The CUAHSI Community Hydrologic Information System

David Tarboton, David Maidment, Ilya Zaslavsky, Dan Ames, Jon Goodall, Richard Hooper, Jeffrey Horsburgh

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

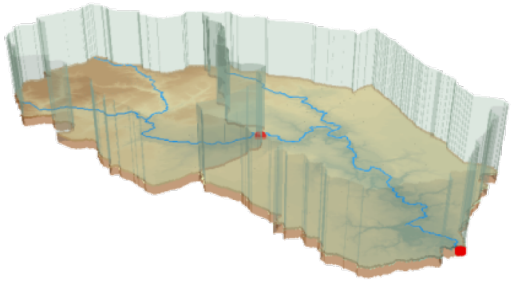
Water quality

Water quantity

Rainfall and Meteorology

Soil water

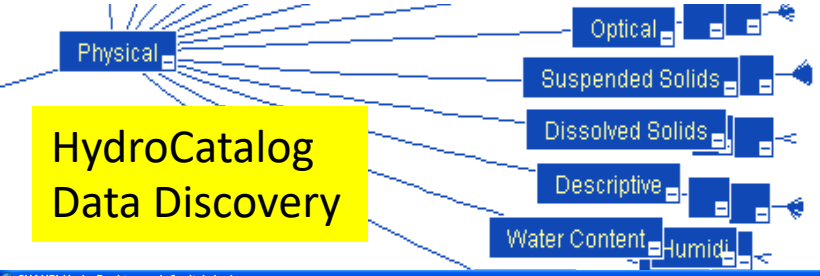
GIS



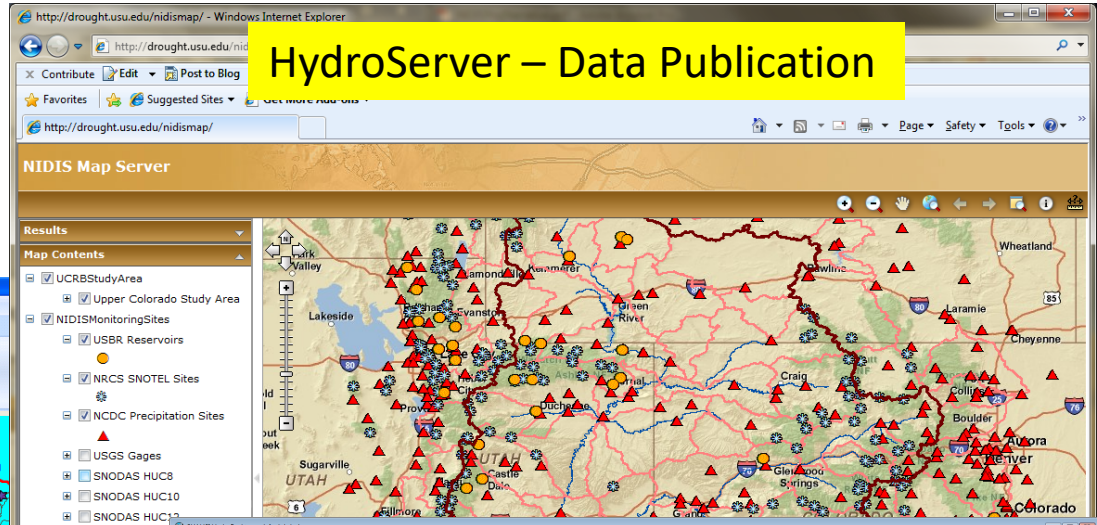
Groundwater

CUAHSI HIS

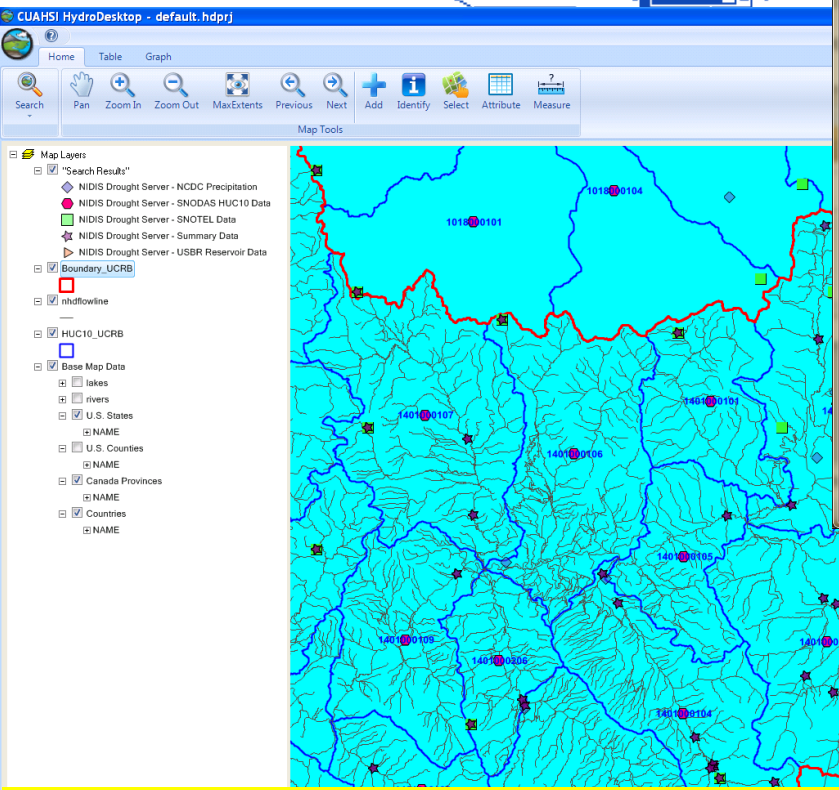
The CUAHSI Hydrologic Information System (HIS) is an internet based system to support the sharing of hydrologic data. It is comprised of hydrologic databases and servers connected through web services as well as software for data publication, discovery and access.



