
NRS

Water is Key!

“Utah’s Best Crop”—
one that never fails


NOTHING SCREAMS THE AMERICAN DREAM LIKE AN ABSURDLY GREEN, LUSH LAWN IN THE MIDDLE OF A NATURAL DESERT!
ANDREWS
WESTERN WATER SHORTAGES

What We Need

Science

- Human dimensions
- Water cycle
- Coupled systems

Education

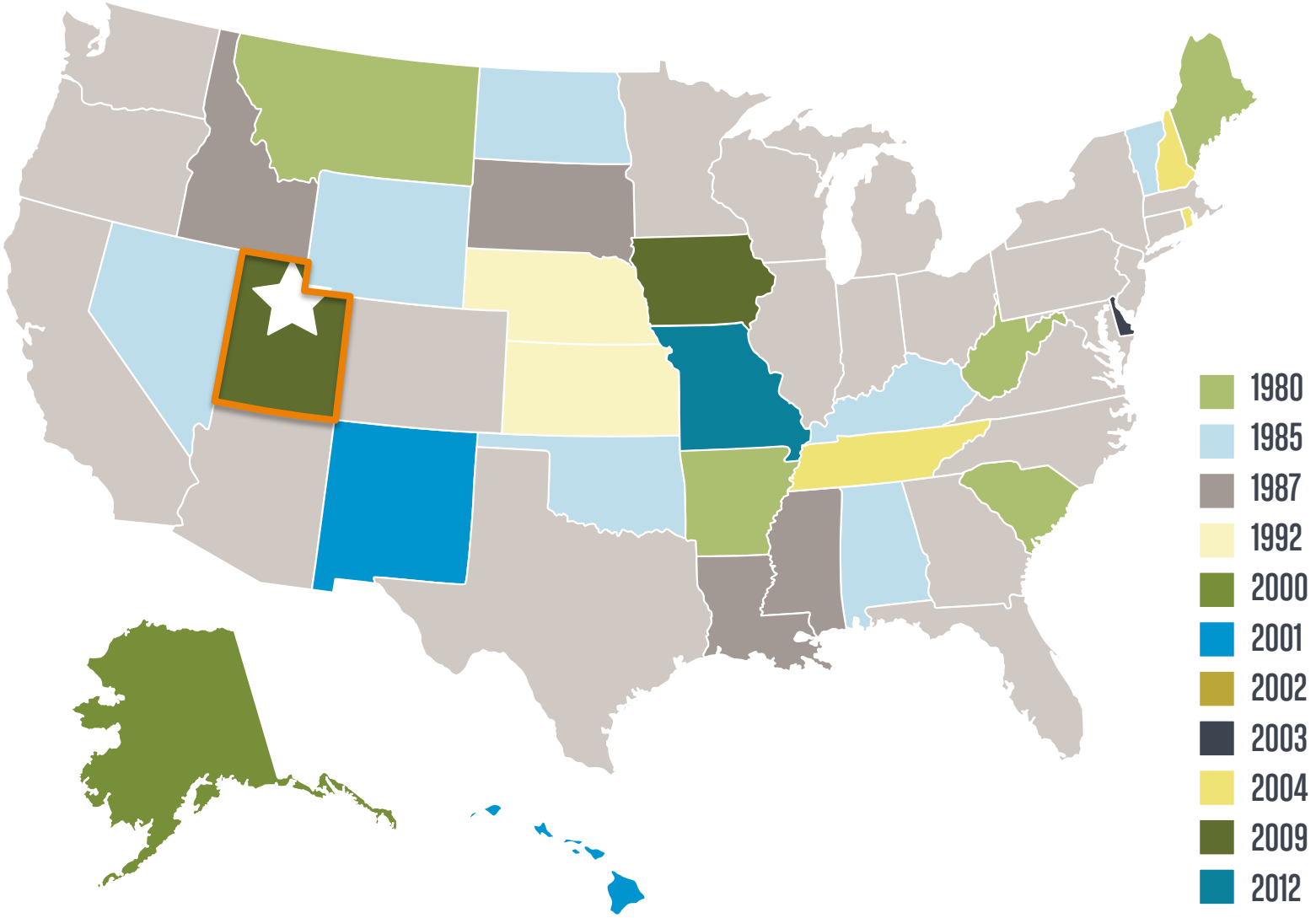
- K-12 STEM
- Undergrad research
- Grad students/ postdocs

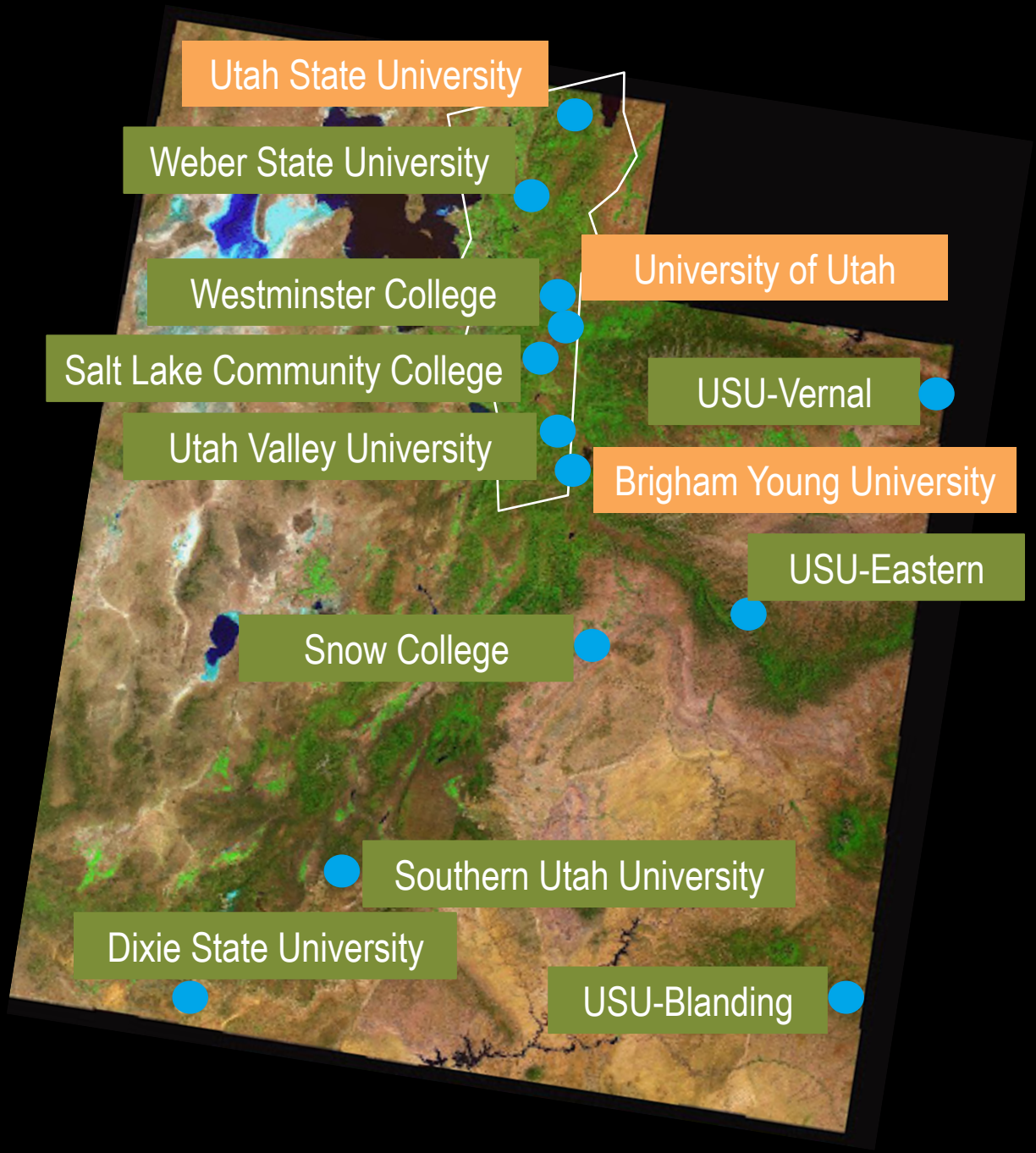
Understanding

- Urbanization
- Water decisions
- Water quality policies

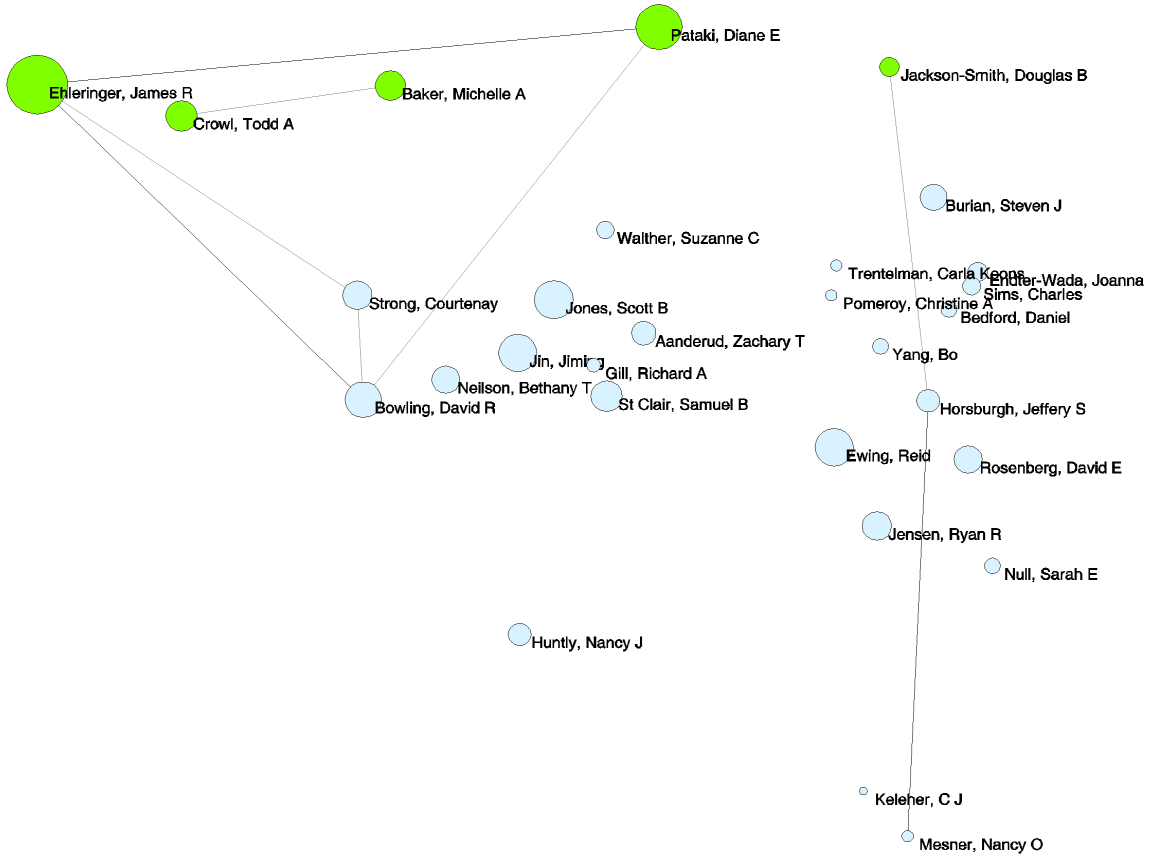
Science for Utah's Water Future

Utah eligible for NSF EPSCoR in 2009



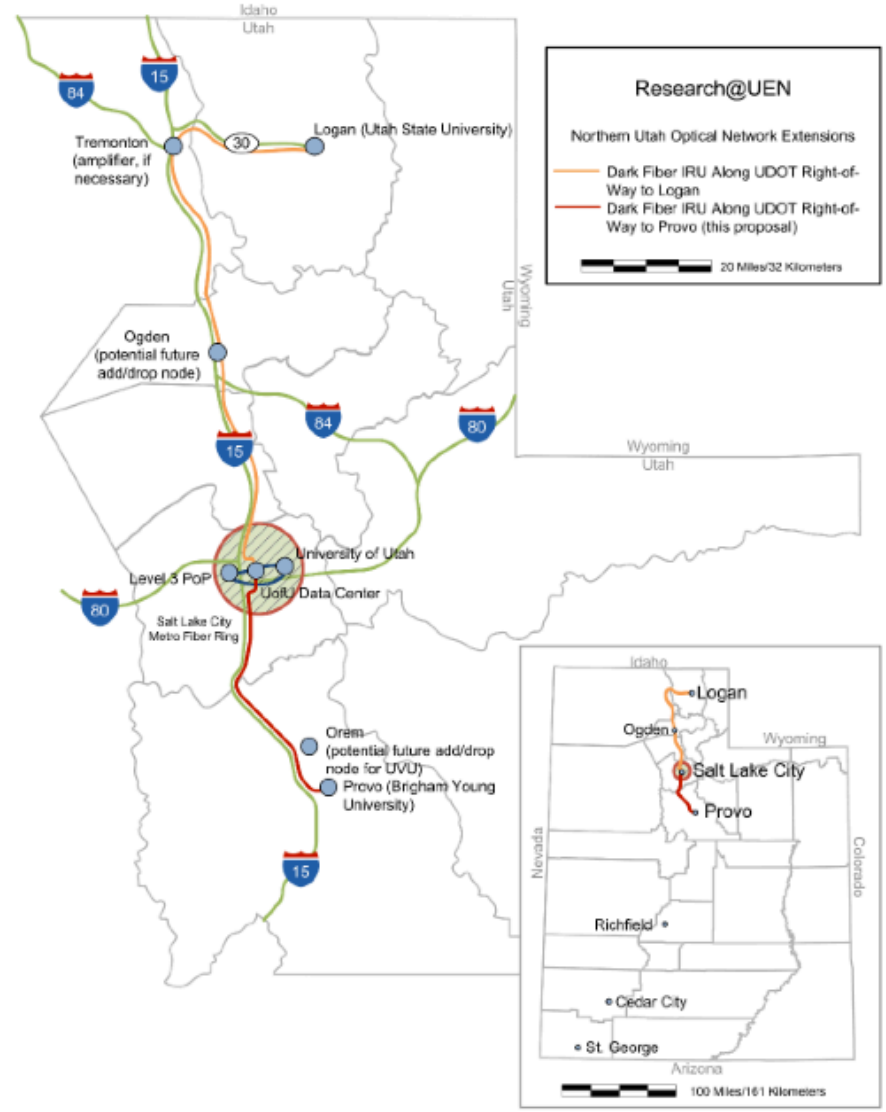

Utah State University
Weber State University
University of Utah
Westminster College
Salt Lake Community College
USU-Vernal
Utah Valley University
Brigham Young University
USU-Eastern
Snow College
Southern Utah University
Dixie State University
USU-Blanding

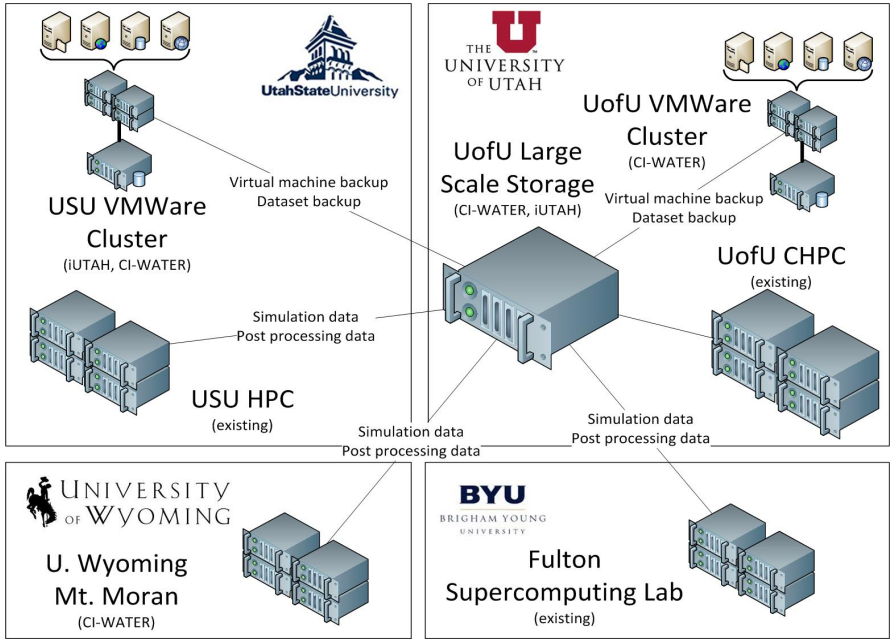
Scholarly Collaboration



Co-authoring among EPSCoR authors 2012-2015

Physical Infrastructure





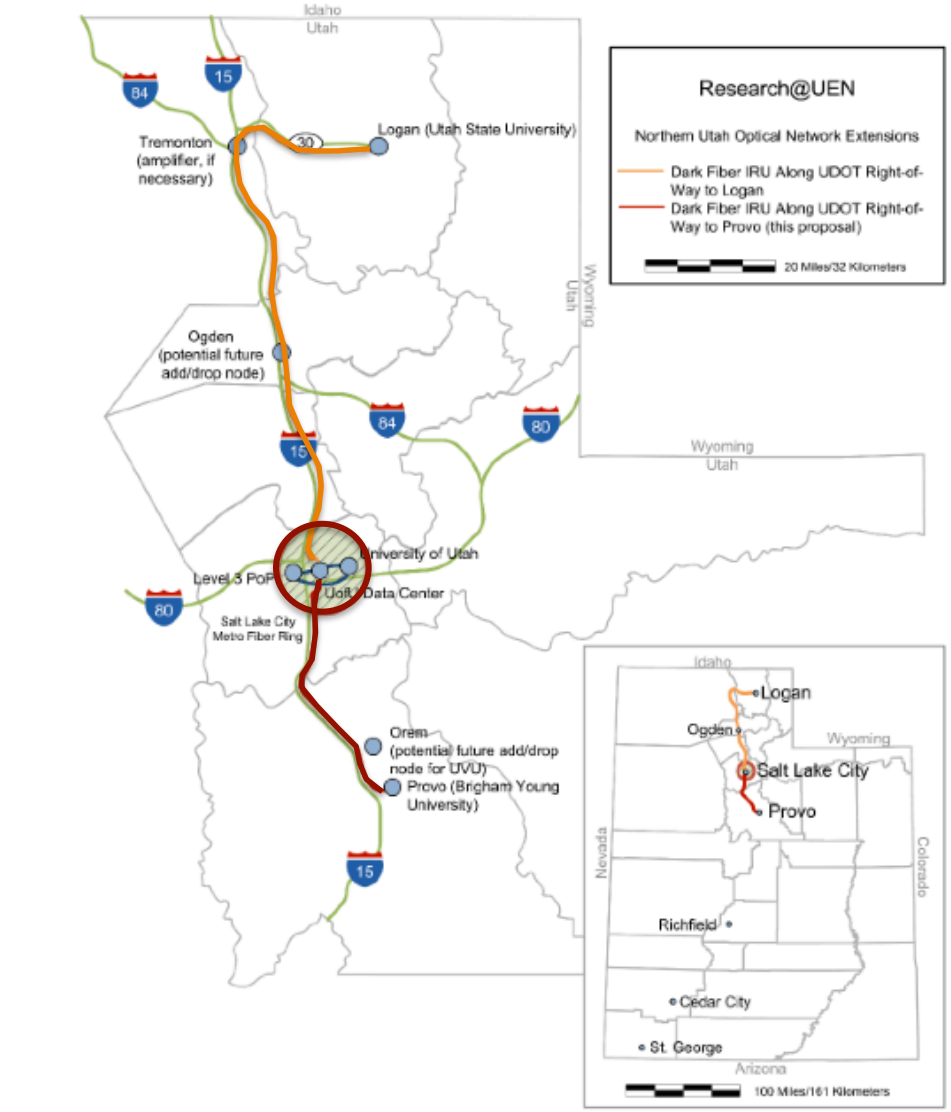
The Problem–Year 1

- Utah is the second driest state in the nation.
- Utah's population is rapidly expanding.
- Increasing climate variability may affect Utah's water supply.
- The intellectual and physical infrastructure Utah needs to address these issues is geographically dispersed and lacks interconnection.

Strategies for Success

Enhance research capacity of the biophysical, social, and engineered water environment

Strategies for Success



Build on Utah's existing strengths in hydrologic modeling and cyber-infrastructure from the CI-WATER and Cyber-infrastructure NSF EPSCoR awards

Strategies for Success

Build programs to increase participation of underrepresented groups that include women, Hispanics and Native Americans

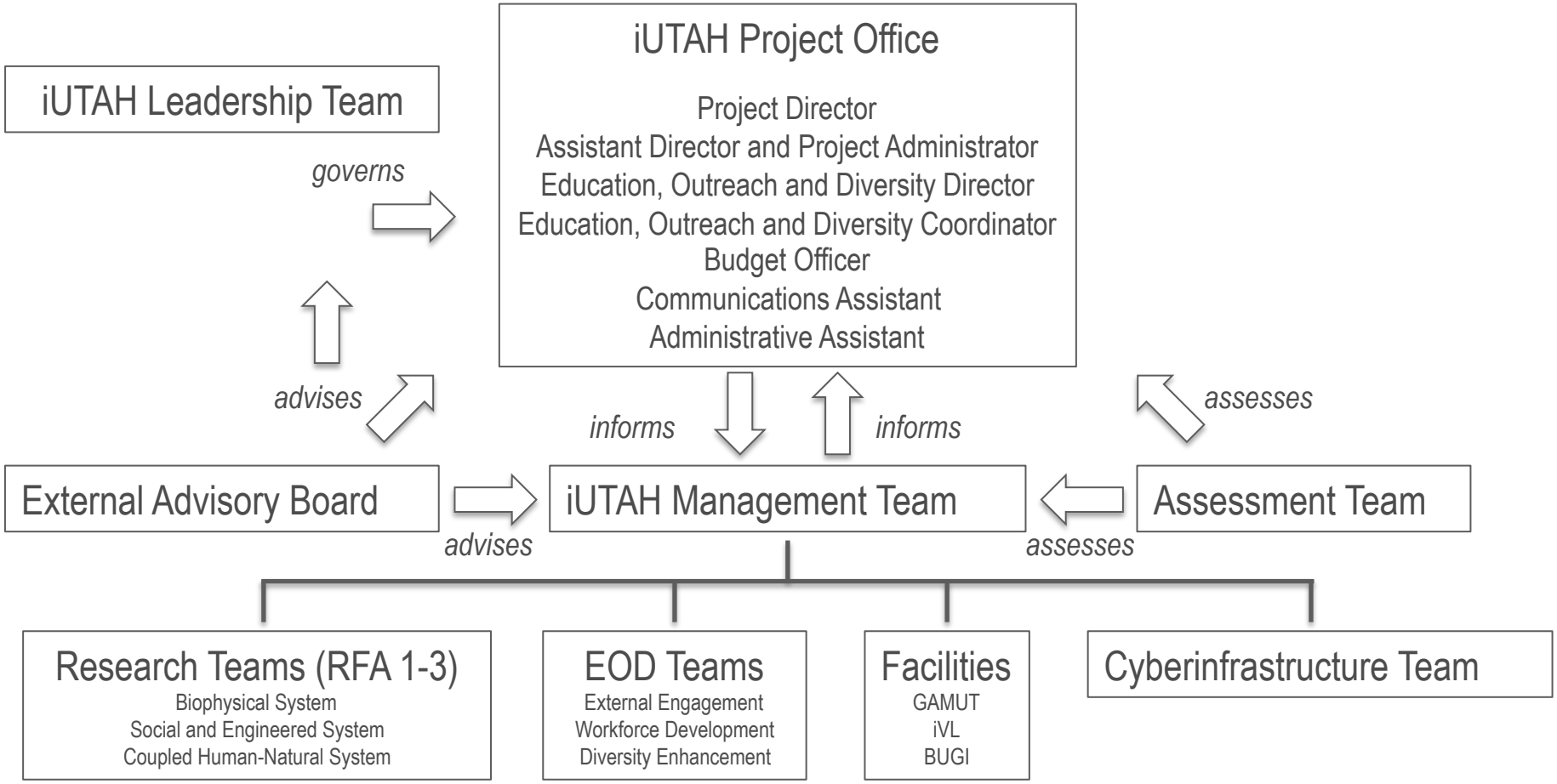
Strategies for Success

Provide educational opportunities for a scientifically literate Utah workforce and citizenry

Strategies for Success

Provide societally relevant science and education regarding current and future water resources

Management Structure



Participating Institutions

Government

- Utah Department of Natural Resources
- Utah System of Higher Education
- Utah Education Network

Outreach

- The Leonardo
- Utah Museum of Natural History
- The Living Planet Aquarium
- Explore Utah Science
- Utah Publix Radio
- UT Water Quality Extension

PhD - Granting institutions

- Utah State University
- University of Utah
- Brigham Young University

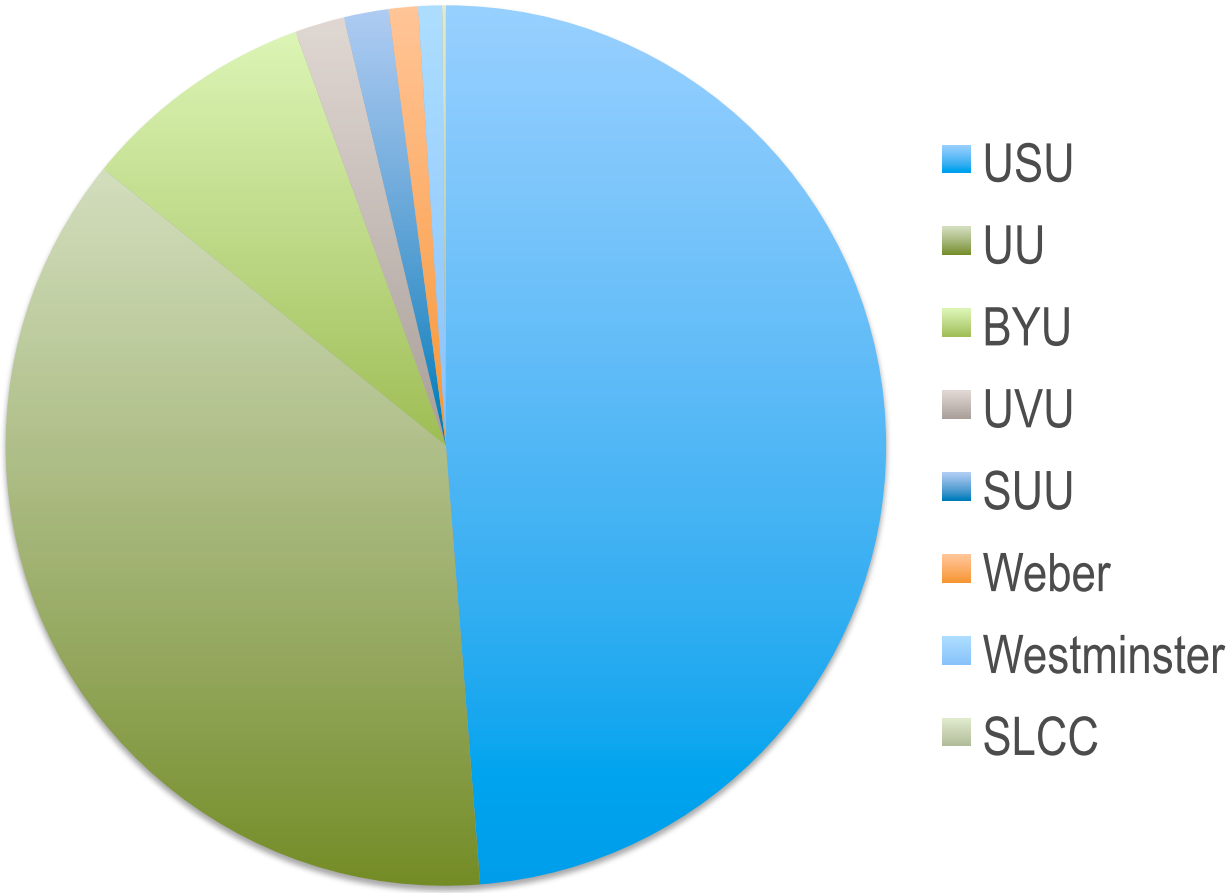
Primarily Undergrad institutions

- Weber State University
- Westminster College
- Salt Lake Community College
- Utah Valley University
- Southern Utah University

