

The CUAHSI Community Hydrologic Information System

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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



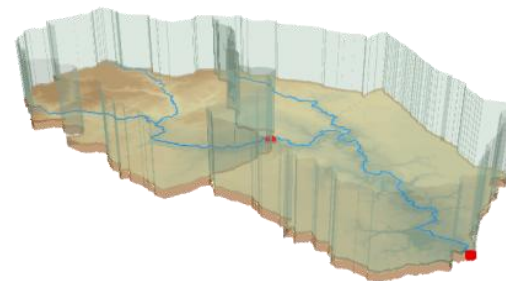
Rainfall and
Meteorology



Soil water



GIS



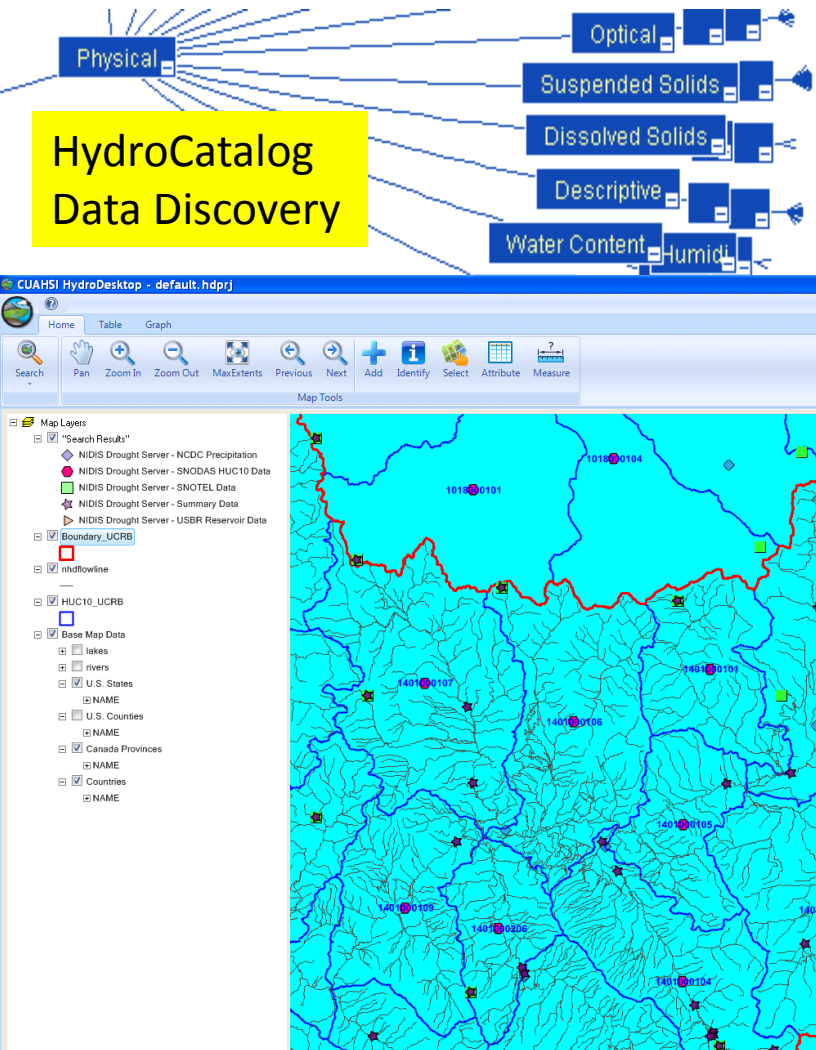
