

# CUAHSI Overview: Infrastructure and Informatics

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Program Manager



# *Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)*

- A consortium of 106 research universities, 6 affiliate members, and 8 int'l affiliates
- Incorporated June, 2001 as a non-profit corporation in Washington, DC



# What is Hydrologic Science?

- Expands beyond traditional hydrology
- Focus on “why” the earth works as it does, like other earth sciences, moving beyond traditional problem-solving orientation
- Embraces parts of hydrology, geomorphology, hydrogeology, biogeochemistry, ...
- Hydrologic cycle is central organizing principle



# Need for CUAHSI

- Larger-scale, longer-term research to advance science
- Enable research at disciplinary boundaries
- Support of larger research teams
- Improve efficiency and effectiveness of data collection and dissemination



# Purpose

- **Science Objective:** To advance hydrologic science in the broadest sense of the term
- **Societal Need:** Will there be enough water for the next century?
  - ...of appropriate quality
  - ...to meet society's needs
  - ...to maintain the integrity of our ecosystems



# CUAHSI GRAND CHALLENGE

Develop a predictive understanding of continental water dynamics and its interaction with climate, landscape, ecology and civilization

Three themes in CUAHSI science plan:

- Patterns and variability
- Climate and human development
- Prediction and adaptation to change

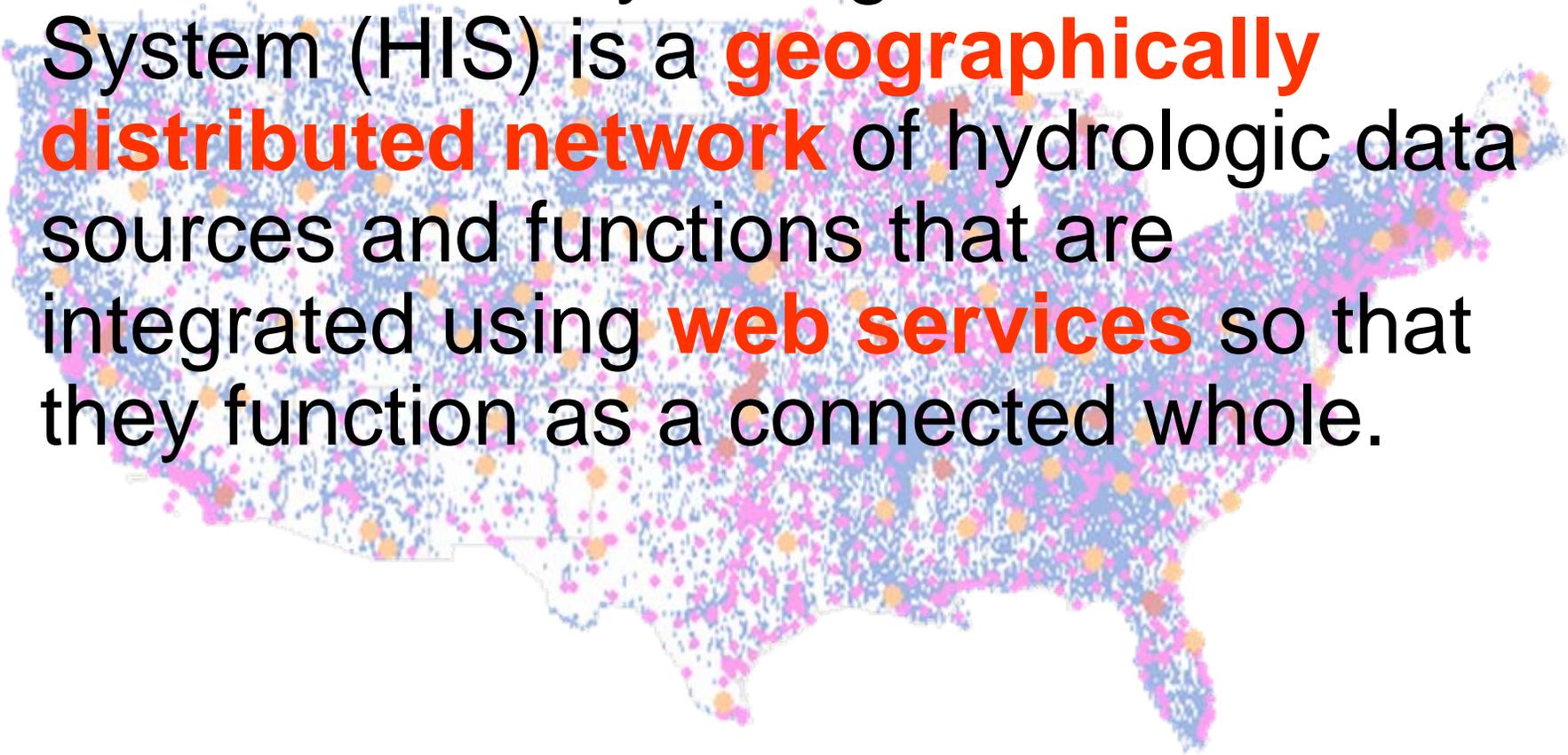
# What CUAHSI is doing?

