About the Speaker

PhD 2004
Research Associate

Watershed
WaterML Rainfall
Bass Guitar
Web Services
Information
Hydrologic
Water Resources
Programming
Hydro
Water Rights
Runoff
Photography
Research
Environmental Engineering
Groundwater
CUAHSI
Surface Water
Systems
WaterOneFlow
Geographic
University of Texas
Arc Hydro Austin
Arc Objects
Environment
What You Will Learn

• What is the CUAHSI Hydrologic Information System (HIS)
  – History
  – Why people use it
• How to access data in HIS
• How to publish your data with HIS
Outline

• The HIS Story

• HIS components

• Putting the pieces together
Outline

• *The HIS Story*

• HIS components

• Putting the pieces together
HIS Connects People with Data

• The CUAHSI* Hydrologic Information System (HIS) provides web services, tools, standards and procedures that enhance access to more and better data for hydrologic analysis.

[his.cuahsi.org](http://his.cuahsi.org)

*Consortium of Universities for the Advancement of Hydrologic Science, Inc.*
Temperature Near Aguascalientes
What is CUAHSI

**Consortium of Universities for the Advancement of Hydrologic Science, Inc**

- Formed in **2001**
- Develops *infrastructure and services to advance hydrologic science* in US universities

[www.cuahsi.org](http://www.cuahsi.org)
CUAHSI Member Institutions

112 North American universities, and 16 international affiliates
CUAHSI Hydrologic Information Systems Project

David R. Maidment
The University of Texas at Austin
(HIS Project Leader)
HIS Team Principle Investigators

David Maidment
U. of Texas

Ilya Zaslavski
UC-San Diego

Jon Goodall
U. of South Carolina

Dan Ames
Idaho State U.

David Tarboton
Utah State U.

David Maidment
U. of Texas
CUAHSI HIS Development

- CUAHSI Regional Meetings (2000)
- HIS Development Project (2010)
too much water
dirty water
water environment
too little water
Please rank these four HIS service categories for helping you.

Conclusion: Data services are the highest priority
Which of the following data analysis difficulties are most important for HIS to address?

**Priorities are:**
- Data formats
- Metadata
CUAHSI Hydrologic Information System

Goal: Enhance hydrologic science by facilitating user access to more and better data for testing hypotheses and analyzing processes

- Advancement of water science is critically dependent on integration of water information
- It is as important to represent hydrologic environments precisely with data as it is to represent hydrologic processes with equations
Currently, the focus is on data from monitoring sites at point locations.
The Result

• WaterML language for describing water data

• National catalog of water data sources

• Free software for data access
CUAHSI Water Data Services, April 2010

47 public services
13,200+ variables
1.8 million sites
22.9 million series
4.7 billion data values

The largest water data catalog in the world

Map Integrating NWIS, STORET, & Climatic Sites
Streamflow

- 2 services
- 7 variables
- 4,363 sites
- 11,484 series
- 9,493,968 records
Salinity

5 services
7 variables
6,613 sites
7,912 series
346,813 records
Water Temperature

6 services
11 variables
11,158 sites
22,953 series
1,546,841 records
Dissolved Oxygen

5 services
18 variables
10,823 sites
21,655 series
930,571 records
Bacteria

1 service
21 variables
4,801 sites
15,483 series
297,849 records
1 service
25 variables
5,635 sites
52,396 series
856,194 records
3 services
7 variables
6,228 sites
16,576 series
785,650 records
For more on the HIS Story

his.cuahsi.org
Outline

• The HIS Story

• *HIS components*

• Putting the pieces together
Web Paradigm

Catalog (Google)

Catalog harvest

Web Server (CNN.com)

Search

Access

Browser (Firefox)
Services-Oriented Architecture for Water Data
HIS System Overview

USGS
Data

University
Data

HydroServers

HIS Central

Metadata Catalog

Hydrologic Ontology

Web Service

Data Discovery

Data Access

Data Registration

Users
(HydroDesktop)
Water Data

Water quantity and quality

Soil water

Rainfall & Snow

Remote sensing

Meteorology

Modeling
Point Observations Time Series

A **point** location in **space**

A **series** of values in **time**

![Streamflow graph](image)
Sources of Observations Data

- USGS
- STORET
- Chesapeake Bay Program
- The San Diego River Park Foundation
- National Atmospheric Deposition Program
- Srbhos
- Crown of the Continent
- Texas Instream Flow Program
- USDA
- Boise State University
- Santa Fe River Watershed Testbed
- Clear Creek Observatory
- Texas Water Development Board
- Superfund Basic Research Program
- Utah State University
- MAST
Getting Water Data (the old way)

