

CIE5401

GIS and Remote Sensing

Susan Steele-Dunne
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CIE5401

GIS and Remote Sensing in

Water Resources Management

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s.c.steele-dunne@tudelft.nl

Course Introduction: Schedule

Lecture Date	Lecture topic	Assignment Due Date
12 February	Introduction to GIS	19 February
19 February	Spatial Analysis in GIS	26 February
26 February	Watershed delineation	5 March
5 March	Visible RS	12 March
12 March	Thermal IR	19 March
19 March	Microwave remote sensing	26 March

Course Introduction: Brightspace

- Lecture notes
- Collegerama
- Assignment instructions and submission
- Grades
- Announcements
- Discussion Board (New thread for each module)

Course Introduction: Assignments

Submit assignments via **Brightspace**.

Turn in a report as a single .pdf file

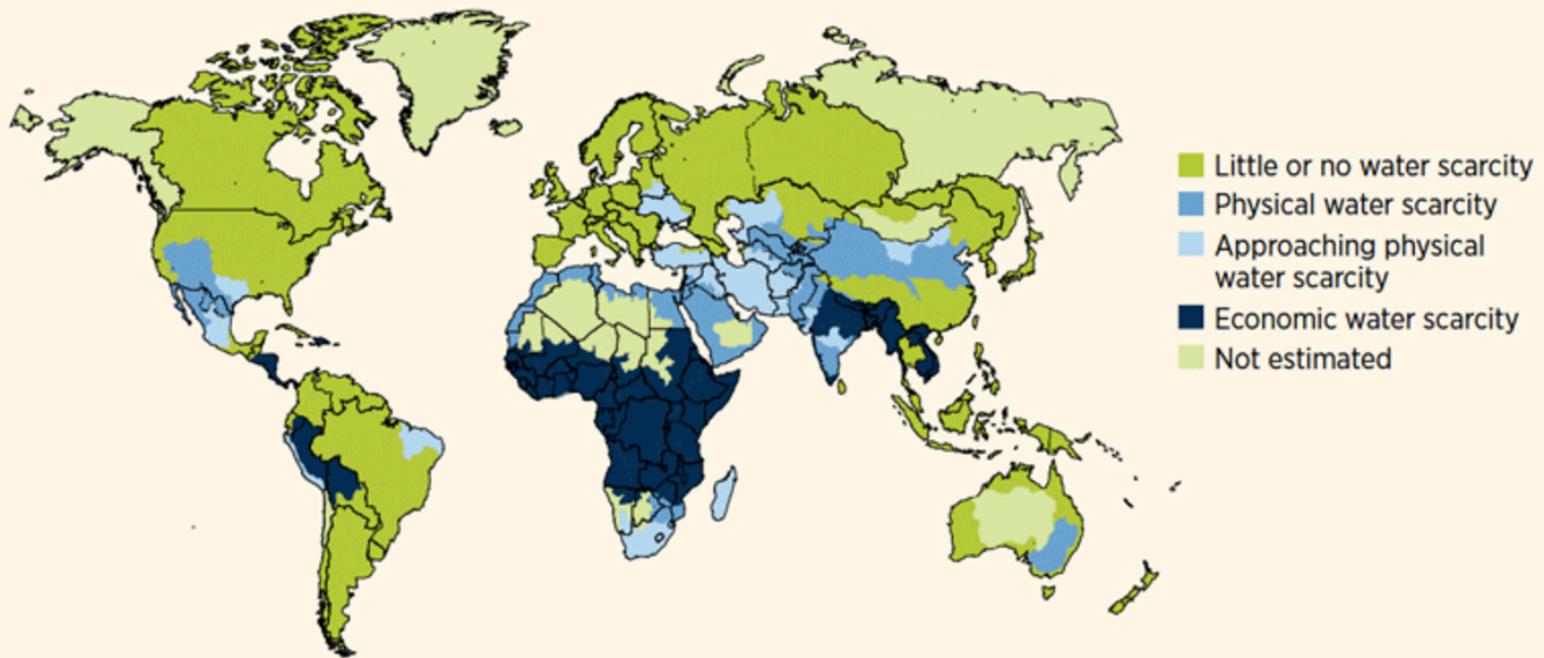
Filename:

Assignment1_YourName_StudentNumber.pdf
(e.g. Assignment1_Steele-Dunne_123456.pdf)

Assignment is due at **8am** on the due date.
10% **per day** penalty for late assignments.

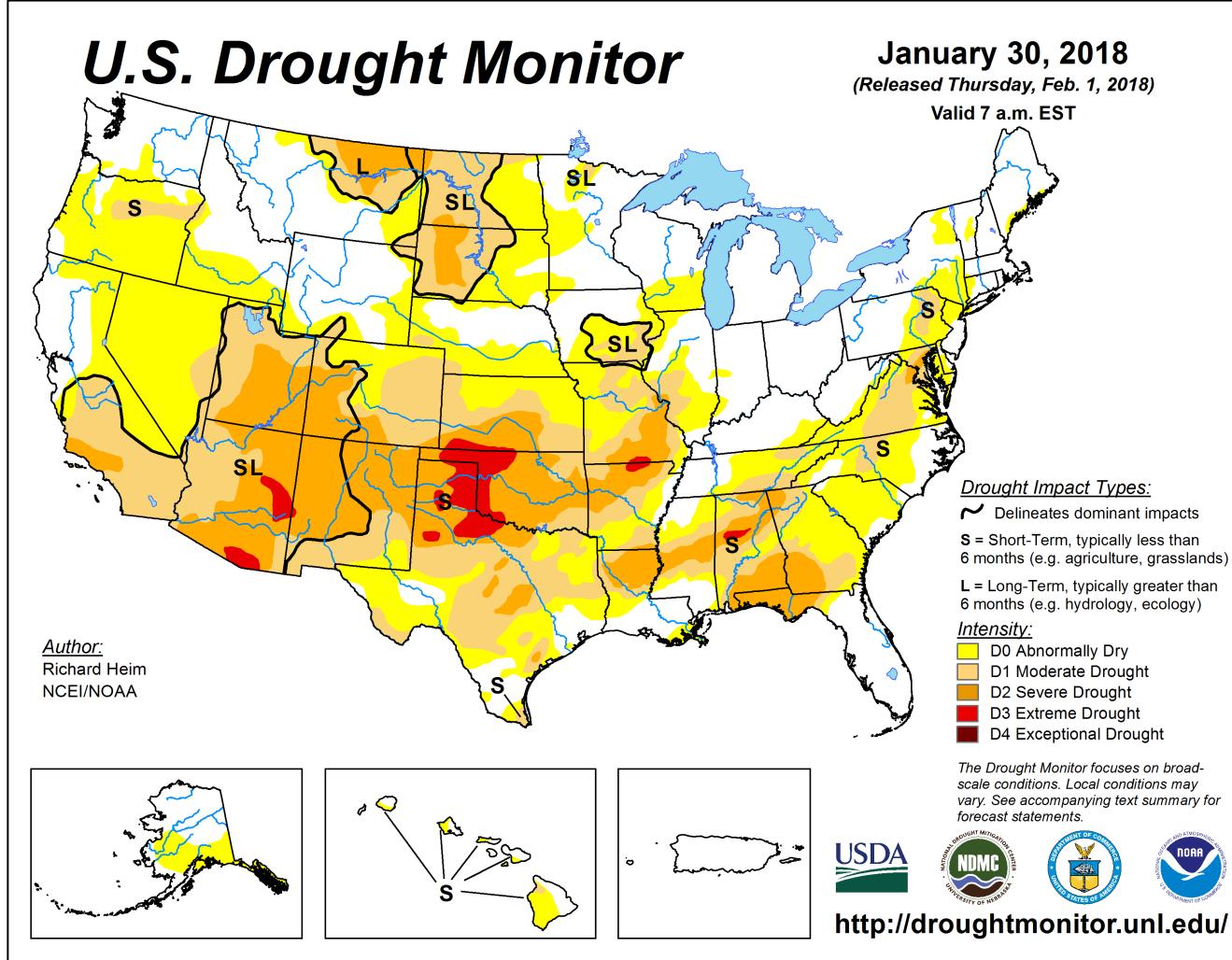
Course Introduction: Spatial Data

Global physical and economic water scarcity



Source: [World Water Development Report 4](#). World Water Assessment Programme (WWAP),
March 2012.

Course Introduction: Spatial Data



The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC-UNL.

Course Introduction: Spatial Data

1953-2013 North Sea Flood in 3D in Science Centre Delft

28 January 2013 by Webredactie M&C



On Wednesday, 30 January 2013 TU Delft will present a new exhibit in Science Centre Delft in which visitors can virtually fly over the area affected in 1953 and can zoom in and out to see how the disaster unfolded.

3D landscape

On 1 February 2013 it will be 60 years ago that the dykes broke in more than 400 places in the provinces of Zeeland and South Holland. What did the disaster look like? It is now possible to show this in detail by combining a virtual 3D landscape of the Netherlands with flood models.

Among other things, the methods developed by the 3Di consortium offer administrators insight into the capricious and often unexpected course of floods and therefore act as cautionary tales on how to deal with these types of disaster. Are evacuation plans realistic; how self-reliant should people be in such situations?



3Di Waterbeheer

sneller, nauwkeuriger, visueel

Nieuwsbrief ↓

Home Instrumentarium Case Studies Academy Videos Publicaties Contact

Case Studies

In de 3Di case studies wordt de werking en functionaliteit van de ontwikkelde ict producten getest. Naast de cases voor de lauching customers worden aanvullende cases uitgevoerd voor supporting customers. Hierin kan de eindgebruiker vroeg/lijd kennismaken met het instrumentarium.

Visualisatie overstroming Alkmaar

Deze film toont het verloop van een gesimuleerde overstroming in Alkmaar. De gesimuleerde waterstanden zijn geprojecteerd in een point cloud afgeleid van de hoogtegegevens van de AHN2. De punten in de wolk zijn ingekleurd op basis van informatie uit luchtfoto's. Deze recentter ontwikkelde techniek maakt het veel nog realistischer. De gebruiker kan tijdens het afspeen van de simulatie, de kijkerspositie instellen. Zo kan als het ware boven het gebied worden gevlogen.



Calamiteitenoefening Delft

De case Calamiteitenoefening Delft was een eerste verkenning van de noodzaak van snel beschikbare rekenresultaten tijdens calamiteiten. Op 4 november 2010 werd het calamiteitenteam geconfronteerd met een glijfzing tijdens een hoogwaterstadium in de boezem van Delfland. Het dilemma waar zij zich over moesten buigen was dat in verband met het hoogwater de binnenstad moet worden afgekoppeld van de rest van de boezem, tenzij voor het wegspuiten van de glijfzing aan de boezem juist moet worden behouden.

Tijdens de oefening bleek de besluitvorming te leiden onder de lange reken-tijden van het gebruikte stromingsmodel en het beperkte aantal vooraf geprogrammeerde situaties. De wens was meerdere scenario's te kunnen doorrekenen en presenteren aan bestuurders binnen tijdsbestek van ongeveer een half uur. Een berekening mag dan niet langer dan enkele minuten duren. De oefening leverde veel input voor het programma de eisen voor het instrumentarium.

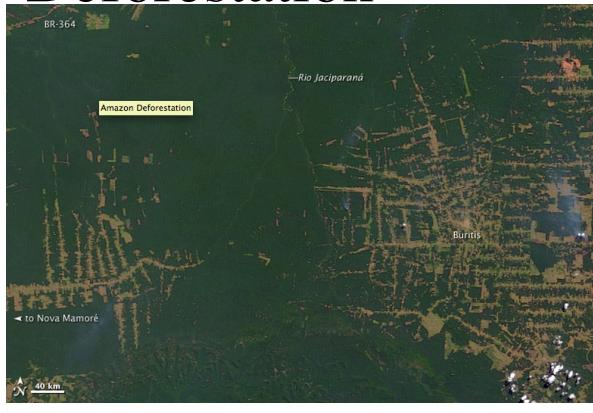


Course Introduction: Spatial Data

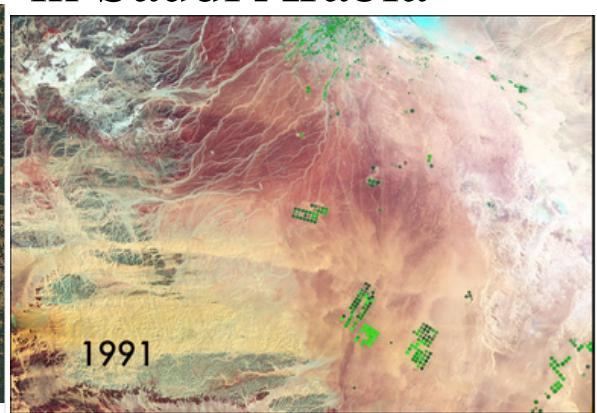
Urbanization in
Dubai



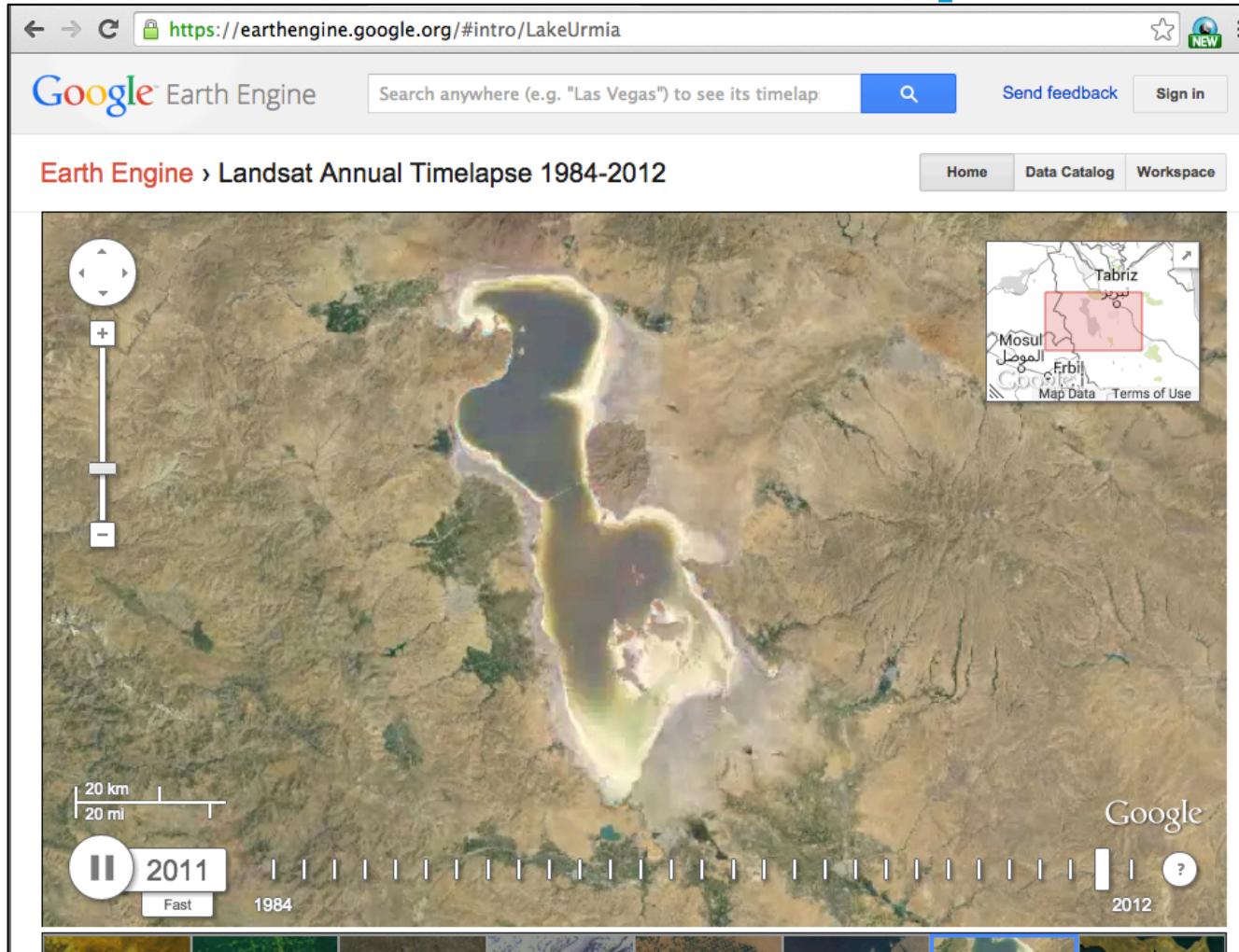
Amazon
Deforestation



Irrigated Agriculture
in Saudi Arabia



Course Introduction: Spatial Data



Google
Earth
Engine

GIS

Data archive
(Landsat,
MODIS,
Sentinel)

Course Introduction: Spatial Data



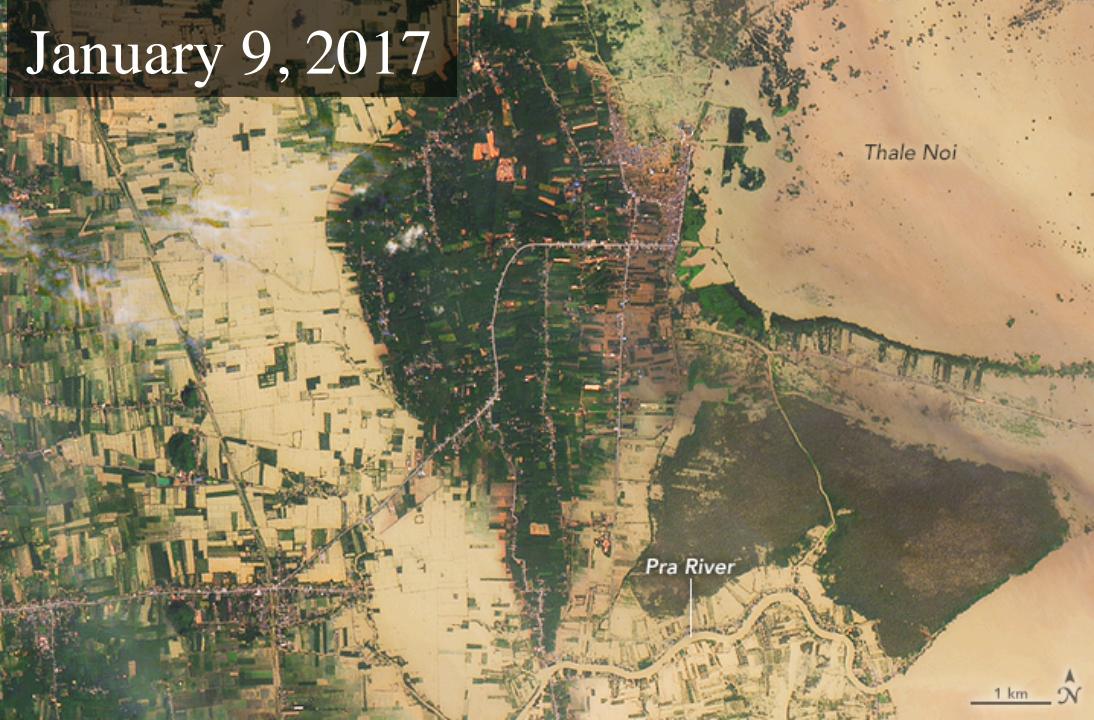
Wet Season transforms the Zambezi River

High water levels
(March 31, 2013).



Dry season
(August 25, 2012).

January 9, 2017



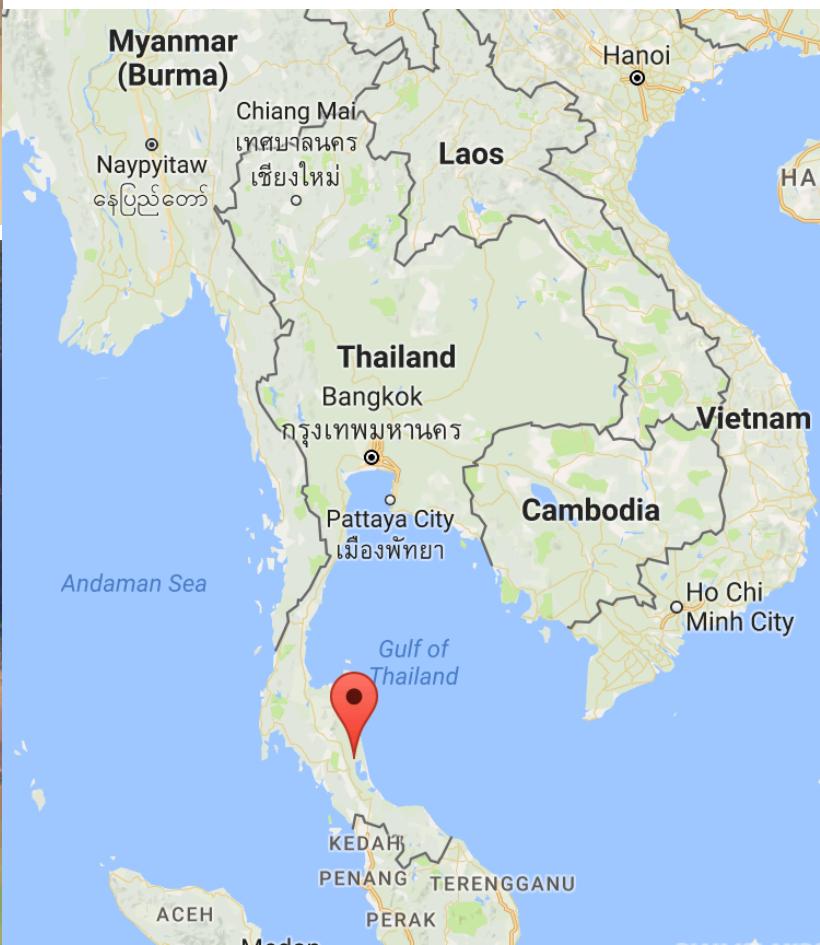
February 2, 2014

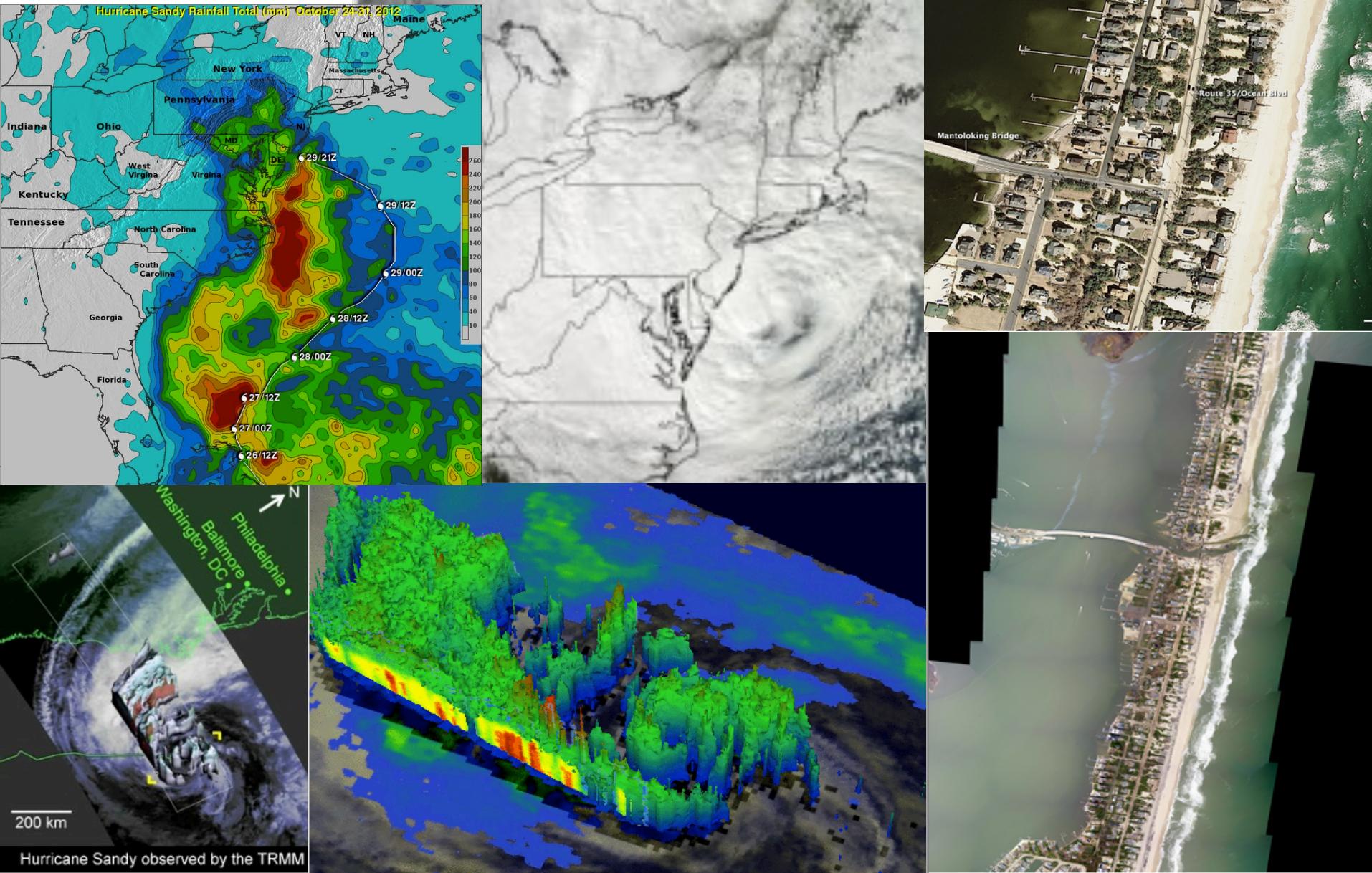


EARTH OBSERVATORY
Where every day is Earth Day

Floods Swamp Southern Thailand

January 13, 2017

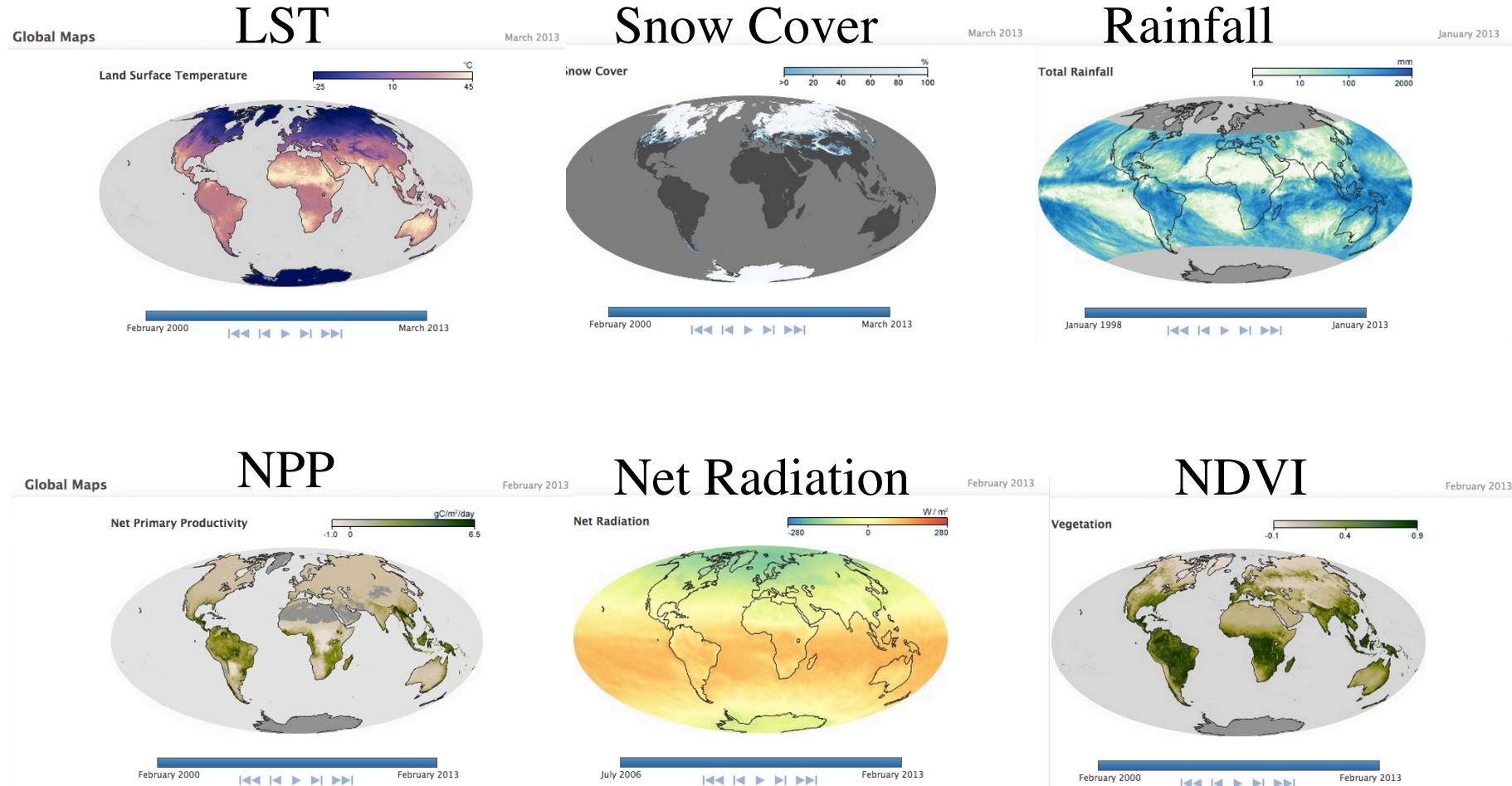




13

http://www.nasa.gov/mission_pages/hurricanes/archives/2012/h2012_Sandy.html

Course Introduction: Spatial Data



Course Introduction: Learning objectives

By the end of this course, you will be able to:

