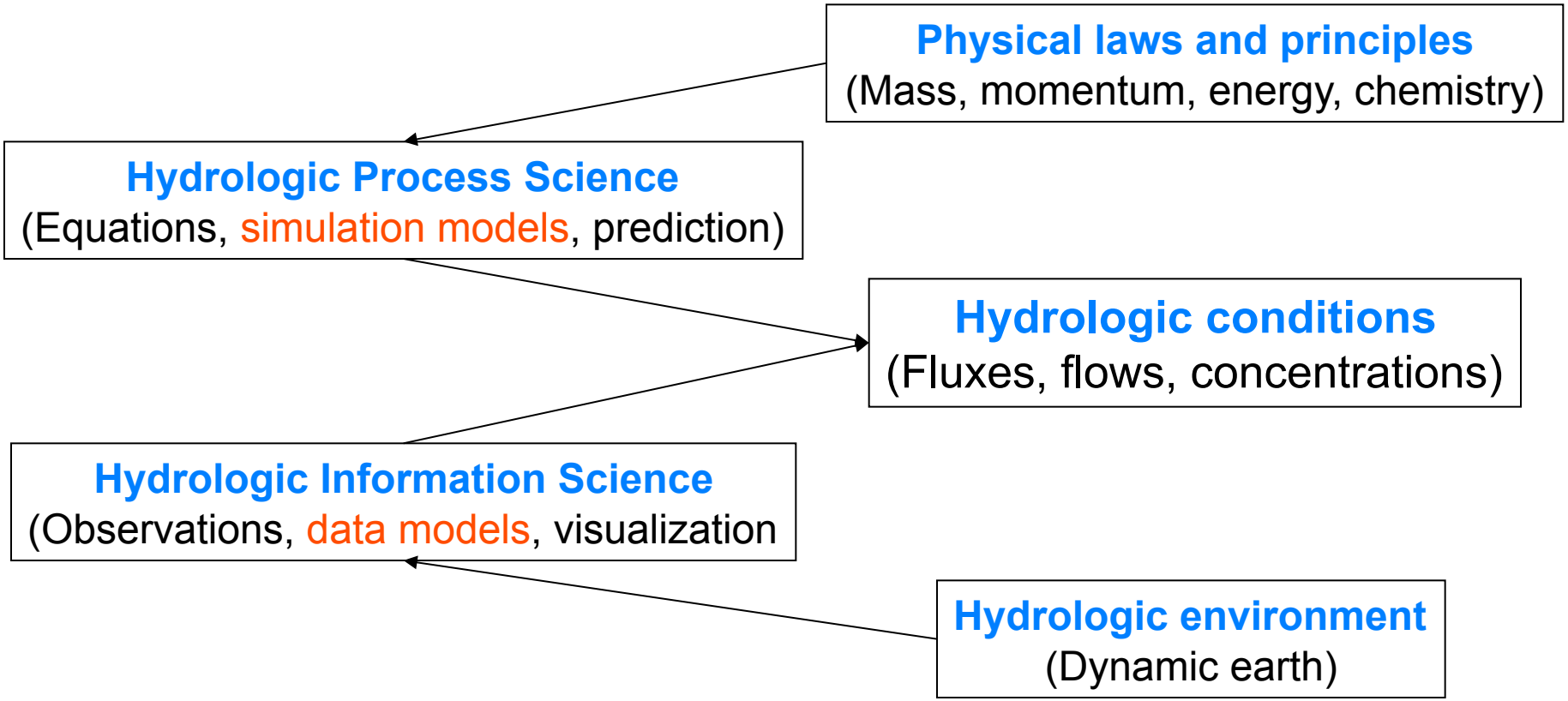
HIS Team and Collaborators

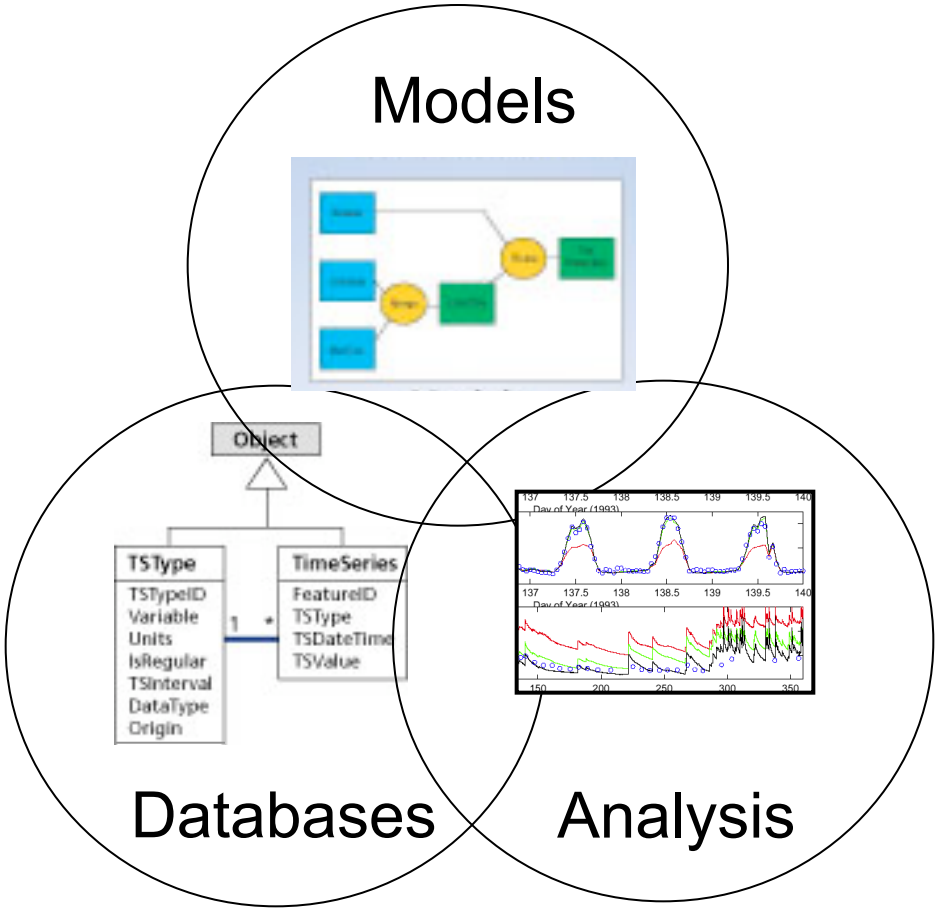
- University of Texas at Austin – David Maidment, Tim Whiteaker, Ernest To, Bryan Enslein, Kate Marney
- San Diego Supercomputer Center – Ilya Zaslavsky, David Valentine, Tom Whitenack
- Utah State University – David Tarboton, Jeff Horsburgh, Kim Schreuders, Justin Berger
- Drexel University – Michael Piasecki, Yoori Choi
- University of South Carolina – Jon Goodall, Tony Castronova
- CUAHSI Program Office – Rick Hooper, David Kirschtel, Conrad Matiuk
- WATERS Network – Testbed Data Managers
- HIS Standing Committee
- USGS – Bob Hirsch, David Briar, Scott McFarlane
- NCDC – Rich Baldwin

The Need: Hydrologic Information Science

It is as important to represent hydrologic environments precisely with data as it is to represent hydrologic processes with equations



Advancement of water science is critically dependent on integration of water information



Databases: Structured data sets to facilitate data integrity and effective sharing and analysis.

