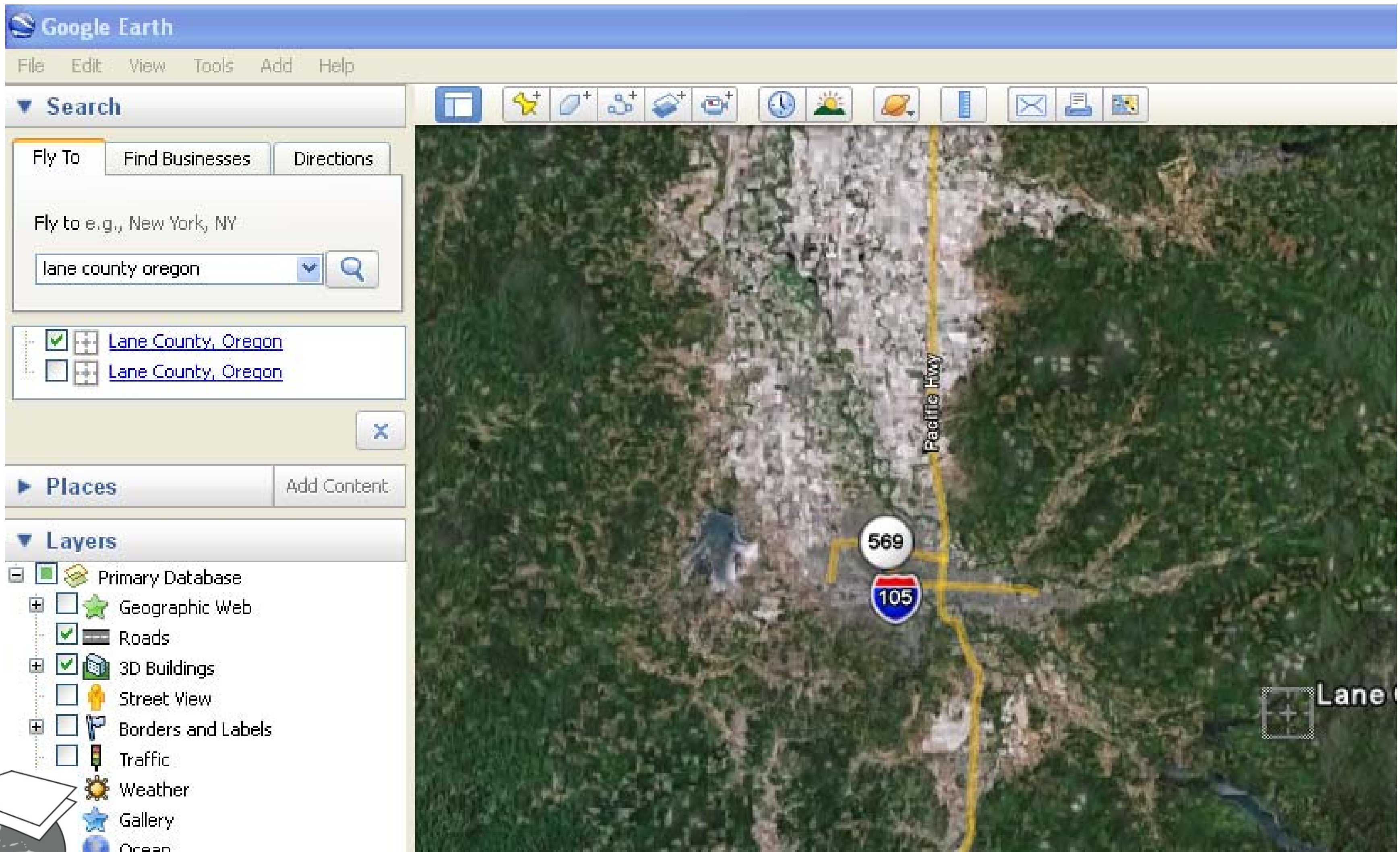
A computer-readable representation of a geographic area or phenomenon that can be displayed or analyzed by a digital computer. This is in contrast to an analog "paper" map.

May or may not be:

- Scalable
- Able to “add” layers (overlay)
- Multimedia

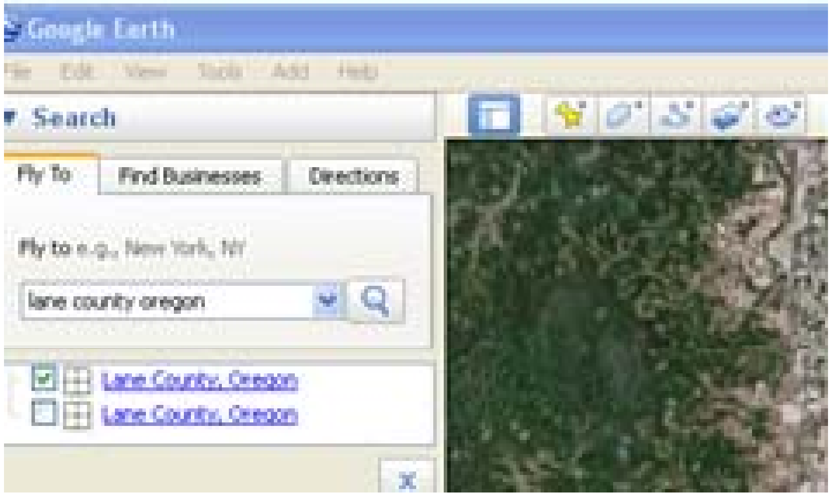
There is little analysis or data selection available