Different Query Pages

Different Query Responses
Web Pages and Web Services

http://www.safl.umn.edu/

http://his.safl.umn.edu/SAFLMC/cuahsi_1_0.asmx

Uses Hypertext Markup Language (HTML)

Uses WaterML

(a Markup Language for water data)
WaterML as a Web Language

Streamflow data in WaterML language

Discharge of the San Marcos River at Luling, June 28 - July 18, 2002

Streamflow (cfs)

<values count="21">
  <value qualifiers="A" dateTime="2002-06-28T00:00:00">203</value>
  <value qualifiers="A" dateTime="2002-06-29T00:00:00">195</value>
  <value qualifiers="A" dateTime="2002-06-30T00:00:00">2010</value>
  <value qualifiers="A" dateTime="2002-07-01T00:00:00">6170</value>
  <value qualifiers="A" dateTime="2002-07-02T00:00:00">11300</value>
  <value qualifiers="A" dateTime="2002-07-03T00:00:00">18700</value>
  <value qualifiers="A" dateTime="2002-07-04T00:00:00">15200</value>
  <value qualifiers="A" dateTime="2002-07-05T00:00:00">10900</value>
  <value qualifiers="A" dateTime="2002-07-06T00:00:00">19000</value>
  <value qualifiers="A" dateTime="2002-07-07T00:00:00">7720</value>
  <value qualifiers="A" dateTime="2002-07-08T00:00:00">5230</value>
  <value qualifiers="A" dateTime="2002-07-09T00:00:00">3710</value>
  <value qualifiers="A" dateTime="2002-07-10T00:00:00">3090</value>
  <value qualifiers="A" dateTime="2002-07-11T00:00:00">2610</value>
  <value qualifiers="A" dateTime="2002-07-12T00:00:00">2260</value>
  <value qualifiers="A" dateTime="2002-07-13T00:00:00">1990</value>
  <value qualifiers="A" dateTime="2002-07-14T00:00:00">1920</value>
  <value qualifiers="A" dateTime="2002-07-15T00:00:00">1780</value>
  <value qualifiers="A" dateTime="2002-07-16T00:00:00">2120</value>
  <value qualifiers="A" dateTime="2002-07-17T00:00:00">3680</value>
  <value qualifiers="A" dateTime="2002-07-18T00:00:00">4010</value>
</values>

<qualifier qualifierCode="A" network="USGS" vocabulary="dv_rmk_cd">Approved for publication -- Processing and review completed.</qualifier>
WaterML includes location, variables, and time series.

```xml
<timeSeriesResponse
    xmlns:gml="http://www.opengis.net/gml"
    xmlns:xlink="http://www.w3.org/1999/xlink"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:wtr="http://www.cuahsi.org/waterML/
    xmlns="http://www.cuahsi.org/waterML/1.0"/>

<queryInfo>...
<timeSeries>
    <sourceInfo xsi:type="SiteInfoType">
        <siteName>Colorado RV at Austin, TX</siteName>
        <siteCode siteID="1389"/>0818000</siteCode>
        <timezoneOffset/>
        <geoLocation/>
        <note>Agency: USGS</note>
    </sourceInfo>
    <variable>
        <variableCode vocabulary="USGS">00060</variableCode>
        <variableName>Discharge</variableName>
        <dataType>Average</dataType>
        <units>cfs</units>
        <optionName/>
    </variable>
    <values>
        <value qualifiers="A" dateTime="2007-01-01T00:00:00">143</value>
        <value qualifiers="A" dateTime="2007-01-02T00:00:00">231</value>
        <value qualifiers="A" dateTime="2007-01-03T00:00:00">112</value>
        <value qualifiers="A" dateTime="2007-01-04T00:00:00">598</value>
        <value qualifiers="A" dateTime="2007-01-05T00:00:00">182</value>
        <value qualifiers="A" dateTime="2007-01-06T00:00:00">212</value>
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        <value qualifiers="A" dateTime="2007-01-09T00:00:00">132</value>
        <value qualifiers="A" dateTime="2007-01-10T00:00:00">133</value>
    </values>
    <qualifier qualifierCode="A" network="USGS" vocabulary="dv_rmk_cd">
      Approved for publication -- Processing and review completed.'</qualifier>
</timeSeries>
</timeSeriesResponse>
```
A **data source** operates an observation network
A **network** is a set of observation sites
A **site** is a point location where one or more variables are measured
A **variable** is a property describing the flow or quality of water
A **value** is an observation of a variable at a particular time
**Metadata** provide additional information about the value
WaterOneFlow