Groundwater



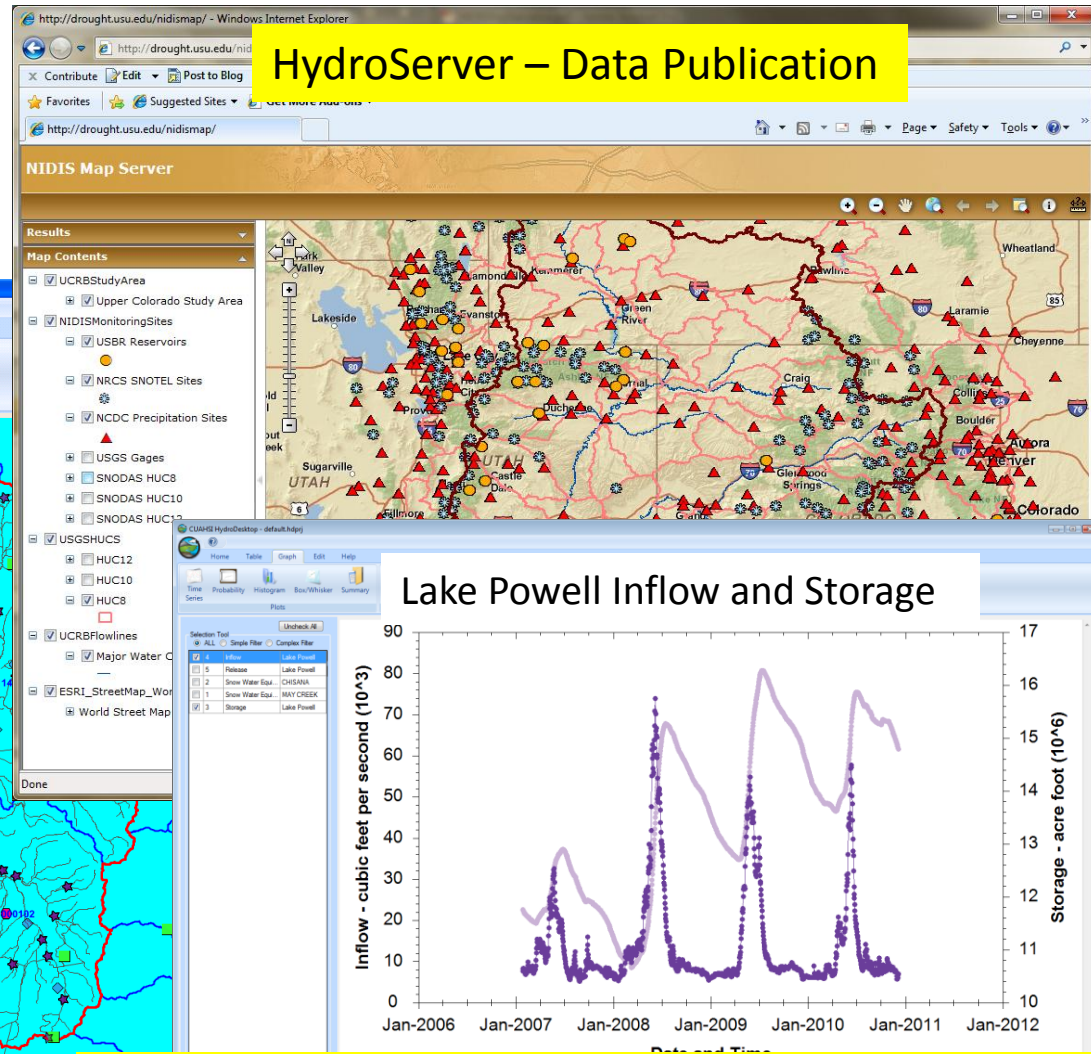
CUAHSI HIS

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



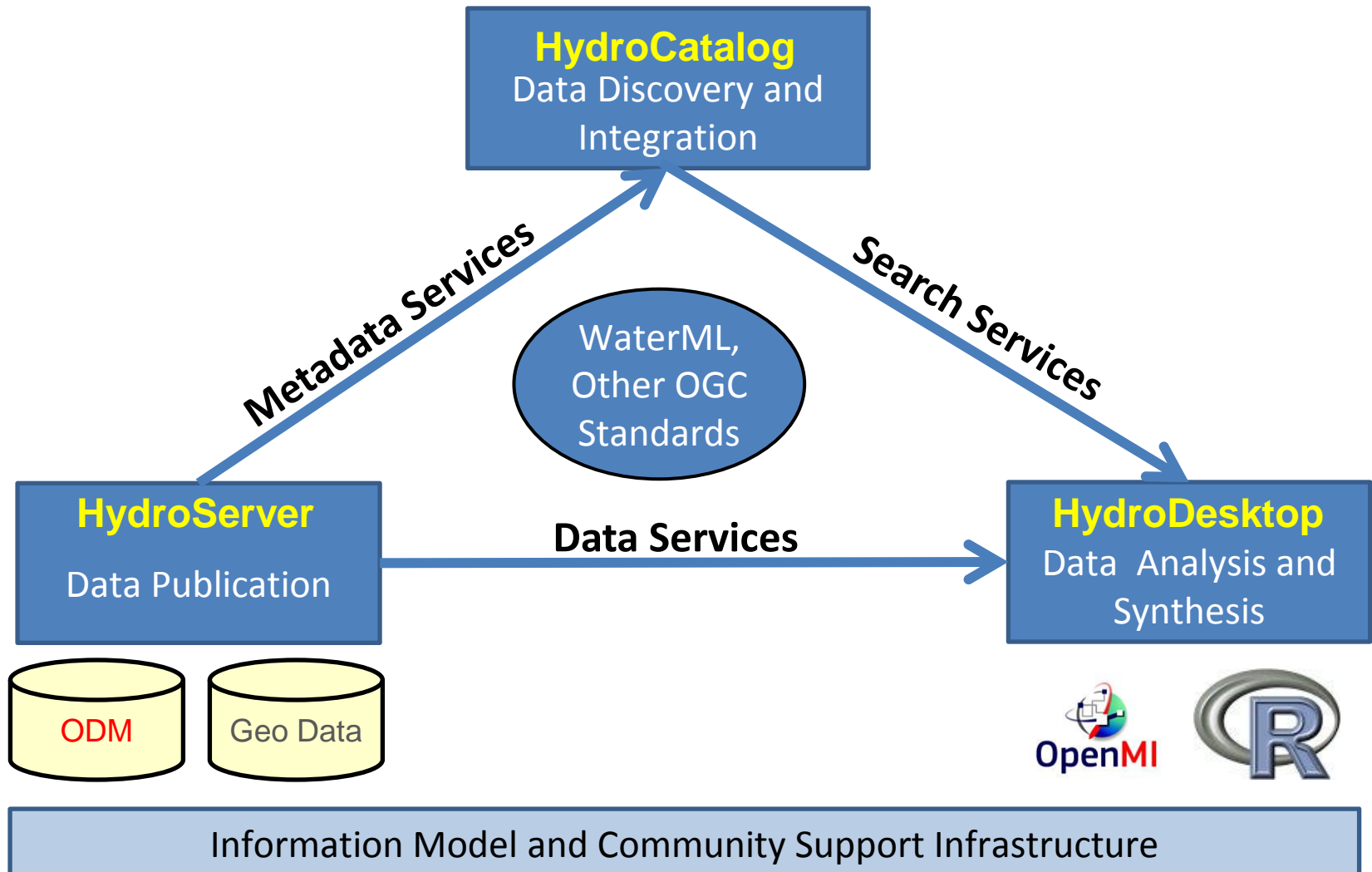
HydroServer – Data Publication



HydroDesktop – Data Access and Analysis

