GIS Data Sources for Water Resources
Outline

• The hierarchical system of watersheds and basins
• Where to obtain data and maps
• National/State/Global Data repositories
  – Hydrography
  – USGS National Water Information System
  – Land Cover
  – Census
  – Elevation
  – Soil (Statsgo/Surgo)
  – Weather
  – Regional data for Oregon
There are 18 water resources regions in the Continental United States 2-digit water resource regions.

- Region 01 New England
- Region 02 Mid-Atlantic
- Region 03 South Atlantic-Gulf
- Region 04 Great Lakes
- Region 05 Ohio
- Region 06 Tennessee
- Region 07 Upper Mississippi
- Region 08 Lower Mississippi
- Region 09 Souris-Red-Rainy
- Region 10 Missouri
- Region 11 Arkansas-White-Red
- Region 12 Texas-Gulf
- Region 13 Rio Grande
- Region 14 Upper Colorado
- Region 15 Lower Colorado
- Region 16 Great Basin
- Region 17 Pacific Northwest
- Region 18 California
- Region 19 Alaska (Old numbering system)
- Region 20 Hawaii
- Region 21 Caribbean
Watershed Region Hierarchy

Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system.
Watershed Hierarchy

Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to or more digits based on the levels of classification in the hydrologic unit system.

HAW HUC 8 0303002
Little Creek HUC 12 030300020603
Watersheds of the US
(Every watershed has a unique number!!!)

An eight-digit code uniquely identifies each of the four levels of classification:

Hydrologic Unit Code 01080204:

01-Region (2-digit)
0108 - The subregion (4-digit)
010802 - The accounting Region (6-digit)
01080204 - The cataloging unit (8-digit HUC)
Hydrologic Unit Code Watersheds

~ 2000 8-HUC for US, about the size of counties
National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD)

• The NHD and WBD are used to portray surface water on The National Map.
• The NHD represents the drainage network with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and stream gages. Vector data.
• The WBD represents drainage basins as enclosed areas in eight different size categories. Vector data.
• Both datasets represent the real world at a nominal scale of 1:24,000-scale or 1” on map = 2,000 feet on the ground.
Watershed Boundary Dataset


- National Program by USGS and USDA (NRCS)
- Boundaries for 10- and 12- digit watersheds
- First cut is by automated delineation from NED
- Hand checked and edited
River networks and attributes for watersheds

http://nhd.usgs.gov/
NHDPlus Version 2.1

Foundation for a Geospatial Hydrologic Framework for the United States

NHDPlus

2.7 million reach catchments in US
average area 3 km²
reach length 2 km
Uniquely labelled

Watershed Boundary Dataset

National Elevation Dataset

National Hydrography Dataset

National Land Cover Dataset
As a member of the NHDPlus team, Horizon Systems is pleased to host the NHDPlus WEB site. NHDPlus is a project envisioned by the US Environmental Protection Agency. The EPA Office of Water, assisted by the US Geological Survey, has supported the development of NHDPlus to enhance the EPA WATERS application. NHDPlus is an integrated suite of application-ready geospatial data sets that incorporate many of the best features of the National Hydrography Dataset (NHD), the National Elevation Dataset (NED), the National Land Cover Dataset (NLCD), and the Watershed Boundary Dataset (WBD).

First released in 2006, the NHDPlus consists of nine components:

- Greatly improved 1:100K National Hydrography Dataset (NHD)
- A set of value added attributes to enhance stream network navigation, analysis and display
- An elevation-based catchment for each flowline in the stream network
  - Catchment characteristics

http://www.horizon-systems.com/nhdplus/

NHDPlus – 1:24,000. Improved over 1:100K NHD
The National Hydrography Dataset (NHD)

- Surface water of the United States.
- Points - stream gages and dams.
- Lines - streams and smaller rivers;
- Lines - water flow through area features (lake)
- Network of water and transported material flow to allow users of the data to trace movement in downstream and upstream directions.
National Hydrography Dataset

STREAM/RIVER (Line)