• Set of **query** functions

• Returns data in **WaterML**

Example Inputs

Developmental service. This service is internal CUAHSI use, EPA STORET
The EPA STORage and RETrievial System (STORET) provides access
provides methods for retrieving data from EPA STORET. For more in

The following operations are supported. For a formal definition, please

- **GetSiteInfo**
  Given a site number, this method returns the site's metadata.

- **GetSiteInfoObject**
  Given a site number, this method returns the site's metadata.

- **GetSites**
  Given an array of site numbers, this method returns the site's metadata.

- **GetValues**
  Given a site number, a variable, a start date, and an end date.

- **GetValuesObject**
  Given a site number, a variable, a start date, and an end date.

- **GetVariableInfo**
  Given a variable code, this method returns the variable's metadata.

- **GetVariableInfoObject**
  Given a variable code, this method returns the variable's metadata.

```xml
<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>
      </geoLocation>
    </geoLocation>
  </sourceInfo>

  - <variable>
    <variableCode vocabulary="NWIS" default="true" variable="Discharge, cubic feet per second"/>
    <units unitsAbbreviation="cfs" unitsCode="35">cubic feet per second</units>
  </variable>

  - <values count="2545">
    <value date="2006-12-31T00:00:00">129</value>
    <value date="2006-12-31T00:15:00">129</value>
    <value date="2006-12-31T00:30:00">129</value>
    <value date="2006-12-31T00:45:00">129</value>
    <value date="2006-12-31T01:00:00">124</value>
    <value date="2006-12-31T01:15:00">129</value>
    <value date="2006-12-31T01:30:00">124</value>
    <value date="2006-12-31T01:45:00">124</value>
    <value date="2006-12-31T02:00:00">124</value>
    <value date="2006-12-31T02:15:00">124</value>
    <value date="2006-12-31T02:30:00">124</value>
    <value date="2006-12-31T02:45:00">122</value>
  </values>
</timeSeries>
```
WaterML and WaterOneFlow

WaterML is an XML language for communicating water data.
WaterOneFlow is a set of web services based on WaterXML.
HIS System – HydroServer

USGS
Data

University
Data

HydroServers

Web Service

Data
Registration

Data
Access

Data
Discovery
And Access

HIS Central

Metadata
Catalog

Hydrologic
Ontology

Users
HydroServer Goals

• A platform for publishing space-time hydrologic datasets that:
  – Provides local control of data
  – Makes data universally available
  – Is open source (hydroserver.codeplex.com)
GIS Data

HydroServer

Ongoing Data Collection

Historical Data Files

Point Observations Data

Data presentation, visualization, and analysis through Internet enabled applications

GetSites
GetSiteInfo
GetVariableInfo
GetValues

WaterML

WaterOneFlow Web Service

ArcGIS Server

Data

presentation,
visualization,
and analysis through Internet enabled applications
Data Storage – Relational Database

Simple Intro to “What Is a Relational Database”
Observations Data Model

Observations Data Model (ODM)
A Relational Model at the Single Observation Level

- **Observations** made at points
- Metadata for **unambiguous interpretation**
- Traceable heritage from **raw** measurements to **usable** information
- **Standard format** for data sharing
- **Cross dimension** retrieval and analysis

\[
V_i(s,t)
\]

\[V_i\]

\[V_i\]

Space, \(S\)

Time, \(T\)

“Where”

“When”

“What”