HydroDesktop – Combining multiple data sources

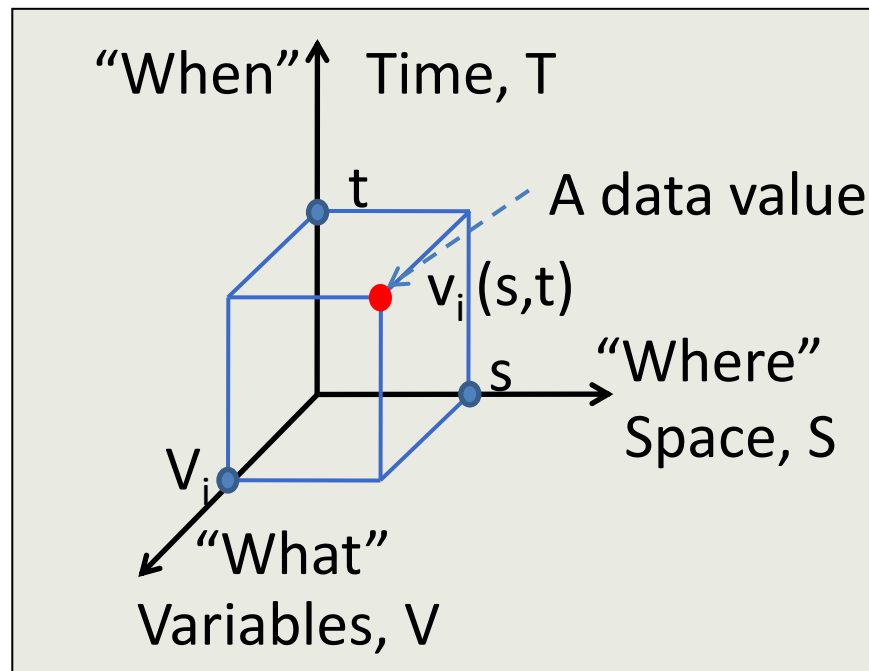
CUAHSI Hydrologic Information System Services-Oriented Architecture



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

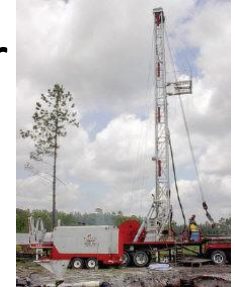
Observations Data Model (ODM)



