Introduction to Quantum Geographic Information Systems (QGIS)

January 24th, 2013

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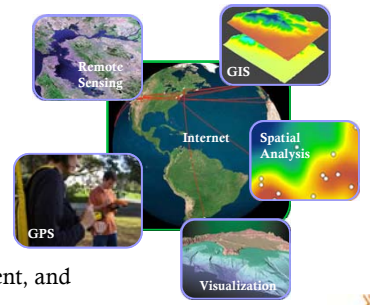


Supporting…
- research,
- management, and
- outreach

in the 43 PVPC communities.

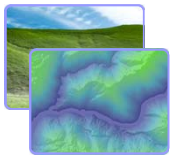
Overview of what GIS means…

Map & Poster Making

Supporting Regional Information Tasks…

Working with Scientists/Lawyers…everyone!

WebGIS Development & Support



Geospatial Data & Database Services

Working with GPS Equip.

Outline

- What is GIS? … And what's its purpose?
- Geospatial Fundamentals
- Geospatial Data
- Geospatial Query & Processing
- Introduction to QGIS (v 1.8)
- Introduction to the Lab

Exercise: Explore GIS data, create new files, perform some simple geoprocessing analyses and create/export a map

GIS

Geographic **I**nformation **S**ystems

- Entry, editing, storage, query and retrieval, transformation, manipulation, analysis, and display of **geospatial data**.
- *Key point*: All data in a GIS is **georeferenced**, i.e. located by means of geographical coordinates with respect to some reference system (usally bound to the Earth)
- The spatial aspects of an environment… (e.g. location, amount, distance, adjacency, isolation, fragmentation, pattern)
  …impact ecological/human/environmental function.

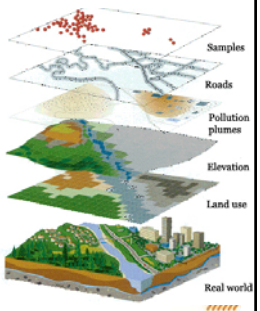
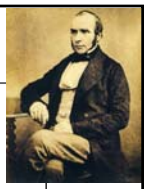


Image credit: ESRI

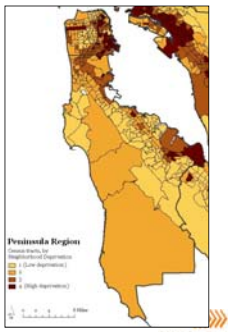
History of GIS

London, mid-1800s



GIS for Public Health

- The first law of geography (Waldo Tobler, UCSB): "Everything is related to everything else, but near things are more related than distant things." [Tobler, 1970, p.236]
- Spatial Autocorrelation
  - Things closer together in space are more alike (correlated) than things further apart.
- Typically Measured with "Moran's I"



Spatial auto-correlation exemplified in neighborhood deprivation

GIS for Suitability Modeling

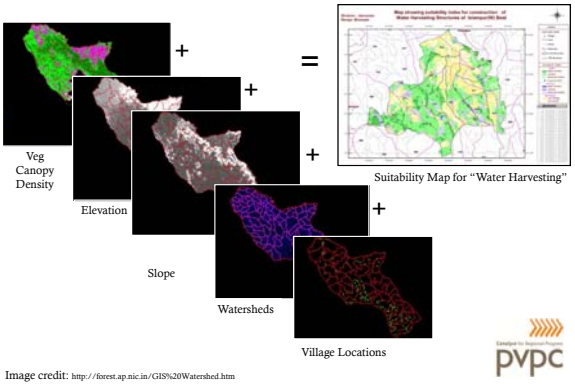


Image credit: http://forest.ap.nic.in/GIS%20Watershed.htm

GIS for Ecological Modeling

- Take your field data, such as:
  - Presence/absence data,
  - Soil moisture data, or
  - Ozone data;
- Interpolate surface for use with modeling;
- Combine with existing data, such as this USGS Landfire Vegetation dataset;

…And model things like habitat, ecosystems, and atmospheric condition.

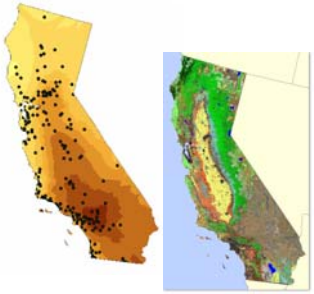


Image credit: ESRI

GIS for Hydrology Analysis

With only an elevation dataset (DEM), you can compute multiple layers, including…

- Slope
- Aspect
- Streams
- Watersheds
- And more!

