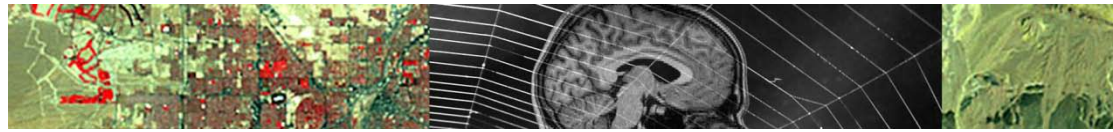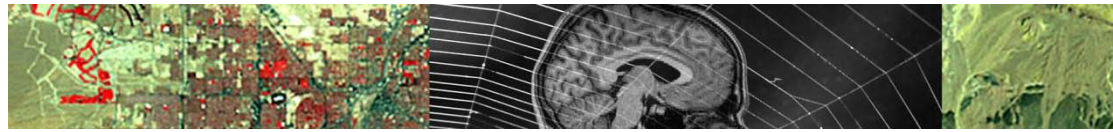# The Changing Face of GIS

Michael F. Goodchild

University of California

Santa Barbara
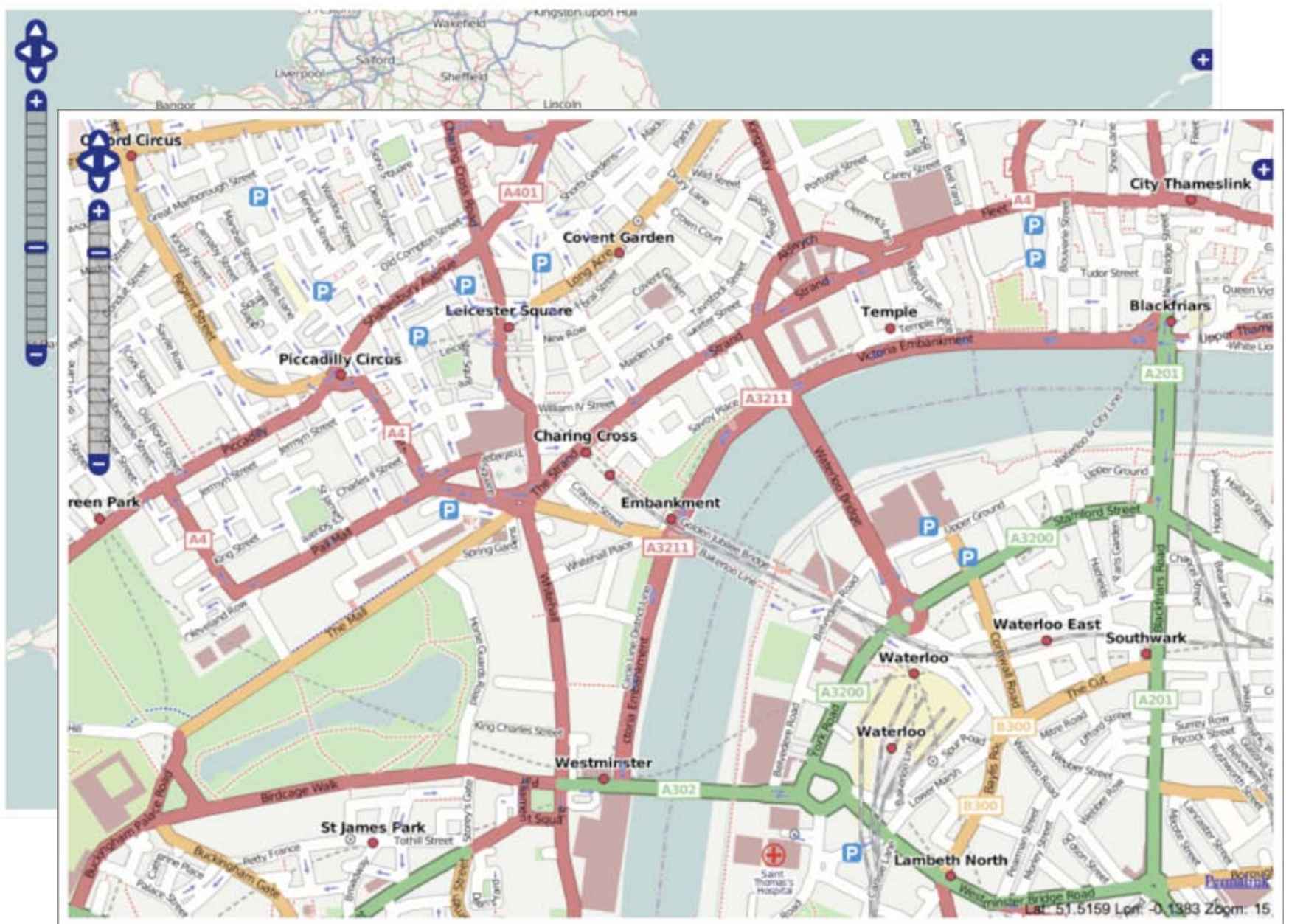
Two topics

- New data sources
- Critical spatial thinking
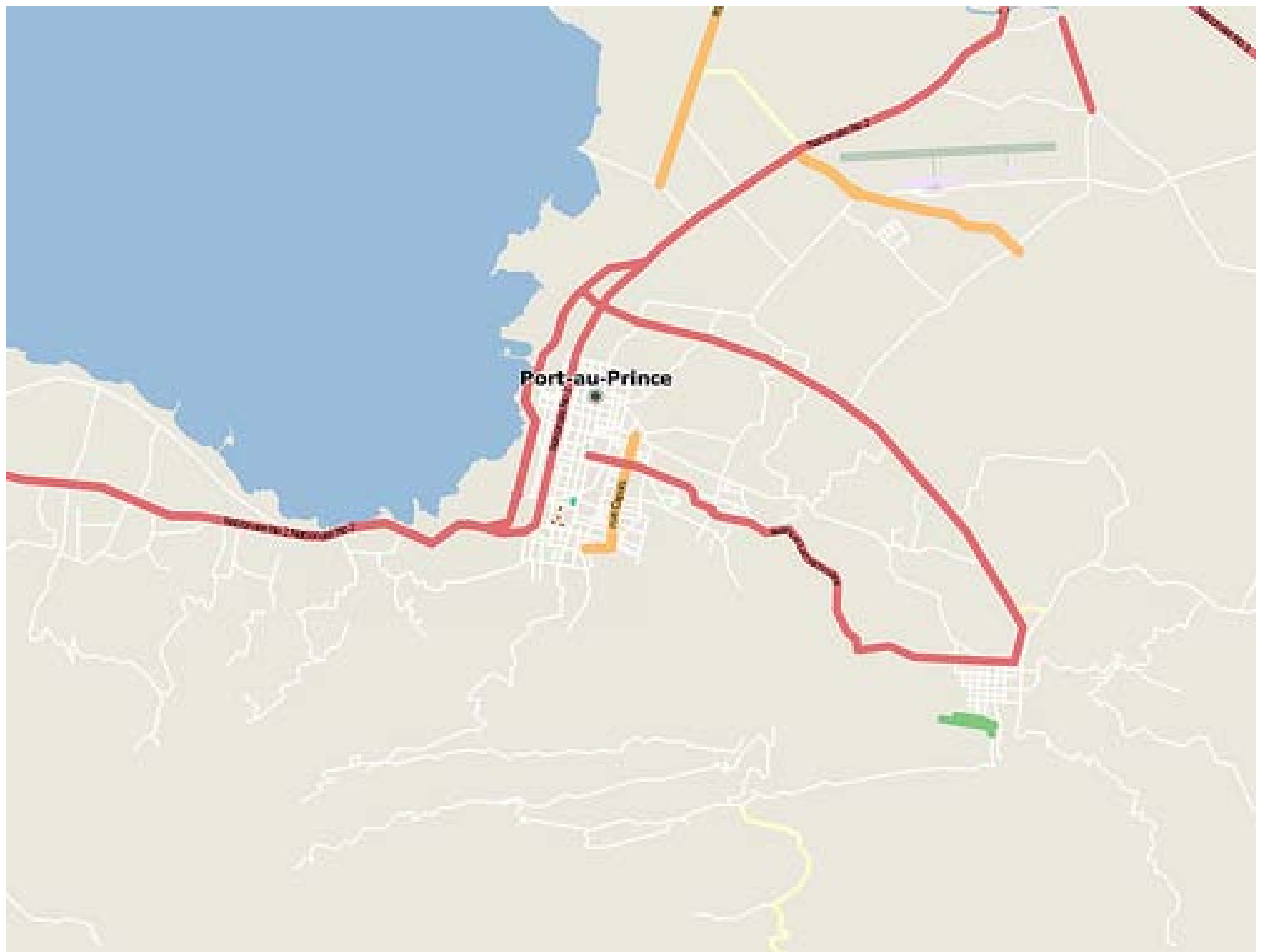
Volunteered geographic information (VGI)

- A phenomenon of the 21st Century
  - recent months
- *User-generated content*
- *Crowdsourcing*
- *Asserted information*
- The empowerment of millions of private citizens
  - largely untrained
  - no obvious reward
  - no guarantee of truth
  - no authority