Virtual Globes

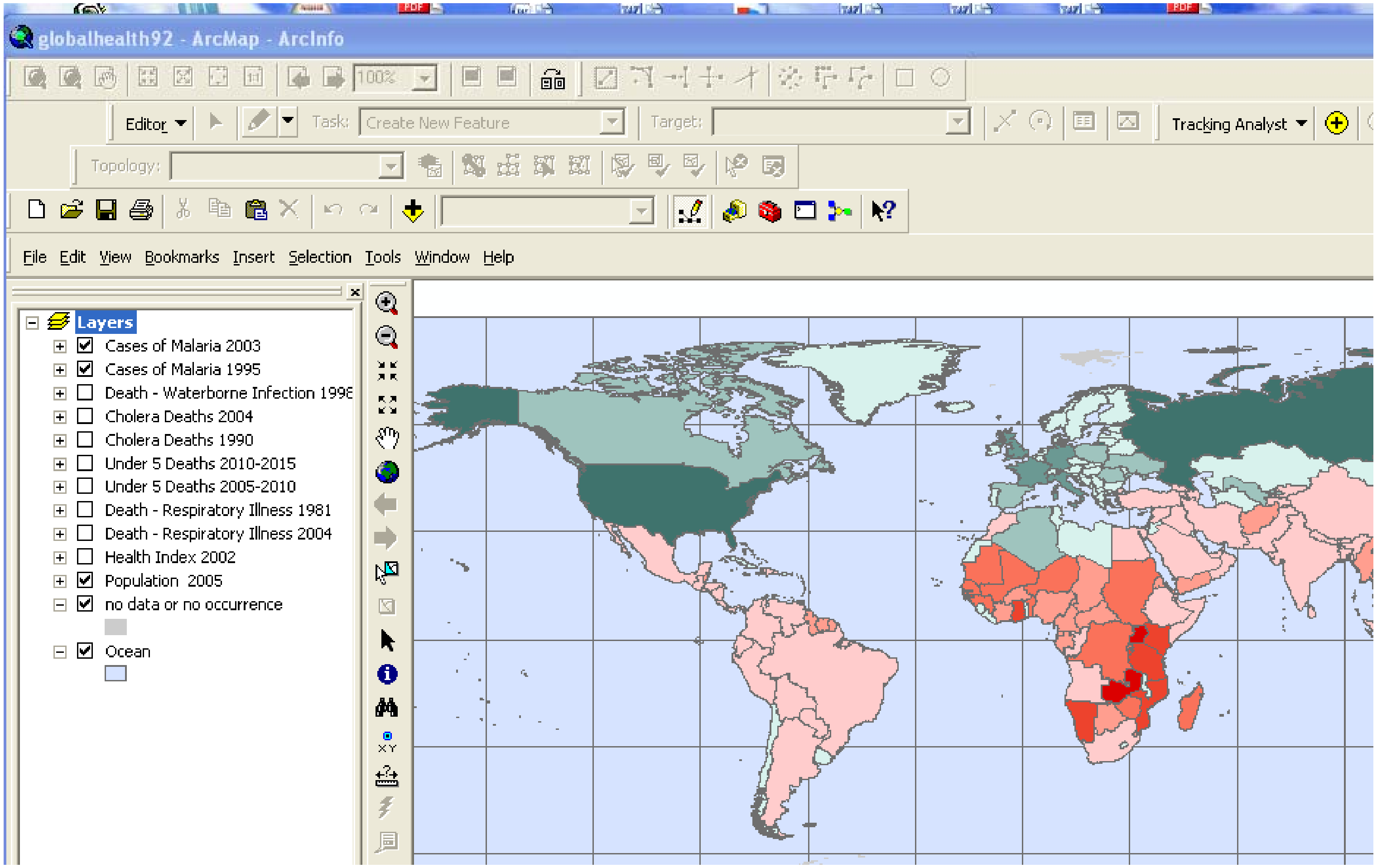


Virtual Globe

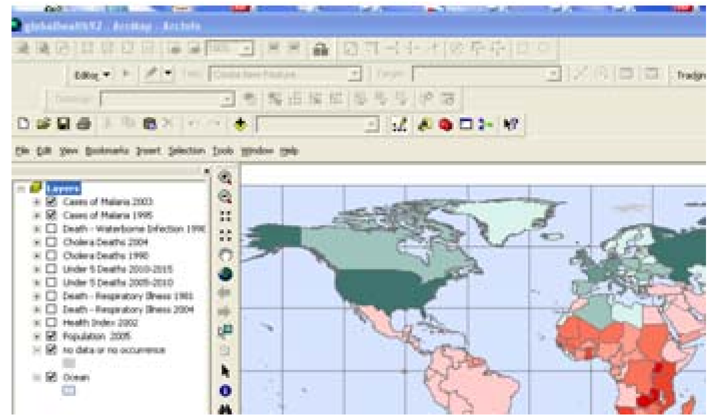
- 3D software model of the earth (or other planet)
- Provide interactivity
- Change view angles
- Ability to change scale
- View layers of data
- Measure area, distance
- Add data layers



