# The CUAHSI Community Hydrologic Information System

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CUAHSI HIS

*Sharing hydrologic data*

http://his.cuahsi.org/

Support EAR 0622374

# Hydrologic Data Challenges

- From dispersed federal agencies
- From investigators collected for different purposes
- Different formats
  - Points
  - Lines
  - Polygons
  - Fields
  - Time Series

Data Heterogeneity

The way that data is organized can enhance or inhibit the analysis that can be done

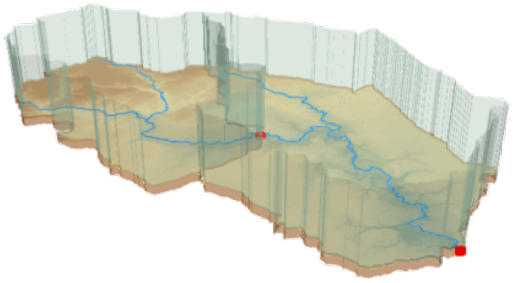
Water quality

Water quantity

Rainfall and Meteorology

Soil water

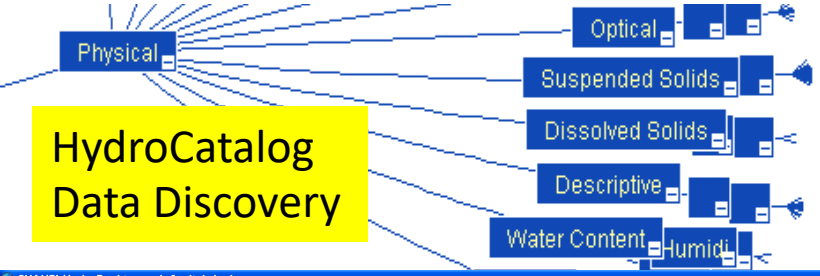
GIS



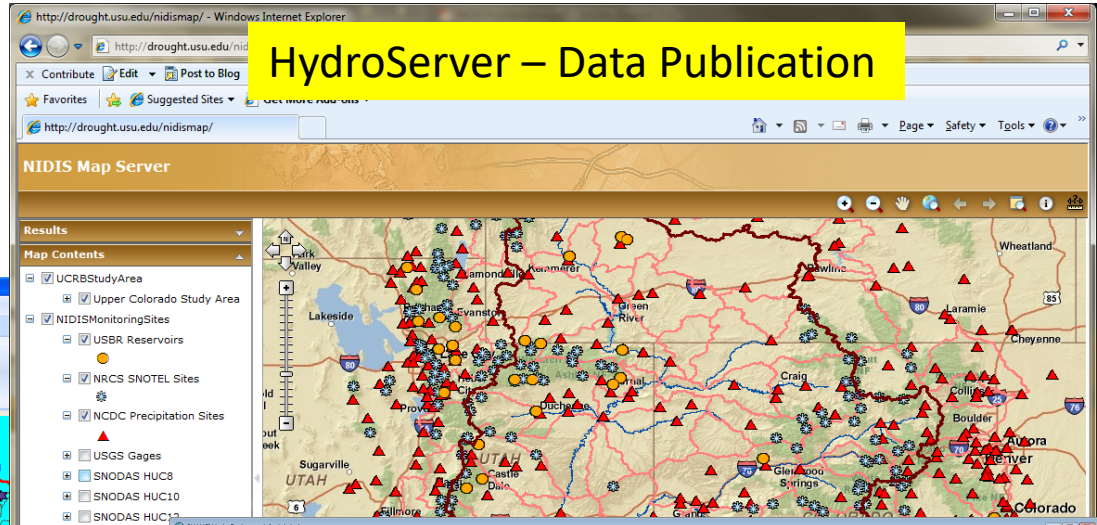
Groundwater

# CUAHSI HIS

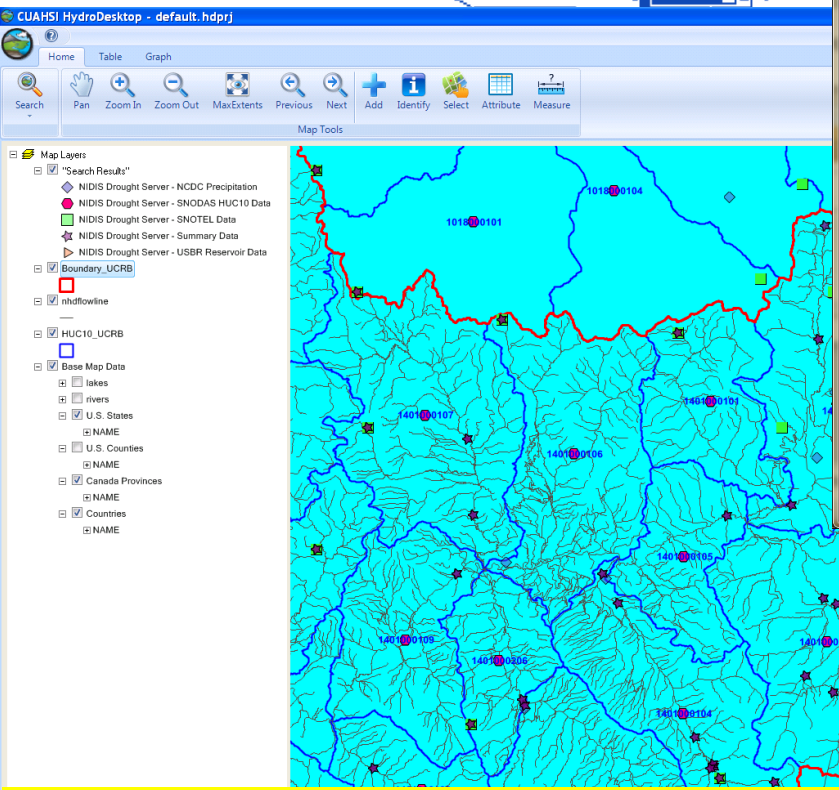
The CUAHSI Hydrologic Information System (HIS) is an internet based system to support the sharing of hydrologic data. It is comprised of hydrologic databases and servers connected through web services as well as software for data publication, discovery and access.