- Standards
- Metadata
- Unambiguous interpretation

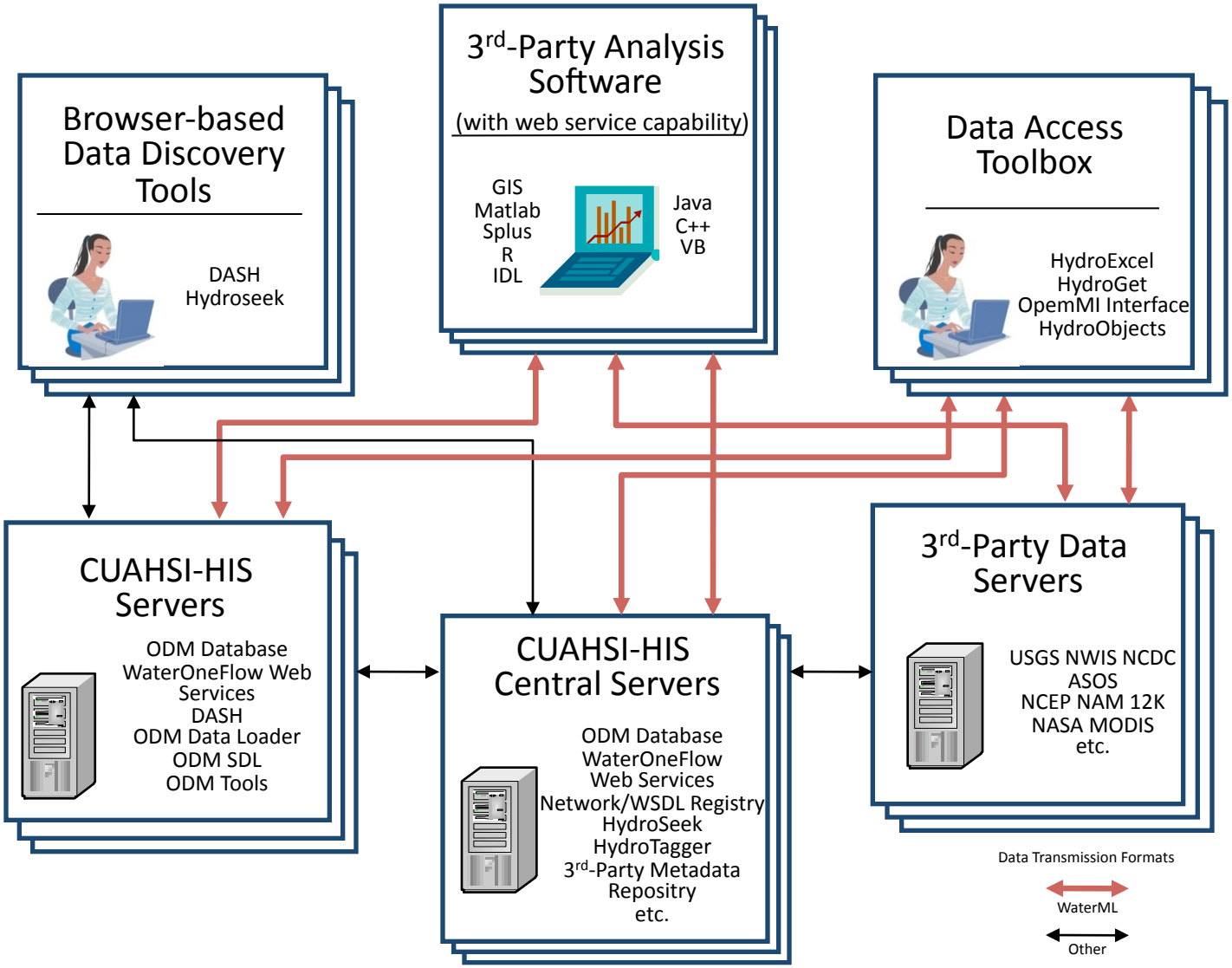
ODM

Analysis: Tools to provide windows into the database to support visualization, queries, analysis, and data driven discovery.

Web Services

Models: Numerical implementations of hydrologic theory to integrate process understanding, test hypotheses and provide hydrologic forecasts.

What is the CUAHSI HIS?



An internet based system to support the sharing of hydrologic data comprising databases connected using the internet through web services as well as software for data discovery, access and publication.

Key HIS components

Clients

HydroExcel

HydroGet

Matlab

HydroSeek

ODM

ODM 1.0

Ontology

WaterOneFlow

GetSiteInfo

GetVariableInfo

GetValues

WSDL Registry

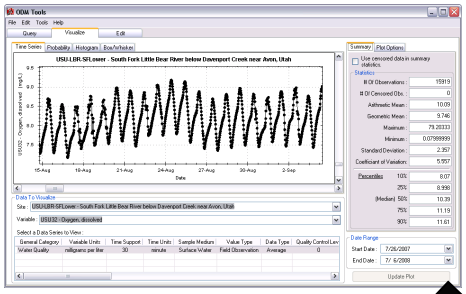
- http://cbe.cae.drexel.edu/wateroneflow/CIMS.asmx?WSDL
- http://ccbay.tamucc.edu/CCBayODWS/cuahsi_1_0.asmx?WSDL
- http://ees-his06.ad.ufl.edu/santafe-srgwl/cuahsi_1_0.asmx?WSDL
- http://ferry.ims.unc.edu/modmon/cuahsi_1_0.asmx?WSDL
- http://his02.usu.edu/littlebearriver/cuahsi_1_0.asmx?WSDL

CV Services

ODM Tools

CUAHSI HIS Data Publication System

Query, Visualize, and Edit data using **ODM Tools**



Analysis

GIS
Matlab
Splus
R
IDL

Java
C++
VB

Access

HydroExcel
HydroGet
HydroLink
HydroObjects

Discovery

Hydroseek

Streaming Data Loader

ODM Database

- GetSites
- GetSiteInfo
- GetVariableInfo
- GetValues

WaterML

WaterOneFlow Web Service

Base Station Computer(s)