INUNDATION AREA (Area)

SPRING/SEEP (Point)

ARTIFICIAL PATH (Line)

LAKE/POND (Area)

SUBMERGED STREAM (Area)

STREAM/RIVER (Area)
NHDPlus for a Portion of Oregon

http://www.horizon-systems.com/nhdplus/
NHD and WBD: Attributes and Networking

- The NHD and WBD are used with other data themes such as elevation, boundaries, transportation, and structures to produce general reference maps.
- The NHD and WBD are coupled with a rich set of attributes imbedded in the data to generate specialized information.
- These analyses are possible because the NHD contains a flow network that allows for tracing water downstream or upstream.
- The NHD and WBD use an addressing system based on reach codes and linear referencing to link specific information about the water such as water discharge rates, water quality, and fish population.
• Slope
• Elevation
• Mean annual flow
  – Corresponding velocity
• Drainage area
• % of upstream drainage area in different land uses
• Stream order

http://www.horizon-systems.com/nhdplus/
River Reach Codes
Used for river address locations

ReachCode = 12030102000005

ReachCode = 12030102000151

Location 0.392 on Reach 120301020000005
Linear Referencing on Flowlines

Using measures, the flow can be estimated at any point along the line.

Bridge and Stream Gage at RR 12 is at Measure 70.246 on Flowline 1630223.

Measure is the % distance upstream from most downstream point on line.
The National Map

http://nationalmap.gov/

A central source for US Government data
National Elevation Dataset

http://ned.usgs.gov/

- Digital Elevation Model with 1 arc-second (30m), 1/3 arc-second (10m) and some 1/9 arc second (3m) cells
- Distributed as part of the National Map
- 10 billion data
- Derived from USGS 1:24,000 quadrangle sheets and at higher resolution from LIDAR

Get the data:  http://nationalmap.gov/viewer.html
National Elevation Dataset Availability

From http://nationalmap.gov/viewer.html
For LIDAR data: Go to http://lidar.cr.usgs.gov/
Oregon LiDAR Data Server OSU

- Andrew Meigs, College of Earth, Oceanic, and Atmospheric Sciences
- Michael Olsen, School of Civil and Construction Engineering
- Paul Montagne, School of Civil and Construction Engineering
- 1m or 3ft DEM
Appendix 1. How to access the data

1. Using windows explorer (or equivalent in other operating systems), go to the network address:
   \lidar.engr.oregonstate.edu\lds

2. You will likely need to login with your ONID account and specify the onid domain. If you do not have an ONID account, you will not be able to access the data at this time. The login screen will look something like this, replacing xxxxxx with your user name:
Digital Elevation Model (DEM)-30 meter
Global DEM: SRTM (90m DEM)

Under agreement with NASA, the USGS EROS Data Center distributes and archives SRTM data in accordance with a joint partnership Memorandum of Understanding between NASA and NGA.

SRTM Data is available in a "finished" grade version for both DTED® and SRTM Raster formats. See Obtaining "Finished" SRTM Data for more information about search and ordering.

To learn more about retrieving "unfinished" or research grade data from the Seamless environment, see Obtaining "Unfinished" SRTM Data for more information.

For more information on SRTM visit JPL's SRTM website.
HydroSheds derived from SRTM

HydroSHEDS

(Hydrological data and maps based on SHuttle Elevation Derivatives at multiple Scales)

HydroSHEDS is a mapping product that provides hydrographic information for regional and global-scale applications in a consistent format. It offers a suite of geo-referenced data sets (vector and raster) at various scales, including river networks, watershed boundaries, drainage directions, and flow accumulations. HydroSHEDS is based on high-resolution elevation data obtained during a Space Shuttle flight for NASA's Shuttle Radar Topography Mission (SRTM).