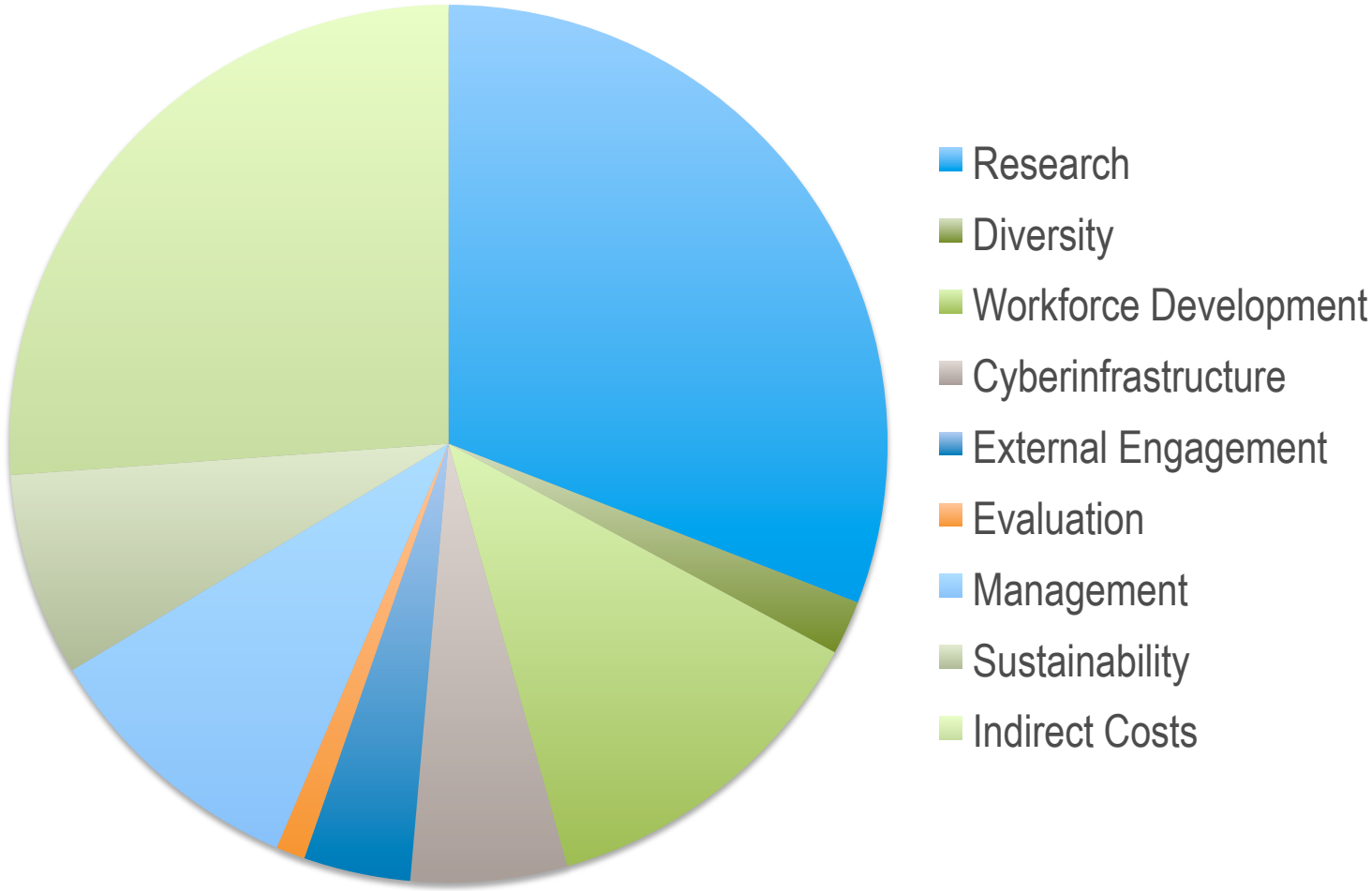
K-12 Education

- Four Corners School
- Rose Park Elementary
- Jordan High School

Budget Allocations



Budget Allocations



iUTAH in Year 3

A Year of Transition and Transformation

The iUTAH Socio-Environmental Observatory

Data Collection

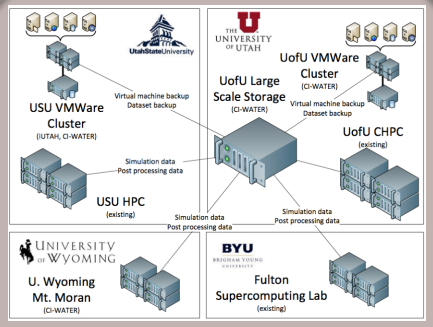
- Surveys
- Interviews
- Neighborhood Typology

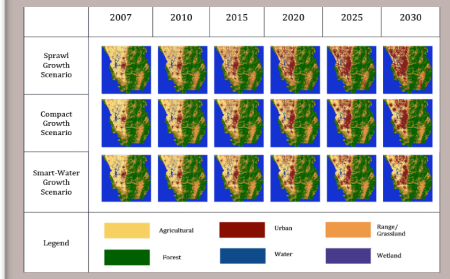
Integrated Observation Networks

- GAMUT
- BUGI
- GIRF

Cyberinfrastructure

- Modeling and Data Federation
- Coupled Modeling
- High Performance Computing
- iUTAH Visualization Lab





Office of Broader Impacts

- Collaborative Research
- Stakeholders
- Outreach
- Workforce Development

The iUTAH Socio-Environmental Observatory

Data Collection

- Surveys
- Interviews
- Neighborhood Typology

Integrated Observation Networks

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- BUGI
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Cyberinfrastructure

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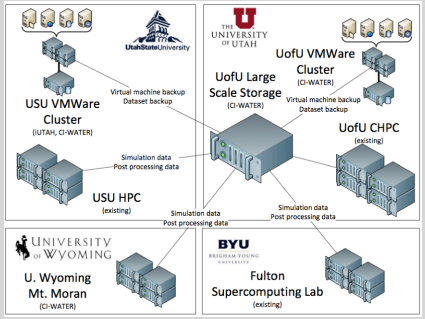

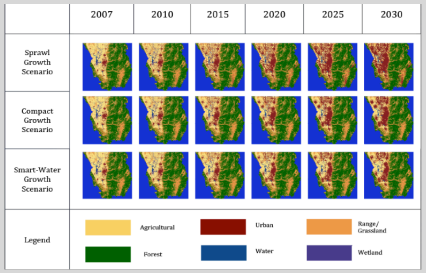

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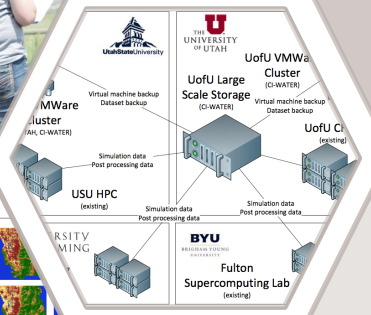
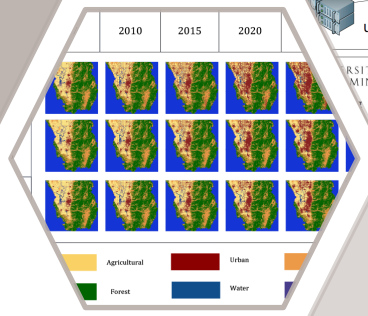




Facilities

Physical and Human Infrastructure for an Integrated Socio-Environmental Observatory

Initial Siloed Concept of iUTAH Facilities at Proposal and Year-1 Stage

Analytical

Ion Chromatography Instruments

RFA1

GAMUT

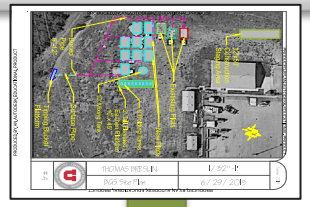
Aquatic and Terrestrial Observatory

RFA1

Cyberinfrastructure

GIRF

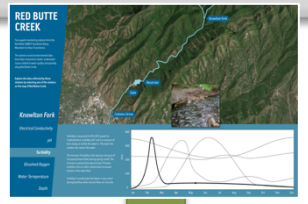
Bioretention Facilities for Engineering and Stormwater Hydrology



RFA2

iVL

Decision Theater



RFA3

The iUTAH Socio-Environmental Observatory

Data Collection

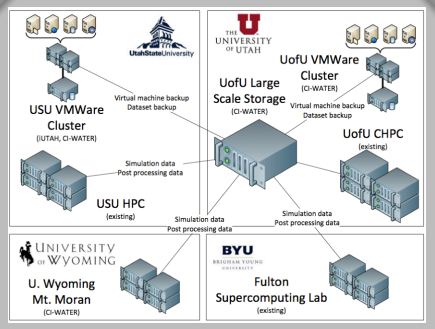
- Surveys
- Interviews
- Neighborhood Typology

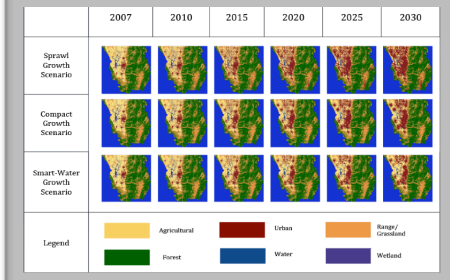
Integrated Observation Networks

- GAMUT
- BUGI
- GIRF

Cyberinfrastructure

- Modeling and Data Federation
- Coupled Modeling
- High Performance Computing
- iUTAH Visualization Lab





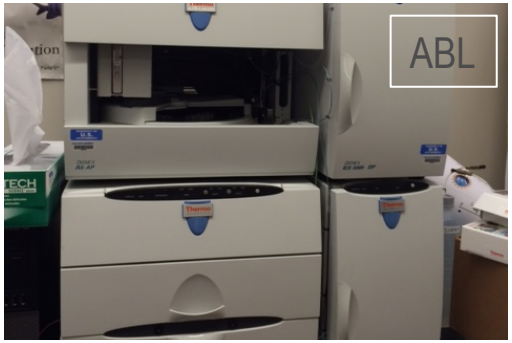
Office of Broader Impacts

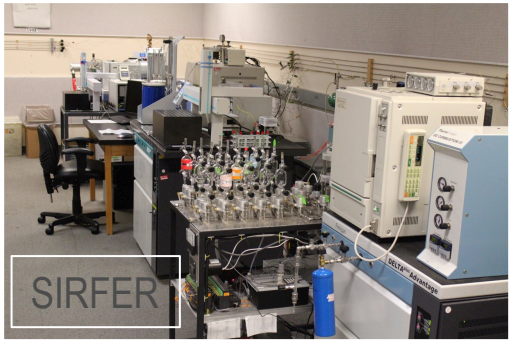
- Collaborative Research
- Stakeholders
- Outreach
- Workforce Development

Core Facilities

Core Analytical Facilities

- Aquatic Biogeochemistry Lab
- Biogeochemistry of Urban Green Infrastructure Lab
- Stable Isotope Ratio Facility for Environmental Research

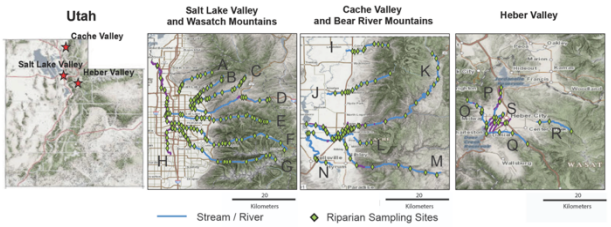


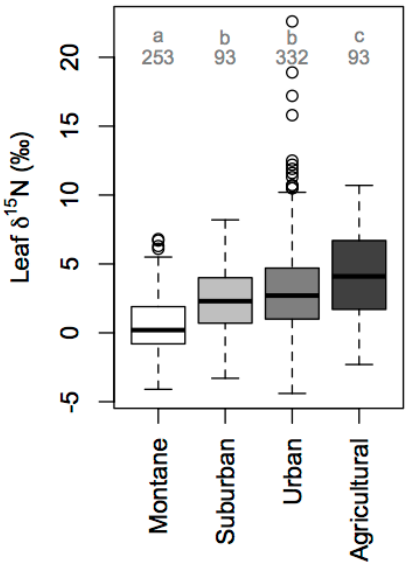


Analytical Capabilities

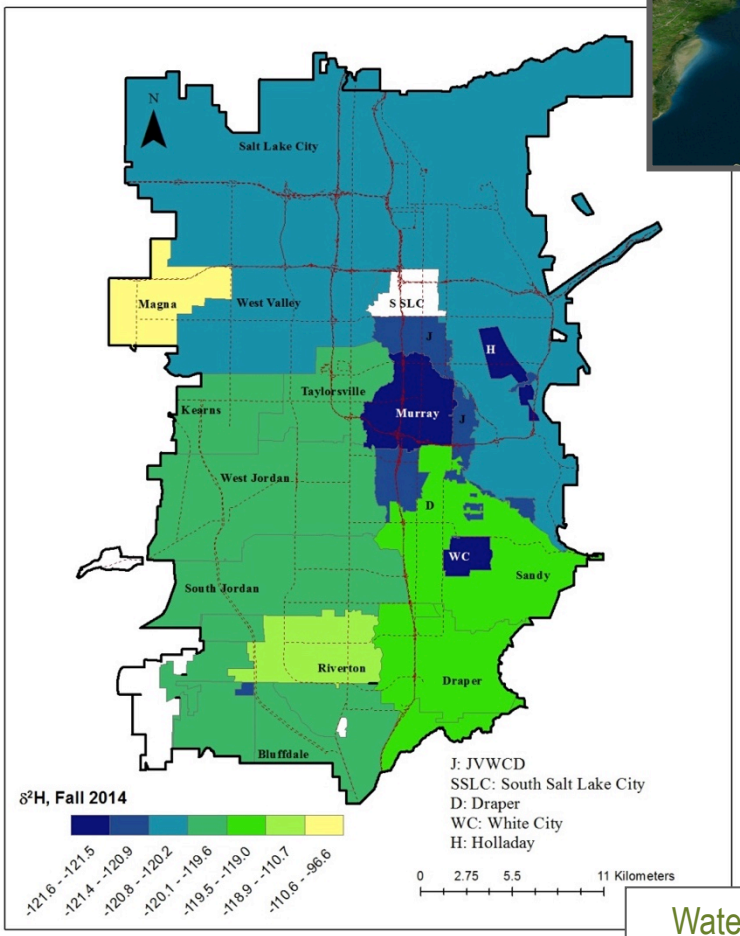
- Discrete analyzer
- Dissolved organic matter
- Gas chromatography
- Ion chromatography
- Organic matter
- Photosynthesis
- Respiration
- Integrated soil moisture
- Stable isotopes
- Trace gases

Leaf $\delta^{15}N$ reflects differential land use and nitrogen loading across all watersheds





Steven Hall, *in press*



Yusuf Jameel, *in prep.*

Water sources in the Salt Lake Valley reflect differences in water management, in water source, and in tap water's evaporative history.

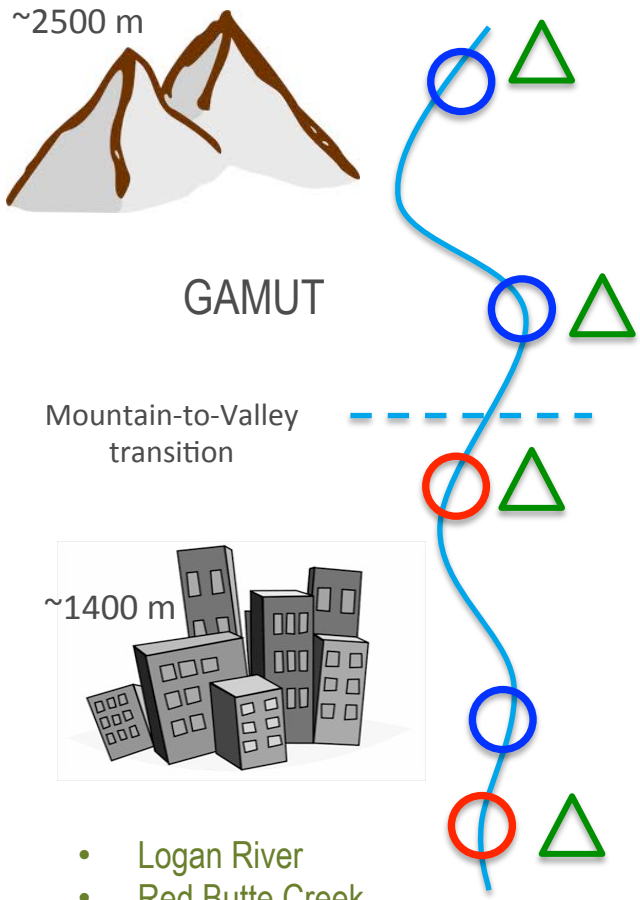
Core Facilities

Integrated Sensor Network

- Logging up to 279 parameters
- 15 (5/6/4) Aquatic Monitoring Stations, +2 planned

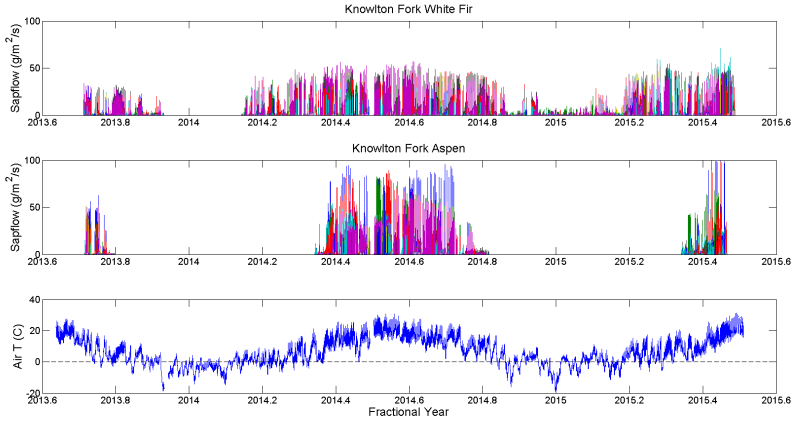
- 12 (4/4/4)Terrestrial Monitoring Stations
- 7 (2/4/1) Storm Drain Sensors, +1 planned

- 4 Mobile Sensor Units

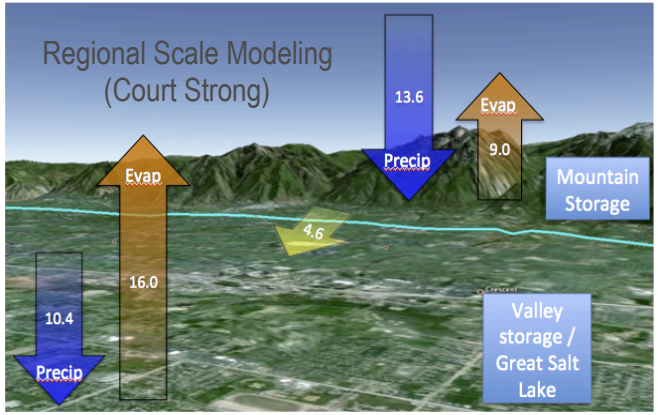


- Logan River
- Red Butte Creek
- Middle Provo River

Scaling Water Fluxes from Trees to Regions



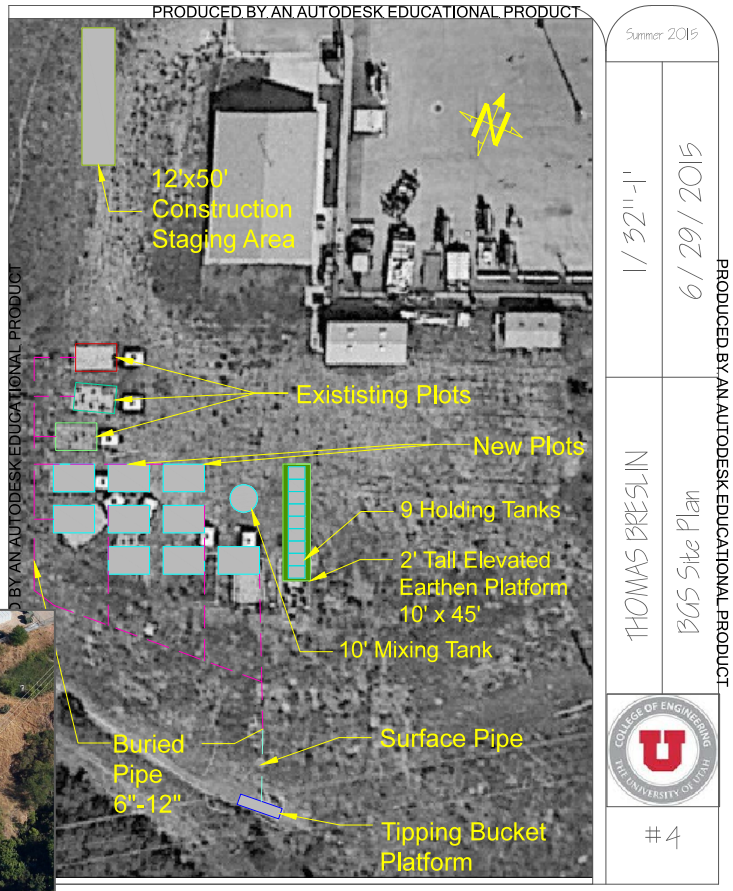
Allison Chan



Core Facilities

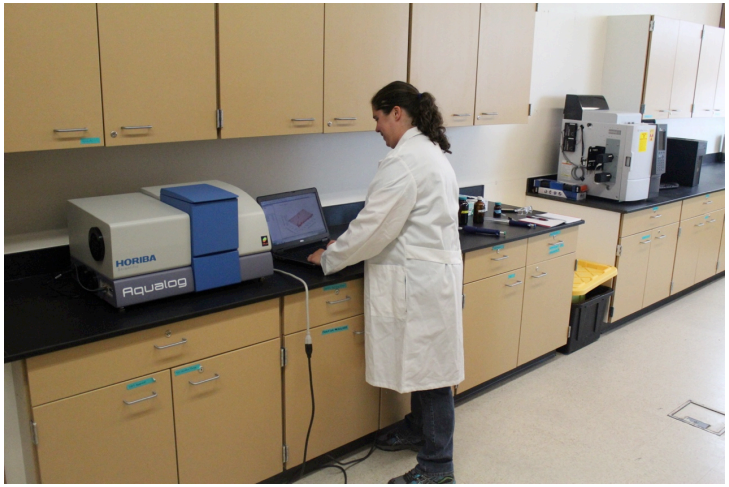
Green Infrastructure Research Facility (GIRF)

- Bioretention systems
- Prescribed stormwater treatment
- Full water balance capacity
- Multi-species complexes to optimize
- Nutrient biogeo-chemistry dynamics



Urban Infrastructure

Biogeochemistry of Urban



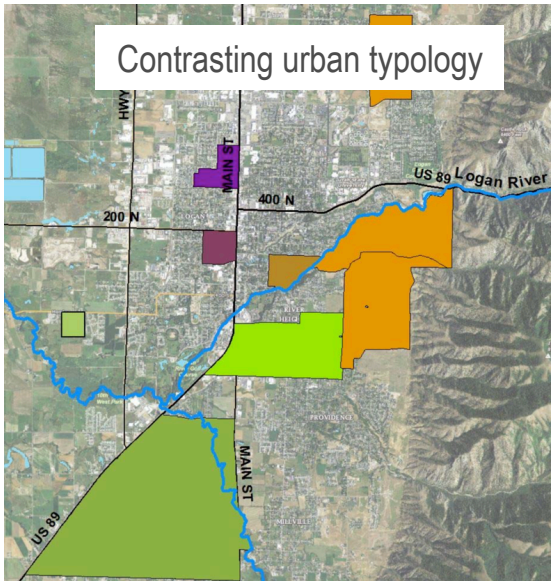
Green Infrastructure (BUGI)

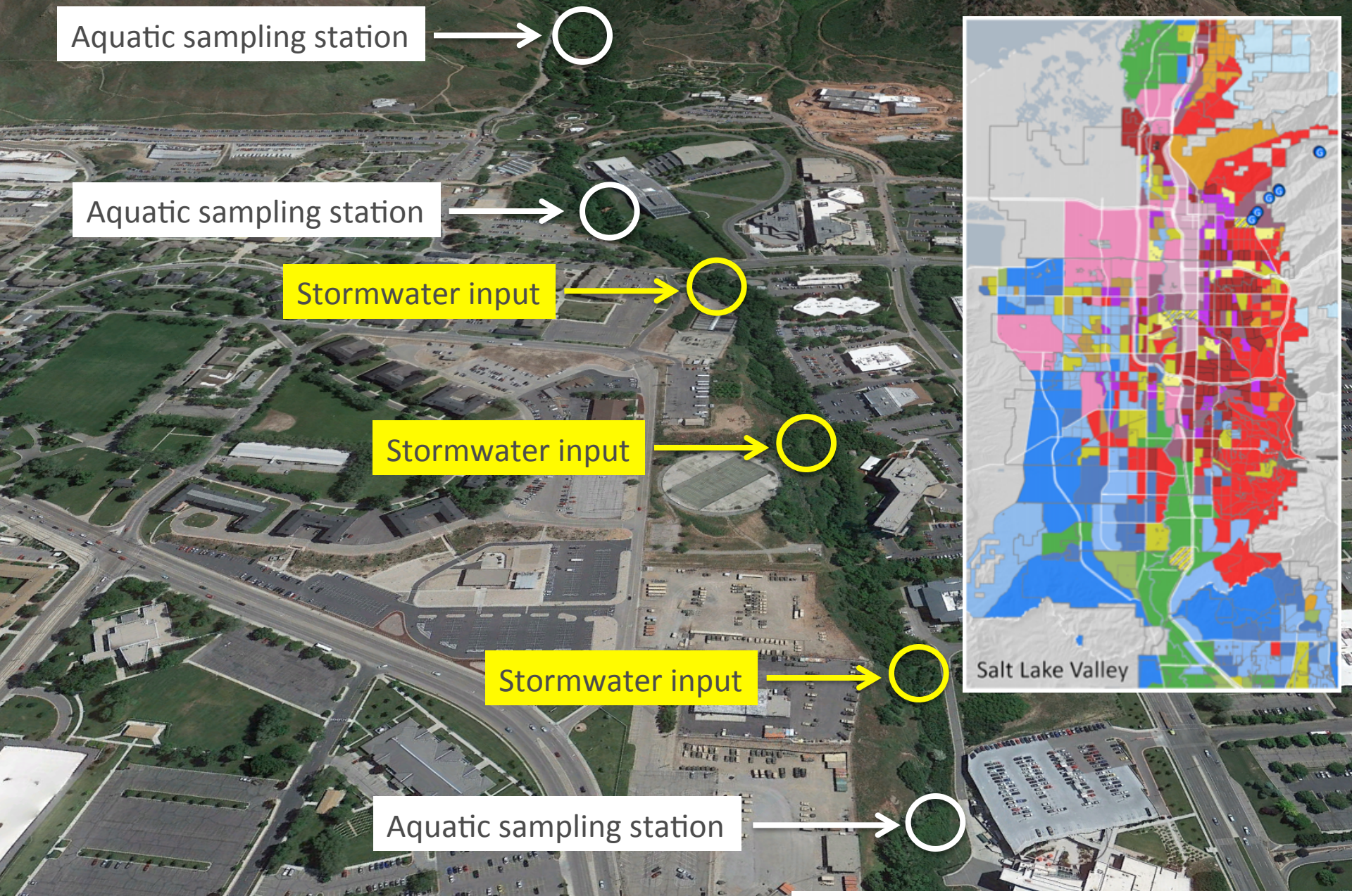
Green Infrastructure Research Facility (GIRF)

Core Facilities

Social and Urban Observation Network

- Logan River (Logan)
- Red Butte Creek (Salt Lake City)
- Middle Provo River (Heber)

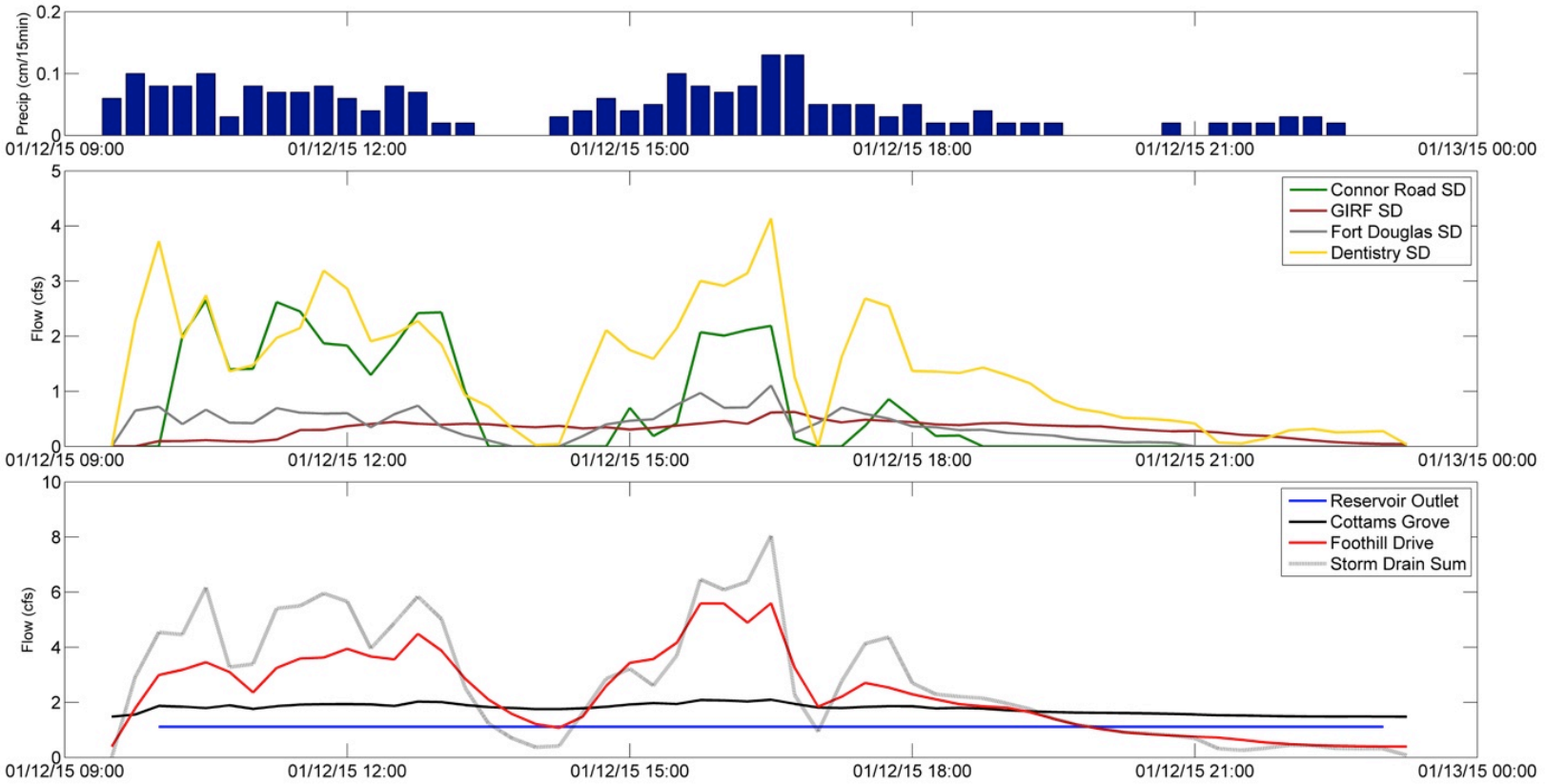




GAMUT

Coupling stormwater fluxes with urban typologies

Changes in the stream water flows across the natural-through-urban gradients where water channels and impervious structures change infiltration capacities