Desktop GIS

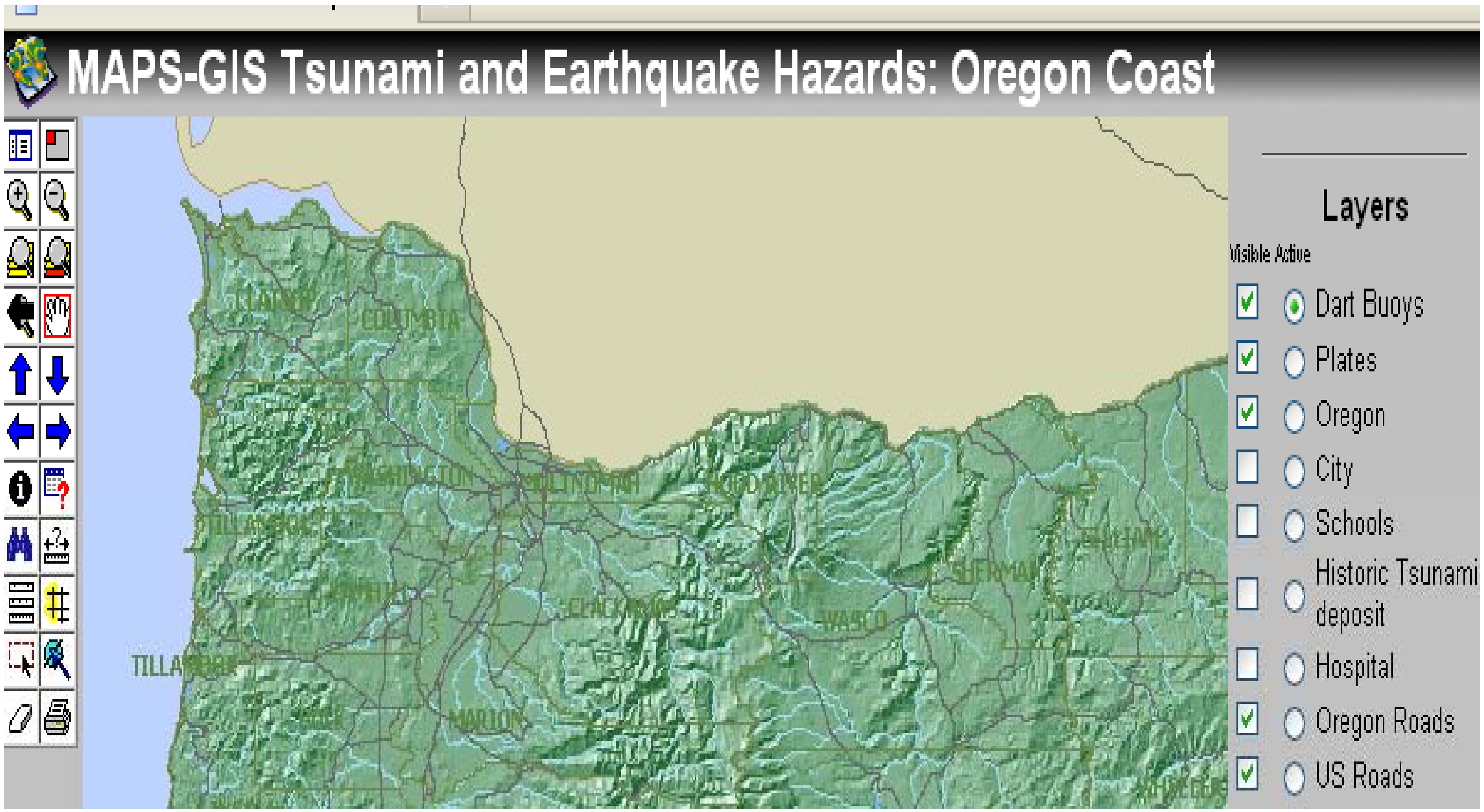

globalhealth92 - ArcMap - ArcInfo
Editor
Task: Create New Feature
Target:
Tracking Analyst
Topology:
File Edit View Bookmarks Insert Selection Tools Window Help
Layers
Cases of Malaria 2003
Cases of Malaria 1995
Death - Waterborne Infection 1998
Cholera Deaths 2004
Cholera Deaths 1990
Under 5 Deaths 2010-2015
Under 5 Deaths 2005-2010
Death - Respiratory Illness 1981
Death - Respiratory Illness 2004
Health Index 2002
Population 2005
no data or no occurrence
Ocean

Desktop GIS Underused in K-12

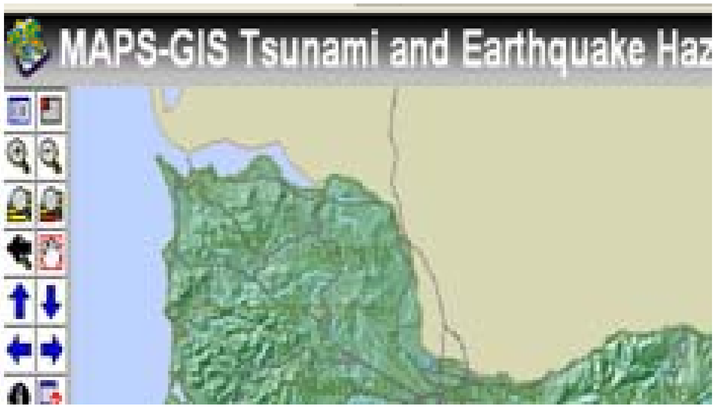


- Cost of hardware
- Cost of software
- Limitation of time
- High-level maintenance required
- Steep learning curve for teachers and students
- Others?

Web-based GIS

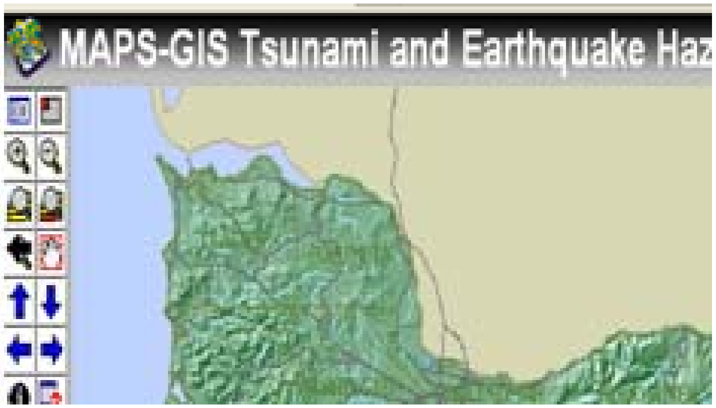


Web-based GIS



- Limited desktop GIS maps and tools
- Available over the Internet
- No software needs (Web-browser)
- Less hardware need (computer high-speed internet)
- Limited data (Only what the developer has provided)

