



## Getting the Map into the Computer

Getting Started with  
Geographic Information Systems  
Chapter 4

## Getting the Map into the Computer

- 4.1 Analog-to-Digital Maps
- 4.2 Finding Existing Map Data
- 4.3 Digitizing and Scanning
- 4.4 Field and Image Data
- 4.5 Data Entry
- 4.6 Editing and Validation

## GIS maps are digital not analog



1100010101110100111

- Maps have a communications function but...
- A map has a storage function for spatial data
- Somehow, the visually “stored” data must get digital
- Real and Virtual maps

## GIS Data Conversion

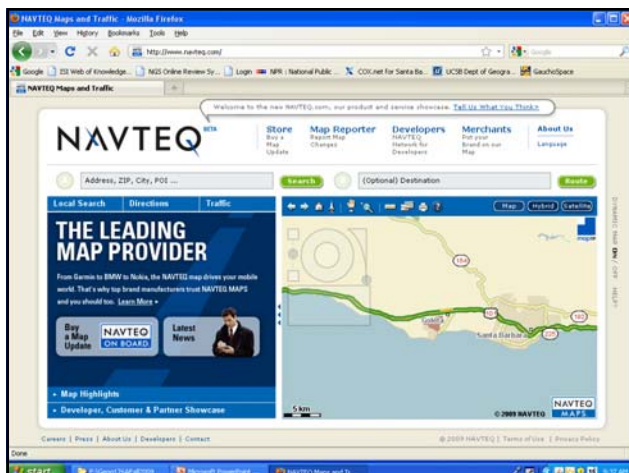
- Traditionally most of the cost of a GIS project
- One time cost
- Depends on reuse
- Requires maintenance
- Often done a whole collection at a time

## Data or service?

- Initially, GIS users wanted raw data for use in GIS, one project at a time
- Data reuse makes a great deal of sense!
- Next came clearinghouses and web portals: facilitating search and **discovery**
- Now the Internet offers web services
  - Solutions not data
  - But, queries can be tracked
- What next?

## Finding Existing Map Data

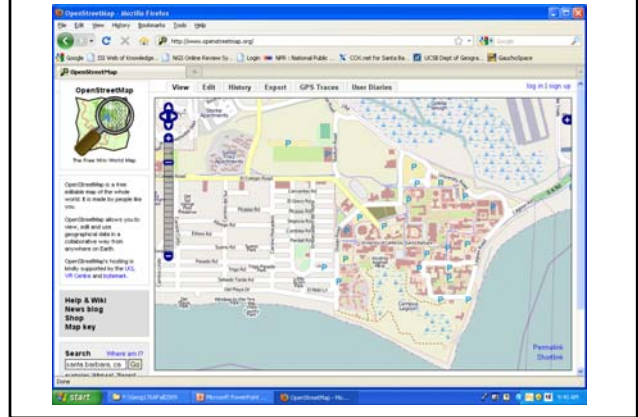
- Map libraries
- Reference sources e.g. data.gov
- State and local agencies
- Federal agencies
- Commercial data suppliers e.g. Rand McNally, Thompson, maps.com
- Teleatlas (TomTom), Navteq (Nokia)



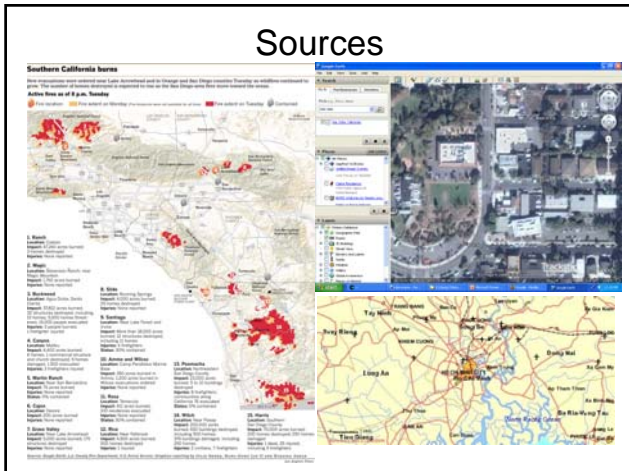
## Apple Maps Ap



## www.openstreetmap.org



## Sources



## Existing Map Data



- Existing map data can be found through a map library, via network searches, or on media such as CD-ROM and disk
- Data providers make their data available via the Web, a network of file servers available over the Internet
- GIS vendors package data with products
- Web portals, search engines, clearing houses, "discovery", the cloud