Streamflow

Provides a common
persistence model for
data storage

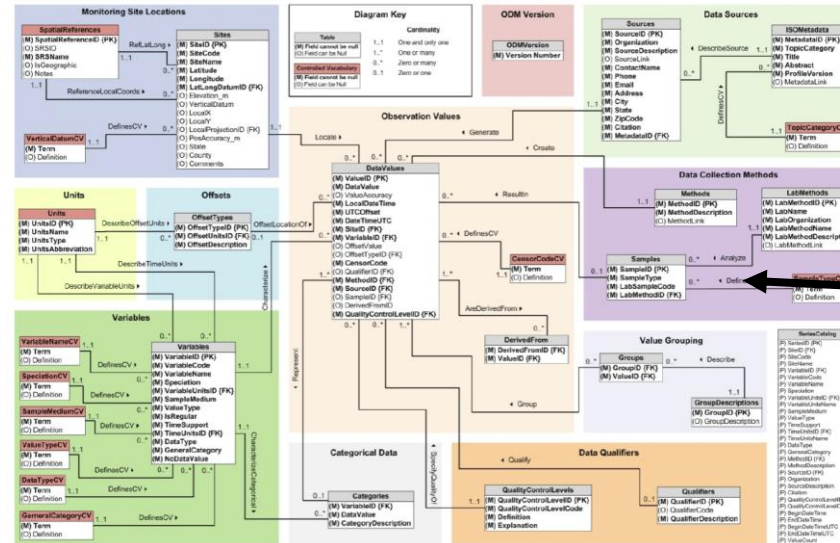
Groundwater
levels



Precipitation
& Climate



Water Quality



Soil
moisture
data



Flux tower data



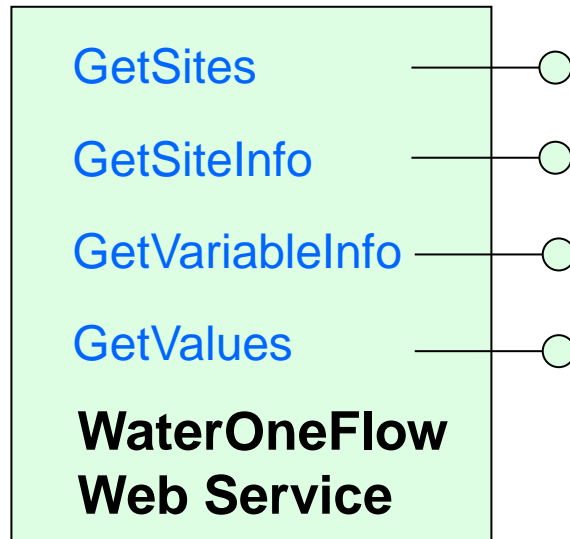
- A **relational database** at the single observation level
- Metadata for **unambiguous interpretation**
- Traceable heritage from **raw** measurements to **usable** information
- Promote **syntactic** and **semantic** consistency
- **Cross dimension** retrieval and analysis