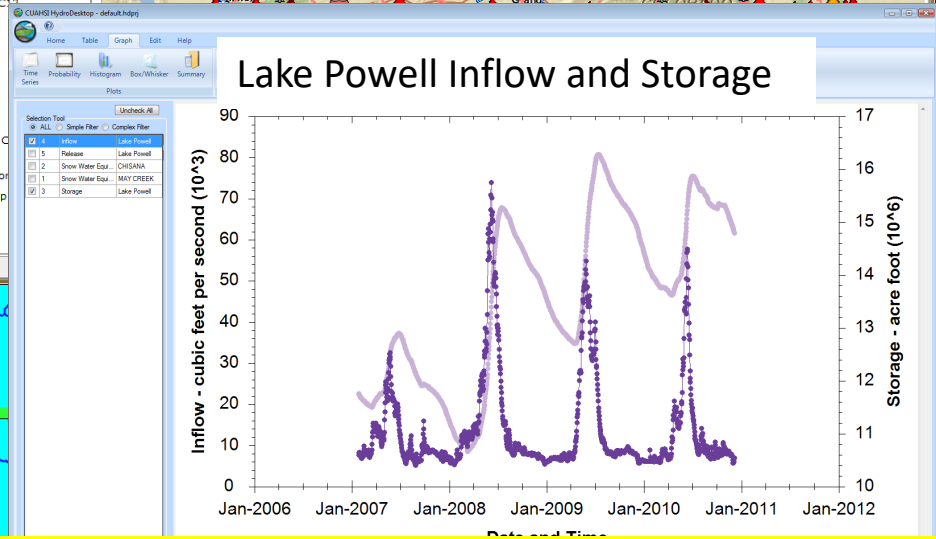

HydroCatalog
Data Discovery




HydroServer – Data Publication

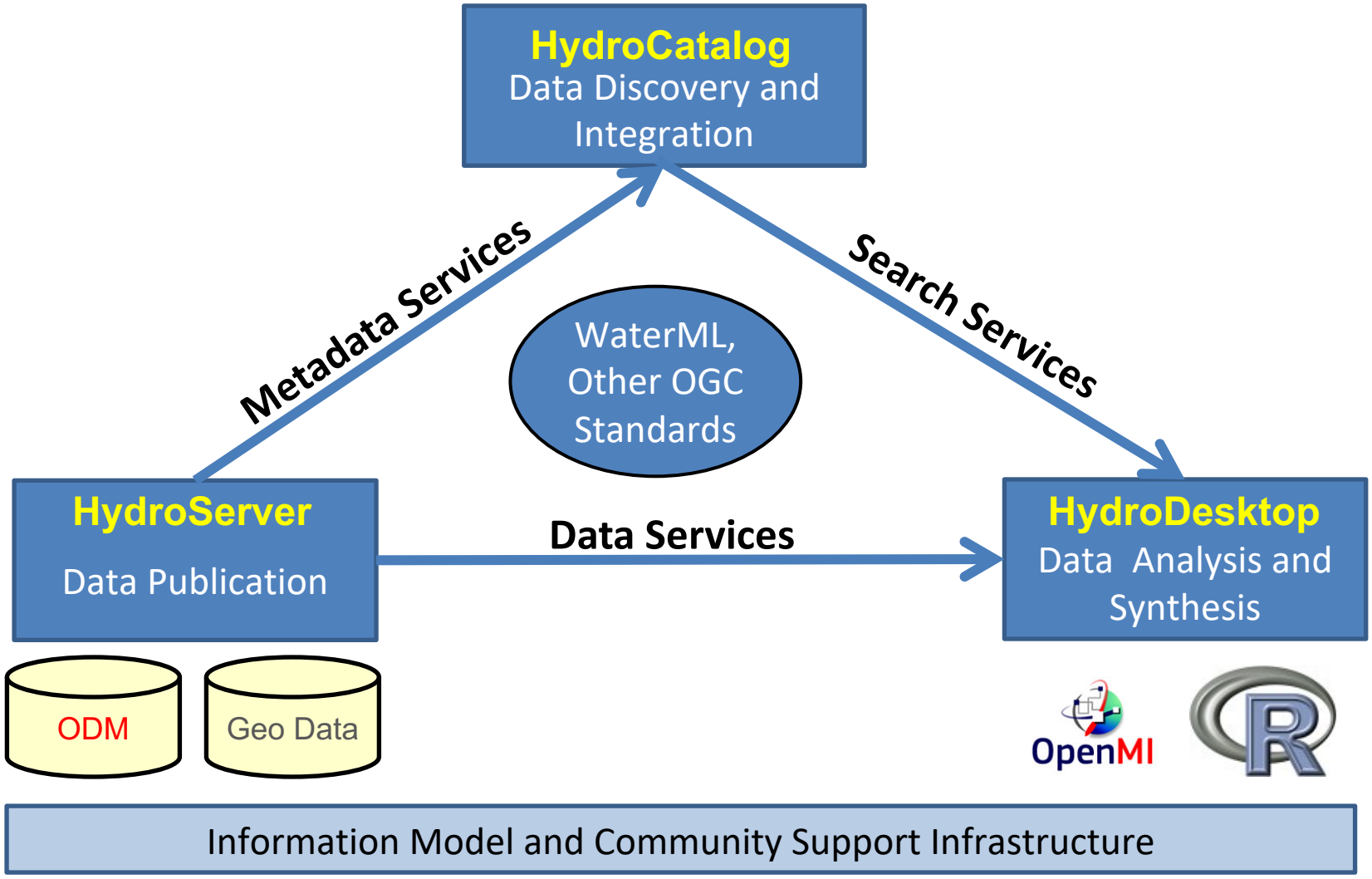



HydroDesktop – Data Access and Analysis




HydroDesktop – Combining multiple data sources

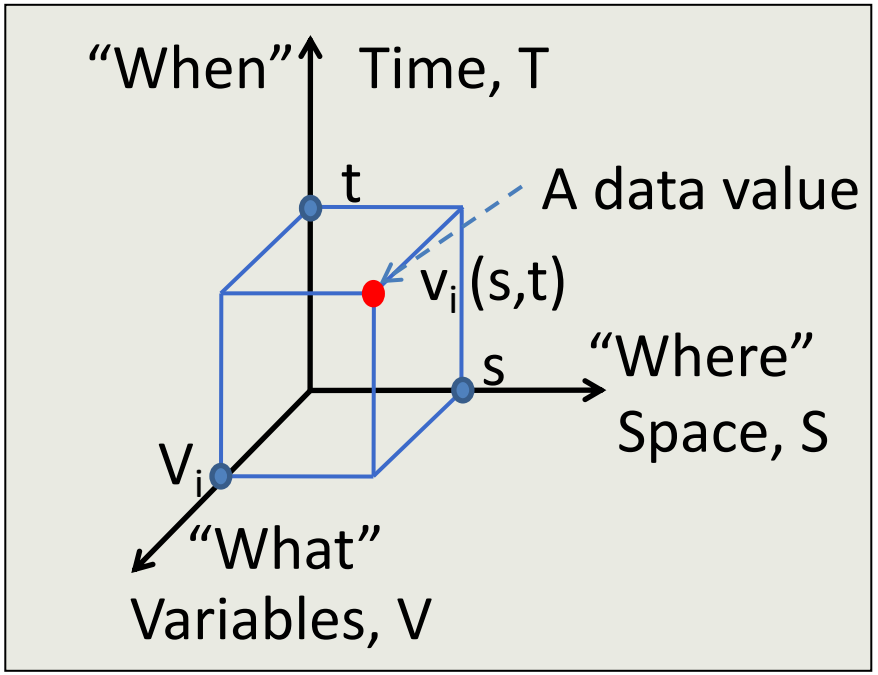
# CUAHSI Hydrologic Information System Services-Oriented Architecture



# What are the basic attributes to be associated with each single data value and how can these best be organized?

| DateTime |
| --- |
| Interval (support) |

| Variable |
| --- |
| Method |
| Quality Control Level |
| Sample Medium |
| Value Type |
| Data Type |
| Source/Organization |




| Location |
| --- |
| Feature of interest |
| Latitude |
| Longitude |
| Site identifiers |

| Units |
| --- |
| Accuracy |
| Censoring |