- BUGI - water quality
- SIRFER - distinguish sources
- iVL – dynamic representation
- GAMUT – flow and nutrient data
- RFA1 – terrestrial/aquatic processes
- RFA2 - storm water modeling
- RFA2 – resident attitudes/choices
- RFA3 – coupled water modeling

Core Facilities

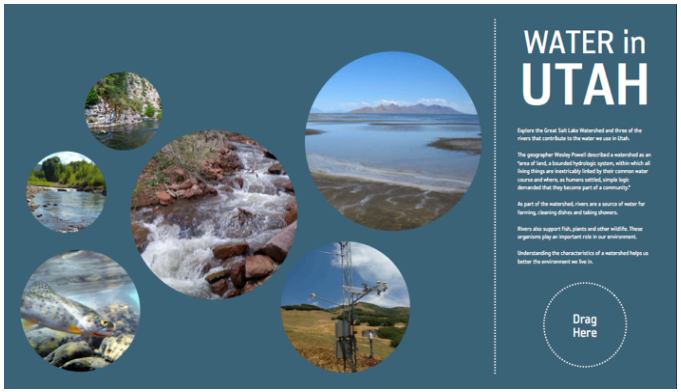
iUTAH Visualization Laboratory (iVL)

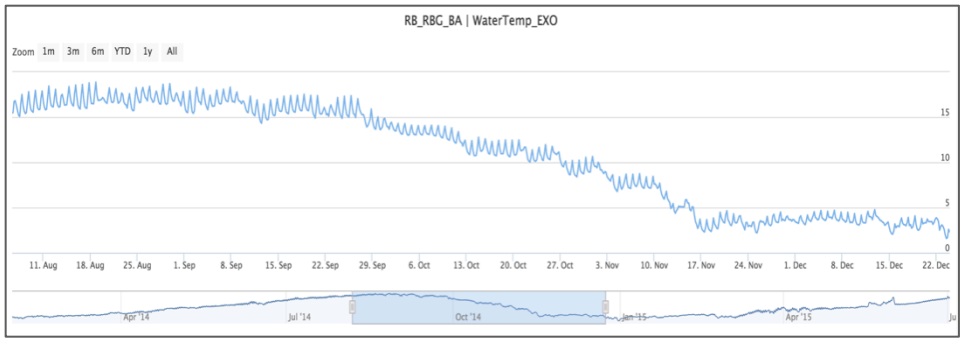
iVL at Intermountain Network and Scientific Computation Ctr., University of Utah

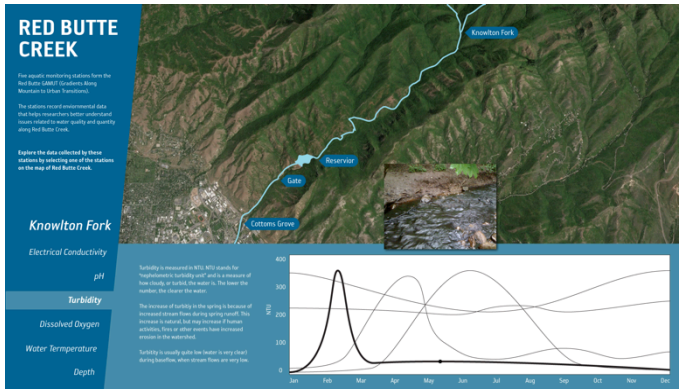
iVL at Utah Water Research Lab, Utah State University

Natural History Museum of Utah Kiosk

- JavaScript web-app running on 42” touchscreen in main museum concourse with exterior view to Red Butte Canyon
- Interactive map selects GAMUT station and measured variables, plots time series, and provides interpretive information







Smartphone and Tablet Adaptation of Kiosk

- JavaScript web-app for undergraduate field classes and K-12 field trip exercises
- Interactive map selects GAMUT station and measured variables, plots time series, and provides interpretive information

Questions ?

Jim Ehleringer
jim.ehleringer@utah.edu

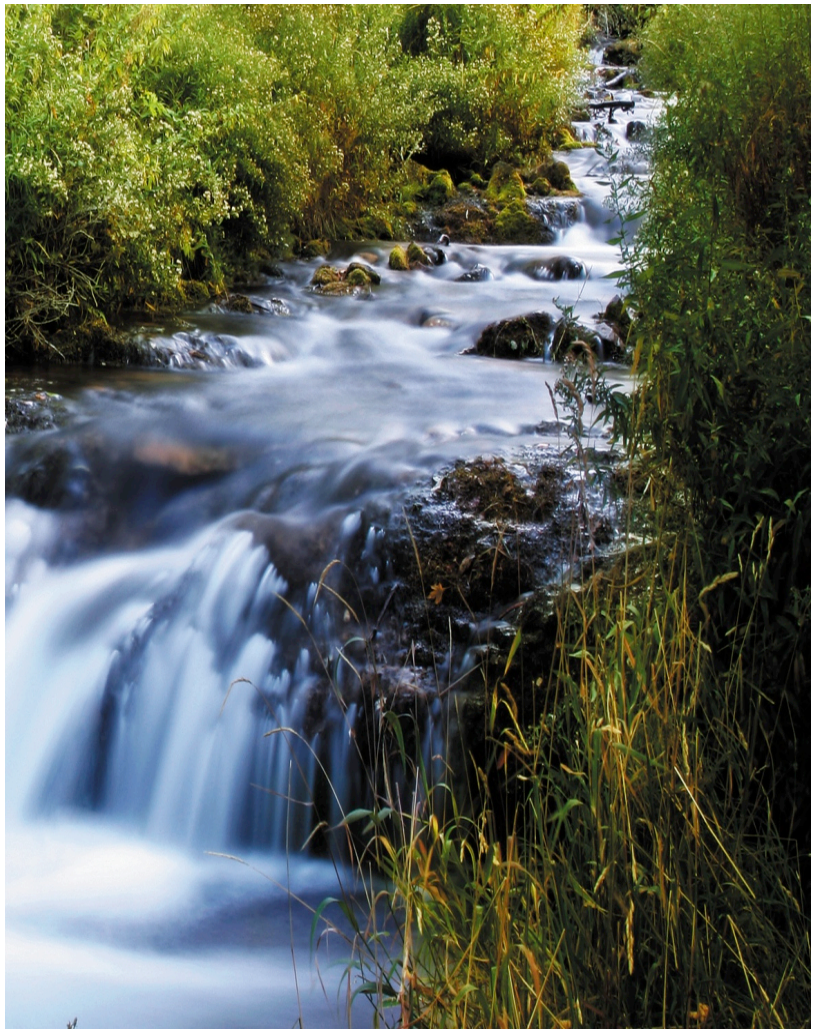

Eco-hydrology
RFA1


RFA 1
Transcending System Boundaries
through Integrative Ecohydrologic Research

Core Questions

What processes control water quantity and quality along mountain-to-urban gradients?

How will the quantity and quality of water change as a result of climate change and land use in forested, urban, exurban, and agricultural environments?



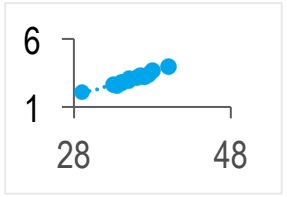
Research Goals

Goals

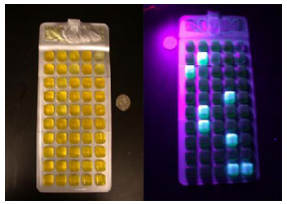
- Improve capacity to monitor WRMA ecohydrologic system on mountain-to-urban gradient
- Enhance capacity to understand ecohydrologic processes in the WRMA as they relate to water resource availability now and in the future

Milestones

Install aquatic and terrestrial instrumentation in all watersheds, build and deploy mobile sensor units



Validate rating curves

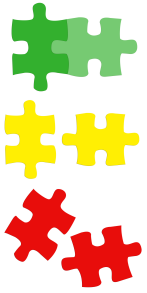


Conduct research on nutrient and contaminant relationships, climate models, water yield-climate models

Assist in the implementation of Summer Institute, mentoring of iFellows, and iUTAH interns

Milestones

- GAMUT expanded to include 3 new stations with installations nearly complete; built mobile urban instrumentation in collaboration with RFA2
- Rating curves 60% complete
- Addressing research questions with 9 graduate students (3 new recruits this year)
- Mentored and trained undergraduates during the iUTAH Summer Institute, iFellows Summer REU, and throughout the academic year (traineeships)

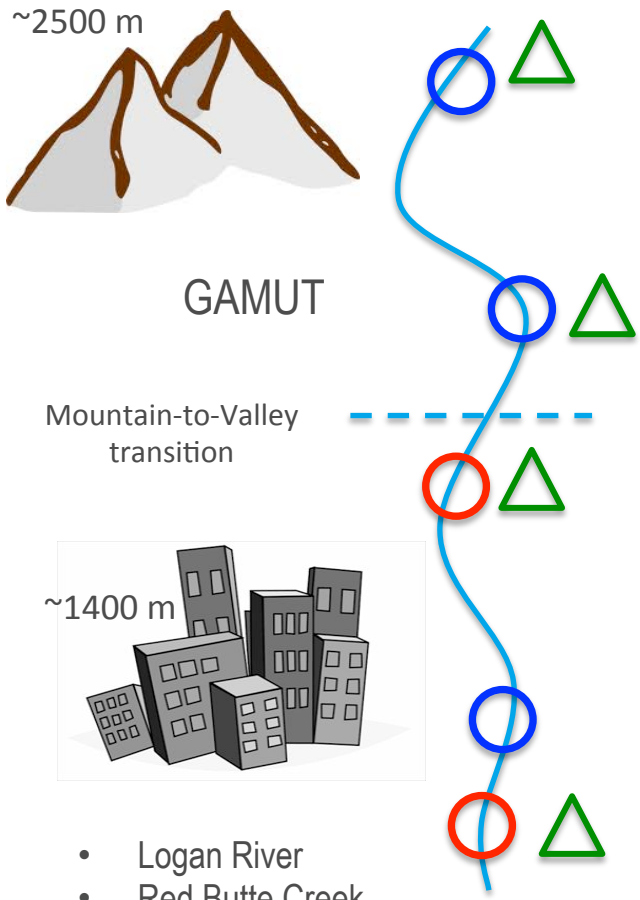


iUTAH's Integrated Sensor Network GAMUT

- Logging up to 279 parameters
- 15 (5/6/4) Aquatic Monitoring Stations, +2 planned

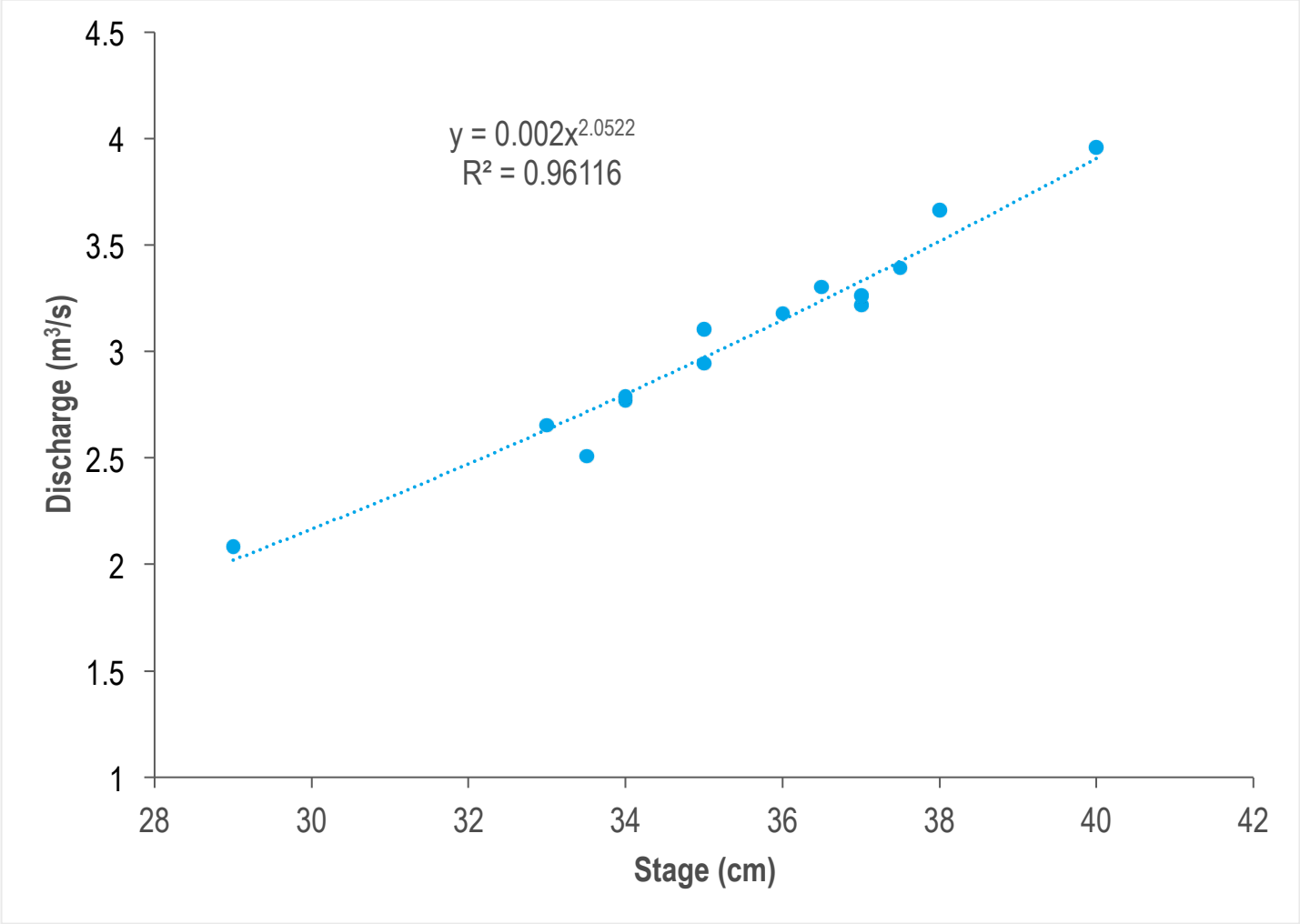
- 12 (4/4/4)Terrestrial Monitoring Stations
- 7 (2/4/1) Storm Drain Sensors, +1 planned

- 4 Mobile Sensor Units

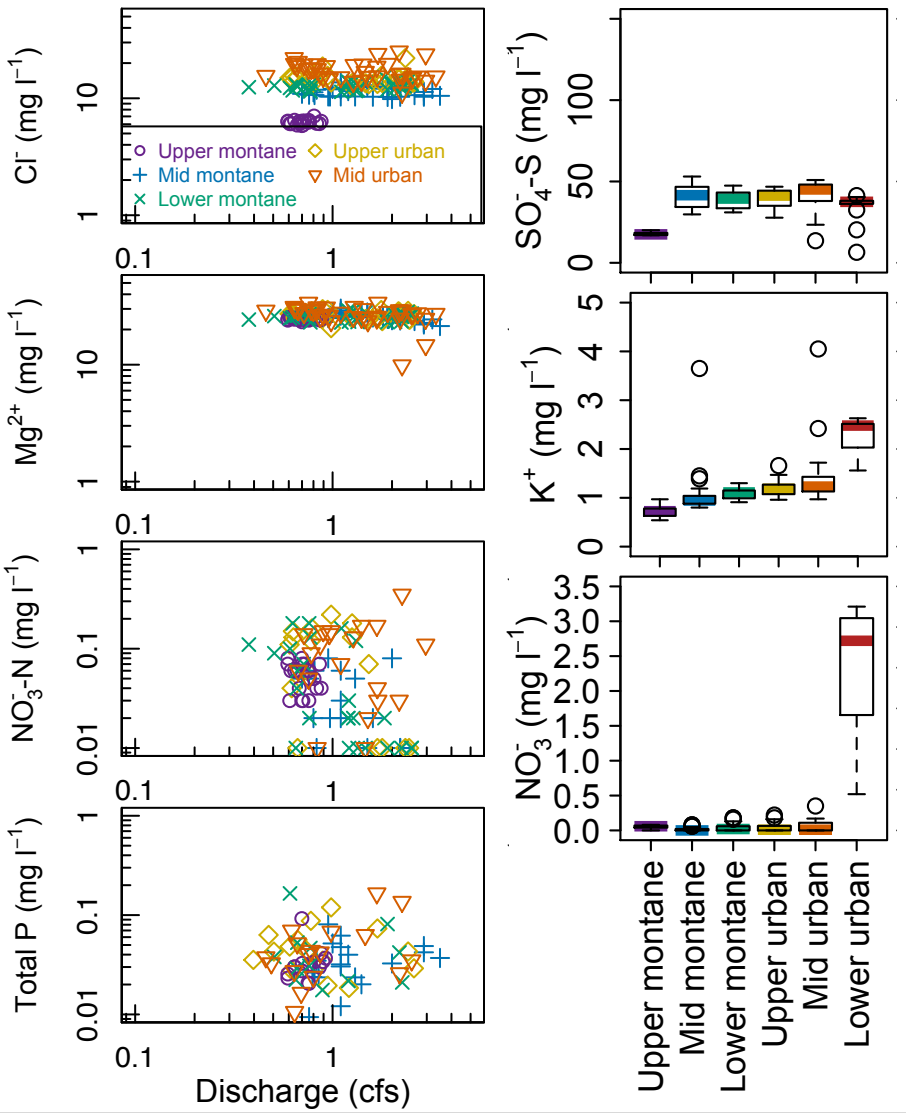


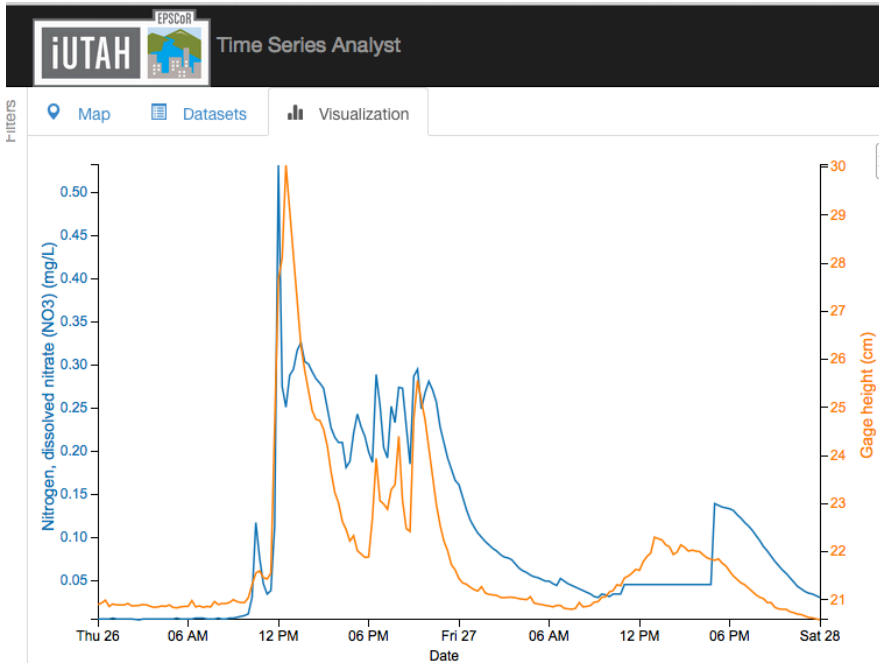
- Logan River
- Red Butte Creek
- Middle Provo River

Sample Rating Curve from the Logan River



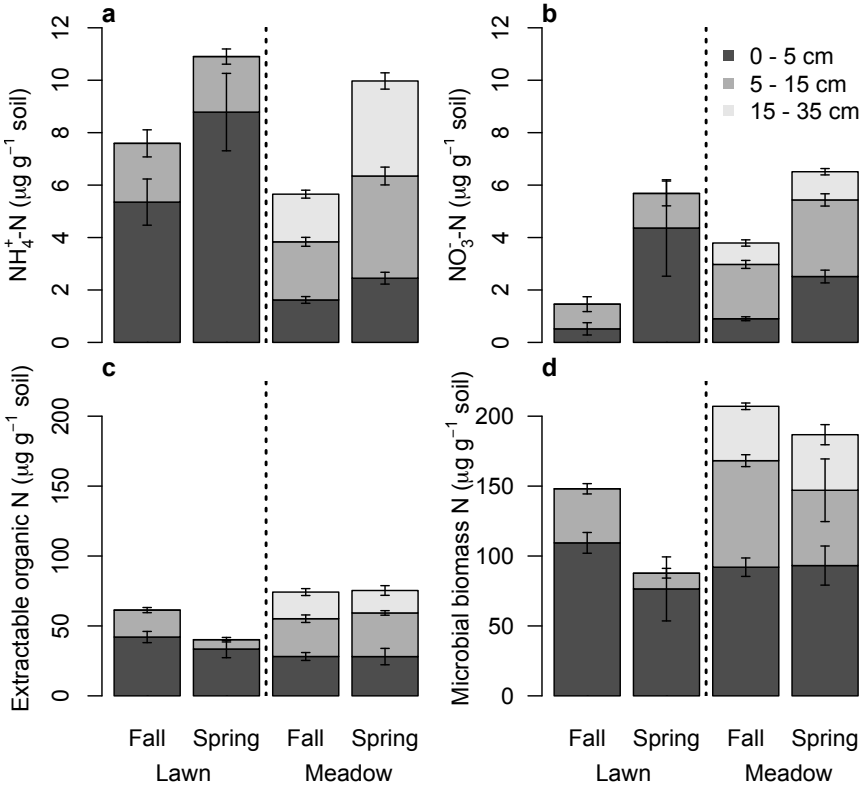
Intellectual Contributions

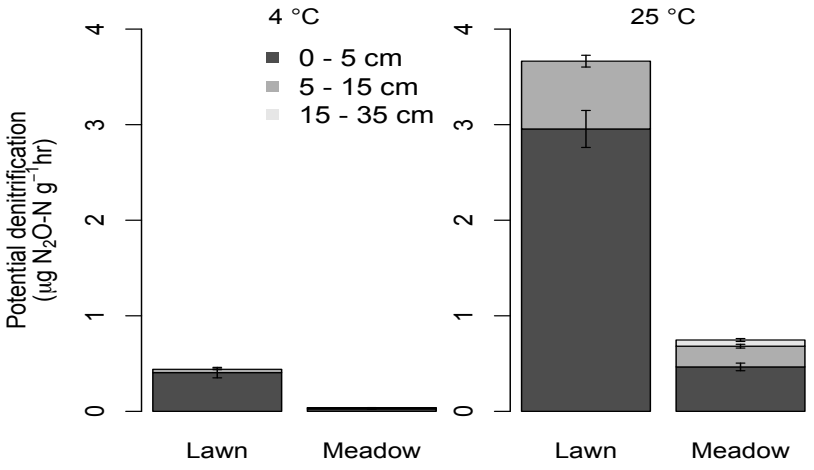




Hall et al., *in prep.*

Intellectual Contributions





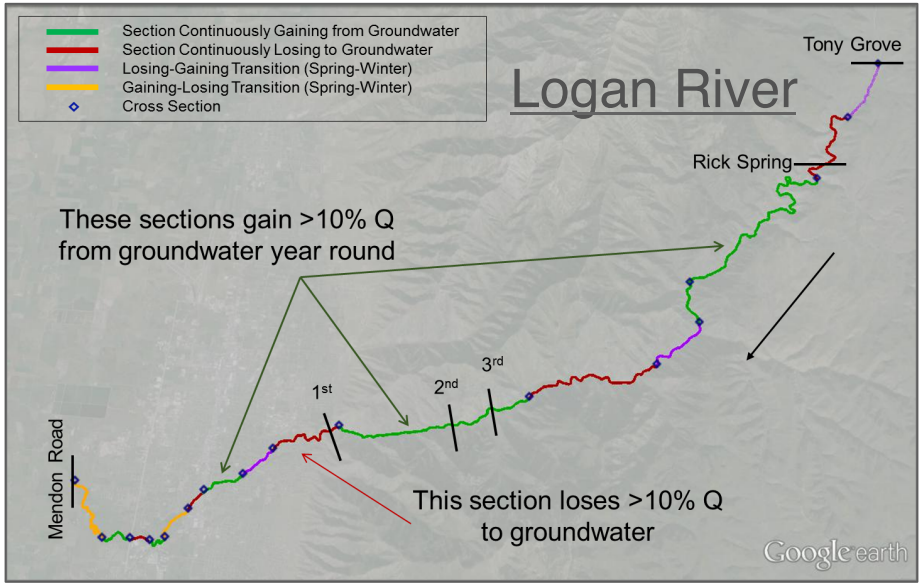
Hall et al., *in review (Ecosystems)*

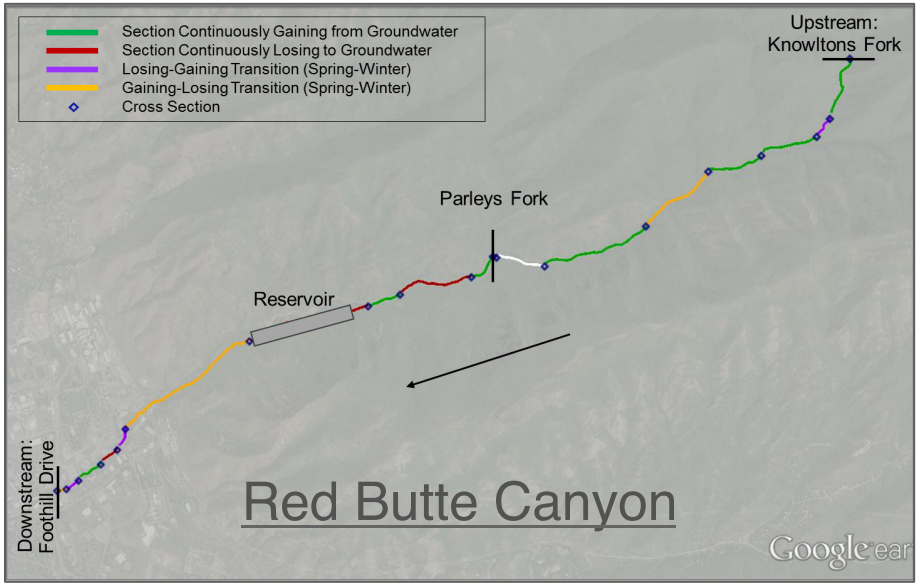
Intellectual Contributions

Preliminary findings for two 2014 field events – We have identified reaches: (1) where net gaining and losing persists seasonally (2) that alternate seasonally between losing and gaining.

Current work – Determining if trends are consistent annually as well as pair these finding with surface water chemistry samples collected in 2015.