Telemetry Network

Sensors

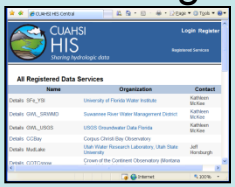
ODM Data Loader

Excel

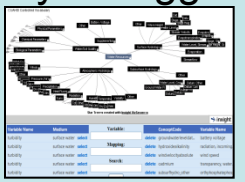
Text

Contribute your ODM

Service Registry



Hydrotagger



Harvester

ODM

ODM

Water Metadata Catalog

HIS Central

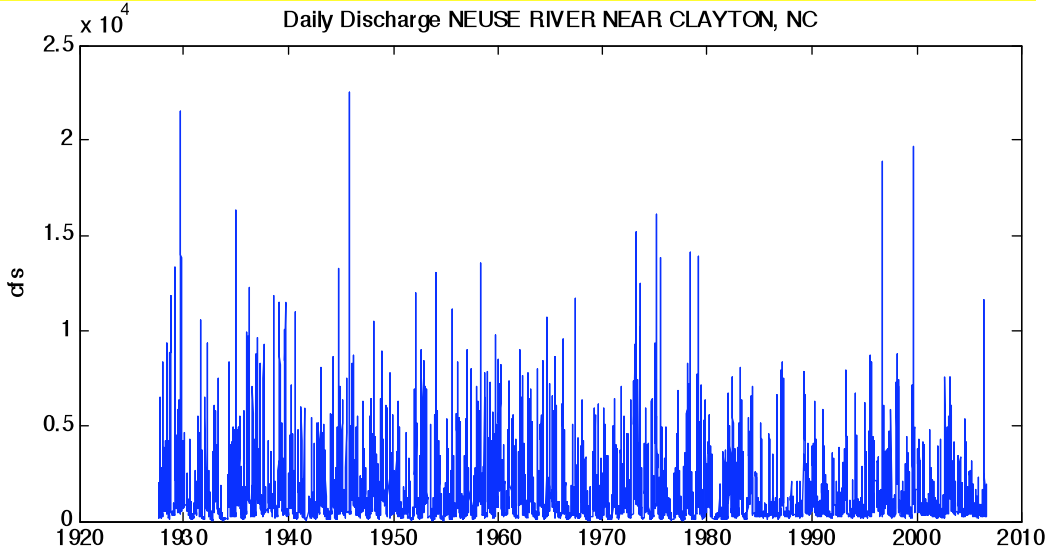
http://his.cuahsi.org

Direct analysis from your favorite analysis environment.

e.g. Matlab

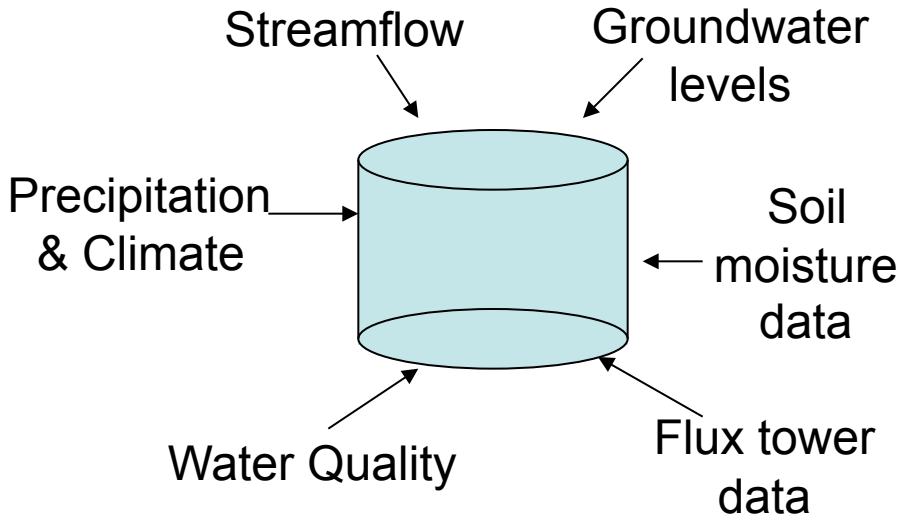
```
% create NWIS Class and an instance of the class
createClassFromWsdl('http://river.sdsc.edu/wateroneflow/
NWIS/DailyValues.asmx?WSDL');
WS = WaterOneFlow;
% GetValues to get the data
siteid='NWIS:02087500';
bdate='2002-09-30T00:00:00';
edate='2006-10-16T00:00:00';
variable='NWIS:00060';
valuesxml=GetValues(WS,siteid,variable,bdate,edate,'');
```

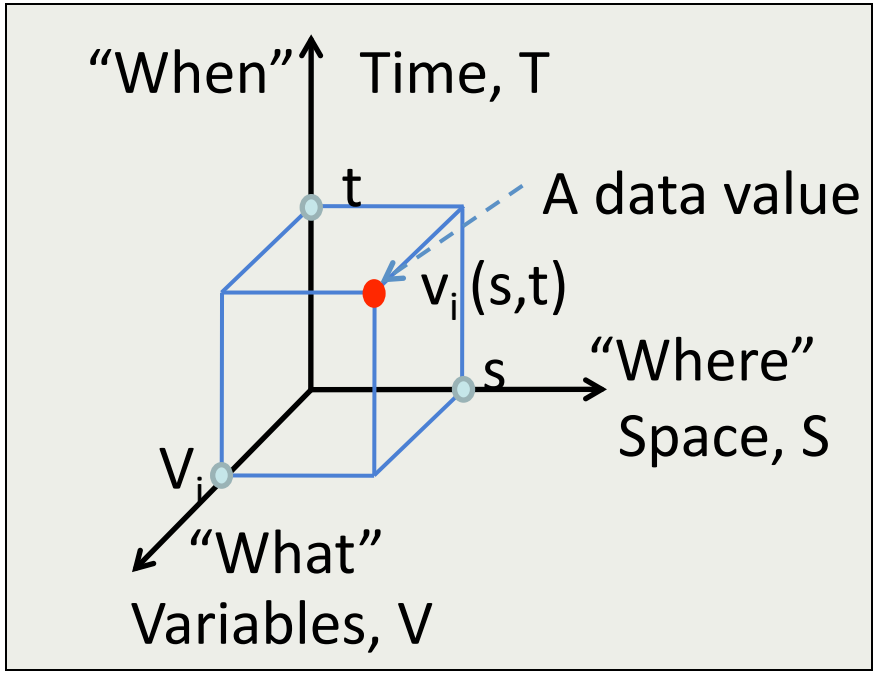
```
<variableCode vocabula
  variableID="12578">
<variableName>Discha
<units unitsAbbreviatio
  second</units>
</variable>
- <values count="1478">
<value qualifiers="A" d
<value qualifiers="A" d
<value qualifiers="A" d
<value qualifiers="A" d
```