- Hydrologic Information Systems
- Observatories
- Hydrologic Measurement Facilities
- Education and Outreach
- Hydrologic Synthesis



# HIS Definition

The CUAHSI Hydrologic Information System (HIS) is a **geographically distributed network** of hydrologic data sources and functions that are integrated using **web services** so that they function as a connected whole.

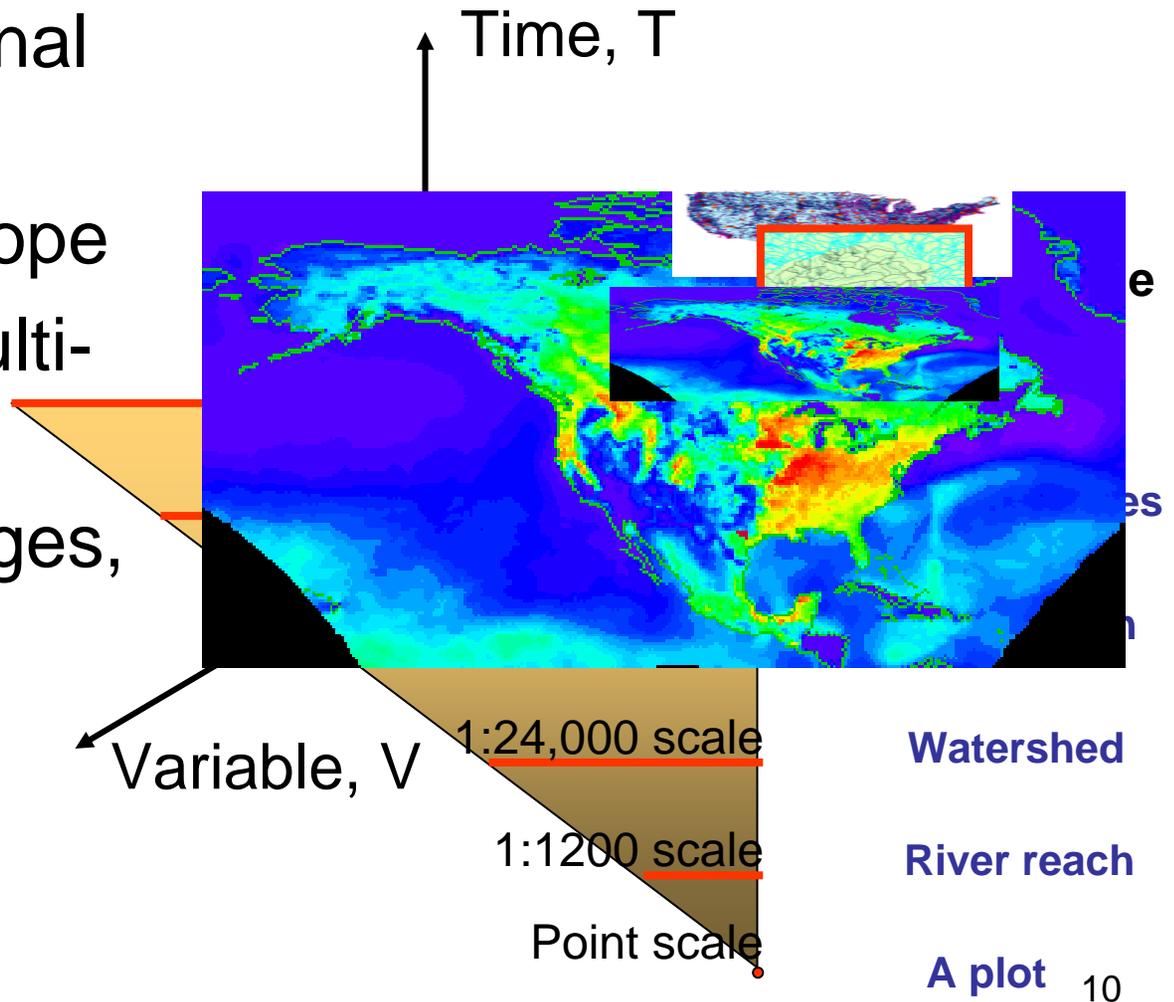


# HIS Progress

- **Phase 1** grant, 2.5 year grant completed
- **Phase 2** grant, 5-yr, \$4.5M to Maidment (Texas)
- **Co-PI's**
  - Ilya Zaslavsky (San Diego Supercomputing Center)
  - David Tarboton (Utah State)
  - Michael Piasecki (Drexel)
  - Jon Goodall (Duke)
- **WATERS Testbeds** serve as beta-testers for software
- First **community-wide distribution** in 12 – 15 months (dependant on establishing support services)

# Data Representation

- Four-dimensional  $\{x,y,z,t\}$
- Continental scope
- Multi-scale, multi-resolution
- Points, coverages, dynamic fields