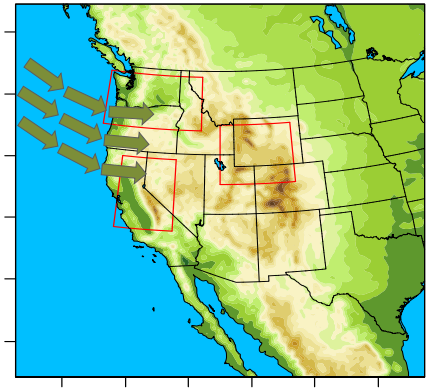
Barnes et al., *in prep.*





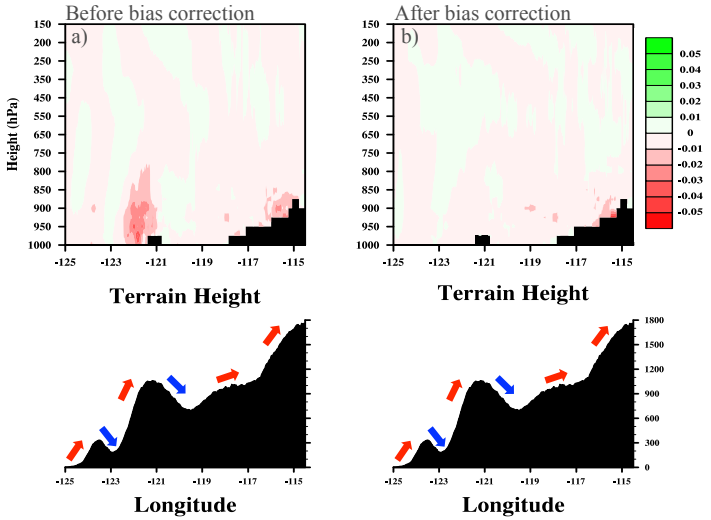
Intellectual Contributions

Figure 1. Model Domain



- Typical atmospheric flow (from west-to-east) over the western United States.
- Flow is perpendicular to complex terrain

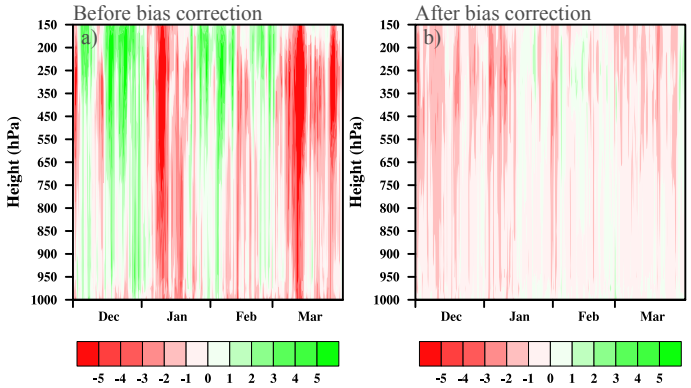
Figure 3. Cross Sectional Bias (1980-2009) of the Vertical Wind Component Across Cascade Range



Bias-reduced model simulations (Figure 3b) shows a reduction in the updrafts and downdrafts along the terrain

- Improvements in the bias reduced model simulation (Figure 2b), which more closely matches the observed momentum.
- Improvements in the west-to-east momentum may reduce the magnitude of topographically forced precipitation.

Figure 2. Seasonal Bias (1980-2009) of Zonal Wind Acros the Cascade Range



Green = west winds; red = east winds

Jin et al., *in prep.*

Broader Impacts

Developed 1 module for the iUTAH Summer Research Institute in 2014

Developed 3 modules for the iUTAH Summer Research Institute in 2015

Developed white papers on QA/QC Processes and Sample and Analysis Plan for water quality

Participated in USU Eastern's Native American Mentorship Program during Summer 2015

GAMUT watershed technicians participated in iUTAH booths at several national conferences (AGU, UCOWR/NIWR/CUAHSI)

Summary of Accomplishments

- Infrastructure
- Manuscripts
- Recruitment, Training and Professional Development

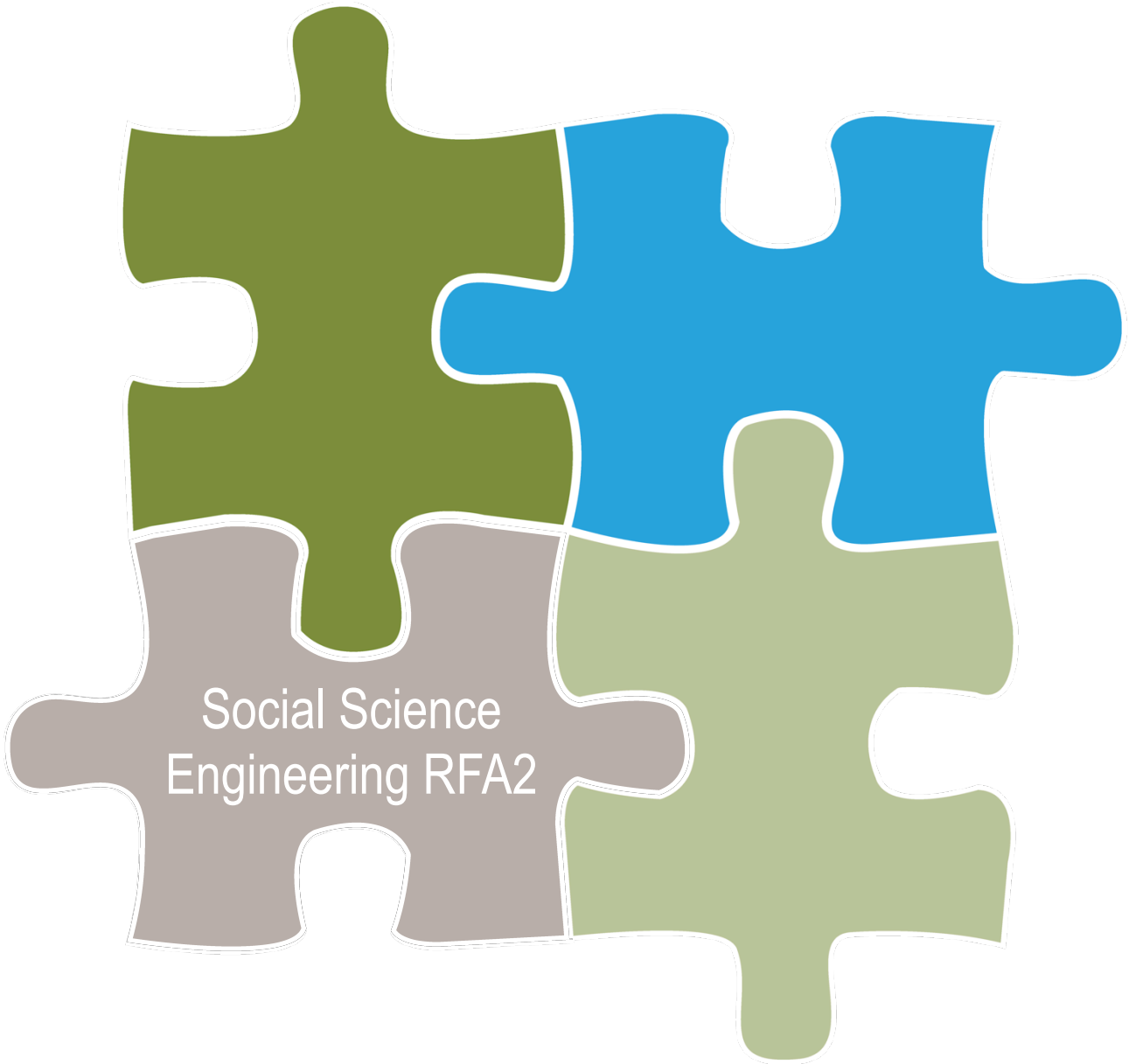
Plans for Year 4

- Maintain GAMUT sensors, validate rating curves, continue data collection
- Publish data sets
- Contribute to models
  - w/RFA3
- Continue to create collaborative research network across institutions
  - Participate in LTER proposal
- Continue to train and mentor graduate and undergraduates students
  - Summer Research Institute/Spring Runoff and national conferences

Questions ?

Zach Aanderud
zachary_aanderud@byu.edu

Dave Bowling
david.bowling@utah.edu


Social Science
Engineering RFA2

RFA 2

Human Drivers of Water Systems: Integrating People, Places, Plants, Pipes, and Policies

Core Questions

What are the current drivers of water and land use management in the region?

How does urban form interact with water use and the quantity and quality of return flows?

Research Goals

Goals

- ***Improve capacity*** of Utah's science community to gather and analyze social and engineering system data on coupled water systems
- ***Understand interactions*** between urban form, environmental change, built water infrastructure, and decision-making in terms of water use
- ***Model impact*** of alternative infrastructure designs and policy options on water use behaviors, water cycle, water quality, and interconnected social and environmental systems

Overlapping Research Teams

Social Science

- Social/ institutional/policy data
- Cross-scale: individual, household, community, . . .

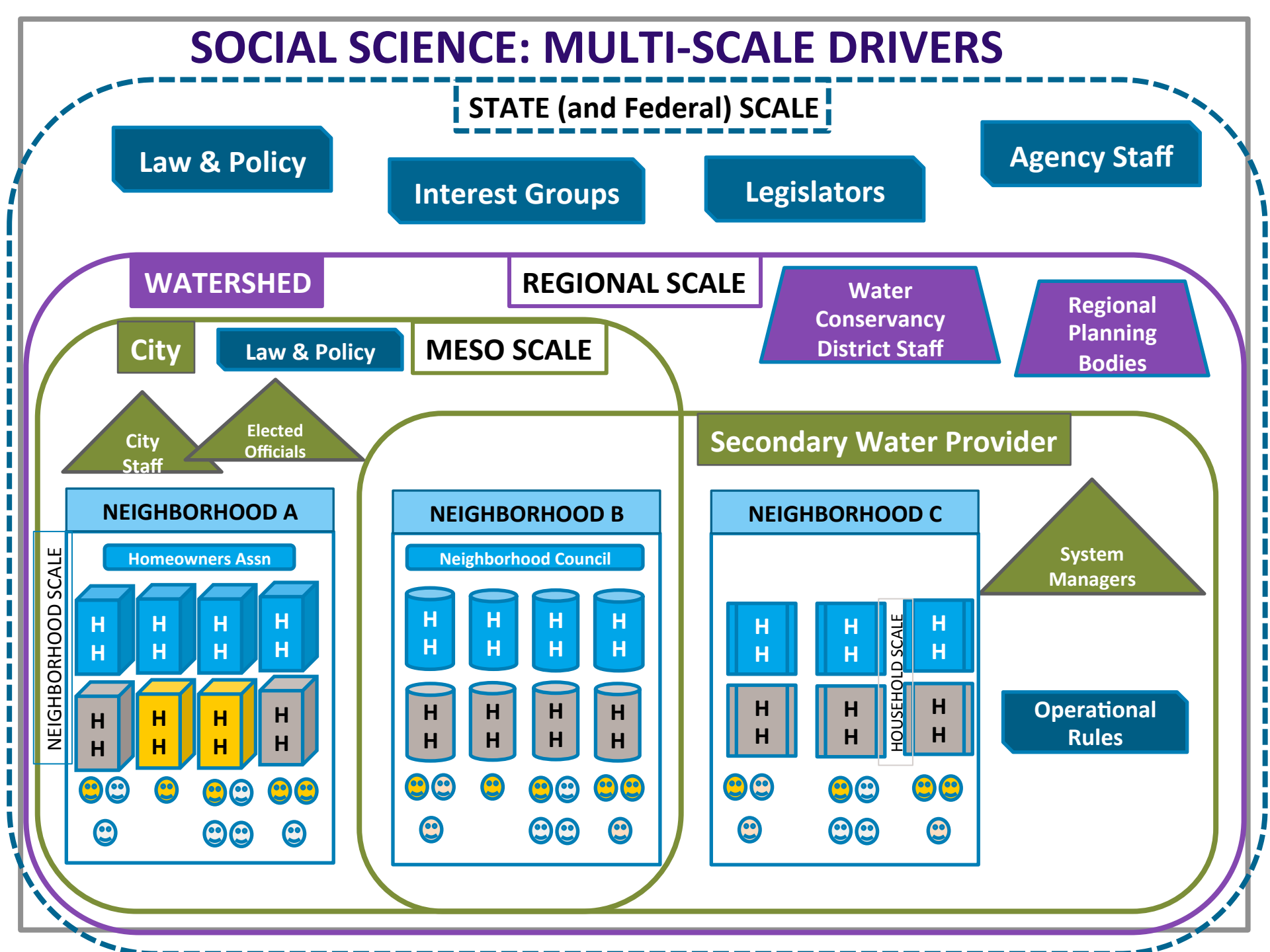
Engineering

- Data on engineered water systems
- Performance of 'green' water infrastructure






SOCIAL SCIENCE: MULTI-SCALE DRIVERS

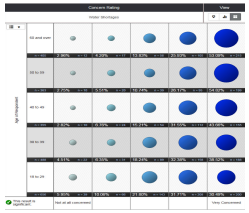


Milestones

Finish installation of urban instrumentation; instrument one new green infrastructure project

Review work with study neighborhoods and stakeholders

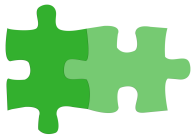
Expand Utah Water iPad Survey project with new collaborators



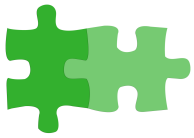
Develop templates for social science data collection and management plans for metadata reporting

Research questions: integrated model of urban growth and stormwater flows, interactional capacity and water programming of WRMA communities, drivers of water use related to urban form, surface runoff model, urban hydrologic models

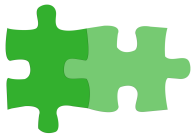
Milestones



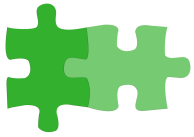
Urban expansion of GAMUT is complete; expansion of green roof work at the University of Utah and Southern Utah University



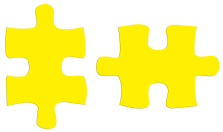
Neighborhood meetings in Heber, SLC and Logan held or planned; meetings with municipal and state water managers ongoing



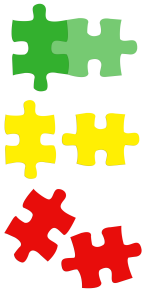
New iPad Survey collaborators at UU, SLCC, SUU, UVU, WSU, and one High School



Substantial revisions to iUTAH Data Policy and Data Publication System/Repository in collaboration with iUTAH CI in Year 3



Addressing research questions with 7 graduate students (2 new recruits this year); work related to GIRF still in early stages



Instrumentation of Engineered Water Systems

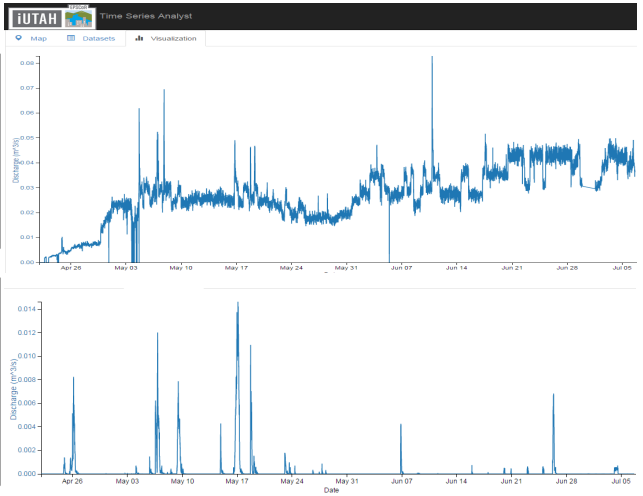
- Extend GAMUT footprint in urban areas
  - More aquatic stations in study streams within urban neighborhoods
  - Measurements of return flows in stormdrains and canals
- Monitor both flows and water quality

River Heights Bridge Storm Drain
LR_RH_SD

Network: Logan River **County:** Cache
State: Utah **Latitude:** 41.725147
Site Type: Storm sewer **Longitude:** -111.825917

GIRF Storm Drain
RB_GIRF_SD

Network: Red Butte Creek **County:** Salt Lake
State: Utah **Latitude:** 40.760912
Site Type: Storm sewer **Longitude:** -111.829696

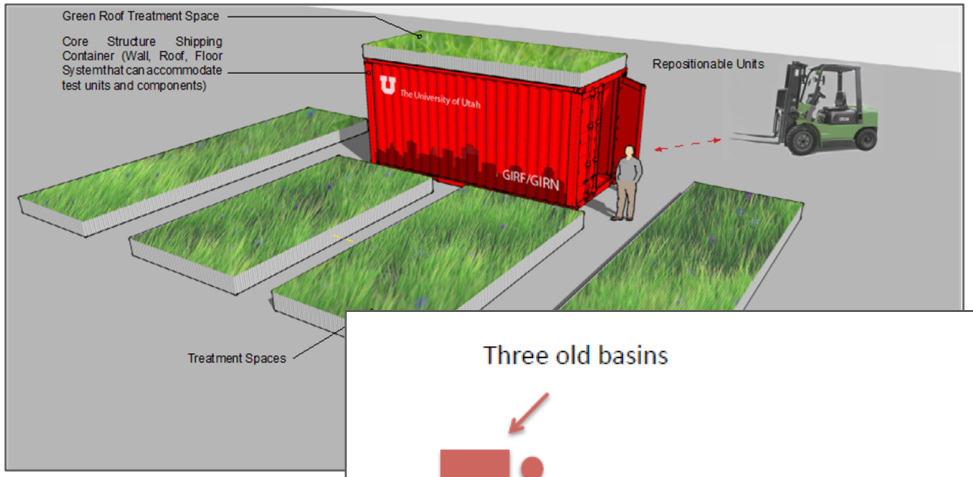


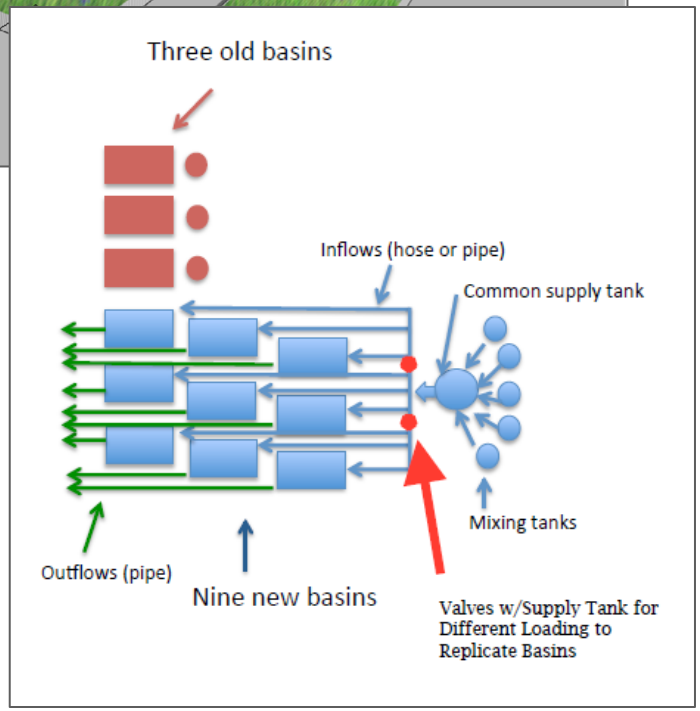
Green Infrastructure (GI) Work

- Instrumentation of Curb Cut Project (Dupont and Rife)
- Monitoring flows and quality of water inputs from road, soil moisture, and lysimeters

Green Infrastructure Research Facility (GIRF)

EXPERIMENTAL RESEARCH SITE: STORMWATER BIOSWALES





Intellectual Contributions

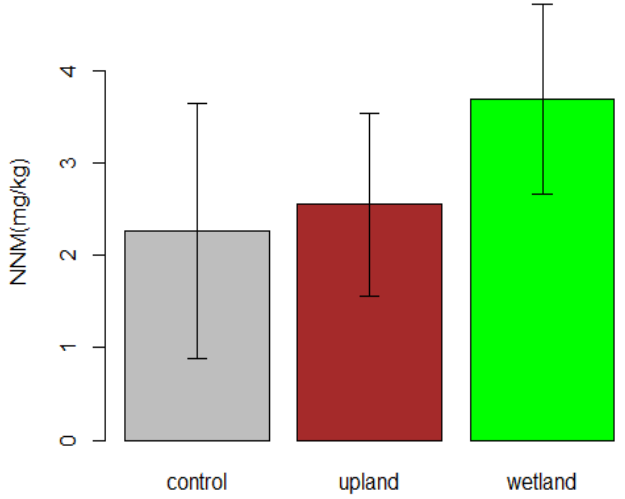
2014/15 Experiments

- Goal: Document performance of different bioswale vegetation treatments on water budget and water quality

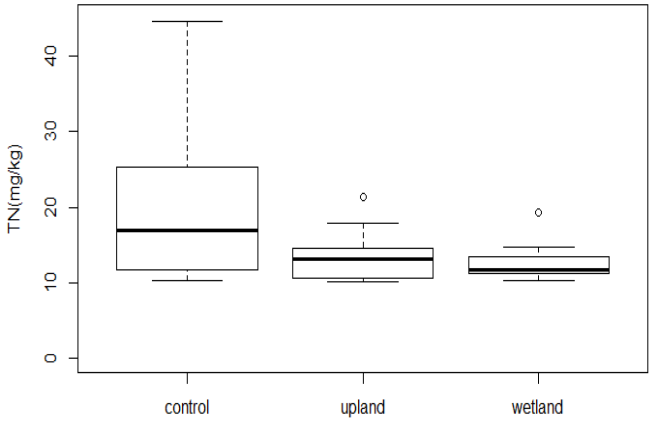
Taking plant measurements in wetland treatment for developing allometric equations

Sapkota et al., *in prep.*

Getting soil samples from control treatment



Average mineralization in bioretention cells with different treatments



Total nitrogen accumulation in bioretention cells with different treatments

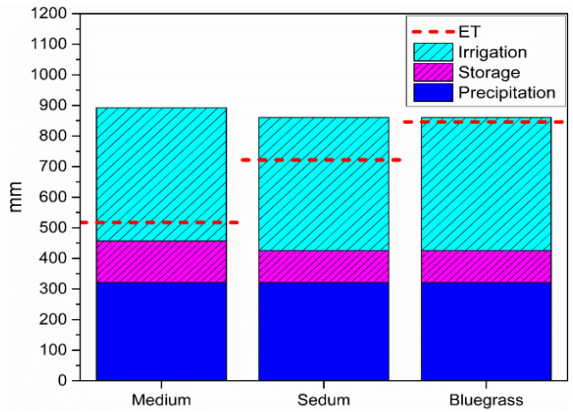
Intellectual Contributions

Testing ET Models with Green Roofs

- Used weighing lysimeters to quantify water balance of green roofs and bioretention structures
- Results used to improve algorithms for evapotranspiration for local climate
- Results incorporated and tested in SWMM models
- Modified model creates more realistic ET process; used to study green infrastructure impacts on Red Butte Creek watershed water budget

Feng et al., *in prep.*

Key Result: Green Roofs Require Large Amounts of Irrigation in This Climate



03/03/2014 – 12/06/2014

Intellectual Contributions

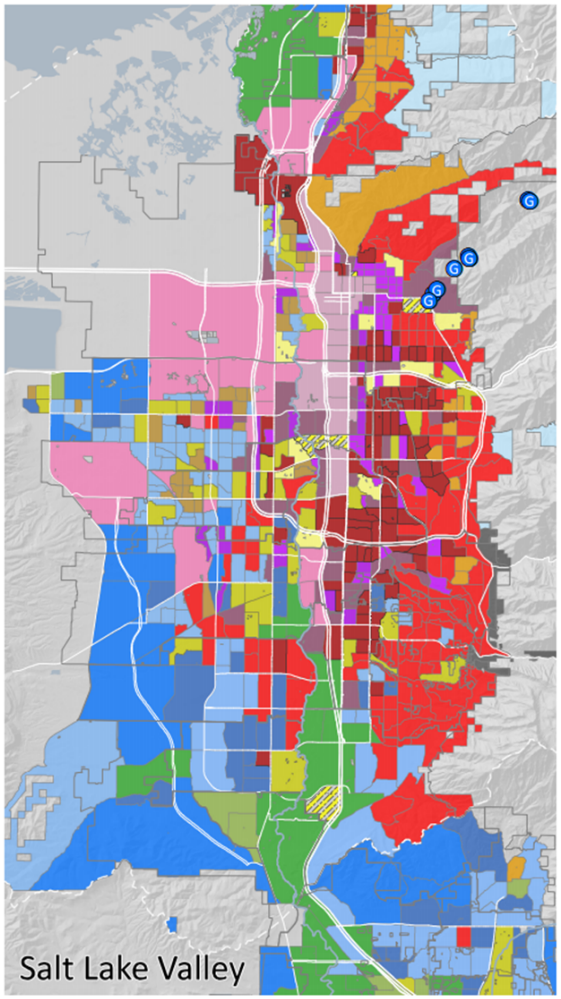
Differentiating Urban Landscapes

Multivariate classification

- Land use
- Land cover
- Housing type/mix/age
- Household type/mix
- Socioeconomic status

Basis for geographic sampling

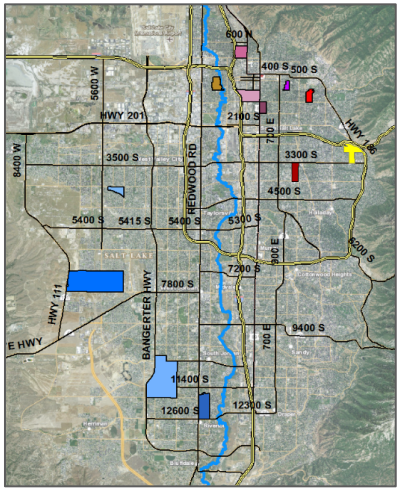
Enables comparisons of contextual effects in analysis

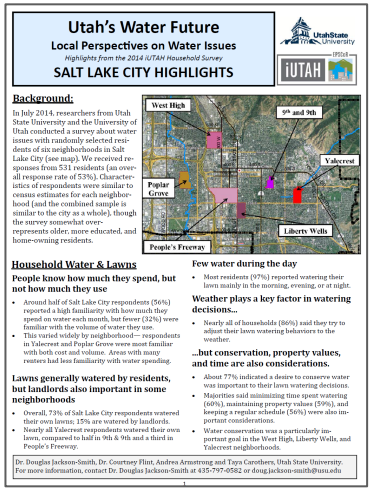


Intellectual Contributions

2014 Household Survey

- 2,400 respondents in 23 neighborhoods across 12 cities
- 62% response rate
- Summary reports disseminated
  - to city and neighborhood leaders
  - to respondents
  - posted on iUTAH website: www.iutahepscor.org/hhsurvey





Utah's Water Future

Local Perspectives on Water Issues

Highlights from the 2014 iUTAH Household Survey

SALT LAKE CITY HIGHLIGHTS

Background:

In July 2014, researchers from Utah State University and the University of Utah conducted a survey about water issues with randomly selected residents of six neighborhoods in Salt Lake City (see map). We received responses from 531 residents (an overall response rate of 53%). Characteristics of respondents were similar to census estimates for each neighborhood (and the combined sample is similar to the city as a whole), though the survey somewhat over-represents older, more educated, and home-owning residents.

West High

9th and 9th

Yalecrest

Poplar Grove

Liberty Wells

People's Freeway

Household Water & Lawns

People know how much they spend, but not how much they use

- Around half of Salt Lake City respondents (56%) reported a high familiarity with how much they spend on water each month, but fewer (32%) were familiar with the volume of water they use.
- This varied widely by neighborhood— respondents in Yalecrest and Poplar Grove were most familiar with both cost and volume. Areas with many renters had less familiarity with water spending.

Lawns generally watered by residents, but landlords also important in some neighborhoods

- Overall, 73% of Salt Lake City respondents watered their own lawns; 15% are watered by landlords.
- Nearly all Yalecrest respondents watered their own lawn, compared to half in 9th & 9th and a third in People's Freeway.

Few water during the day

- Most residents (97%) reported watering their lawn mainly in the morning, evening, or at night.

Weather plays a key factor in watering decisions...

- Nearly all of households (86%) said they try to adjust their lawn watering behaviors to the weather.

...but conservation, property values, and time are also considerations.

- About 77% indicated a desire to conserve water was important to their lawn watering decisions.
- Majorities said minimizing time spent watering (60%), maintaining property values (59%), and keeping a regular schedule (56%) were also important considerations.
- Water conservation was a particularly important goal in the West High, Liberty Wells, and Yalecrest neighborhoods.