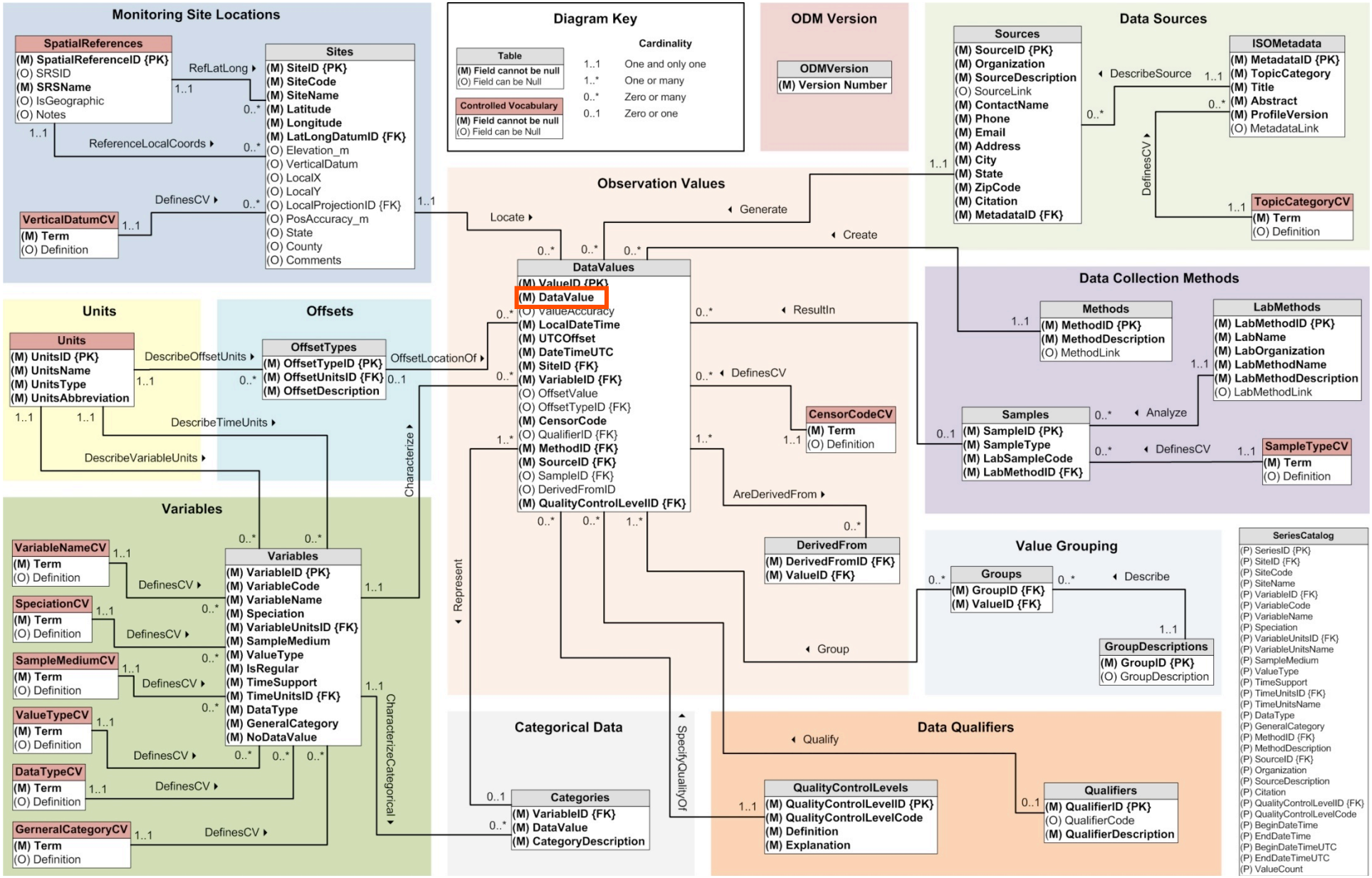
CUAHSI Observations Data Model

- A relational database at the single observation level (atomic model)
- Stores observation data 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