Web-based GIS



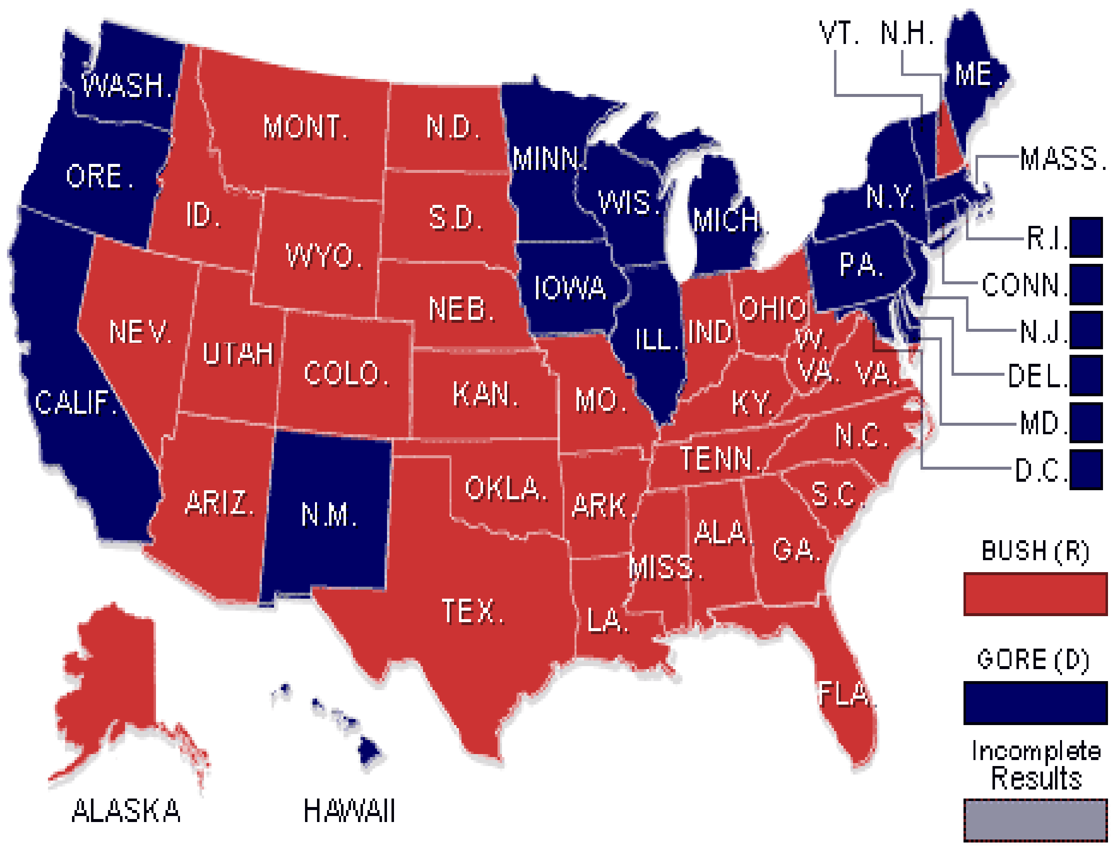
- Scalable
- Measurement
- Layers overlays
- Boolean Logic Queries – select
- Identify
- Find
- Data download
- Spatial Buffer

Spatial Data

- Scale of data
  - Global, local
- Type of data
  - Point, line, polygon, raster (grid)

GIS Spatial Data

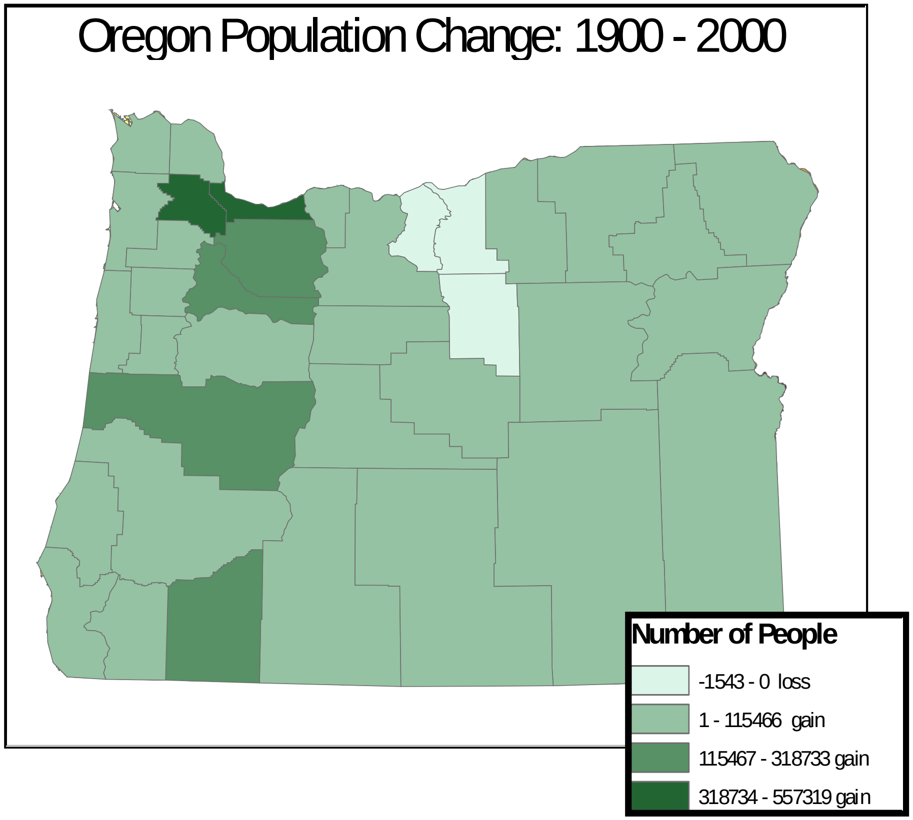
State: population, election results, income averages



ytimes.com/images/2000/11/07/politics/elections/president/map_us_PRESW_001107.gif_

