iUTAH Cyberinfrastructure to Support Data Collection and Management for the GAMUT Monitoring Network
innovative Urban Transitions and Aridregion Hydro-sustainability (iUTAH)

- Statewide effort
- $20 million competitive award from NSF EPSCoR
- Research capacity building
- Interdisciplinary and multi-institution
- Focused on sustainable management of Utah’s water resources

Support: NSF EPS 1208732
Sensor network developed between USU/UofU/BYU
Mix of aquatic and terrestrial *in situ* and re-locatable sensors
Measure aspects of water inputs and outputs and water quality over gradient
Deployed in three watersheds

**Gradients Along Mountain to Urban Transitions (GAMUT) Network**
3 watersheds have similar water source (high elevation snow) but different land use transitions:

- **Logan River**: irrigated agriculture transitioning to moderate density urban at moderate pace.
- **Red Butte Creek**: highly urbanized.
- **Provo River**: irrigated agriculture transitioning to low density urban at rapid pace.
## Gradients Along Mountain to Urban Transitions (GAMUT) Network

| Table 1. Parameters to be measured by the iUTAH Climate and Ecohydrology Sensor Network. |
|---------------------------------------------|---------------------------------------------|
| **Fundamental Suite**                      | **Enhanced/Urban Suite**                    |
| **Terrestrial Sensors**                    |                                              |
| Barometric pressure                        | Barometric pressure                        |
| Wind speed and direction                   | Wind speed and direction                   |
| Air temperature                           | Air temperature                            |
| Relative humidity                          | Relative humidity                           |
| Precipitation                              | Precipitation                              |
| Snow depth                                 | Snow depth                                 |
| Soil temperature, moisture, conductivity   | Soil temperature, moisture, conductivity   |
| Solar radiation (net radiation and PAR)    | Solar radiation (net radiation and PAR)    |
| **Aquatic Sensors**                        |                                              |
| Stream stage                               | Stream stage                               |
| Temperature                                | Temperature                                |
| Electrical Conductivity                    | Electrical Conductivity                    |
| pH                                        | pH                                         |
| Dissolved oxygen                           | Dissolved oxygen                           |
| Turbidity                                  | Turbidity                                  |
| Total algae (chlorophyll a + phycocyanin)  | Total algae (chlorophyll a + phycocyanin)  |
| fDOM                                       | fDOM                                       |
| Nitrate                                    | Nitrate                                    |
Cyberinfrastructure

Challenges to Managing Sensor Data

- Volume of data
- Data heterogeneity
- Multiple watersheds
- Multiple institutions
- Scale
- Synchronize timing, data access, equipment tracking
- Standardize data editing
Data Loading and Storage

iUTAH Modeling and Data Federation Facility

Primary Databases at USU

Backup Databases at UofU
Data Loading and Storage

- Observations Data Model (ODM): 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

Data Loading and Storage
Data Access and Publication

- Publish data and register with CUAHSI HIS
  - Discoverable and available nationally
  - Published data citable

- Data Accessed via
  - Web services
  - iUTAH Modeling and Data Federation (data.iutahepscor.org)
  - Direct database connection: using ODM Tools and/or preferred software

```r
# Load the required libraries
library(RODBC)

# Specify the database connection information
# database <- "ODBC"
userID <- "User"

# Open a channel to the database using odbcConnect
channel <- odbcConnect(database, userID)

# Get QC Level 1 stage data for all sites
MenPT = sqlQuery(channel, paste("SELECT LocalDateTime AS DATE, DataValue AS PT FROM Data"
), where = "MenPT"
)

# Compare Wellesville and Mendon, adjust dates as desired
```
Data Visualization and Management

iUTAH Modeling and Data Federation Facility

Remote Data Managers

Development of and Support for Data Management Tools
Data Visualization and Management

- **Plot Display Options**
- **Date Range Restrictions**
- **Multiple Plot Types**
- **Dynamic Zooming and Panning**
- **Time Series Selection**
Data Visualization and Management
Data Visualization and Management

Build Query

Filters on Data Series

Export Data Series
Sensor Data Quality Control

Sediment in sensor cup

Sensor drift and calibration shift

Strange anomalies

Dead battery
Sensor Data Quality Control

Data Editing Tools

Python Code Console

Dynamic Data Editing Display

Python Script Editor
Track physical infrastructure: sensors, data loggers, batteries, etc.

Track events: deployments, calibrations, site visits, factory servicings, etc.

Connects to ODM where streaming data is stored

Web interface
Equipment Details | View full equipment details

Equipment Description

Equipment ID: 99999999999
Serial Number: 99999999999
Model Name: DTS-12
Description: Forest Technology Systems DTS-12 Digital Turbidity Sensor
Purchase Date: 1/20/2013
Notes: Measures water turbidity and water temperature.
Link: http://www.ftsenvironmental.com/products/sensors/dts12/
Owner Institution: Utah State University
Owner Contact: Michelle Baker
Owner Address: 5305 Old Main Hill, Logan, UT 84322-5305
Owner Phone: 1.435.797.7131
Email: michelle.baker@usu.edu

Manufacturer
Vendor Name: Forest Technology Systems
Contact Name: Someguy Thatworksthere
Address: 1123 Fir Avenue, Suite C., Blaine, WA, 98230
Phone: 1.800.548.4264
Email: sales@ftshydrology.com
Web Address: http://www.ftsenvironmental.com/

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Web Address: http://www.ftsenvironmental.com/
Site Visit Details | View full site visit details

Site Visit Location

Site Code: USU-LR-UWRL
Site Name: Logan River at the Utah Water Research Laboratory
Latitude: 43
Longitude: -111
Elevation: 4355 m

Site Visit Description

Crew: Jeff Horsburgh, Amber Jones
Begin Date Time: 2/22/2013 1:00 PM MST
End Date Time: 2/22/2013 2:00 PM MST
Environmental Observations: The weather was sunny. The river was low. Water was clear.
Site Visit Notes: None.

Field Activities Performed (click the activity type to view details)

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Begin Date/Time</th>
<th>End Date/Time</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration</td>
<td>2/22/2013 1:00 PM MST</td>
<td>2/22/2013 1:10 PM MST</td>
<td>Sensor Calibration</td>
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<tr>
<td>Deployment</td>
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<td>2/22/2013 2:00 PM MST</td>
<td>Sensor Deployment</td>
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<tr>
<td>Monday</td>
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<td>Wednesday</td>
<td>Thursday</td>
<td>Friday</td>
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<td>Red Butte Creek Site3</td>
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<tr>
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<td>Logan River Site2</td>
<td>Red Butte Creek Site1</td>
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</table>

Display: ✔️ Site Visits  ❏ Factory Service Events
Deluge of Data

- **Tools for:**
  - Storage
  - Publication
  - Access
  - Processing
  - Equipment Tracking
- **Fulfill Needs of iUTAH researchers**
- **Cyberinfrastructure is research, too!**
Questions?

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