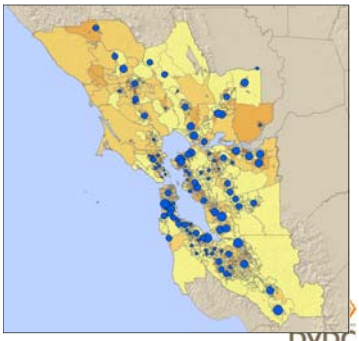
… all of which can be used for input into modeling, regression, spatial statistics and other GIS hydrological analysis.

GIS for Public Policy Analysis

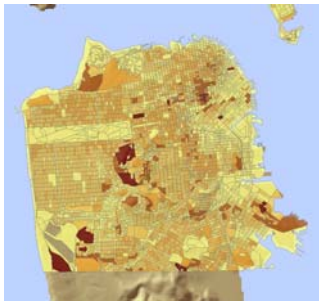
- Number of households in poverty, by census tract.

with

- Average family size



GIS for Public Policy Analysis



- Amount of households owned

…and rented.

- Average household size
- Population in 2000

GIS for Transportation Analysis

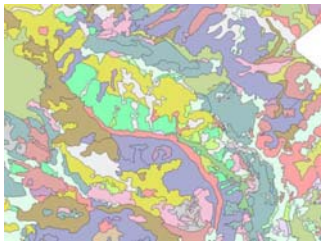
- Using the *Network Analyst* extension, one can measure:
  - Fastest/optimal/efficient route
  - Areas that are *x* distance along roads
  - Distance *x* along roads

Image credit: ESRI

pvpc

GIS for Vegetation Mapping

- Map vegetation patches using manual delineation
  - First delineate around homogeneous patches…
    - …then assign a vegetation type to each polygon.
- You can also do this in an automated way using remote sensing/image analysis!



pvpc

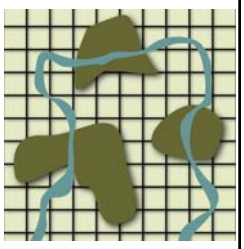
Image credit: CNPS

Geospatial Fundamentals #1: Location

pvpc

Geospatial Fundamentals #2: Size, Shape

- Size
  - Area within a patch
- Shape:
  - Compactness, sinuosity, complexity
- Size and Shape of a patch can influence biotic and abiotic processes



Geospatial Fundamental #3: Context

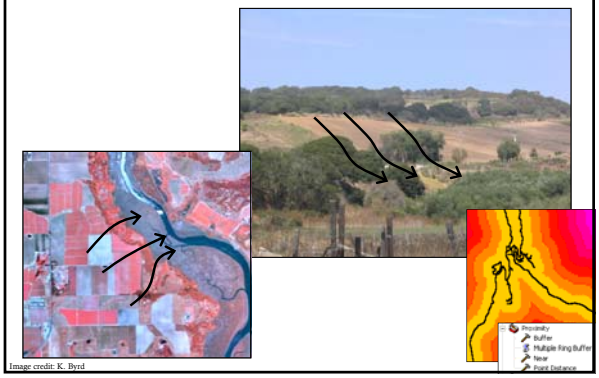
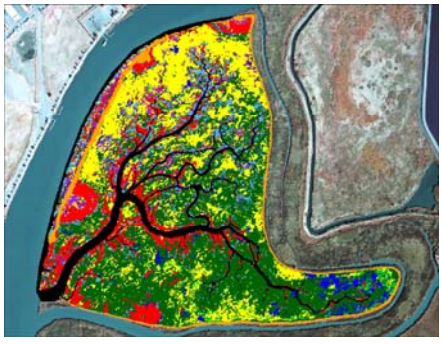


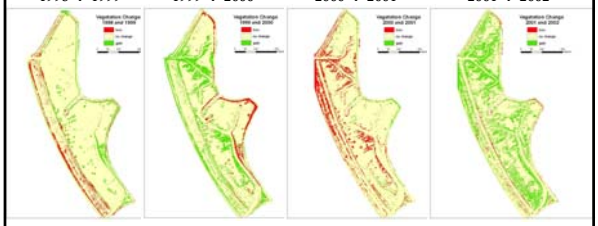
Image credit: K. Byrd

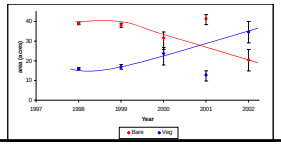
Geospatial Fundamental #4: Pattern



Geospatial Fundamental #5: Change & Spread

1998 → 1999 | 1999 → 2000 | 2000 → 2001 | 2001 → 2002



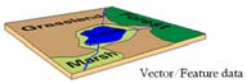


What are we going to do with GIS??