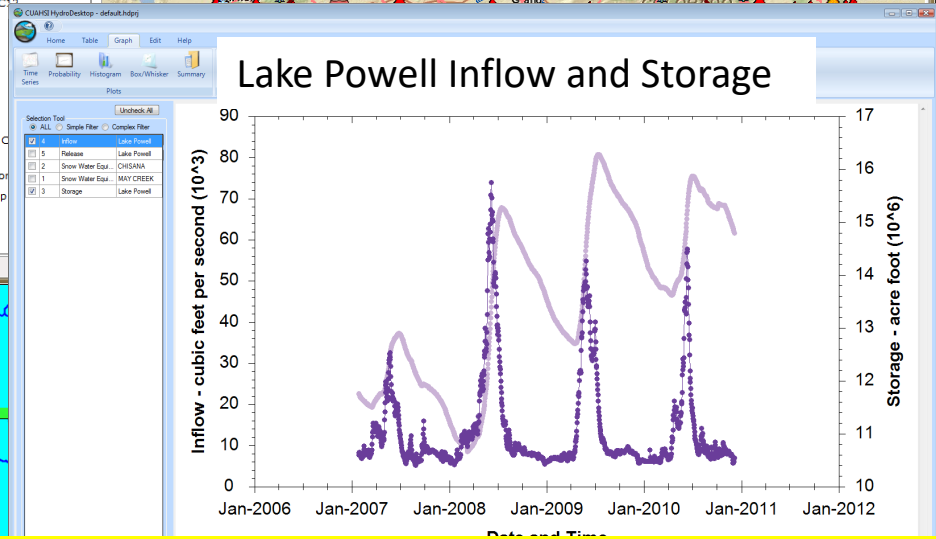
HydroCatalog
Data Discovery



HydroServer – Data Publication

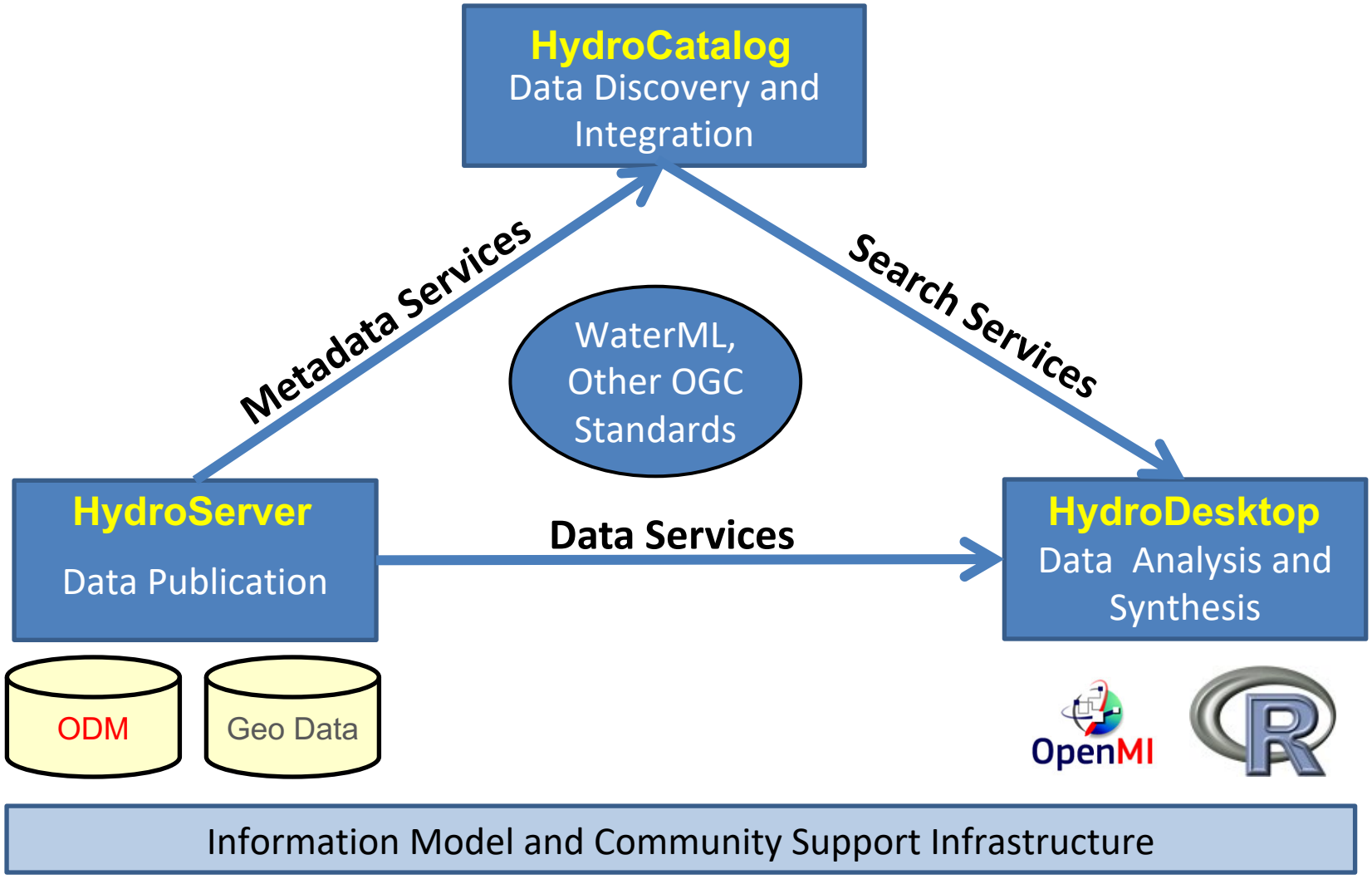


HydroDesktop – Data Access and Analysis



HydroDesktop – Combining multiple data sources

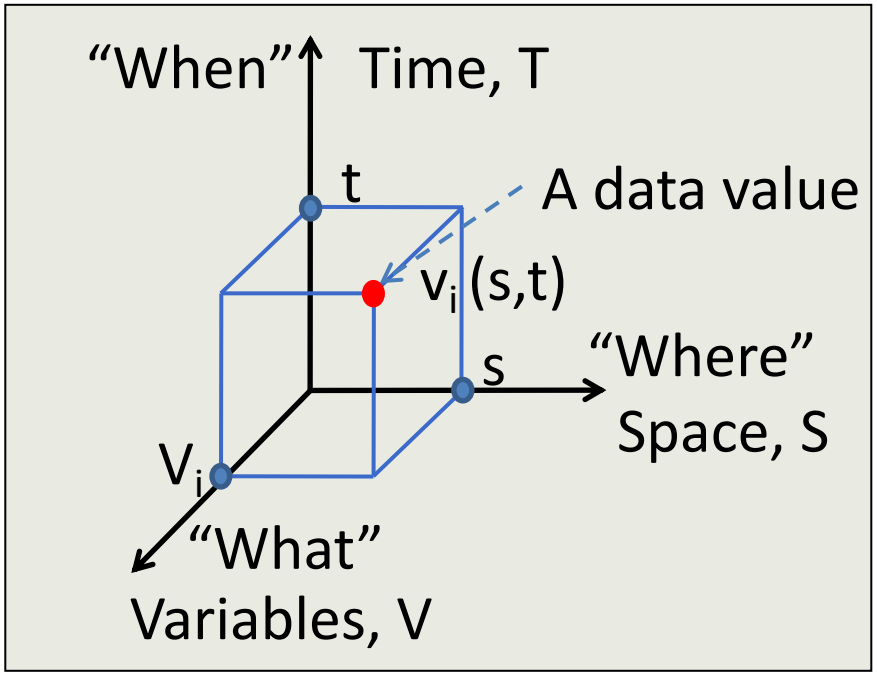
CUAHSI Hydrologic Information System Services-Oriented Architecture



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



Units
Accuracy
Censoring
Qualifying comments

Location
Feature of interest

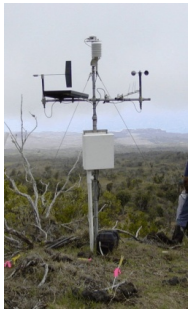
Observations Data Model (ODM)