http://hydrosheds.cr.usgs.gov/
Produced from Shuttle Radar Topography Mission

HydroSHEDS
Amazon Basin

River network derived from SRTM elevation data at 500 m resolution

Only major rivers and streams are visualized

River line width proportional to upstream basin area

0 500 1000
Kilometers
Global DEM: GTOPO30

1 km DEM, Model of the Earth

https://lta.cr.usgs.gov/GTOPO30
Drainage in North America

Hydro1K is derived from GTOPO30 using raster GIS analysis

https://lta.cr.usgs.gov/HYDRO1K
Soil Data

- Natural Resources Conservation Service (NRCS)
- State Soil Geographic Database-STASGO
- Soil Survey Geographic Database- SURGO

http://www.soils.usda.gov/survey/geography/ssurgo/
1:250,000 Scale Soil Information

https://gdg.sc.egov.usda.gov/
SSURGO: County Level Digital Soil Maps

1:24,000 scale soil information

Just released, 2005 North America Land Cover at 250 m spatial resolution
This product is based on observations acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS). The classification legend is designed in three hierarchical levels using the Food and Agriculture Organization (FAO) Land Classification System. Level I and II are common for North America while level III is country specific.

Access the North American Land Cover data.

Mission
The USGS Land Cover Institute (LCI) is a focal point for advancing the science, knowledge, and application of land use and land cover information.

What can LCI do for you?
The USGS and other agencies and organizations have produced land cover data to meet a wide variety of spatial needs. The USGS LCI has been established to provide access to, and scientific and technical support for, the application of these land cover data.

Learn more... Click here!

http://landcover.usgs.gov/
National Land Cover Dataset


Get the data:  http://www.mrlc.gov/
# NLCC Regional Land Cover Classification System Key

**Water**

- 11 Open Water
- 12 Perennial Ice/Snow

**Developed**

- 21 Low Intensity Residential
- 22 High Intensity Residential
- 23 Commercial/Industrial/Transportation

**Barren**

- 31 Bare Rock/Sand/Clay
- 32 Quarries/Strip Mines/Gravel Pits
- 33 Transitional

**Forested Upland**

- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest

**Shrubland**

- 51 Shrubland

**Non-Natural Woody**

- 61 Orchards/Vineyards/Other

**Herbaceous Upland Natural/Semi-natural Vegetation**

- 71 Grasslands/Herbaceous

**Herbaceous Planted/Cultivated**

- 81 Pasture/Hay
National Water Information System (NWIS)

- Water observations data, such as streamflow, groundwater levels and water quality, are obtained from the USGS *National Water Information System*.

- The maps describing observation sites are well suited for GIS representation but…

- Time-indexed observational datasets are less so, and incorporating time series data within GIS is still a challenge.
National Water Information System

**NWISWeb Data for the Nation**

**Data Category**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Real-time</strong></td>
<td>Current-conditions data transmitted from selected surface water, ground-water, and water-quality sites</td>
</tr>
<tr>
<td><strong>Site information</strong></td>
<td>Descriptive site information for all sites with links to all available water data for individual sites.</td>
</tr>
<tr>
<td><strong>Surface water</strong></td>
<td>Water flow and levels in streams, lakes, and springs.</td>
</tr>
<tr>
<td><strong>Ground water</strong></td>
<td>Water levels in wells.</td>
</tr>
<tr>
<td><strong>Water quality</strong></td>
<td>Chemical and physical data for streams, lakes, springs, and wells.</td>
</tr>
</tbody>
</table>

Web access to USGS water resources data in real time

USGS Water Watch

Daily Streamflow Conditions

Monday, September 09, 2013 14:30ET

Explanation

- Black: High
- Deep Blue: > 90th percentile
- Medium Blue: 76th - 90th percentile
- Light Blue: 25th - 75th percentile
- Orange: 10th - 24th percentile
- Red: < 10th percentile
- Gray Circle: Not ranked

Web access to USGS water resources data in real time
http://waterdata.usgs.gov/nwis/rt
USGS National Water Information System

• Real-time and Historic Data
  – Streamflow and stage
  – Groundwater levels
  – Water Quality
  – Site information