A data value

Where

\(v_i(s,t)\)
Publication of Point Observations Data

- Loading Data into ODM Databases
  - ODM Data Loader
  - ODM Streaming Data Loader
- Editing and managing data
  - ODM Tools
- Implementation of WaterOneFlow Web Services

Tools available at: http://his.cuahsi.org
Publication of Spatial (GIS) Datasets

• Publishing spatial datasets using ArcGIS Server
  – Using OGC standards that can be consumed by a number of GIS clients
  – WMS, WFS, WCS
Data Presentation Via a Map Interface

- Internet map server built using ArcGIS
- Web browser client
- Combine spatial data and observational data
- Launch data visualization tools

http://maps.usu.edu/map/
Data Preview, Visualization, and Analysis

Time Series Analyst

- Web browser client
- Descriptive statistics
- Linked to the map application
- Data preview and download

http://icewater.usu.edu/tsa/
ODM Databases and Web Services

Capabilities
Database Configuration Tool

WaterOneFlow Services
HydroServer Capabilities Database
Spatial Services

ODM

ArcGIS Server Spatial Data Services
HydroServer Capabilities Web Service

- Publish capabilities of each HydroServer
  - Published observational data services
  - Published spatial data services
  - Information transmitted in XML format

- Makes HydroServers self describing
HydroServer Website

- HydroServer home page
- Observational data services
- GIS data services
- Online map
- Time Series Analyst
- Data Query and Download

http://icewater.usu.edu
ICEWATER – A Regional HIS

- ICEWATER – INRA Constellation of Experimental WATERsheds
- Coalition of 8 universities

- Point Observations
  - Stream gages
  - Water quality sampling
  - Weather stations
  - Soil moisture
  - Snow monitoring
  - Groundwater level/quality
- Spatially Distributed Data
  - Land use/cover
  - Terrain
  - Hydrography

http://icewater.inra.org
How Do I Create a HydroServer?

1. Get a Windows Server Machine with IIS and .NET Framework
2. Install Microsoft SQL Server
3. Install **FREE** HydroServer software from http://hydroserver.codeplex.com/
   - Database
   - WaterOneFlow
   - Website
4. Install ESRI ArcGIS Server
5. Create Services and Document them in Capabilities database
Why Publish Data with HIS

- Recognition
- Collaboration
- Public service
- Cost savings
What Have We Covered

• HIS Overview
• HydroServer
  – ODM
  – WaterML
HIS System – HIS Central

USGS
  Data
  Web Service

University
  Data

HydroServers

HIS Central
  Metadata Catalog
  Hydrologic Ontology

Data Discovery And Access

Data Access

Data Registration

Users
HIS Central

- **Publishers**
  - Register a data service

- **Users**
  - Find a data service

- **Supported by**
  - Metadata Catalog
  - Hydrologic Ontology

http://hiscentral.cuahsi.org
Data Series – Metadata description

There are C measurements of Variable $V_i$ at Site $S_j$ from time $t_1$ to time $t_2$. 
Series Catalog

Series Catalog

SeriesID {PK}
  SiteID {FK} $S_j$
  SiteCode
  SiteName
  VariableID {FK} $V_i$
  VariableCode
  VariableName
  Speciation
  VariableUnitsID {FK}
  VariableUnitsName
  SampleMedium
  ValueType
  TimeSupport
  TimeUnitsID {FK}
  TimeUnitsName
  DataType
  GeneralCategory
  MethodID {FK}
  MethodDescription
  SourceID {FK}
  Organization
  SourceDescription
  Citation
  QualityControlLevelID {FK}
  QualityControlLevelCode
  BeginDateTime $t_1$
  EndDateTime
  BeginDateTimeUTC $t_2$
  EndDateTimeUTC
  ValueCount $C$

Variables

End Date Time, $t_2$

Begin Date Time, $t_1$

Site, $S_j$

Time

Space

Count, $C$
CUAHSI Water Data Services, April 2010

47 public services
13,200+ variables
1.8 million sites
22.9 million series
4.7 billion data values

Map Integrating NWIS, STORET, & Climatic Sites

The largest water data catalog in the world
Data Heterogeneity

- **Syntactic mediation**
  - Heterogeneity of format
  - Use WaterML to get data into the same format