- 1) Explain what a GIS is, and to describe its key features
- 2) Use GIS to map and analyze data
- 3) Use GIS spatial analysis to work on real WRM problems

- 4) Understand important terminology in remote sensing
- 5) Explain the advantages and disadvantages of measurements in different parts of the EM spectrum
- 6) Use real remote sensing data to study problems in WRM

CT5401 – Lecture 1

Introduction to GIS

- What is GIS?
- Data models to represent our world
- Functions of a GIS
- Real applications of GIS in Hydrology and Water Resources Management
- Introduction to Assignment 1

CT5401 – Lecture 1

Introduction to GIS

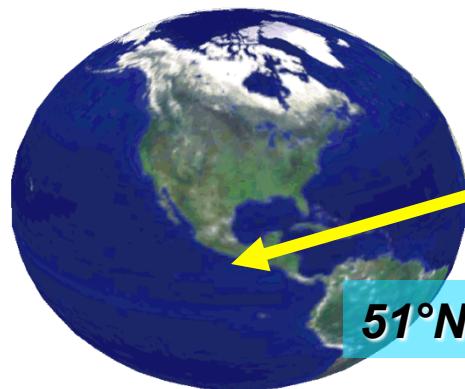
- **What is GIS?**
- Data models to represent our world
- Functions of a GIS
- Real applications of GIS in Hydrology and Water Resources Management
- Introduction to Assignment 1

What is a GIS?

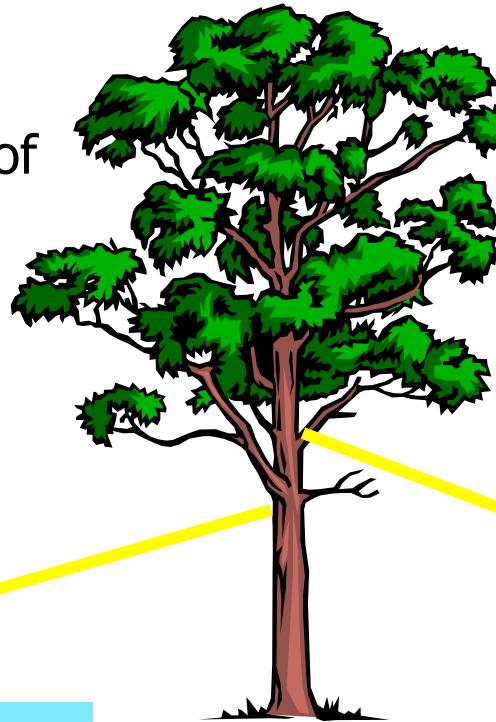
GIS is all about geographical data

We can describe any element of our world in **two** ways:

Location Information:
Where is it?



51°N, 112°W



Attribute Information:
What is it?

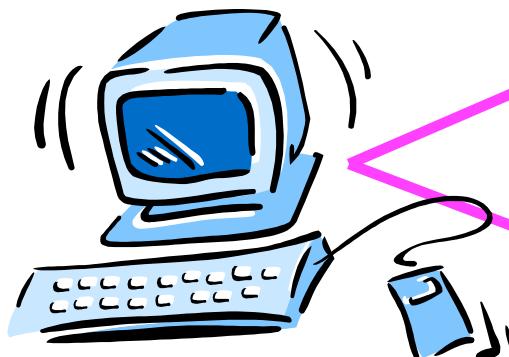
Species: Oak
Height: 15m
Age: 75 Yrs
Condition:
Good



What is a GIS

GIS links datasets

GIS software links the location data and the attribute data:



The screenshot shows the Quantum GIS (QGIS) application interface. At the top, there's a toolbar with various icons. Below it is a 'Layers' panel containing several layers: 'trees_incl_sqmi', 'alaska_mil_airports' (which is checked), 'majrivers', 'landcover', and 'alaska'. On the right side of the interface is a map of Alaska, with a pink arrow pointing from the computer illustration towards the map. Below the map is a status bar showing coordinates (-7010695, 6509312), scale (1:9856593), and a render EPSG:2964 checkbox. The main area of the window displays an 'Attribute table – alaska_mil_airports :: 1 / 11 feature(s) selected'. This table has columns: cat, NA3, ELEV, F_CODE, IKO, NAME, and USE. The table lists 11 rows of data, with row 4 highlighted in blue. The data is as follows:

	cat	NA3	ELEV	F_CODE	IKO	NAME	USE
0	13	US75867	138	Airport/Air...	PAGA	EDWARD G ...	Joint Militar...
1	16	US00211	1461	Airport/Air...	PA	KALAKAKET...	Military
2	35	US99779	408	Airport/Air...	PAFB	WAINWRIGHT...	Military
3	37	US49463	501	Airport/Air...	PAEI	EIELSON AFB	Military
4	40	US11435	1167	Airport/Air...	PABI	ALLEN AAF	Military
5	46	US00341	345	Airport/Air...	PAFR	BRYANT AHP	Military
6	47	US58704	192	Airport/Air...	PAED	ELMENDOR...	Military
7	55	US00488	606	Airport/Air...	PA	BIG MOUNT...	Military
8	57	US81498	51	Airport/Air...	PAKN	KING SALM...	Joint Militar...
9	59	US22587	66	Airport/Air...	PADQ	KODIAK	Joint Militar...
10	65	US00578	66	Airport/Air...	PA	NIKOLSKI AS	Military

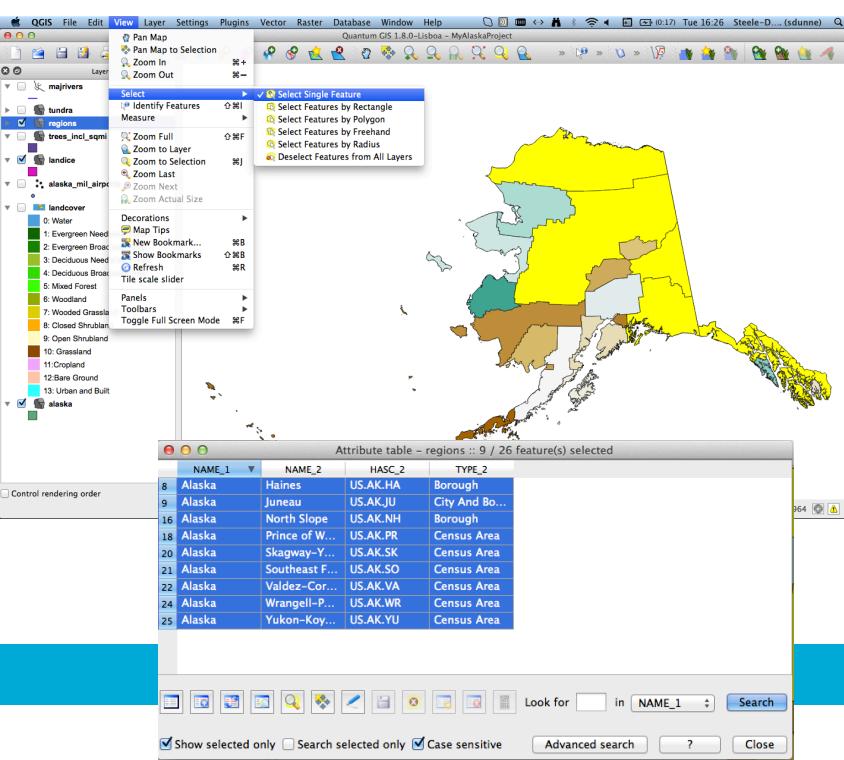
At the bottom of the attribute table window, there are search and filter options, including a search bar, a 'Search' button, and checkboxes for 'Show selected only', 'Search selected only', and 'Case sensitive'.

What is a GIS?

GIS software can answer questions about our world:

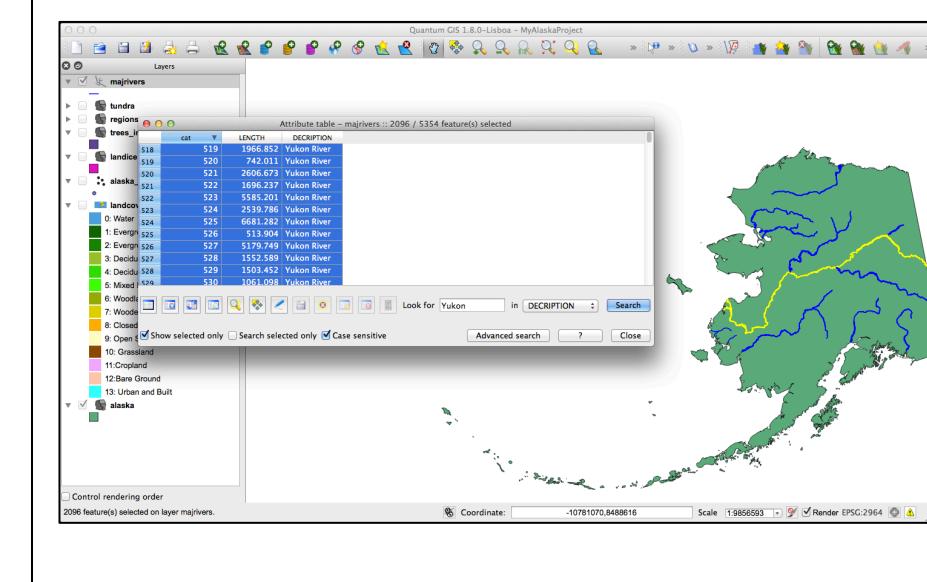
Spatial Questions:

Which regions share a border with Canada?



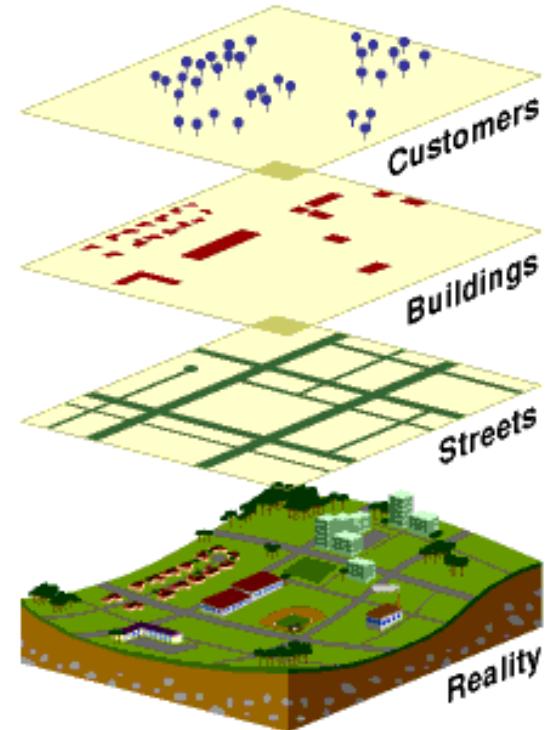
Attribute Questions:

Where is the Yukon River?



What is a GIS?

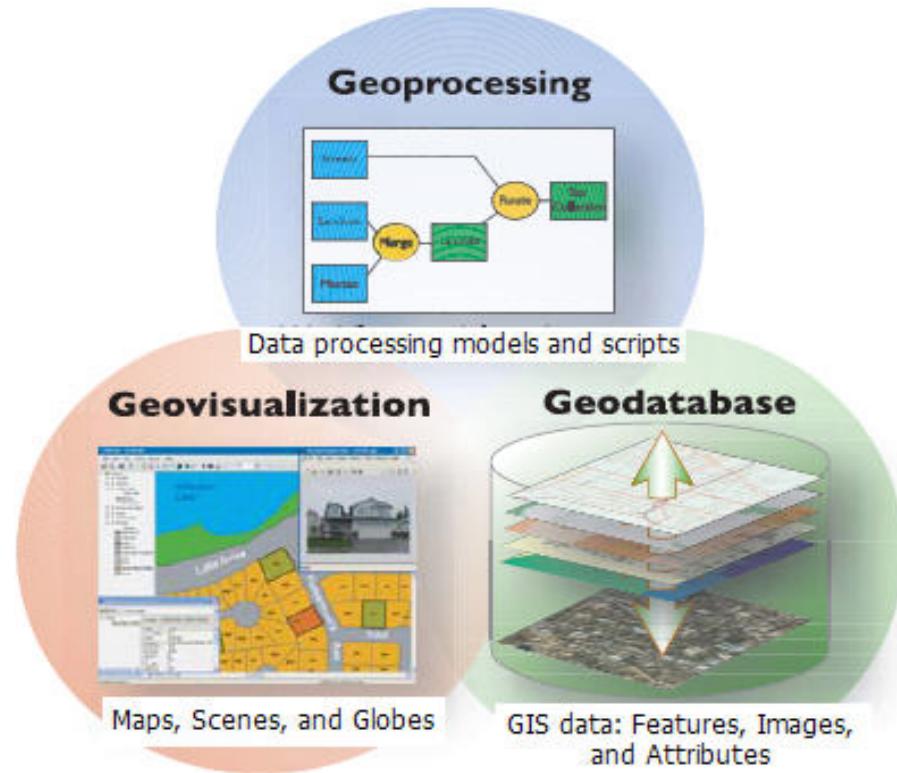
- In a GIS, different types of information are represented as separate map layers
- Each layer is linked to descriptive information
- Layers are combined to make a map



Geographical Information Systems

Key functions of a GIS:

- Data management
- Mapping and Visualization
- Geoprocessing



GIS: Working with individual data elements

The image shows a GIS application interface with two attribute tables and a map.

Map View: A map of a region showing land cover and major rivers. A yellow polygon highlights a specific area on the map, which corresponds to the selected feature in the attribute table on the left.

Attribute Table 1 (tundra): Shows data for tundra features.

cat	F_CODEDESC	F_CODE	AREA_KM2	
163	208	Tundra	BJ110	121.615
164	211	Tundra	BJ110	349.375
165	212	Tundra	BJ110	2187.445
166	213	Tundra	BJ110	525.593
167	124	Tundra	BJ110	25130.627
168	125	Tundra	BJ110	213375.175
169	126	Tundra	BJ110	273.369
170	127	Tundra	BJ110	29333.047
171	128	Tundra	BJ110	421.842
172	129	Tundra	BJ110	24998.047
173	130	Tundra	BJ110	2165.804
174	131	Tundra	BJ110	30788.766

Attribute Table 2 (majrivers): Shows data for major rivers.

cat	LENGTH	DESCRIPTION	
3766	3767	9120.086	Colville River
3767	3768	3082.968	Colville River
3768	3769	1385.638	Colville River
3769	3770	10253.359	Colville River
3770	3771	500.131	Colville River
3771	3772	989.401	Colville River
3772	3773	2200.673	Colville River
3773	3774	1302.916	Colville River
3774	3775	8331.03	Colville River
3775	3776	3149.144	Colville River
3776	3777	12988.205	Colville River
3777	3778	466.039	Colville River

Select one object: An arrow points from the text "Select one object" to the highlighted yellow area on the map.

Select by rectangle: A rectangle is drawn on the map, highlighting a specific segment of a river. This corresponds to the selected feature in the attribute table on the right.

GIS: Working with GIS datasets

The screenshot shows the ArcMap interface with a map of the Horn of Africa. The legend on the left lists various datasets including Cities, Country Bnd - Middle East, Country, Rivers, Roads, Lakes, Ocean, Shorname, and a DEM layer. A process flow diagram is overlaid on the map, showing the following steps:

```
graph LR; Landuse([Land use]) --> SelectAgriculture[Select: Agriculture from land uses]; Landuse --> ClipGeology[Clip: Geology to study area watershed]; Landuse --> StudyArea([Study Area)]; Landuse --> Geology([Geology)]; SelectAgriculture --> PotentialPesticide[Potential Pesticide use in study area]; ClipGeology --> MakeFeatureLayer[Make Feature Layer: Permeable soil types]; StudyArea --> ClipGeology; Geology --> ClipGeology; PotentialPesticide --> SelectByLocation[Select By Location: Pesticides on permeable soils]; MakeFeatureLayer --> PermeableSoils([Permeable soils]); PermeableSoils --> SelectByLocation; SelectByLocation --> PotentialPesticideOnSoils[Potential pesticide use on permeable soils]
```

A table at the bottom right lists the datasets in the project:

Dataset	Type	Last Modified
Cities	Feature Class	Thu 9/23/2004 3:54 PM
CitiesAnno	Feature Class	Thu 9/23/2004 11:06 AM
Roads	Feature Class	Mon 10/4/2004 10:55 AM
RoadsAnno	Feature Class	Thu 9/30/2004 8:58 AM
ParkBoundaries	Feature Class	Tue 9/28/2004 8:56 AM
States	Feature Class	Thu 9/23/2004 3:54 PM
Streams	Feature Class	Thu 9/23/2004 11:06 AM
UtahRelief	Raster Dataset	Mon 10/4/2004 10:55 AM
150mNaturalColor	Raster Dataset	Thu 9/30/2004 8:58 AM

Secure <https://www.arcgis.com/features/index.html>

ArcGIS Features Plans Gallery Map Scene Help Search Sign In esri

Mapping Without Limits

ArcGIS Online is a Complete, Cloud-Based Mapping Platform

[Try ArcGIS](#) [What Is ArcGIS?](#)

Google Earth Engine

A planetary-scale platform for Earth science data & analysis

Powered by Google's cloud infrastructure

▶ WATCH VIDEO

The screenshot shows a satellite map of a coastal region, likely the Mississippi River delta in the Gulf of Mexico. The map is overlaid with various data layers, including a network of rivers and streams in blue and green, and a large area of brownish land. A white rectangular button with a play icon and the text "WATCH VIDEO" is positioned in the lower-left quadrant of the map. Above the map, there is promotional text: "A planetary-scale platform for Earth science data & analysis" and "Powered by Google's cloud infrastructure". The top of the image shows a browser header with a secure connection indicator, the URL "https://earthengine.google.com", and several browser icons.

26



Secure | <https://qgis.org/en/site/>

2.18.16 (new LTR)
2.14.22 (previous LTR)

DISCOVER QGIS

FOR USERS

GET INVOLVED

DOCUMENTATION

Search

Time until pa
Time until ne

QGIS

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For your desktop, server, in your web browser and as developer libraries

[Download Now](#)

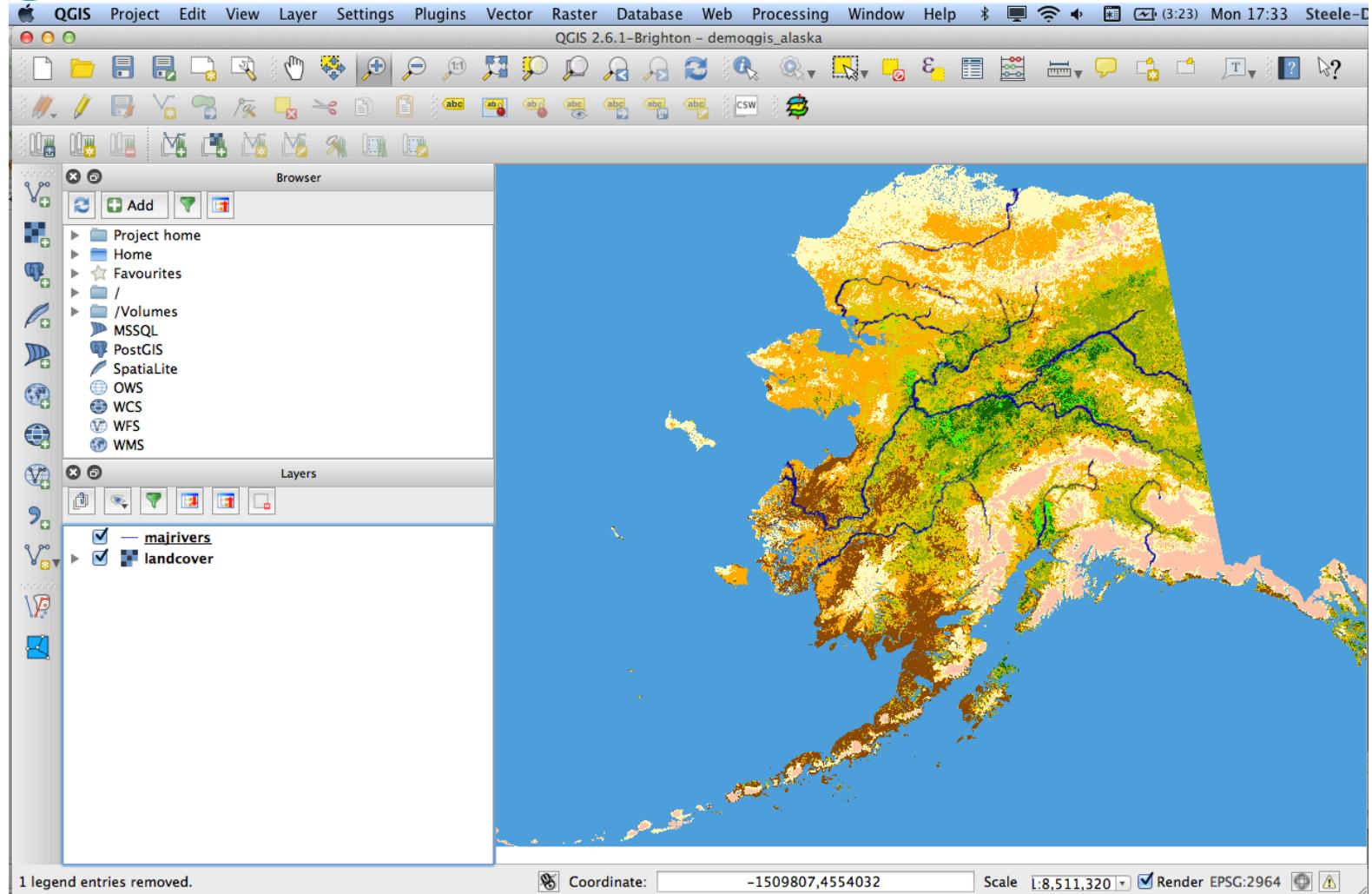
[Support QGIS](#)

<https://qgis.org/en/site/#myCarousel>

27

<http://qgis.org/>

QGIS



Why QGIS?

- It's **free** (really) and open source
- It's cross-platform (i.e. it runs on Linux, Unix, Windows, Mac OS, Android(!))
- It makes use of plug-ins to extend capabilities & to handle lots of data formats.
- It can provide a front-end to GRASS
- It's fast
- It's **free**

GRASS GIS

Secure | <https://grass.osgeo.org>



GRASS GIS

Bringing advanced geospatial technologies to the world.



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Latest News

Page 1 of 32 > >>

Feb 1, 2018
GRASS GIS 7.4.0 released
We are pleased to announce the **GRASS GIS 7.4.0 release**
[More]

Jan 17, 2018
GRASS GIS as described by a Google Code-In student
The Google Code-In contest is almost over. Today, January 17th, was the last day in which students could submit their work for revision. Last night we got one of the last tasks submissions for GRASS GIS within the contest. We had asked the students to write a short blog entry about GRASS GIS. Surprisingly, we got a bit more than that! Check this very nice text by Taylor Fang. Thanks tfang! And welcome!
[More]

Next event

FOSDEM, 3-4 February 2018. Brussels.



Home

Celebrating 33 years!

GRASS GIS, commonly referred to as GRASS (Geographic Resources Analysis Support System), is a **free** and open source [Geographic Information System](#) (GIS) software suite used for geospatial data management and analysis, image processing, graphics and maps production, spatial modeling, and visualization. GRASS GIS is currently used in academic and commercial settings around the world, as well as by many governmental agencies and environmental consulting companies. It is a founding member of the [Open Source Geospatial Foundation](#) (OSGeo).

Latest stable long term support (LTS) release: [GRASS GIS 7.4](#)

 Mac OS X  Windows  Linux

[... and Addons](#) | [Source Code](#)

Newcomers: How to start with GRASS GIS?

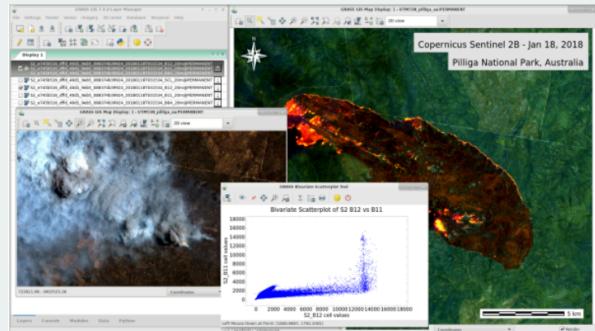
- About GRASS GIS
- Read the [First Day Documentation](#)
- Go through [Tutorial and Courses](#) in various languages
- Learn more with the [GRASS GIS migration hints](#)

Code quality check: build passing

Module of the Day

`g.access` Controls access to the current mapset for other users on the system.