| Qualifying comments |

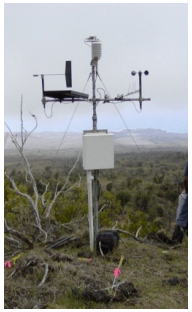
# Observations Data Model (ODM)

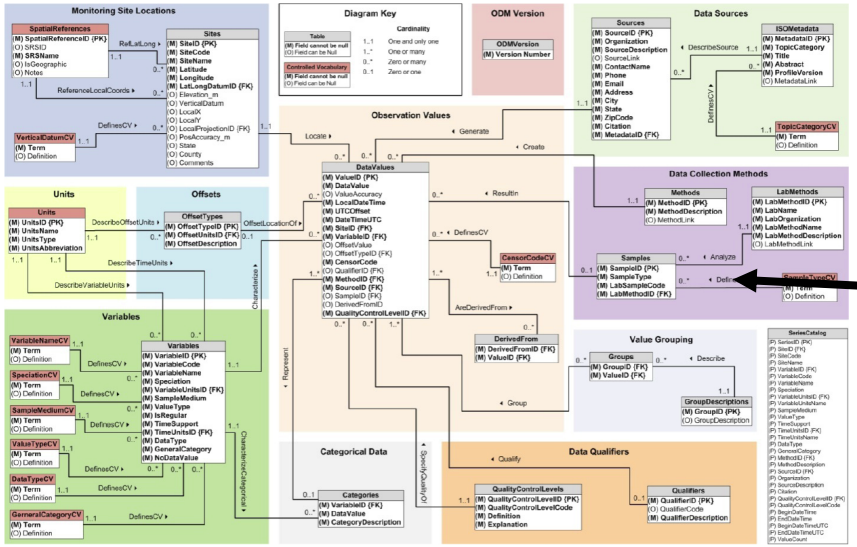
Streamflow

Provides a common persistence model for data storage

Groundwater levels

Precipitation & Climate






Soil moisture data

Water Quality

Flux tower data

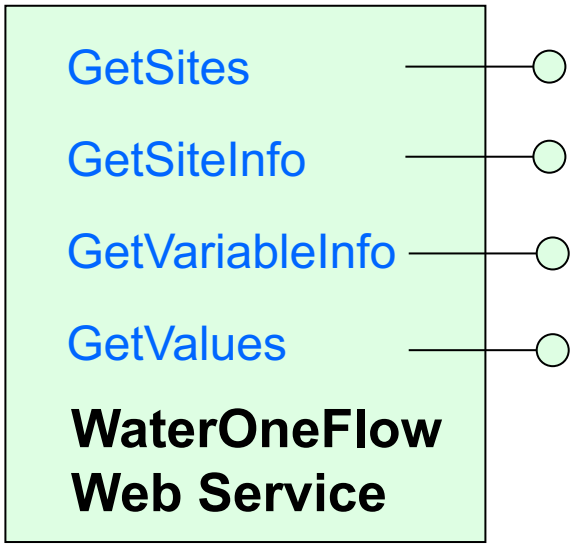
- A relational database at the single observation level
- Metadata for unambiguous interpretation
- Traceable heritage from raw measurements to usable information
- Promote syntactic and semantic consistency
- Cross dimension retrieval and analysis

Horsburgh, J. S., D. G. Tarboton, D. R. Maidment, and I. Zaslavsky (2008), A relational model for environmental and water resources data, *Water Resources Research*, 44, W05406, doi:10.1029/2007WR006392.