www.openstreetmap.org

Port-au-Prince

http://www.directrelief.org/Flash/HaitiShipments/Index.html

University of California, Santa Barbara (UCSB)
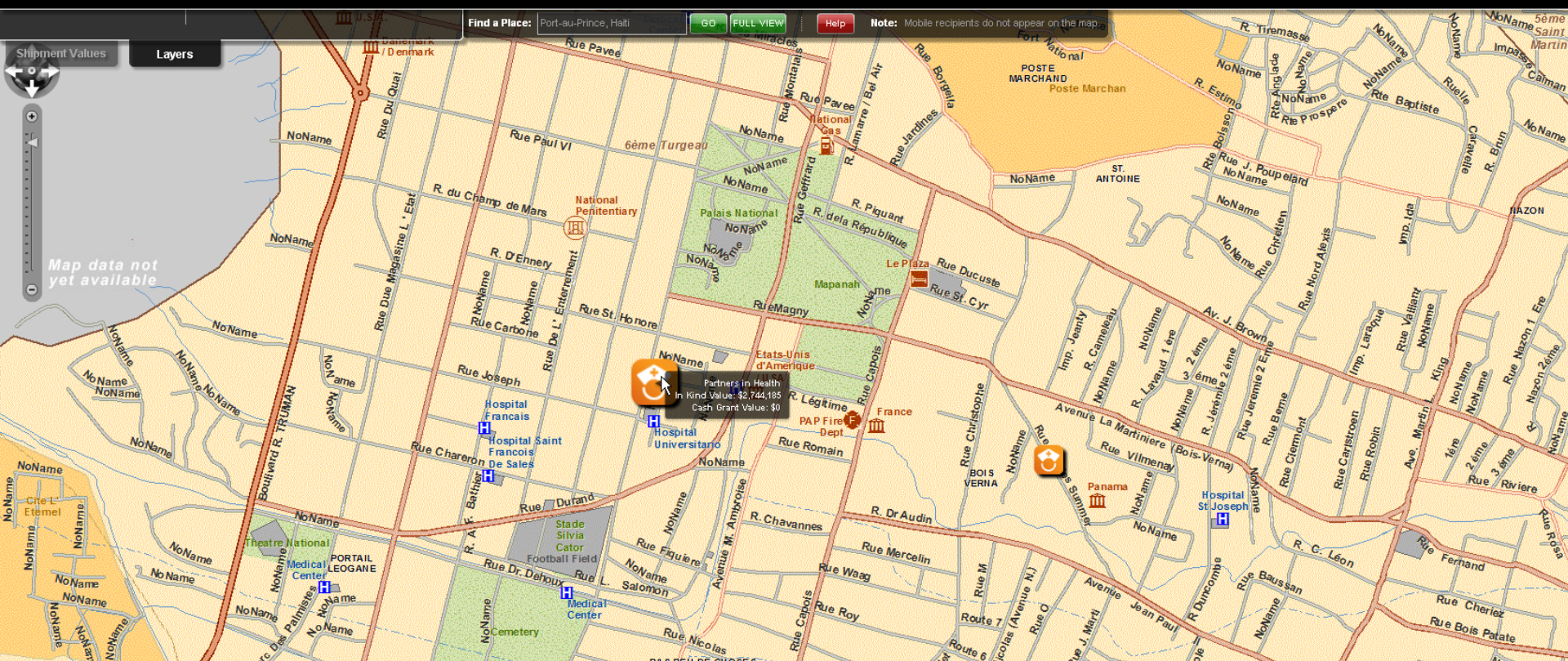