Screenshots (click for more)

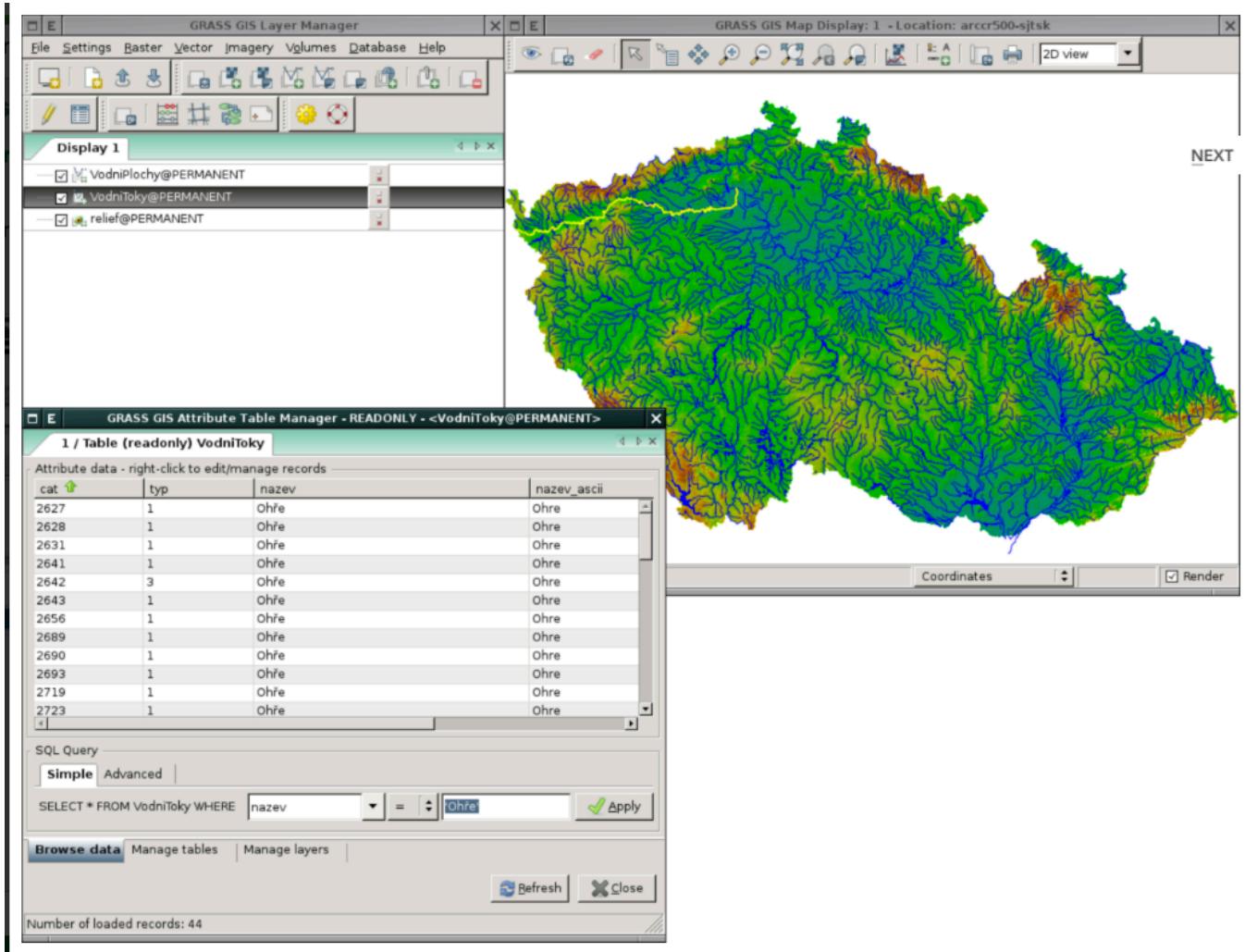


You are at the official GRASS GIS site (United States) - [mirror sites](#)

30

<http://grass.osgeo.org/>

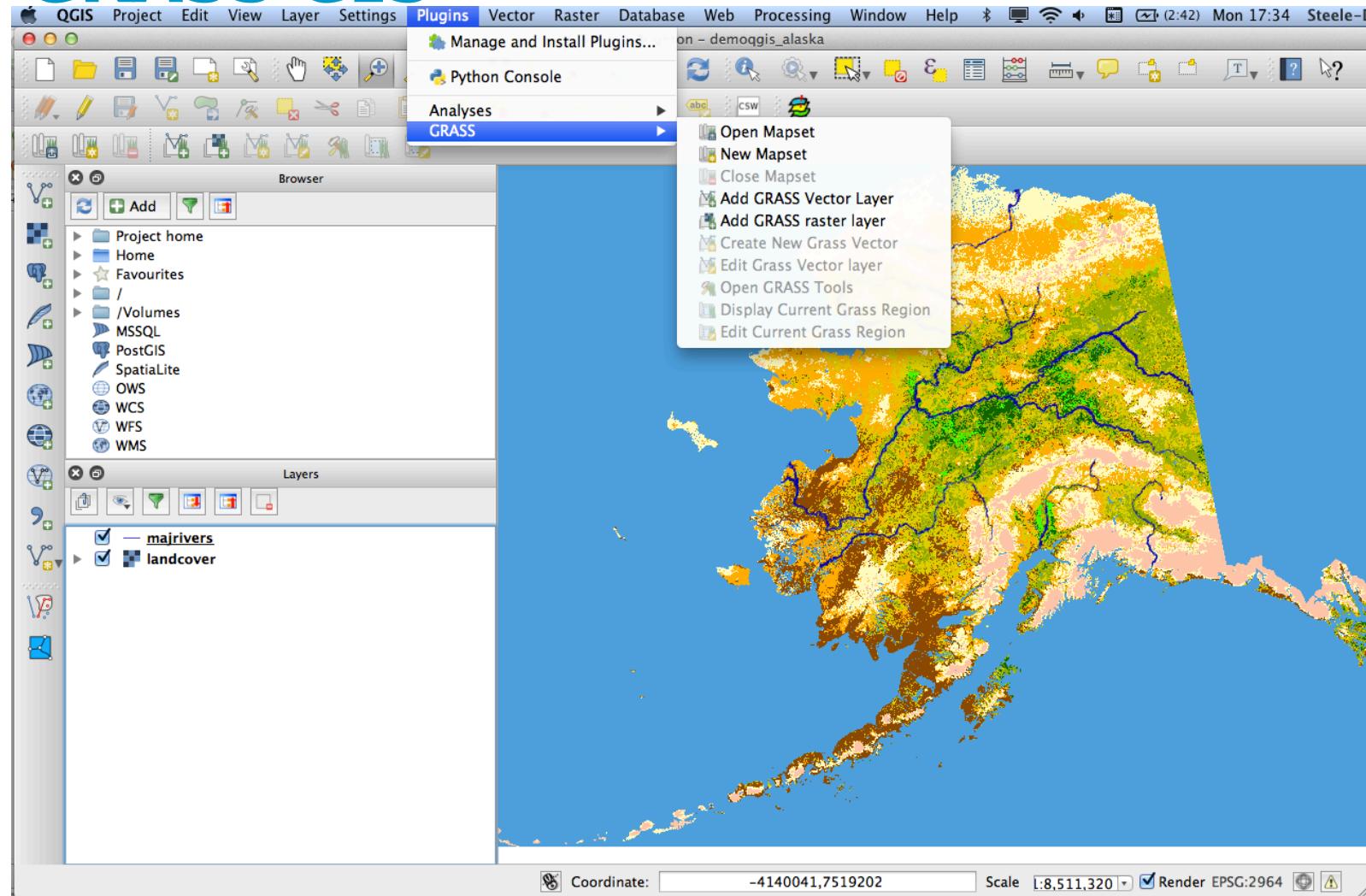
GRASS GIS



31

<https://grass.osgeo.org/screenshots/user-interface/>

GRASS GIS



Why QGIS?

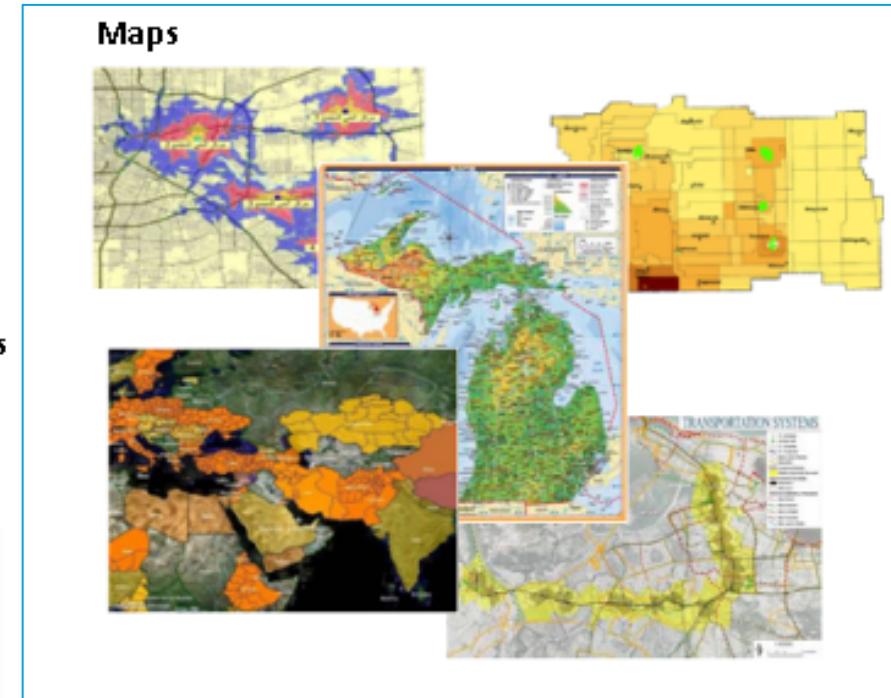
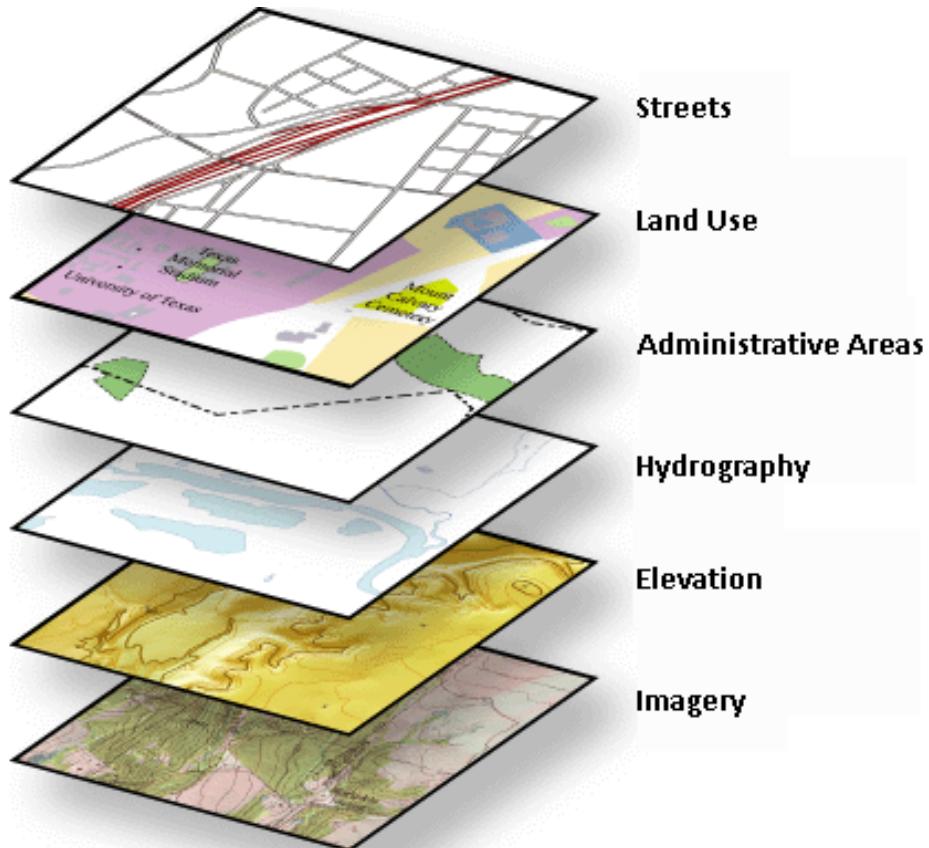
CT5401 – Lecture 1

Introduction to GIS

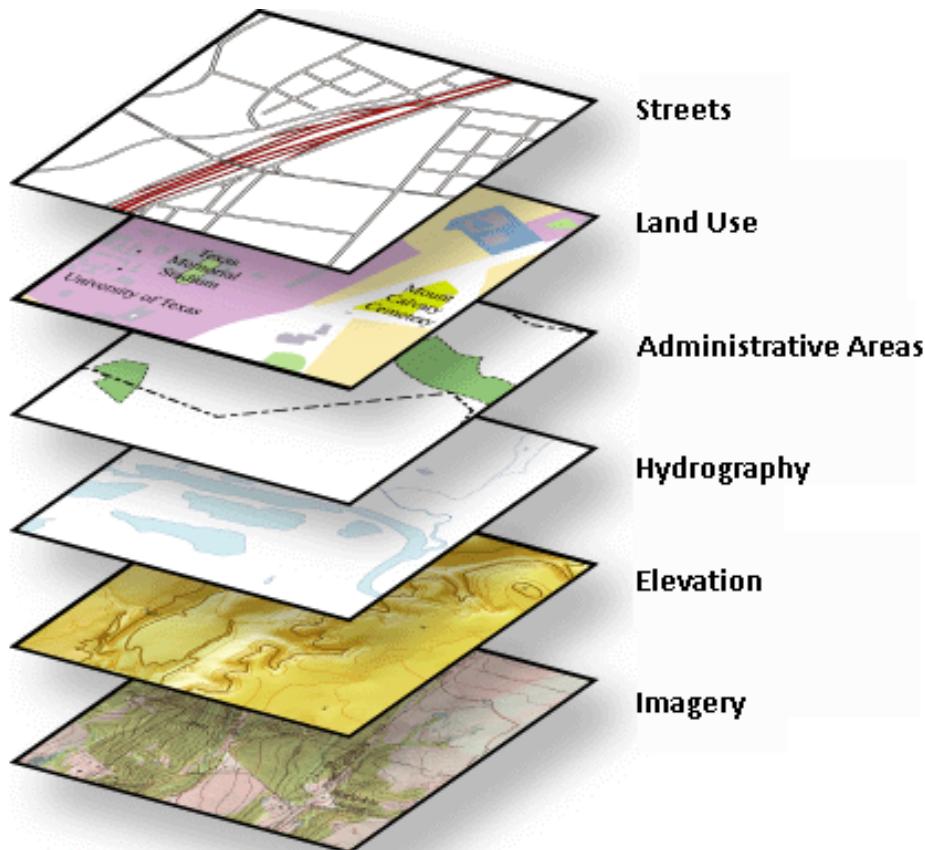
- What is GIS?
- **Data models to represent our world**
- Functions of a GIS
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- Introduction to Assignment 1

Data models

A map is made up of layers

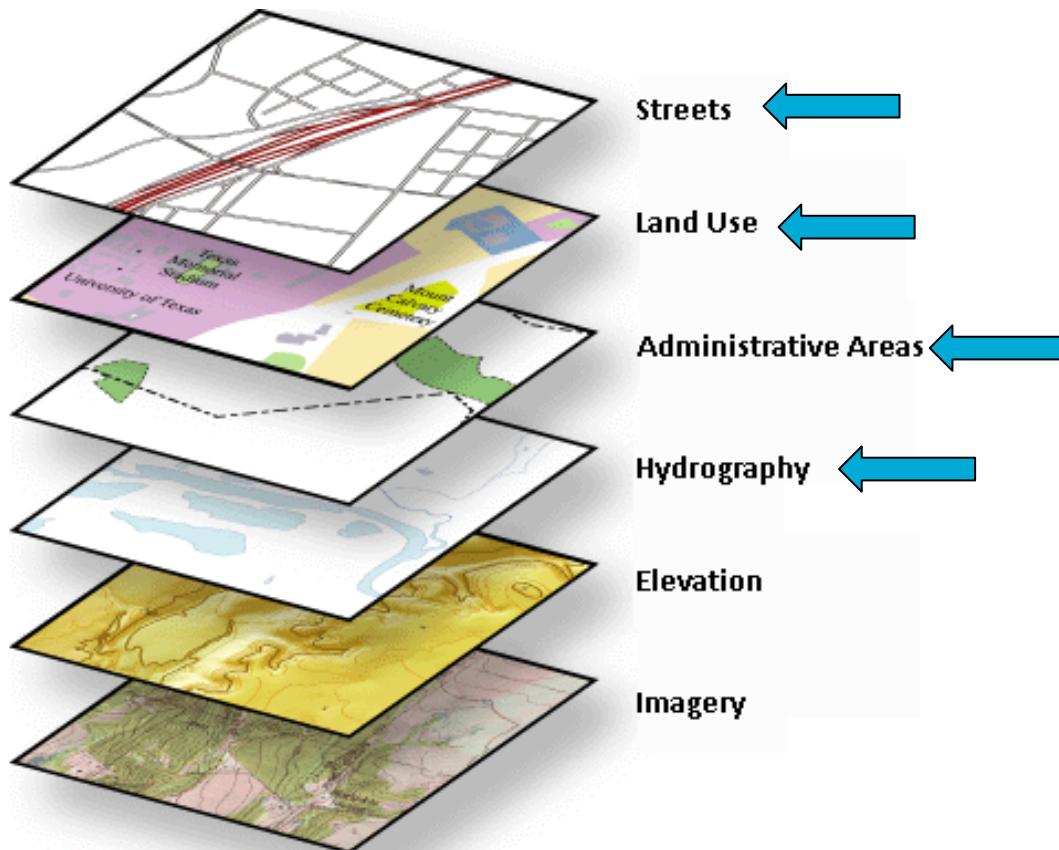


Data models: GIS data structures



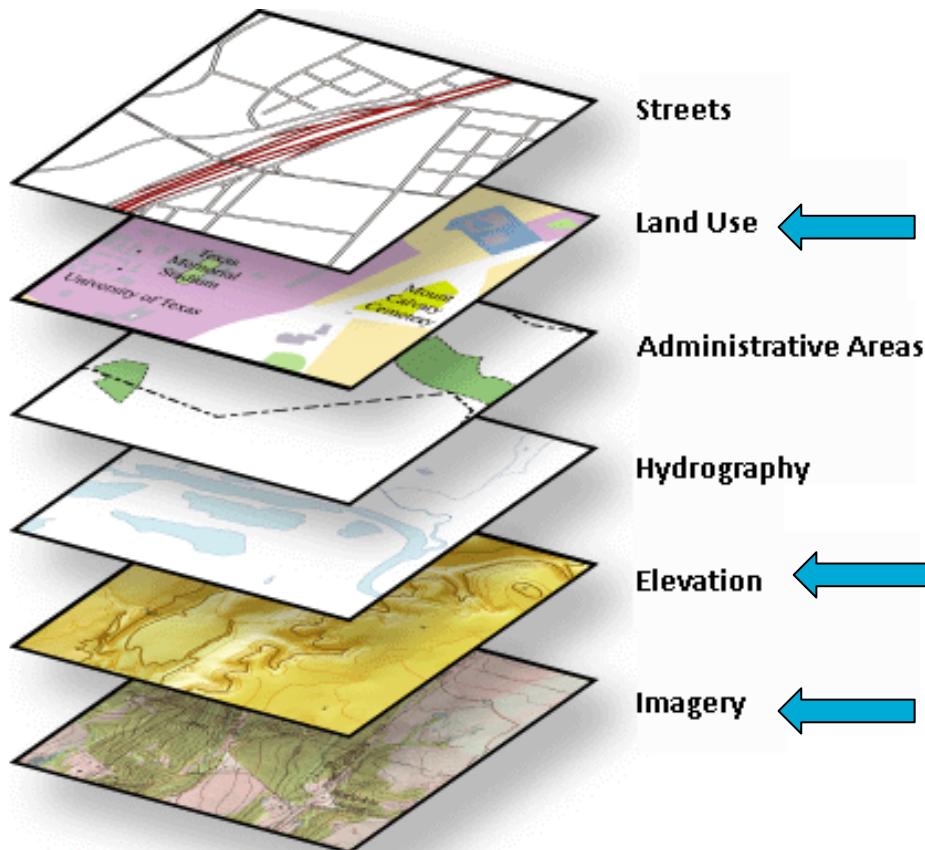
- Feature classes
- Raster datasets
- Attributes and descriptive information

Data models: GIS data structures



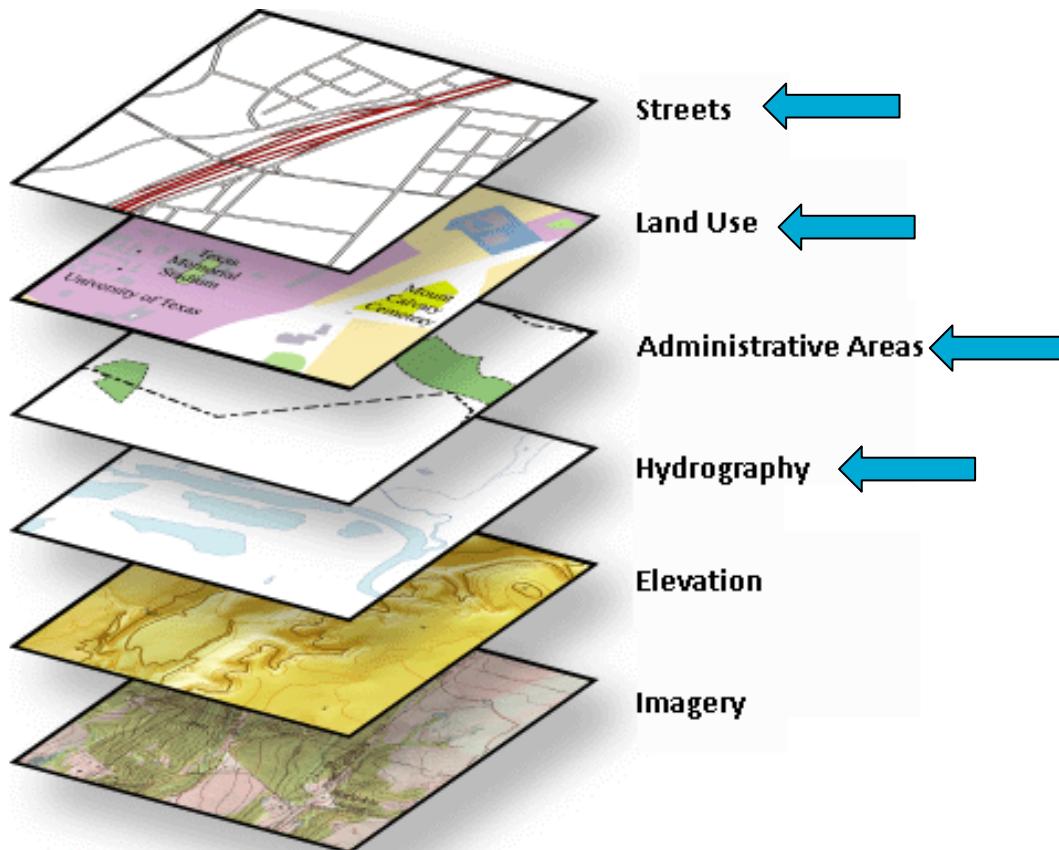
- Feature classes
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- Attributes and descriptive information

Data models: GIS data structures



- Feature classes
- **Raster datasets**
- Attributes and descriptive information

Data models: GIS data structures



- Feature classes
- Raster datasets
- **Attributes and descriptive information**

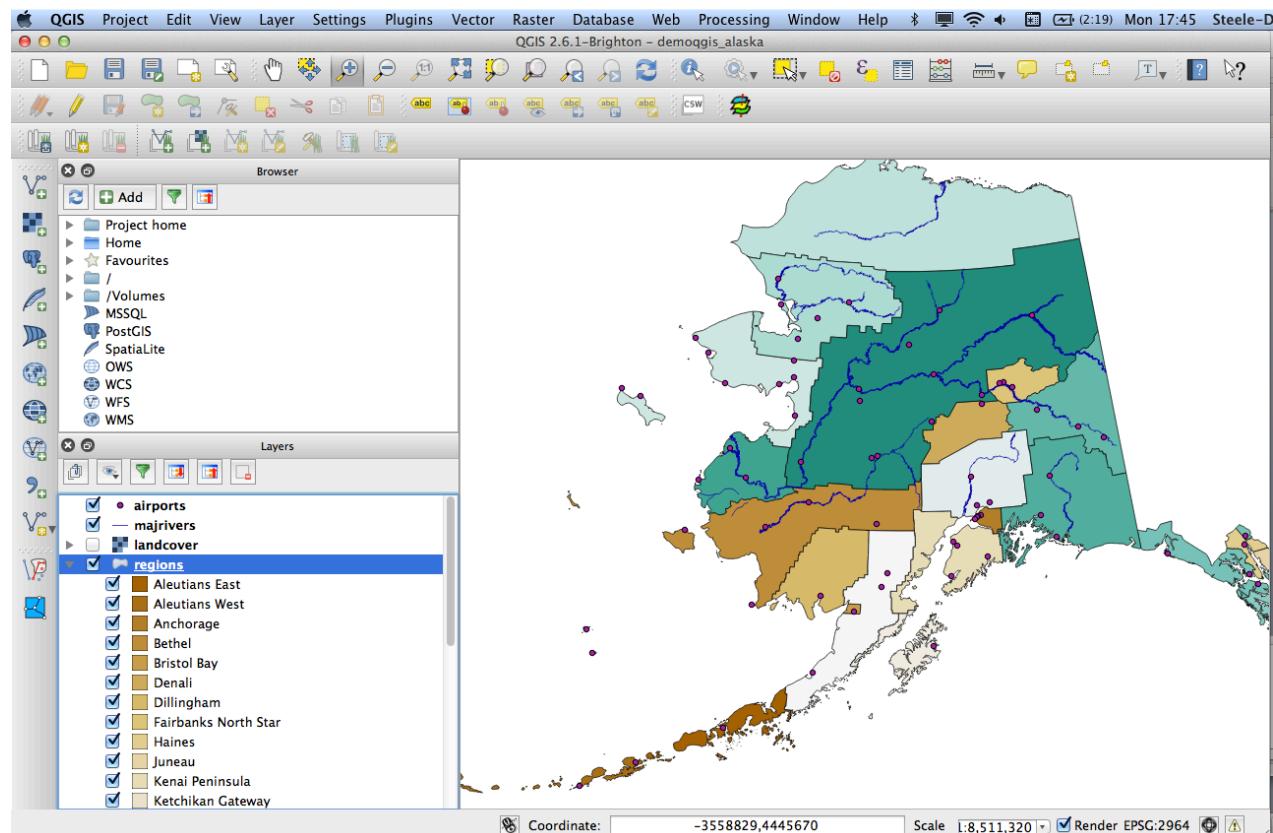
Data models: GIS data structures

Vector for Discrete Data

Vector is **shape-based** data

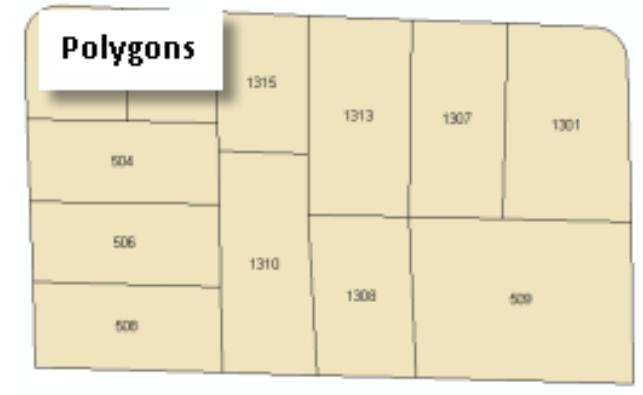
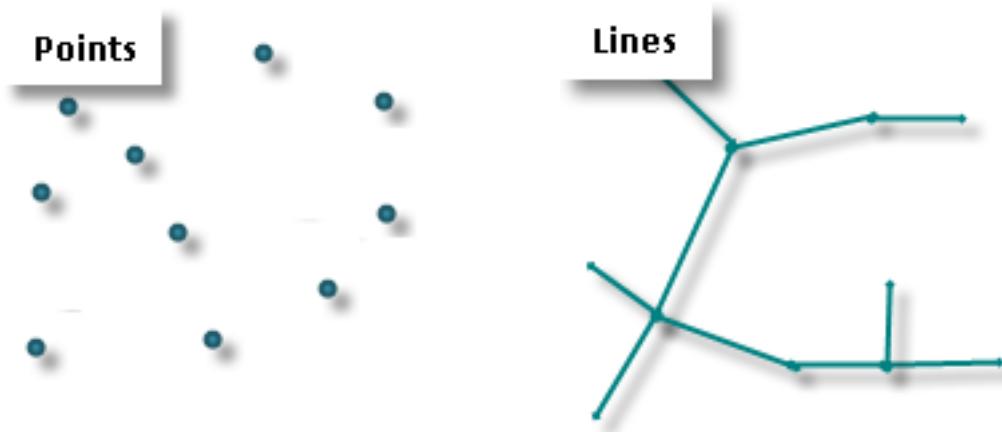
A representation of the world using **points, lines, and polygons**

Vector models are useful for storing data that has distinct **boundaries**, such as country borders, land parcels and streets



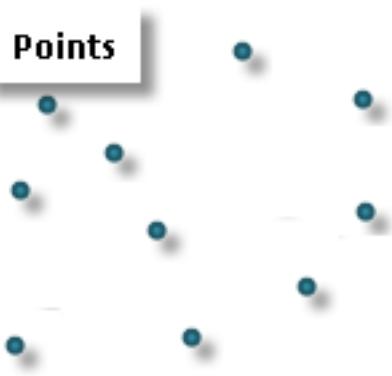
Data models: GIS data structures

Vector for Discrete Data



Data models: GIS data structures

Vector for Discrete Data



e.g.