You have at your disposal today:
QGIS (v 1.8)
& data
& me!

We are going to learn together:

- How to map and query data from the Belchertown files
- Determine project needs and data processing steps
- Make a map for distribution!



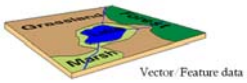
This Afternoon's Outline

- What is GIS? …And what can you do with it?
- Geospatial Fundamentals
- **Geospatial Data**
- Introduction to QGIS
- Introduction to the Lab

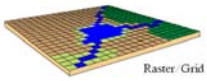
Exercise: Explore GIS data, create new files, do simple geoprocessing analyses, and create/export a map

GIS Data Types

- Vector
  - Shapefile
  - Coverage
- Raster
  - Grid
  - Images



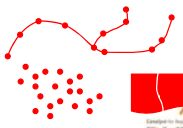
Vector/Feature data


Raster/Grid data

GIS Data > Vector > **Shapefile**

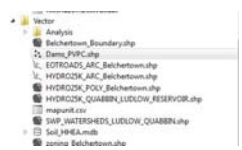
File type extension	*What it is*	*Description*	*Example*
.shp	Main file	Stores each shape with a list of its vertices	counties.shp
.shx	Index file	Each record contains the offset of the corresponding main file record from the beginning of the main file	counties.shx
.dbf	dBASE table	Contains feature attributes 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

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

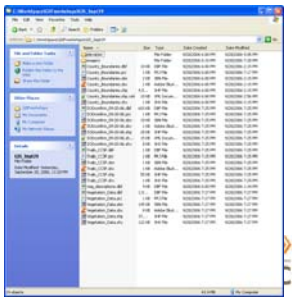


GIS Data > Vector > Shapefile

- How shapefiles look in QGIS Browser

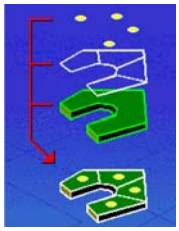


- How shapefiles look in windows explorer



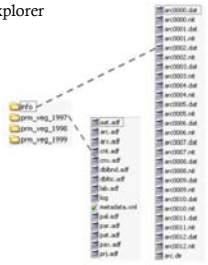
GIS Data
> Vector
> Coverage

- Coverages are vector data that are based GIS topology, which is the spatial relationship between geographic features.
- 1 coverage can be made up of points, *arcs*, and polygons

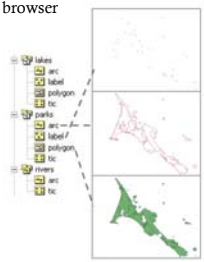


GIS Data
> Vector
> Coverage

- How coverages appear windows explorer

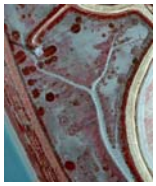


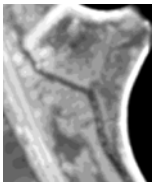
- How coverages appear in QGIS browser

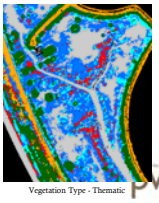


GIS Data
> Raster
> Grid

- Represented in *pixels,* or *cells*
- Continuous
  - Examples
    - Raw imagery
    - Elevation – "Digital Elevation Models"
    - Precipitation
    - Temperature
- Thematic
  - Examples
    - Vegetation type
    - Habitat type
    - Soil map (if represented in raster)


Raw imagery - Continuous


Elevation - Continuous


Vegetation Type - Thematic

GIS Data
> Raster

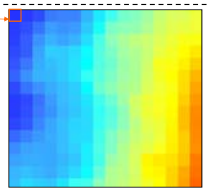
- In its rawest form, a grid is represented in *pixels,* or *cells*