# WaterML and WaterOneFlow

WaterML is an XML language for communicating water data
WaterOneFlow is a set of web services based on WaterML

- Set of query functions



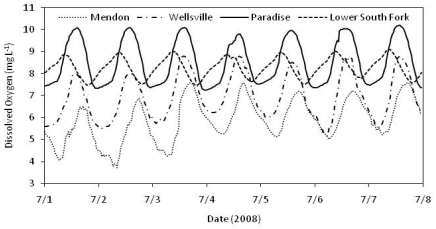

- Returns data in WaterML

```
<timeSeries>
- <sourceInfo xsi:type="SiteInfoType">
    <siteName>Colorado Rv at Austin, TX</siteName>
    <siteCode network="NWIS" siteID="4619631">08158000
  - <geoLocation>
    - <geogLocation xsi:type="LatLonPointType" srs="EPSG
        <latitude>30.24465429</latitude>
        <longitude>-97.694448</longitude>
      </geogLocation>
    </geoLocation>
  </sourceInfo>
- <variable>
    <variableCode vocabulary="NWIS" default="true" variable
    <variableName>Discharge, cubic feet per second</vari
    <units unitsAbbreviation="cfs" unitsCode="35">cubic fee
  </variable>
- <values count="2545">
    <value dateTime="2006-12-31T00:00:00">129</value>
    <value dateTime="2006-12-31T00:15:00">129</value>
    <value dateTime="2006-12-31T00:30:00">129</value>
    <value dateTime="2006-12-31T00:45:00">129</value>
    <value dateTime="2006-12-31T01:00:00">124</value>
    <value dateTime="2006-12-31T01:15:00">129</value>
    <value dateTime="2006-12-31T01:30:00">124</value>
    <value dateTime="2006-12-31T01:45:00">124</value>
    <value dateTime="2006-12-31T02:00:00">124</value>
```

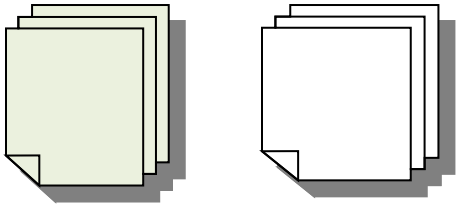
# HydroServer – Data Publication

## Point Observations Data

Ongoing Data Collection

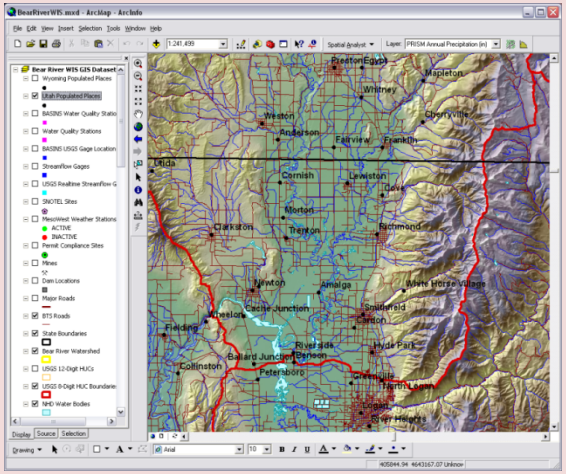


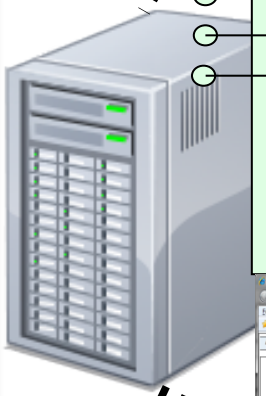

Historical Data Files



ODM Database

## GIS Data

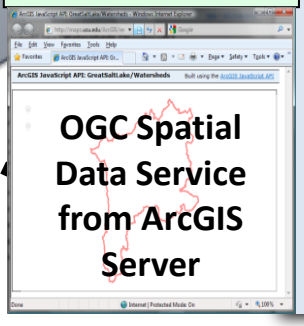




- GetSites
- GetSiteInfo
- GetVariableInfo
- GetValues

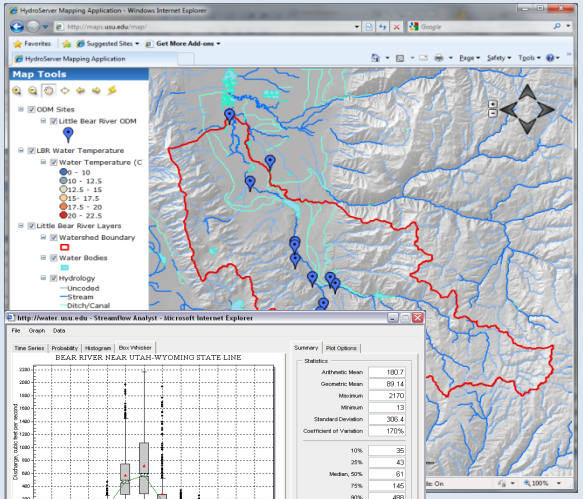
WaterML

**WaterOneFlow Web Service**



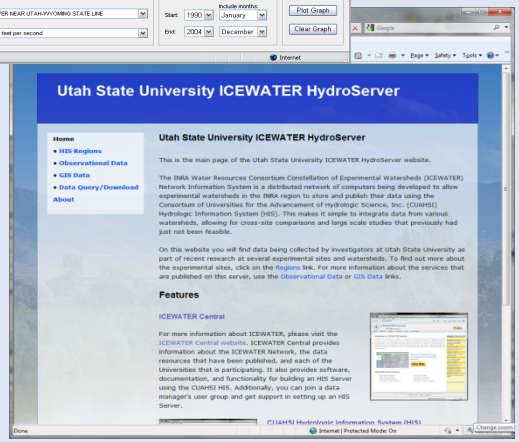
**OGC Spatial Data Service from ArcGIS Server**