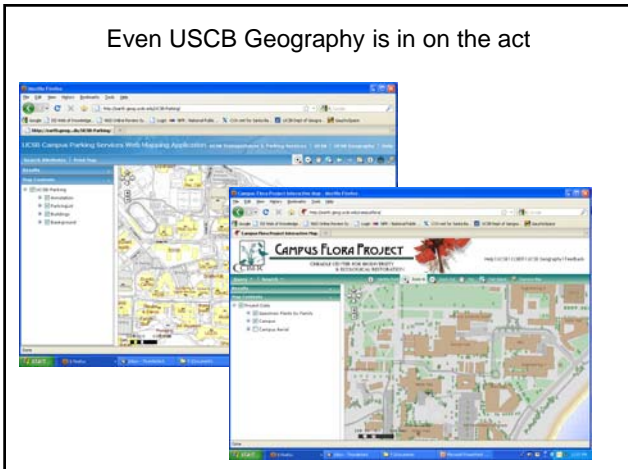
## Commercial vendors



## DeLorme: Eartha



## Even USCB Geography is in on the act



## Global data

- Concept of GSDI
- NGA: World data, e.g. VMAP0
- Global Map: ISCGM  
<http://www.iscgm.org/cgi-bin/fswiki/wiki.cgi>
- NASA Worldwind
- GDEM and SRTM
- United Nations: UNEP, UNICEF etc.
- Many clearing houses by topic, e.g. weather
- Continental data bases e.g.  
<http://www.africover.org>, CORINE



## US Federal Data Agencies

- USGS
- NOAA
- Census Bureau
- NGA
- EPA
- FEMA
- many more...



## National Spatial Data Infrastructure

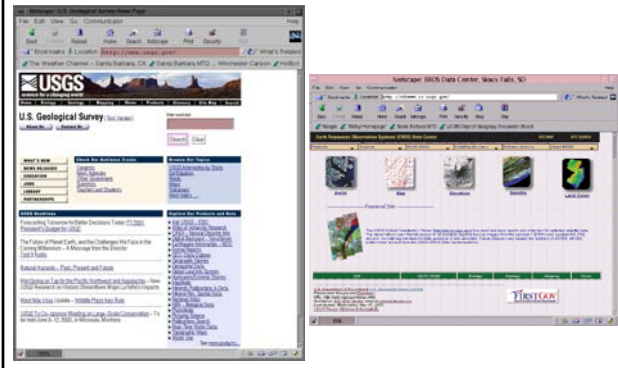


## National Spatial Data Clearinghouse

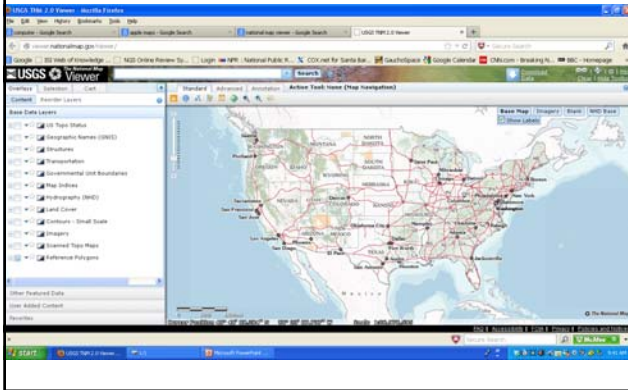
NSDI network  
Includes  
geodata.gov  
Geospatial  
onestop, eGov  
initiative from  
2002



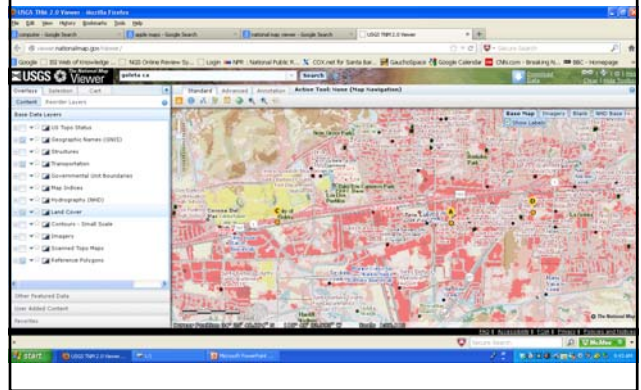
## USGS: National Mapping



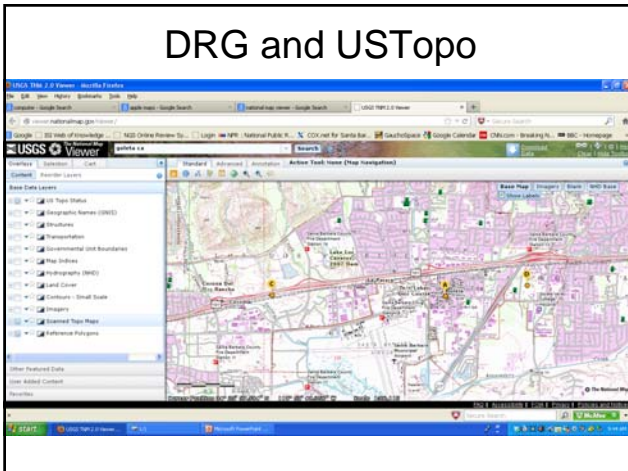
## National Map Viewer



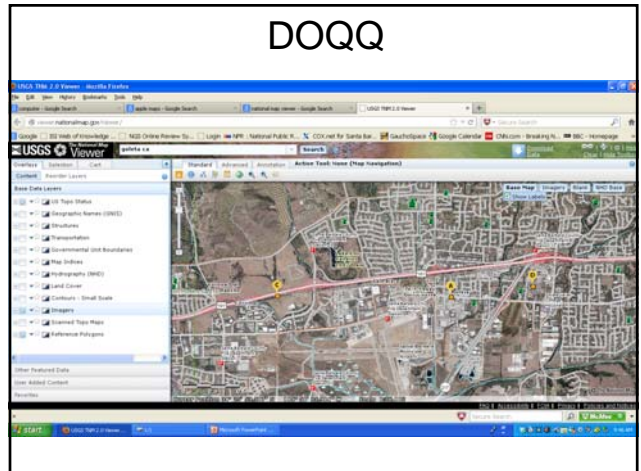
## Land use, place names, transportation