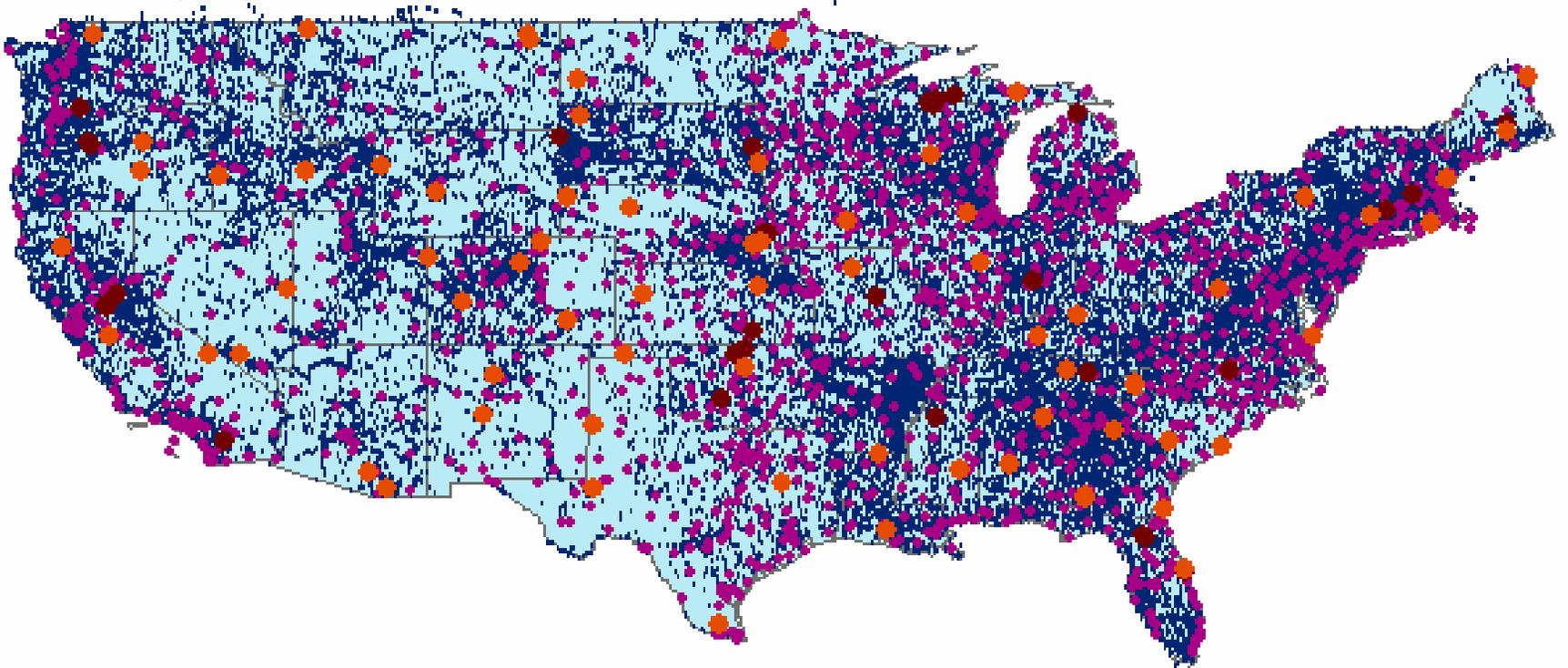


# Digital Continent

- Integrating monitoring and research data yields a single body of information for the country
- Observatories contribute intensive information to this body
- Observatories are placed within context of climate, geology, soils, etc. but are not assumed to be representative of an area.
- Digital observatories may be watersheds, aquifers, river reaches, or any region that is part of the continent



# Observation Stations Map for the US



# Inference Space

- “Transcending place” means testing hypotheses in areas thought to be similar (in some attributes).
- Digital continent will enable identification of “similar” areas and (some) data about that spot.
- Observatories will enable inference about similar regions (e.g., presumably one can infer more about Delaware R. from Potomac than about Rio Grande).



# DOs are the foundation of EOs

- Collaboration of Mission and Science Agencies
  - DO contains both monitoring and research data
  - DO supports hypothesis test, decision support systems, mgmt models
- Interdisciplinary communication
  - Scientists can access multiple conceptualizations to improve understanding
  - Everyone benefits from context provided
- Incentives must exist for people and agencies to *want* to contribute (and they do!)



# HIS 1.0 (1 Nov 2006)

- Point Time Series
  - Discovery and Publication
  - Agencies
    - USGS NWIS
    - NCDC
    - EPA Storet
  - [LTER Trends]
- Static Federation to Observatory Test Beds



# CUAHSI Hydrologic Information System Architecture

**National HIS** – San Diego Supercomputer Center

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Map interface, observations catalogs and web services for **national data sources**

**Workgroup HIS** – river authority, research centre or univ.

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Map interface, observations catalogs and web services for **regional data sources**; observations databases and web services for **individual investigator data**

**HIS Server**

**Personal HIS** – an individual scientist or manager

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**Application templates** and **HydroObjects** for direct ingestion of data into analysis environments: Excel, ArcGIS, Matlab, programming languages; **MyDB** for storage of analysis data