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</siteCode>
- <geoLocation>
  - <geogLocation xsi:type="LatLonPointType" srs="EPSG"
    <latitude>30.24465429</latitude>
    <longitude>-97.694448</longitude>
  </geogLocation>
</geoLocation>
</sourceInfo>
- <variable>
  <variableCode vocabulary="NWIS" default="true" variableID="00000"
  <variableName>Discharge, cubic feet per second</variableName>
  <units unitsAbbreviation="cfs" unitsCode="35">cubic feet per second</units>
</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>
```

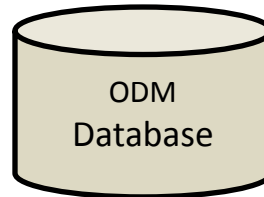
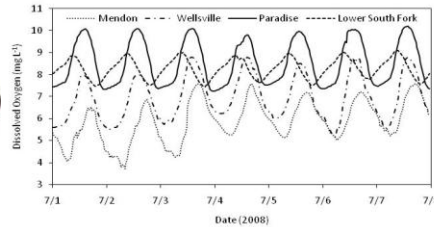
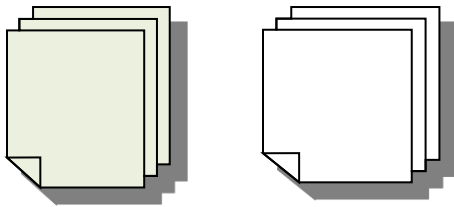
HydroServer – Data Publication

Point Observations Data

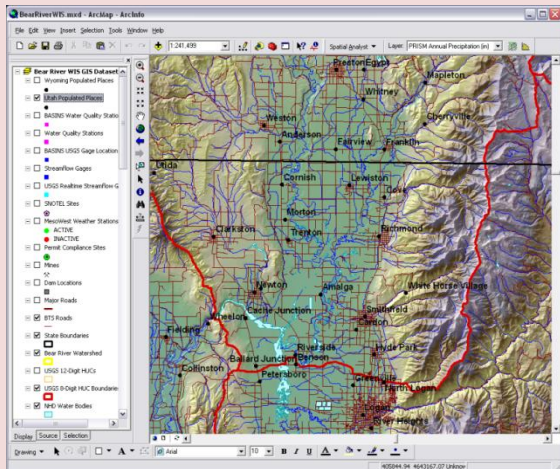
Ongoing Data Collection



Historical Data Files



GIS Data



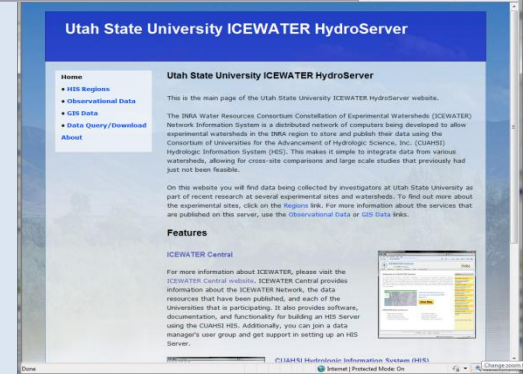
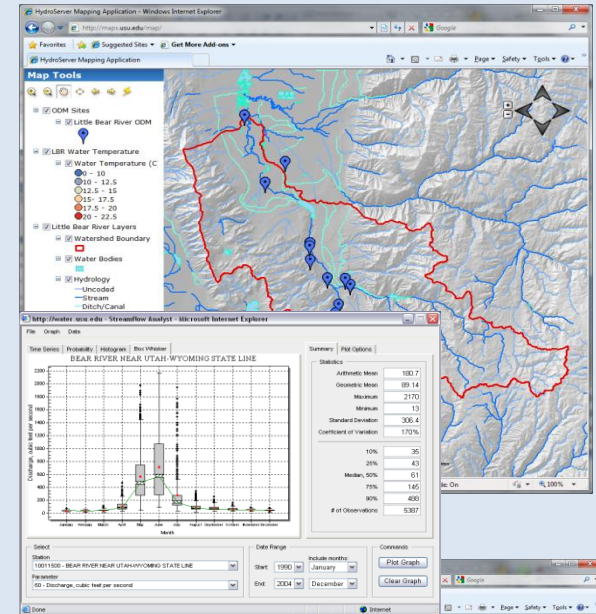
GetSites
GetSiteInfo
GetVariableInfo
GetValues

WaterML

WaterOneFlow
Web Service

OGC Spatial
Data Service
from ArcGIS
Server

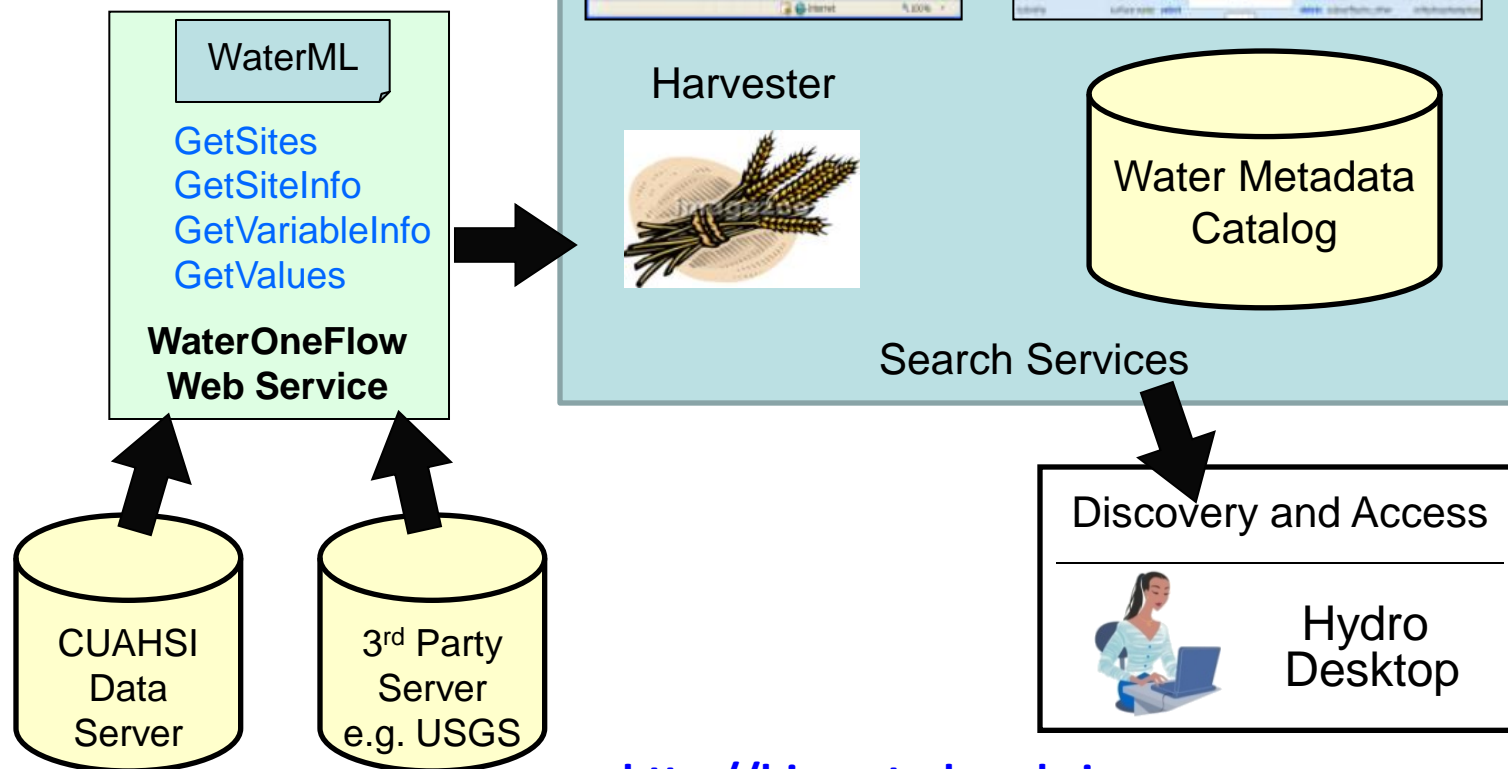
Internet Applications



Data presentation, visualization,
and analysis through Internet
enabled applications

HydroCatalog

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



HydroDesktop – Data Access and Analysis