## DRG and USTopo



## DOQQ



## Seamless download

- Identify a point, quad, region (e.g. county), or polygon
- Server “cuts out” and mosaics data
- Sends an e-mail with limited time access to an ftp site
- Data are zipped and structured by layer
- Process is automated, but requests can get very large, very quickly!

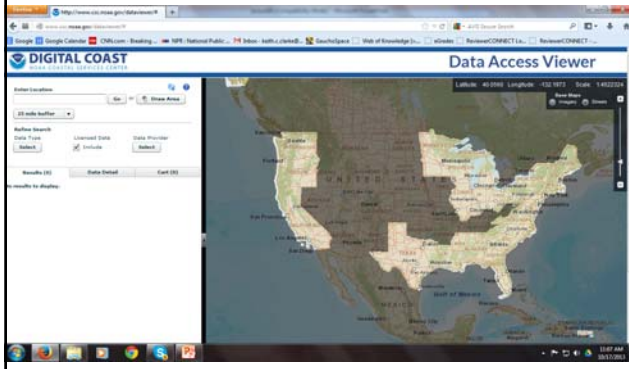
## GeoPDF and the “Map Store”



## U.S. Bureau of the Census



# NOAA: Digital Coast



# Eros Data Center

- Distributed active archive center
- Sioux Falls, SD
- Operated by USGS



Microsoft Internet Explorer

http://data2.usgs.gov/geomdata/index.php

**USGS**  
science for a changing world

USGS Home Contact USGS Search USGS

**USGS Geographic Data Download**

**Data Site Information:**

- These data files are for use in geographical information systems (GIS) for analysis and integration with other geospatial data. They are not directly viewable using WWW browsers or image viewing tools. The USGS offers free software for viewing some digital topographic products, including DLO, DEM, DLGSD73 and DRO data. They are tools for data review, and are not substitutes for commercial geographic information system software.
- **State Maps** are available for a limited number of data sets.
- **Public Domain Software** for use with DEM, DLO, DRO, DLG, and DLGSD73 files.
- **Digital Data Transfer Standard (DDTS)** information. **Note:** Please be aware that not all 3rd party files have been converted to DDTS format. For a complete listing of data available in 3rd party and DDTS, please go to [DataMatters](#).

1:250,000 Scale Digital Elevation Models (DEM) ▾

1:24,000 Scale Digital Elevation Models (DEM) SDTS format only ▾

National Elevation Dataset (NED) ▾

1:2,000,000 Digital Line Graphs (DLG) SDTS format only ▾

1:100,000 Scale Digital Line Graphs (DLG) ▾

1:24,000 Scale Digital Line Graphs (DLG) SDTS Format Only ▾

1:250,000 & 1:100,000 Scale Land Use Land Cover (LULC) ▾

National Hydrography Dataset (NHD) ▾

CTOP030 ▾

Done

# GNIS Feature locations

USGS Search Results: Results Display

http://geonames.usgs.gov/gnis/featureQuery.do?query=110122707670404320\_000001

**USGS**  
Geographic Names Information System (GNIS)

Feature Query Results

Click the feature names for details and to access data members.  
Click any column name to sort the list ascending or descending.

Feature Name	Category	Class	Locality	Subtype	State	County	State FIPS	County FIPS	Feature ID	Feature Date
USGS Valley Community Therapeutic Hospital	11012271	Hospital	Sioux Falls	1101227101	SD	Minnehaha	46	020	110122710101	12-2-2008
South Dakota Methodist	11012272	Building	Sioux Falls	1101227201	CA	Coconino	24	19	110122720101	12-2-2008
Sioux Valley Community Center	11012273	Building	Sioux Falls	1101227301	CA	Coconino	8	20	110122730101	12-2-2008
Sioux Branch South Dakota Public Library	11012274	Building	Sioux Falls	1101227401	CA	Coconino	18	02	110122740101	12-2-2008
Methodist Center School	11012275	Building	Sioux Falls	1101227501	CA	Coconino	17	08	110122750101	12-2-2008
Sioux Valley School of Commerce	11012276	Building	Sioux Falls	1101227601	CA	Coconino	8	20	110122760101	12-2-2008
Sioux Falls	11012277	City	Sioux Falls	1101227701	CA	Coconino	8	20	110122770101	12-2-2008
Sioux Falls	11012278	City	Sioux Falls	1101227801	CA	Coconino	23	25	110122780101	12-2-2008
Church of Christ	11012279	Church	Sioux Falls	1101227901	CA	Coconino	13	03	110122790101	12-2-2008
Sioux Church of God in Christ	11012280	Church	Sioux Falls	1101228001	CA	Coconino	8	18	110122800101	12-2-2008
Sioux Presbyterian Church	11012281	Church	Sioux Falls	1101228101	CA	Coconino	13	03	110122810101	12-2-2008
La Bible	11012282	Club	Sioux Falls	1101228201	CA	Coconino	18	08	110122820101	12-2-2008
City of Sioux	11012283	City	Sioux Falls	1101228301	CA	Coconino	13	03	110122830101	12-2-2008
Sioux Valley Hospital	11012284	Hospital	Sioux Falls	1101228401	CA	Coconino	18	02	110122840101	12-2-2008
Sioux Valley Community Hospital	11012285	Hospital	Sioux Falls	1101228501	CA	Coconino	18	02	110122850101	12-2-2008