**HIS Analyst**

# HIS Server

- Supports data discovery, delivery and publication

- **Data discovery** – how do I find the data I want? →

- Map interface and observations catalogs

- **Data delivery** – how do I acquire the data I want? →

- Use web services or retrieve from local database

- **Data Publication** – how do I publish my observation data? →

- Use Observations Data Model

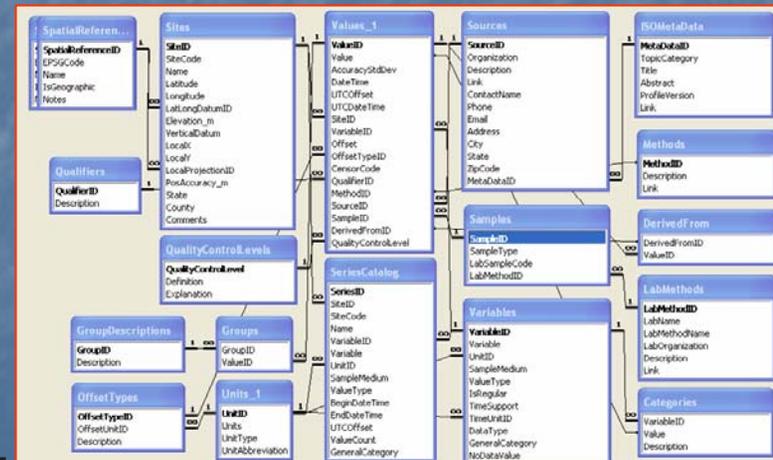


## USGS NWIS Web services

<http://river.sdsc.edu/NWISTS/NWIS.aspx>

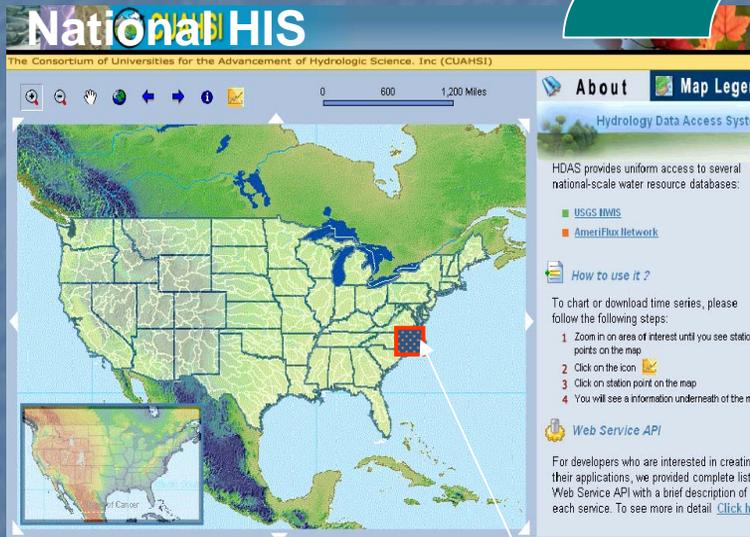
Method Name

GetSiteInfo



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# National and Workgroup HIS



National HIS has a polygon in it marking the region of coverage of a workgroup HIS server

*For HIS 1.0 the National and Workgroup HIS servers are not dynamically connected.*

Station Name : NEUSE RIVER NEAR CLAYTON, NC	Discharge begin date : 1927-08-01	Ground Water begin date : 0000-00-00
Station # : 02087500	Discharge end date : 2004-09-30	Ground Water end date : 0000-00-00