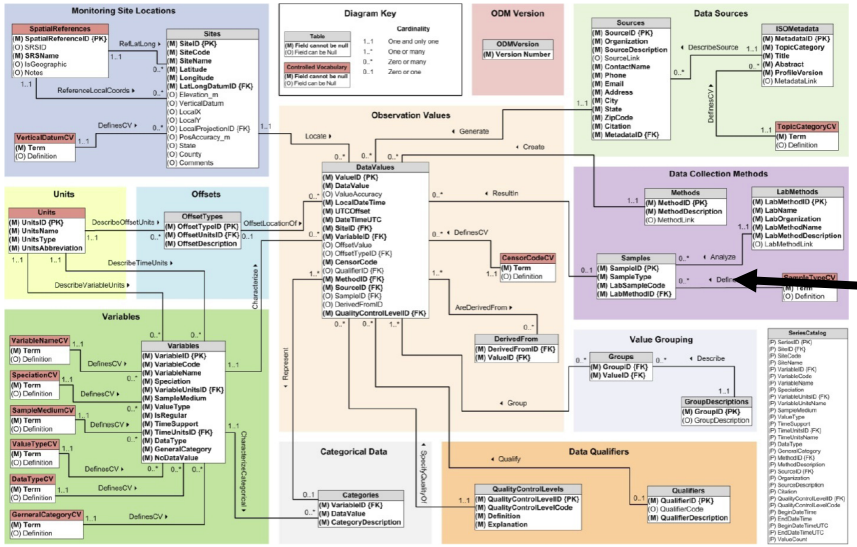
Streamflow

Provides a common persistence model for data storage

Groundwater levels

Precipitation & Climate





Soil moisture data

Water Quality

Flux tower data

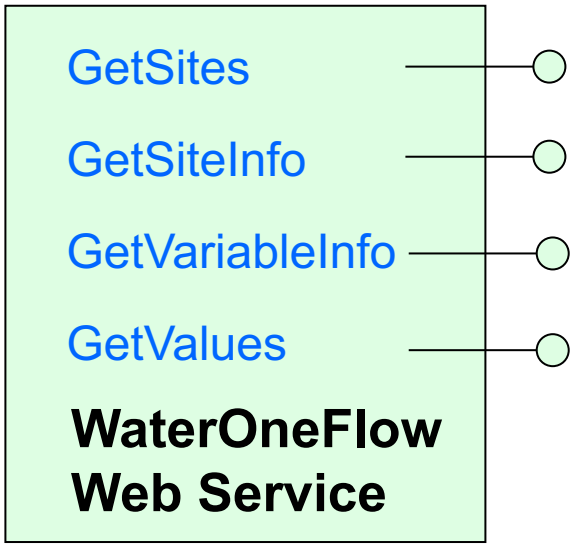
- A relational database at the single observation level
- Metadata for unambiguous interpretation
- Traceable heritage from raw measurements to usable information
- Promote syntactic and semantic consistency
- Cross dimension retrieval and analysis