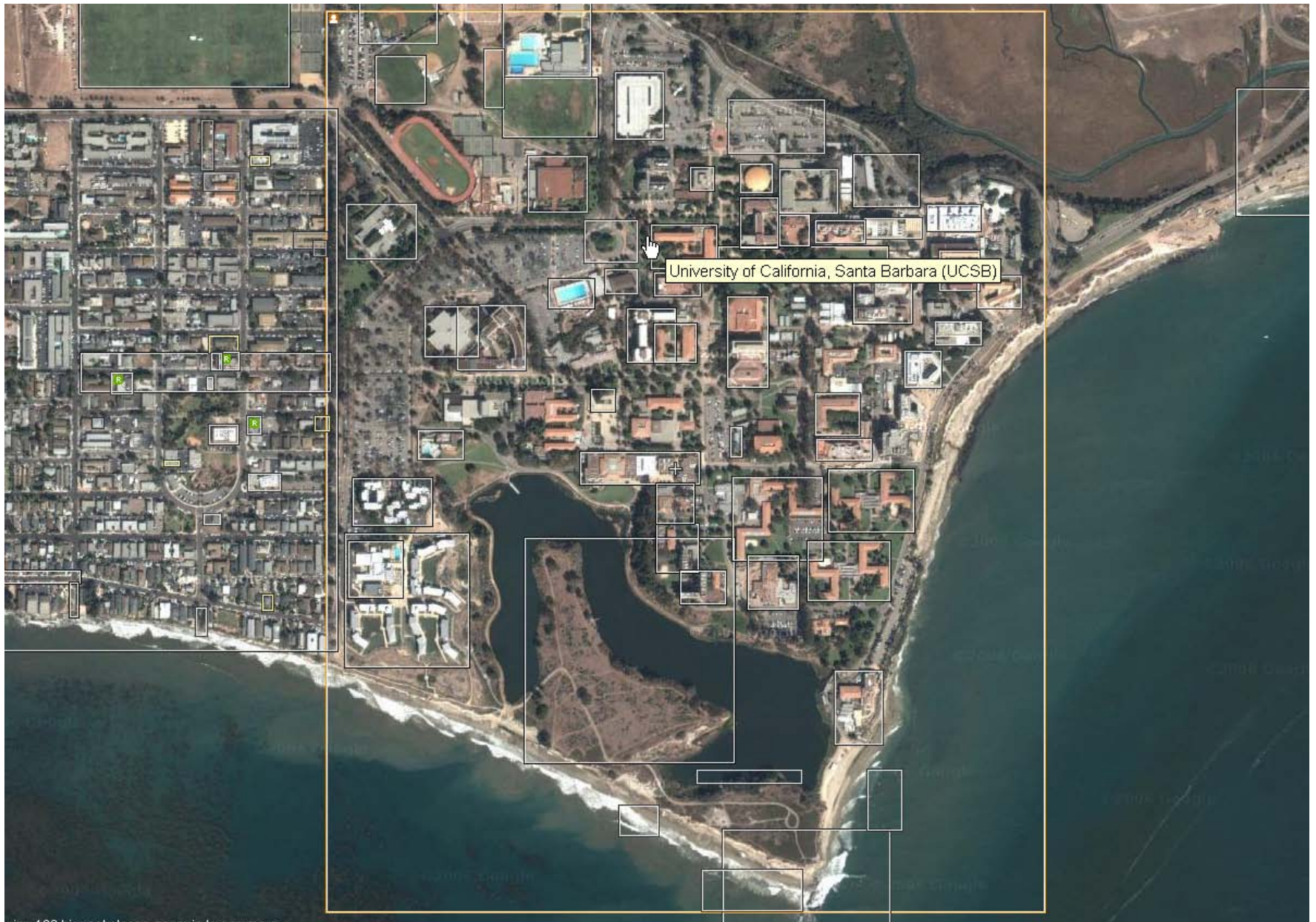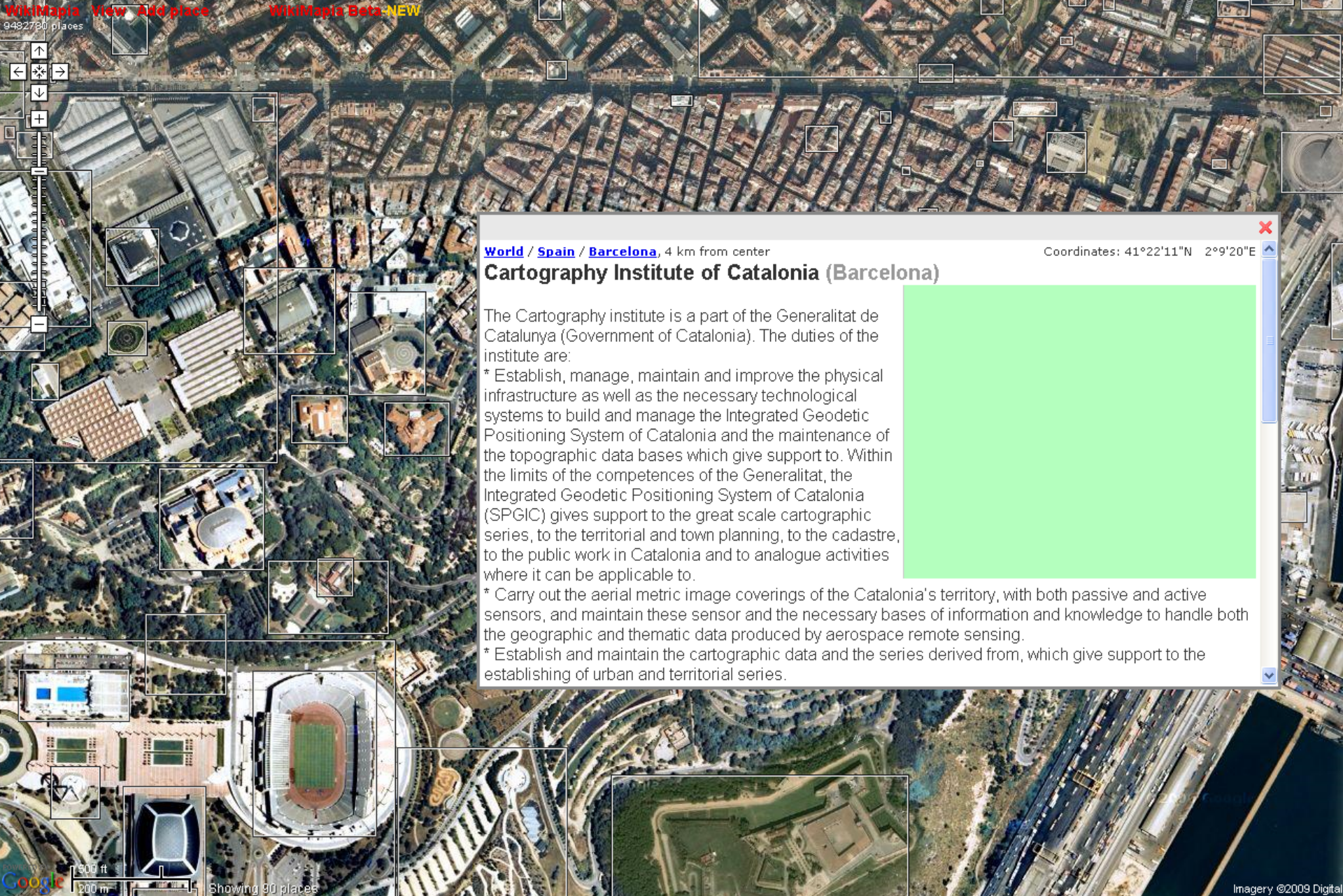
World / Spain / Barcelona, 4 km from center   Coordinates: 41°22'11"N 2°9'20"E