## Internet Applications





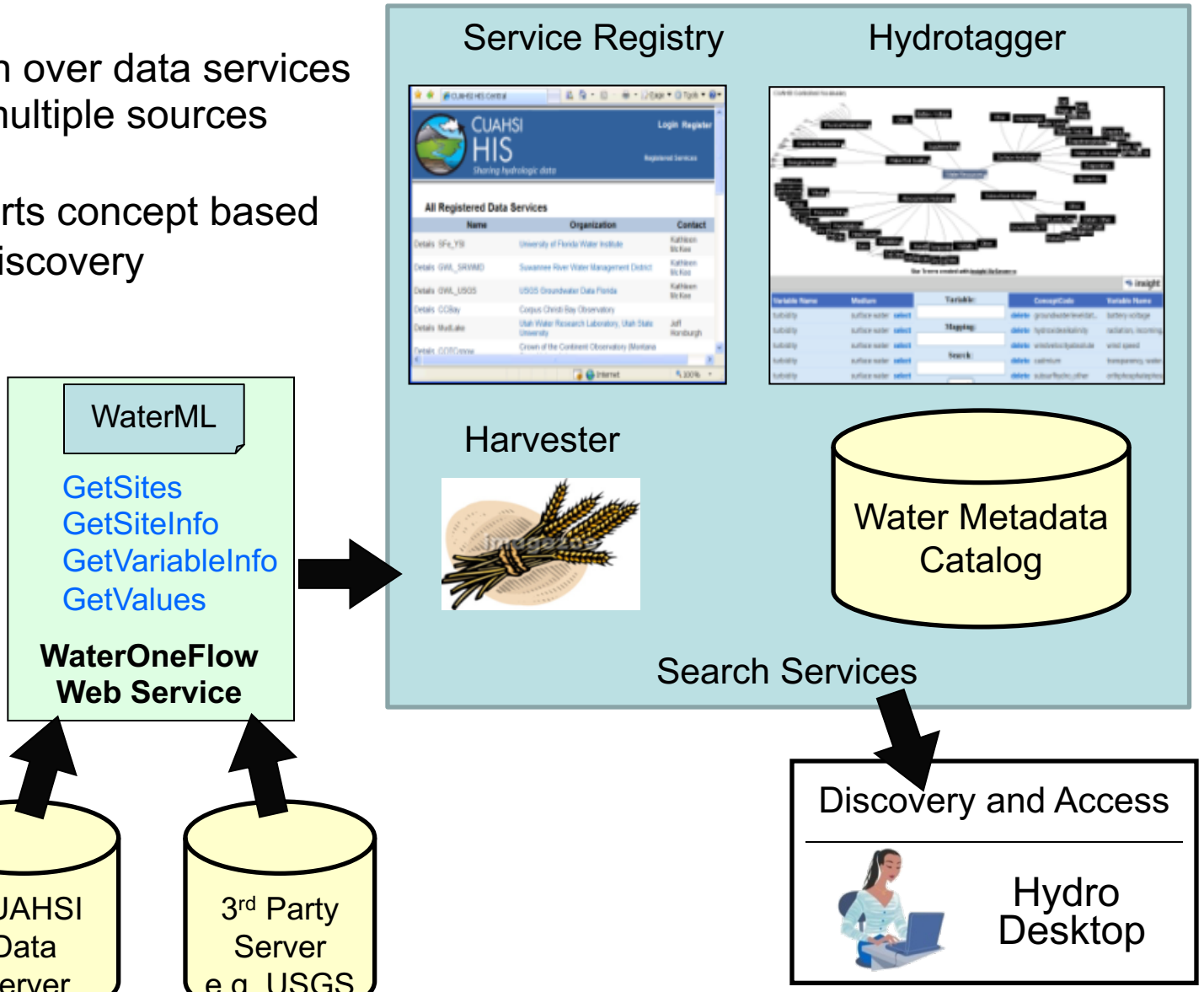





Data presentation, visualization, and analysis through Internet enabled applications