• Tabular or Graphical Format

```
agency_cd  site_no  dv_dt  dv_va
  5s       15s     10d     12n   3s
USGS  08158000  1999-01-24  152
USGS  08158000  1999-01-25  333
USGS  08158000  1999-01-26  1180
USGS  08158000  1999-01-27  1160
USGS  08158000  1999-01-28  1030
USGS  08158000  1999-01-29  184
USGS  08158000  1999-01-30  151
USGS  08158000  1999-01-31  158
USGS  08158000  1999-02-01  150
USGS  08158000  1999-02-02  152
USGS  08158000  1999-02-03  154
USGS  08158000  1999-02-04  155
```
http://www.wcc.nrcs.usda.gov/snotel/

Select a State

Snotel Information and Technology
Geospatial Data Gateway
Get Data – by state or county
# Geospatial Data Gateway

## Cadastral
- Public Land Survey System (PLSS) Townships, 36 maps 8.793 MB
- Public Land Survey System (PLSS) Sections, 36 maps 66.863 MB

## Census
- TIGER 2010 Census Blocks, 36 maps 335.848 MB
- TIGER 2010 Census Block Groups, 36 maps 25.095 MB
- TIGER 2010 Census Tracts, 36 maps 14.684 MB

## Climate Precipitation
- 1971-2000 Monthly Average Precipitation by State, 12 maps 43.150 MB
- 1971-2000 Annual Average Precipitation by State, 1 map 17.994 MB
- 1981-2010 Monthly Average Precipitation by State, 12 maps 54.858 MB
- 1981-2010 Annual Average Precipitation by State, 1 map 50.098 MB

## Climate PrismRaster
- 1961-1990 Annual Average Raster Precipitation by State, 1 map 3.084 MB
- 1971-2000 Annual Average Raster Precip and Temp by State, 1 map 36.742 MB
- 1981-2010 Annual Average Raster Precip and Temp by State, 1 map 21.659 MB

## Climate Temperature
- 1971-2000 Annual Average Minimum Temperature by State, 1 map 23.106 MB
- 1971-2000 Annual Average Maximum Temperature by State, 1 map 29.023 MB
- 1981-2010 Annual Average Minimum Temperature by State, 1 map 21.285 MB
- 1981-2010 Annual Average Maximum Temperature by State, 1 map 29.080 MB
# Geospatial Data Gateway

<table>
<thead>
<tr>
<th>Elevation</th>
<th>LiDAR Elevation Dataset - Bare Earth DEM - 1 Meter, 1 map 43.162 MB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LiDAR Elevation Dataset - Bare Earth DEM - 2 Meter, 1 map 11.138 MB</td>
</tr>
<tr>
<td></td>
<td>National Elevation Dataset 3 Meter, 708 maps 23549.576 MB</td>
</tr>
<tr>
<td></td>
<td>National Elevation Dataset 10 Meter, 1960 maps 12629.820 MB</td>
</tr>
<tr>
<td></td>
<td>National Elevation Dataset 30 Meter (60 meter AK), 47 maps 2053.434 MB</td>
</tr>
<tr>
<td>Elevation Derivatives</td>
<td>LiDAR Elevation Dataset - Bare Earth Slope - 1 Meter, 1 map 69.380 MB</td>
</tr>
<tr>
<td></td>
<td>LiDAR Elevation Dataset - Bare Earth Slope - 2 Meter, 1 map 17.399 MB</td>
</tr>
<tr>
<td></td>
<td>LiDAR Elevation Dataset - Bare Earth Aspect - 1 Meter, 1 map 24.930 MB</td>
</tr>
<tr>
<td></td>
<td>LiDAR Elevation Dataset - Bare Earth Aspect - 2 Meter, 1 map 17.317 MB</td>
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<tr>
<td></td>
<td>LiDAR Elevation Dataset - Bare Earth Hillshade - 1 Meter, 1 map 11.991 MB</td>
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<tr>
<td></td>
<td>LiDAR Elevation Dataset - Bare Earth Hillshade - 2 Meter, 1 map 2.782 MB</td>
</tr>
<tr>
<td>Geographic Names</td>
<td>Geographic Names - Populated Places, 36 maps 2.111 MB</td>
</tr>
<tr>
<td></td>
<td>Geographic Names - Non-Populated Places, 36 maps 76.435 MB</td>
</tr>
<tr>
<td>Geology</td>
<td>National scale Geology by State, 1 map 20.563 MB</td>
</tr>
<tr>
<td>Government Units</td>
<td>NRCS Counties by State, 1 map 1.440 MB</td>
</tr>
<tr>
<td></td>
<td>NRCS States by State, 1 map 0.520 MB</td>
</tr>
<tr>
<td></td>
<td>TIGER/NRCS 113th Congress Districts by State, 1 map 0.814 MB</td>
</tr>
</tbody>
</table>
### Geospatial Data Gateway