Agency Code : USGS	Discharge count number : 28186	Ground Water count number : 0
Coord. accuracy Code : S	Peak begin date : 1919-07-23	Water Quality begin data : 1955-02-01
Lat & Long Datum Code : NAD83	Peak end date : 2004-08-16	Water Quality end date : 1999-09-28
Latitude (dd) : 35.64722220	Peak count number : 78	Water Quality count number : 237
Longitude (dd) : -78.40527780		

Workgroup HIS has local observations catalogs for coverage of national data sources in its region. These local catalogs are partitioned from the national observations catalogs.



# Data Sources

NASA

Storet

Ameriflux

NCDC

Unidata

NWIS

NCAR

Extract

Transform

CUAHSI Web Services

Excel

Visual Basic

ArcGIS

C/C++

Load

Matlab

Fortran

Access

Java

# Applications

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



Some operational services

# How Excel connects to ODM

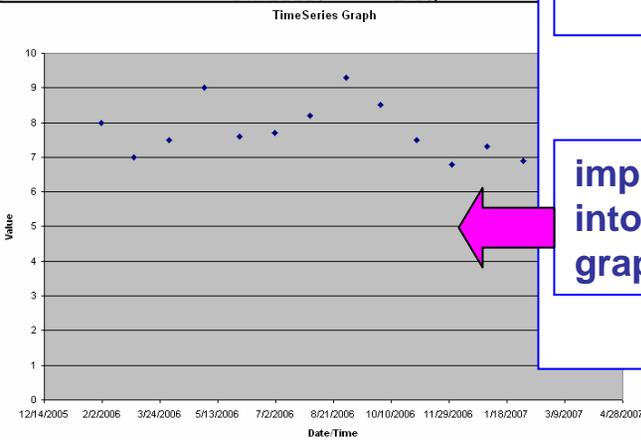
Do not change the cell positions below!