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



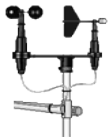
- Returns data in WaterML

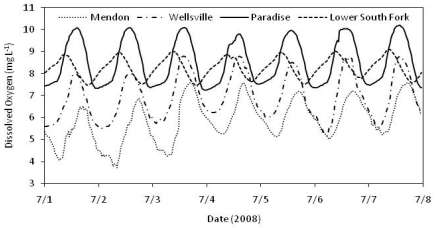
```
<timeSeries>
- <sourceInfo xsi:type="SiteInfoType">
    <siteName>Colorado Rv at Austin, TX</siteName>
    <siteCode network="NWIS" siteID="4619631">08158000
  - <geoLocation>
    - <geogLocation xsi:type="LatLonPointType" srs="EPSG
        <latitude>30.24465429</latitude>
        <longitude>-97.694448</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

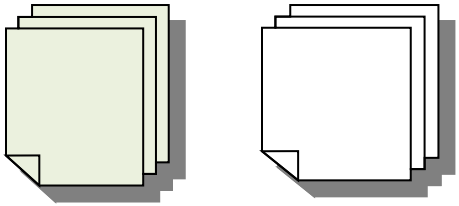
Point Observations Data

Ongoing Data Collection



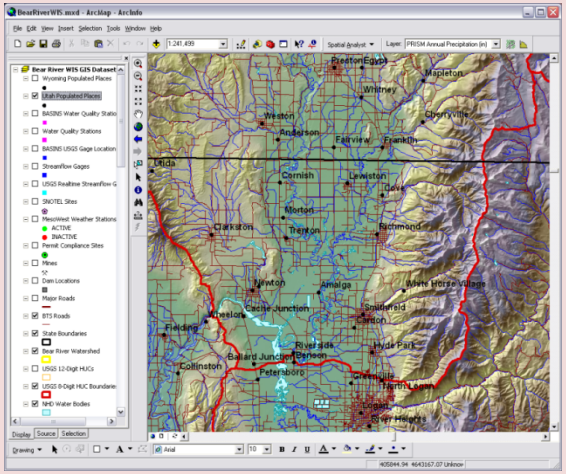


Historical Data Files



ODM Database

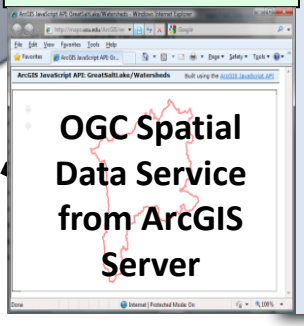
GIS Data



GetSites
GetSiteInfo
GetVariableInfo
GetValues

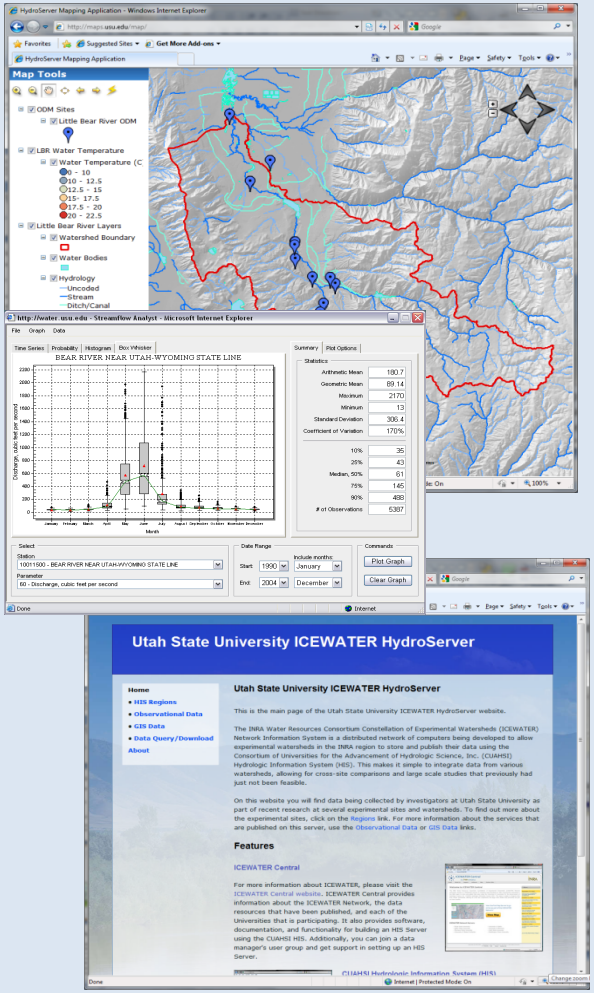
WaterML

WaterOneFlow Web Service



OGC Spatial Data Service from ArcGIS Server

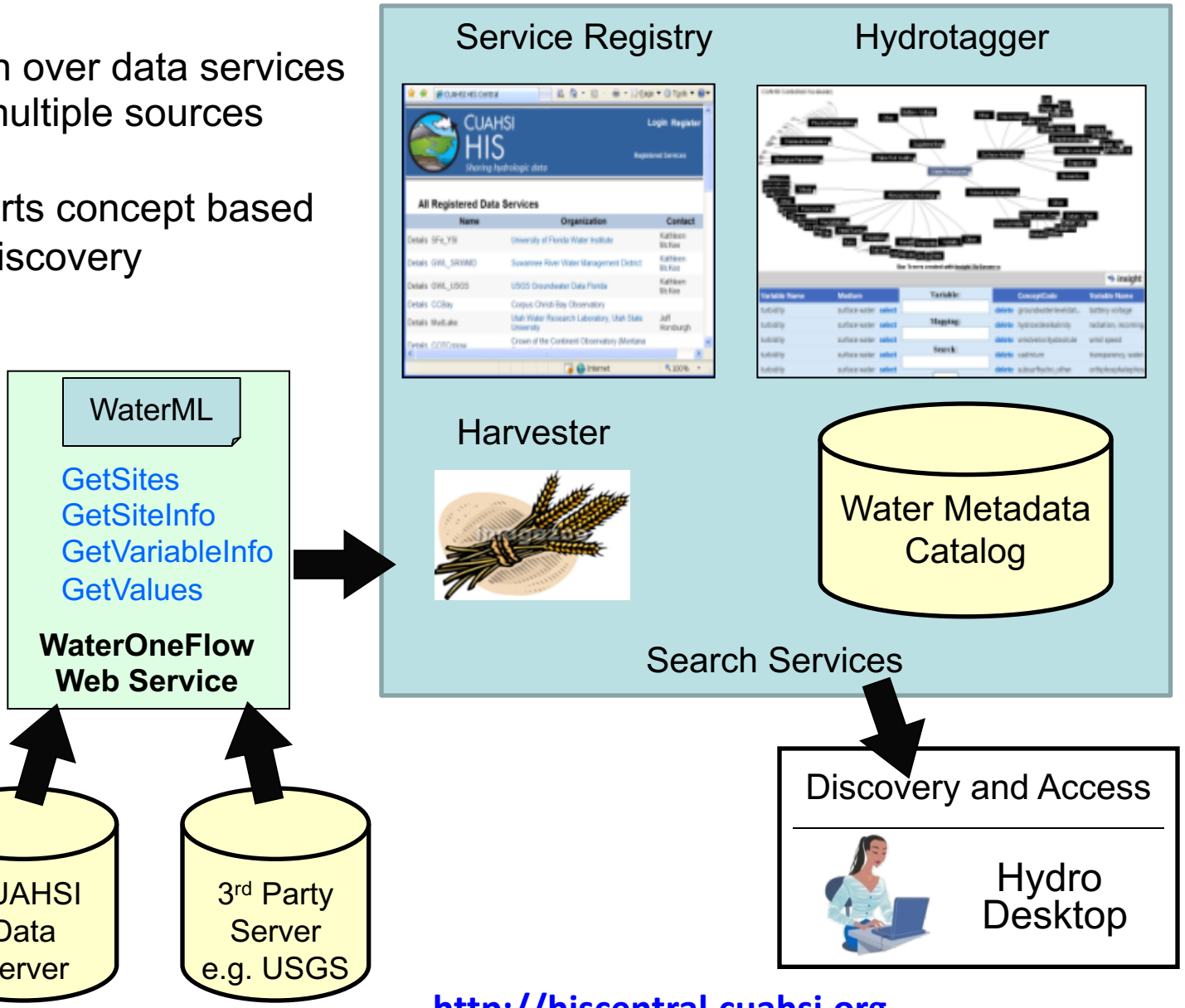
Internet Applications