GIS Spatial Data

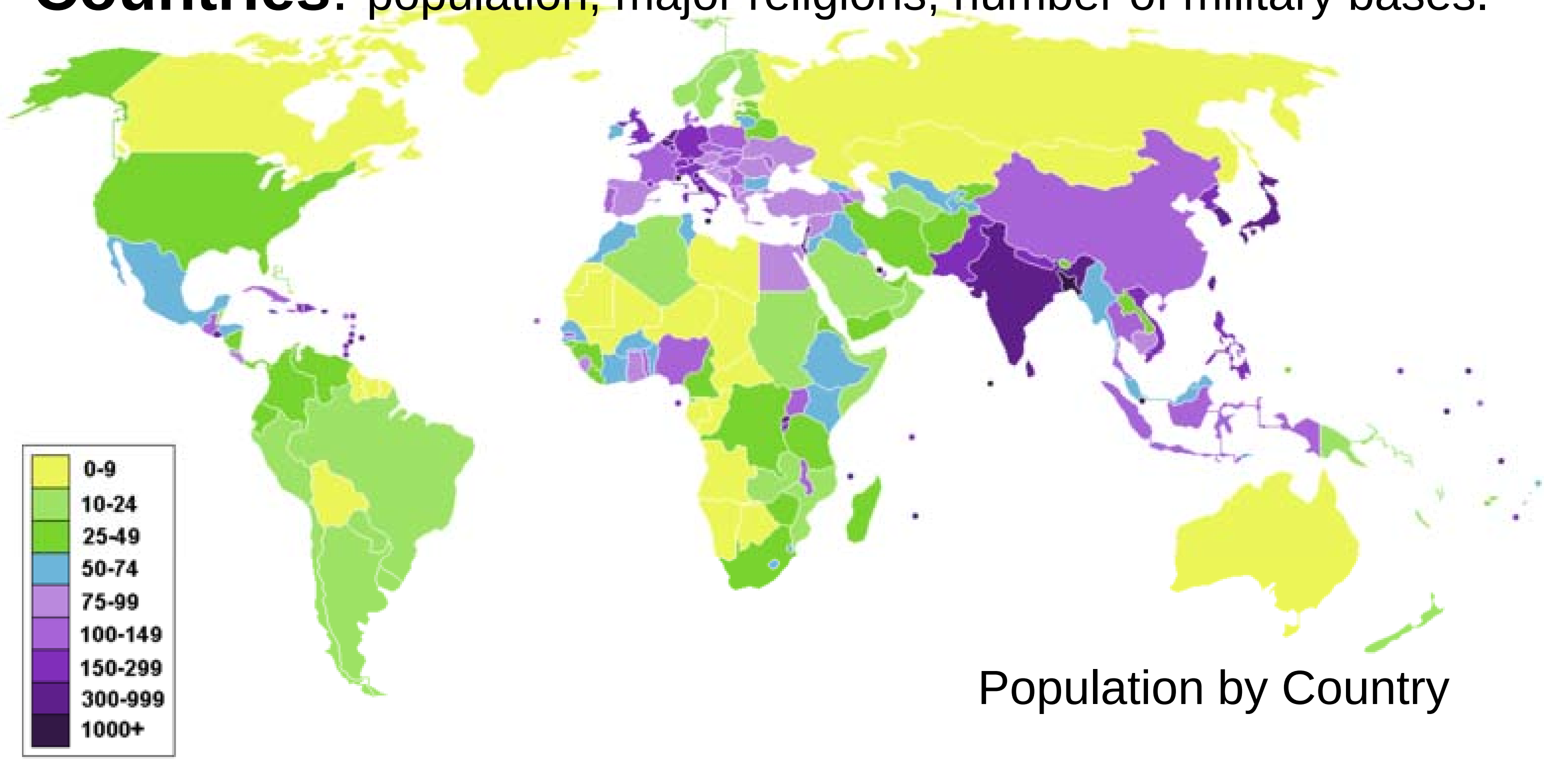
County: population, election results, economic information.



GIS Spatial Data

Spatial data - information connected to a place.

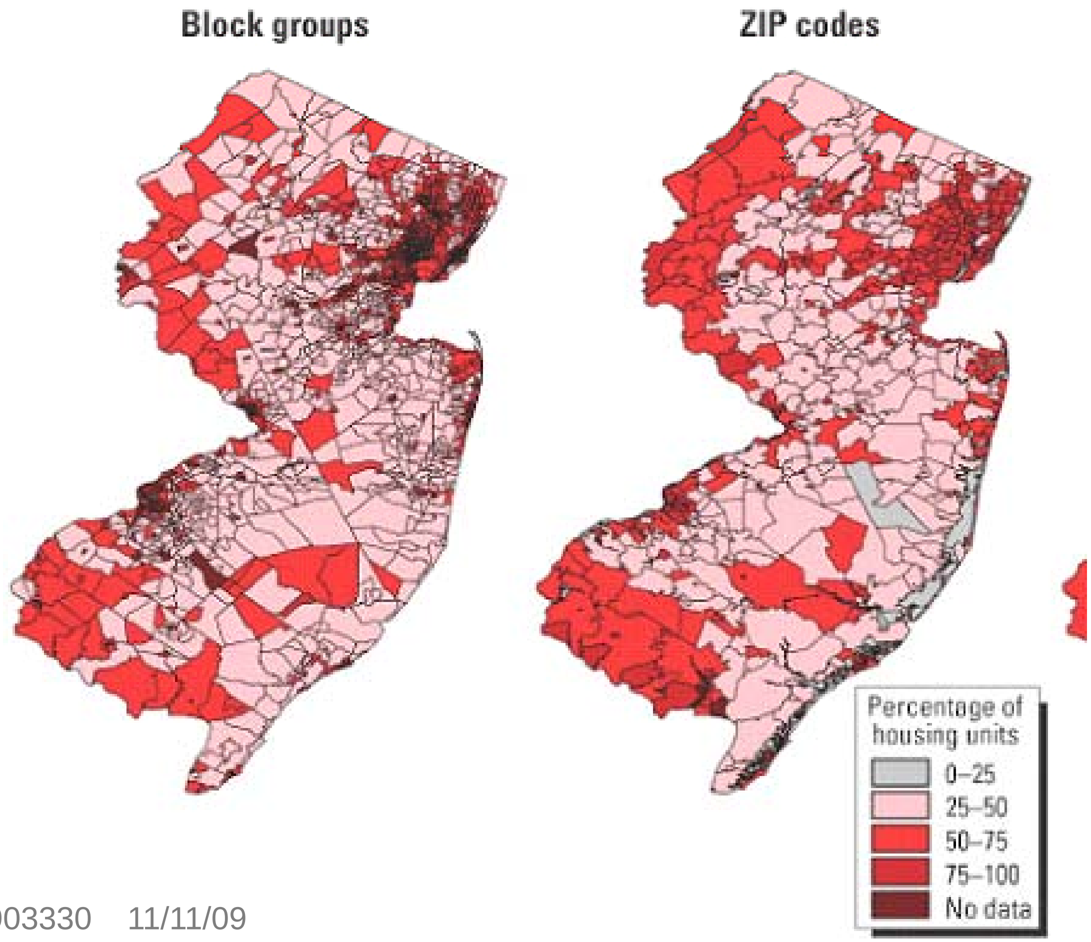
Countries: population, major religions, number of military bases.