Cartography Institute of Catalonia (Barcelona)

The Cartography institute is a part of the Generalitat de Catalunya (Government of Catalonia). The duties of the institute are:
* Establish, manage, maintain and improve the physical infrastructure as well as the necessary technological systems to build and manage the Integrated Geodetic Positioning System of Catalonia and the maintenance of the topographic data bases which give support to. Within the limits of the competences of the Generalitat, the Integrated Geodetic Positioning System of Catalonia (SPGIC) gives support to the great scale cartographic series, to the territorial and town planning, to the cadastre, to the public work in Catalonia and to analogue activities where it can be applicable to.
* Carry out the aerial metric image coverings of the Catalonia's territory, with both passive and active sensors, and maintain these sensor and the necessary bases of information and knowledge to handle both the geographic and thematic data produced by aerospace remote sensing.
* Establish and maintain the cartographic data and the series derived from, which give support to the establishing of urban and territorial series.

500 ft
200 m
Showing 90 places

Imagery ©2009 Digital

www.wikimapia.org

murmur

(Click the red dots

murmur

284631: 750 Spadina Ave

Helen McLean
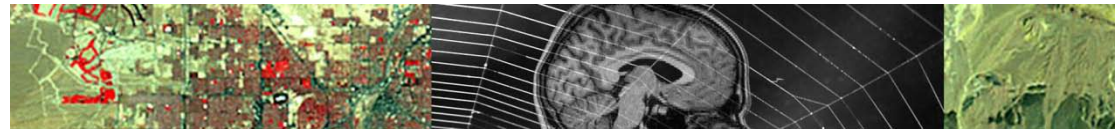
Anonymous

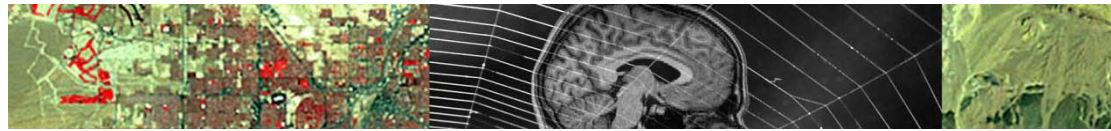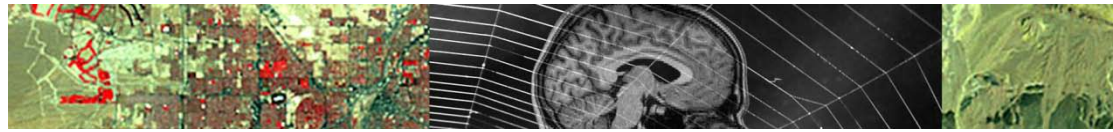**Eva MacDonald**

- info@murmurtoronto.ca -

Types of VGI

- Asserted or authoritative
  - hybrids
    - Tomtom

- Egocentric or allocentric
  - whose location?
    - location-based social networking
    - http://vgi.spatial.ucsb.edu/inventory

- Structured or unstructured
  - accuracy

VGI quality

- Spatial context
  - automatic checks

- Crowdsourcing mechanism
  - how many eyes?

- Authoritative data often older
  - standards of *in*accuracy

- The VGI cycle
  - initial enthusiasm
  - popularity attracts misuse

Emergency management

- **Recent fires in Santa Barbara**
  - Zaca Fire (July 07)
    - burned for 2 months
    - no houses lost
  - Gap Fire (July 08)
    - burned for 7 days
    - no houses lost
  - Tea Fire (November 08)
    - burned for 2 days
    - 230 houses lost
  - Jesusita Fire (May 09)
    - burned for 2 days
    - 75 houses lost

Follow

FEMA: California Tea Fire
Nov 13, 2008

tea fire santa barbara | VPNewsLog
Nov 13, 2008 7:48 PM

The Tea Fire
Nov 13, 2008 11:24 PM

Fire destroys 80+ houses in Montecito, Santa ...
Nov 13, 2008

Santa Barbara "Tea" Fire
Nov 13, 2008 9:44 PM

Canned Spam in high demand - Crime Scene
Nov 13, 2008

Las Alturas Fire Montecito 2008 Tea Fire
Nov 13, 2008 8:42 PM

Wildfire Today: Update on Tea fire near Monte...
Nov 13, 2008

Lal Masjid of Bradistan « Pak Tea House
Nov 13, 2008 9:50 PM

Oprah's house Montecito: Oprah's house fire ·...
Nov 13, 2008

Tea Fire Westmont College
Nov 14, 2008 3:11 AM

Tea Fire (Santa Barbara & Mon...
Nov 14, 2008 7:39 AM

Tea Fire SB fr
Nov 14, 2008

Montecito Fire (See Pic and Video Footage) - ...
Nov 13, 2008

Tea Fire Montecito/Santa Barbara pt. 1
Nov 14, 2008 12:00 AM

Santa Barbara Tea Fire Time Lapse
Nov 14, 2008 5:46 AM

Water Fill Up Helicopter Tea Fire Santa Barb...
Nov 14, 2008 10:51 AM

365 days: Abwarten und Tee trinken
Nov 13, 2008

Tea Fire Santa Barbara Helicopter Water Drop
Nov 14, 2008 1:55 AM

Santa Barbara "Tea Fire" Helicopter
Nov 14, 2008 2:00 AM

3 pm | 4 pm | 5 pm | 6 pm | 7 pm | 8 pm | 9 pm | 10 pm | 11 pm | **Nov 14, 2008** | 2 am | 3 am | 4 am | 5 am | 6 am | 7 am | 8 am | 9 am | 10 am | 11 am | 12 pm | 1 pm | 2 pm

SHOW SOURCES ⌄

File Edit View History Bookmarks Tools Help

http://maps.google.com/maps?hl=en&tab=wl

google mymaps

Jesusita Fire - Google Maps

Web Images Videos **Maps** News Shopping Gmail more ▼

glennon@gmail.com | My Profile | Web History | My Account | Help | Sign out

Google maps

Find businesses, addresses and places of interest.

Search Maps Show search options

Get Directions My Maps

Collaborate Import

Done Save

Title

Jesusita Fire

Description

Size: Approximately 8,733 acres
Containment: 100% contained on May 18, 2009 at
6PM local time (source: InciWeb)

Ignition Time: 145PM PDT, May 5, 2009.

Jesusita Fire Perimeter
fire boundary interpolated from MODIS satellite imagery,

Tea Fire Boundary
Tea Fire Size: 1940 Acres (8 square km) Dates:

Gap Fire Boundary
Gap Fire Size: 9443 Acres(38.6 square km) Dates:

Southeastern Extent of Zaca Fire
The Zaca fire started on July 4, 2007 and by August 31,

Approximate Jesusita Fire Ignition Point
This is a preliminary point for the Jesusita Fire's ignition

County Local Assistance Center
The County of Santa Barbara will be establishing a

Red Cross Headquarters
American Red Cross, Santa Barbara County Chapter

Cool Time Series of Jesusita Fire
A cool time-series of the Jesusita Fire from

Report a problem

RSS | View in Google Earth | Print | Send | Link

Traffic   More...   Map Satellite Terrain
☑ Show labels

Title   Jesusita Fire Perimeter

Description Plain text - **Rich text** - Edit HTML

B I U F T T T ∞ ≔ ≔ T 🖼

fire boundary interpolated from MODIS
satellite imagery, television imagery, and
Twitter accounts.