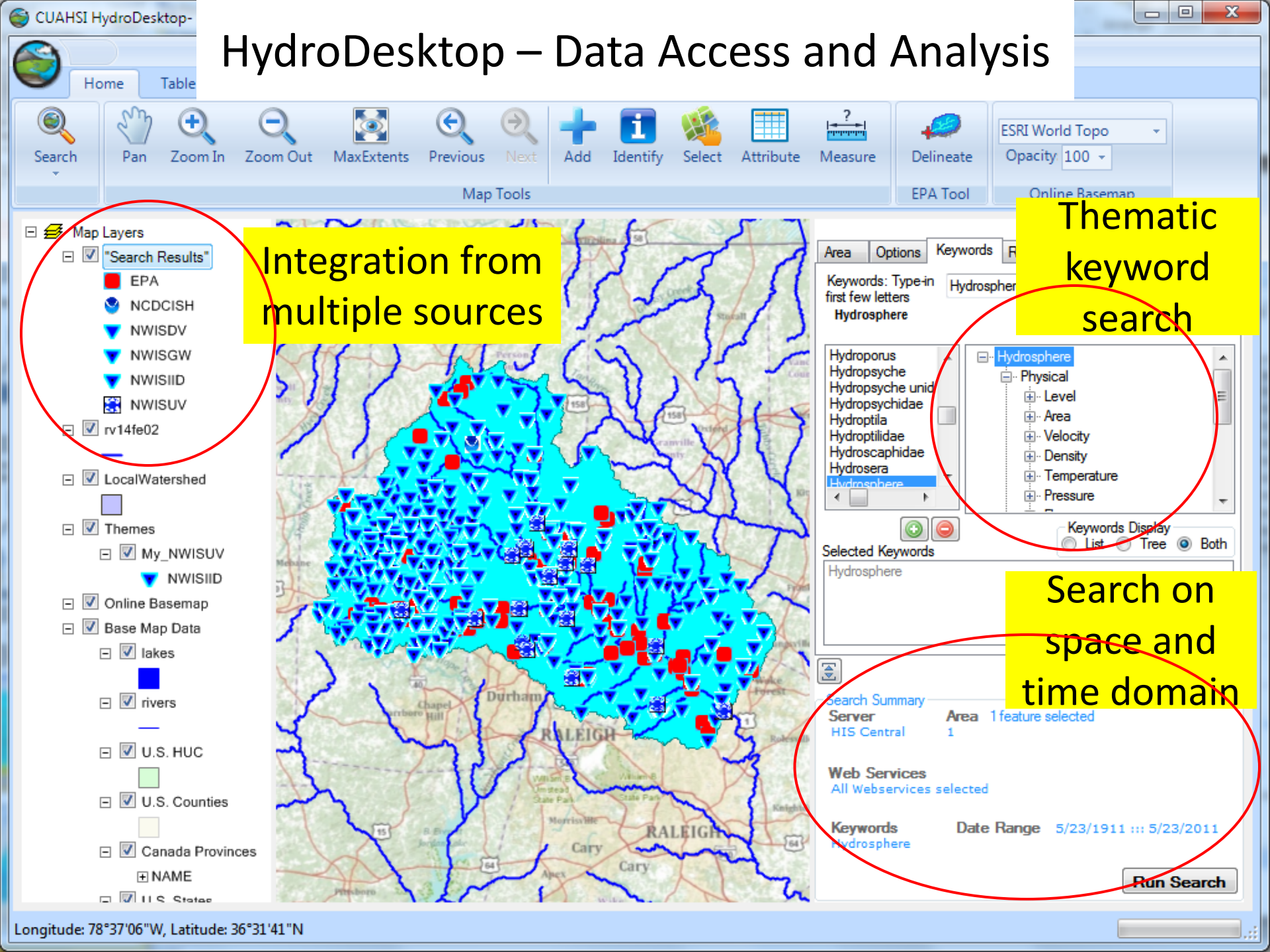
# HydroCatalog

- Search over data services from multiple sources
- Supports concept based data discovery