Population by Country

GIS Spatial Data

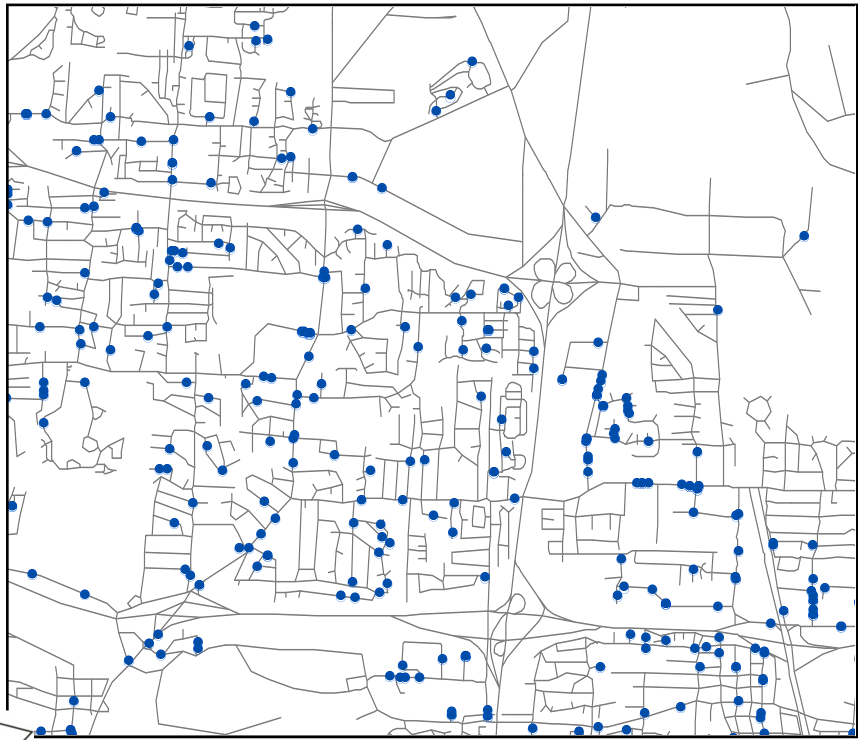
Census blocks, zip codes: age, gender, economic information



GIS Spatial Data

Latitude and longitude: city location, point source pollution

Street address: number of occupants, price of home

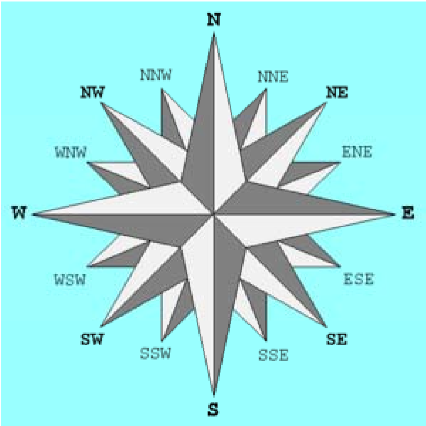


Blue dots represent street addresses where a burglary occurred in 2006.

Spatial Thinking: Direction - Location

Cardinal Directions:

North – South – East - West



Relative and Absolute Location :

Absolute location - The main post office Eugene, Oregon is at 44° 03’ 13.90” north latitude and 123° 05’ 37.35” west longitude.

Relative location - The main post office is .5 miles due west of the Willamette River and approximately 60 miles south of Oregon’s capital city, Salem.

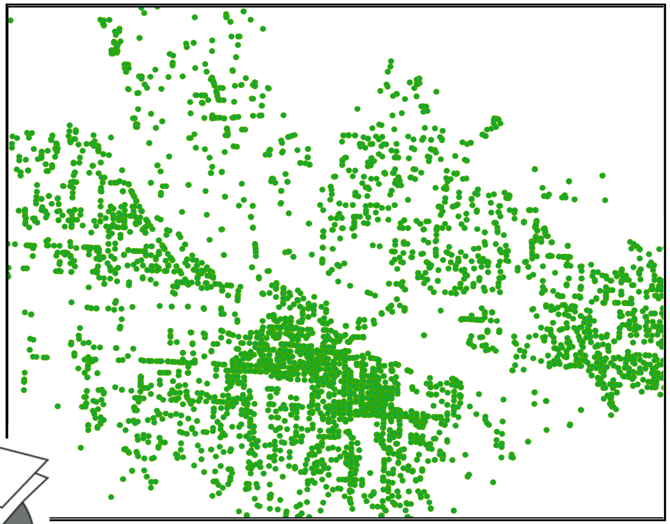
Spatial Thinking: Pattern

The shape and distribution of data.