Well locations

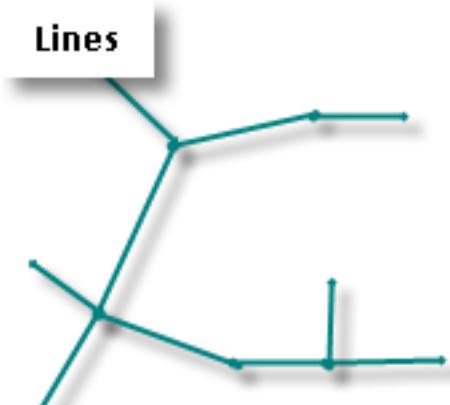
Weather station locations

Stream gauge locations

Pollutant point sources

Water hydrants

Gulleys



e.g.

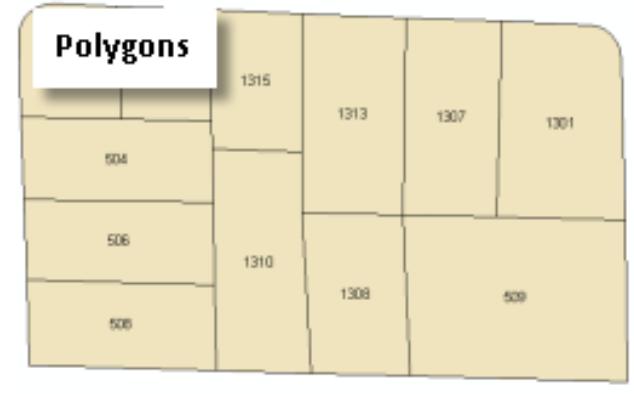
River

Pipelines (e.g. water or sewer)

Elevation contour lines

Other contour lines (e.g. annual precipitation)

Road centerline



e.g.

Land parcel

Soil types

Land use zones

Country boundaries

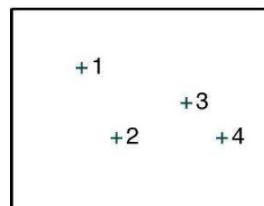
Lakes

Buildings

Data models: GIS data structures

Vector for Discrete Data

Points

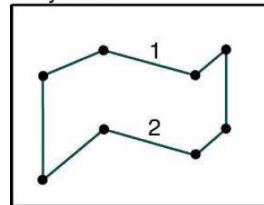


Point number

(x,y) coordinates

1	(2,4)
2	(3,2)
3	(5,3)
4	(6,2)

Polylines

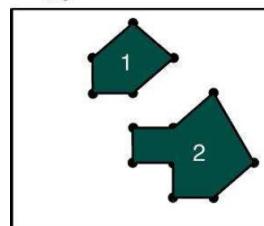


Polyline number

(x,y) coordinates

1	(1,5) (3,6) (6,5) (7,6)
2	(1,1) (3,3) (6,2) (7,3)

Polygons



Polygon number

(x,y) coordinates

1	(2,4) (2,5) (3,6) (4,5) (3,4) (2,4)
2	(3,2) (3,3) (4,3) (5,4) (6,2) (5,1) (4,1) (4,2) (3,2)

Data models: GIS data structures

Vector: Grootchalige Basiskaart Nederland (GBKN)

A digital topographic map with prescribed content and precision including the most important topographic features (buildings, roads, waterways).

GBKN is a basemap, for all of the Netherlands, for use in many applications.

Scale from 1:500 to 1:5000.

Data models: GIS data structures

Vector: Grootchalige Basiskaart Nederland (GBKN)

Consultancy

Presentation: e.g. basis for maps

Registration: e.g. underground cables and pipes

Design e.g. civil engineering, architecture, infrastructure.

Basis in GIS: You can couple administrative data to geographical data on the built environment



Data models: GIS data structures

Grootschalige Basiskaart Nederland (GBKN)

GBKN-Urban Precision 28cm



Data models: GIS data structures

Grootschalige Basiskaart Nederland (GBKN)

GBKN-Rural Precision 56cm



Data models: GIS data structures

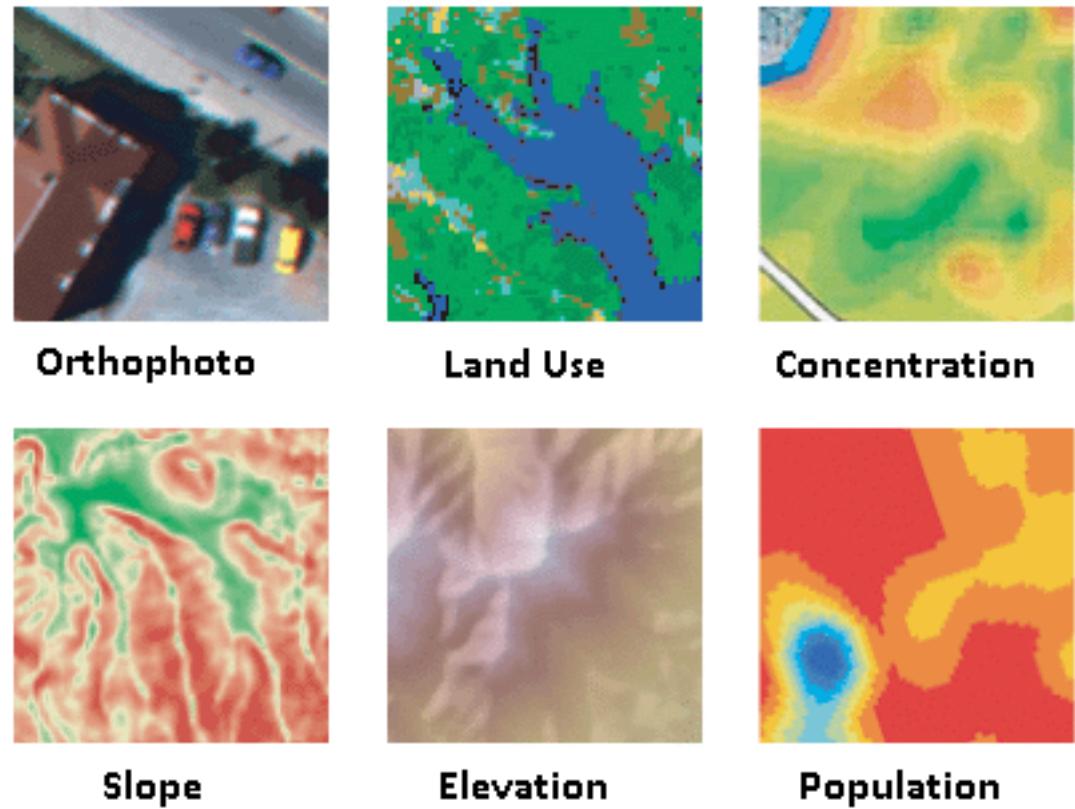
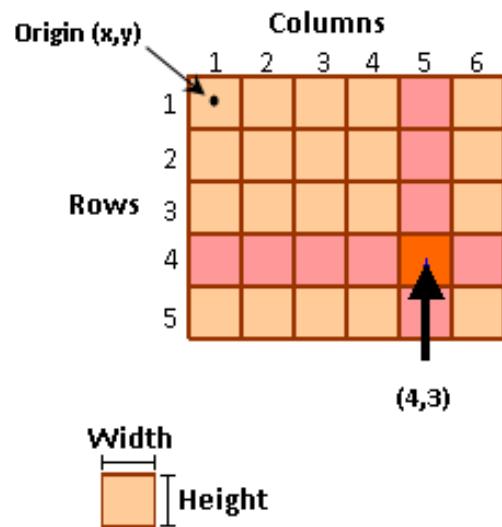
Raster for continuous data

- Continuously changing values
- Stored as floating point values
- Elevation, noise pollution, rainfall, slope, temperature
- Cells organized in rows and columns, assigned index position number
- Many storage formats
e.g. TIFF, JPEG, ESRI Grid



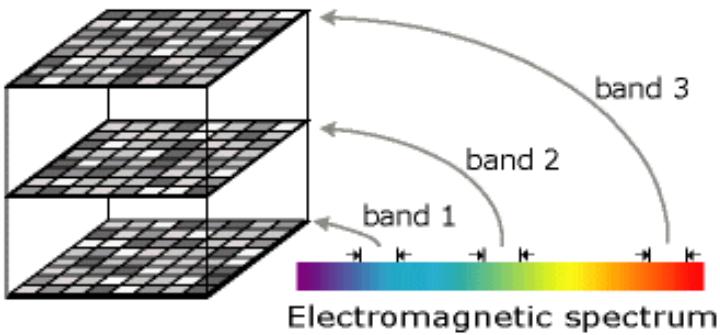
Data models: GIS data structures

Raster for continuous data



Data models: GIS data structures

Raster for continuous data



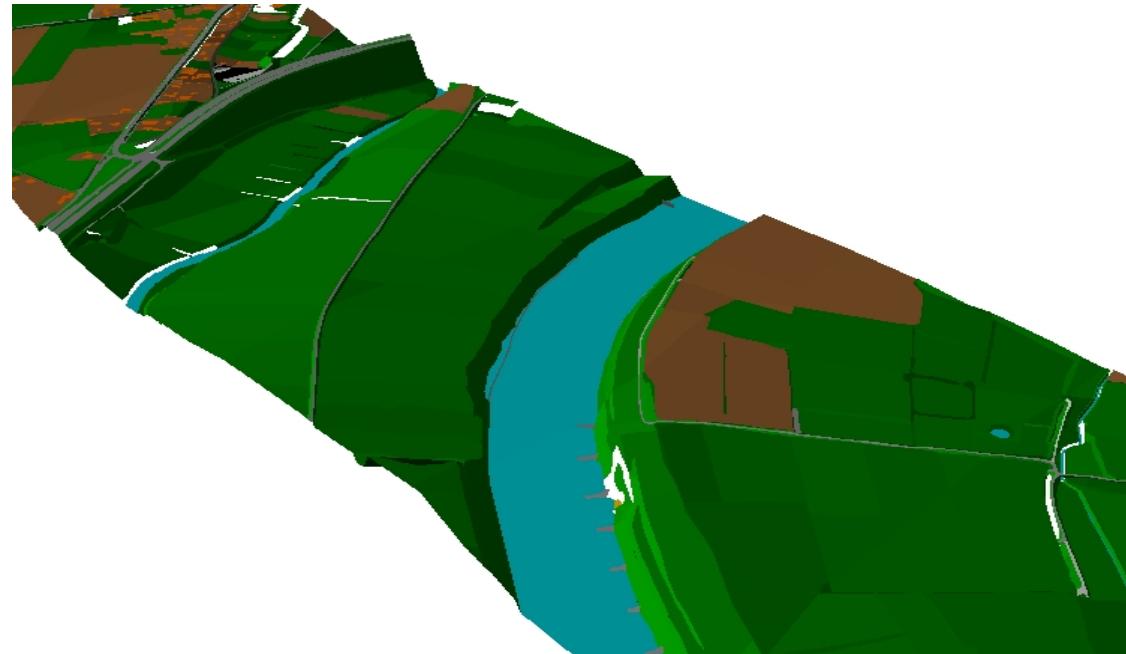
Landsat 7 images of Galveston, Texas before (left) and after (right), depicts scarring left after Hurricane Ike.

GIS data structures: Raster

Digitaal Topografisch Bestand (DTB)

Produced by **Rijkswaterstaat**
(Ministry for Infrastructure and Environment)

Detailed topographic
geo-information
(Scale 1:1000)
on roads and waterways.



51

GIS data structures: Raster

Digitaal Topografisch Bestand (DTB)



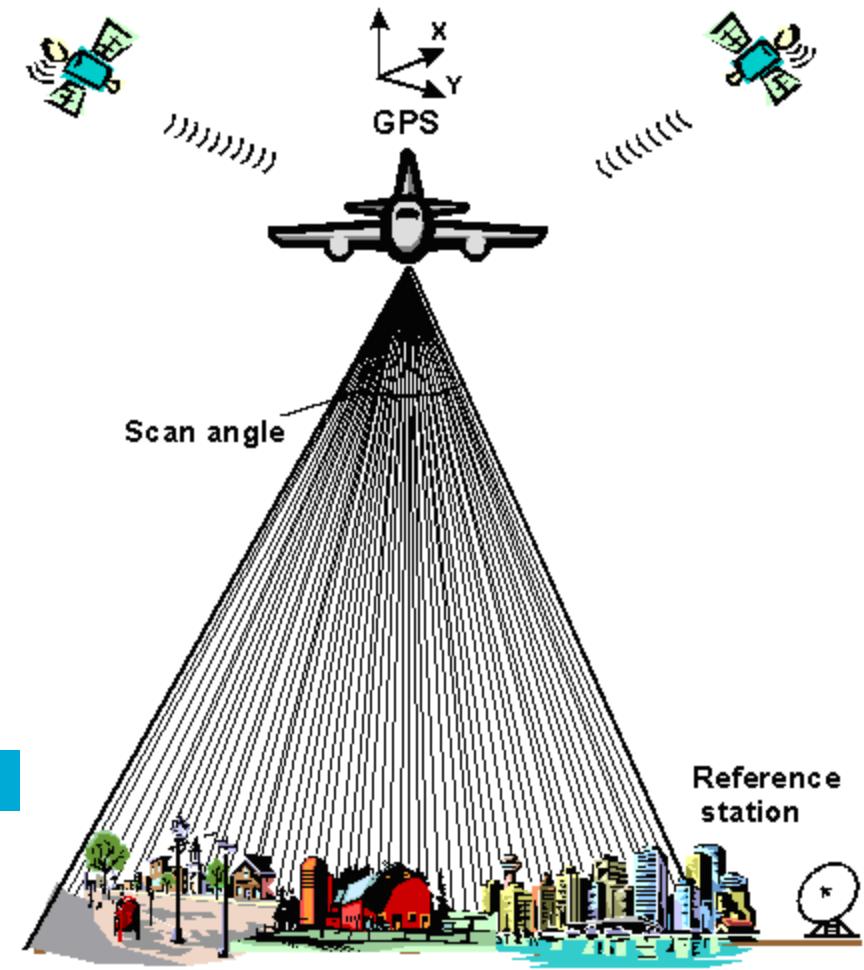
52

GIS data structures: Raster

Actueel Hoogtebestand Nederland Actual Height Model of the Netherlands

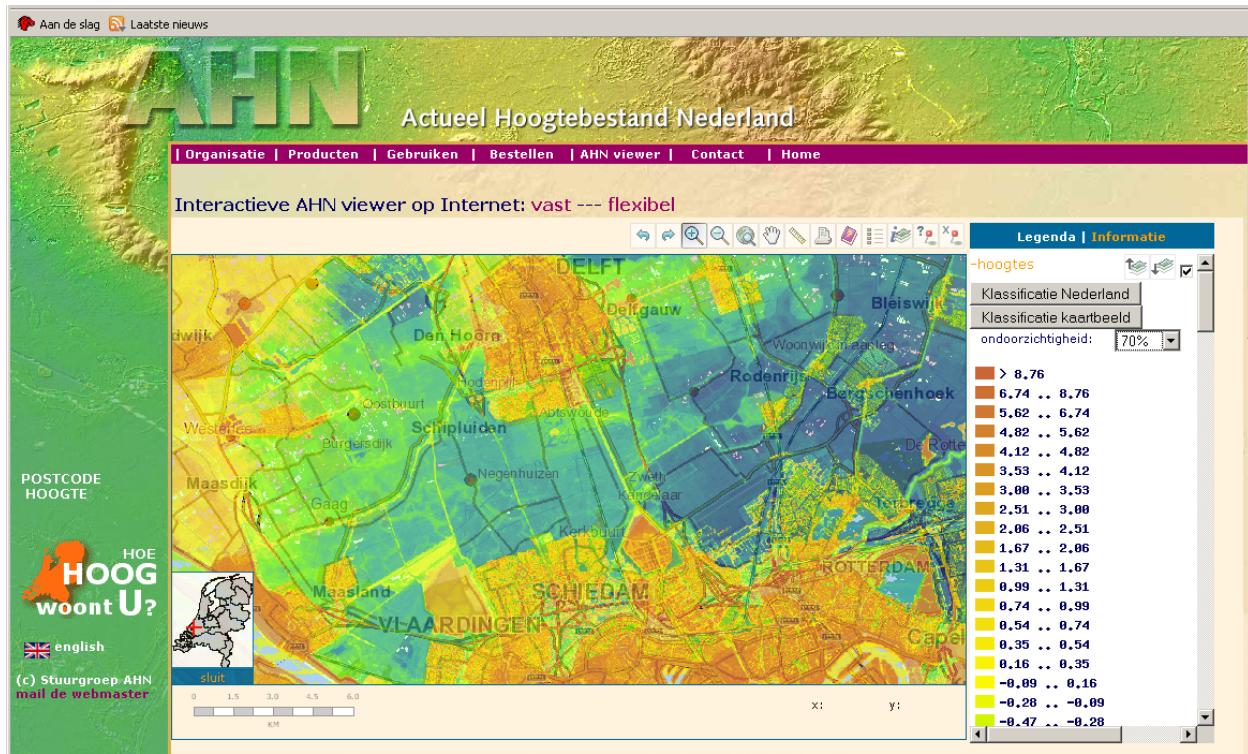
Website: www.ahn.nl

Airborne Laser Altimetry
LIDAR
Light Detection and Ranging



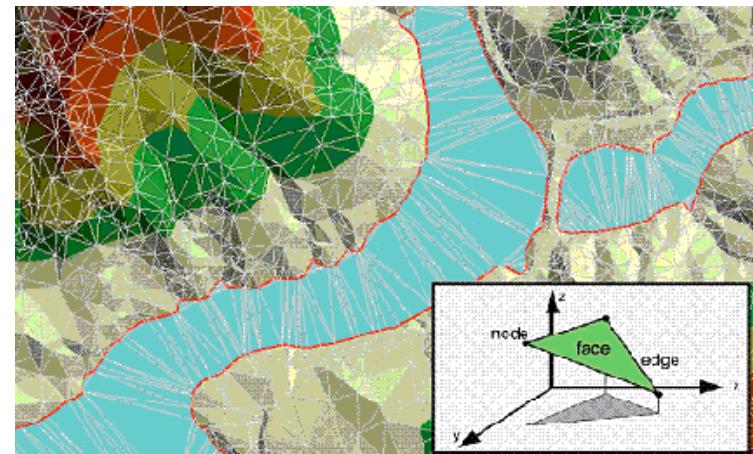
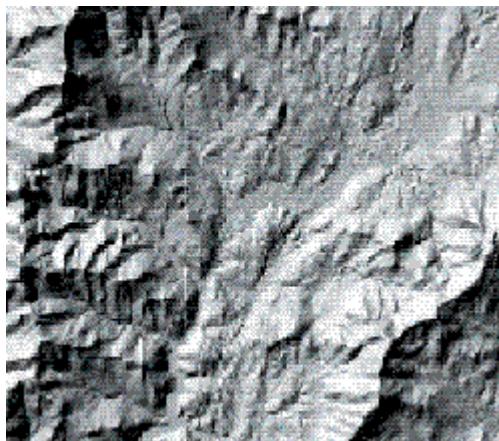
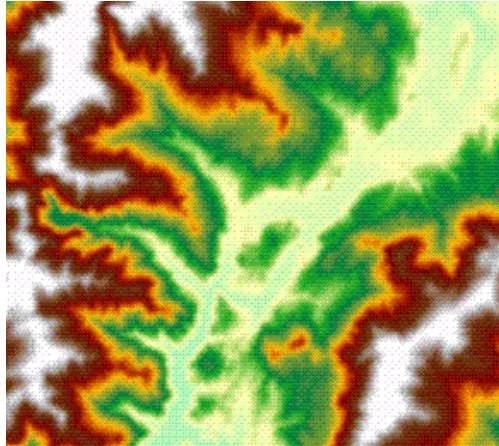
GIS data structures: Raster

Actueel Hoogtebestand Nederland Actual Height Model of the Netherlands

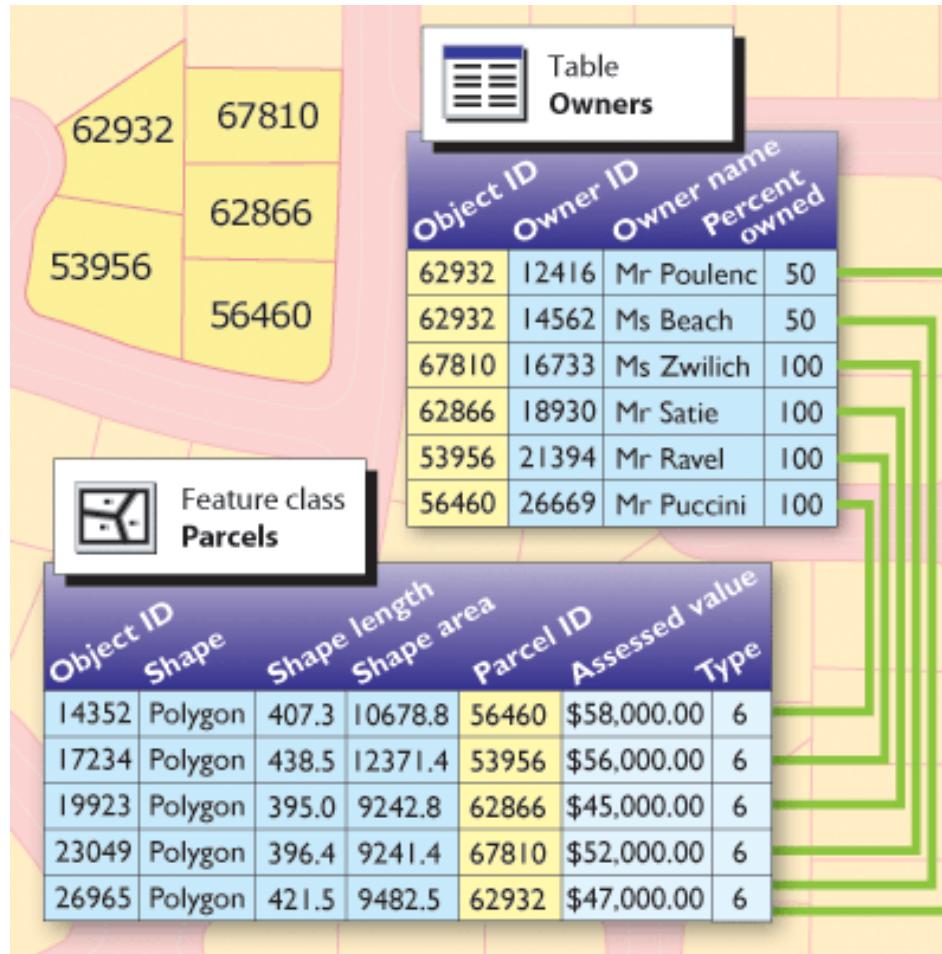


GIS data structures:

Surfaces: Features or Rasters?



GIS data structure: Attributes



Activity: GIS data models for Water Resources Management

Let's come up with some “projects”, and formulate a problem you might address with GIS.

- (a)
- (b)
- (c)
- (d)

Divide into groups of 3-4 students.

Each group will focus on one project.

Activity: GIS data models for Water Resources Management

For your task:

- 1) What data will you collect for your geodatabase?
- 2) Will that data be raster/feature/attribute data?
- 3) What will the attributes of the feature data be?
- 4) Can you think of 2 spatial questions you might ask?
2 attribute questions?