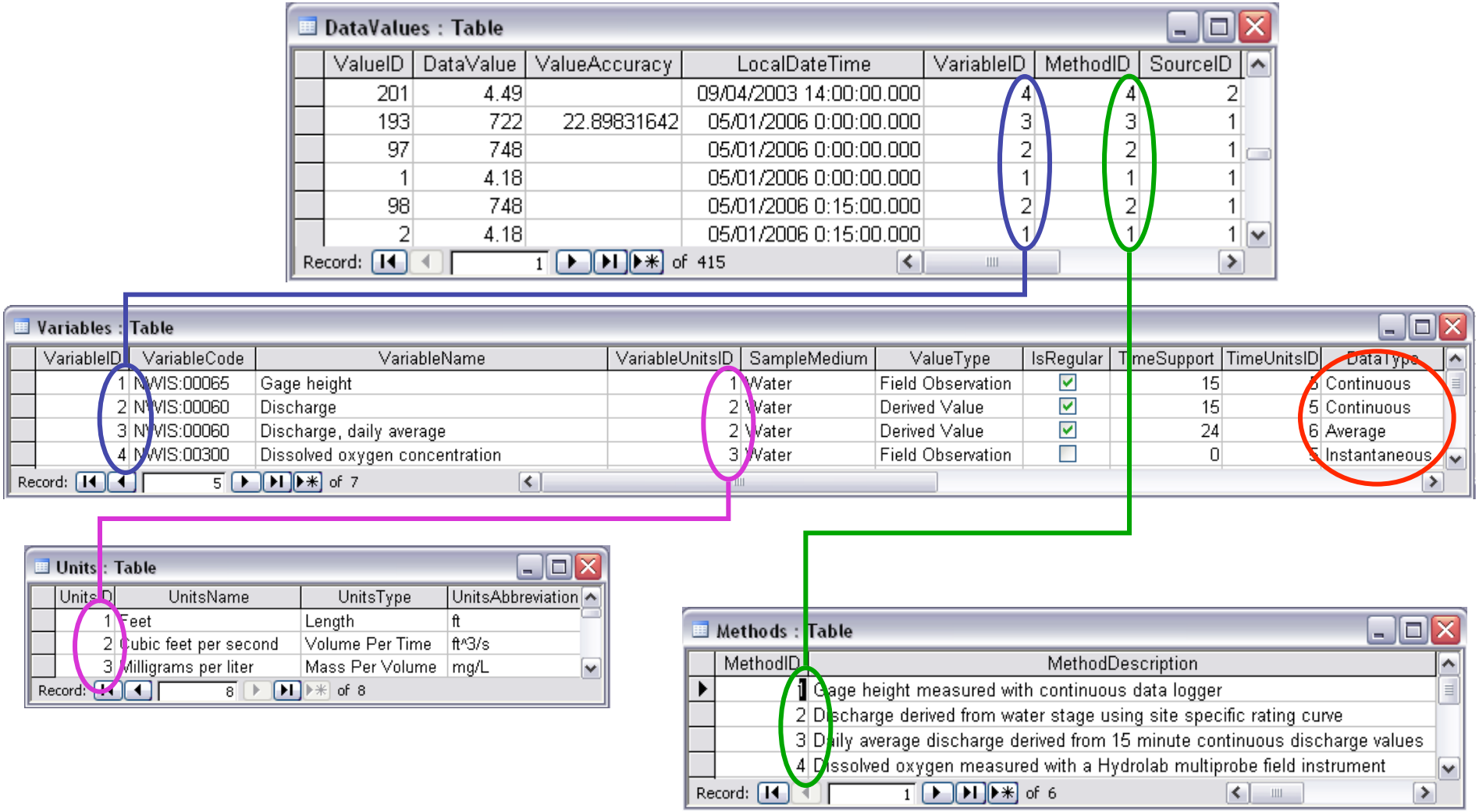


CUAHSI Observations Data Model http://his.cuahsi.org/odmdatabases.html



Horsburgh, J. S., D. G. Tarboton, D. R. Maidment and I. Zaslavsky, (2008), A Relational Model for Environmental and Water Resources Data, *Water Resour. Res.,* 44: W05406, doi:10.1029/2007WR006392.

Discharge, Stage, Concentration and Daily Average Example



DataValues : Table

ValueID	DataValue	ValueAccuracy	LocalDateTime	VariableID	MethodID	SourceID
201	4.49		09/04/2003 14:00:00.000	4	4	2
193	722	22.89831642	05/01/2006 0:00:00.000	3	3	1
97	748		05/01/2006 0:00:00.000	2	2	1
1	4.18		05/01/2006 0:00:00.000	1	1	1
98	748		05/01/2006 0:15:00.000	2	2	1
2	4.18		05/01/2006 0:15:00.000	1	1	1

Record: 1 of 415

Variables : Table

VariableID	VariableCode	VariableName	VariableUnitsID	SampleMedium	ValueType	IsRegular	TimeSupport	TimeUnitsID	DataType
1	NWIS:00065	Gage height	1	Water	Field Observation	☑	15	5	Continuous
2	NWIS:00060	Discharge	2	Water	Derived Value	☑	15	5	Continuous
3	NWIS:00060	Discharge, daily average	2	Water	Derived Value	☑	24	6	Average
4	NWIS:00300	Dissolved oxygen concentration	3	Water	Field Observation	☐	0	5	Instantaneous

Record: 5 of 7

Units : Table

UnitsID	UnitsName	UnitsType	UnitsAbbreviation
1	Feet	Length	ft
2	Cubic feet per second	Volume Per Time	ft^3/s
3	Milligrams per liter	Mass Per Volume	mg/L

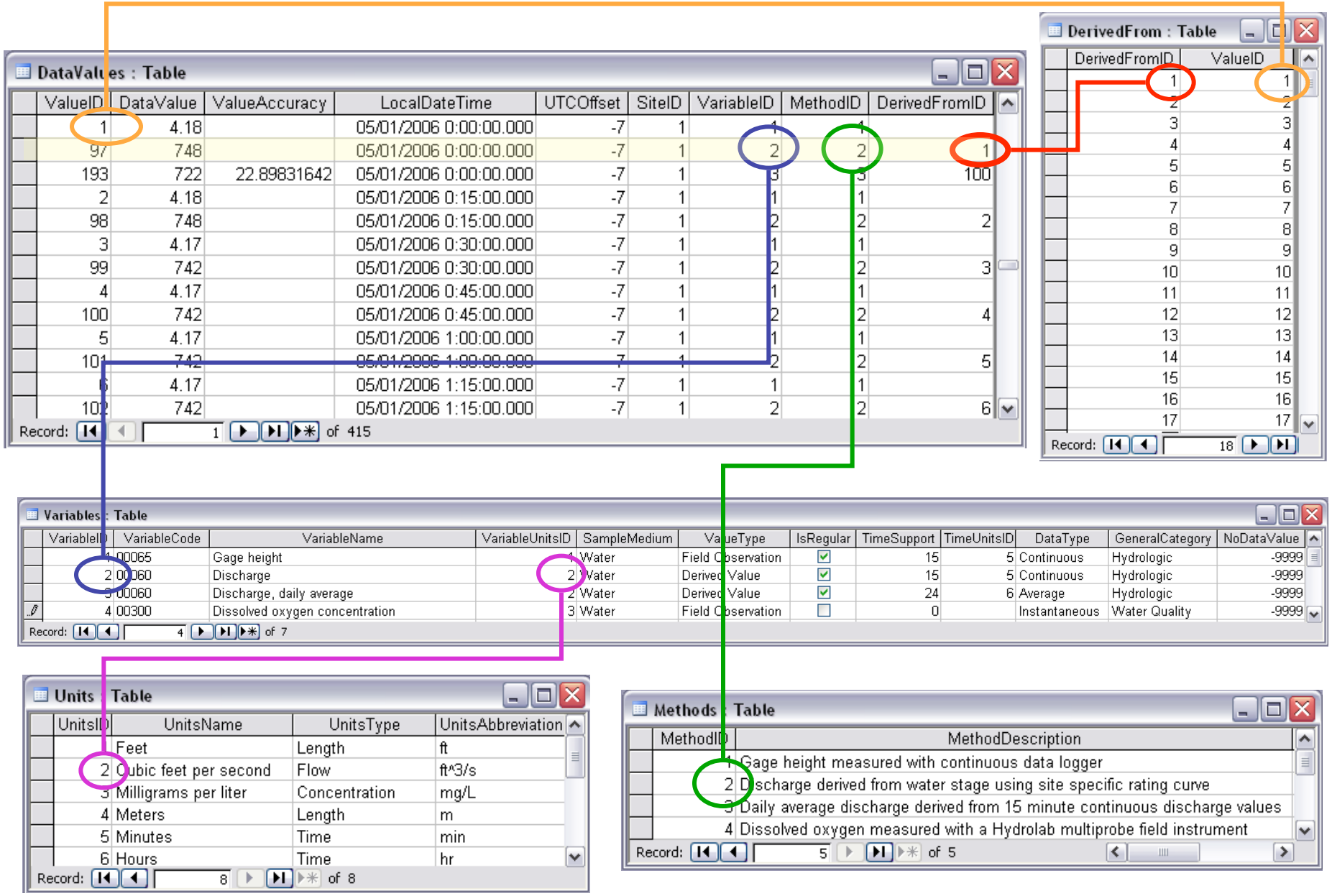
Record: 8 of 8

Methods : Table

MethodID	MethodDescription
1	Gage height measured with continuous data logger
2	Discharge derived from water stage using site specific rating curve
3	Daily average discharge derived from 15 minute continuous discharge values
4	Dissolved oxygen measured with a Hydrolab multiprobe field instrument