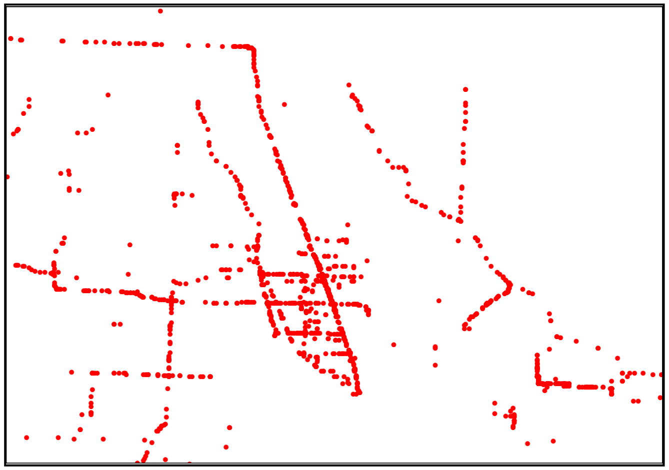
Shape – geometry: linear, circular, rectangular

Distribution – Clustered, dispersed, random, density

Dots indicate burglary locations. The pattern has dense areas and is clustered in places.



Dots indicate car accidents. The pattern is linear*and there are areas of higher density or clusters.



The linear pattern here makes sense because the map is showing accidents along streets.

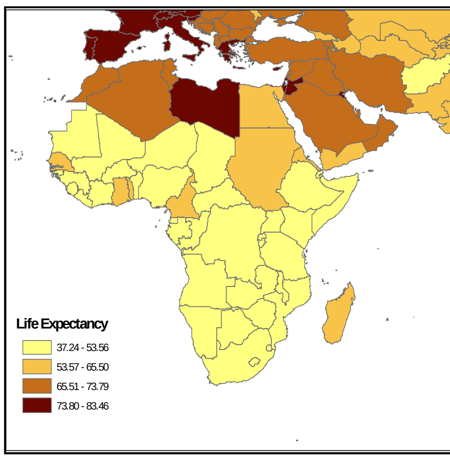
Spatial Thinking: Correlation

The relationship between two sets of data.

- A positive correlation means that places are similar (Both high or low with respect to a specific trait)
- A negative correlation mean that places are different. (One low and one high with respect to a specific trait)

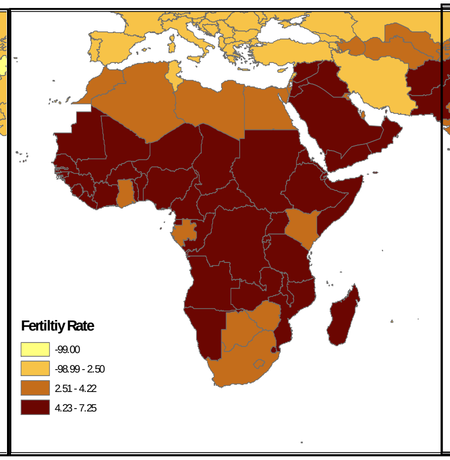
Negative Correlation

Life Expectancy



Low life expectance

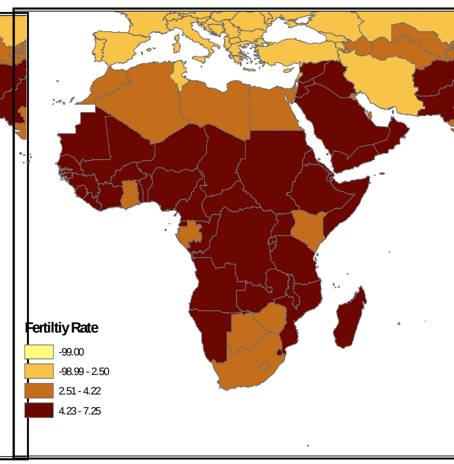
Fertility Rate



High fertility

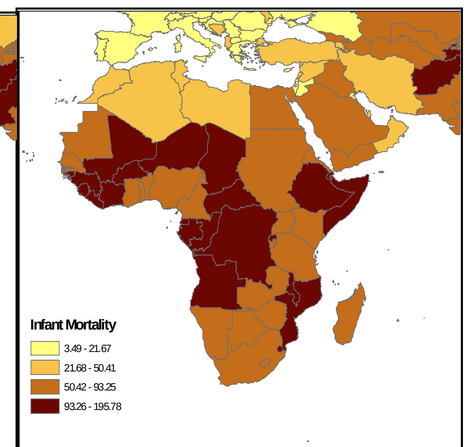
Positive Correlation

Fertility Rate



High fertility

Infant Mortality Rate



High mortality

Spatial Thinking: Scale

The relationship between the image size (map) and the actual earth. The larger the scale (the more you “zoom” in) the larger the object are, but you see less area.

Small Scale Map → Large Scale Map

Spatial Thinking: Query

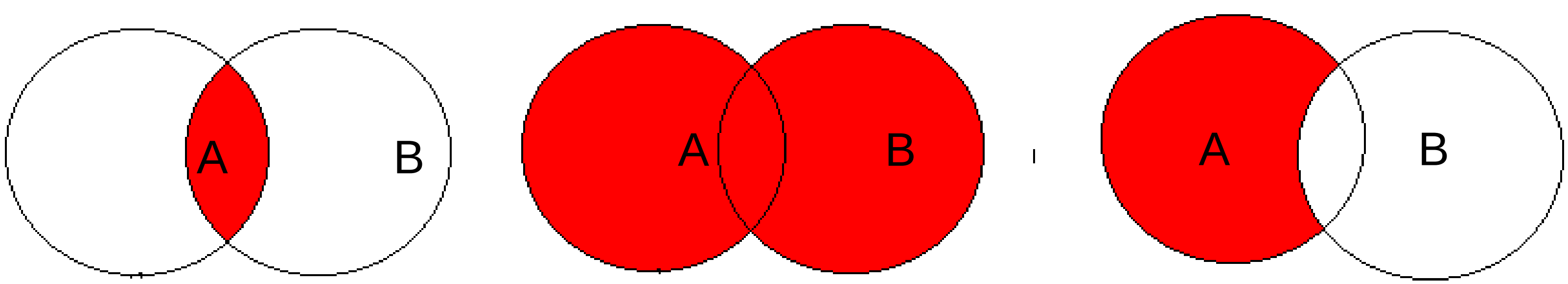
A way to "ask" spatial or logical questions.