- **Semantic mediation**
  - Heterogeneity of meaning
  - Each water data source uses its own vocabulary
  - Match these up with a concept from the CUAHSI hydrologic ontology
  - Make standard scientific data queries and have these automatically translated into specific queries on each data source
### Streamflow

- **FLOW,STREAM,MEANDAILY(CUBICFEETPERSEC)**
- **FLOW:1=NoFlow,2=Low,3=Normal,4=Flood,5=High,6=D**
- **FLOWRATE(GALLONSPERDAY)**
- **FLOWRATEINSTANTANEOUS(MGD)**
- **FLOWSTREAM,INSTANTANEOUS(CUBICFEETPERSEC)**
- **INSTANTANEOUSSTREAMFLOW(CU.METERS/SEC.)**
- Discharge, cubic feet per second

### Nutrients

- **NITRATENITROGEN,BOTTOMDEPOS.(MG/KG-NDRYWT)**
- **NITRATENITROGEN,DISSOLVED(MG/LASN)**
- **NITRATENITROGEN,TOTAL(MG/LASN)**
- **NITRITE,DISSOLVED(MG/LASN)**
- **NITRITENITROGEN,BOTTOMDEPOS.(MG/KG-NDRYWT)**
- **NITRITENITROGEN,TOTAL(MG/LASN)**
- **NITRITEPLUSNITRATE,BOT.DEPOS.(MG/KG-NDRYWT)**
- **NITRITEPLUSNITRATE,DISS1DET.(MG/LASN)**
- **NITRITEPLUSNITRATE,TOTAL1DET.(MG/LASN)**
- **NITROGEN,AMMONIA,BOTTOMDEPOSITS(MG/KG-N)**
- **NITROGEN,AMMONIA,DISSOLVED(MG/LASN)**
- **NITROGEN,AMMONIA,TOTAL(MG/LASN)**
- **NITROGEN,KJELDAHL,DISSOLVED(MG/LASN)**
- **NITROGEN,KJELDAHL,TOTAL(MG/LASN)**
- **NITROGEN,ORG.KJEL,BOT.DEPOS(MG/KG-NDRYWT)**
- **NITROGEN,ORGANIC,DISSOLVED(MG/LASN)**
- **NITROGEN,ORGANIC,TOTAL(MG/LASN)**
- **NITROGEN,TOTAL(MG/LASN)**
- **NITROGEN,TOTAL,BOTTOMDEPOSITS(MG/KG-NDRYWT)**
- **NITROGENKJELDAHLTOTALBOTTOMDEPDRYWT(MG/KG)**
- **PHOSPHATE,ORTHO(MG/LASPO4)**
- **PHOSPHATE,TOTAL(MG/LASPO4)**
- **PHOSPHORUS,DISSOLVED(MG/LASP)**
- **PHOSPHORUS,TOTAL,BOTTOMDEPOSIT(MG/KGDRYWT)**
- **PHOSPHORUS,TOTAL,WETMETHOD(MG/LASP)**

### Water Temperature

- **Continuous Temperature**
- **Temperature**
- **Temperature, water, degrees Celsius**
- **TEMPERATURE,WATER(DEGREESCENTIGRADE)**
- **TEMPERATURE,WATER(DEGREESCENTIGRADE)24HRMIN**
- **TEMPERATURE,WATER(DEGREESCENTIGRADE,24HRAVG**
- **TEMPERATURE,WATER(DEGREESFAHRENHEIT)**
- **WaterTemperature**
- **WATERTEMPERATURE,#OFMEASUREMENTSIN24-HRS**
- **WATERTEMPERATURE,DEGREESCENTIGRADE,24HRMAX**
Conceptual Framework

• **Chemical** descriptions from EPA/USGS Substance Registry System
  [http://www.epa.gov/srs/](http://www.epa.gov/srs/)

• **Physical** descriptions from **CF Conventions**
  – NetCDF Climate & Forecast; 137 variables

• **Biological** descriptions from **Integrated Taxonomic Information System**
Each **Variable** in your data is connected to a corresponding **Concept**.
Water Temperature