**Hydrography**
- National Hydrography Dataset 1:24,000, 4 maps 149.599 MB

**Hydrologic Units**
- 8 Digit Watershed Boundary Dataset, 4 maps 0.526 MB
- 10 Digit Watershed Boundary Dataset in HUC8, 4 maps 1.562 MB
- 12 Digit Watershed Boundary Dataset in HUC8, 4 maps 2.735 MB
- Watershed Boundary Dataset Lines for HUC2-12, 4 maps 3.597 MB

**Land Use Land Cover**
- National Land Cover Dataset by State, 1 map 46.157 MB
- Cropland Data Layer by State, 1 map 143.396 MB
Oregon Water Resources

Agency Resources

Resources For:
- Well Constructors
- Exempt Use Water Well Recording
- Realtors®
- Certified Water Right Examiners
- Water Conservation
- Drought Watch
- Conservation and Supply Resources and Programs
- Deschutes Basin Mitigation Program
- Environmental Justice
- Gold Mining: FAQ
- Assignments and Ownership Updates

Lookup Information:
- Lookup Water Rights
- Find Out if a Property has a Water Right
- Find a Well Log
- Well ID Application Form
- Find a Document (Vault)
- Near Real Time Streamflow Data
- Ground Water Data
- Dams in Oregon
- Work Groups
# Other Related Data Sources

## Other Sources of Gage Data

<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
</table>

## Geographic Data

<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topozone</strong> <a href="http://topozone.com">http://topozone.com</a></td>
<td>Allows you to input a place name (or browse by USGS topo sheet) and zoom in and view the topo maps at different scales (e.g. 1:100k, 1:24k). Print 8.5x11 maps for free or pay to order other maps.</td>
</tr>
</tbody>
</table>

## Other Environmental Data

<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oregon Climate Service</strong> <a href="http://www.ocs.oregonstate.edu/">http://www.ocs.oregonstate.edu/</a></td>
<td>Provides climate, precipitation, and temperature data.</td>
</tr>
<tr>
<td><strong>Oregon Explorer</strong> <a href="http://oregonexplorer.info">http://oregonexplorer.info</a></td>
<td>Integrates many sources of environmental data and includes an online GIS tool that allows you to view data about fish populations, water quality listed streams, etc. as well as view topographic maps and aerial photos.</td>
</tr>
<tr>
<td><strong>Oregon Department of Environmental Quality Databases, GIS and Mapping Applications</strong> <a href="http://www.deq.state.or.us/news/databases.htm">http://www.deq.state.or.us/news/databases.htm</a></td>
<td>Water quality data and links.</td>
</tr>
<tr>
<td><strong>Oregon Water Resources Department</strong> <a href="http://egov.oregon.gov/OWRD/">http://egov.oregon.gov/OWRD/</a></td>
<td>Includes an online mapping tool and database that allows you to view water rights and watermaster district information.</td>
</tr>
<tr>
<td><strong>EPA Surf Your Watershed</strong> <a href="http://cfpub.epa.gov/surf/">http://cfpub.epa.gov/surf/</a></td>
<td>Provides overview information about regional basins and links to local citizen conservation groups there.</td>
</tr>
</tbody>
</table>
Western Regional Climate Center

http://www.wrcc.dri.edu/

**Historical Climate Information**
Western U.S. Historical Summaries; Precipitation Maps; Station Inventories; Wind and Evaporation Data; Coastal Water Table; State Narratives; Station Descriptions; Anomalies.