GetValues	
Site Code	8
Variable Code (Storet Code)	100005
Start Date	1/1/1900
End Date	6/20/2006

Click to Get Values

DateTime	Value
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DateTime	Value
1/1/2006	7
2/1/2006	8
3/1/2006	7
4/1/2006	7.5
5/1/2006	9



## Excel

- Obtains inputs for CUAHSI web methods from relevant cells.
- Available Web methods are GetSiteInfo, GetVariableInfo, GetValues methods.

imports VB object into Excel and graphs it

## HydroObjects

parses user inputs into a standardized CUAHSI web method request.

converts XML to VB object

## CUAHSI Web service

converts standardized request to SQLquery.

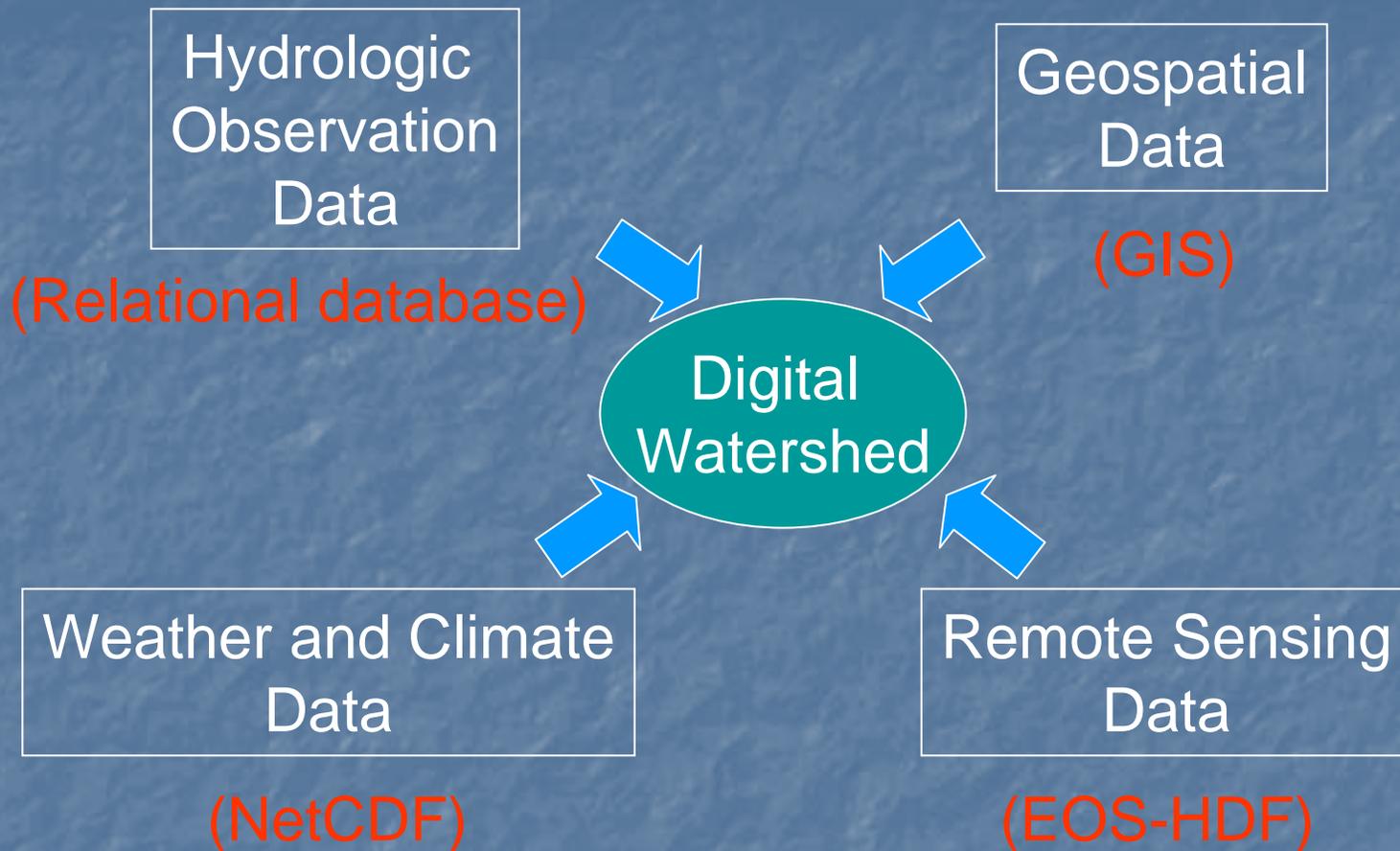
SQL query

Observations Data Model

Response

converts response to a standardized XML.