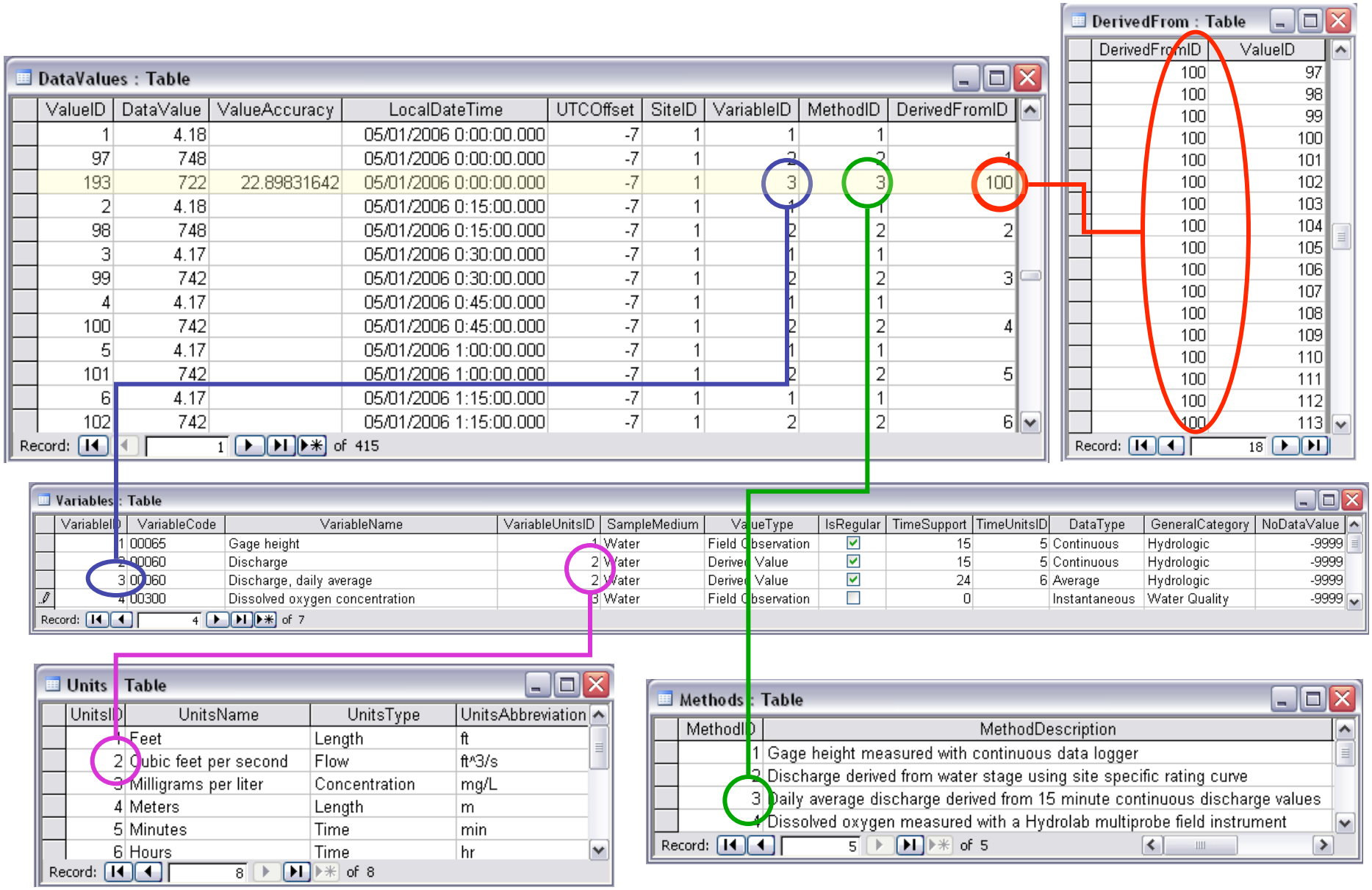
Record: 1 of 6

Stage and Streamflow Example



Daily Average Discharge Example

Daily Average Discharge Derived from 15 Minute Discharge Data



DataValues : Table

ValueID	DataValue	ValueAccuracy	LocalDateTime	UTCOffset	SiteID	VariableID	MethodID	DerivedFromID
1	4.18		05/01/2006 0:00:00.000	-7	1	1	1	
97	748		05/01/2006 0:00:00.000	-7	1	2	2	1
193	722	22.89831642	05/01/2006 0:00:00.000	-7	1	3	3	100
2	4.18		05/01/2006 0:15:00.000	-7	1	1	1	
98	748		05/01/2006 0:15:00.000	-7	1	2	2	2
3	4.17		05/01/2006 0:30:00.000	-7	1	1	1	
99	742		05/01/2006 0:30:00.000	-7	1	2	2	3
4	4.17		05/01/2006 0:45:00.000	-7	1	1	1	
100	742		05/01/2006 0:45:00.000	-7	1	2	2	4
5	4.17		05/01/2006 1:00:00.000	-7	1	1	1	
101	742		05/01/2006 1:00:00.000	-7	1	2	2	5
6	4.17		05/01/2006 1:15:00.000	-7	1	1	1	
102	742		05/01/2006 1:15:00.000	-7	1	2	2	6

Record: 1 of 415

DerivedFrom : Table

DerivedFromID	ValueID
100	97
100	98
100	99
100	100
100	101
100	102
100	103
100	104
100	105
100	106
100	107
100	108
100	109
100	110
100	111
100	112
100	113