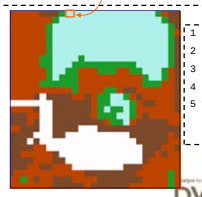
```
ncols 16
nrows 15
xllcorner -156.08749650000
yllcorner 18.870890200000
cellsize 0.3
0 0 1 1 1 2 3 3 5 6 8 9 12 14 18 21 25 30 35
41 47 53 59 66 73 79 86 92 97 102 106 109 112
113 113 113 111 109 106 103 98 94 89 83 78 72
67 61 56 51 46 41 37 32 29 25 22 19 etc...
```

```
ncols 26
nrows 30

xllcorner 564687.9
yllcorner 4191966.8

cellsize 0.2
1 1 1 1 1 2 2 2 4 5 5 5 5 5 5 5
5 5 4 1 2 2 1 1 1 1 1 1 1 1 4 5
5 5 5 5 5 5 etc...
```



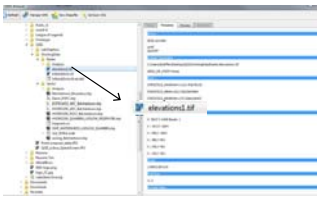


```
1 grass
2 forest
3 rock
4 edge
5 water
```

Continuous **Thematic**

GIS Data
> Raster
> Grid

- How grids appear in QGIS Browser
- How grids appear in your folder

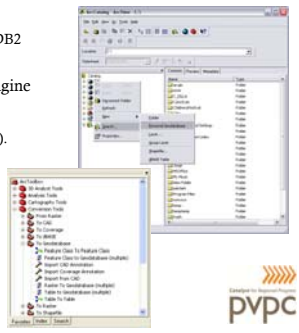


GIS Data
> Raster
> Images

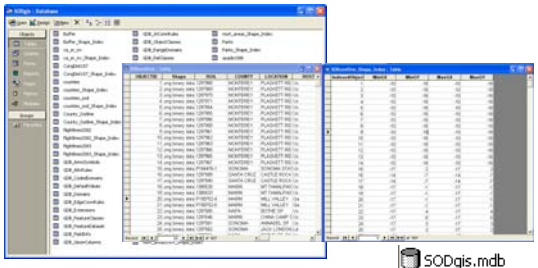
- Examples:
  - Aerial photography, e.g. color-infrared or true-color aerial imagery
  - Satellite imagery, e.g. Landsat, QuickBird, SPOT, MODIS
  - Digital Raster Graphics (DRG) → Digital topo quads
- File types:
  - TIFF or GeoTIFF (.tif)
  - Erdas Imagine image files (.img)
  - JPEG & JPEG 2000(.jpeg & .jp2)
  - MrSID (.sid)

GIS Data
> Geodatabases (can store both types)

- Enterprise geodatabases
  - Requires a 'host' DBMS
    - SQL Server, Oracle, or IBM DB2
- Personal Geodatabases
  - Based on the Microsoft JET engine
    - Appears as an .mdb file (Microsoft's JET engine is also used by Microsoft Access).
- File geodatabases
  - Stored in files, not Access.
  - Improved performance
  - Cross-platform (well, almost..)
  - No 2 GB limit! (1TB)

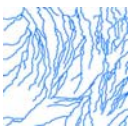


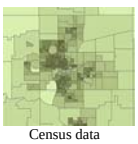
GIS Data
> Geodatabases (can store both types)