The screenshot displays the HydroDesktop application window. The top toolbar includes navigation tools like Search, Pan, Zoom In, Zoom Out, MaxExtents, Previous, Next, Add, Identify, Select, Attribute, Measure, Delineate, and EPA Tool. The Map Layers panel on the left lists several layers: "Search Results" (circled in red), EPA, NCD CISH, NWISDV, NWISGW, NWISIID, NWISUV, rv14fe02, LocalWatershed, Themes (My_NWISUV, NWISIID), Online Basemap, Base Map Data (lakes, rivers), U.S. HUC, U.S. Counties, Canada Provinces, and U.S. States. The central map shows a watershed boundary in blue, with various data points and polygons overlaid. The right panel features a search interface with tabs for Area, Options, Keywords, and Results. The Keywords tab is active, showing a list of keywords related to "Hydrosphere" (circled in red). Below this, a "Selected Keywords" section lists "Hydrosphere". At the bottom right, a "Search Summary" section shows "Server: HIS Central", "Web Services: All Webservice selected", and "Keywords: Hydrosphere". A "Run Search" button is located at the bottom right. A yellow box highlights the "Thematic keyword search" area, and another yellow box highlights the "Search on space and time domain" area. The status bar at the bottom shows coordinates: Longitude: 78°37'06"W, Latitude: 36°31'41"N.

Integration from multiple sources

Thematic keyword search

Search on space and time domain

Longitude: 78°37'06"W, Latitude: 36°31'41"N



Integration with “R” Statistics Package

R Console

Abort Source/Load Quartz History Start X11 Set Colors Authentication Save Open In Editor

/Users/jago