Dr. Douglas Jackson-Smith, Dr. Courtney Flint, Andrea Armstrong and Taya Carothers, Utah State University. For more information, contact Dr. Douglas Jackson-Smith at 435-797-0582 or doug.jackson-smith@usu.edu

Intellectual Contributions

2014 Household Survey Key Findings

- **PEOPLE = MORE FOCUSED ON INDOOR WATER**
  - *People more focused on indoor water use behaviors; less convinced they can improve outdoor water use (contrary to experts' views)*
- **PLACE MATTERS:**
  - *Perceptions of water supply, water use behaviors, concerns, and policy preferences vary widely by neighborhood and valley*
- **HOUSING TYPE MATTERS:**
  - *Renters and residents of multi-unit dwellings have less control over outdoor landscaping & water use*
- **DEMOGRAPHICS MATTER:**
  - *Gender, Religion, Race/Ethnicity, Socioeconomic Status linked to experiences, perspectives, self-reported behaviors*
- **RECREATIONAL ACTIVITIES MATTER:**
  - *Strong predictor of concern about water quality, other water risks*

Integrating Household Survey with Other Data

- Flooding paper (Hale, Flint, et al.)
  - Many people have been impacted by flooding
  - Yet flooding = lowest level of concern
  - Linked to maps of flood plains & flooding events
  - Results allow us to tease out predictive value of:
    - Objective measures of actual flooding risk
    - Sociodemographic drivers of risk perception (who you are: e.g., religion, race, income)
- Water use data *(from public utilities)*
- Water price data *(from policy work)*
- Proximity to local water bodies

Utah Water Survey (iPad Survey)

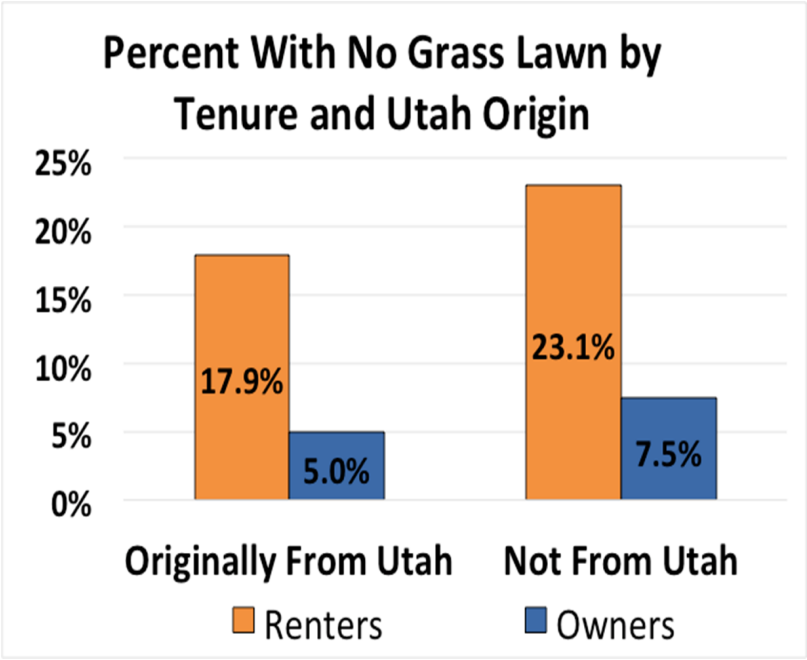
Goal: Statewide poll

- Public Intercept Survey:
  grocery stores selected from diverse urban areas
- Collaborative Success:
  6 universities, 1 High School, dozens of students
- Statewide Coverage
  - 18 stores to date: approached over 10,000 adults
  - 44% response rate: nearly 5,000 observations
- Basis for Survey Data Viewer development (iVL):
  http://django.uwrl.usu.edu/surveydata/

Intellectual Contributions

iPad Survey Key Findings

- Younger people less concerned about water shortages
- People with farm ties much less likely to be concerned about climate change
- People originally from Utah more likely to have a lawn



Broader Impacts

Utah's Water Future

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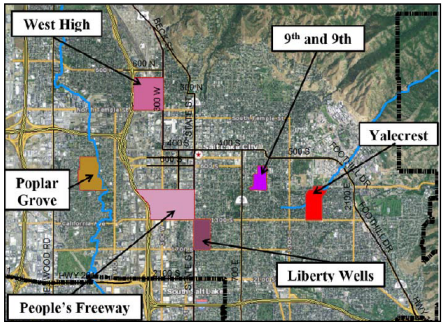

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1

Household Survey Summary Reports disaggregated at the neighborhood level: www.iutaheoscor.org/hhsurvey

Urban typology developed by RFA2 researchers identifies important, disproportionate drivers of water consumption

Survey Data Viewer developed in collaboration with iUTAH CI/iVL:
http://django.uwrl.usu.edu/surveydata/

Methodological developments:

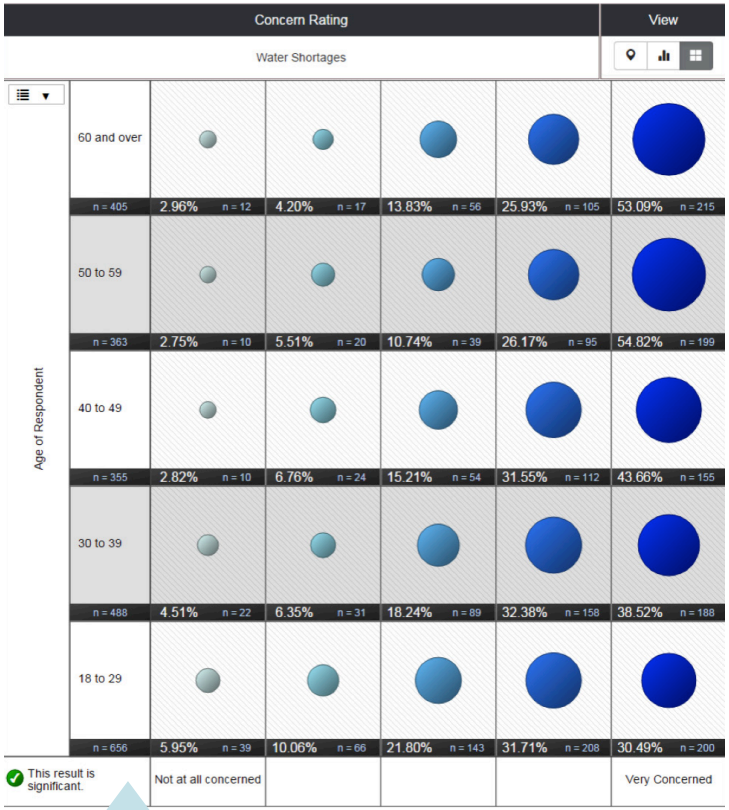
- Survey techniques: drop-off/pick-up surveys, iPad surveys, news media analysis, qualitative public intercept surveys
- Hierarchical statistical analysis techniques
- Data management of social water science

Developed 2 modules for the iUTAH Summer Research Institute in 2014

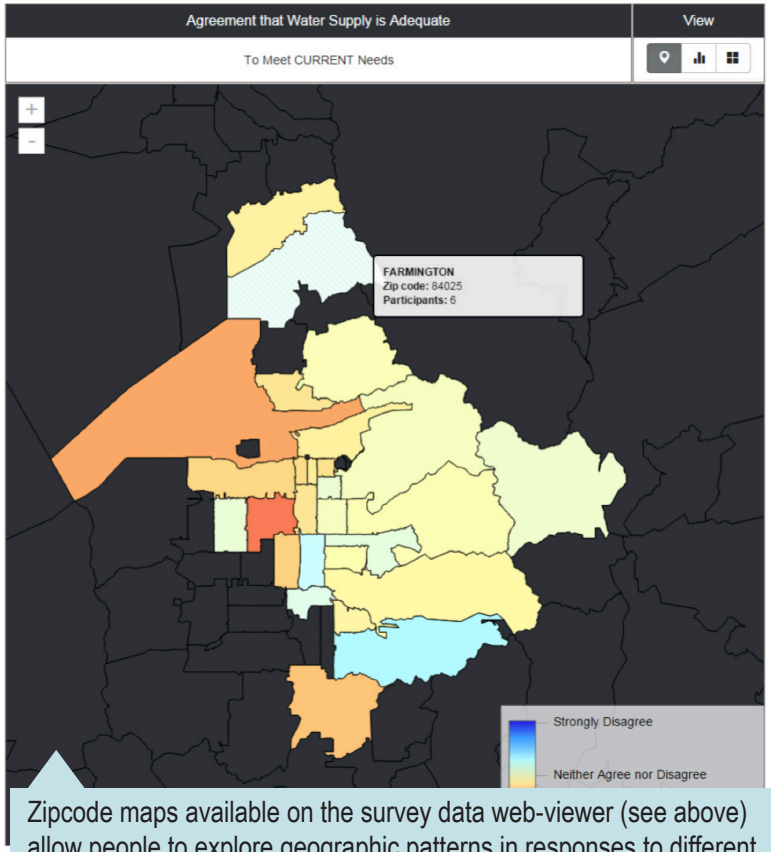
Developed 1 engineering-themed module for the iUTAH Summer Research Institute in 2015

Participated in USU Eastern's Native American Mentorship Program during Summer 2015

Survey Data Viewer



Screenshot of survey data web-viewer showing a crosstabulation of respondent age against concern about water shortages. People over 50 appear to be more concerned than young adults.



Zipcode maps available on the survey data web-viewer (see above) allow people to explore geographic patterns in responses to different questions. Agreement that the current water supply is adequate varies across the Salt Lake Valley.

Summary of Accomplishments

- Infrastructure
- Manuscripts
- Grants
- Recruitment, Training and Professional Development

Plans for Year 4

- Use social science and engineering research to help build integrated systems models w/ RFA3
- Capture biophysical, policy, and other contextual data for study neighborhoods – integrate across scales
- Inform RFA1 data collection and analysis with neighborhood-level social science data
- Analyze data from new urban instrumentation sites
- Complete GIRF facility and integrate with BUGI
- Publish data sets and peer-reviewed manuscripts
- Continue to build collaborative research network across institutions
- Continue to train and mentor graduate and undergraduates
  - Summer Research Institute / iFellows Summer REU

Questions ?

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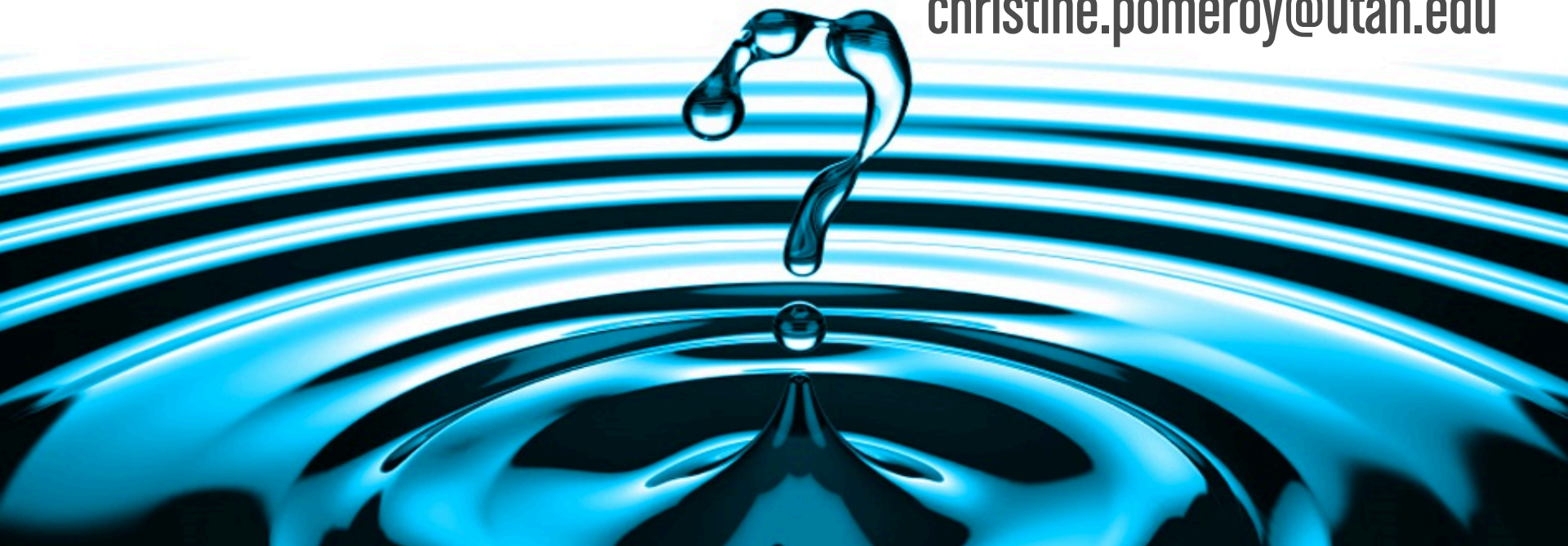
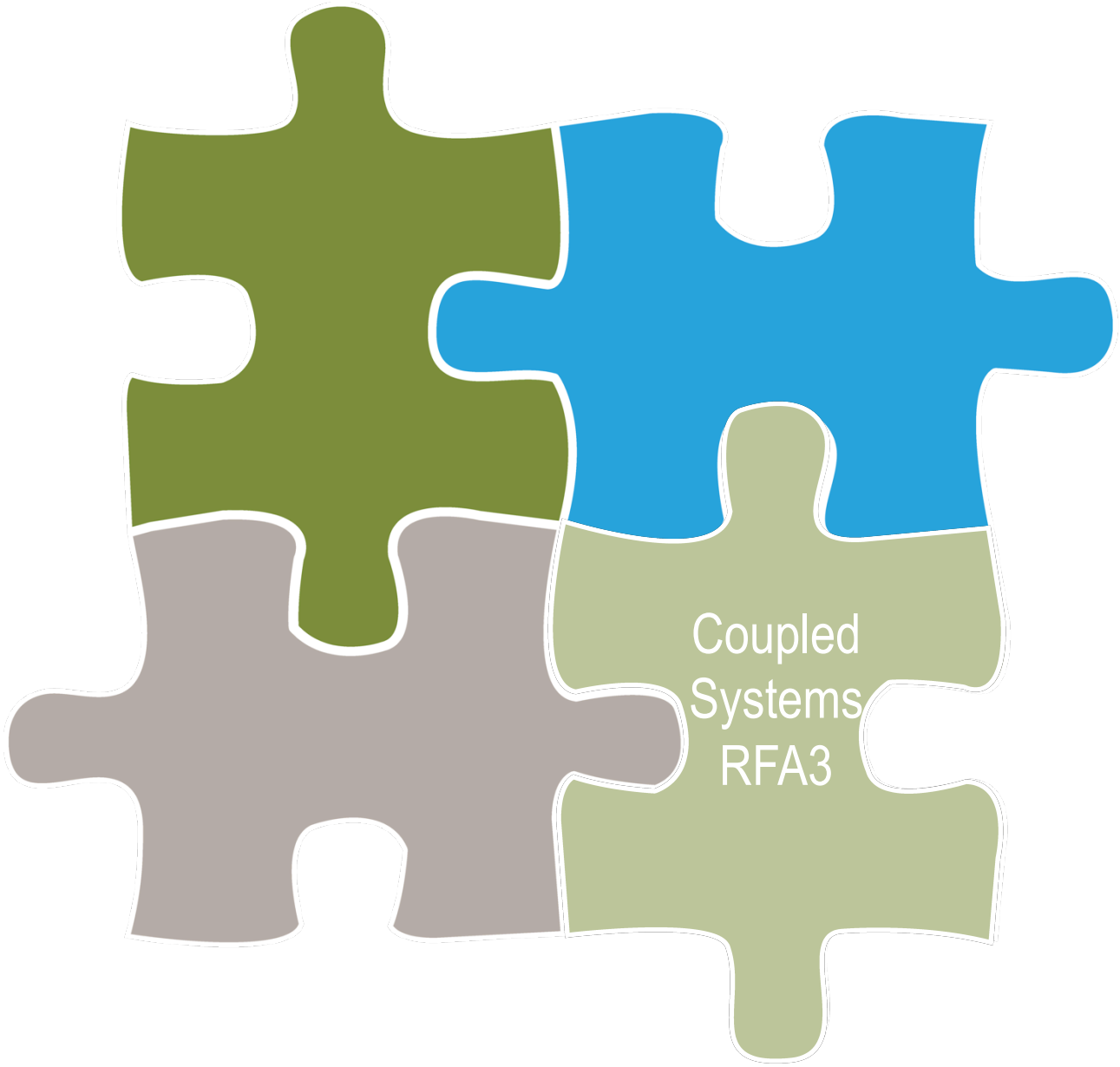
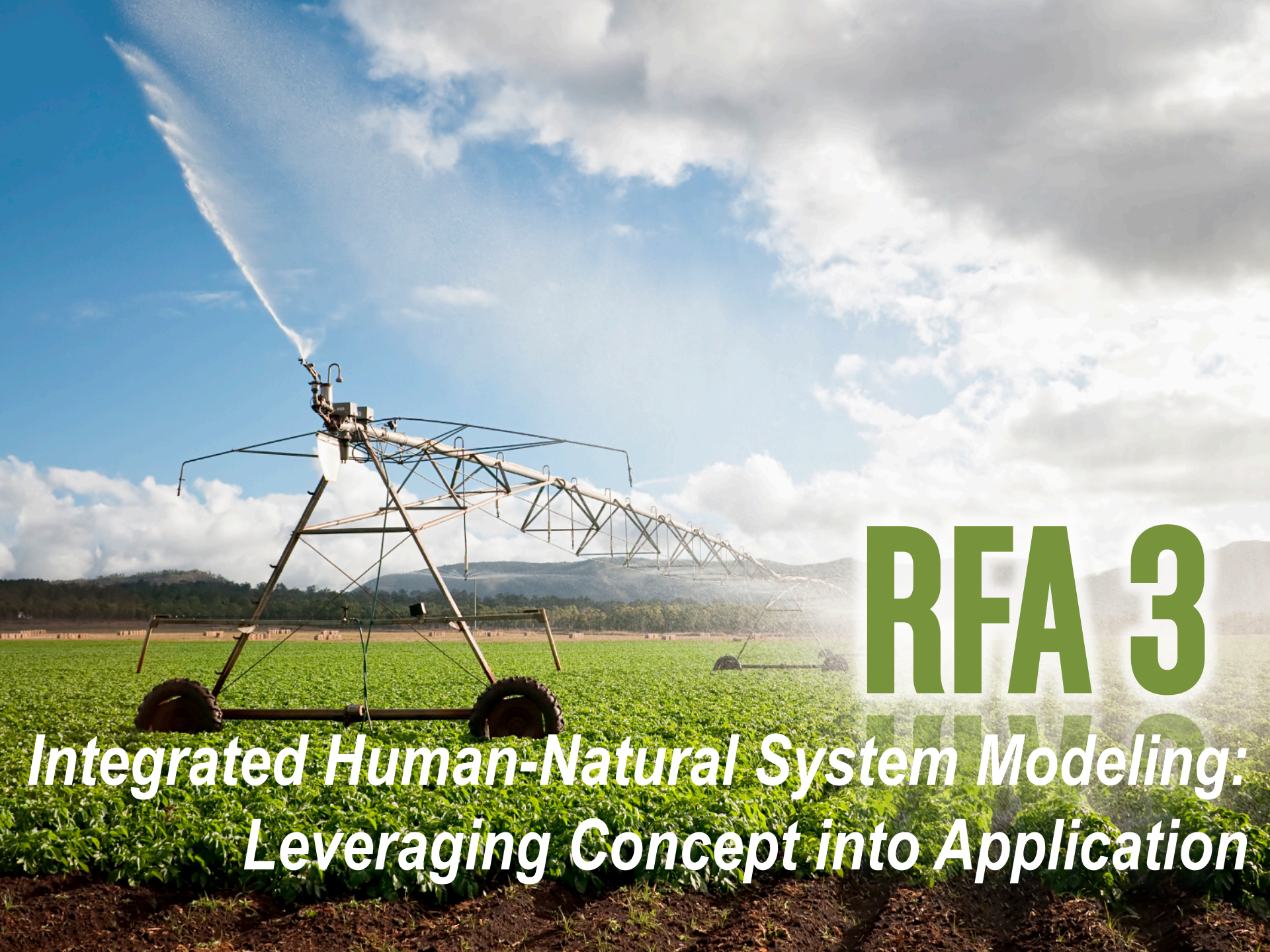



Coupled
Systems
RFA3



RFA 3

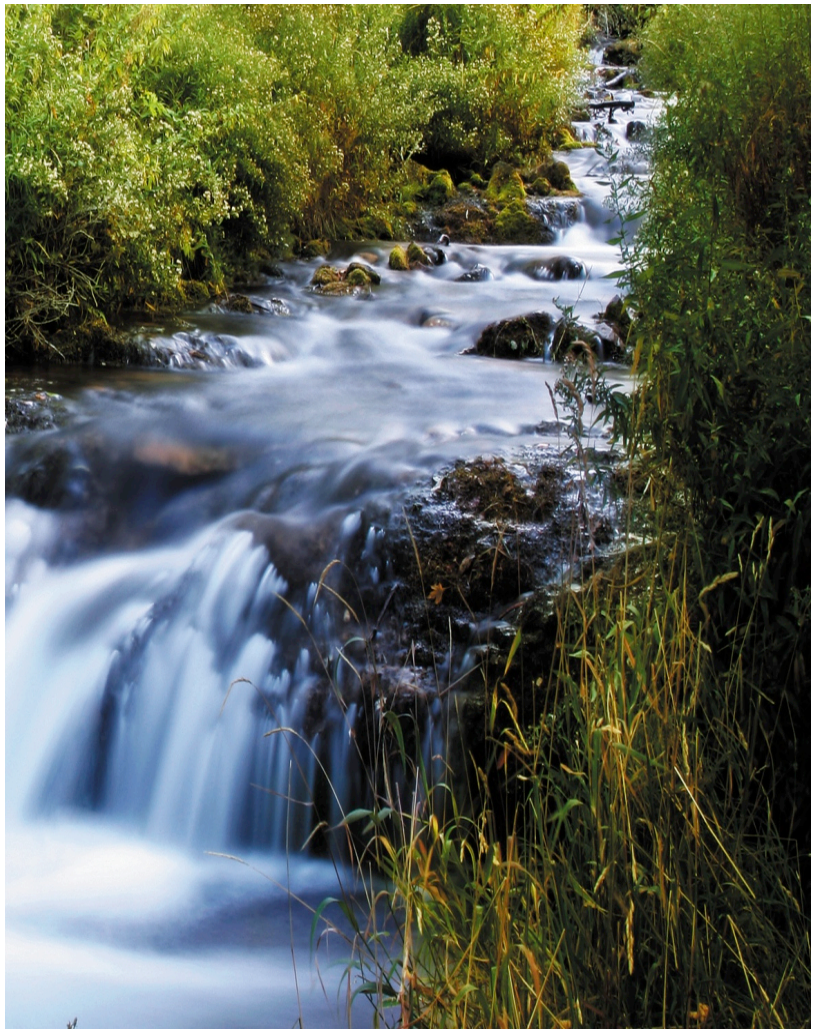
Integrated Human-Natural System Modeling: Leveraging Concept into Application

Core Questions

What are the major social and biophysical processes that control the flows of water and material into and out of the WRMA?

How can specific models representing hydrology, ecology, and human systems be coupled and executed to ensure efficient exchange of inputs and outputs?

How can we best visualize our model and data products to enhance communication among faculty, students, and stakeholders?



Research Goals

Goals

- Describe the water system as a whole by defining and including linkages between biophysical and social dynamics using results from RFAs 1 and 2
- Facilitate interactions with stakeholders and linkages among disparate datasets and models to improve the capacity to study the complexity of local water issues

Milestones

Publish conceptual model and continue model development

Develop technical evaluation of methods for model coupling

Continue model coupling

Entrain stakeholders into Coupled Modeling Workshop series

Develop stakeholder-responsive products

Develop EOD-oriented products

Develop visualization capacity for project-wide applications, web applications, and interactive tools

Milestones

- The iSAW model was published in *Earth's Future* March 2015
- Software development by Castronova and Buahin is ongoing
- Substantial progress in model coupling
- Stakeholder involvement limited to planning stage
- SLC Department of Public Utilities using systems dynamics model of supply and distribution system based on CI water and informed by RFA3 parcel-scale water use model; NHMU kiosk
- iVL at USU is up and running; UU facility is still under development

Coupled Modeling Workshop Series

- 1.5-day workshop held in SLC on 24-25 February 2015
- 21 attendees from USU and UU; faculty and grad students; team members from RFAs 3 and 2 (both social science and engineering)
- Established new intercampus collaborations and task force for pursuit of external funding

Monthly Cross-Campus RFA3 Calls

- In Years 1-2, RFA3 meetings were in-person and campus specific
- In Year 3, monthly RFA3 all-hands teleconferences have facilitated coordination of research and development of proposals
- Statistics: 4 monthly meetings, 50 attendees, 5 inter-campus RFA3 visits, 252 minutes of GTM™ logged

GoToMeeting by CITRIX

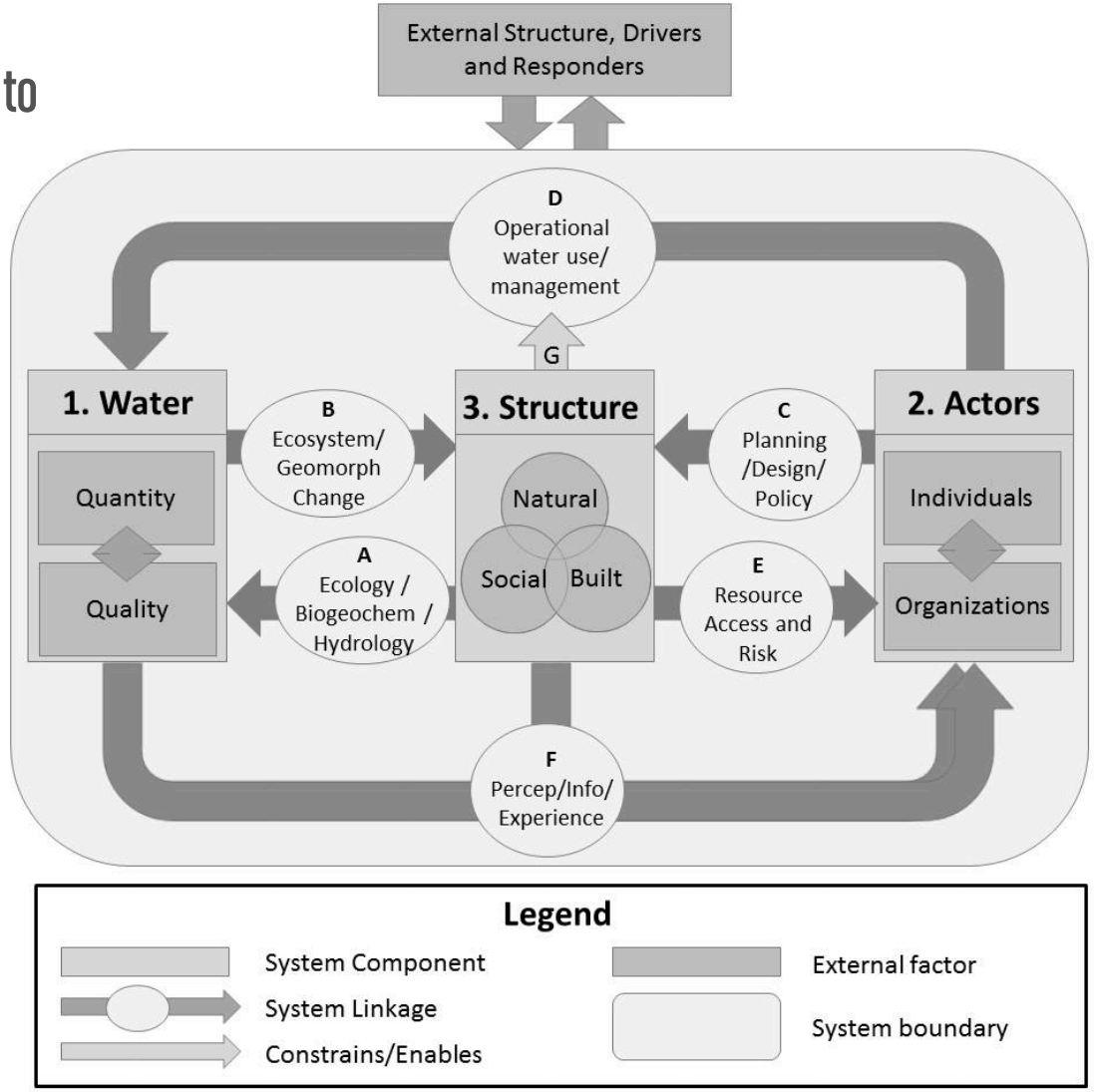
RFA2/RFA3 Liaison
Joanna Endter-Wada
Environment & Society, Watershed Sciences (USU)

Intellectual Contributions

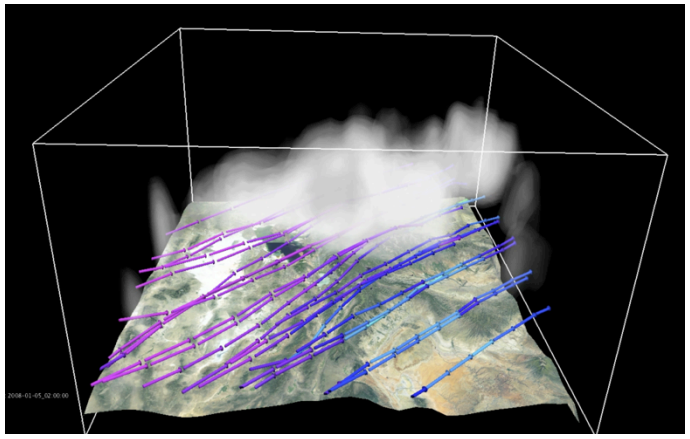
Integrating Structure, Actors, and Water to Study Socio-Hydro-Ecological Systems (iSAW)

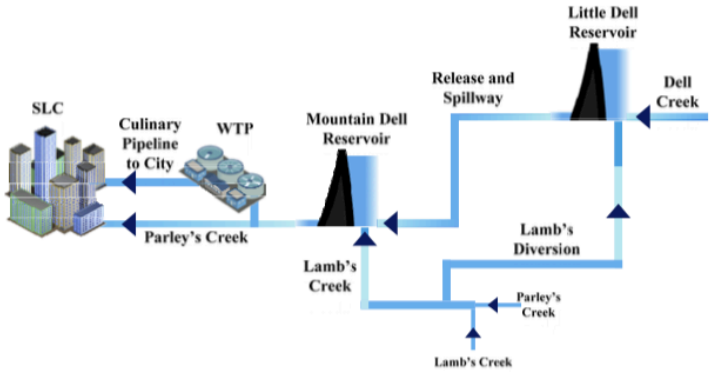
- Point of integration between RFAs 1,2,3
- Collaboration tool:
  - Interdisciplinary research
  - Proposal writing
  - Coupled modeling