**Current Observations, Forecasts and Monitoring**
Nat'l Weather Service Current and Past 24-hour Reports; Snotel; Climate Prediction Center Outlooks; Satellite and Radar Imagery; SPI; Anomalies; Divisional Climate Plots;

**WRCC Projects**
El Nino & La Nina; CEMP; WET; BLM RAWS; Yucca Mtn; Current Weather Plots; NSOE; Snotel; California Climate Data Archive; Photo Gallery; Webcam.

**More Climate Information**
Solar Radiation, Sunrise/Sunset Information (USNO); WGA data and information; Nat'l Climatic Data Center, Climate Prediction Center; CEFA; Nat'l Drought Mitigation Center.
What is Cloud Computing?
Following slides are from Dr Kristin Tolle, Microsoft Research Connections
MICROSOFT’S DATA CENTER EVOLUTION

- Data Center Co-Location Generation 1
- Quincy and San Antonio Generation 2
- Chicago and Dublin Generation 3
- Modular Data Center Generation 4

Deployment Scale Unit

- Server: Capacity
- Rack: Density & Deployment
- Containers: Scalability & Sustainability
- IT PAC: Time to Market, Lower TCO

Powered by Windows Azure
Inside a Container

Compute Rack
2 “Side by Side” Servers

Disk Sled Rack

On the truck
At the Manufacturer’s Austin Plant (Dell)
CONTAINERS ARRIVING IN LONGMONT COLORADO
Modular Cloud Construction
COMPUTE/STORAGE CONTAINER

Transformer & UPS

Air Flow Vents
Completed Cloud Computing facility in Longmont, Colorado
These Data Centers are at the Center of the Cloud

<table>
<thead>
<tr>
<th>AWS</th>
<th>North America</th>
<th>US West (Oregon)</th>
<th>Boardman, OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWS</td>
<td>North America</td>
<td>GovCloud</td>
<td>Portland, OR or Seattle, WA</td>
</tr>
</tbody>
</table>

You can access a larger version [here](#).

People thought that our previous post on this topic was helpful, so we wanted to provide some more insight. We have been looking into the physical side of the cloud— the data centers that Amazon, Google, Microsoft and others use to host the infrastructure that powers our applications. We initially focused on trying to figure out where the data centers are physically located (which is a more difficult task than you might expect) and ended up compiling some other information that we think might be interesting to others:
ArcGIS Online: Maps about the Earth

http://www.arcgis.com/home/gallery.html#c=esri&t=maps&o=modified
Transition from Datasets to Data Services

• The transition from datasets to data services that is currently going on in GIS is based on cloud computing where computation is done on remote computer systems that are highly standardized computational and data storage machines.

• As in other fields, aggregation of information in a few, centralized systems is becoming a trend that is facilitating integration of information from disparate fields.
ArcGIS Services

An **image service** – access to **continuous dataset (raster)** such as elevation, land cover or soils, where what you see on the screen is just an image.

Behind it – is **computing cloud and the data themselves**, aggregated across the United States, and in some cases across the world,

**Geoprocessing services** can be performed upon them, as if they were on your local computer.

A **dynamic map service** similarly creates an image map of **vector** GIS data and permits extraction of vector datasets (“Extract Landscape Source Data”) for a limited region of space.
ArcGIS Services are Accessed through Catalog
ArcGIS Online Services

http://landscape1.arcgis.com/arcgis/services/
http://landscape2.arcgis.com/arcgis/services/
http://landscape3.arcgis.com/arcgis/services/
http://elevation.arcgis.com/arcgis/services/
http://hydro.arcgis.com/arcgis/services