Delete   Cancel   OK

Los Padres
National

San Marcos Pass Rd

Los Padres
National Forest

Rattlesnake
Canyon Park

Lauro Canyon
Reservoir

Santa Barbara
Botanic Gardens

Mission
Canyon

Cielito

Parma Park

San Antonio Creek

San Antonio
Canyon Park

154

192

Cathedral Oaks Rd

Grove

N La Cumbre Rd

N Ontare Rd

N San Roque Rd

Foothill

192

Foothill Rd

192

Rocky
Nook Park

144

El Real

State St

Nogal

Modoc Rd

101

1

Santa Barbara
Municipal
Golf Course

Alameda Padre Serra

Riviera

1 mi

Imagery ©2009 DigitalGlobe, GeoEye, U.S. Geological Survey, Data MBARI, Map data ©2009 Google Terms of Use Report a problem

Done

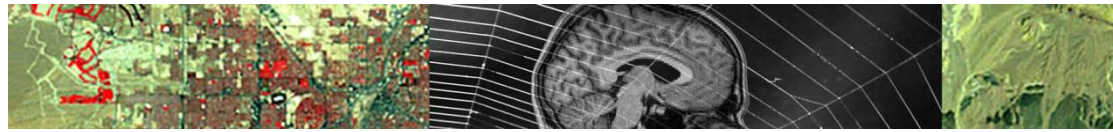| Hits	Source
595673	Jesusita Fire (Ethan)
188308	SBC Jesusita Fire Santa Barbara, CA (Robert O'Connor - fire news blog)
89214	Jesusita Fire Map (Randy - Independent.com)
67525	Jesusita Fire in Santa Barbara - LA Times map (Los Angeles Times)
27777	Map of burned homes in Santa Barbara (Los Angeles Times)
26330	Jesusita Fire Evacuation Areas: Approximation (COSB)
25454	Santa Barbara 'Jesusita Fire' (ABC7 Eyewitness News)
19592	Jesusita Fire - Santa Barbara (lanewspace)
2446	Santa Barbara Damaged Homes 2008 (Los Angeles Times, note: mapped for comparison with Jesusita)
2048	Jesusita Fire (longhairedhippy)
1314	Santa Barbara Fire Evacuation (Gary);
962	Jesusita Fire in Santa Barbara (ABC30 Action News)
788	Wildfire ~ Santa Barbara (Buffalo)
505	Closure map - Jesusita Fire in Santa Barbara (Los Angeles Times)
461	Untitled (Matthew, note: discovered via google.com.mx);
396	Jesusita Fire Structure Damage (Paul Bartsch);

Lessons learned

- Authoritative information
  - must be verified by officials
  - too slow for the Tea and Jesusita Fires
- Asserted information
  - carries risk of false positives
    - false rumor of Tea Fire in Mission Canyon
    - some unnecessary evacuations
  - people are willing to accept false positives
  - lack of authoritative information amounts to false negatives
  - false negatives are far less acceptable than false positives
    - there were some posted false negatives

Critical spatial thinking

- Larger than GIS
  - now that the technology is easier to use
- What every Google Earth user needs to know
- Focus on fundamental spatial concepts
  - from simple, acquired in early childhood
  - to advanced, acquired in college
- One of Gardner's seven types of intelligence
  - almost entirely neglected in education

"1. Linguistic
Children with this kind of intelligence enjoy writing, reading, telling stories or doing crossword puzzles.

2. Logical-Mathematical
Children with lots of logical intelligence are interested in patterns, categories and relationships. They are drawn to arithmetic problems, strategy games and experiments.

3. Bodily-Kinesthetic
These kids process knowledge through bodily sensations. They are often athletic, dancers or good at crafts such as sewing or woodworking.

4. Spatial
These children think in images and pictures. They may be fascinated with mazes or jigsaw puzzles, or spend free time drawing, building with Lego or **daydreaming**.

5. Musical
Musical children are always singing or drumming to themselves. They are usually quite aware of sounds others may miss. These kids are often discriminating listeners.
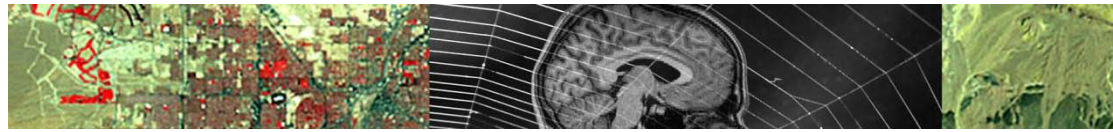
6. Interpersonal
Children who are leaders among their peers, who are good at communicating and who seem to understand others' feelings and motives possess interpersonal intelligence.
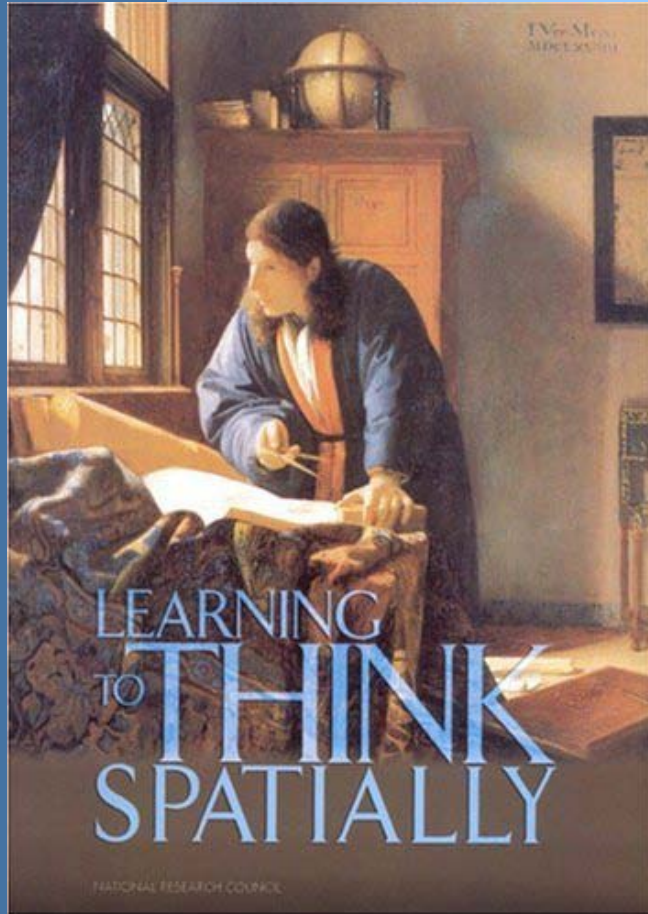
7. Intrapersonal
These children may be shy. They are very aware of their own feelings and are self-motivated."