6 services
11 variables
11,158 sites
22,953 series
1,546,841 records

Continuous Temperature
Temperature
Temperature, water, degrees Celsius
TEMPERATURE,WATER(DEGREESCELSIUS)
TEMPERATURE,WATER(DEGREESCELSIUS)24HRMIN
TEMPERATURE,WATER(DEGREESCELSIUS),24HRAVG
TEMPERATURE,WATER(DEGREESFAHRENHEIT)
WaterTemperature
WATERTEMPERATURE,#OFMEASUREMENTSIN24_HRS
WATERTEMPERATURE,DEGREESCELSIUS,24HRMAX
HIS Central Web Page

[Image of HIS Central Web Page]

All Registered Data Services

<table>
<thead>
<tr>
<th>Data Service Title</th>
<th>Observation Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltimore Precipitation</td>
<td>BaltPrecip</td>
</tr>
<tr>
<td>Baltimore Ecosystem Study Stream Chemistry Data</td>
<td>BESOD</td>
</tr>
<tr>
<td>Baltimore Ecosystem Study Soils Data</td>
<td>BESSoil</td>
</tr>
<tr>
<td>Baltimore Waters Test Bed Ground Water Level Data</td>
<td>BaltimoreGW</td>
</tr>
<tr>
<td>Beacon Institute for River and Estuary</td>
<td>BEACON_IBM</td>
</tr>
<tr>
<td>Dry Creek Experimental Watershed, SW Idaho</td>
<td>ODMDCE</td>
</tr>
<tr>
<td>Chesapeake Bay Information Management System</td>
<td>CIMS</td>
</tr>
</tbody>
</table>

Dry Creek Experimental Watershed, SW Idaho

Boise State University, Hydrologic Sciences Department

ODMDCEW2

http://icewater.boisestate.edu/bicow2/dataservices/cuahsi_1.0.asmx?WSDL

Contact: Pam Aishlin
pamaishlin@boisestate.edu
208-426-2220

Service Statistics:

- Sites: 98
- Geographic Extent: 43.74071, -110.1786 to 43.86634, -110.089
- Variables: 24
- Values: 4736590

Last Harvested on 7/25/2010 1:12:59 PM

Abstract

Dry Creek Experimental Watershed was established by Dr. Jim McNamara in 1998 as an outdoor laboratory for student and faculty research toward improving understanding of hydrologic processes in semi-and mountainous terrain and testing and improving data integration and hydrologic modeling. Continuous and discrete data collection includes climate, surface water, groundwater and soil.

http://hiscentral.cuahsi.org
HIS Central Web Service

- Programmatic methods to query the national metadata catalog
- Search by:
  - Location
  - Variable (concept)
  - Date Range
  - Data source (WaterOneFlow service)

http://hiscentral.cuahsi.org/webservices/hiscentral.asmx
HIS in Familiar Software
HydroExcel: WaterOneFlow Excel Client

HydroExcel is an Excel spreadsheet that provides direct access to WaterOneFlow web services, serving data both from national data providers and universities. The spreadsheet uses VBA macros and an object library called HydroObjects to communicate with and retrieve data from WaterOneFlow web services.

Before you begin:
- Enable Excel macros. Your security settings may prevent the macros in this spreadsheet from running. If macros are disabled, and you don’t see an option to enable them, you may need to go into Excel’s security settings and allow macros or at least disable macros with notification. You will likely then have to close the spreadsheet and reopen it in order for the macros to work.
- HydroExcel uses HydroObjects, an object library for communicating with the WaterOneFlow web services. So if you want to use HydroExcel, get and install HydroObjects.
- HydroObjects requires the .Net Framework 2.0 from Microsoft. If you are using Office 2003, then Service Pack 3 for Microsoft Office 2003 is also required.

HydroExcel Version 1.1.2 Resources:
This latest version of HydroExcel features right-click menus and additional buttons to improve the workflow, the ability to save raw WaterML files to disk as XML files, and the display of some additional items available in WaterML such as variable specification.
- Microsoft Office 2003 version [XLS; 7.5M] (requires HydroObjects)
- Microsoft Office 2007 version [XLSB; 1.1M] (requires HydroObjects)
- HydroExcel Version 1.1.2 Software Manual [PDF; 3.8M; 48 pages]
Choosing a Service