Record: 18

Variables : Table

VariableID	VariableCode	VariableName	VariableUnitsID	SampleMedium	ValueType	IsRegular	TimeSupport	TimeUnitsID	DataType	GeneralCategory	NoDataValue
1	00065	Gage height	1	Water	Field Observation	☑	15	5	Continuous	Hydrologic	-9999
2	00060	Discharge	2	Water	Derived Value	☑	15	5	Continuous	Hydrologic	-9999
3	00060	Discharge, daily average	2	Water	Derived Value	☑	24	6	Average	Hydrologic	-9999
4	00300	Dissolved oxygen concentration	3	Water	Field Observation	☐	0		Instantaneous	Water Quality	-9999

Record: 4 of 7

Units : Table

UnitsID	UnitsName	UnitsType	UnitsAbbreviation
1	Feet	Length	ft
2	Cubic feet per second	Flow	ft^3/s
3	Milligrams per liter	Concentration	mg/L
4	Meters	Length	m
5	Minutes	Time	min
6	Hours	Time	hr

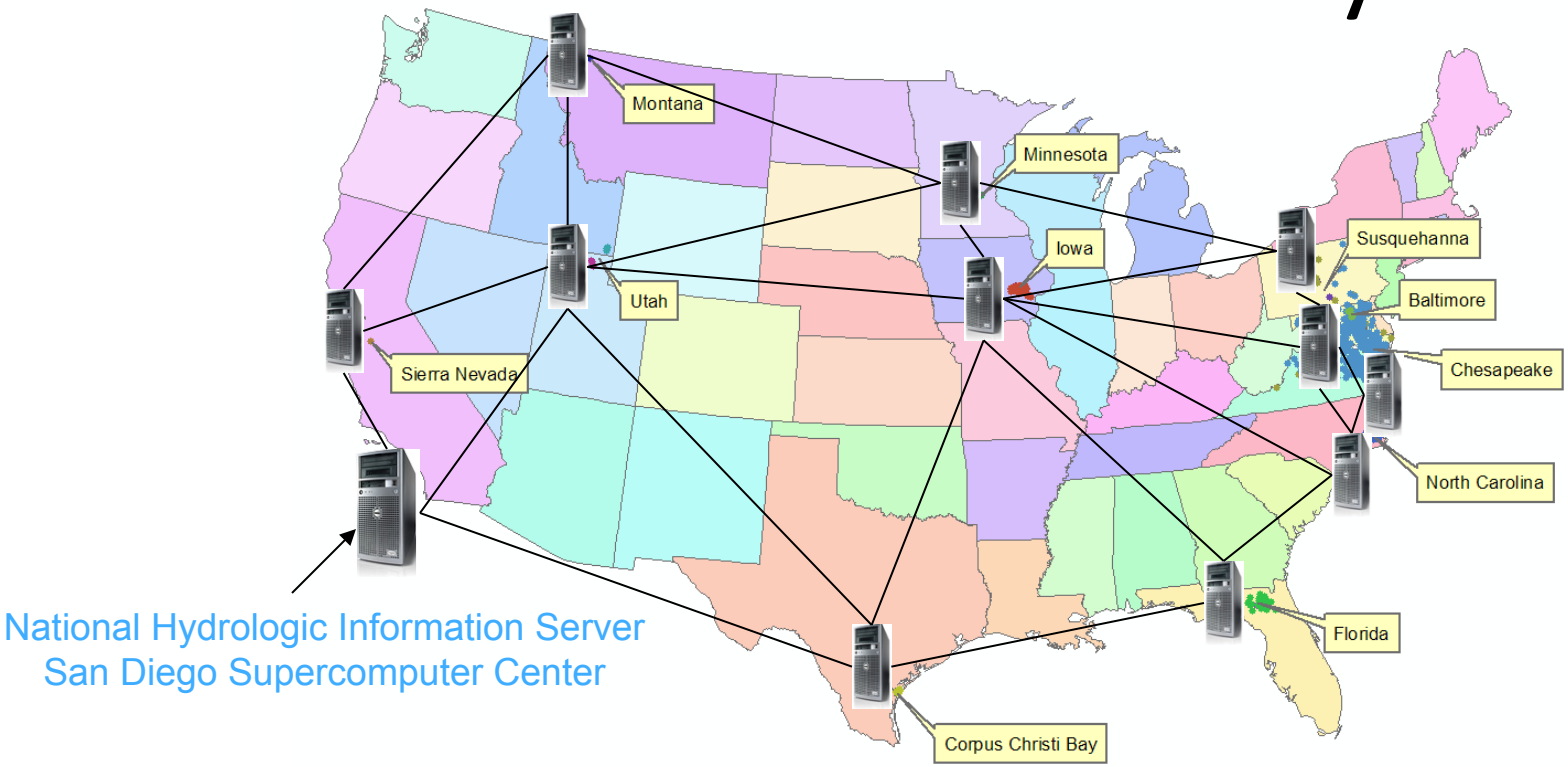
Record: 8 of 8

Methods : Table

MethodID	MethodDescription
1	Gage height measured with continuous data logger
2	Discharge derived from water stage using site specific rating curve
3	Daily average discharge derived from 15 minute continuous discharge values
4	Dissolved oxygen measured with a Hydrolab multiprobe field instrument

Record: 5 of 5

HIS Implementation in WATERS Network Information System

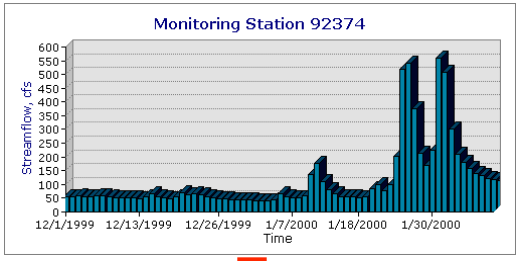


- 11 WATERS Network test bed projects
- 16 ODM instances (some test beds have more than one ODM instance)
- Data from 1246 sites, of these, 167 sites are operated by WATERS investigators

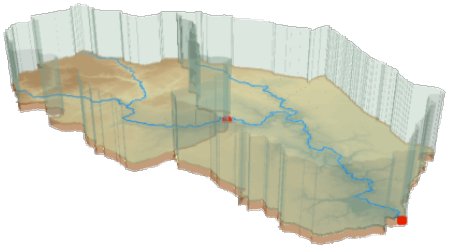
HIS Desktop (to be developed in 2009)