Boolean Logic- to select or highlight information

All cities with a population of 1 million and are in California (A and B)

All cities with a population of 1 million or that are in California (A or B)

All cities with a population of 1 million not in California (A not B)

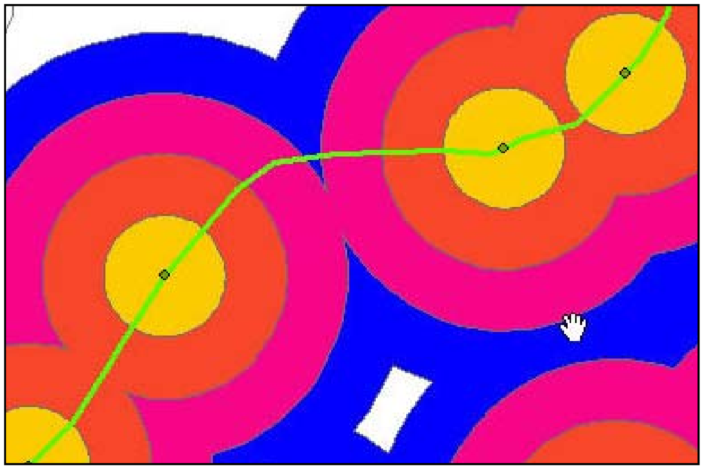


AND **OR** **NOT**

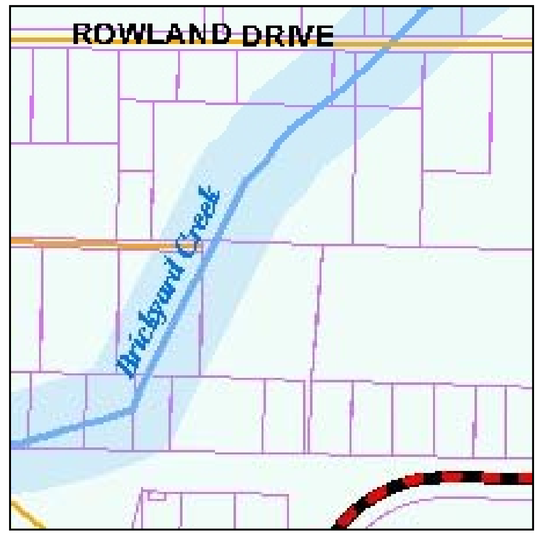
Spatial Thinking: Buffers

Spatial buffers are identified areas that have a specific size or distance around some geographic feature like a river or a city.

One, two, three, and four mile buffers around city location points to identify the radius of pollution spread.



A buffer around an urban creek to identify the location of sensitive riparian habitat.



Geospatial Thinking Across the Curriculum

Embedding geospatial tools and thinking addresses national education standards in:

- Technology
- Math
- Social Science
- Science
- English language (French?)

National Technology Standards – ISTE

Standard 2: Social, ethical, and human issues	•Understand the ethical, cultural, and societal issues related to technology. •Develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
Standard 3: Technology productivity tools	•Use technology tools to enhance learning, increase productivity, and promote creativity.
Standard 5: Technology research tools	•Use technology tools to process data and report results. •Evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.
Standard 6: Technology problem-solving and decision-making tools	•Use technology resources for solving problems and making informed decisions. •Employ technology in the development of strategies for solving problems in the real world.

National Social Studies Standards

Theme I: Culture – Processes	•Compare and analyze societal patterns for preserving and transmitting culture while adapting to environmental or social change. •Explain and apply ideas, theories and modes of inquiry from anthropology and sociology in the examination of persistent issues and social problems. •Interpret patterns of behavior reflecting values and attitudes that contribute or pose obstacles to cross-cultural understanding. •Analyze a current or past problem or issue through an analysis of the cultural patterns of the groups involved and the ways in which these contribute or present obstacles to finding solutions
Theme II: Time, Continuity, and Change	•Read and observe data for analysis and discuss their findings. •Construct reasoned arguments. •Build a project online or physical that reflects knowledge.

National Science Education Standards

Standard A: Develop abilities necessary to do scientific inquiry and understandings about scientific inquiry	•Use technology and mathematics to improve investigations and communications. •Recognize and analyze alternative explanations and models. •Communicate and defend a scientific argument.
Standard E: Abilities of technological design and understandings about science and technology	•Identify a problem or design an opportunity.

National Mathematics Standards

Algebra	•Understand the meaning of equivalent forms of expressions, equations, inequalities, and relations. •Use mathematical models to represent and understand quantitative relationships. •Identify essential quantitative relationships in a situation and determine the class or classes of functions that might model the relationships. •Draw reasonable conclusions about a situation being modeled. •Represent and analyze mathematical situations and structures using algebraic symbols.
Measurement	•Understand measurable attributes of objects and the units, systems, and processes of measurement. •Make decisions about units and scales that are appropriate for problem situations involving measurement. •Apply appropriate techniques, tools, and formulas to measurement situations. •Analyze precision, accuracy, and approximate error in measurement situations.

National Mathematics Standards

Data Analysis and Probability	•Formulate questions that can be addressed with data. •Understand the meaning of measurement data and categorical data, of univariate and bivariate data, and of the term variable. •Compute basic statistics and understand the distinction between a statistic and a parameter. •Develop and evaluate inferences and predictions that are based on data.. •Use simulations to explore the variability of sample statistics from a known population and to construct sampling distributions. •Understand how sample statistics reflect the values of population parameters and use sampling distributions as the basis for informal inference. •Understand and apply basic concepts of probability. •Understand the concepts of sample space and probability distribution and construct sample spaces and distributions in simple cases.

English Language Standards – NCTE

Standard 4	•Students adjust their use of spoken, written, and visual language to communicate effectively with a variety of audiences and for different purposes.
Standard 8	•Students use a variety of technological and informational resources (e.g., libraries, databases, and computer networks, video) to gather and synthesize information