Tell HydroExcel which web service to use

Web Services for National Data Sources

<table>
<thead>
<tr>
<th>Data Source</th>
<th>WSDL Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States Geological St</td>
<td><a href="http://river.sdsc.edu/wateroneflow/NWIS/DailyValues.asmx?WSDL">http://river.sdsc.edu/wateroneflow/NWIS/DailyValues.asmx?WSDL</a></td>
<td>NWIS daily value data (e.g., daily average)</td>
</tr>
<tr>
<td>United States Geological St</td>
<td><a href="http://river.sdsc.edu/wateroneflow/NWIS/Groundwater.asmx?WSDL">http://river.sdsc.edu/wateroneflow/NWIS/Groundwater.asmx?WSDL</a></td>
<td>NWIS groundwater data</td>
</tr>
<tr>
<td>United States Geological St</td>
<td><a href="http://river.sdsc.edu/wateroneflow/NWIS/UnitValues.asmx?WSDL">http://river.sdsc.edu/wateroneflow/NWIS/UnitValues.asmx?WSDL</a></td>
<td>NWIS real time data</td>
</tr>
<tr>
<td>United States Geological St</td>
<td><a href="http://river.sdsc.edu/wateroneflow/NWIS/Data.asmx?WSDL">http://river.sdsc.edu/wateroneflow/NWIS/Data.asmx?WSDL</a></td>
<td>NWIS instantaneous irregular data (e.g., instantaneous)</td>
</tr>
<tr>
<td>Environmental Protection Ag</td>
<td><a href="http://river.sdsc.edu/wateroneflow/EP/zuahsi_1_0.asmx?WSDL">http://river.sdsc.edu/wateroneflow/EP/zuahsi_1_0.asmx?WSDL</a></td>
<td>STORET water quality data</td>
</tr>
<tr>
<td>NASA</td>
<td><a href="http://river.sdsc.edu/wateroneflow/MISS/Service.asmx?WSDL">http://river.sdsc.edu/wateroneflow/MISS/Service.asmx?WSDL</a></td>
<td>Atmospheric data derived from remote sensing missions</td>
</tr>
<tr>
<td>USDA-ARS</td>
<td><a href="http://river.sdsc.edu/wateroneflow/MODIS/Service.asmx?WSDL">http://river.sdsc.edu/wateroneflow/MODIS/Service.asmx?WSDL</a></td>
<td>USDA-ARS Snow data network</td>
</tr>
</tbody>
</table>
Choosing a Site

Find sites and variables available from the web service

Google Earth opens, showing our sites

Let's use this site

- GetSites
- GetSiteInfo
- GetVariableInfo
- GetValues

WaterML

WaterOneFlow

Web Service
Downloading Time Series

Input our site and a desired variable, e.g., net radiation, and tell HydroExcel to get the time series for March, 2007.
Exploring the Time Series

Explore time series using analytical capabilities of Excel
HydroExcel Limitations

• Can’t hold much data
• No dates before year 1900
• Not truly geospatially enabled
• Not free

• How can I use HIS in software built to work with HIS from the ground up?
HydroDesktop

• Free, open source solution for HIS data access

• [www.hydrodesktop.org](http://www.hydrodesktop.org)
GIS fully integrated with HIS

- Metadata catalog
- Ontology keywords
- WaterOneFlow/WaterML

Discovery
Access
Analysis
Built-in Analysis

- Tables
- Graphs
- Editing
- Export
Customizable with Plug-ins

- Community development
- Build on the HydroDesktop framework
Outline

• The HIS Story

• HIS components

• Putting the pieces together
Services-Oriented Architecture for Water Data

HIS Central

Catalog

WaterML

Service registration
Catalog harvest
Search

Data access

HydroServer
Data Publisher

HydroDesktop
User
HIS Overview Report

• Summarizes the conceptual framework, methodology, and application tools for HIS version 1.1
• Shows how to develop and publish a CUAHSI Water Data Service
• Available at:

http://his.cuahsi.org/documents/HISOverview.pdf
The Road Ahead

• WaterML 2.0
  – World Meteorological Organization
  – Open Geospatial Consortium
  – Hydrology Domain Working Group

• HydroServer – Data access control

• HydroDesktop – Refinement
Put Your Dots on the Map
Start Using HIS

• HIS Website
  – his.cuahsi.org

• HydroDesktop
  – www.hydrodesktop.org

• CUAHSI User Support Specialist
  – Yoori Choi
  – ychoi@cuahsi.org