# Data Types



# HIS Extensions

- Integration of Weather Data
  - Work with NCAR; prototype on Ohio
  - Move from gridded to watershed-based delivery of data
- Hydrogeology
  - Constructing stratigraphy for continent
- Geologic Framework
  - Geomorphic and geologic history
- Incorporation of human dimension
  - Transportation; structures
  - Permits, Toxic Release Inventory, etc.
  - Flood plain (contribution from real estate sector?)
  - FEMA Lidar products
- Explicit development of AK, HI, PR beyond CONUS



# Questions?

- Contact info:

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202 777 7305

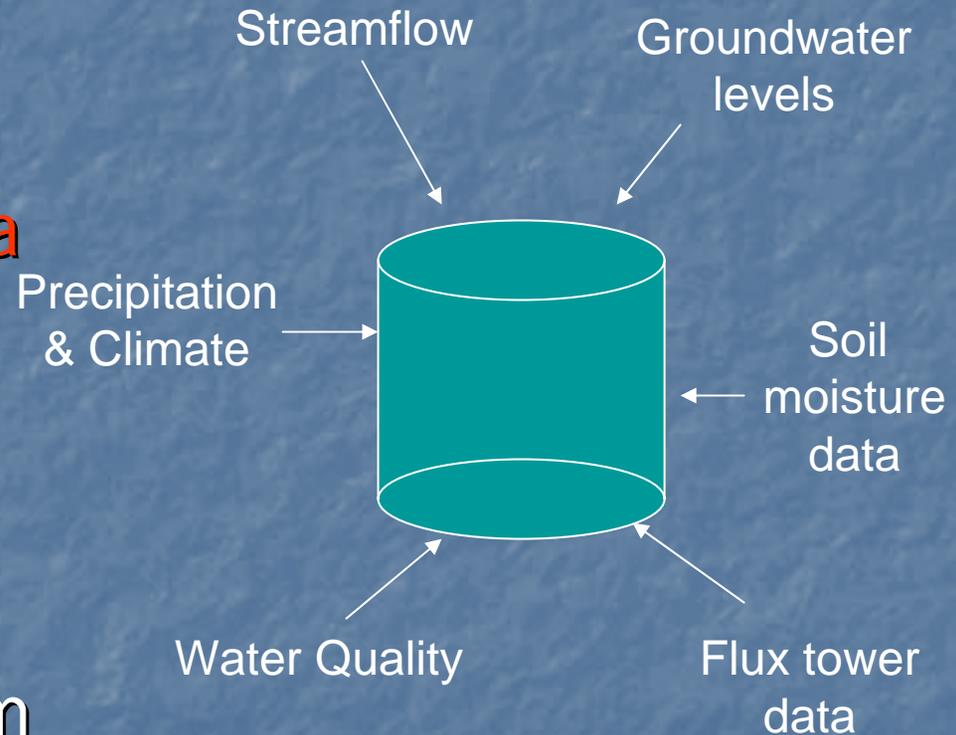


# Extra Slides



# 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



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# Water OneFlow

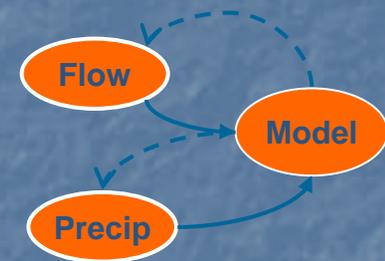
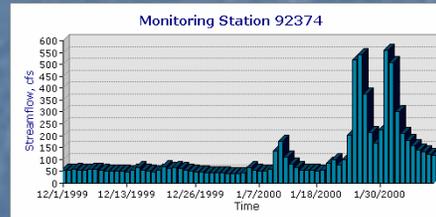
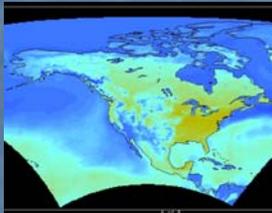
- We need a **"Water OneFlow"** – a common window for water data and models



Federal  
State

Local

Academic



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