Howard Gardner

http://www.professorlamp.com/ed/TAG/7_Intelligences.html
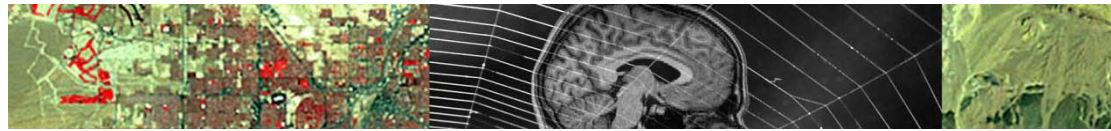
What is spatial thinking?

"Three aspects of spatial ability:

- Spatial knowledge
  - symmetry, orientation, scale, distance decay, etc.
- Spatial ways of thinking and acting
  - using diagramming or graphing, recognizing patterns in data, change over space from change over time, etc.
- Spatial capabilities
  - ability to use tools and technologies such as spreadsheet, graphical, statistical, and GIS software to analyze spatial data"

http://www.nap.edu/catalog/11019.html

UCSB is spatial

What fundamental concepts exist in spatial intelligence?

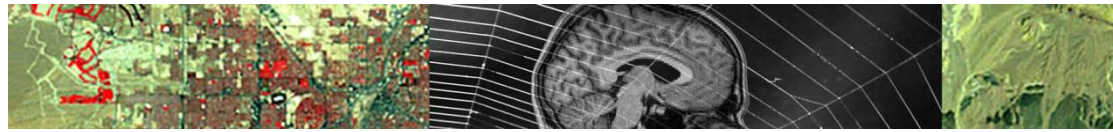- Are they sophisticated and abstract enough to warrant a place in the curriculum?
  - like mathematics, statistics, language, music
  - can spatial intelligence gain more respect?
  - where in the curriculum?
- Are they an appropriate basis for improved GIS user interface design?
  - does the interface need improvement?
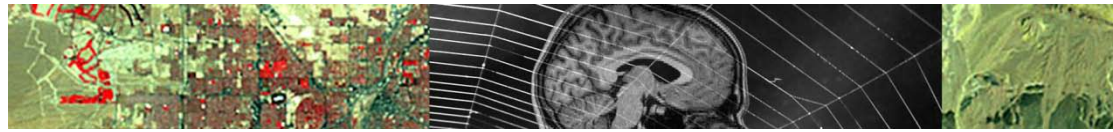
1. Location

- Defining and measuring location
  - the impossibility of exact measurement
- From infinitesimal point to extended area
- Location as context
- Location as common key
- It is important to know *where* events occur