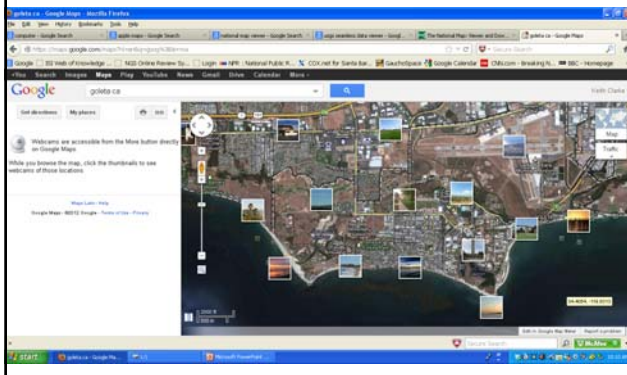
## GeoNames server



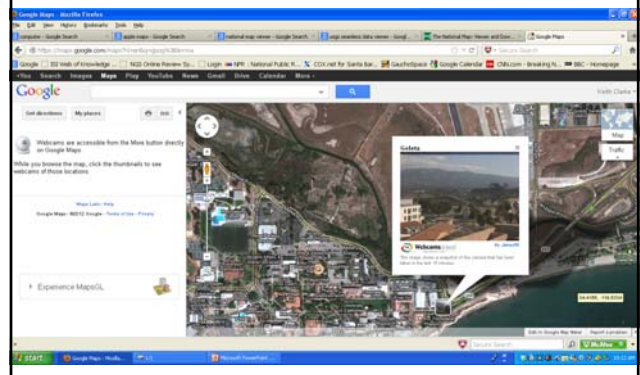
## Metacarta.com



## GeoTagged images, social media

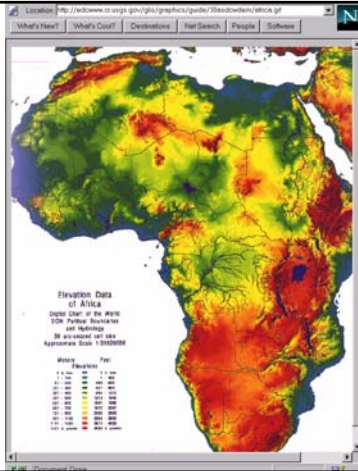


## Geotagged Webcams

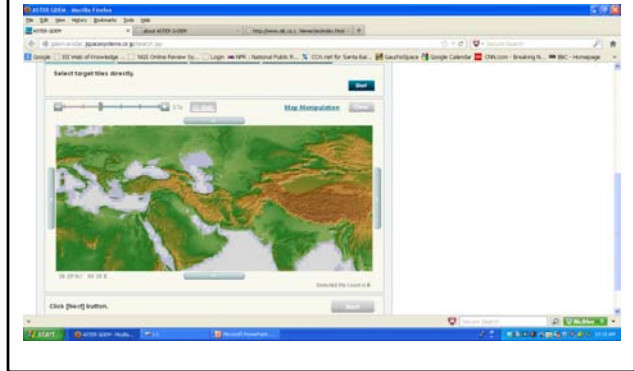


## Terrain data

- DEM
- DLG
- Contours
- DCW
- Contours
- SRTM
- GDEM



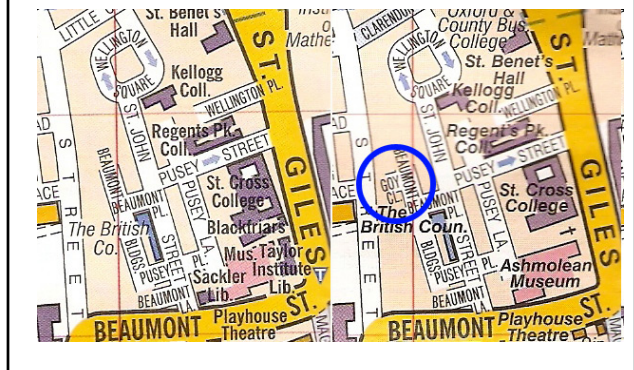
## GDEM: search, tiles



## Your Spatial Data “Rights”

- US Federal
  - FOIA
  - COFUR
- State (e.g. California, Teale Data Center)
- Local (e.g. Portland, OR Metro)
- Other countries
- Protection for security
- Steganography, watermarks, deliberate error
- Attributes vs. map data