(Hale et al. 2015, *Earth's Future*)



Intellectual Contributions





Leveraging models from CI-WATER

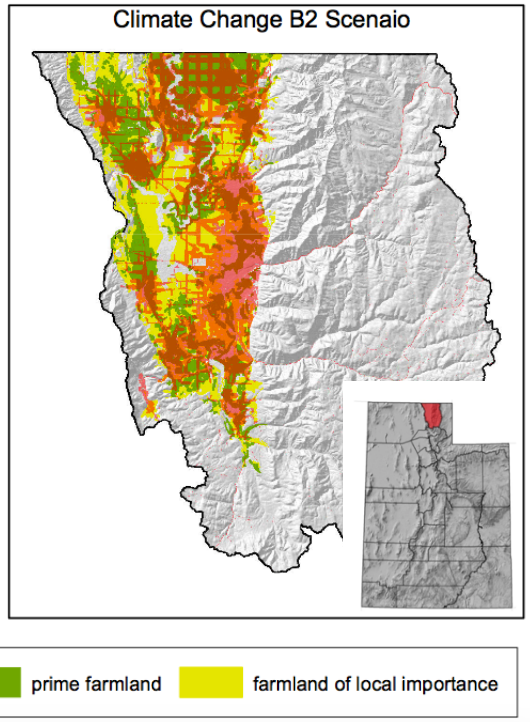
- iUTAH is using high resolution climate model output developed by CI-WATER (Court Strong)
- iUTAH is using the urban water supply model developed by CI-WATER (Erfan Goharian and Steve Burian)

Intellectual Contributions

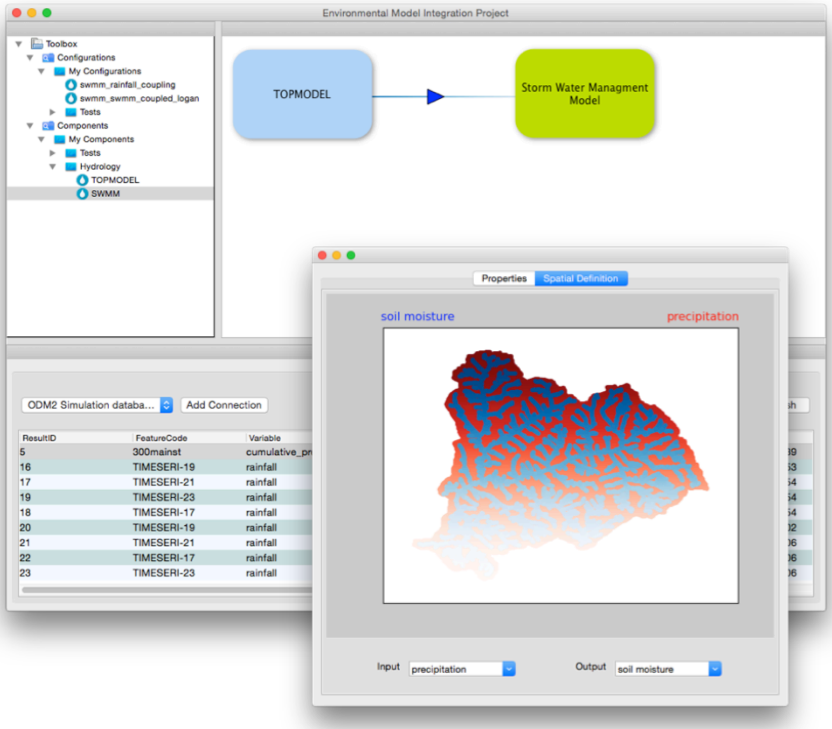
Framework for modeling urban growth including agriculture-to-urban transitions

- Based on a cellular automata model (SLEUTH)
- Basis for simulating future water demand scenarios

Enjie Li
Graduate Student
Environment and Society (USU)



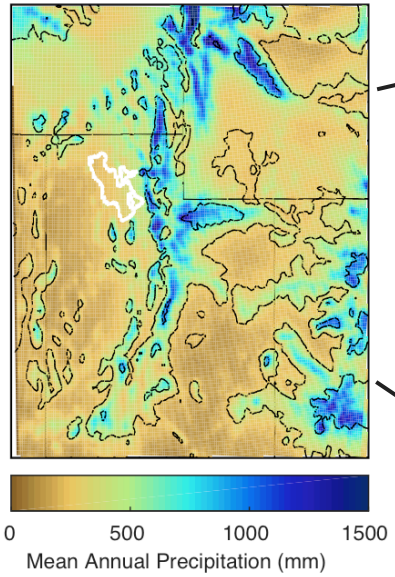
Intellectual Contributions



- Tony Castronova developed a framework that will enable us to couple models written in multiple languages with contrasting spatial and temporal resolutions

Intellectual Contributions

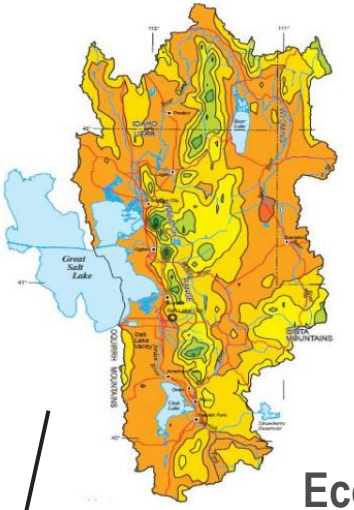
Active sharing of data and models between campuses



High resolution climate modeling (UU, Court Strong)

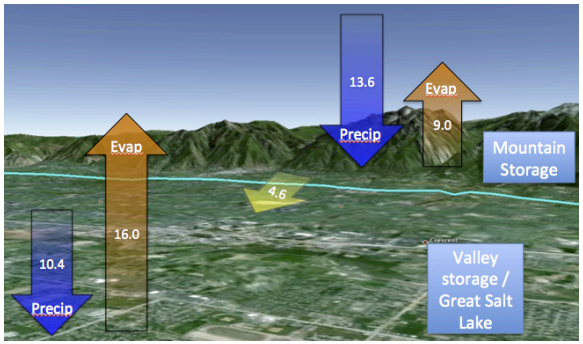
precipitation, temperature, and humidity

precipitation, evaporation, runoff



rainfall runoff

Ecosystem service and rainfall runoff modeling (USU, Sarah Null)



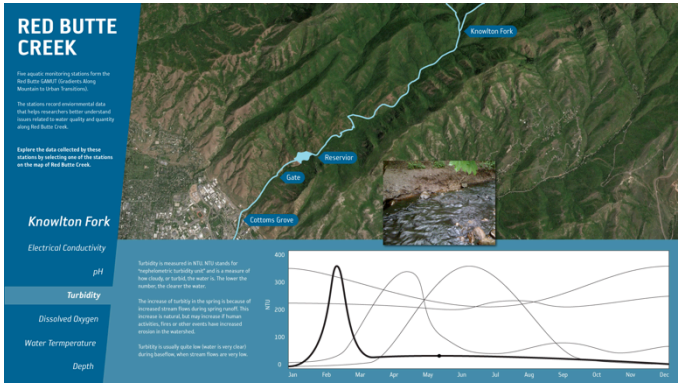
Water balance sensitivity analysis (iUTAH)

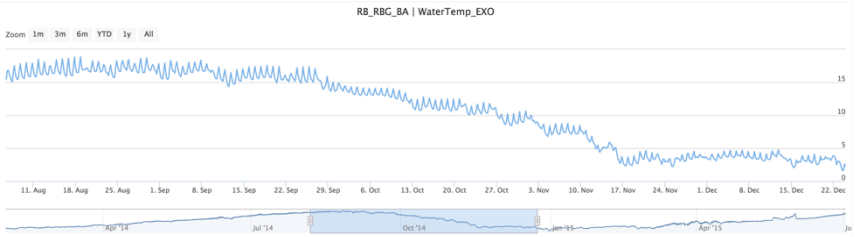
Broader Impacts

- Expanded existing museum partnership with NHMU
- Novel climate modeling has led to multiple invited talks and panel appearances across the state
- Collaboration with critical stakeholders, who supplied data, collaborated on models, or used RFA3 decision tools

NHMU Kiosk (iVL)

- JavaScript web-app running on 42” touch-screen in a main museum concourse with exterior view towards RBC
- Interactive map selects GAMUT station and measured variables, plots time-series and provides interpretive information





Adaptation of NHMU Kiosk for Field Classes

- Web app to run localized on field-systems (tablets and field sensor/data loggers) for field classes around the state

Summary of Accomplishments

- Infrastructure
  - iVL facility at Utah State University up and running; planning for University of Utah facility complete
- Manuscripts: 6 submitted, 2 accepted, 1 published
- Grants: 1 collaborative grant (EPA)
- Recruitment, Training, and Professional Development
  - Recruited one Postdoctoral Associate (**Krishna Khatri**)
  - Recruited three Undergraduate Students for the iFellows Summer REU in 2014
  - Recruited four Undergraduate Students for the iFellows Summer REU in 2015
  - Trained four GRAs across 2 campuses
  - Dr. Rebecca Hale, iUTAH Postdoctoral Associate, accepted a research faculty appointment at Idaho State University, where she will continue her EPSCoR involvement

Plans for Year 4

- Continue ongoing investigations on scaling and computational challenges in coupling models
- Expand capacity to represent and investigate agriculture as an element of the socio-hydro-ecological system
- Complete iVL infrastructure at the University of Utah location
- Provide a leadership role in ongoing efforts to respond to NSF's FY16 INFEWS funding call
- Continue Coupled Modeling Workshop series with expanded stakeholder participation
- Continue to train and mentor graduate and undergraduate students

Questions ?

Court Strong
court.strong@utah.edu

Sarah Null
sarah.null@usu.edu

The iUTAH Socio-Environmental Observatory

Data Collection

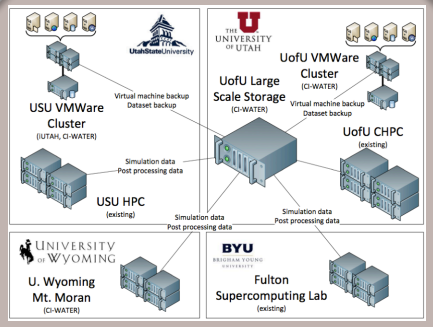
- Surveys
- Interviews
- Neighborhood Typology

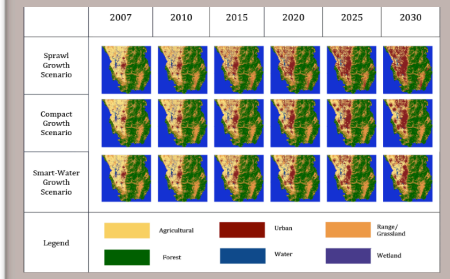
Integrated Observation Networks

- GAMUT
- BUGI
- GIRF

Cyberinfrastructure

- Modeling and Data Federation
- Coupled Modeling
- High Performance Computing
- iUTAH Visualization Lab





Office of Broader Impacts

- Collaborative Research
- Stakeholders
- Outreach
- Workforce Development

The iUTAH Socio-Environmental Observatory

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- Surveys
- Interviews
- Neighborhood Typology

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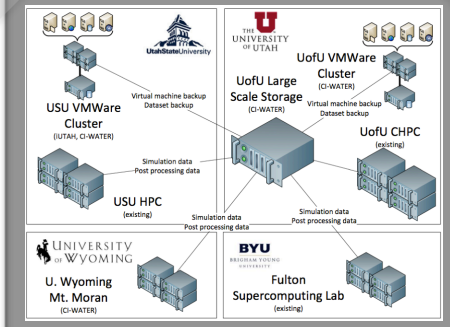
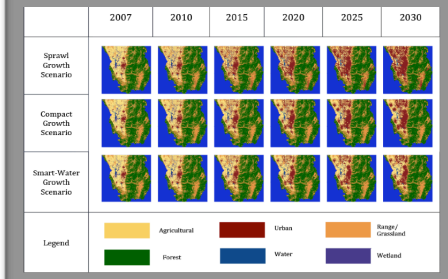




Office of Broader Impacts

- Collaborative Research
- Stakeholders
- Outreach
- Workforce Development

Cyberinfrastructure

Innovative Management, Integration, and Visualization for iUTAH's Data Products and Resources

Research Goals

Goals

- Increase capacity for data collection, organization, management, sharing, and synthesis to higher-level products and increase capacity for integration of data and models

Objectives

Develop infrastructure to support data collection and management activities of iUTAH facilities and researchers

Enable iUTAH researchers to share and access data using standard formats, protocols, and services

Support iUTAH participants in discovering and accessing iUTAH and relevant external data

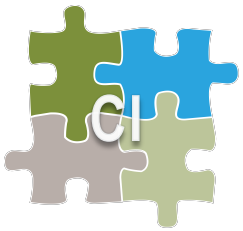
Support iUTAH researchers in identifying and prioritizing modeling needs, models to be used, and access to computational resources

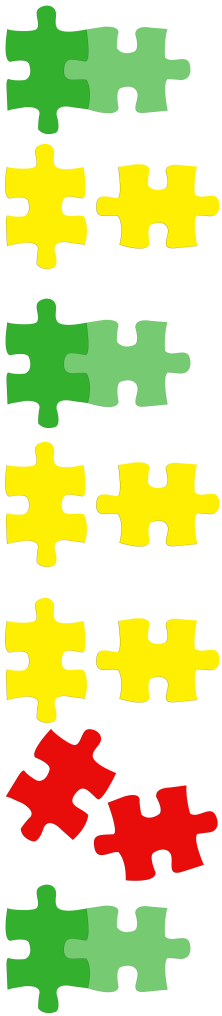
Provide online resources for citizens, K-12, undergraduate, and graduate students throughout Utah

Milestones

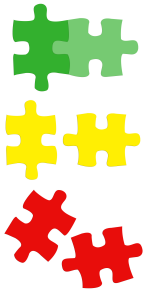
- GAMUT datasets discoverable and accessible through MDF
- External datasets discoverable and accessible through MDF
- Initial release of collaborative functionality for publication, archival and sharing of iUTAH datasets
- Initial release of collaborative model sharing tool
- Deploy databases and software to support GIRF data
- Deploy DataONE member node
- Add storage to virtualization infrastructure

Milestones

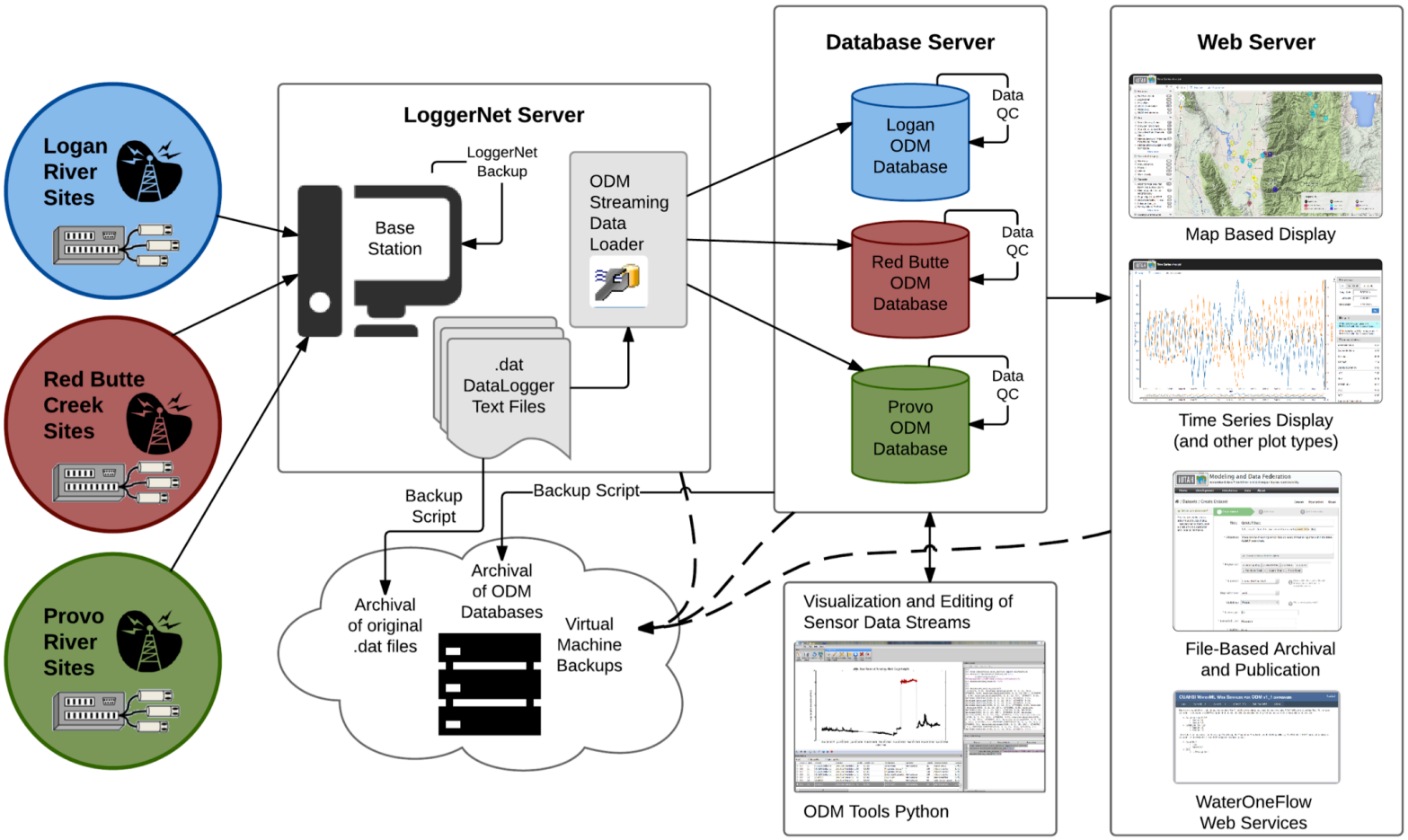




- Raw GAMUT data published and updated daily; faceted discovery and browsing implemented; GAMUT published with CUAHSI HIS
- USGS flow data and CUWCD flow/reservoir release data accessible; SNOTEL data not yet online
- Functionality for user deposition of datasets fully implemented in the iUTAH data repository
- Collaborative model sharing work is ongoing, with working software produced
- Urban stormwater sites have been incorporated into GAMUT database and workflow; databases that support RFA1 biweekly sampling ready to be adapted for use by BUGI
- DataONE may not be the most feasible solution from a long-term sustainability perspective; CI is exploring alternatives
- Three new virtualization host servers and 20 TB of new disk storage have been added

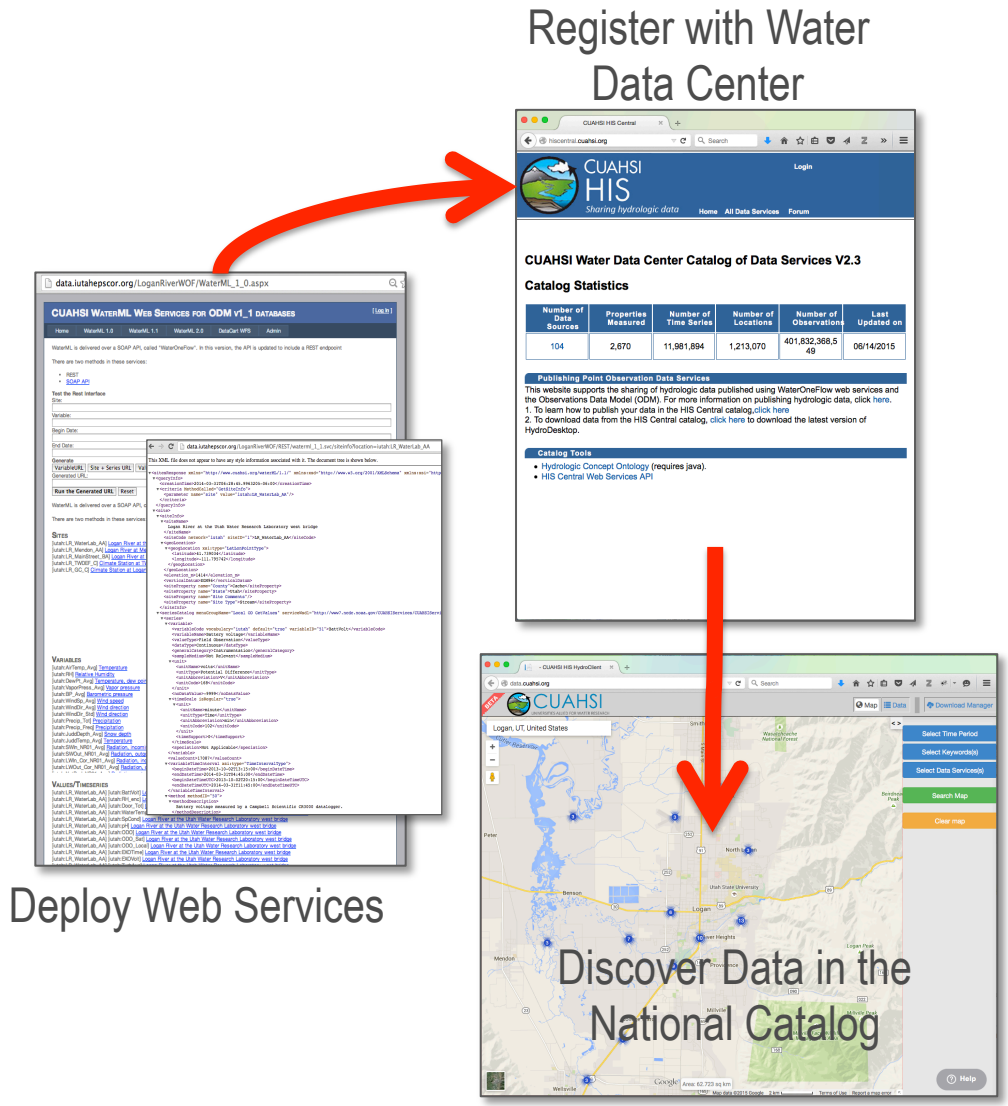


Formalized GAMUT Data Workflow



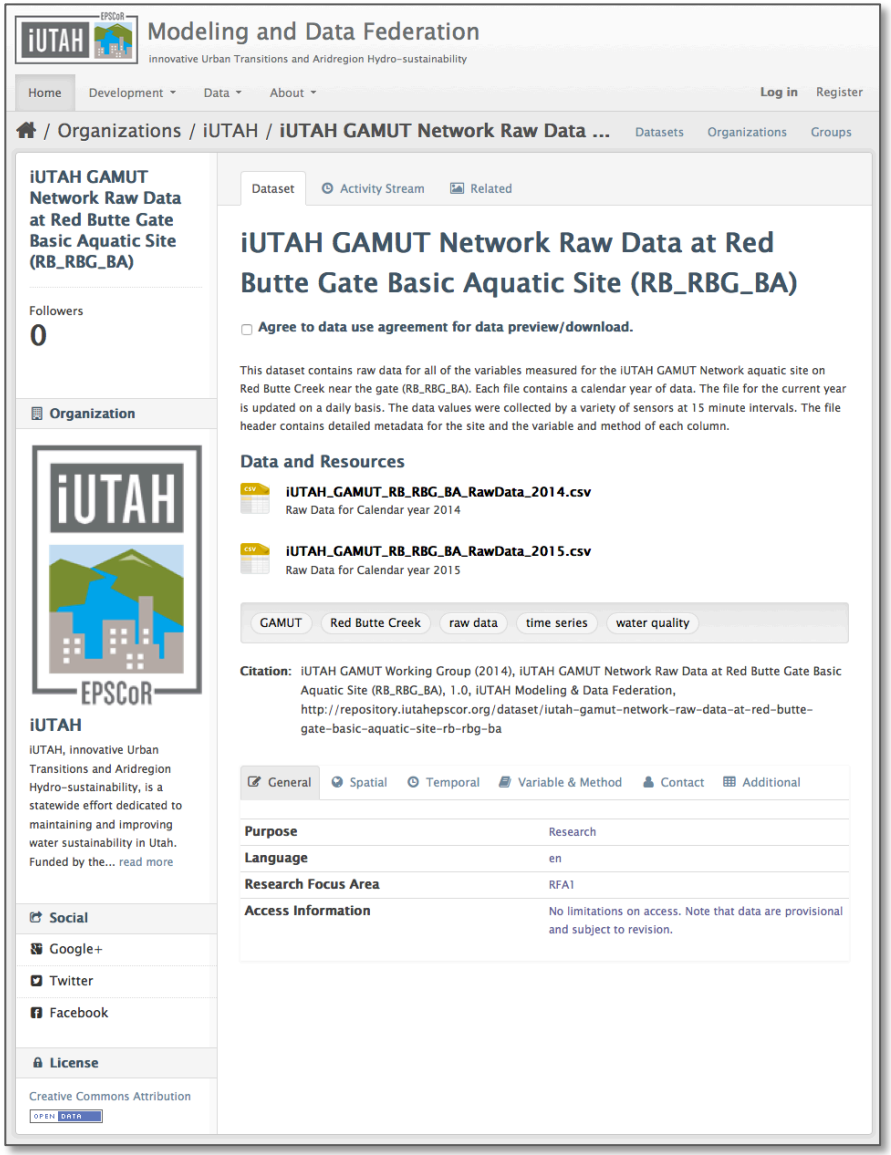
CUAHSI HIS Web Services for GAMUT

- Established CUAHSI HIS web services for GAMUT databases
- Registered with the CUAHSI Water Data Center
- Data are searchable using HydroDesktop and the new CUAHSI HIS web client



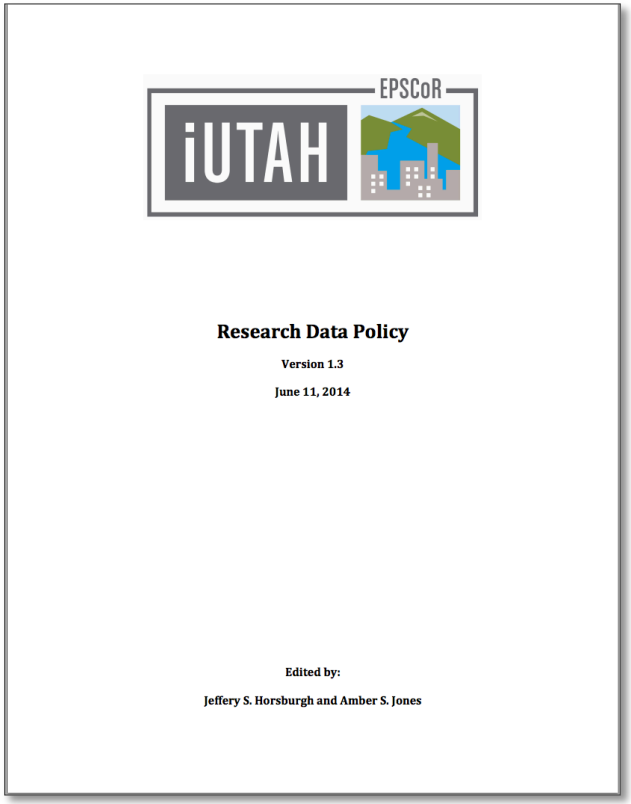
Automated Archival of Raw GAMUT Data

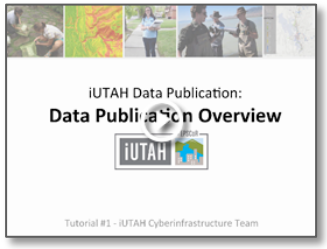
- RFA1 investigators wanted easy file-based access to the GAMUT data
- We automated publication to the iUTAH data Repository
- Data are “chunked” yearly and the current year is updated daily



Data Policy, Publication and Training

- Policy fully implemented after Year 3 modifications
- Data collection plans are submitted, reviewed, approved, etc.
- Data publication system running —a number of datasets and metadata records submitted
- Developed video tutorials to train on iUTAH data management and publication

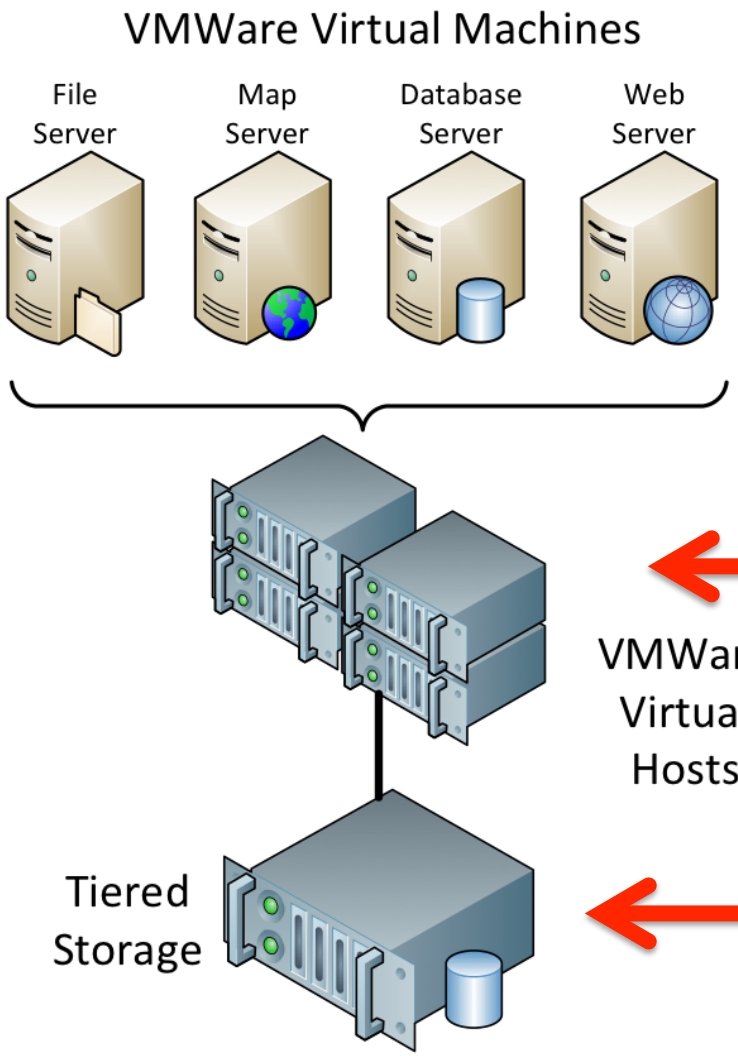




Support for New Monitoring Sites Coming Online

- Storm drain sites
- New GAMUT sites
- Sapflux sites
- Canal sites

Hardware Upgrades



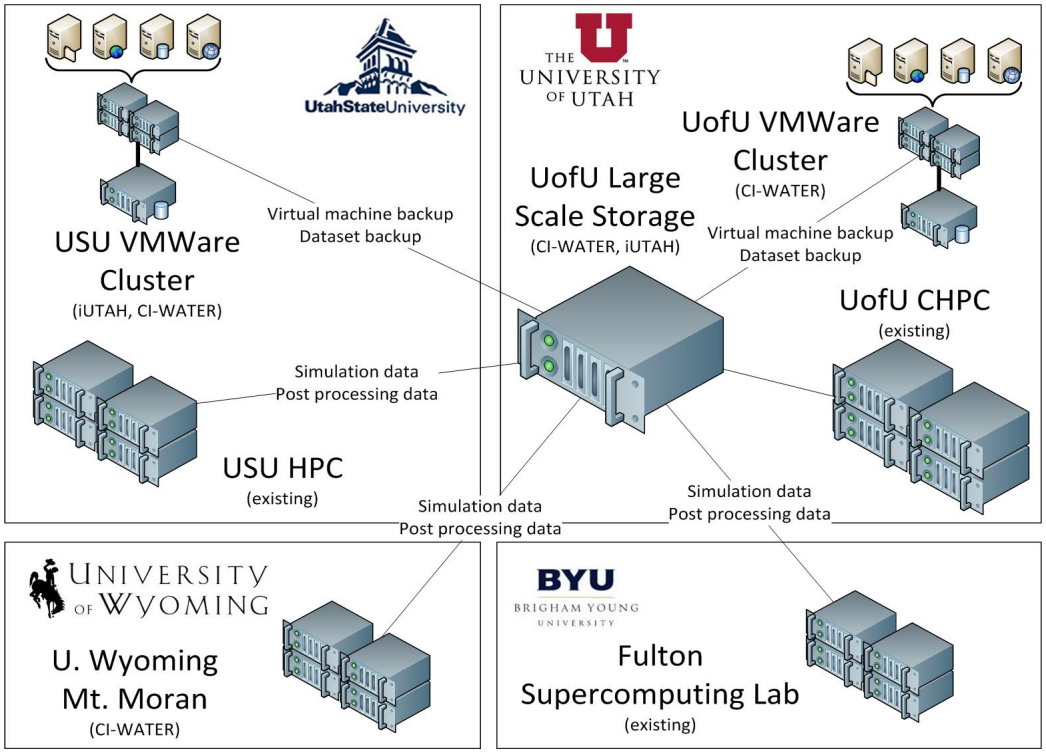
Services and applications hosted by the iUTAH Modeling and Data Federation are all virtualized.