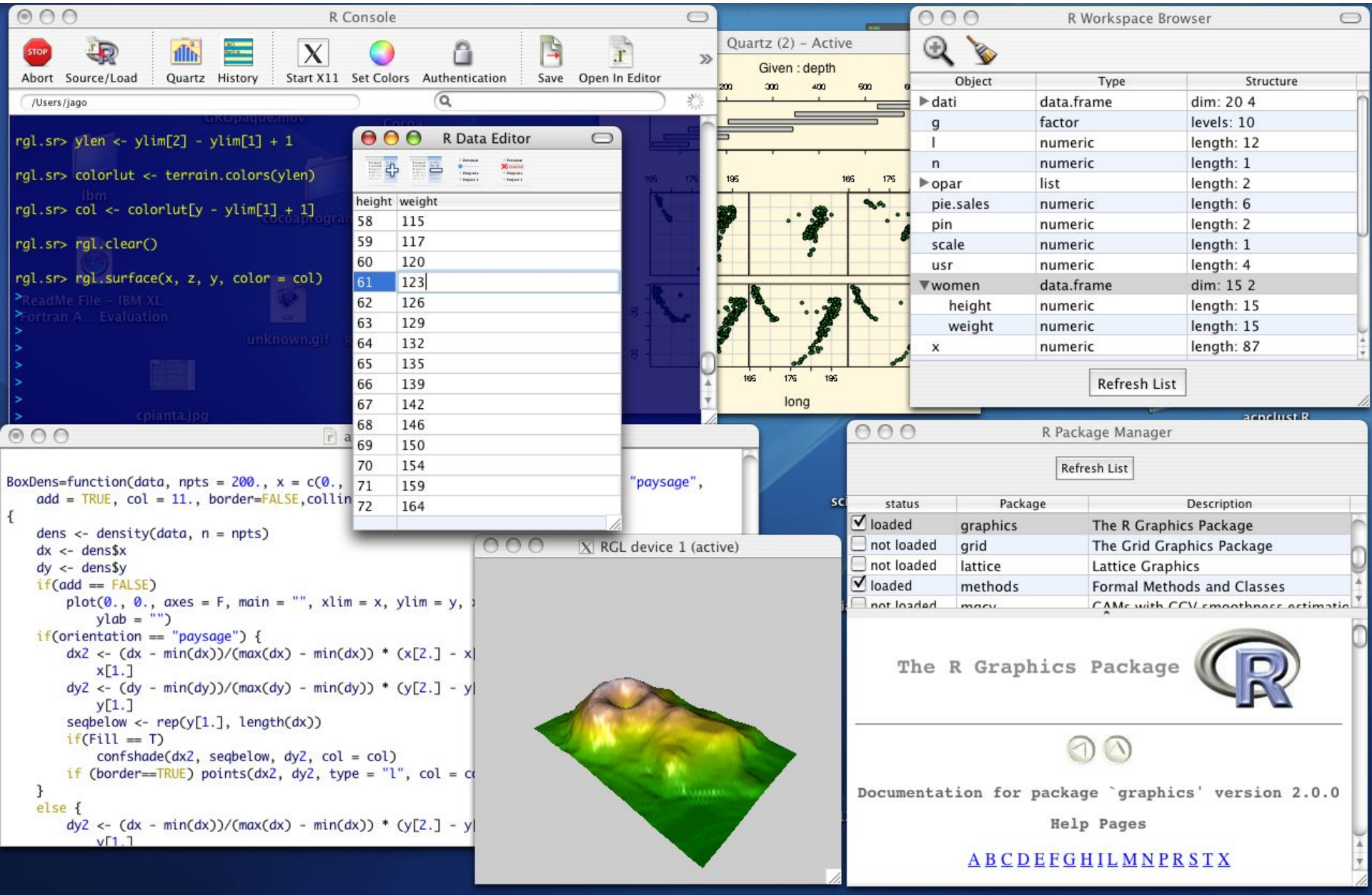



http://hiscentral.cuahsi.org

# HydroDesktop – Data Access and Analysis



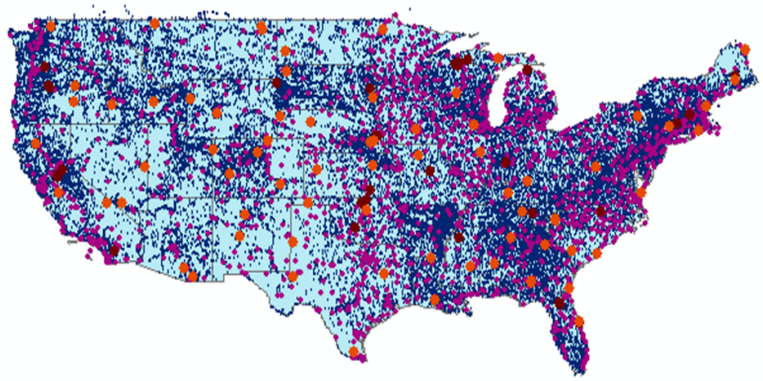
# Integration with “R” Statistics Package



# Open Geospatial Consortium Web Service Standards

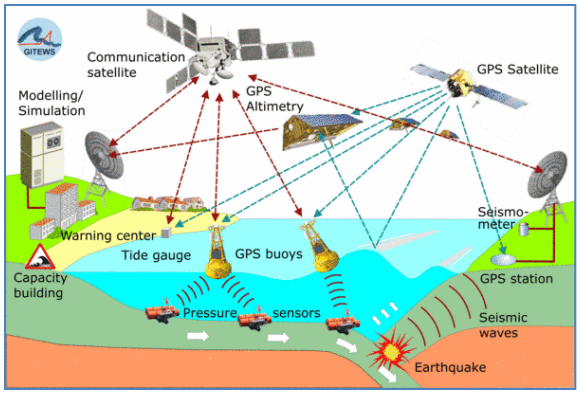
These standards have been developed over the past 10 years ….
…. by 400 companies and agencies working within the OGC

- Map Services



- Web Map Service (WMS)
- Web Feature Service (WFS)
- Web Coverage Service (WCS)
- Catalog Services for the Web (CS/W)

- Observation Services




- Observations and Measurements Model
- Sensor Web Enablement (SWE)
- Sensor Observation Service (SOS)

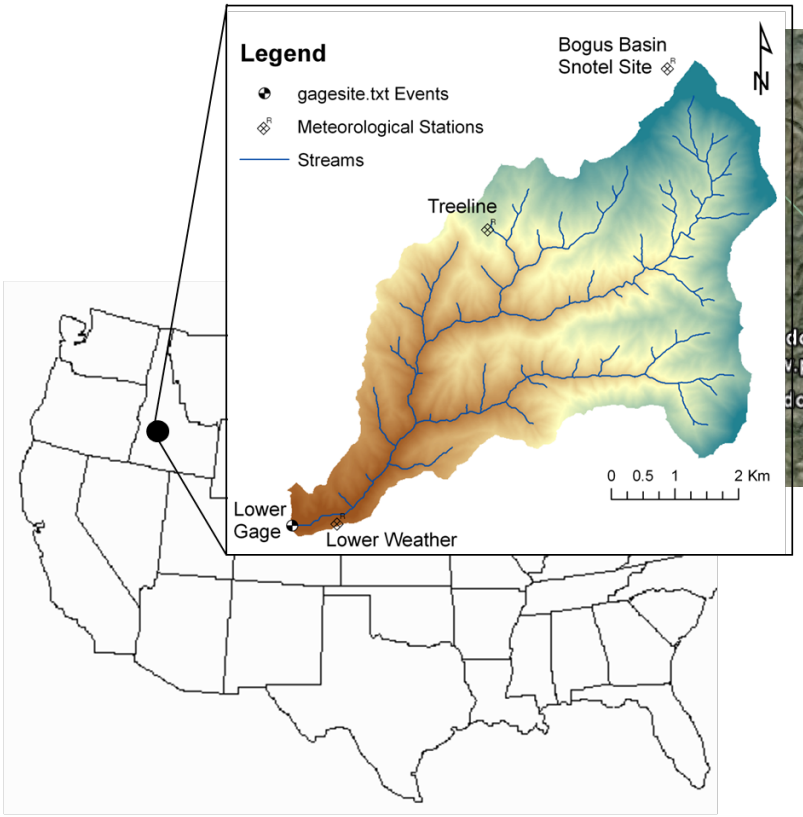
OGC Hydrology Domain Working Group evolving WaterML into an International Standard
http://www.opengeospatial.org/projects/groups/waterml2.0swg

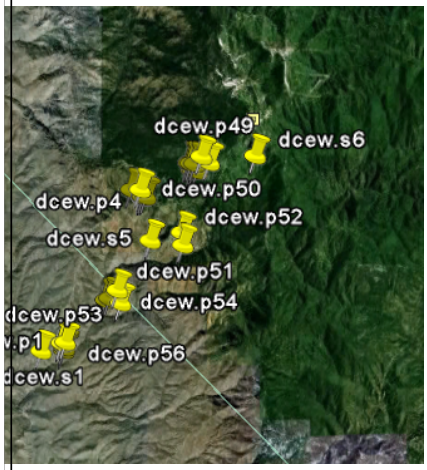
# A growing collection of HydroServers and community of users