- | | |
|--------------|---|
| 3 minutes - | Think by yourself and make a list |
| 10 minutes – | Combine your list with the rest of your group and brainstorm |
| 15 minutes - | Share results with whole class.
Do they have any additional suggestions? |
- (Each group appoint someone to write notes, and someone to present to whole class)

CT5401 – Lecture 1

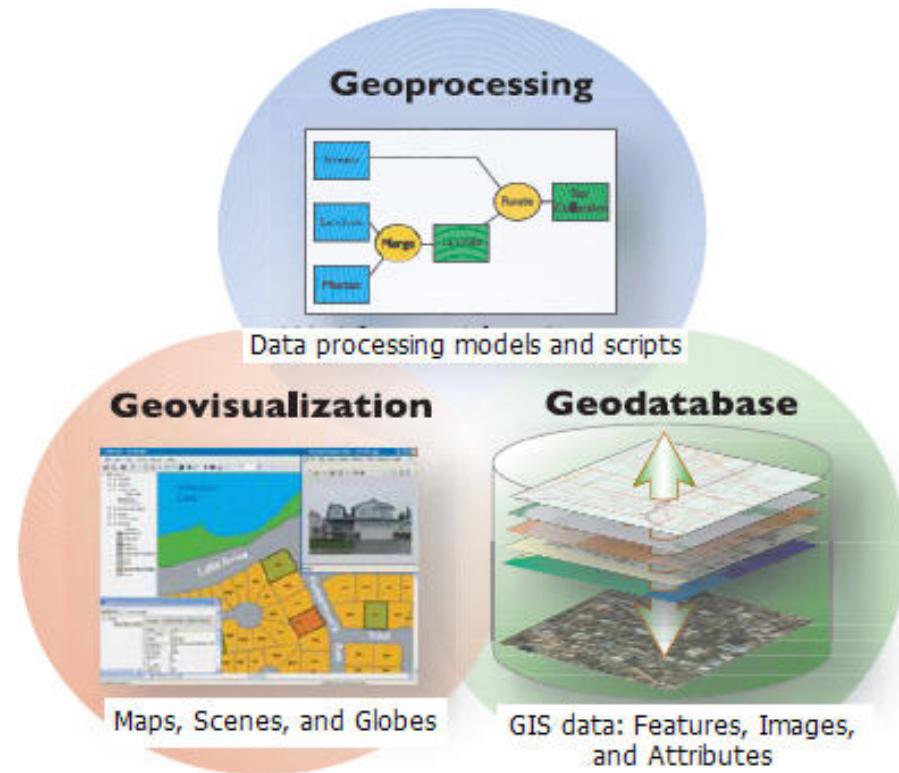
Introduction to GIS

- What is GIS?
- Data models to represent our world
- **Functions of a GIS**
- Real applications of GIS in Hydrology and Water Resources Management
- Introduction to Assignment 1

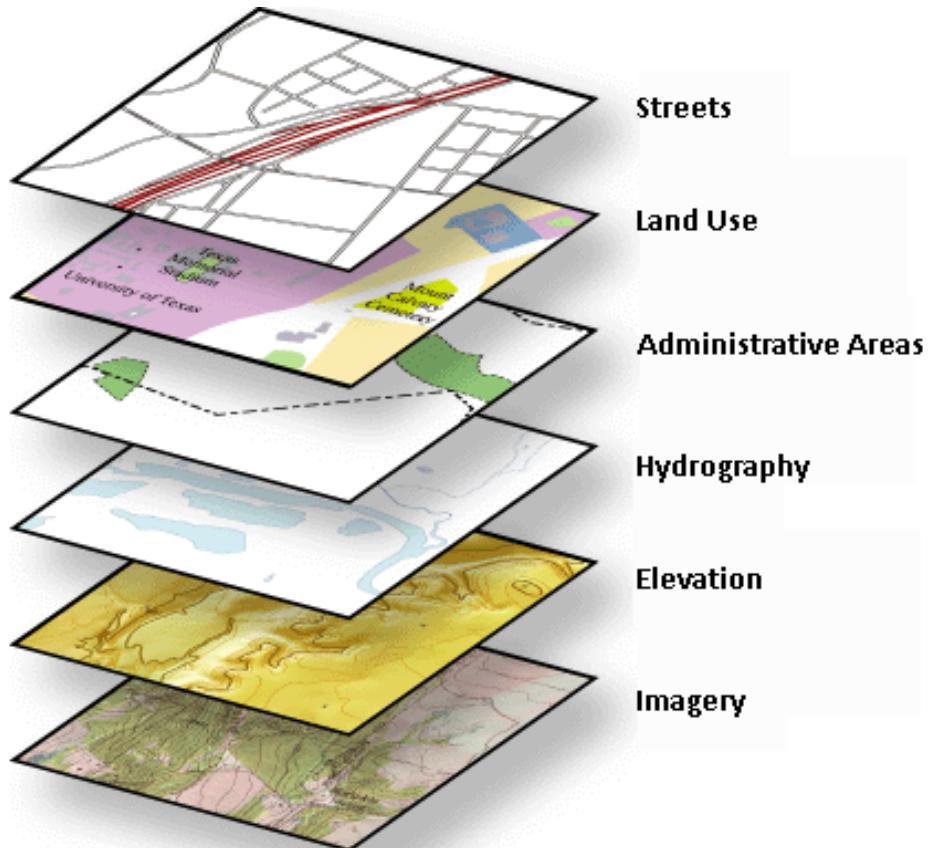
Geographical Information Systems

Key functions of a GIS:

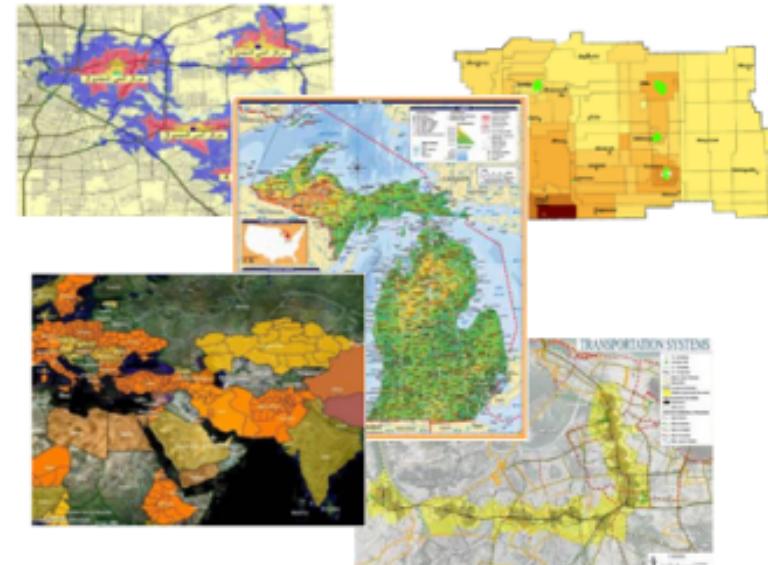
- ***Data management***
- Mapping and Visualization
- Geoprocessing



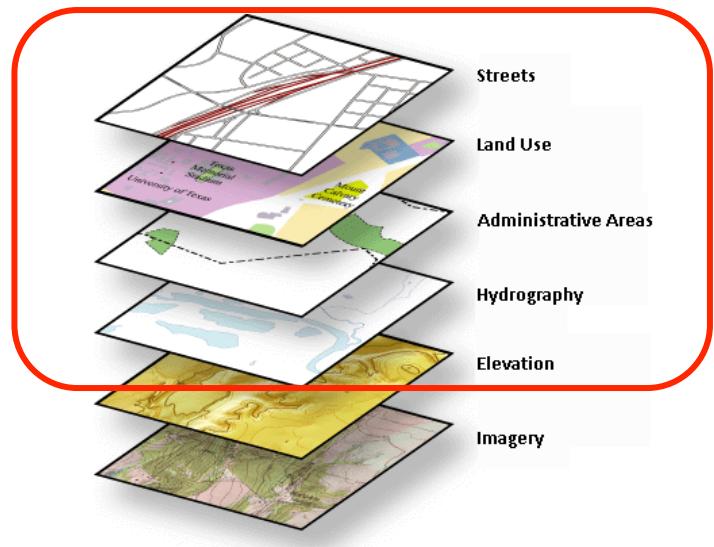
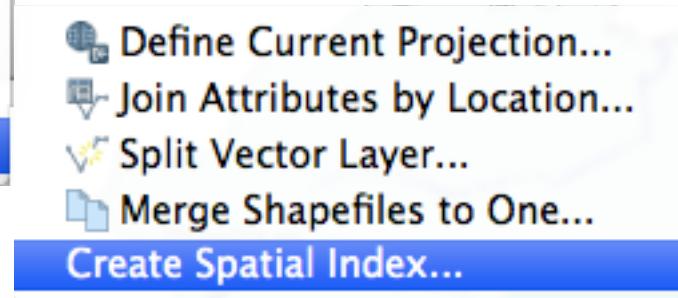
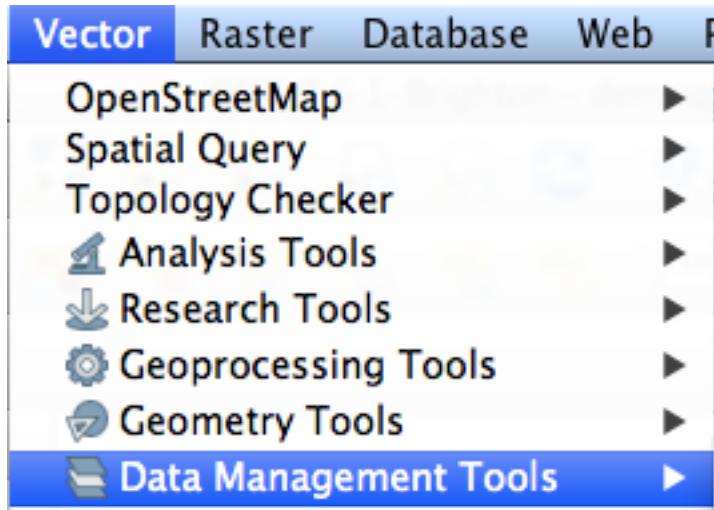
Data management



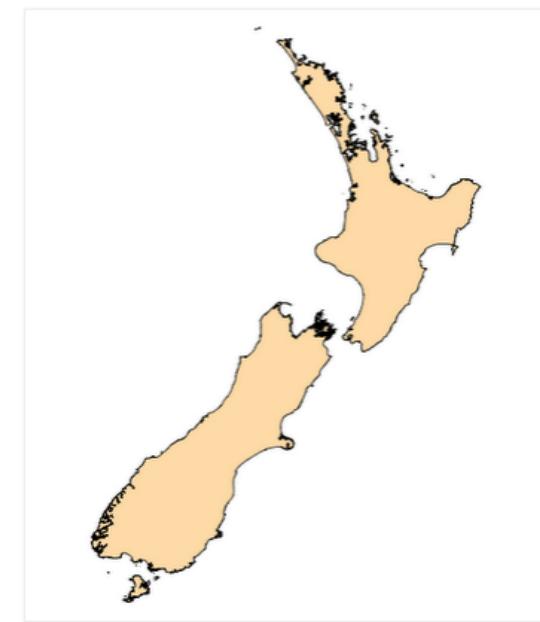
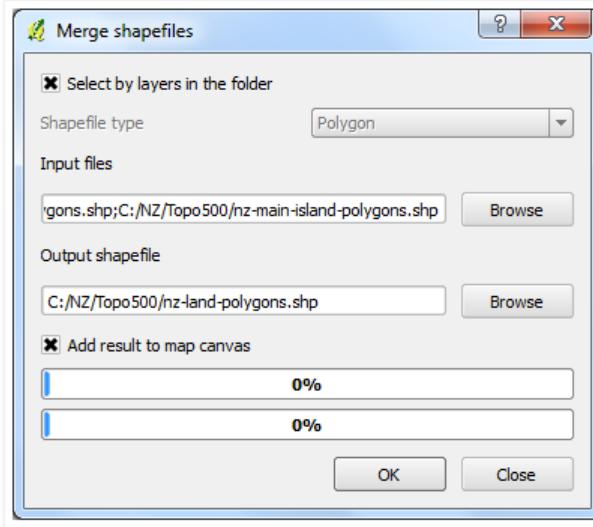
Maps



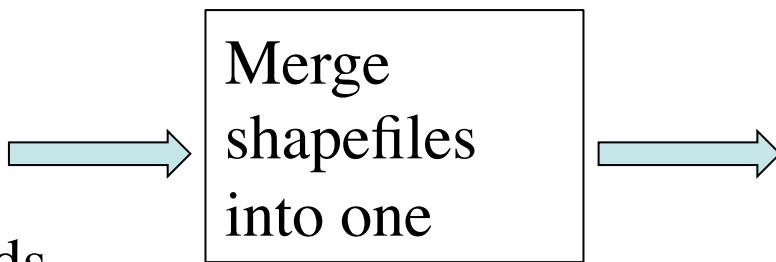
Data Management: Vector



Data Management: Vector



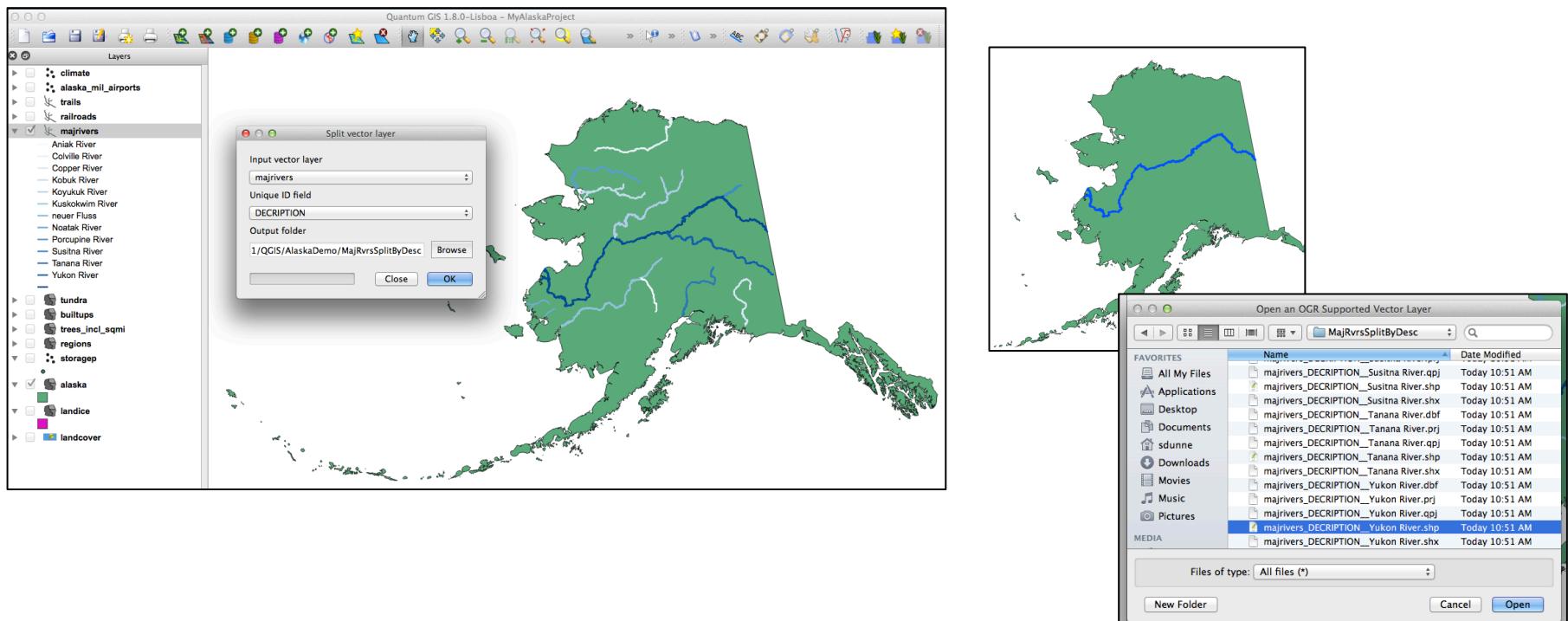
Layer of mainland
+
Layer of islands



Single layer of mainland & islands

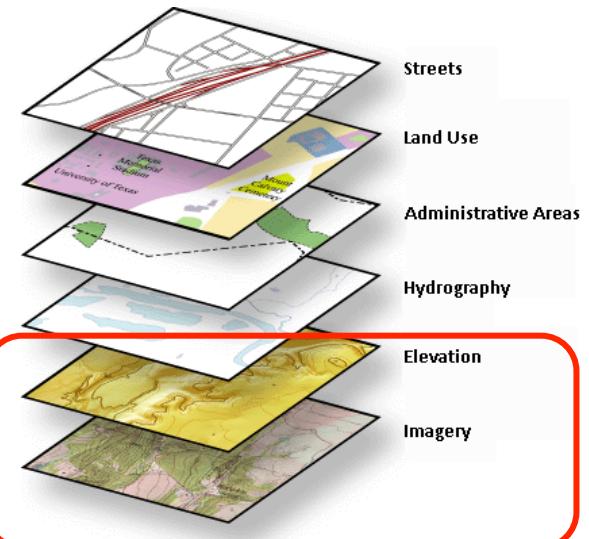
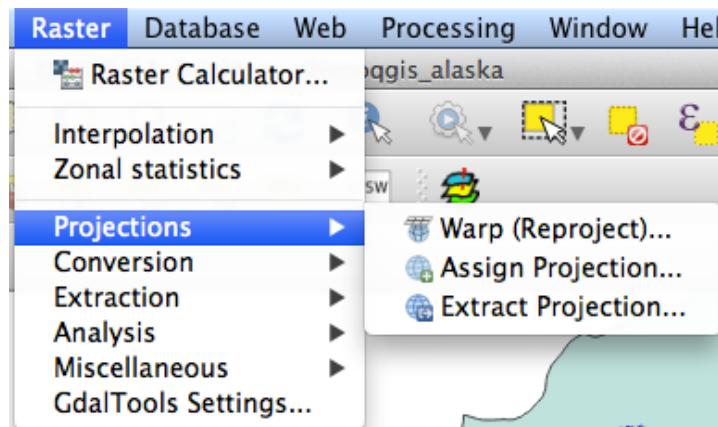
Data management: Vector

All major rivers → Split vector layer → Layer file for each river

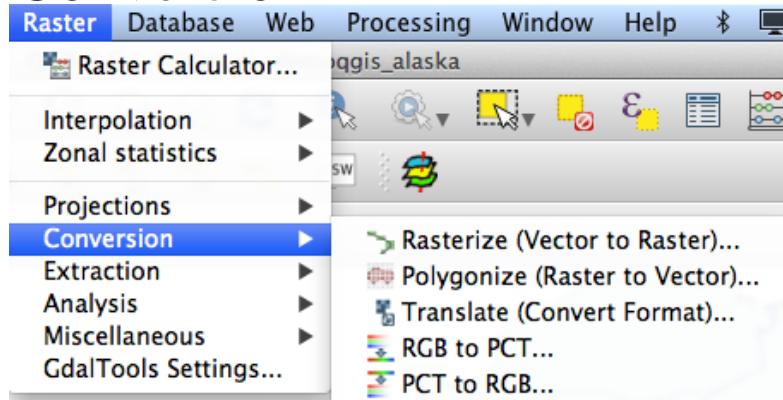


Data Management: Raster

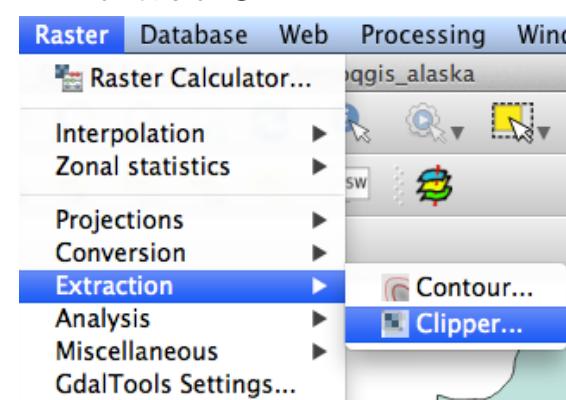
Projection



Conversion



Extraction



Data Management: Raster

Conversion



Polygon
Vector layer

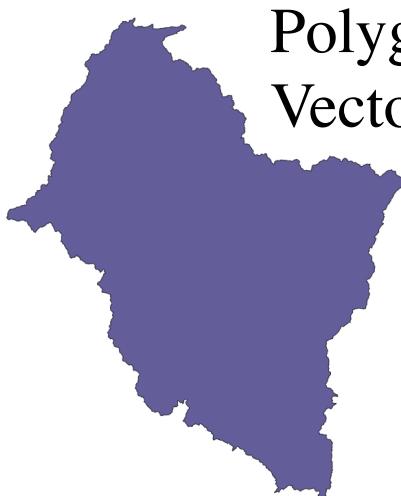
Raster



Why?

Data Management: Raster

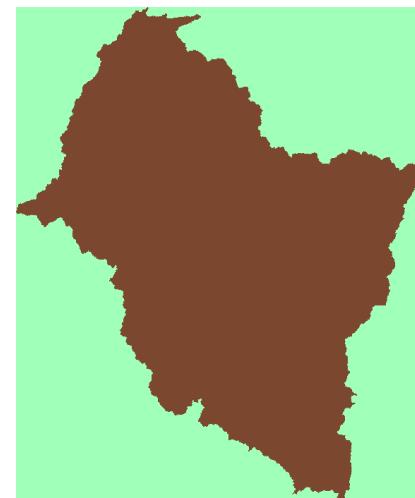
Conversion



Polygon
Vector layer

- Smaller file size.
- Geoprocessing with other vector data
- Zonal analysis
- Join with attributes

Raster



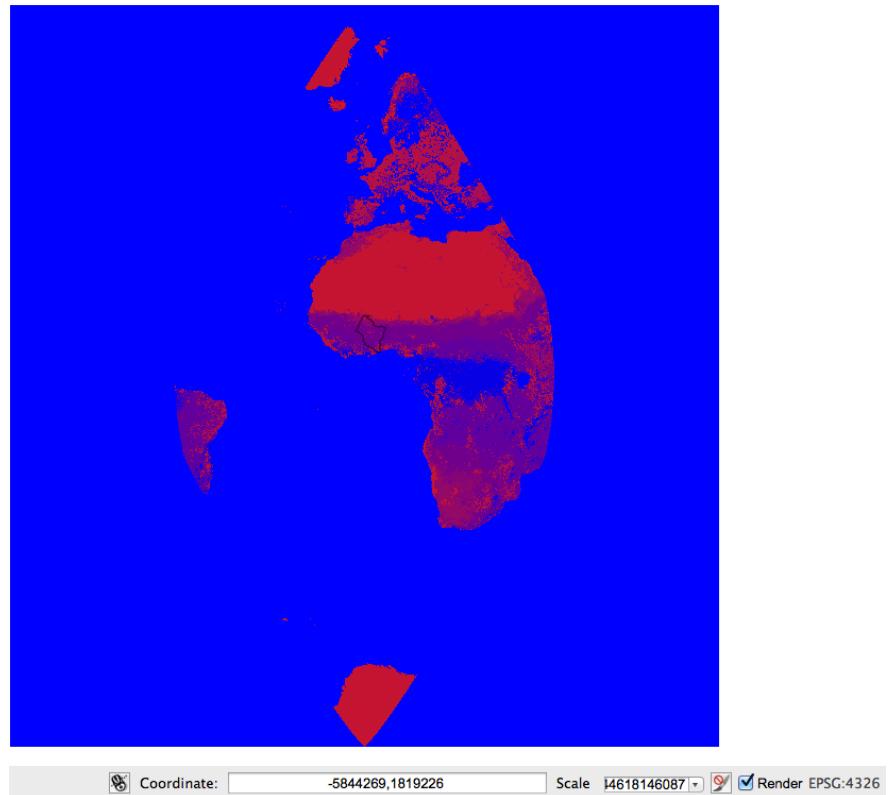
- Map algebra
- Use as a mask

Data Management: Raster

Warp: Reproject and/or resample raster data

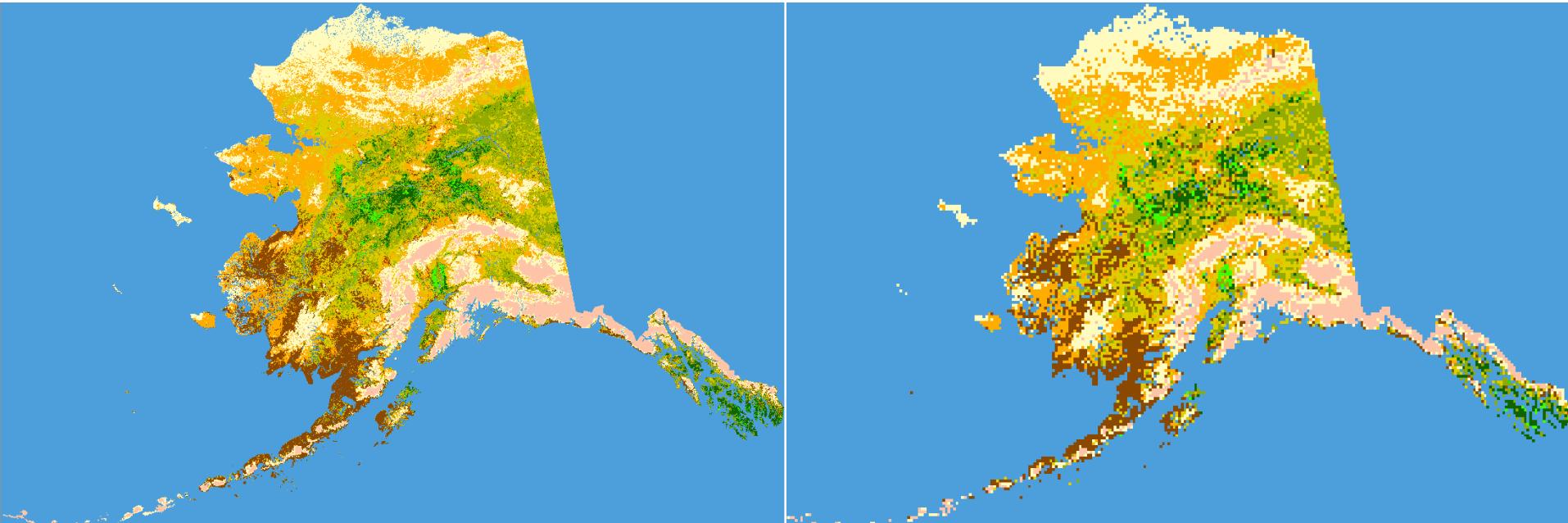
Why reproject?