Data presentation, visualization, and analysis through Internet enabled applications

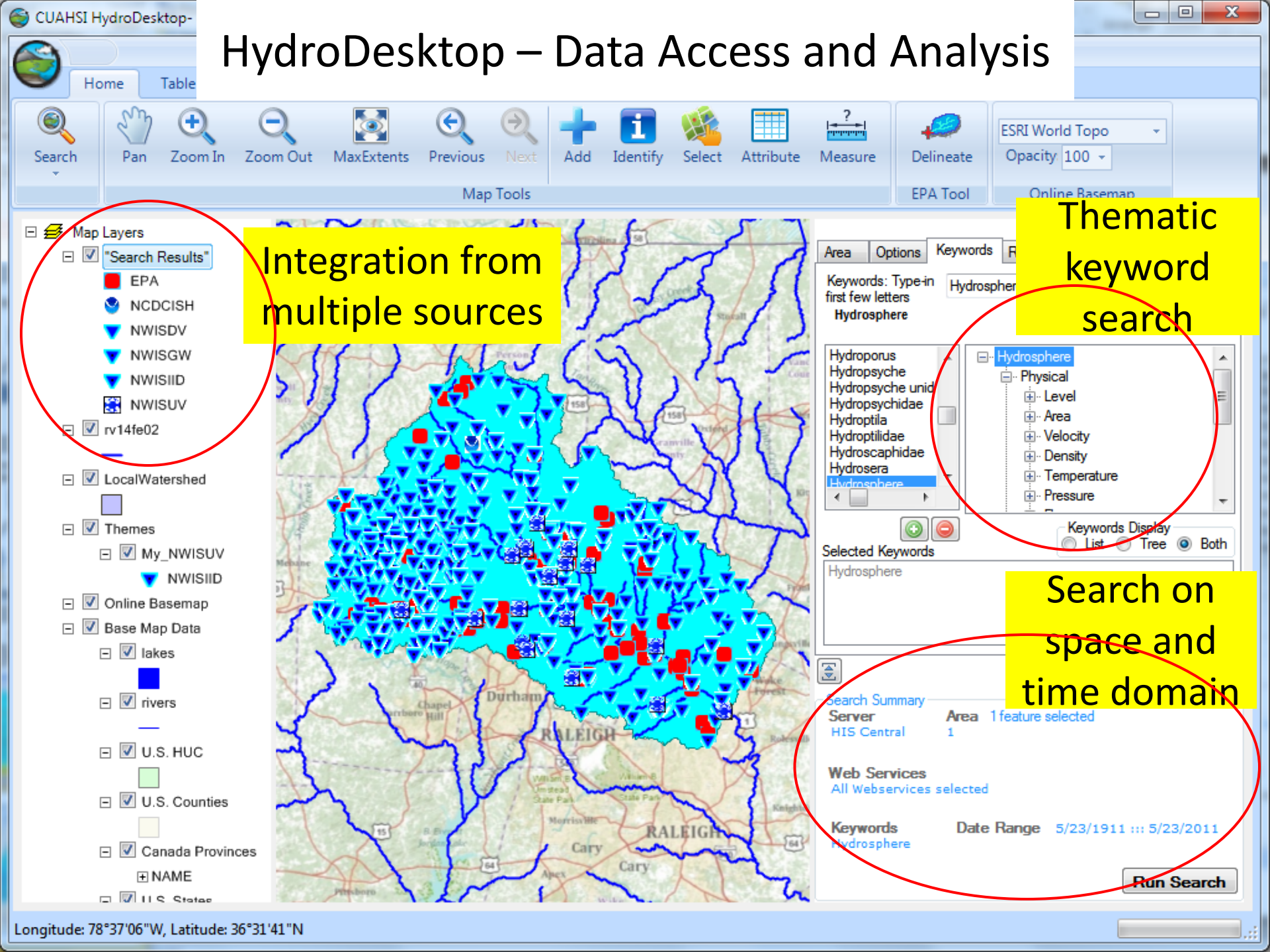
HydroCatalog

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

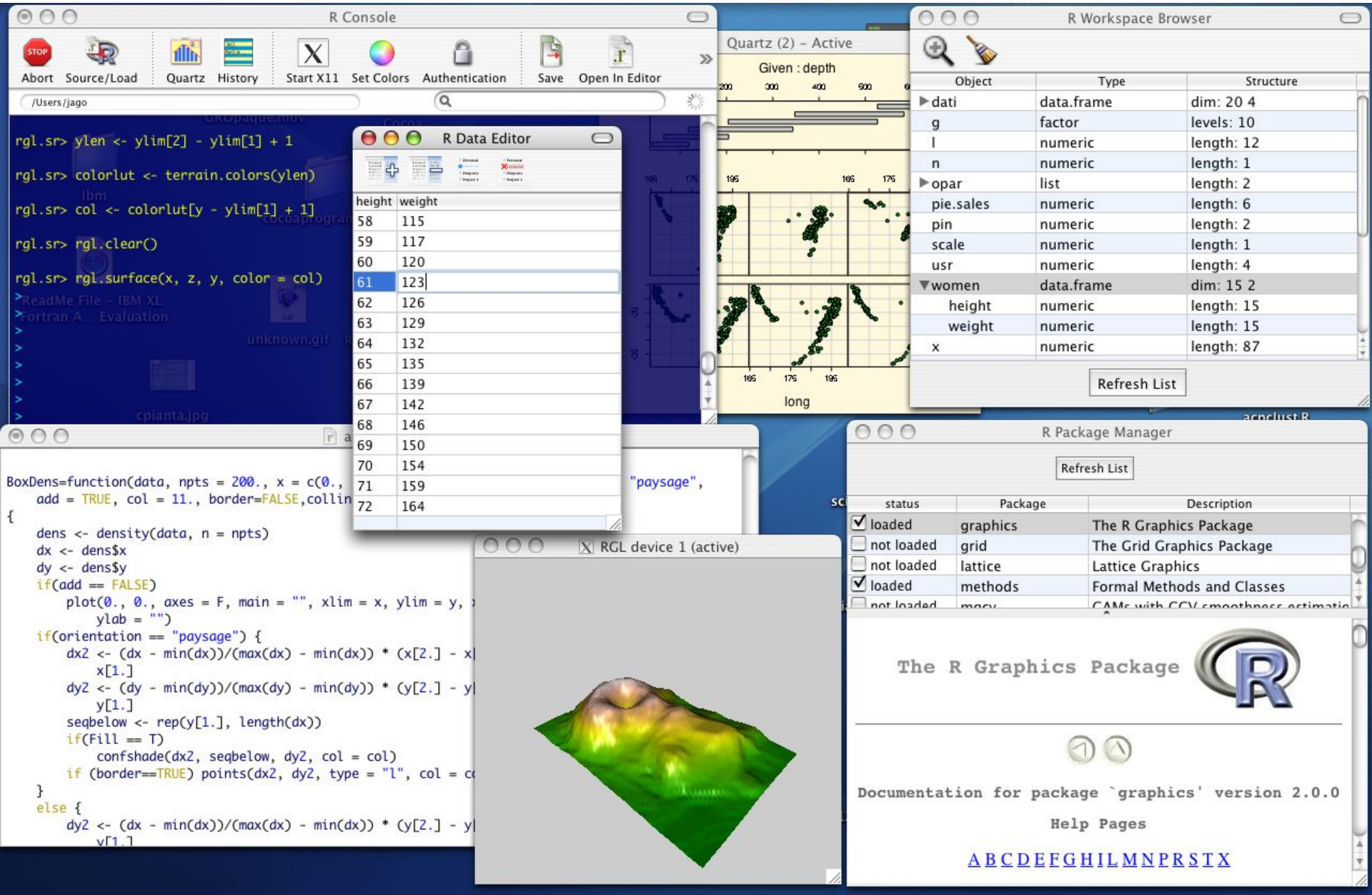


http://hiscentral.cuahsi.org

HydroDesktop – Data Access and Analysis



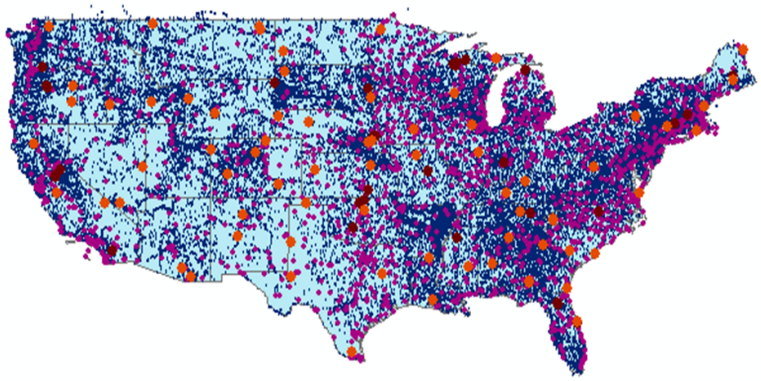
Integration with “R” Statistics Package



Open Geospatial Consortium Web Service Standards

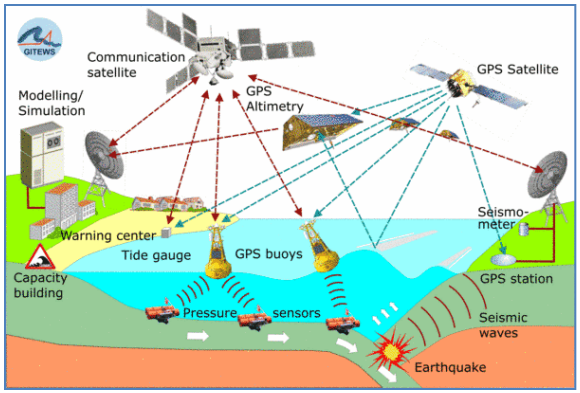
These standards have been developed over the past 10 years ….