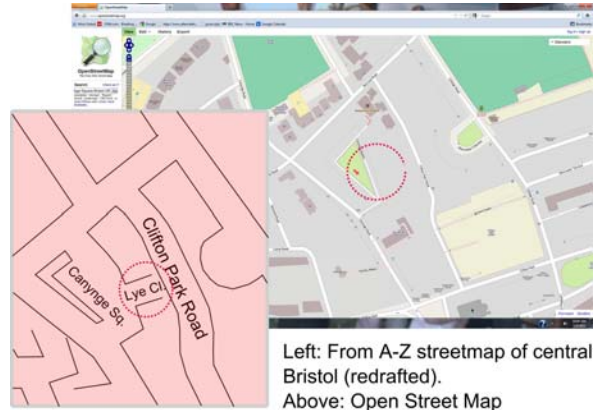
## Cartographic traps



## “Goy Close”



## A Cartographic Trap



## GeoPrivacy: Google Street View

A screenshot of a news article from GIGAOM. The article is titled "Google Street View Opt Out Goes Live in Germany While Spain Investigates" and is dated August 15, 2015. The author is Matthew Ingram. The article discusses German citizens requesting that photos of their homes or businesses be blurred to prevent them from being identified in Google's Street View photo service. It also mentions that Spain is investigating Google's collection of wireless data via its Street View cars. The article includes a small image of a red car with a camera mounted on the roof.

Occasionally TIGER Data are Inaccurate or Imprecise



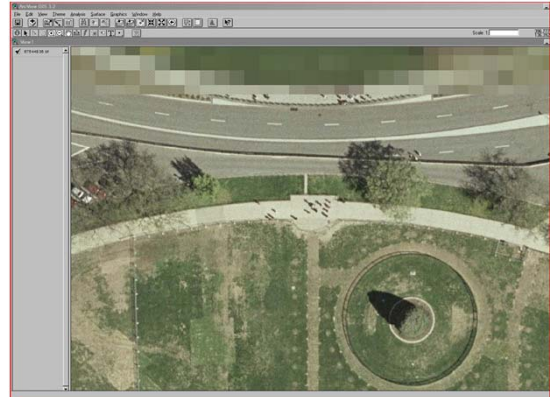
OAK RIDGE NATIONAL LABORATORY  
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE

CORONA (KH Satellites)  
Goleta, CA, 1967 Image



The White House in TNM



## Post 9-11 2001: 2005 report

### Mapping the Risks

Assessing the Homeland Security  
Implications of Publicly Available  
Geospatial Information

JOHN C. BAKER, BETH E. LACHMAN, DAVID R. FREILINGER,  
KEVIN M. O'CONNELL, ALEXANDER C. HOU, MICHAEL S.  
TSENG, DAVID ORLETSKY, CHARLES YOST

Prepared for the National Geospatial-Intelligence Agency  
Approved for public release, distribution unlimited

 NATIONAL DEFENSE RESEARCH INSTITUTE

## GIS data can be:

- Purchased
- Found from existing sources in digital form
- Captured from analog maps by GEOCODING

## GEOCODING

- Geocoding is the conversion of spatial information into digital form
- Geocoding involves capturing the map, and sometimes also capturing the attributes
- Necessarily involves coordinates
- Often involves address matching

## GEOCODING LEAVES A "STAMP" ON DATA



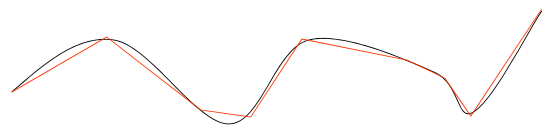
- The method of geocoding can influence the structure and error associated with the spatial information which results
- Examples: scanning (raster), digitizing (vector)

## Geocoding methods for geospatial data

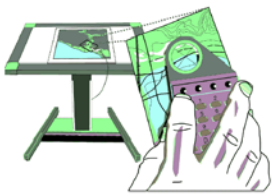
- Measure the map
  - Digitizing
  - Scanning
- Measure the earth
  - Field data collection

## Digitizing

- Captures map data by tracing lines from a map by hand
- Uses a cursor and an electronically-sensitive tablet
- Result is a string of points with (x, y) values



## The Digitizing Tablet



1. Digitizer cursor transmits a pulse from an electromagnetic coil under the view lens.
2. Pulse is picked up by nearest grid wires under tablet surface.
3. Result is sent to computer after conversion to x and y units.



## Digitizing

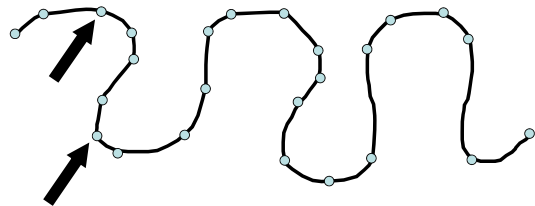
- Stable base map
- Fix to tablet
- Digitize control
- Determine coordinate transformation
- Trace features
- Proof plot
- Edit
- Clean and build

## Digitizing

- Cursor data entry
- Secondary tablet (menu/template)
- Voice command entry
- Point select
- Stream mode
- Distance mode