- Need to measure areas/lengths (not in degrees!)
- Combine raster maps
- Visualize data
- Using GRASS



Data Management: Raster

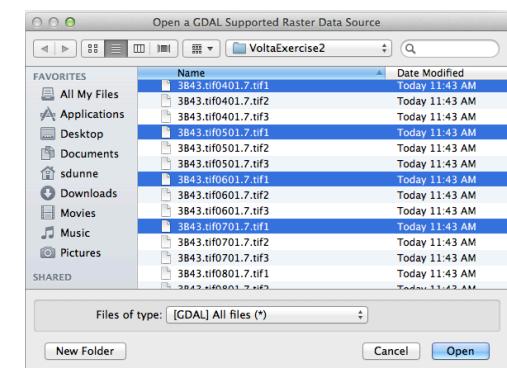
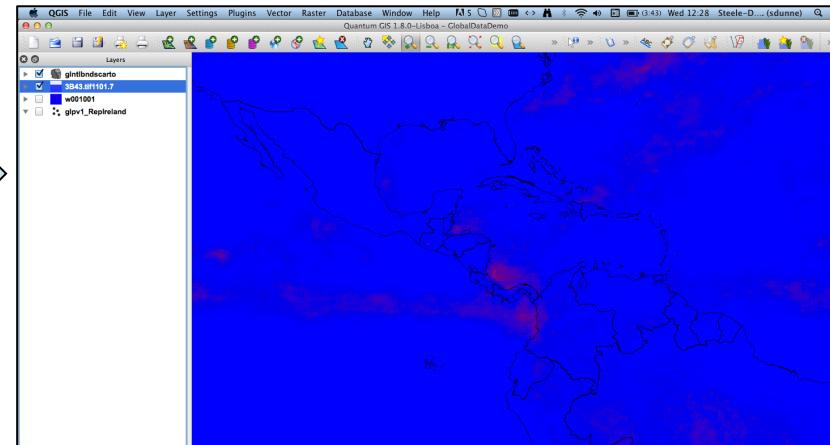
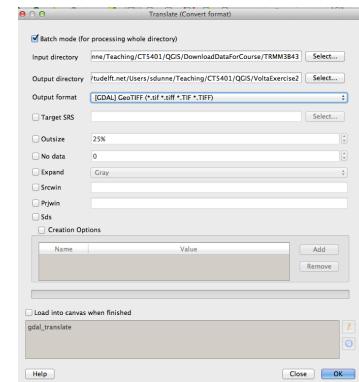
Warp: Reproject and/or resample raster data



Data Management: Raster

The screenshot shows the GES DISC Mirador interface. At the top, there's a navigation bar with links like 'GES DISC Home', 'Data Services', 'Science Portals', 'Mission Portals', 'More...', 'Analyze Data with Giovanni', 'Search for Data with Mirador', 'Simple Subset Wizard', and 'More...'. Below the navigation bar is a sidebar with sections for 'OVERVIEW', 'HELP CENTER', 'DATA HOLDINGS', and 'Additional Features' (News, Restricted Data, Feedback, FAQ). The main content area displays a message about a rollback and replacement of TRMM VIRS Data for Sat. January 26, 2013, followed by messages about retrospective processing of Version 7 TMPA and data replacement for TRMM 3B42/3B43 Products for Jan. 2000-Sep. 2010. Below these messages is a table titled '3B43: Monthly 0.25 x 0.25 degree merged TRMM and other sources estimates' with columns for Year, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. The table shows values of 1 for all months from 1998 to 2012. At the bottom, there's a file tree showing various datasets like GADM_data, GlobalLandCover, hydrobasins_africa, SEDAC, TRMM3B43, and USGS_DEM.

Translate

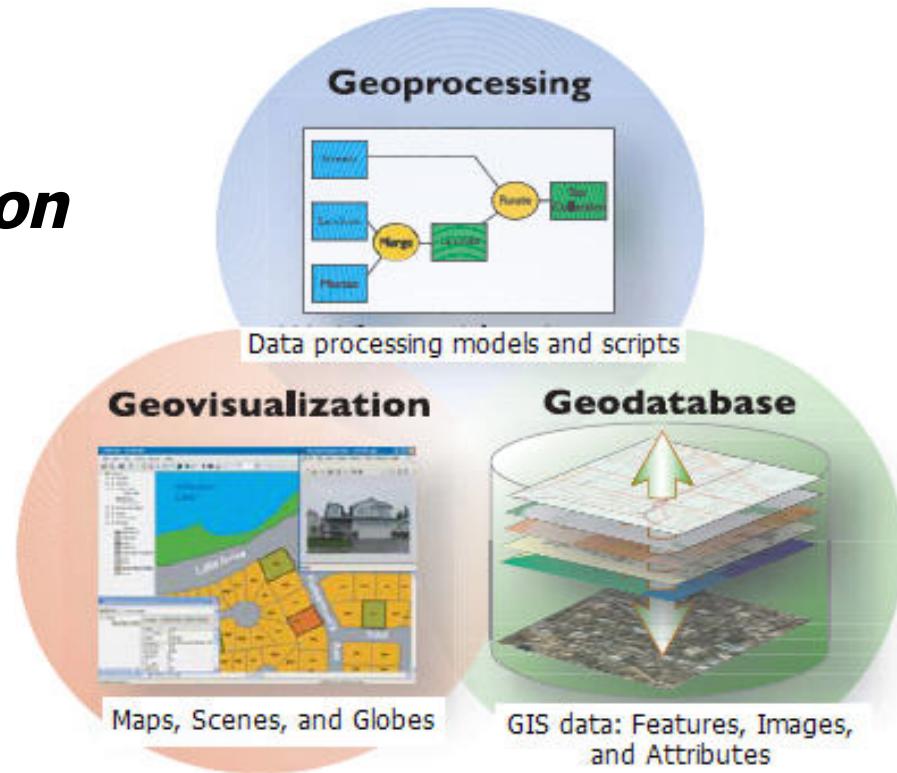


Convert data format for use in QGIS, or other software

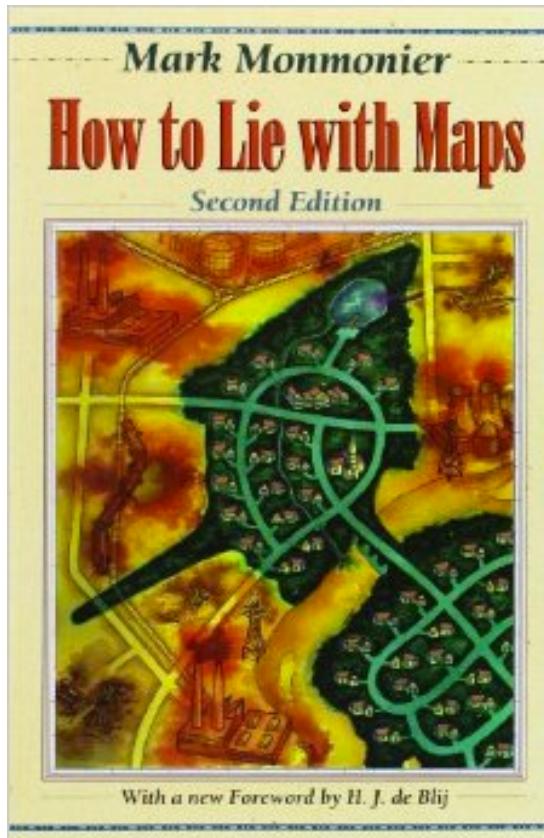
Geographical Information Systems

Key functions of a GIS:

- Data management
- ***Mapping and Visualization***
- Geoprocessing



Mapping and Visualization

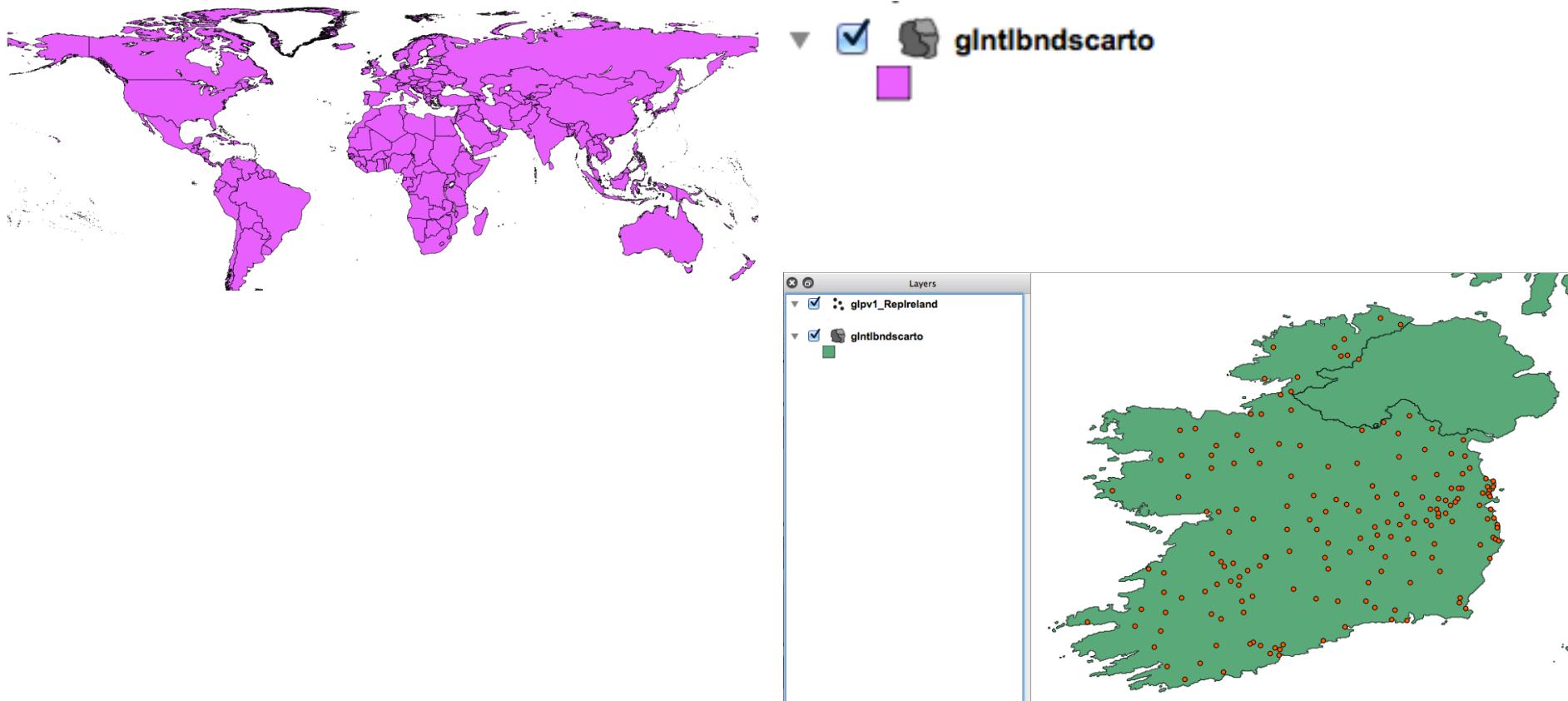


- Introduction to projections
- Key elements of maps
- How important symbols are!

https://www.researchgate.net/publication/37420071_How_to_Lie_with_Maps

Mapping and Visualization

Vector: Single symbol maps

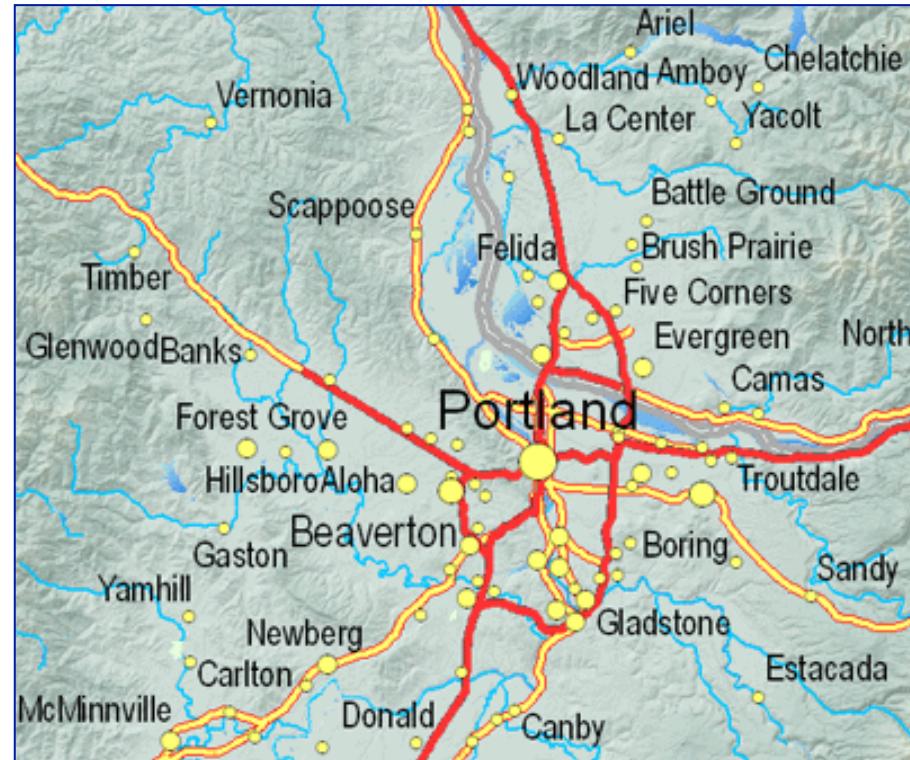


Mapping and Visualization

Vector: Symbolize by attribute

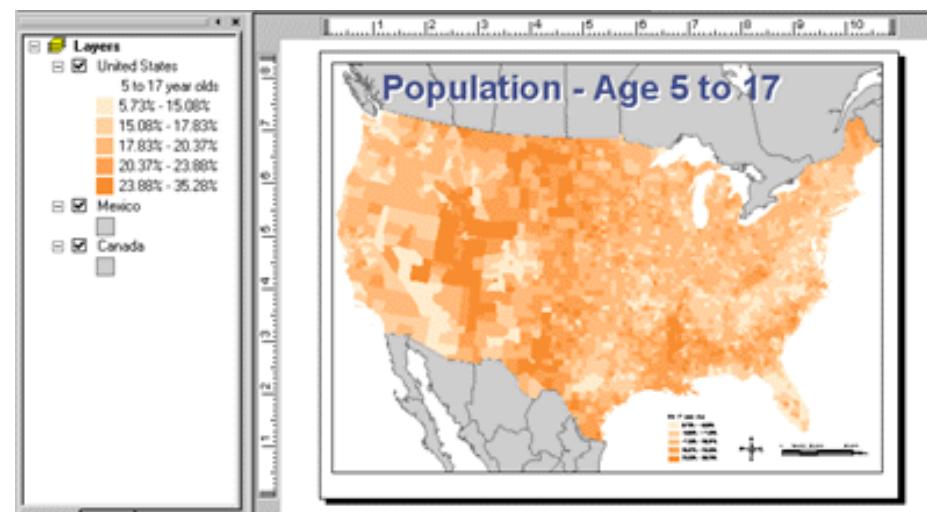
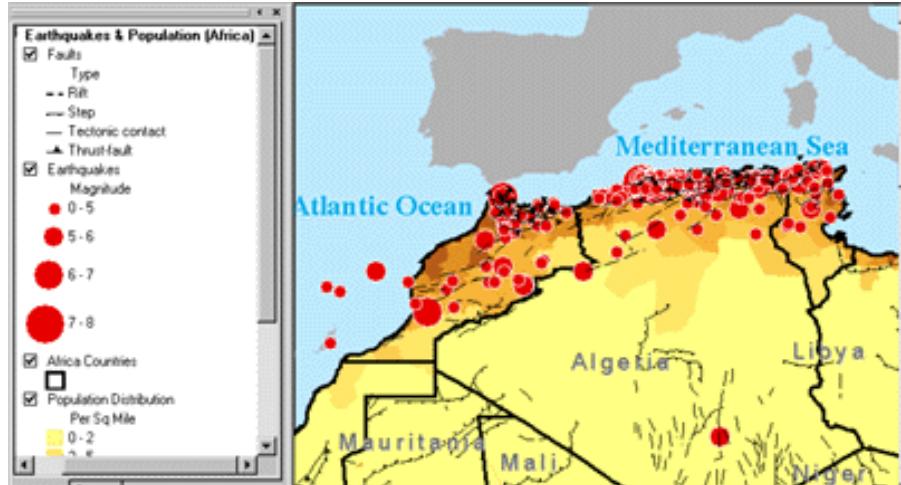
Attribute category
(roads)

Attribute quantity
(population)



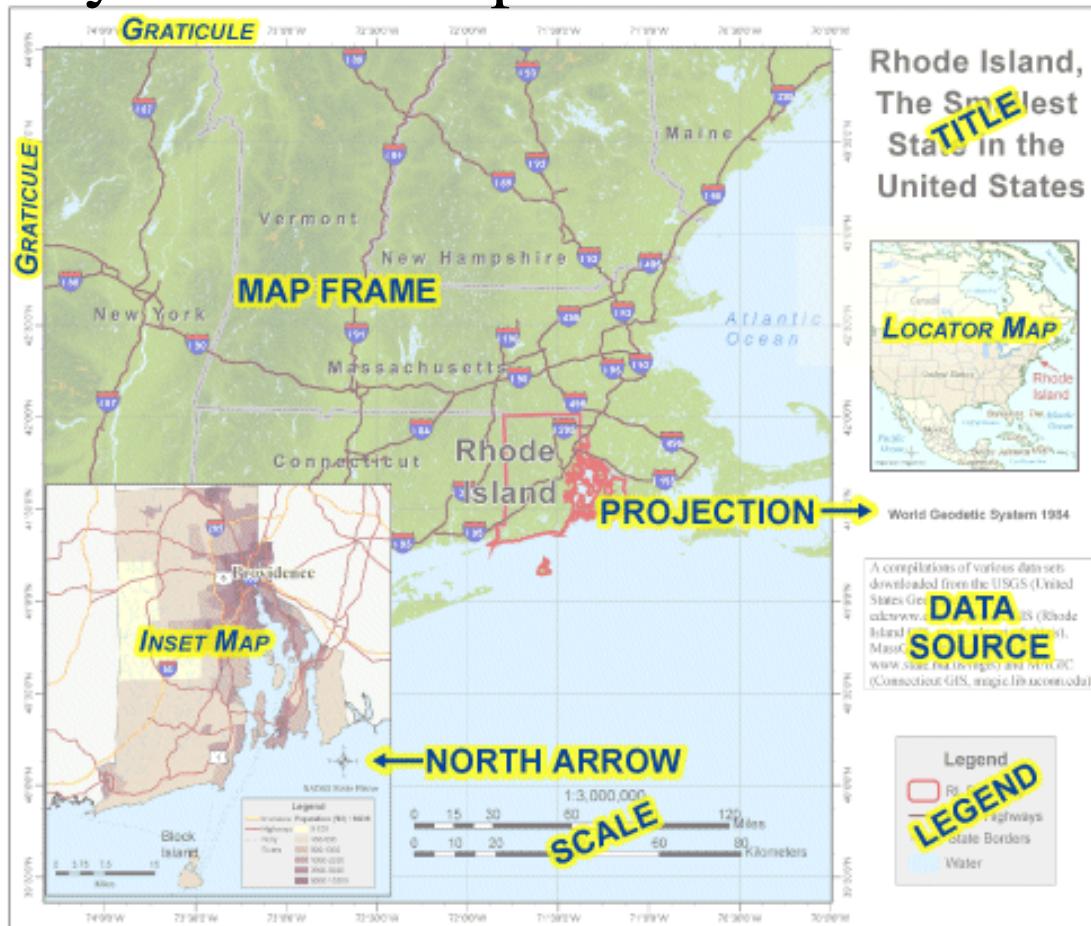
Mapping and Visualization

Vector: Symbolize by attribute quantity



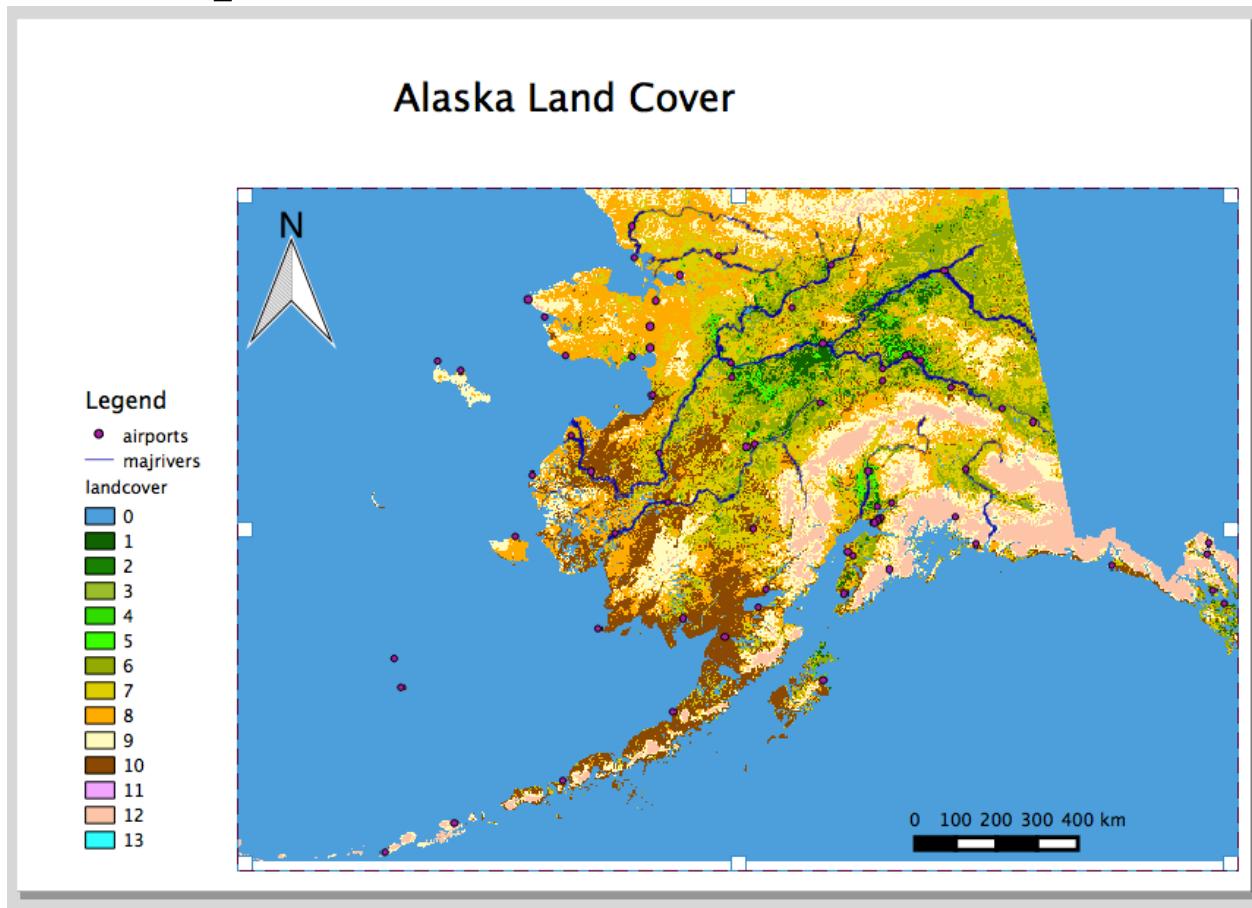
Mapping and Visualization

Map layout and composition



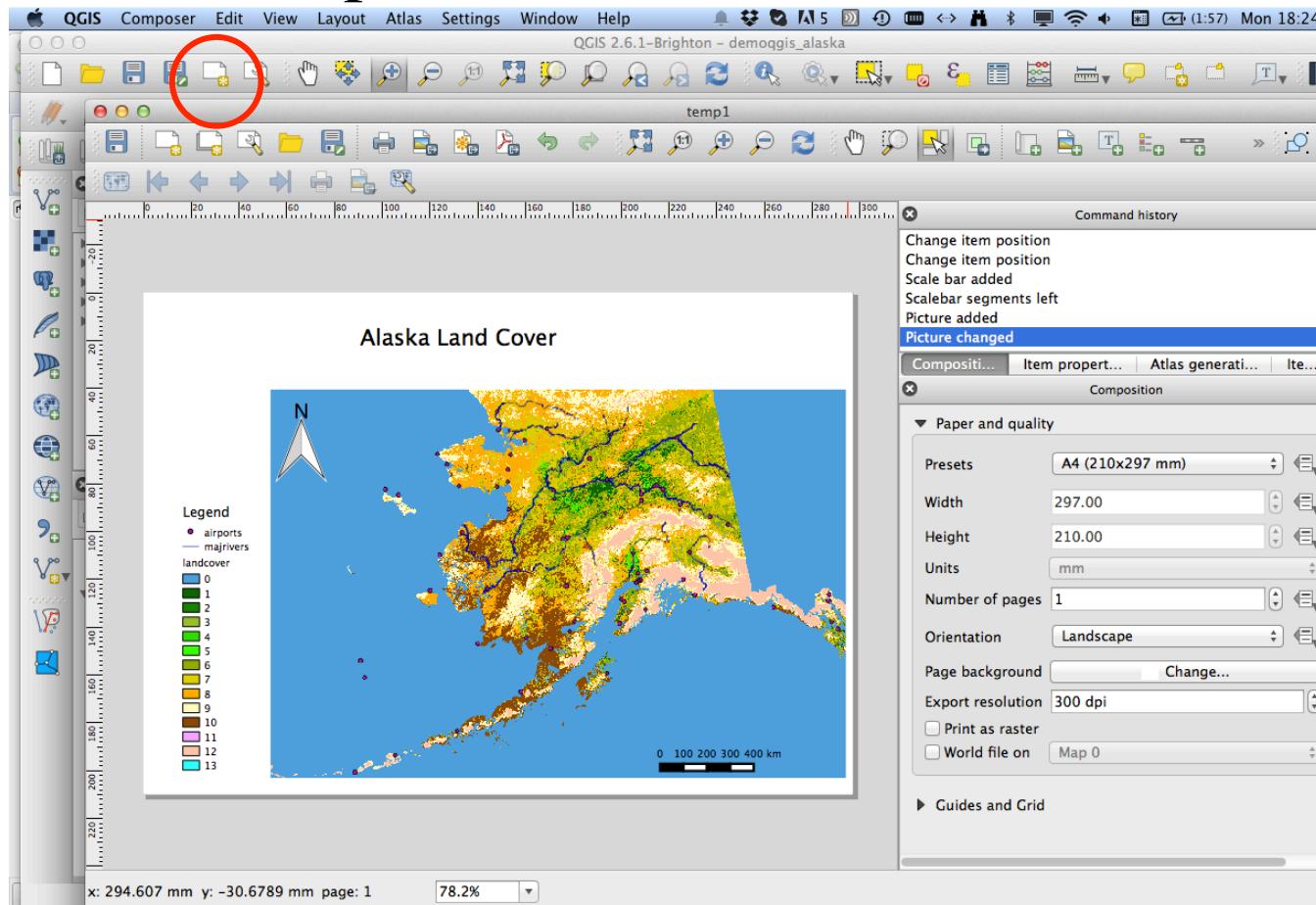
Mapping and Visualization

Print composer



Mapping and Visualization

Print composer

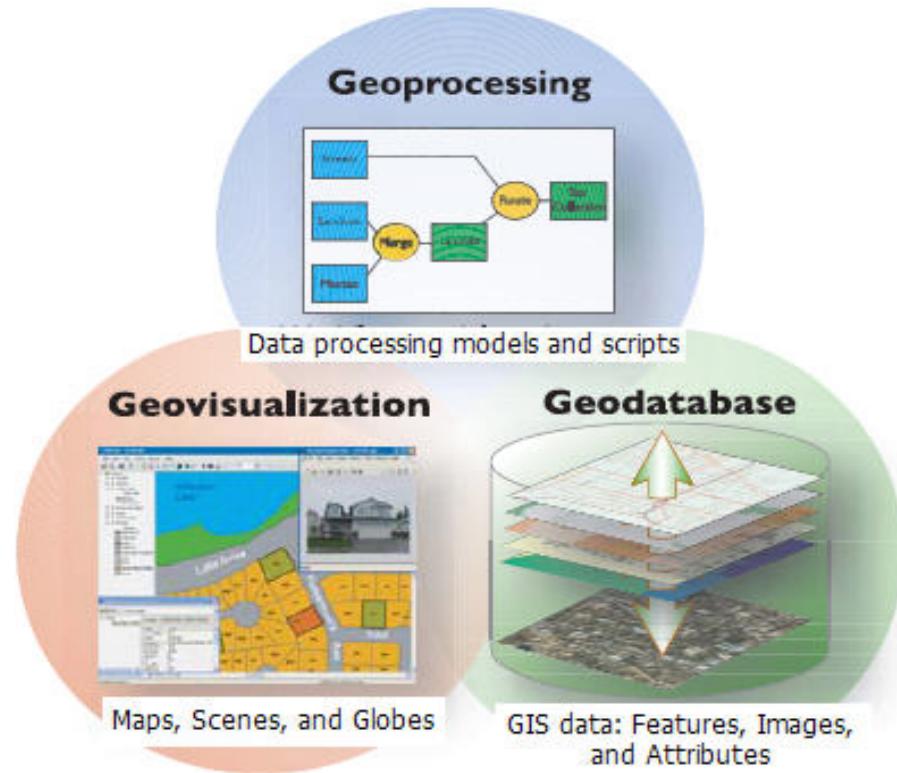


78

Geographical Information Systems

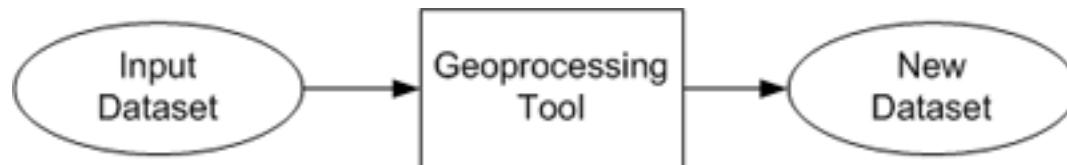
Key functions of a GIS:

- Data management
- Mapping and Visualization
- ***Geoprocessing***



Geoprocessing

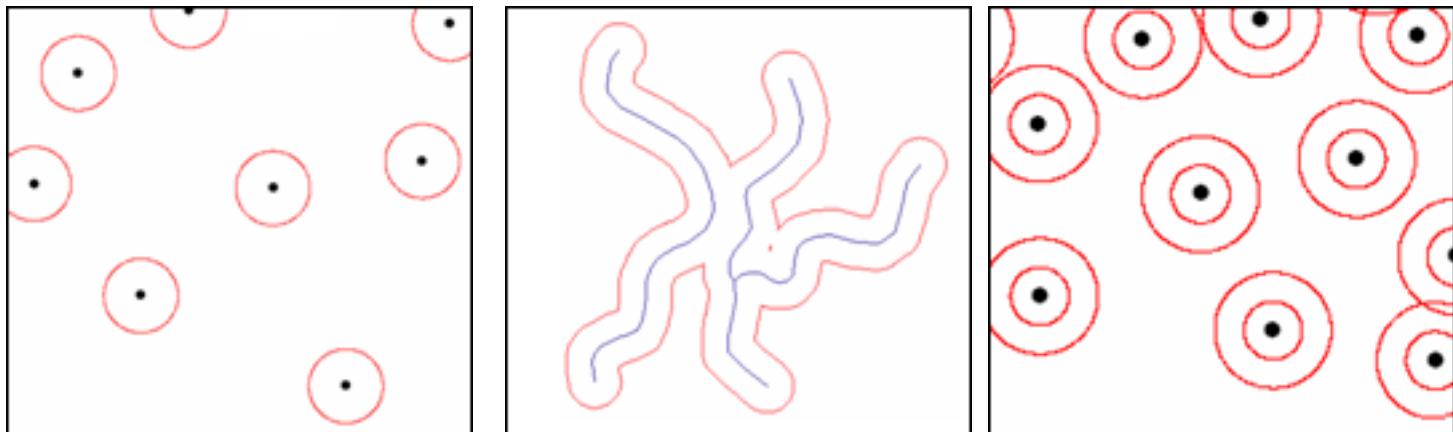
Geoprocessing = operating on geographic data to create new information



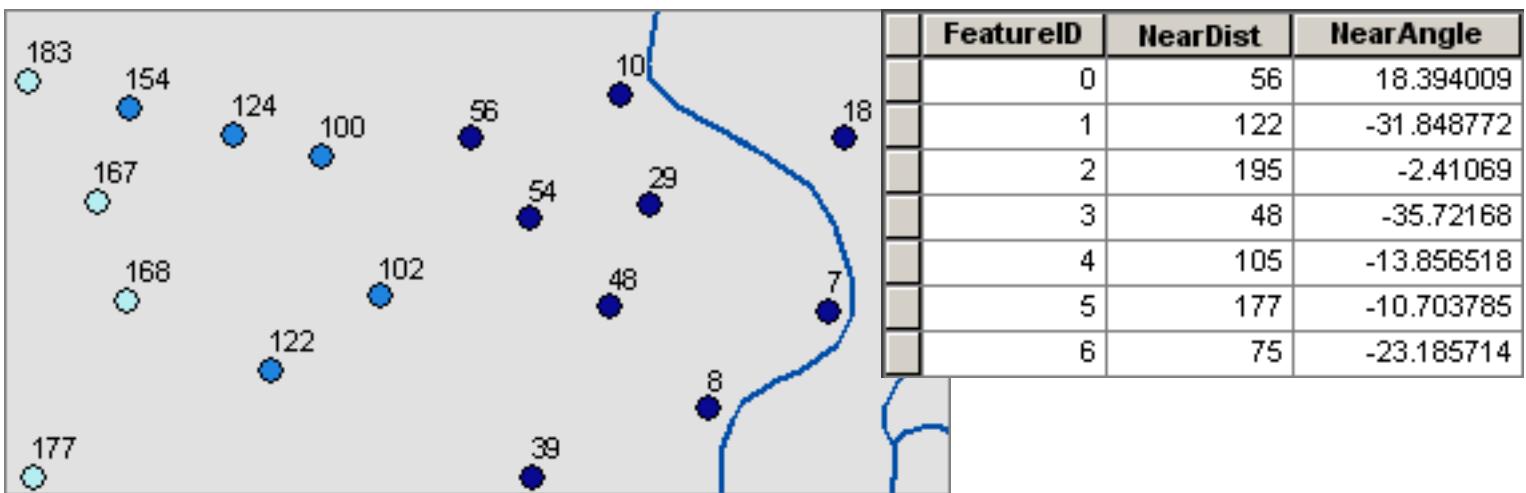
Goals: 1) To model a system
2) To automate GIS tasks

Geoprocessing: Proximity Analysis

Buffer

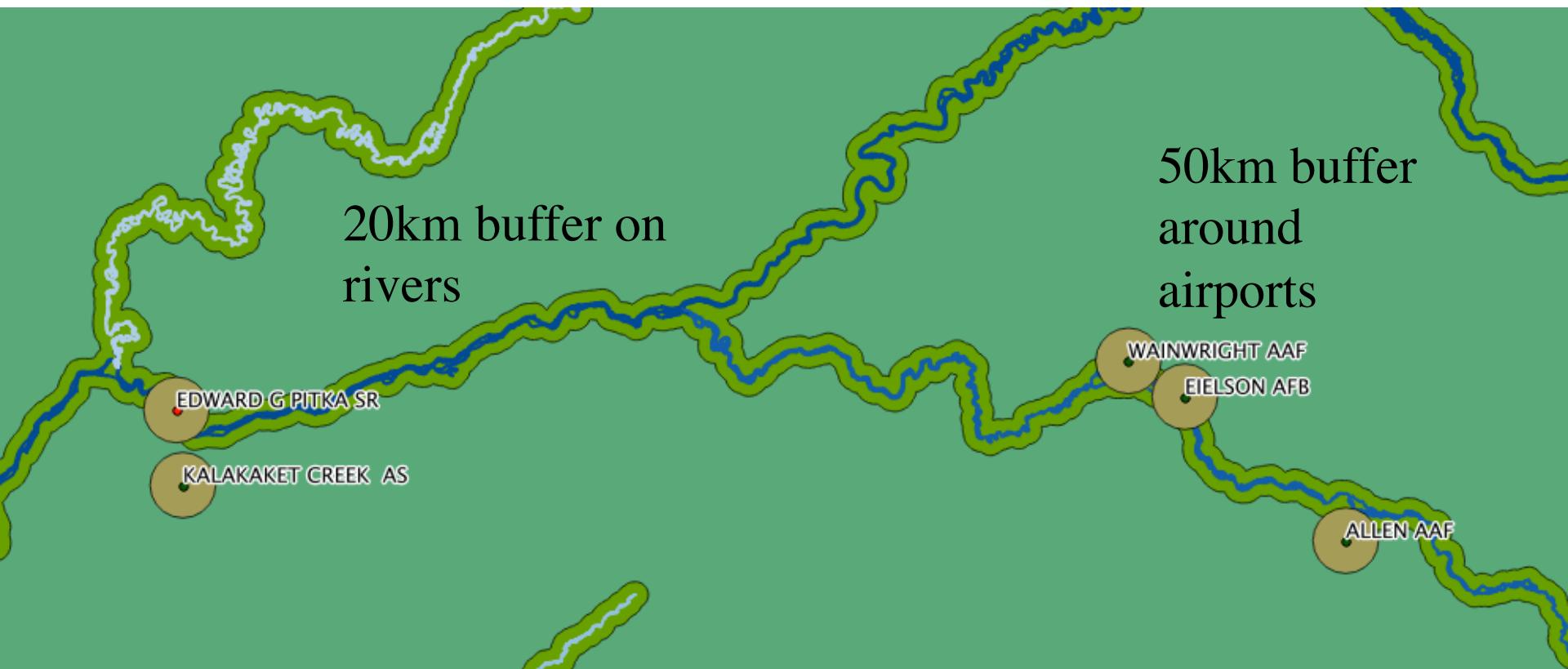


Near

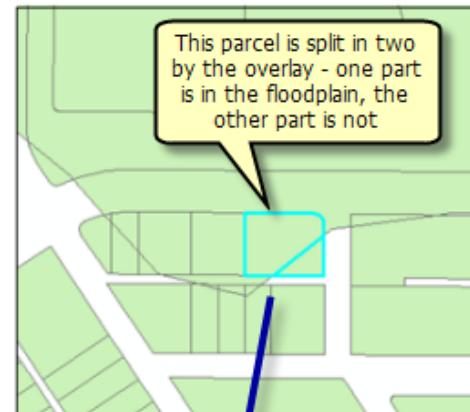
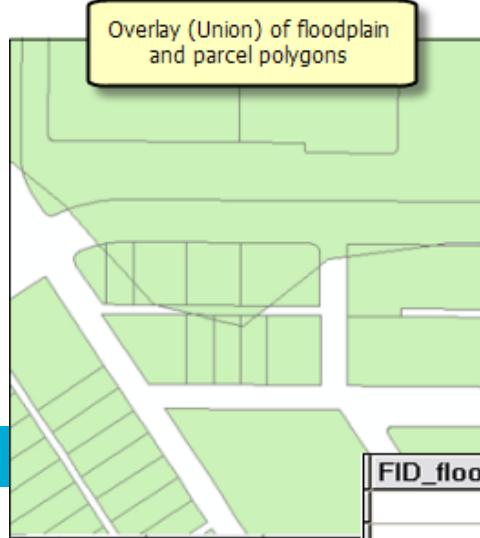
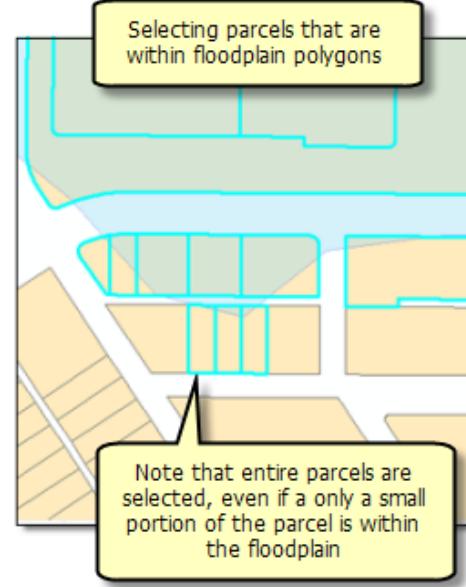
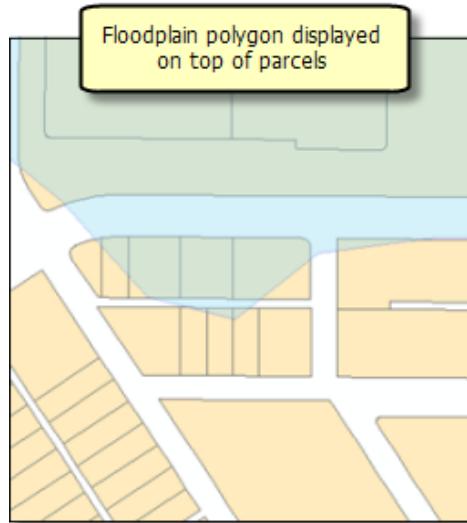


Geoprocessing: Vector

Buffer

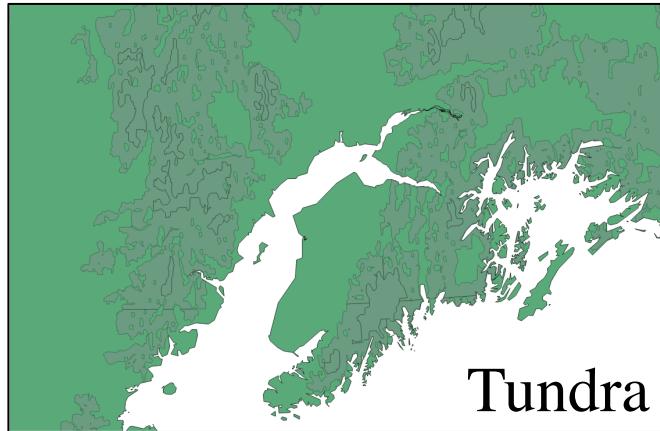


Geoprocessing: Overlay Analysis

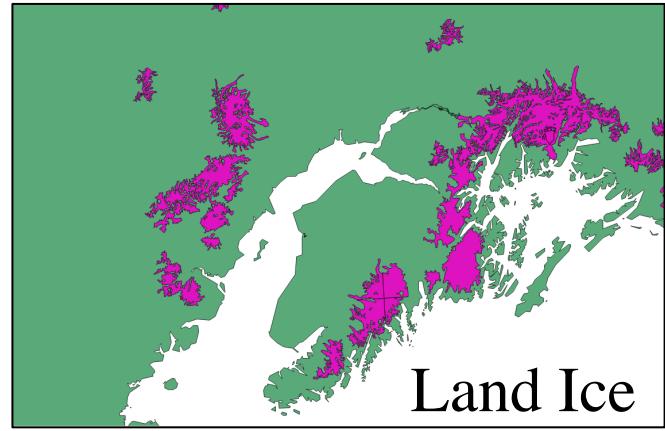


FID_flood	FID_parcels	Landuse	Shape_Area
3	500	PI	1013.98214
3	501	PI	1093.83982
-1	502	PI	335.67542
3	502	PI	1270.84552
-1	503	PI	389.41059

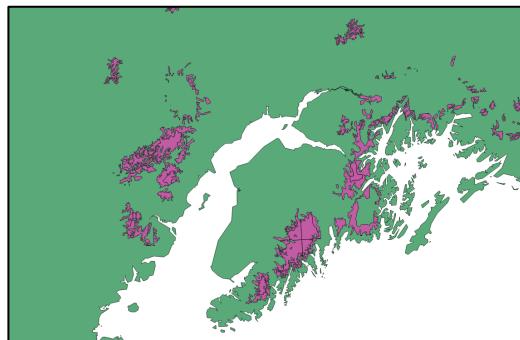
Geoprocessing: Vector



Tundra



Land Ice

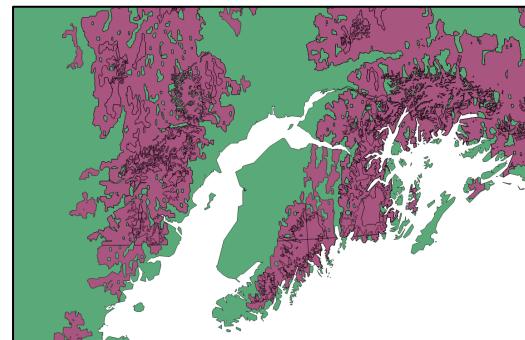


Tundra Intersect Land Ice

 Intersect



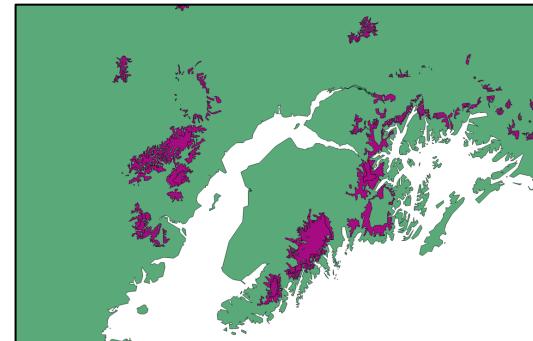
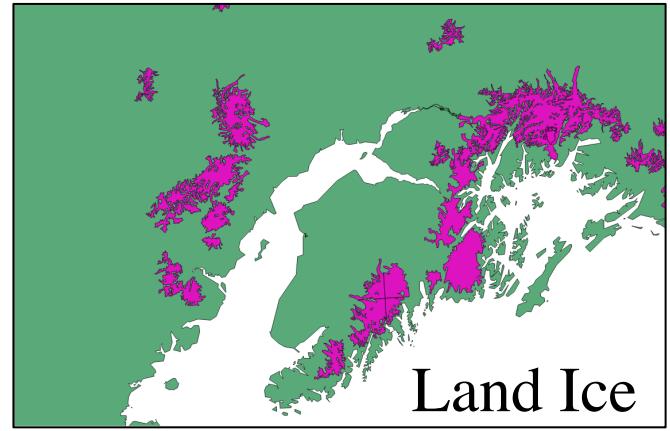
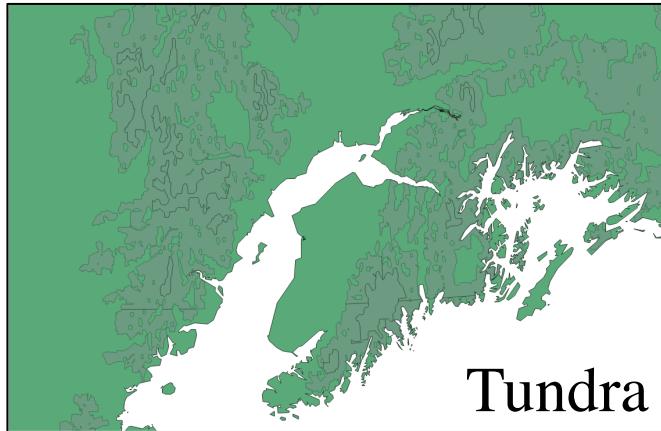
Symmetrical
Difference
 Symmetrical difference



Union

 Union

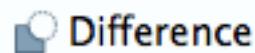
Geoprocessing: Vector



Clip

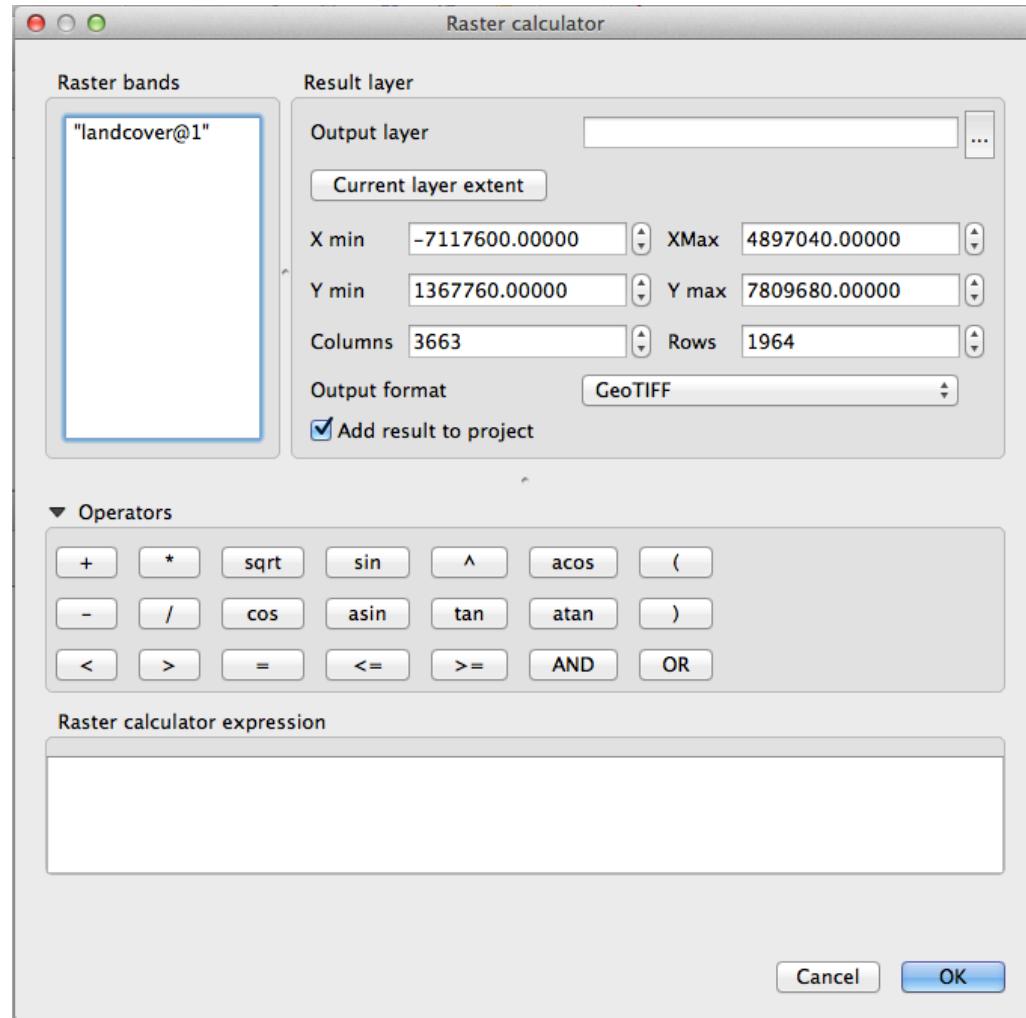


Difference



Geoprocessing: Raster

Raster Calculator

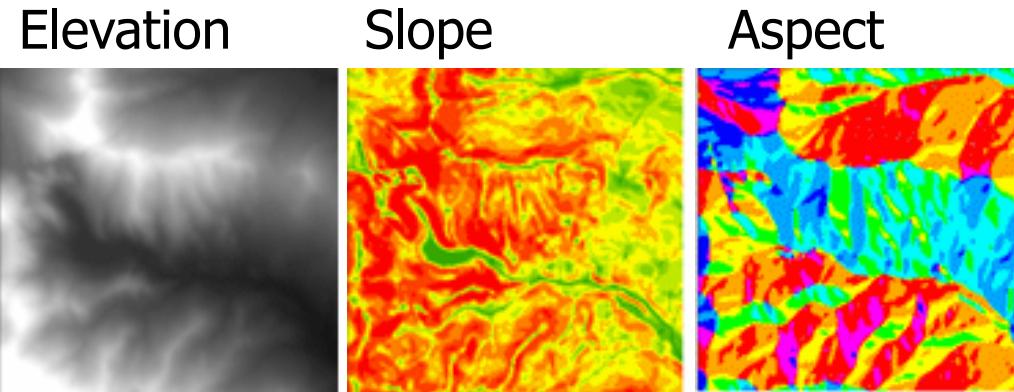


86

<http://spatialgalaxy.net/2012/01/25/using-the-qgis-raster-calculator/>
http://www.qgistutorials.com/en/docs/raster_styling_and_analysis.html

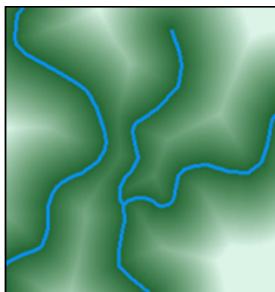
Geoprocessing: Raster

Terrain Analysis (more later with GRASS)