```
rgl.sr> ylen <- ylim[2] - ylim[1] + 1
rgl.sr> colorlut <- terrain.colors(ylen)
rgl.sr> col <- colorlut[y - ylim[1] + 1]
rgl.sr> rgl.clear()
rgl.sr> rgl.surface(x, z, y, color = col)
```

R Data Editor

height	weight
58	115
59	117
60	120
61	123
62	126
63	129
64	132
65	135
66	139
67	142
68	146
69	150
70	154
71	159
72	164

Quartz (2) - Active

Given : depth

long

R Workspace Browser

Object	Type	Structure
▶ dati	data.frame	dim: 20 4
g	factor	levels: 10
l	numeric	length: 12
n	numeric	length: 1
▶ opar	list	length: 2
pie.sales	numeric	length: 6
pin	numeric	length: 2
scale	numeric	length: 1
usr	numeric	length: 4
▼ women	data.frame	dim: 15 2
height	numeric	length: 15
weight	numeric	length: 15
x	numeric	length: 87

Refresh List

R Package Manager

Refresh List

status	Package	Description
<input checked="" type="checkbox"/> loaded	graphics	The R Graphics Package
<input type="checkbox"/> not loaded	grid	The Grid Graphics Package
<input type="checkbox"/> not loaded	lattice	Lattice Graphics
<input checked="" type="checkbox"/> loaded	methods	Formal Methods and Classes
<input type="checkbox"/> not loaded	mgcv	GAMs with GCV smoothness estimation

The R Graphics Package

Documentation for package 'graphics' version 2.0.0

Help Pages

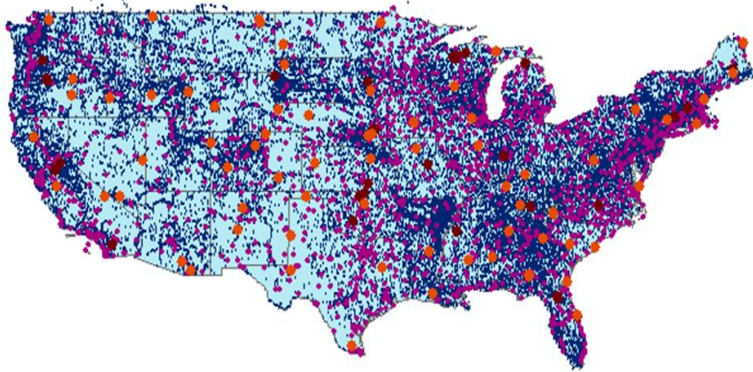
ABCDEFGHIJKLMNOPQRSTUVWXYZ

RGL device 1 (active)

Open Geospatial Consortium Web Service Standards

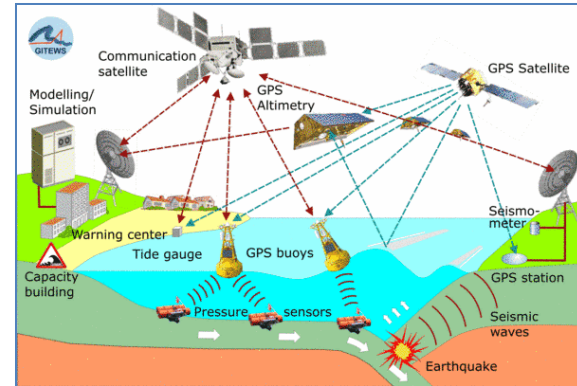
These standards have been developed over the past 10 years
... by 400 companies and agencies working within the OGC

- Map Services



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

- Observation Services