…. by 400 companies and agencies working within the OGC

- 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)

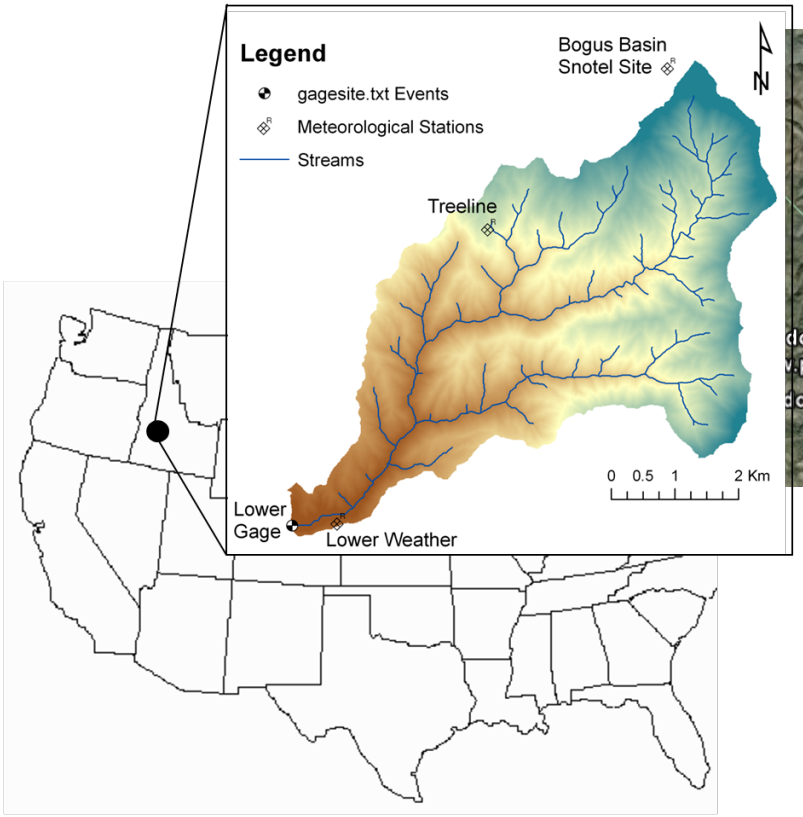
OGC Hydrology Domain Working Group evolving WaterML into an International Standard
http://www.opengeospatial.org/projects/groups/waterml2.0swg

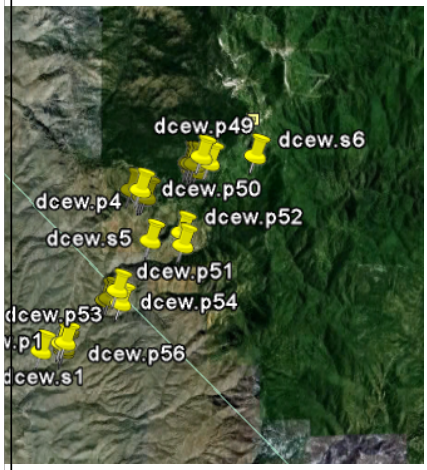
A growing collection of HydroServers and community of users

- 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

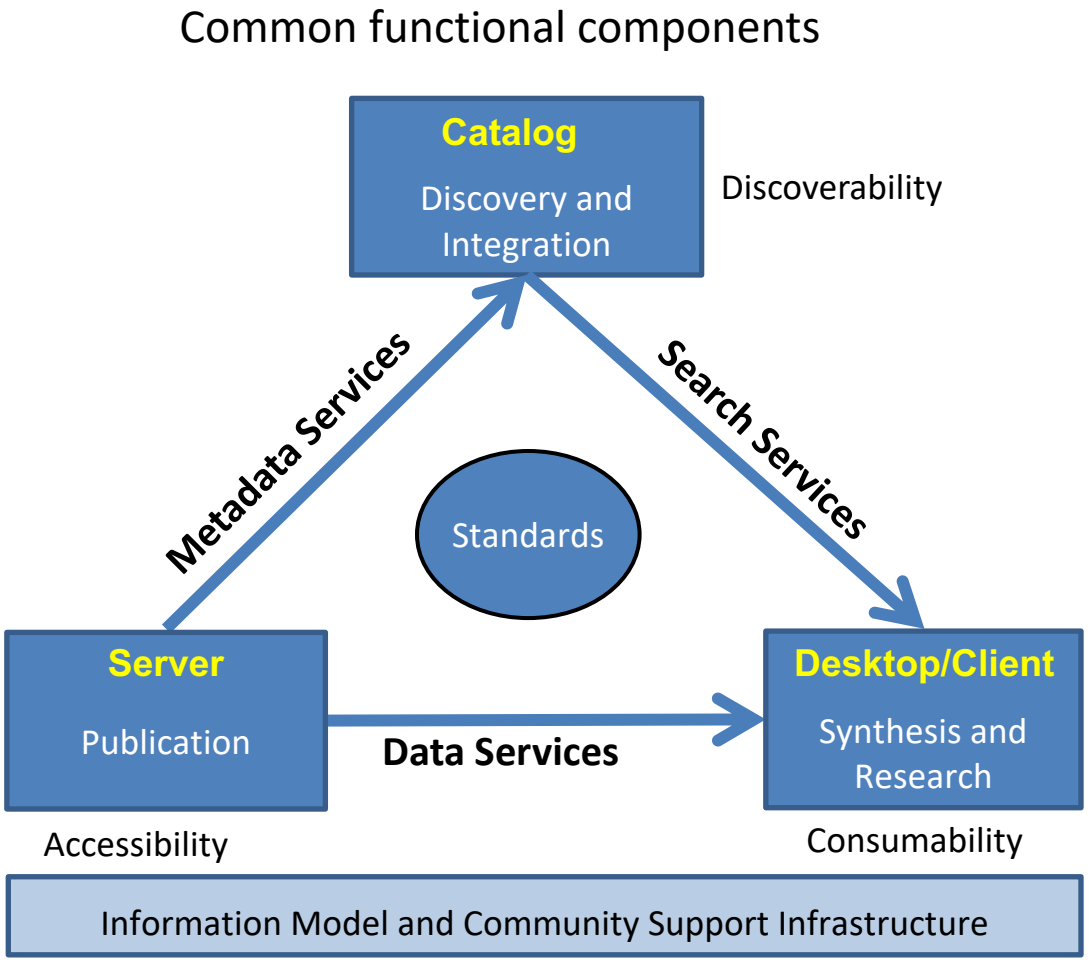
Published by Jim McNamara, Boise State University

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 Support Specialist)
  - 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 – Jeff Horsburgh, Kim Schreuders, Stephanie Reeder, Edward Wai Tsui, Ravichand Vegiraju, Ketan Patil
- 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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Sharing hydrologic data

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Support EAR 0622374