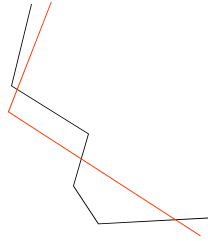


## Selecting points to digitize



## Some common digitizing errors

- Slivers
- Duplicate lines
- Duplicate nodes
- Unended lines
- Gaps
- Zingers



## Scanning

- Places a map on a glass plate, and passes a light beam over it
- Measures the reflected light intensity
- Result is a grid of pixels
- Image size and resolution are important
- Features can “drop out”

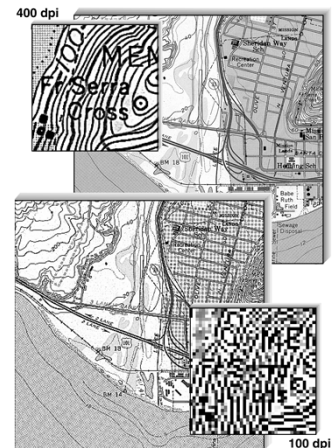
## Scanning

- Flat bed
- Drum
- DPI
- File size



## Scanning example

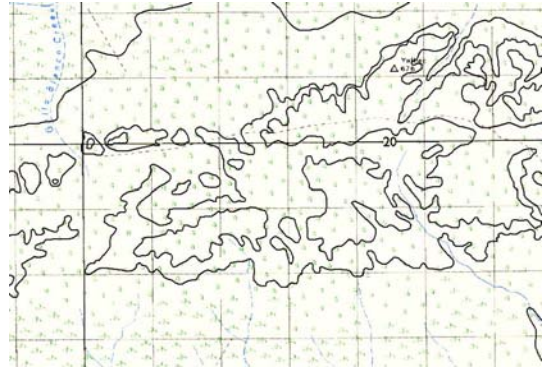
15 x 15 cm (3.6 x 3.6 km)  
 grid is 0.25 mm  
 ground equivalent is 6 m  
 600 x 600 pixels  
 one byte per color (0-255)  
 1.08 MB



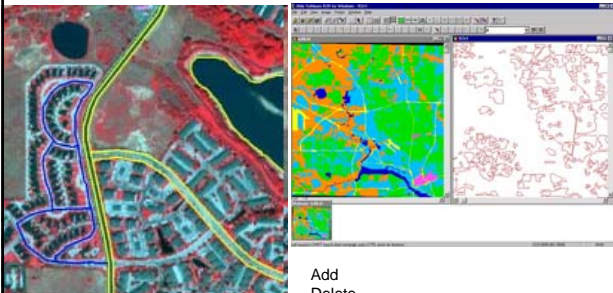
## File size for raster images

- Header block: Usually contains name of format, metadata, nrows, ncols, cell size in bytes
- Data bloc: nrows x ncols x bytesize (x color bands)
- Some image formats e.g. PNG support a transparent layer
- Image format conversion often involves flattening