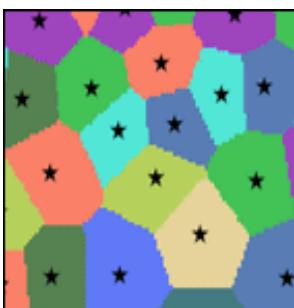


Geoprocessing: Proximity Analysis

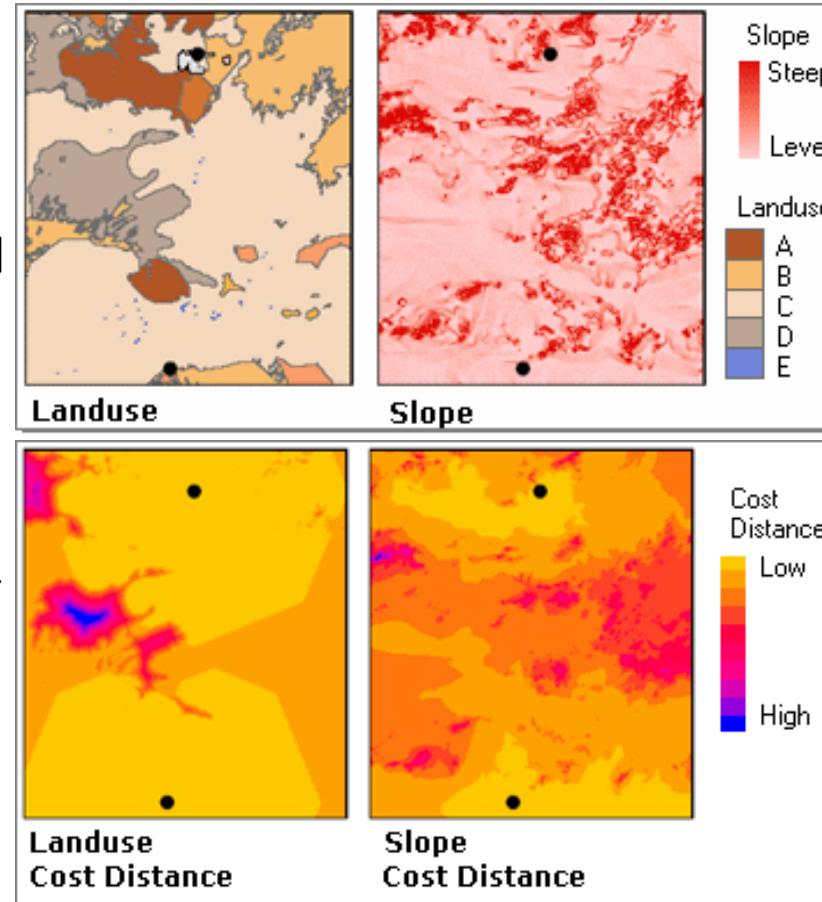
Euclidean Distance



Euclidean Allocation



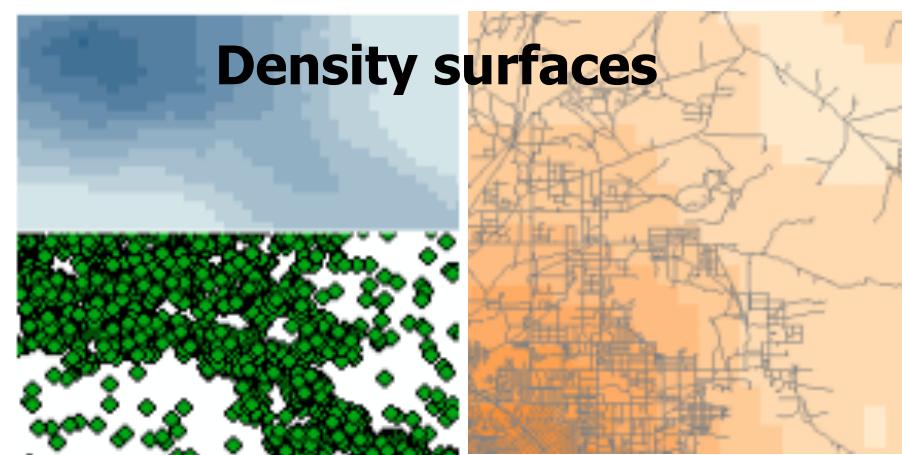
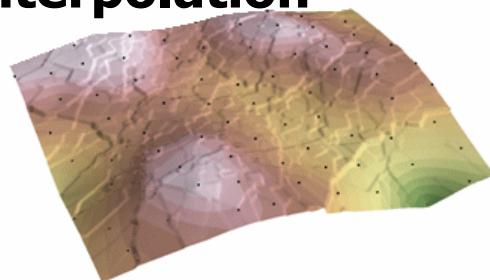
Cost Distance



Geoprocessing: Surface creation & analysis

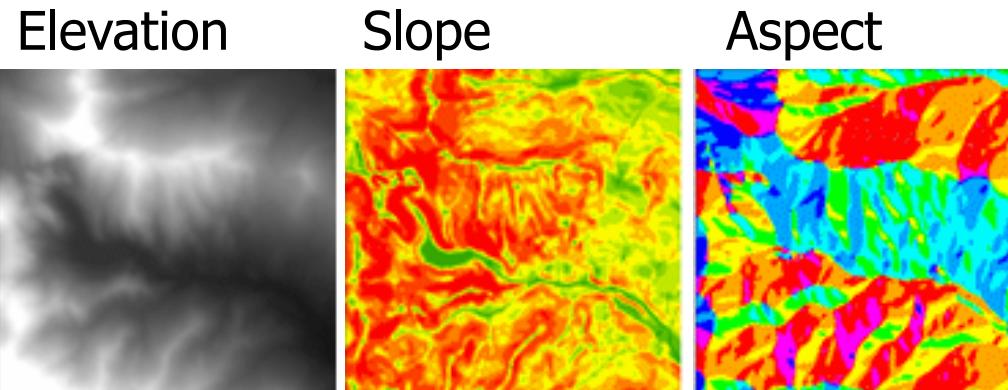


Geostatistical Interpolation

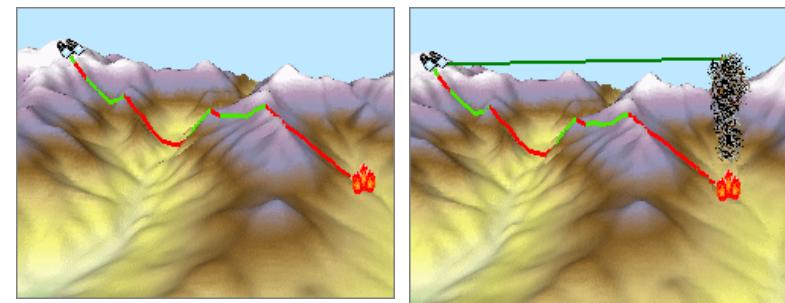


Geoprocessing: Surface creation & analysis

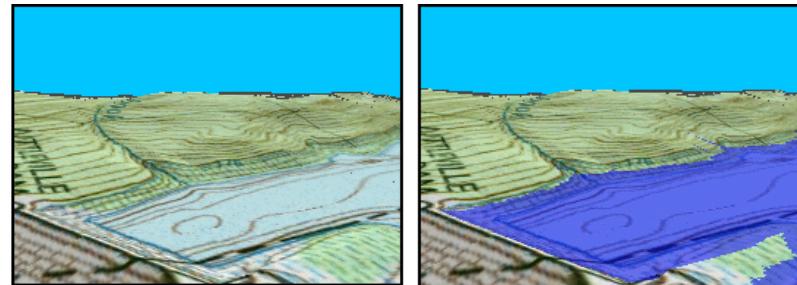
Terrain Analysis



Visibility tools



Volume tools



Activity: GIS data models for Water Resources Management

For your task:

- 1) What are the steps involved in solving your problem? i.e. how do you use your data to make a decision?**
- 2) Are there any tools that you've seen today that might be helpful?**

3 minutes - Think by yourself and make a list

10 minutes – Combine your list with the rest of your group and brainstorm

15 minutes - Share results with whole class.

Do they have any additional suggestions?

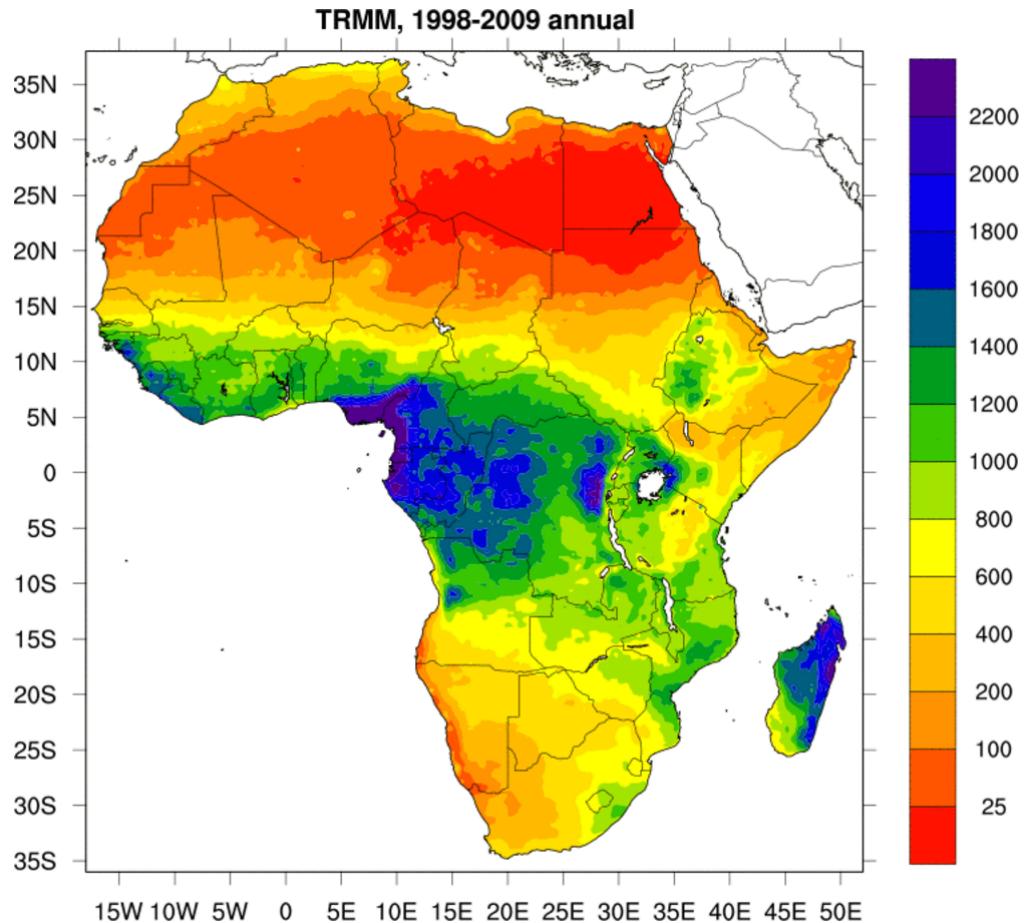
(Each group appoint someone to write notes, and someone to present to whole class)

CT5401 – Lecture 1

Introduction to GIS

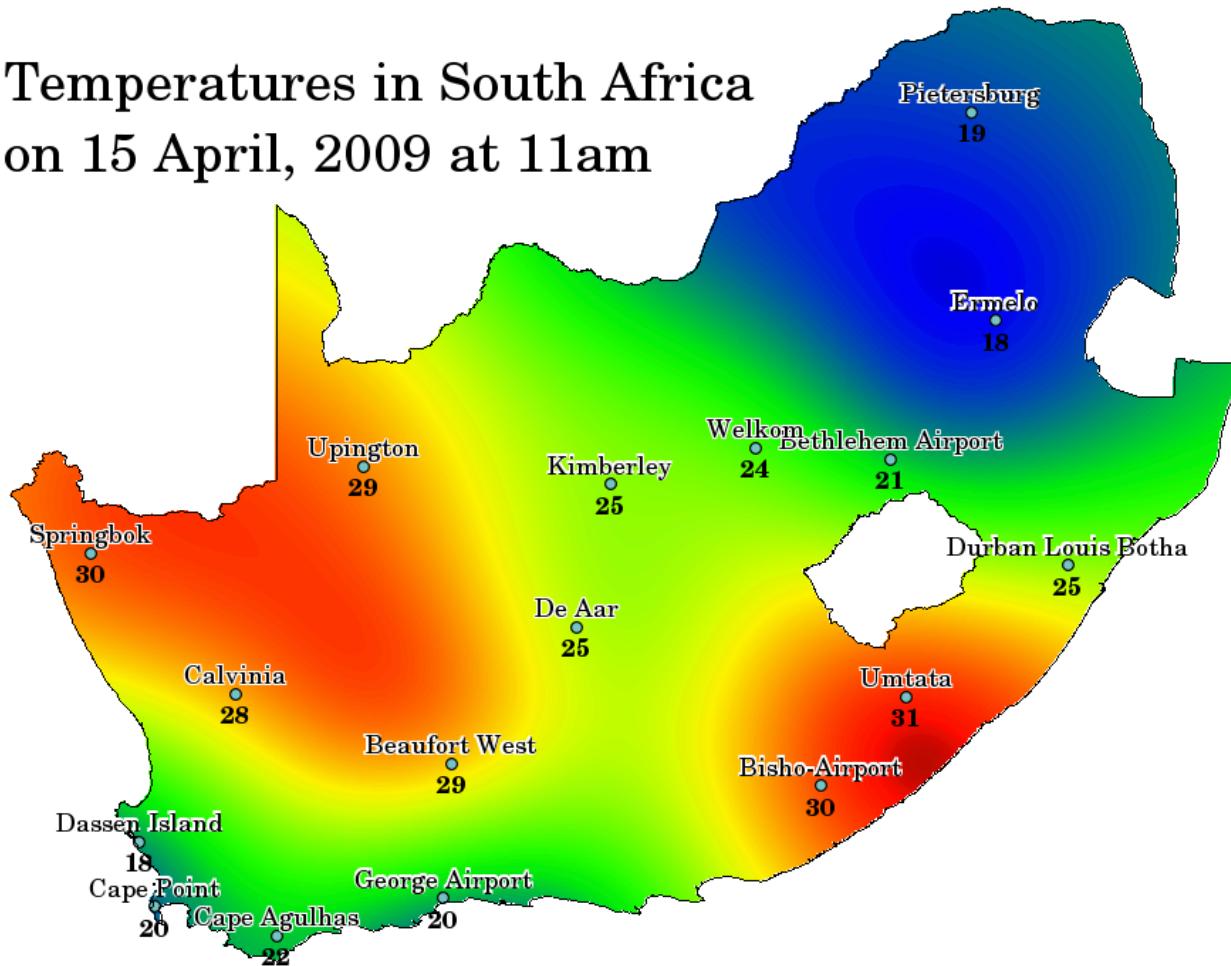
- What is GIS?
- Data models to represent our world
- Functions of a GIS
- **Real applications of GIS in Hydrology and Water Resources Management**
- Introduction to Assignment 1

Work with and map RS data

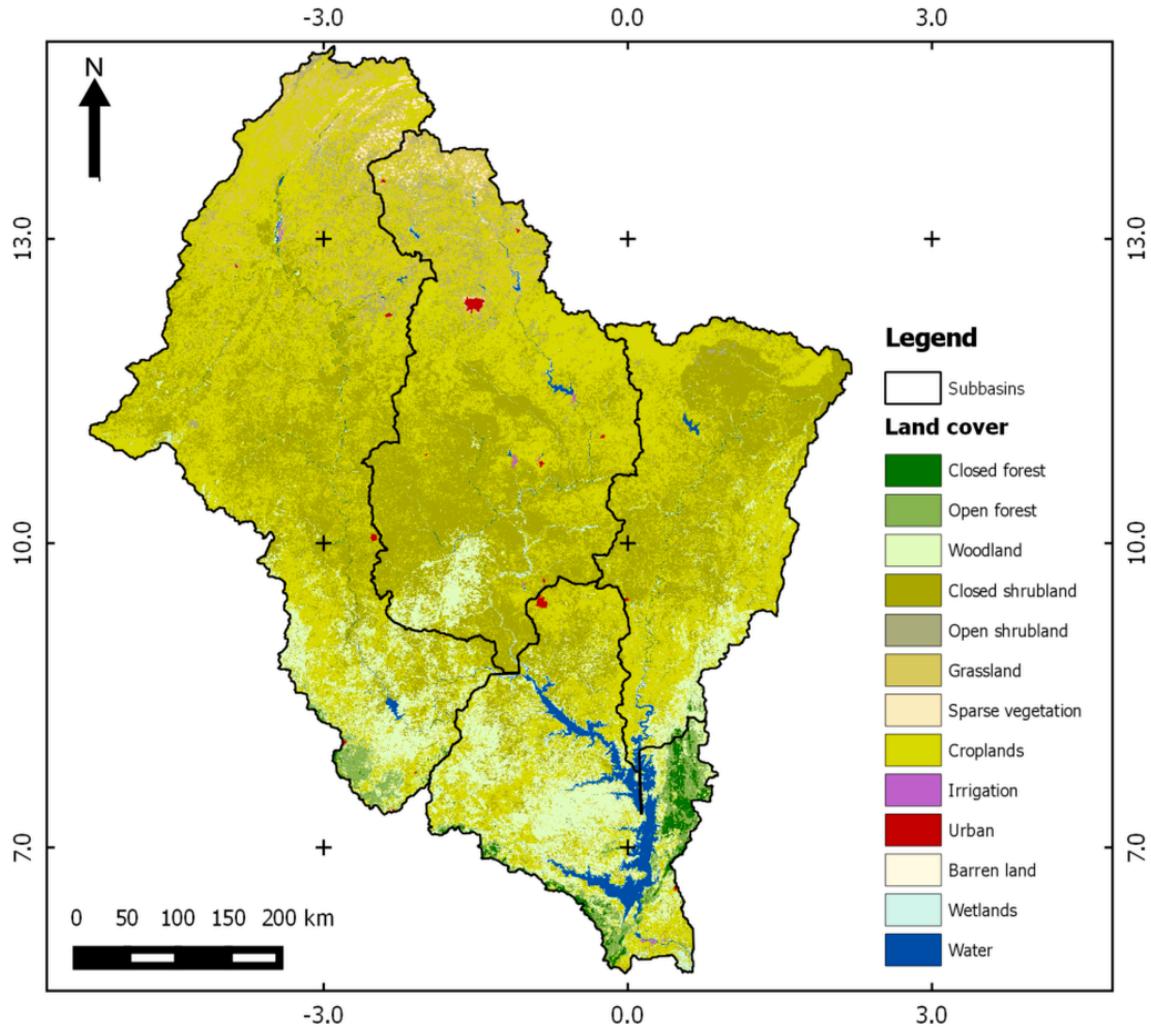


Interpolation (e.g. station data)

Temperatures in South Africa
on 15 April, 2009 at 11am

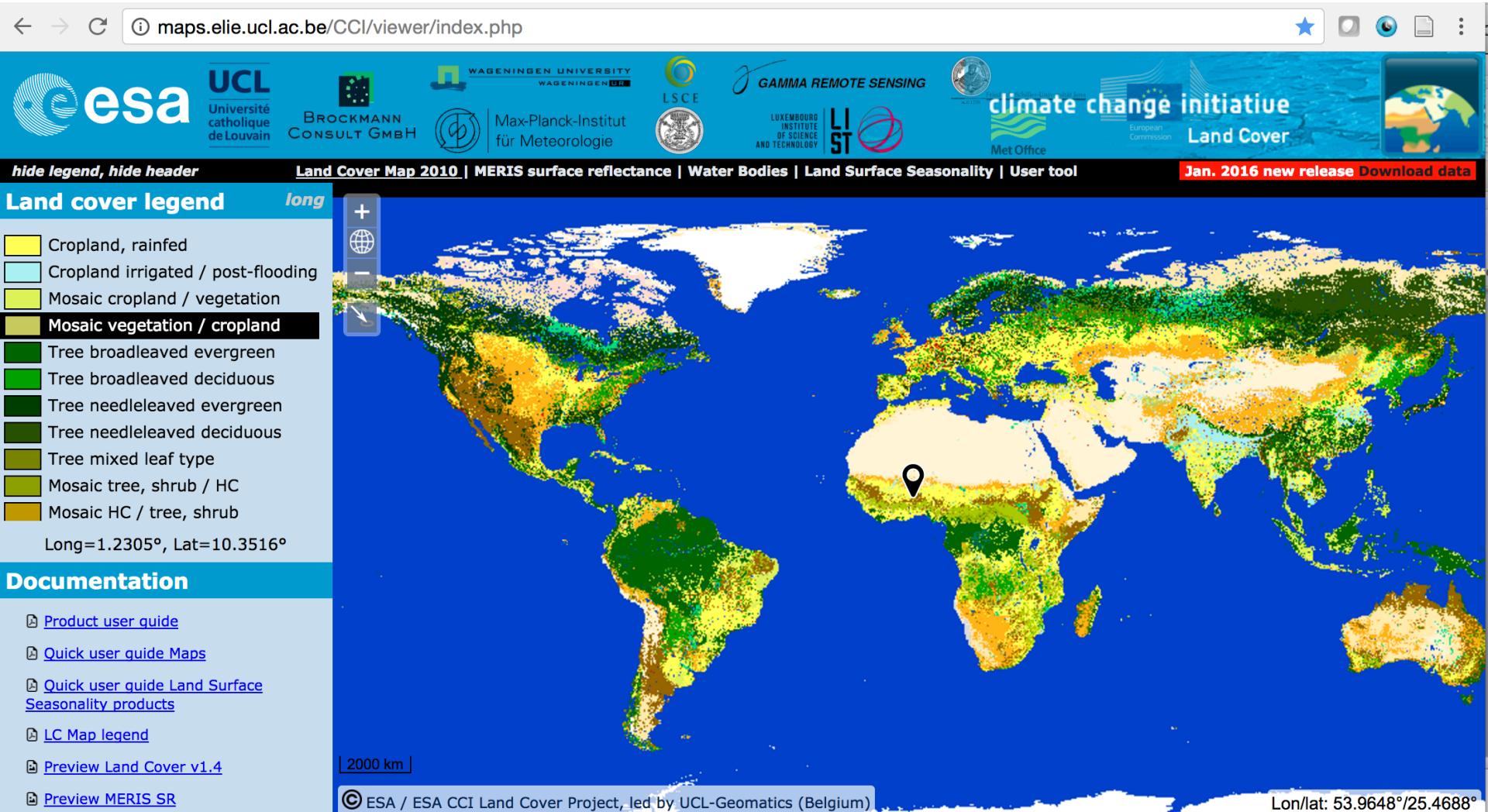


Delineate watersheds

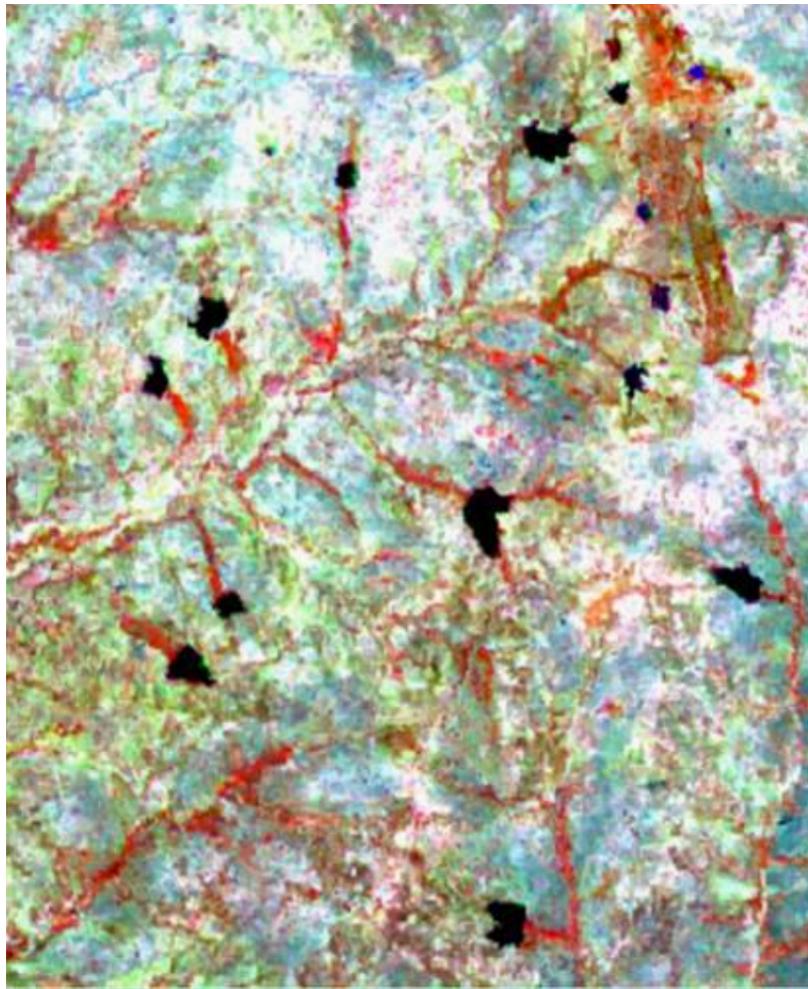


Guzinski et al.
(Remote Sensing, 2014)

Classification



Classification



Detecting
small
reservoirs

CT5401 – Lecture 1

Introduction to GIS

- What is GIS?
- Data models to represent our world
- Functions of a GIS
- Real applications of GIS in Hydrology and Water Resources Management
- **Introduction to Assignment 1**

Introduction to Assignment 1

Part 1: Population

Calculate the total population of the Volta Basin.

Use QGIS Print Composer to make a map showing the Volta Basin outline overlaying the population count map.

Part 2: Household water demand

Assume that household water use is 90 liters per person per day in urban areas and 40 liters per person per day in rural areas. Calculate the total household water demand for the population in the Volta basin.

Part 3: Transboundary River basin

Use field calculator to calculate the area in km² of the Volta Basin.

The Volta basin is shared by six countries: Burkina Faso, Ghana, Togo, Mali, Benin, and Cote d'Ivoire. Calculate the percentage of the total Volta basin area belonging to each of the six countries. Use QGIS Print Composer to make a map showing the Volta Basin outline and the country outlines.



Data: Country outlines

The screenshot shows the homepage of the GADM.org website. The header features the title "Global Administrative Areas" and the subtitle "Boundaries without limits". Below the header is a navigation bar with four buttons: "Download" (highlighted in white), "Known problems", "About", and "Contact". The main content area is titled "GADM database of Global Administrative Areas". It describes GADM as a spatial database of administrative areas for use in GIS software, mentioning various names for such areas across different regions. A note indicates the current version is 2.8 (November 2015) and the next release is January 2016. At the bottom is a world map showing administrative boundaries in red against a blue background.

Data: Population

sedac.ciesin.columbia.edu

EARTHDATA Data Discovery DAACs Community Science Disciplines

 SOCIOECONOMIC DATA AND APPLICATIONS CENTER (SEDAC)
A Data Center in NASA's Earth Observing System Data and Information System (EOSDIS) — Hosted by CIESIN at Columbia University

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Tools and Apps - SEDAC Map Viewer

GPWv4: Population Density - 2015
SDEI: PM 2.5 Grids from MODIS, MISR and SeaWiFS,...
Anthropogenic Biomes v2: 2000
Probabilities of Urban Expansion to 2030

The SEDAC Map Viewer is a Web mapping tool for visualizing all SEDAC map layers. Maps are organized by data collection and theme and up to four windows can be displayed at a time.

SEDAC Hazards and Population Mapper (HazPop)
Population Estimation Service (PES)
SEDAC Map Viewer

101

Data: River basin outline

www.fao.org/geonetwork/srv/en/main.home?uuid=e54e2014-d23b-402b-8e73-c827628d17f4

FAO // GeoNetwork [Find and analyze geo-spatial data]

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Username _____ Password _____ Login

WHAT? _____

WHERE?

World map with search and zoom tools.

- Any -

Show map

FIND INTERACTIVE MAPS, GIS DATASETS, SATELLITE IMAGERY AND RELATED APPLICATIONS

Map icons: Email, Star, Print, Facebook, Google+

Identification info

Title: Hydrological basins in Africa (Derived from HydroSHEDS)
Date: 2009-01-28T15:23:00

Creation: Date identifies when the resource was brought into existence
First edition.
Digital map: Map represented in raster or vector form

Major hydrological basins and their sub-basins. This dataset divides the African continent according to its hydrological characteristics.

The dataset consists of the following information:- numerical code and name of the major basin (MAJ_BAS and MAJ_NAME); - area of the major basin in square km (MAJ_AREA); - numerical code and name of the sub-basin (SUB_BAS and SUB_NAME); - area of the sub-basin in square km (SUB_AREA); - numerical code of the sub-basin towards which the sub-basin flows (TO_SUBBAS) (the codes -888 and -999 have been assigned respectively to internal sub-basins and to sub-basins draining into the sea)

To assess which part of the land area flows to which river. The dataset is developed as part of an assessment of water



A red oval highlights the 'Title' and 'Date' fields in the 'Identification info' section.

102

Report

- 1) Answers to questions
- 2) Map made in Print Composer
- 3) Flow chart/description of tools used to find the answers.