- University of Maryland, Baltimore County
- Montana State University
- University of Texas at Austin
- University of Iowa
- Utah State University
- University of Florida
- University of New Mexico
- University of Idaho
- Boise State University
- University of Texas at Arlington
- University of California, San Diego
- Idaho State University

Dry Creek Experimental Watershed (DCEW)

(28 km$^2$ semi-arid steep topography, Boise Front)




68 Sites
24 Variables
4,700,000+ values

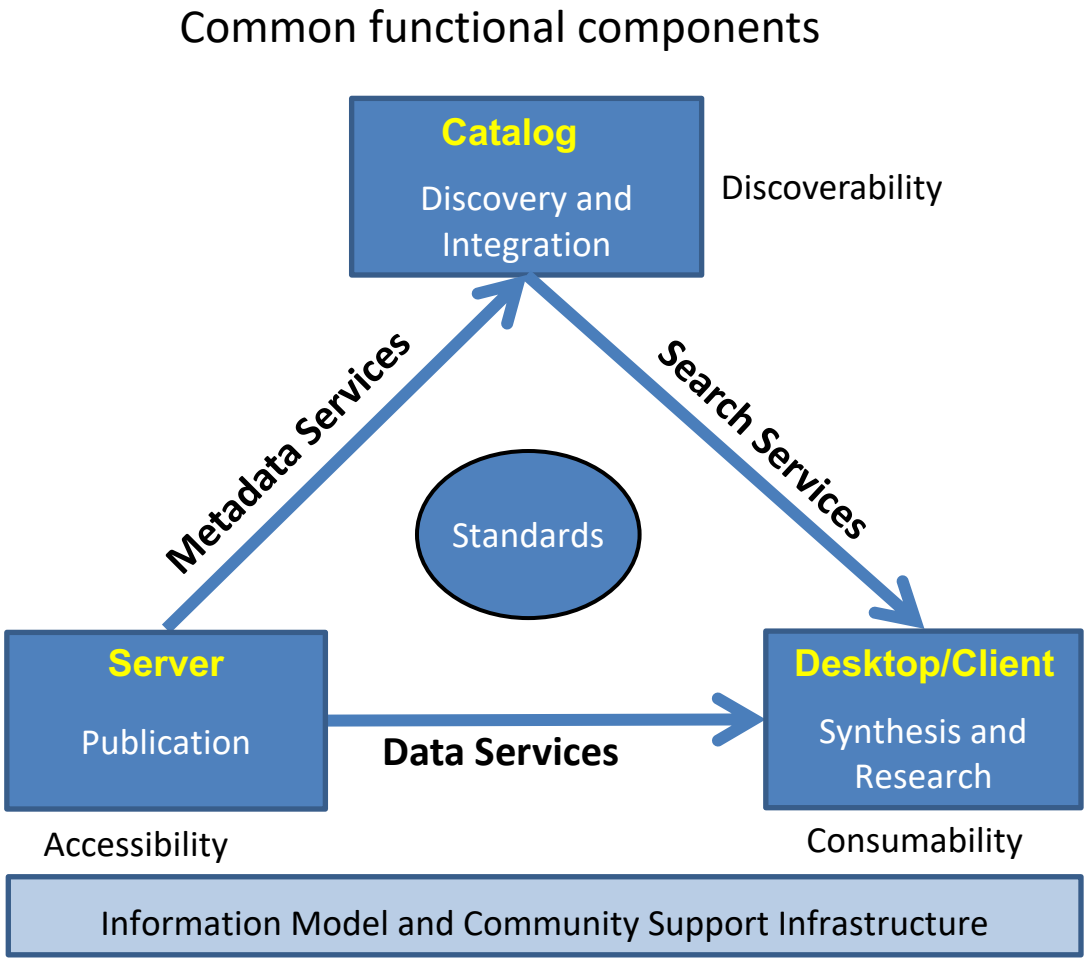
Published by Jim McNamara, Boise State University

# Open Development Model


- http://hydrodesktop.codeplex.com
- http://hydroserver.codeplex.com
- http://hydrocatalog.codeplex.com

# General aspects of the approach

- Storage in a community data model
- Publication from a server
- Data access through internet-based services using consistent language and format
- Tools for access and analysis
- Discovery through thematic and geographic search functionality
- Integrated modeling and analysis combining information from multiple sources



# Looking to the Future

- Move from prototype to operations
  - Operational support of software and systems
  - User support and training
  - Repositories
  - CUAHSI Data Center (User Solutions Engineer)
  - NSF Data Management Requirements
- Research and development of new functionality
  - data and model sharing “hub” to enhance interactive collaboration (pending)
- Community
  - HIS has become bigger than one project (emerging software ecosystem)
  - Open Development Model (inspire, enable and incorporate broad contributions)
  - The community is the infrastructure that persists (is sustainable)

# Thanks! HIS Project Team and Sponsors

- University of Texas at Austin – David Maidment, Tim Whiteaker, James Seppi, Fernando Salas, Jingqi Dong, Harish Sangireddy
- San Diego Supercomputer Center – Ilya Zaslavsky, David Valentine, Tom Whitenack, Matt Rodriguez
- Utah State University – David Tarboton, Jeff Horsburgh, Kim Schreuders, Stephanie Reeder
- University of South Carolina – Jon Goodall, Anthony Castronova
- Idaho State University – Dan Ames, Ted Dunsford, Jiří Kadlec, Yang Cao, Dinesh Grover
- Drexel University/CUNY – Michael Piasecki
- WATERS Network – Testbed Data Managers
- CUAHSI Program Office – Rick Hooper, Yoori Choi, Conrad Matiuk
- ESRI – Dean Djokic, Zichuan Ye

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Support EAR 0622374