## On-screen (heads up) digitizing

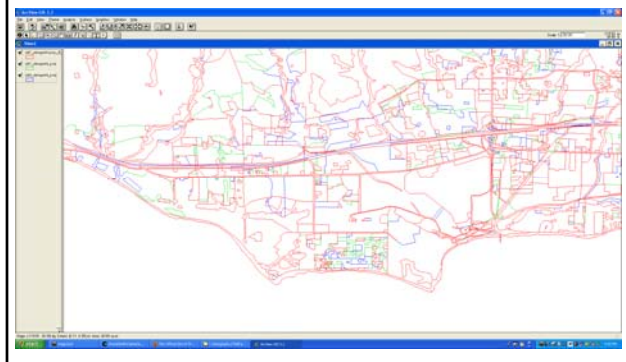


## Select and trace vectors or updates



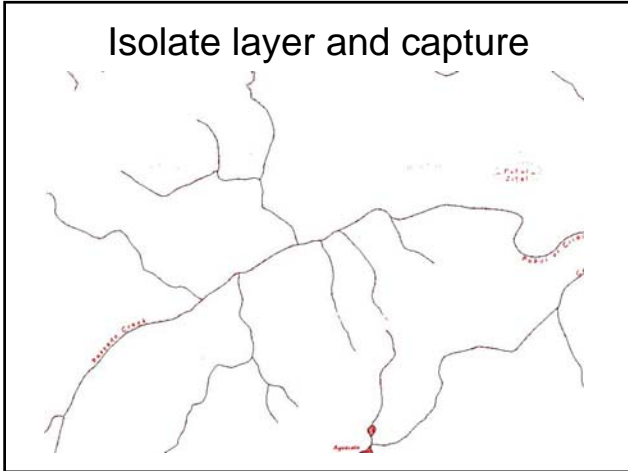
Add  
Delete  
Move  
Split  
Join

## Capturing change

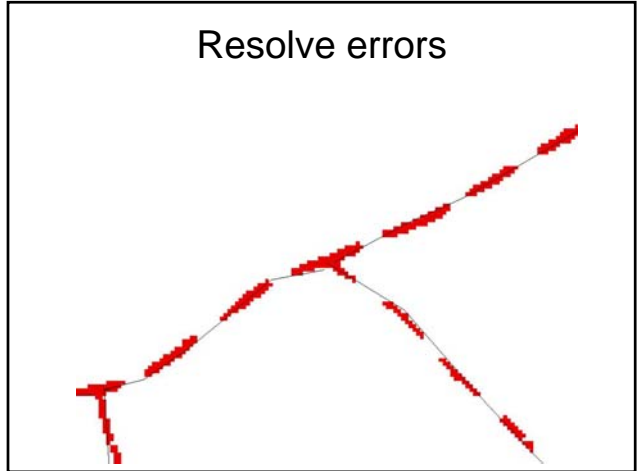




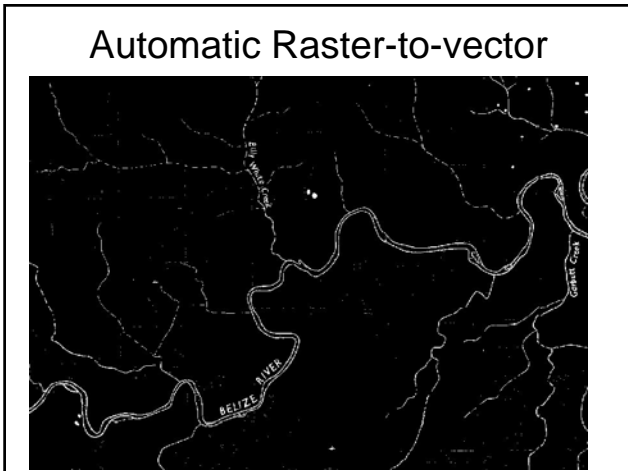
Isolate layer and capture



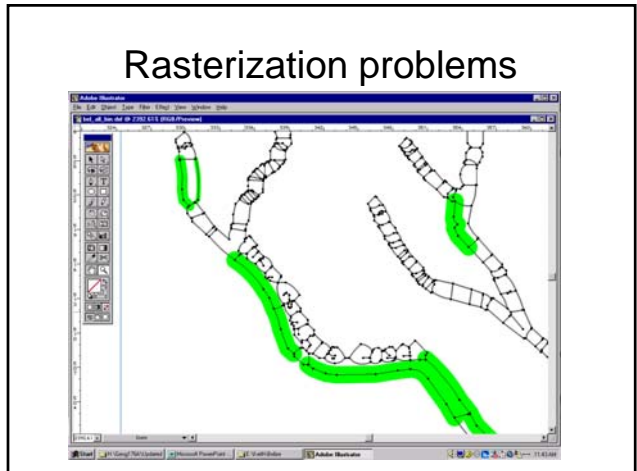
Resolve errors



Automatic Raster-to-vector

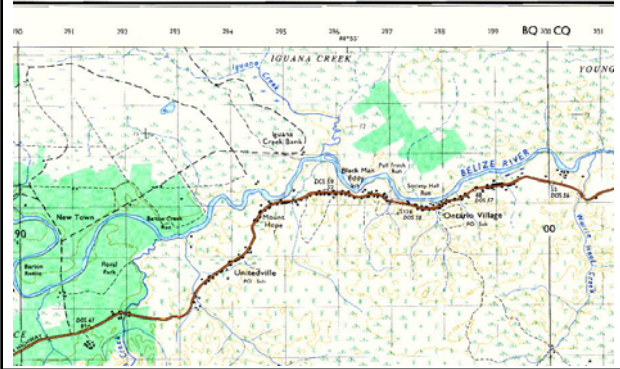


Rasterization problems



## Feature vs. Text

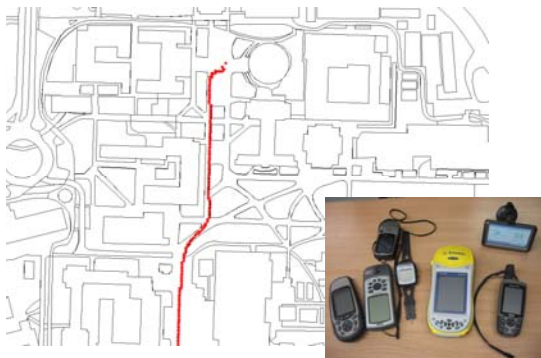
BELIZ



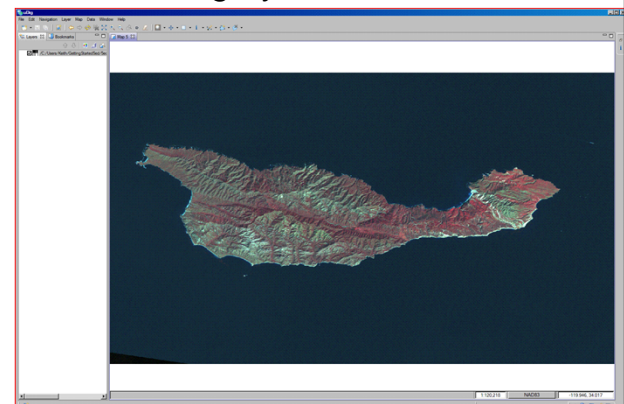
## Field data collection



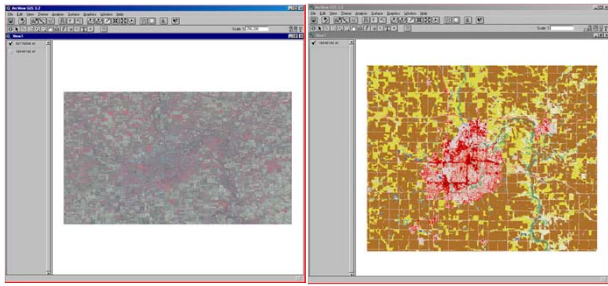
## GPS navigation/tracks



## Imagery source data



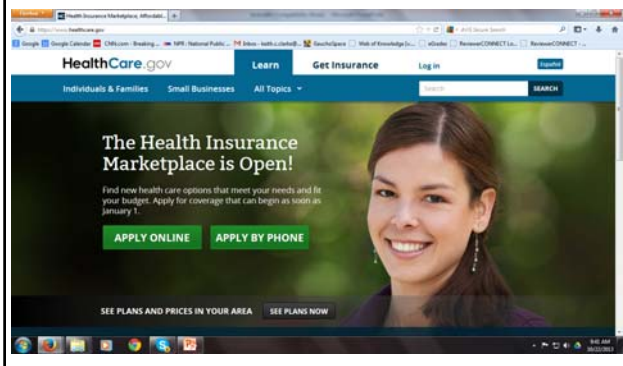
## Derived data; e.g. LULC



## Attribute data

- Logically can be thought of as in a flat file
- Table with rows and columns
- Attributes by records
- Entries called values

## Forms-based data entry



## Address Matching

- Most GISs contain capability
- Start with 123 Main St, Santa Barbara, CA 93101
- End with Coordinates
- May need to interpolate along blocks
- Street number range, left and right side e.g. 101-199
- Example: 145 = 100 block + 45/99 left side

## 123 State Street, Santa Barbara

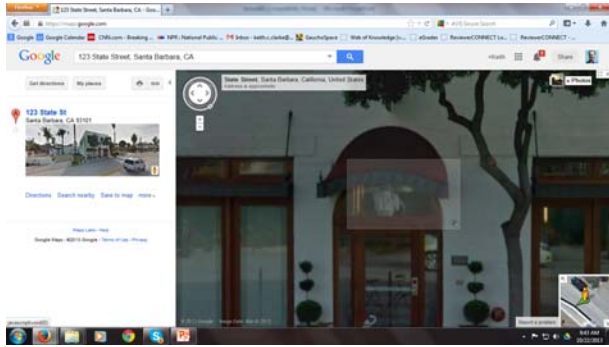
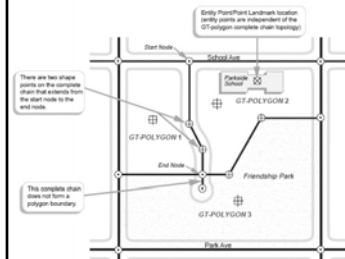


Figure 1-1 Basic TIGER/Line<sup>®</sup> File Topology  
The illustration below shows a generalized block that consists of three GT polygons (GT stands for geometry and topology). The block contains a point landmark (Parade School) inside GT-polygon 2 and an area landmark (Friendship Park) that is coextensive with GT-polygon 3.



