The CUAHSI Community Hydrologic Information System

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http://his.cuahsi.org/
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
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.
CUAHSI Hydrologic Information System

Services-Oriented Architecture

HydroCatalog
Data Discovery and Integration

Metadata Services
Search Services

WaterML, Other OGC Standards

HydroServer
Data Publication
ODM
Geo Data

Data Services

HydroDesktop
Data Analysis and Synthesis

OpenMI
R

Information Model and Community Support Infrastructure
What are the basic attributes to be associated with each single data value and how can these best be organized?

<table>
<thead>
<tr>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date/Time</td>
</tr>
<tr>
<td>Interval (support)</td>
</tr>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Quality Control Level</td>
</tr>
<tr>
<td>Sample Medium</td>
</tr>
<tr>
<td>Value Type</td>
</tr>
<tr>
<td>Data Type</td>
</tr>
<tr>
<td>Source/Organization</td>
</tr>
<tr>
<td>Units</td>
</tr>
<tr>
<td>Accuracy</td>
</tr>
<tr>
<td>Censoring</td>
</tr>
<tr>
<td>Qualifying comments</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Feature of interest</td>
</tr>
<tr>
<td>Latitude</td>
</tr>
<tr>
<td>Longitude</td>
</tr>
<tr>
<td>Site identifiers</td>
</tr>
</tbody>
</table>

![Diagram showing spatial and temporal dimensions](image)
Observations Data Model (ODM)

Streamflow
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

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
  - GetSites
  - GetSiteInfo
  - GetVariableInfo
  - GetValues

WaterOneFlow Web Service

- Returns data in WaterML

```xml
<timeSeries>
  - <sourceInfo xsi:type="SiteInfoType">
    <siteName>Colorado River at Austin, TX</siteName>
    <siteCode network="NWIS" siteID="4619631">08158001</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" variable="Discharge, cubic feet per second">
      <units unitsCode="35">cubic feet per second</units>
    </variableCode>
  </variable>
  - <values count="2545">
    <value dateTime="2006-12-31T00:00:00" value="129">
    <value dateTime="2006-12-31T00:15:00" value="129">
    <value dateTime="2006-12-31T00:30:00" value="129">
    <value dateTime="2006-12-31T00:45:00" value="129">
    <value dateTime="2006-12-31T1:00:00" value="124">
    <value dateTime="2006-12-31T1:15:00" value="129">
    <value dateTime="2006-12-31T1:30:00" value="124">
    <value dateTime="2006-12-31T1:45:00" value="124">
    </values>
</timeSeries>
```
HydroServer – Data Publication

Ongoing Data Collection

Data presentation, visualization, and analysis through Internet enabled applications

Internet Applications

Point Observations Data

Historical Data Files

GIS Data

ODM Database

- GetSites
- GetSiteInfo
- GetVariableInfo
- GetValues

WaterML

WaterOneFlow Web Service

OGC Spatial Data Service from ArcGIS Server

Data presentation, visualization, and analysis through Internet enabled applications
• Search over data services from multiple sources
• Supports concept based data discovery

HydroCatalog

Service Registry

Hydrotagger

Harvester

Water Metadata Catalog

Search Services

Discovery and Access

CUAHSI Data Server

3rd Party Server e.g. USGS

Web Service

WaterML

GetSites
GetSiteInfo
GetVariableInfo
GetValues

WaterOneFlow Web Service

http://hiscentral.cuahsi.org
HydroDesktop – Data Access and Analysis

Integration from multiple sources

Thematic keyword search

Search on space and time domain
Integration with “R” Statistics Package
Open Geospatial Consortium
Web Service Standards

• 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)

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

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

- [http://hydrodesktop.codeplex.com](http://hydrodesktop.codeplex.com)
- [http://hydroserver.codeplex.com](http://hydroserver.codeplex.com)
- [http://hydrocatalog.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

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