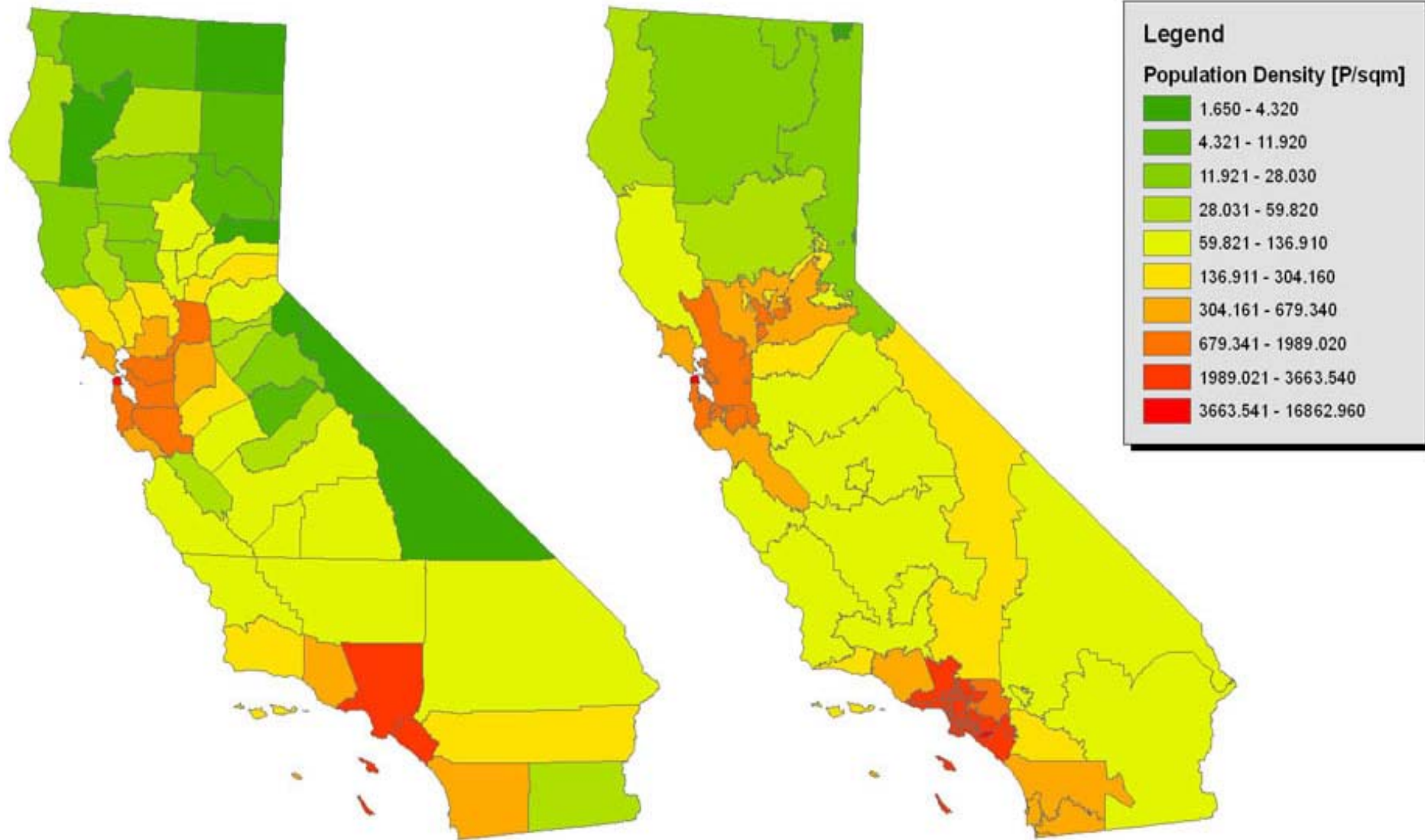# 2. Distance, direction

- Measurement
  - plane, globe
  - buffers

- Distance decay
  - decline of interaction with distance
  - cost, time impediments
  - footprints of human behavior

3. Neighborhood/region/territory

- The context of individuals
  - action space
- Homogeneous areas
- The reporting zone containing the individual
  - arbitrarily imposed on a continuous Earth
- The ecological fallacy
  - the modifiable areal unit problem
- Competition for space
  - trade areas, bird territories
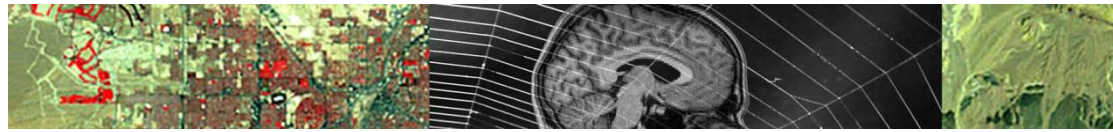 - functional regions

Areal Interpolation Example: Population Density in California

Legend

Population Density [P/sqm]

|	
	1.650 - 4.320
	4.321 - 11.920
	11.921 - 28.030
	28.031 - 59.820
	59.821 - 136.910
	136.911 - 304.160
	304.161 - 679.340
	679.341 - 1989.020
	1989.021 - 3663.540
	3663.541 - 16862.960

Original dataset
Population density by county

After areal interpolation
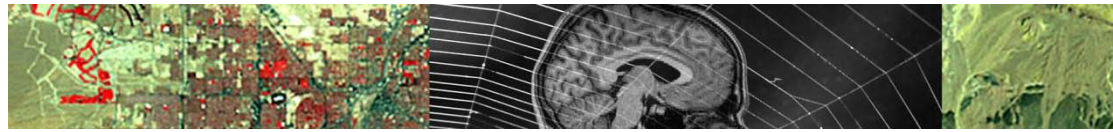Population density 3-digit zip code regions

4. Scale

- Level of detail
  - the inevitability of generalization
- Methods of upscaling, downscaling
- Fractal concepts
- Scale is always important
  - many properties cannot be defined independently of scale
    - length of a coastline
    - slope of a topographic surface
    - land use class
    - "the flattest spot in the US"
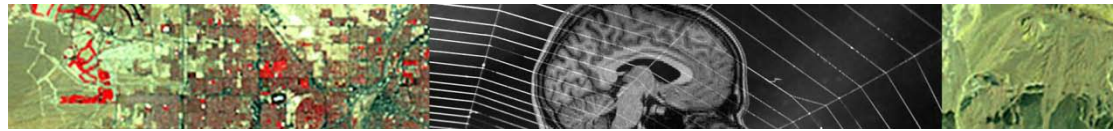
Conclusions

- Web 2.0 is creating novel sources of geospatial information
  - that can complement traditional sources
  - that can play a key role in time-critical situations
- It is possible to enumerate the fundamental concepts of a spatial approach
  - four broadly defined concepts
  - 27 in De Smith, Goodchild, and Longley (2006) *Geospatial Analysis*
    - www.spatialanalysisonline.com
  - 186 in www.teachspatial.org ontology

Conclusions (2)

- Critical spatial thinking is more than GIS
  - an enveloping conceptual framework for many new technologies and disciplines
  - phenomena embedded in space and time
  - many drivers
- One of a minimal set of intelligences
  - part of everyone's education