In collaboration with CI-WATER doubled the number of virtual hosts (6)

Increased capacity of virtualization storage by 20TB

iUTAH CI is . . .

iUTAH CI is . . .



. . . a cross-institutional effort, delivering innovative data management, integration, and visualization tools to iUTAH users across RFAs and beyond.

iUTAH CI is . . .

. . . an innovative and highly productive scientific enterprise.

Environ Monit Assess (2015) 187:348
DOI 10.1007/s10661-015-4594-3

A data management and publication workflow for a large-scale, heterogeneous sensor network

Amber Spackman Jones · Jeffery S. Horsburgh · Stephanie L. Reeder · Maurier Ramirez · Juan Caraballo

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Evaluating the Simulation Times and Mass Balance Errors of Component-Based Models: An Application of OpenMI 2.0 to an Urban Stormwater System

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Jeffery S. Horsburgh, Department of Civil and Environmental Engineering and Utah Water Research Laboratory, Utah State University, Logan, Utah, USA

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Open source software for visualization and quality control of continuous hydrologic and water quality sensor data

Jeffery S. Horsburgh [a,*], Stephanie L. Reeder [b], Amber Spackman Jones [b], Jacob Meline [b]

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ABSTRACT

It is common for *in situ* hydrologic and water quality data to be collected at high frequencies and for extended durations. These data streams, which may also be collected across many monitoring sites require infrastructure for data storage and management. The Observations Data Model (ODM), which is part of the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS), was developed as a standard data model in which to organize, store, and describe point observations data. In this paper we describe ODM Tools Python, an open source software application that allows users to query and export, visualize, and perform quality control post processing on time series of environmental observations data stored in an ODM database using automated Python scripting that records the corrections and adjustments made to data series in the quality control process and ensures data editing steps are traceable and reproducible.

Software availability

Name of software: ODM Tools Python
Developers: Jeffery S. Horsburgh, Stephanie L. Reeder, Amber Spackman Jones, Jacob Meline, and James Patton
Contact: jeff.horsburgh@usu.edu
Year first available: 2014
Hardware required: A personal computer
Software required: Microsoft Windows, Mac OSX, or Linux operating system
Software availability: All source code, installers, example ODM databases, and documentation for the ODM Tools Python software application can be accessed at https://github.com/UCHICJODMToolsPython.
Cost: Free. Software and source code are released under the New Berkeley Software Distribution (BSD) License, which allows for liberal reuse of the software and code.

1. Introduction

Environmental monitoring with *in situ* environmental sensors presents many challenges for data management, particularly for large-scale networks consisting of multiple sites, sensors, and personnel. Over the past decade, there has been a drastic increase in the use of automated data collection in scientific research. The high frequency, extended duration, and spatial distribution of data collection efforts require cyberinfrastructure to support and facilitate research using sensor data streams. Researchers and practitioners need tools for data import and storage as well as data access and management. In addition to addressing the challenges presented by managing the sheer quantity of data, monitoring network managers need practices to ensure high data quality, including standard procedures and software tools for data post processing and quality control.

In this paper we describe a workflow for scripted quality control editing of continuous, *in situ* time series datasets and the architecture and functionality of an open source software tool called ODM Tools Python that implements this workflow. ODM Tools Python enables users to query and export, visualize, and edit time

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http://dx.doi.org/10.1016/j.envsoft.2015.04.002
1364-8152/

Intellectual Contributions

GAMUT Data Workflow

- Hardware and software cyberinfrastructure workflow used for managing GAMUT data
- Focused on describing how others could implement
- Undergraduate Student co-authors

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Abstract It is common for hydrology researchers to collect data using in situ sensors at high frequencies, for extended durations, and with spatial distributions that produce data volumes requiring infrastructure for data storage, management, and sharing. The availability and utility of these data in addressing scientific questions related to water availability, water quality, and natural disasters relies on effective cyberinfrastructure that facilitates transformation of raw sensor data into usable data products. It also depends on the ability of researchers to share and access the data in useable formats. In this paper, we describe a data management and publication workflow and software tools for research groups and sites conducting long-term monitoring using in situ sensors. Functionality includes the ability to track monitoring equipment inventory and events related to field maintenance. Linking this information to the observational data is imperative in ensuring the quality of sensor-based data products. We present these tools in the context of a case study for the innovative Urban Transitions and Aridregion Hydrosustainability (iUTAH) sensor network. The iUTAH monitoring network includes sensors at aquatic and terrestrial sites for continuous monitoring of common meteorological variables, snow accumulation and melt, soil moisture, surface water flow, and surface water quality. We present the overall workflow we have developed for effectively transferring data from field monitoring sites to ultimate end-users and describe the software tools we have deployed for storing, managing, and sharing the sensor data. These tools are all open source and available for others to use.

Keywords Cyberinfrastructure · Sensor · Quality control · Data management · Hydrology · Data models · Observatory

Introduction

Advances in the development of in situ environmental sensors have led to the ubiquitous use of sensors and sensor networks in environmental monitoring (Martinez et al. 2004; Hart and Martinez 2006; Rundel et al. 2009). Researchers and practitioners are collecting data with in situ sensors at high frequencies, for extended durations, and with spatial distributions that generate volumes of data for which the deployment of cyberinfrastructure (CI) for data management is necessary. Additional challenges are presented by networks that consist of multiple data collection sites, sensors, and personnel (Rüegg et al. 2014). Consistency in data management across these factors can facilitate data integration.

CI integrates computing hardware, digitally enabled sensors, data observatories and experimental facilities,

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Software for Sensor Data Management

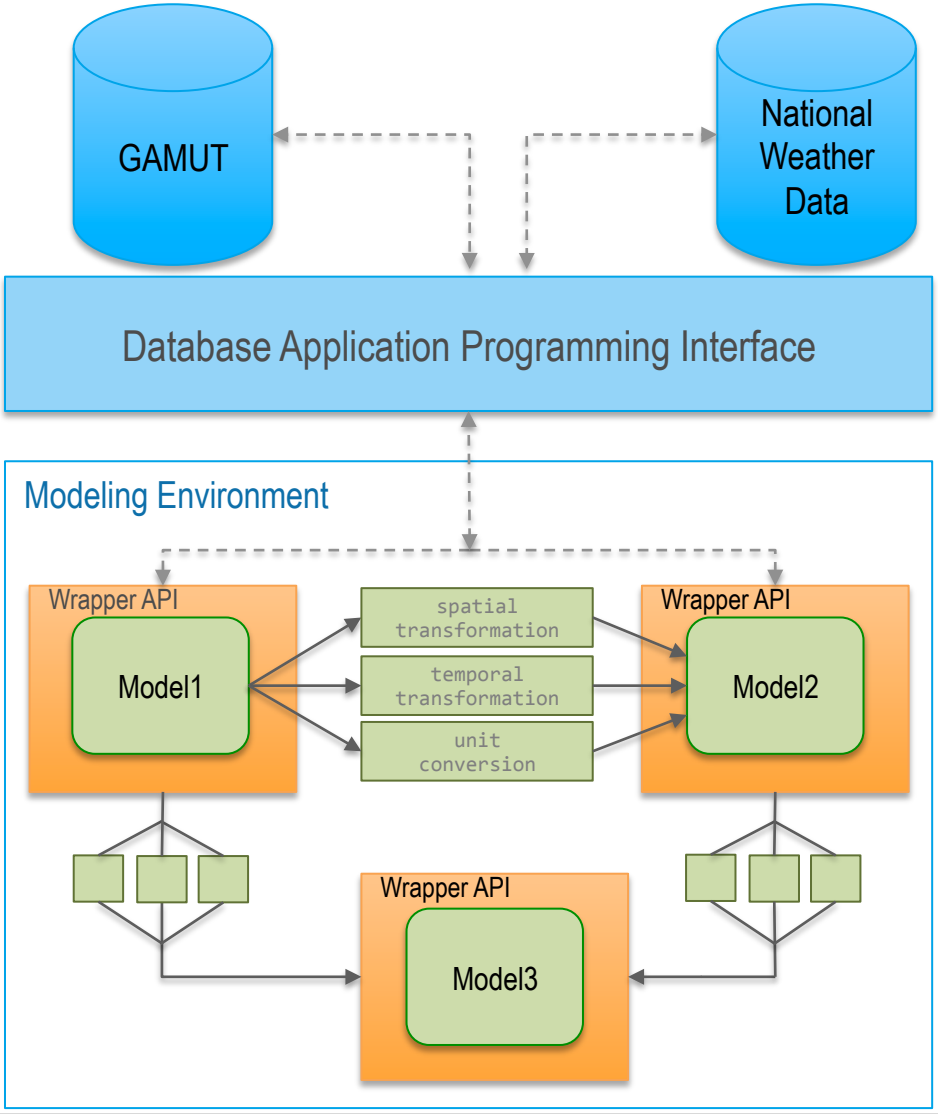
- Scripted and reproducible QC of sensor data streams
- Integrated with CUAHSI HIS
- Open source
- Cross platform
- Undergraduate Student co-author

Horsburgh, J. S., S. L. Reeder, A. Spackman Jones, J. Meline (2015). Open source software for visualization and quality control of continuous hydrologic and water quality sensor data, *Environmental Modelling & Software*, 70, 32-44, doi:10.1016/j.envsoft.2015.04.002.

Intellectual Contributions

Software for Coupling Environmental Models

- Extend existing coupled modeling architectures to engage a broad audience of modelers
- Design software wrappers to facilitate the transfer and ingestion of data between models in a generic manner
- Develop code that does not obstruct the functionality of legacy and newly developed software models
- Automatic transformation of temporally and spatially misaligned data between coupled models during simulations
- Access to environmental data (e.g. GAMUT) and server-side simulation results (e.g. NetCDF)
- Maintain platform independent software to appeal to a diverse audience of modelers and models



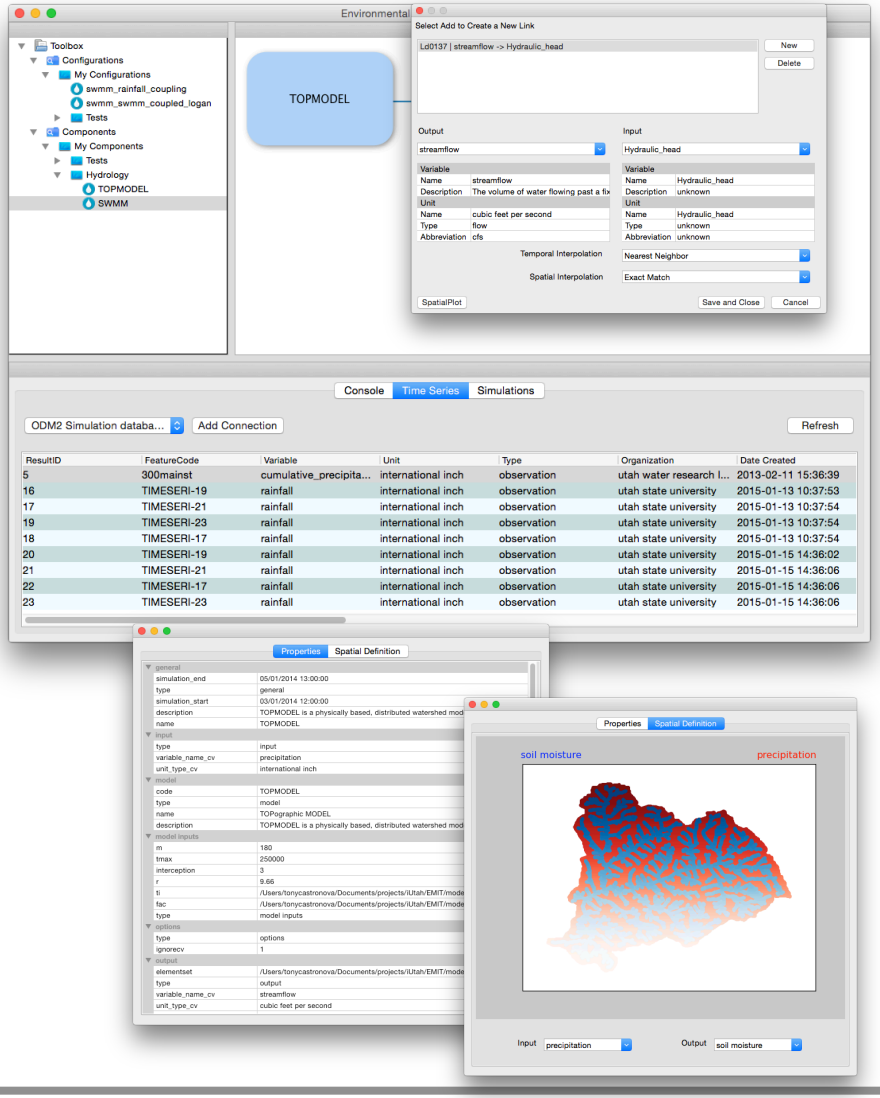
Intellectual Contributions

Software to Facilitate Model Coupling

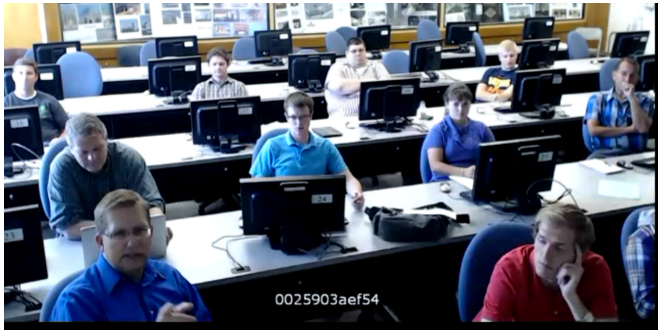
- Provide a intuitive entry point to the coupled modeling API to facilitate model coupling and sharing
- Provide tools to lower the learning curve for creating coupled modeling workflows
- Engage iUTAH scientists to collaboratively develop the next generation of coupled environmental models

Key Features

- Graphical workflow builder
- Database integration provides easy access to environmental sensor data
- Simulation result storage in server-side databases to provide archival and sharing
- Spatial and temporal results visualization
- Metadata display and edit capabilities



Broader Impacts



Expanded collaboratively taught Hydroinformatics graduate course from 4 to 6 participating institutions

Contributed open source software to numerous repositories

Survey Data Viewer developed in collaboration with RFA2/iVL:

http://data.iutahepscor.org/surveys/

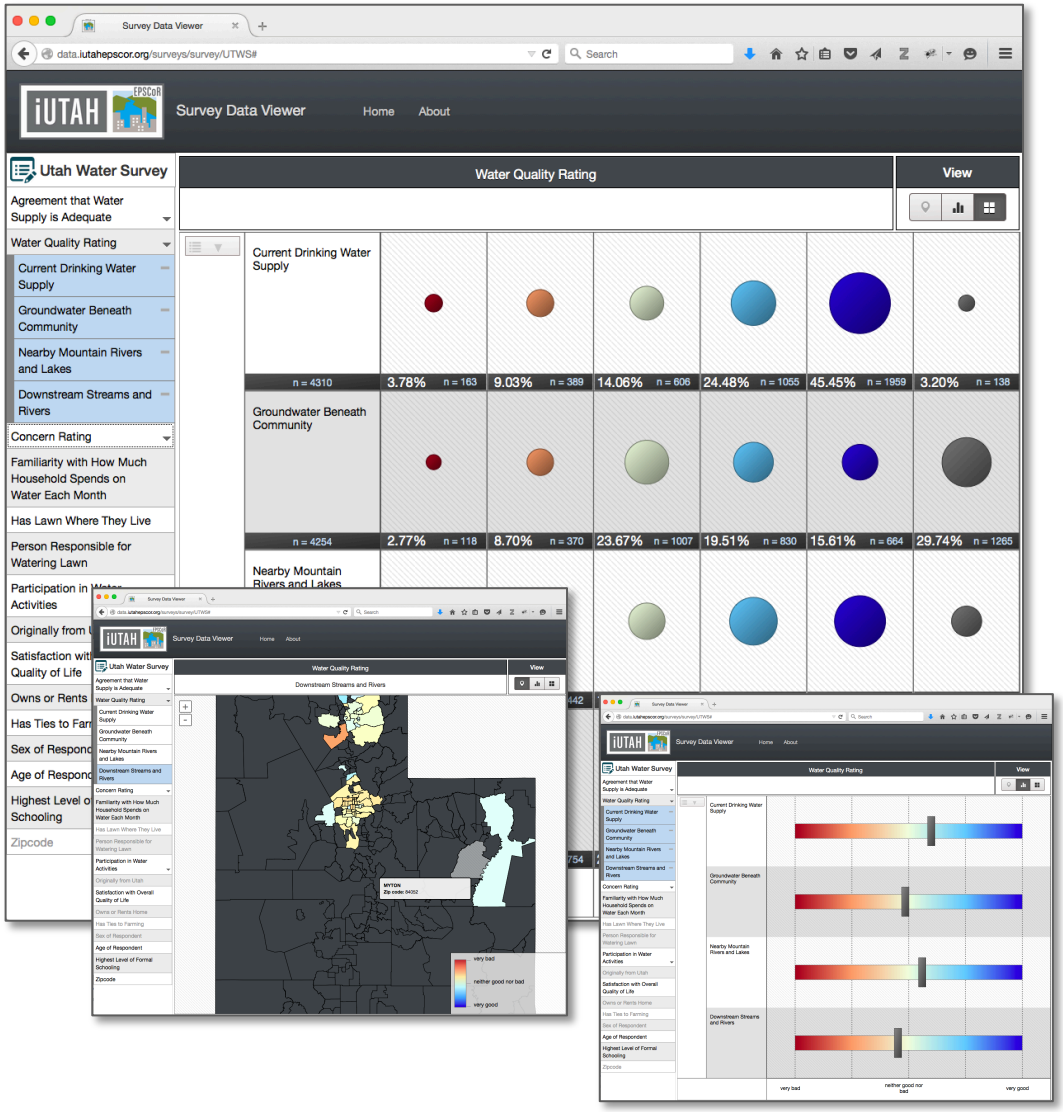
Methodological developments:

- Management of social water science data
- QA/QC of sensor data
- GAMUT data workflow

Visualizing Social Science Survey Results

- Visualization of public intercept survey results
- Generic and reusable survey template
- Open source code

http://data.iutahepscor.org/surveys/

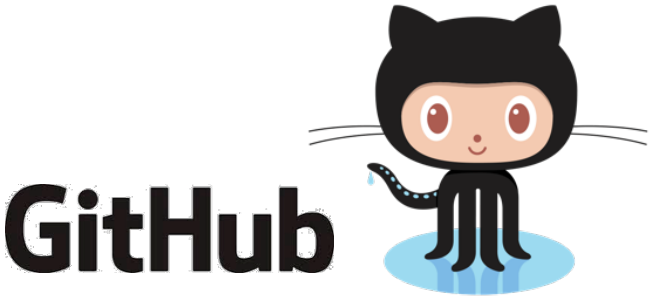


iUTAH Datasets Published Online and Publicly Available

- Individual dataset landing pages
- Browseable and searchable
- Citable

Open Source Code Repositories

- **WEBTSA** – GAMUT time series data visualization
  - https://github.com/UCHIC/WEBTSA
- **ODM Streaming Data Loader**
  - https://github.com/ODM2/ODM2StreamingDataLoader
- **ODM Tools Python** – Sensor data management and QC
  - https://github.com/UCHIC/ODMToolsPython
- **ODM2 Sensor** – Sensor equipment management
  - https://github.com/UCHIC/ODM2Sensor
- **iUTAH Utilities** – Automated alerts, etc.
  - https://github.com/UCHIC/iUtahUtilities
- iUTAH Survey Data Viewer – Visualization of survey data
  - https://github.com/UCHIC/SurveyDataViewer
- **iUTAH Data** – Modeling and Data Federation Website
  - https://github.com/UCHIC/iUTAHData



Hydroinformatics Course

Creating the Next Generation of "Cyber-savvy" Engineers and Scientists

- Expanded in 2014 to 5 partner universities
- 45 students total across the campuses
- Will be offered at USU, BYU, and U of U again this fall

"I'm learning so many new techniques that will be incredibly helpful in my research. I never knew about data management plans and while they are tedious, they are so helpful once they're implemented. I also have only ever dabbled in SQL up to this point and now I find myself using it more often than not."

"My team used basic concepts from almost every class period and topic section in our term project. It was cool to see how all the individual skills added up to help us create and maintain hydrologic information."

"I have enjoyed the distance learning with multiple professors and input from other students."

Summary of Accomplishments

- Infrastructure
  - Increased virtualization server capacity (3 new host servers)
  - Increased storage infrastructure (+ 20 TB)
- Manuscripts: 5 submitted, 1 accepted, 2 published
- Recruitment, Training, and Professional Development
  - Trained one GRA
  - Trained and mentored five Undergraduate Student programmers in the development of software and hardware cyberinfrastructure
  - Collaborated in the development of data management best practices and techniques
  - Offered Hydroinformatics graduate course in collaboration with 5 partner institutions and an enrollment of 45 students

Plans for Year 4

- Identify needs and build infrastructure in support of BUGI
- Add new features to GAMUT QA/QC software in collaboration with watershed technicians
- Implement data management/publication workflows for sample-based datasets
- Implement new release of the field equipment management database and website
- Continue development of coupled modeling software and scenarios
- Continue interaction and collaboration with iVL

Questions ?