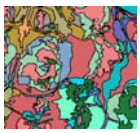
Vector data examples

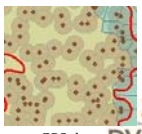

Counties


Rivers

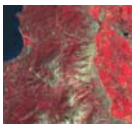

Census data


Habitat boundaries


Soil type


GPS data

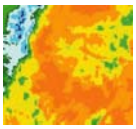
Raster data examples


Satellite imagery


Elevation


Digital USGS topo map

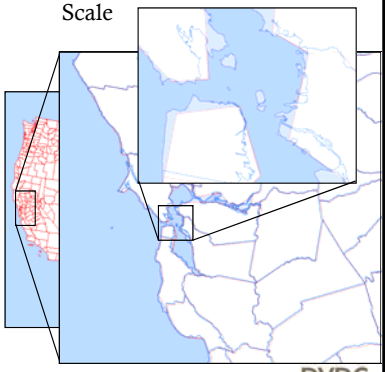

Landcover/landuse


Precipitation


Aerial photography

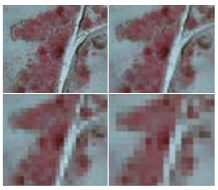
Geospatial Data Considerations: Scale

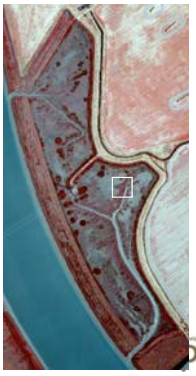
- Zooming in on a small scale map does not increase its level of accuracy or detail.
- Map detail is determined by the data's source scale.



Geospatial Data Considerations: Scale

- Another definition of scale involves raster datasets:
  - Grain/resolution – size of your pixel
  - Extent – size of your study area





Geospatial Data Considerations: Scale

- Pay attention to source scale and grain size of your spatial data:
  - Difficult to compare analysis from maps of different scales
  - Difficult to compare datasets with different grain sizes.
- Pay attention to thematic, or attribute, resolution.
- Rule of thumb: Match the appropriate scale to the level of detail required in the project.
  - Ask yourself, *"Can you resolve what you want to see?"*

LANDCOV, Cal GAP vector, MMU = 100hectares

C-CAP data, NOAA raster, 30m pixel

Multi-source LC Data, CDF, raster, 100m pixel

Free Data/Symbols for MA

- **MassGIS:** http://www.mass.gov/mgis
- **Natural Earth (great for regional-scale QGIS Cartography):** www.naturalearthdata.com
- **GIS @ Tufts:** https://wikis.uit.tufts.edu/confluence/display/GISatTufts/Online+GIS+Data+Sources

Geospatial data portal, with links to political, cultural, and physical data

For the U.S

- Berkeley/Penn Urban & Environmental Modeler's Datakit
  http://www.dcrp.ced.berkeley.edu/research/footprint/

This Afternoon's Outline

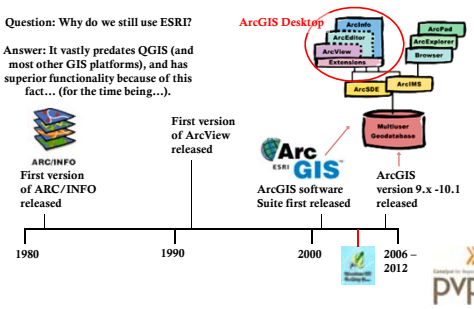
- What is GIS? …And what can you do with it?
- Geospatial Fundamentals
- Geospatial Data
- **Introduction to QGIS**
- Introduction to the Lab

Exercise: Explore GIS data, create new files, do simple geoprocessing analyses, and create/export a map

Introduction to Software

Question: Why do we still use ESRI?

Answer: It vastly predates QGIS (and most other GIS platforms), and has superior functionality because of this fact… (for the time being…).

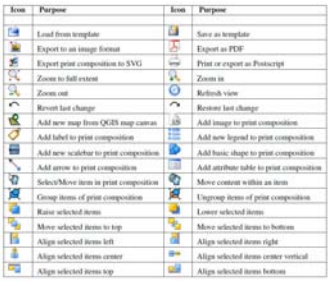


QGIS Extensions/Functions

- Geoprocessing Tools (Clip, buffer, etc.)
- Analysis Tools (Nearest Neighbor)
- Network Tools (i.e. Road Graph, Time-Distance Rate Calculations)
- Terrain Analysis
- Raster & Field Calculator
- Database functions & queries (compatible with open-source db formats, such as MSSQL)
- Plugin's available for MapBook Creation, CAD work…much much more!

QGIS Support Page

- Software documentation
- Patches and updates
- Sample code
- Wiki
- And more!



QGIS:
http://www.qgis.org/

More Training

- VCGI 'FREE' Webinars
  - QGIS: Layer Properties 1/24/13
  - QGIS: Understanding and Using Attribute Data, Queries and Analysis Webinar 1/29/13

  http://www.vcgi.org/commres/?page=./events/default_content.cfm
- Book tutorials
  - ESRI books (useful for GIS basics, and understanding geoprocessing)
  - Other, online QGIS Tutorials
- Software tutorials

Available GIS Tools/Software

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