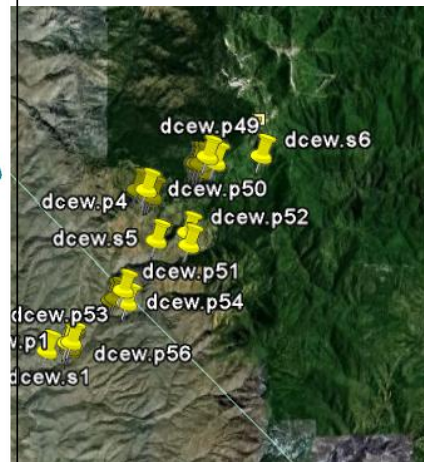
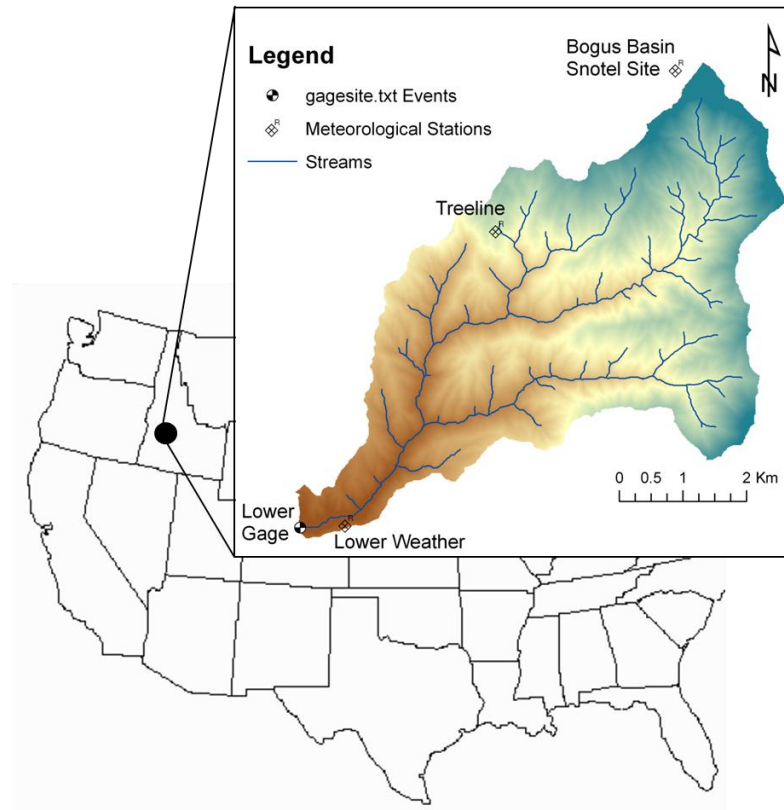
- Observations and Measurements Model
- Sensor Web Enablement (SWE)
- Sensor Observation Service (SOS)

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 km² semi-arid steep topography, Boise Front)



68 Sites
24 Variables
4,700,000+ values

Published by Jim
McNamara, Boise
State University

Open Development Model



The screenshot shows the HydroDesktop project page on the CodePlex Open Source Community. The browser address bar displays <http://hydrodesktop.codeplex.com/>. The page features the HydroDesktop logo, which includes a globe icon and the text "HydroDesktop CUAHSI Open Source Hydrologic Data Tools". Navigation tabs include Home, Downloads, Documentation, Discussions, Issue Tracker, Source Code, People, and License. A search bar is located in the top right corner. The main content area includes links for "View All Comments", "Print View", "Page Info", and "Change History (all pages)". A sidebar on the right shows that 24 people are following the project, a large green "Download" button, and a table of project details.

Property	Value
CURRENT	1.1.390
DATE	Wed Jan 26 2011 at 7:00 AM
STATUS	Stable
RATING	No Ratings
	530 downloads
MORE	View all downloads

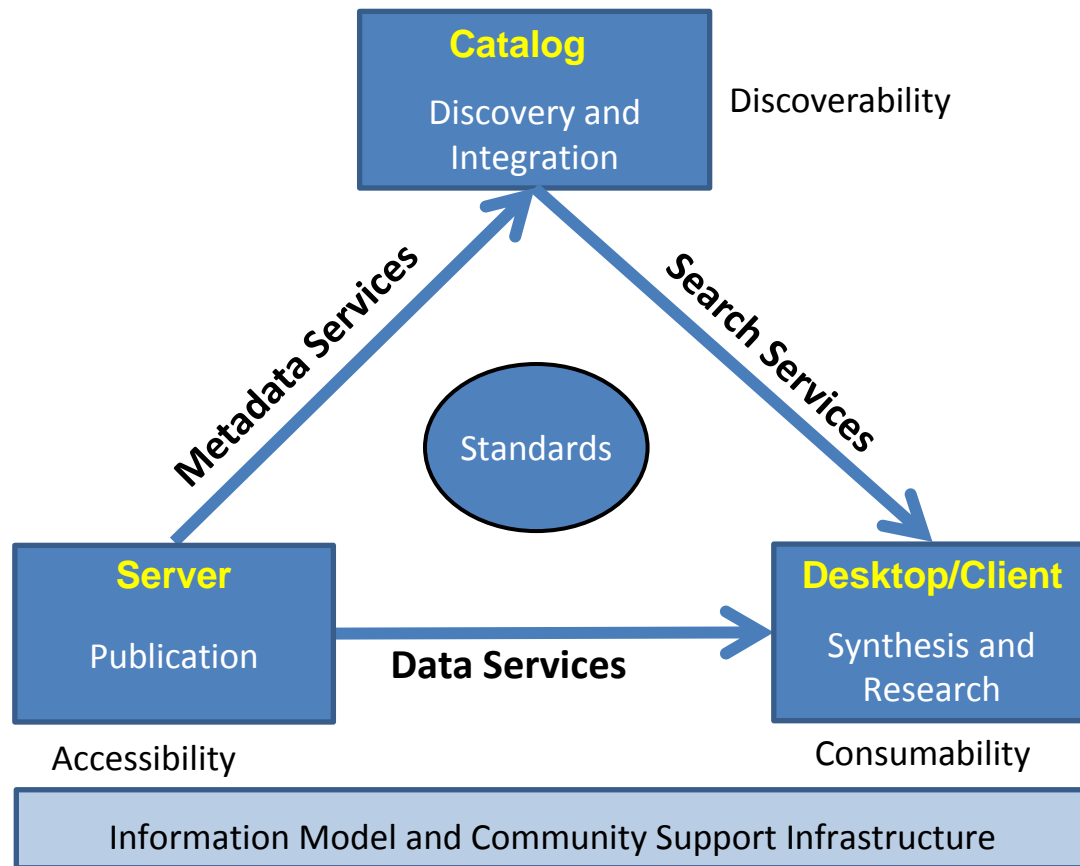
Below the table, there is an "Activity" section with a "View Detailed Stats" button. The bottom of the page shows a "Related Projects" section.

- <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

Common functional components



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



<http://his.cuahsi.org/>