Harvesting data from web services

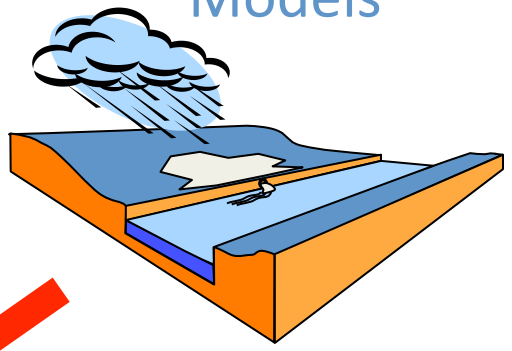
Observations



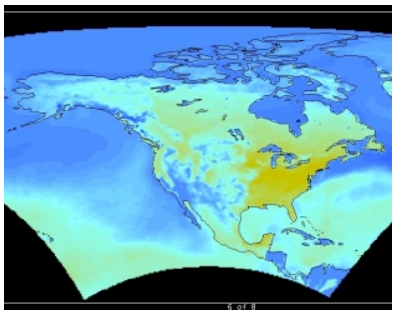
GIS



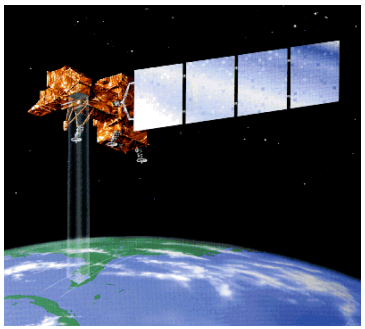
Models



Climate



Remote Sensing



HIS Desktop can be rebranded to become CZO Desktop if necessary

Critical Zone Observatory Data Discovery

- Each CZO maintains its own data management system(s) using the data formats it prefers
- The three CZO's have a common metadata management system, expressed in tables, where each table record describes a particular data series or dataset, including its URL address
- CZO Metadata tables are published and accessed through the internet using Web Feature Services (WFS) defined by the Open Geospatial Consortium
- Metadata table records are linked to geographic features, also published as Web Feature Services to show data location on a base map

CZO Data Types

1. Regular Time Series – data measured with automated sensors at a fixed location at regular intervals
2. Irregular Time Series – manually collected field samples from a fixed location at irregular intervals

Point Observations Time Series

3. GIS coverages and photos
4. One-Time Collections – rock and soil samples collected once at known position and depth
5. Other Data – LIDAR, land surveys, channel cross-sections, tree surveys, geophysics, snow surveys

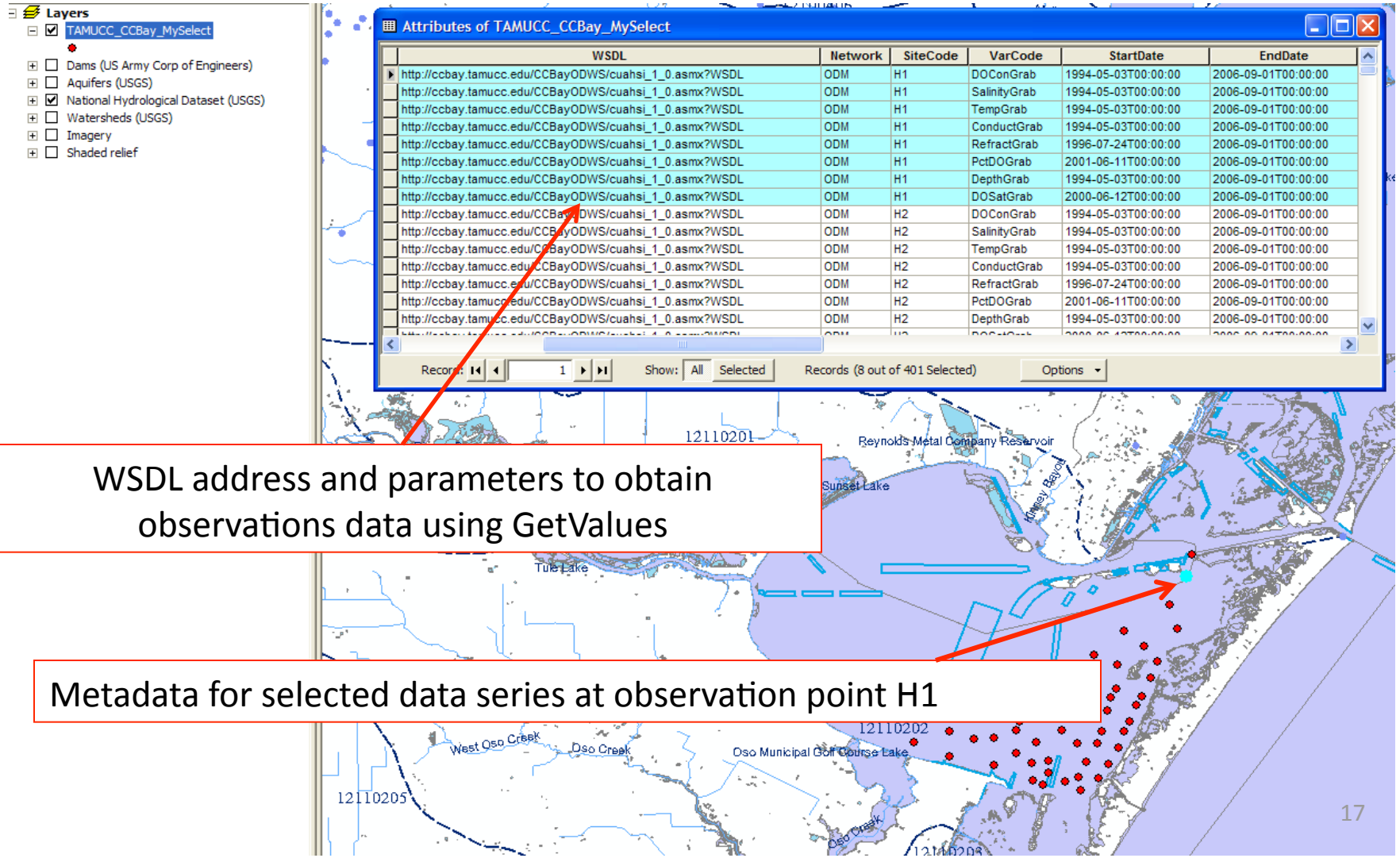
Observations Catalog for Waters Network Testbed Project in Corpus Christi Bay

http://129.116.104.172/ArcGIS/services/CCBAY_MySelect/GeoDataServer/WFSServer

displayed over the US Hydrology Base Map from

http://downloads2.esri.com/resources/arcgisdesktop/maps/us_hydrology.mxd

The same metadata structure supports data access through WaterML



WSDL address and parameters to obtain observations data using GetValues

Metadata for selected data series at observation point H1

Summary

- Generic method for publishing observational data
  - Supports many types of point observational data
  - ODM and WaterML Overcome syntactic and semantic heterogeneity using a standard data model and controlled vocabularies
  - Supports a national network of observatory test beds but can grow!
- Web services provide programmatic machine access to data
  - Work with the data in your data analysis software of choice
- Internet-based applications provide user interfaces for the data and geographic context for monitoring sites