## TIGER basis



## Database Management Systems

- Data definition module sets constraints on the attribute values
- Data entry module to enter and correct values
- Data management system for storage and retrieval
- Legal data definitions can be listed as a data dictionary
- Database manager checks values with this dictionary, enforcing data validation

## Database elements

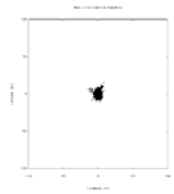
- Type of value
  - Range
  - Missing data
  - Duplicate data
  - Key
- ```
Attribute_labels = "ID #", "Feature",
"Name", "Surface", "Lanes", "Traffic", "per hour"
"1",
"Road",
"US 11",
"tarmac",
"3",
"113"
"2",
"Road",
"1 S1",
"concrete",
"4",
"432"
"3",
"Road",
"Link Bridge Road",
"tarmac",
"2",
"12",
"4"
```

## The Role of Error

- Enforcement for map data is usually by using topology
- Map and attribute data errors are the data producer's responsibility, but the GIS user must understand error
- Accuracy and precision of map and attribute data in a GIS affect all other operations, especially when maps are compared across scales

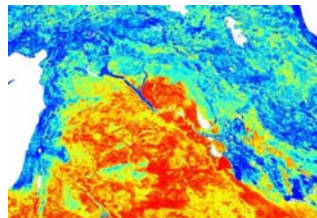
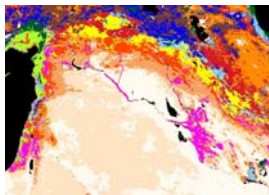
## Types of error

- Omission and commission
- Additive and multiplicative
- Positional or attribute
- Systematic or random
- Measurement or process
- Dealing with uncertainty in mapping



## Remote sensing example

<http://www.yale.edu/ceo/Projects/swap/landcover/uncertainty.htm>



Red high  
Blue low

coming next.....

# What is where?