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The iUTAH Socio-Environmental Observatory

Data Collection

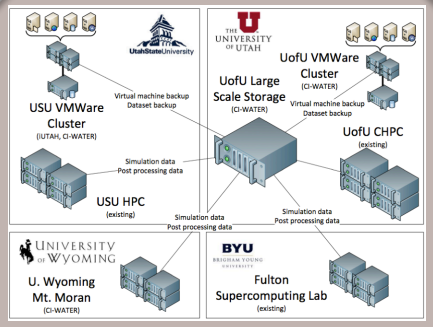
- Surveys
- Interviews
- Neighborhood Typology

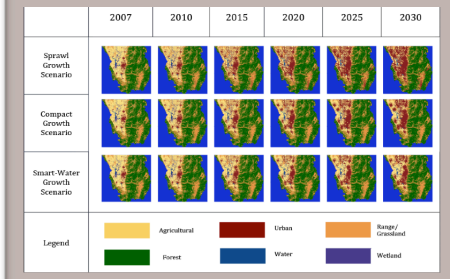
Integrated Observation Networks

- GAMUT
- BUGI
- GIRF

Cyberinfrastructure

- Modeling and Data Federation
- Coupled Modeling
- High Performance Computing
- iUTAH Visualization Lab





Office of Broader Impacts

- Collaborative Research
- Stakeholders
- Outreach
- Workforce Development

The iUTAH Socio-Environmental Observatory

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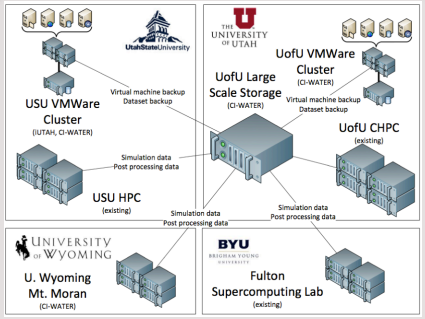

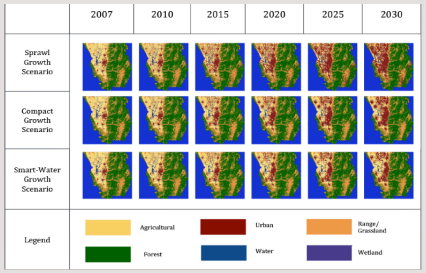

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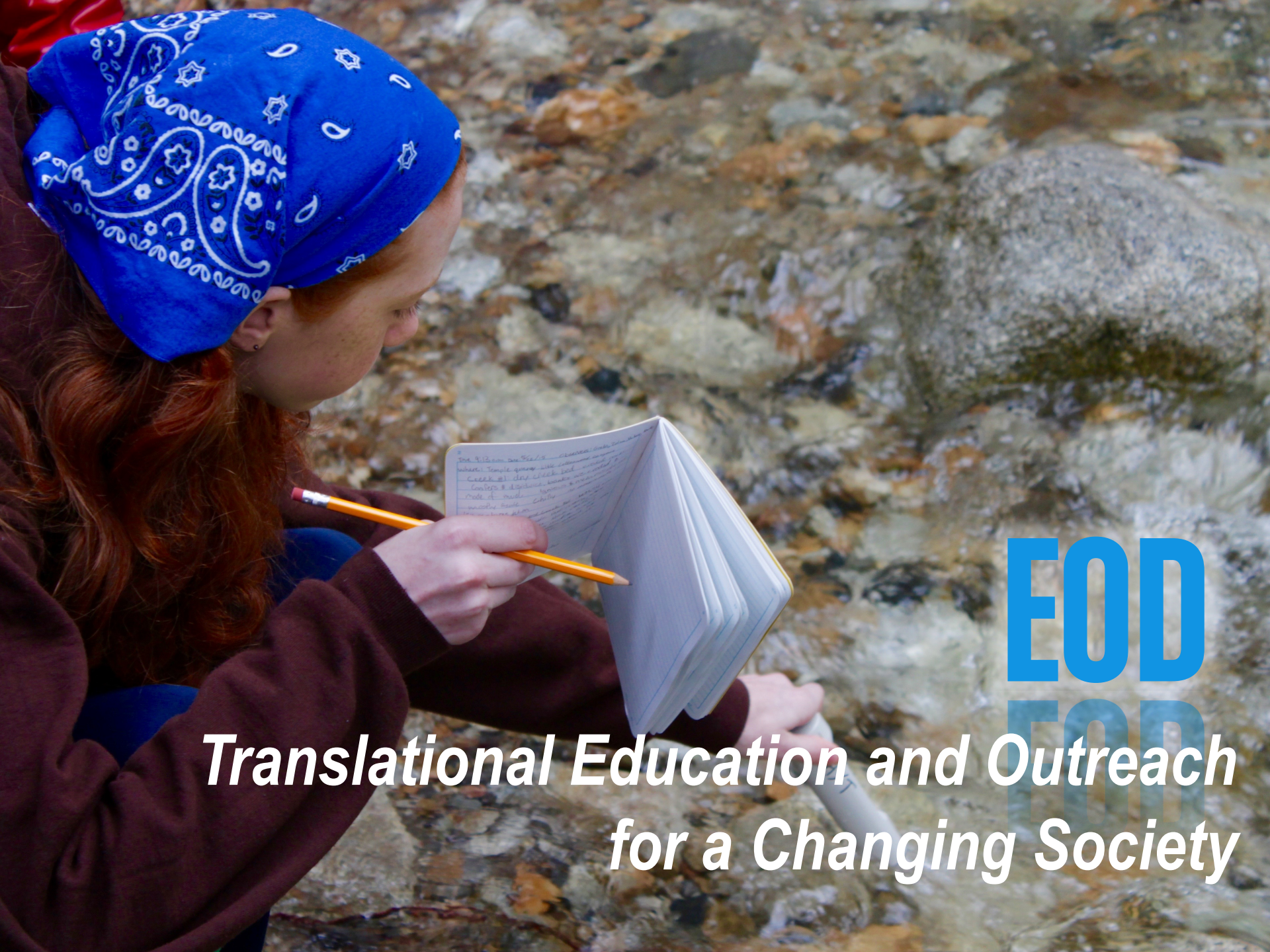
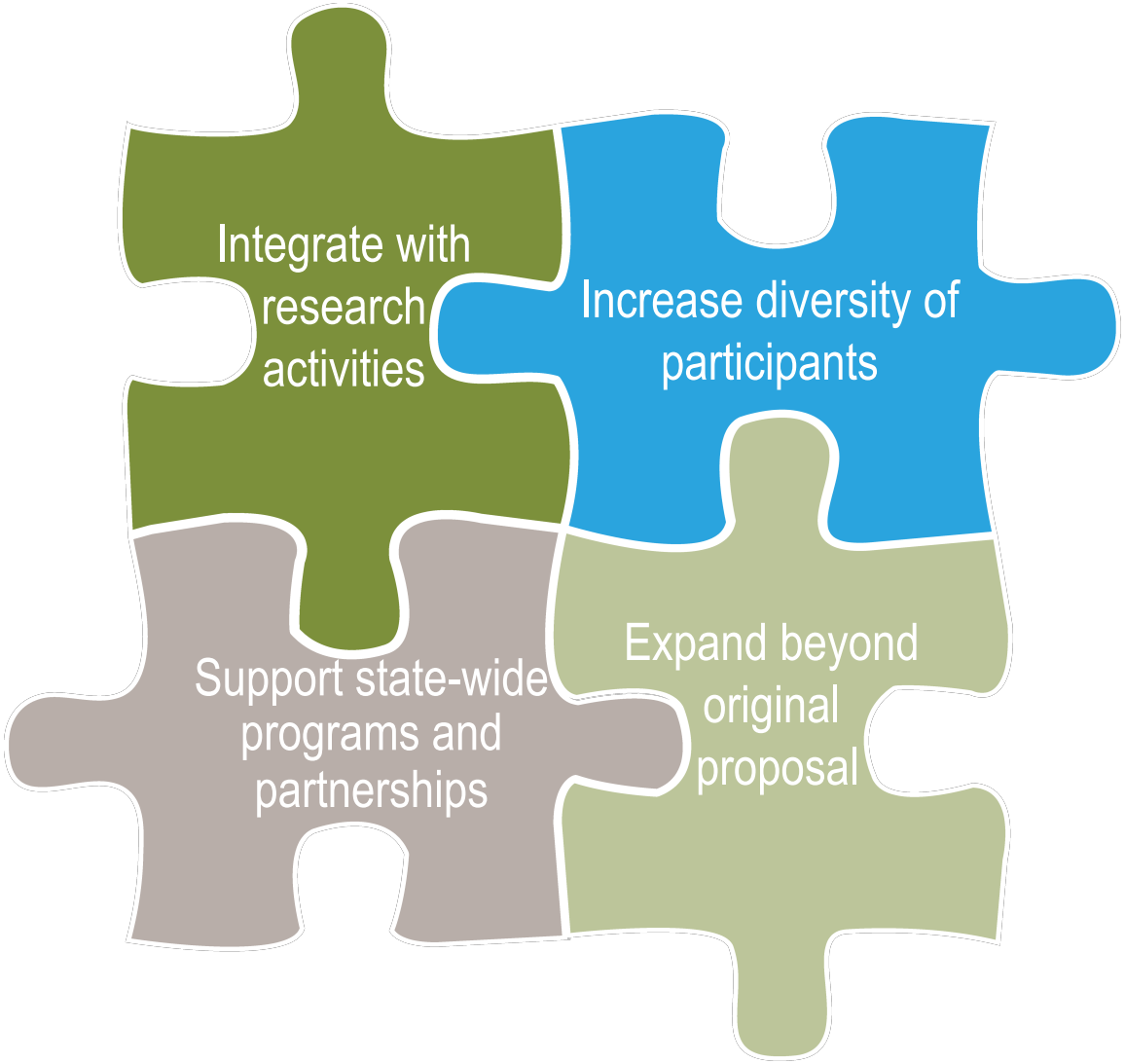

EOD
Translational Education and Outreach
for a Changing Society

EOD Goals


Integrate with research activities
Increase diversity of participants
Support state-wide programs and partnerships
Expand beyond original proposal

Signature Programs

iFellows Summer REU

- 18 students from 7 colleges and universities
- Mentored at all R1 institutions
- Broad range of projects in natural and social sciences, engineering
  - 5 in RFA1
  - 8 in RFA2
  - 5 in RFA3

Summer Research Institute

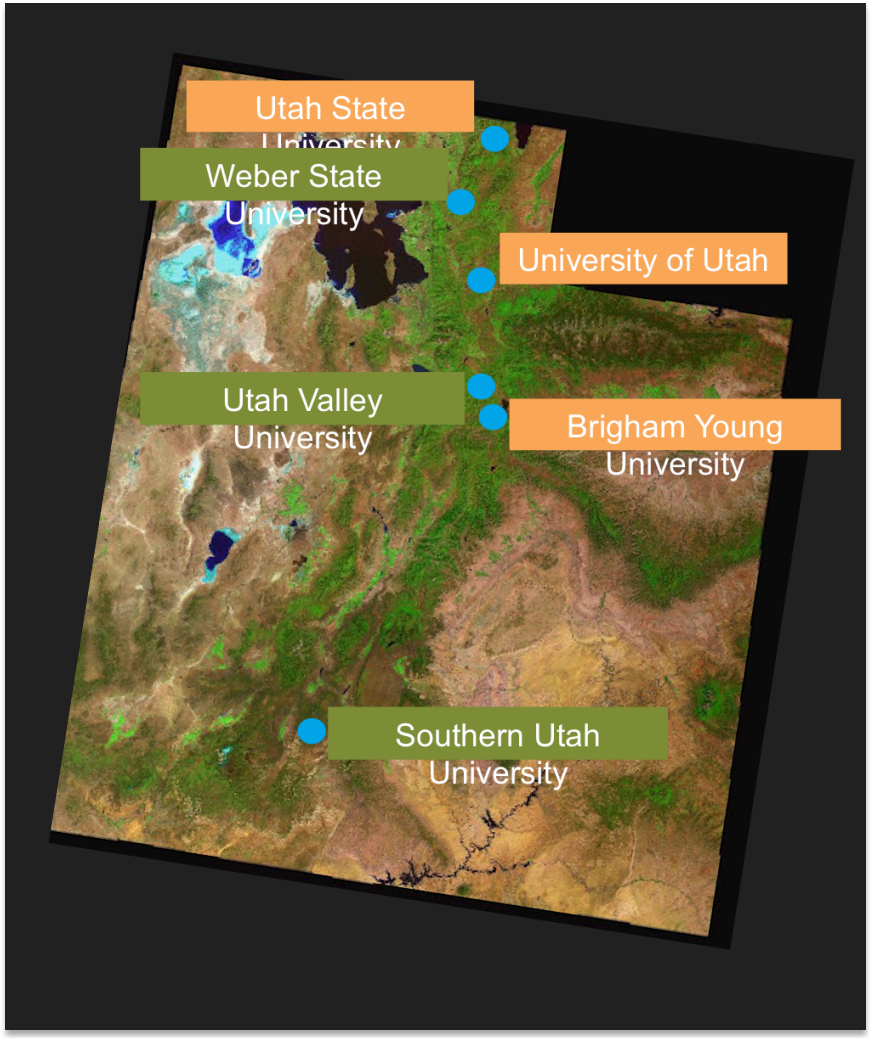
- Engages secondary teachers, high school and college students
- Partnership with U of U Genetic Science Learning Ctr.
- 4-day field experience studying water quality and supply
- Provo River focus; leadership from BYU faculty and students

Taking Learning Outdoors

- Yearlong program helps classroom teachers integrate nature across curriculum
- Partnership with Natural History Museum of Utah
- 15 teachers in 2014-15, reaching 1,285 students (mainly elementary)

Research Catalyst Grants

- Grants to faculty at PUIs engage undergraduates in research and encourage R1 collaboration
- 5 awards in 2014-15
  - Nutrient & trace metal loading in Utah Lake (UVU, BYU)
  - Watershed-damming landslides (UVU, U of U)
  - Green roof infrastructure (SUU, U of U)
  - iPad water survey (WSU, SUU, USU, U of U)
  - Geochemistry of backyard wells & gardens (UVU)



EOD Innovation Awards

- Awards to museums, schools and nonprofits for initiatives that increase understanding of water science
- Awards in 2014-15:
  - Rose Park Elementary
  - U of U Global Change & Sustainability Center
  - The Leonardo science museum
  - Natural History Museum of Utah
  - Frehner Museum of Natural History (SUU)

EOD Innovation Awards

- iUTAH WaterGirls
  - Created by SLCC professor
  - Water-focused field experience to stimulate science interest for middle school-age girls

- The Source
  - Utah Public Radio partnership
  - Helps support year-long series of radio shows about water science, issues, and programs

New Initiatives

iUTAH Traineeships

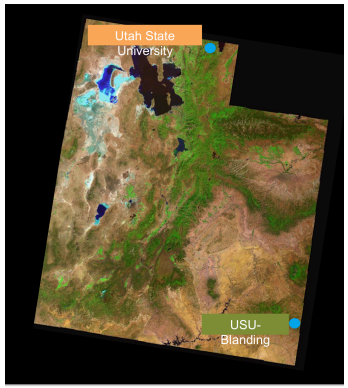
- Low industry & agency demand for iUTAH internships
- Helps undergraduate students gain marketable skills for non-academic jobs
- Most positions focus on maintenance and use of sensor and sampling technology
- Faculty supervisors submit mentorship plans focused on non-academic employment

WSU Access and Outreach

- Events for high school students in under-represented groups
- Multicultural Youth Conference
  - Presented STEM career and education info to 180 students
- Summit Leadership Institute
  - 3 days of STEM activities for 25-40 high school seniors from n. Wasatch Front

USU-Blanding Native American Mentorships

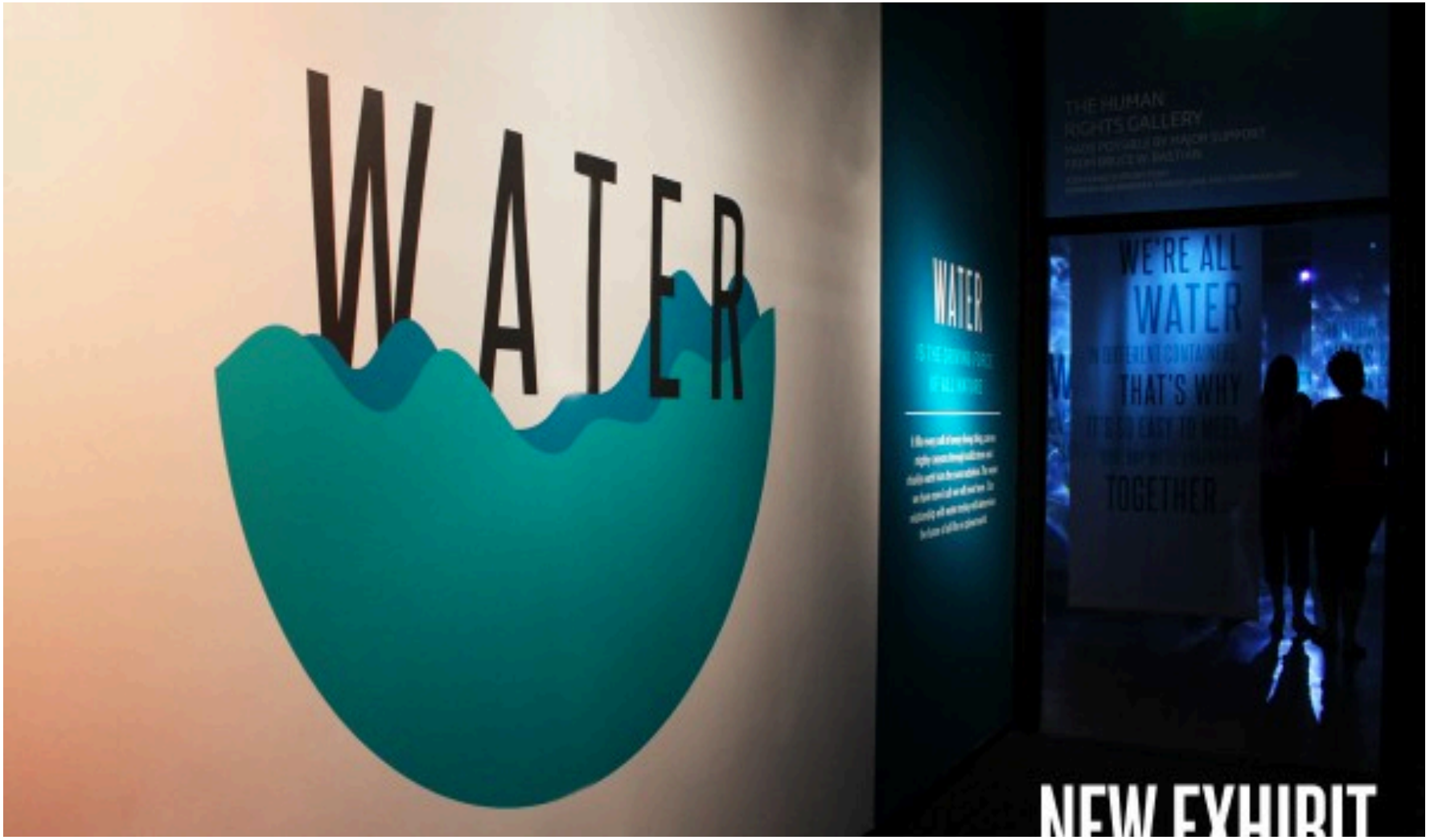
- Introduced iUTAH and water issues to 21 students from USU's Blanding campus (60% Native American)
- 2 students rotated through iUTAH labs (biology, sociology, engineering)
- Worked alongside graduate students and iFellows



Engagement with Native American Stakeholders

- American Indian Science and Engineering Society (AISES)
  - Attended joint region 1&3 conference in Salt Lake City
  - Supported travel for 16 Native American students
- Society for Advancement of Hispanics/Chicanos and Native Americans in Science (SACNAS)
  - Partnered with 4 other EPSCoR jurisdictions at 2014 conference
- *Water Runs Through This Book* – funded by iUTAH, this book weaves poetry, science and photography with a Navajo perspective

Broadening Our Impacts



Advance Discovery and Understanding and Promote Teaching

- Taking Learning Outdoors and Summer Institute improve science capacity in K-12 classrooms
- Emphasize near-peer and faculty-student mentoring
  - Mentoring plans with faculty applications for trainees
  - Mentor training at iFellows cohort meetings led by Lucas Moyer-Horner

Advance Discovery and Understanding and Promote Learning

- iFellows program has been growing each year (50% more students served than in 2013)
- Traineeship initiative addresses concern over internships
- Cross-institutional classes by USU, U of U faculty
  - Hydro-informatics (45 students in fall 2014)
  - Green Infrastructure (to be offered fall 2015)

Broaden Participation of Underrepresented Groups

- Collaboration with Weber State University
  - Water as theme for sparking interest in STEM careers
  - Emphasis on north end of Wasatch Front
- Evolving partnership with Utah's Native American-serving institution
- Year 4 goal: more outreach to minority communities in Salt Lake City area

Enhance Infrastructure for Research and Education

- Collaborations spreading across Utah
  - Increased participation by PUIs in undergrad research
  - Taking Learning Outdoors will move to southern Utah for 2015-16
- Seeking options for maintaining REU programs
- Building capacity to train faculty on NSF broader impacts

Broaden Dissemination to Enhance Understanding

- Increased outreach across the state
  - Museum water exhibit now part of “Leo on Wheels”
  - Increased reach through public radio
  - Science Unwrapped events in Cache Valley
- Website overhaul adds content for external audiences, with help from USU graduate class
- New printed/online materials in English, Spanish

Partnership, Collaboration and Integration

- Now reaching most PUIs, could do better with Dixie State and USU regional campuses
- Integrating EOD, research and cyber-infrastructure: the Utah Water Survey
  - iPad survey originated from 2014 Summer Institute Extends reach of Household Survey (>4,400 responses)
  - Engages students, faculty at USU, U of U, 4 PUIs
  - Web-hosted data visualization thanks to CI group/iVL

EOD Goals Revisited

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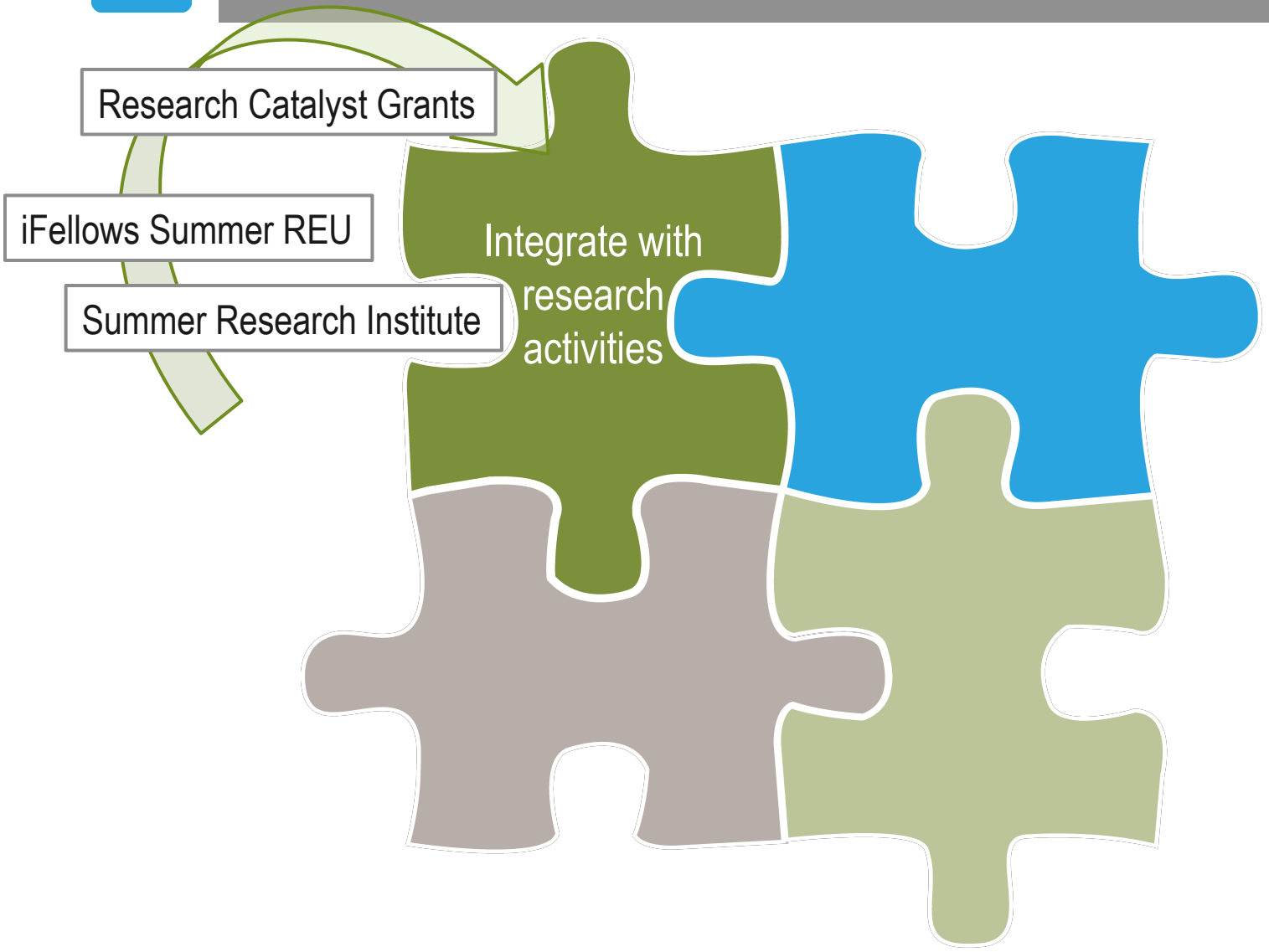
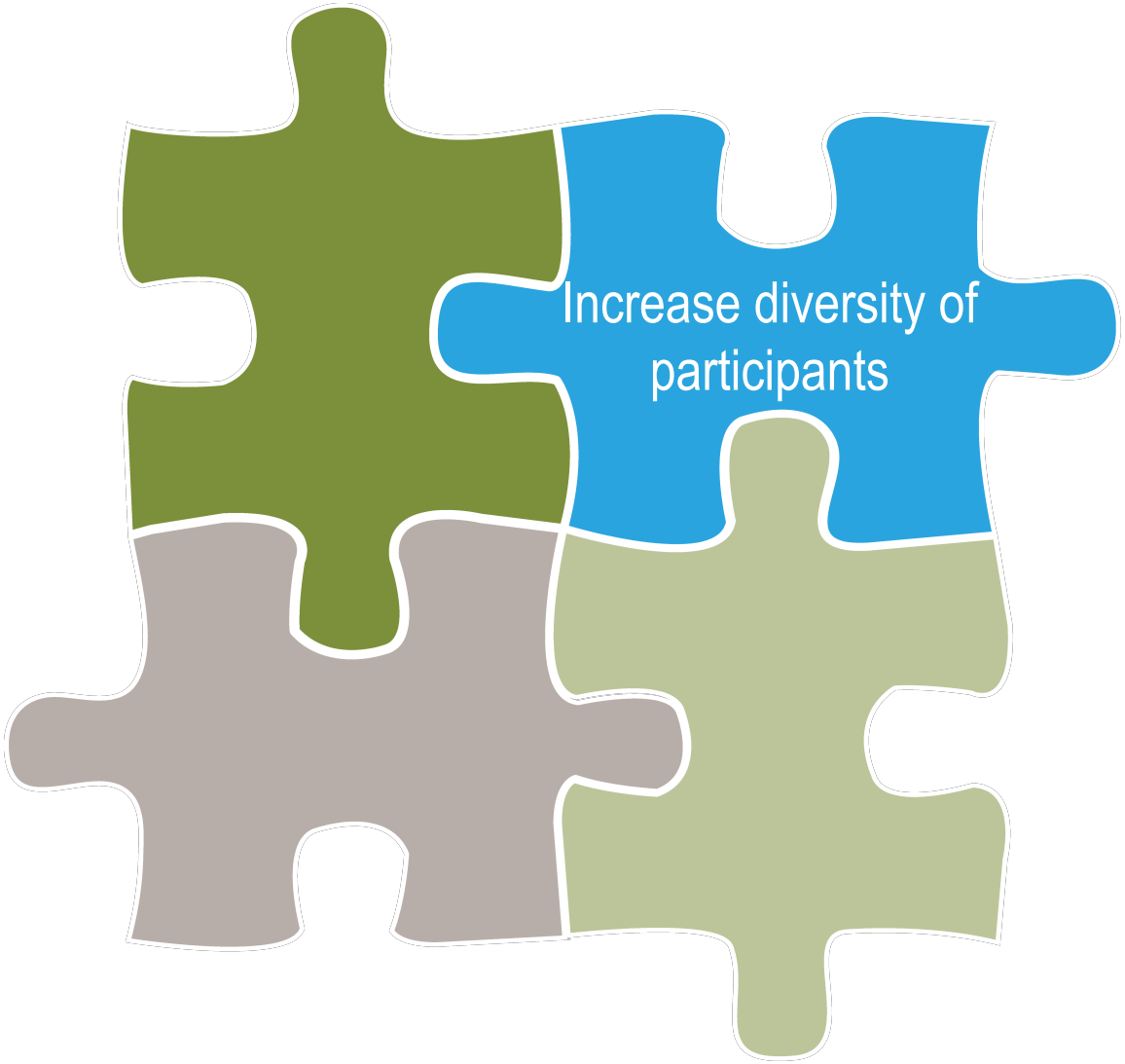


EOD Goals Revisited



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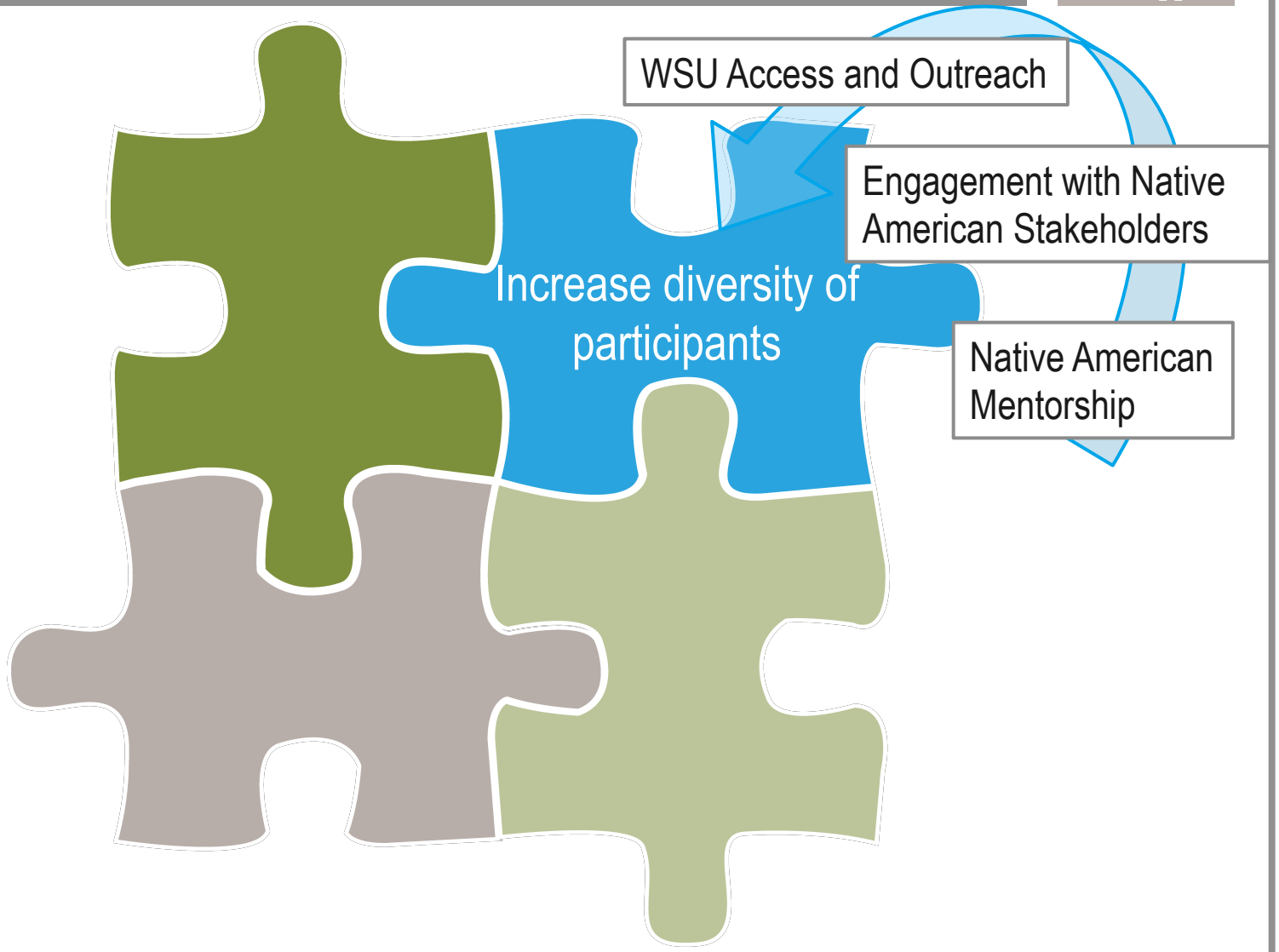

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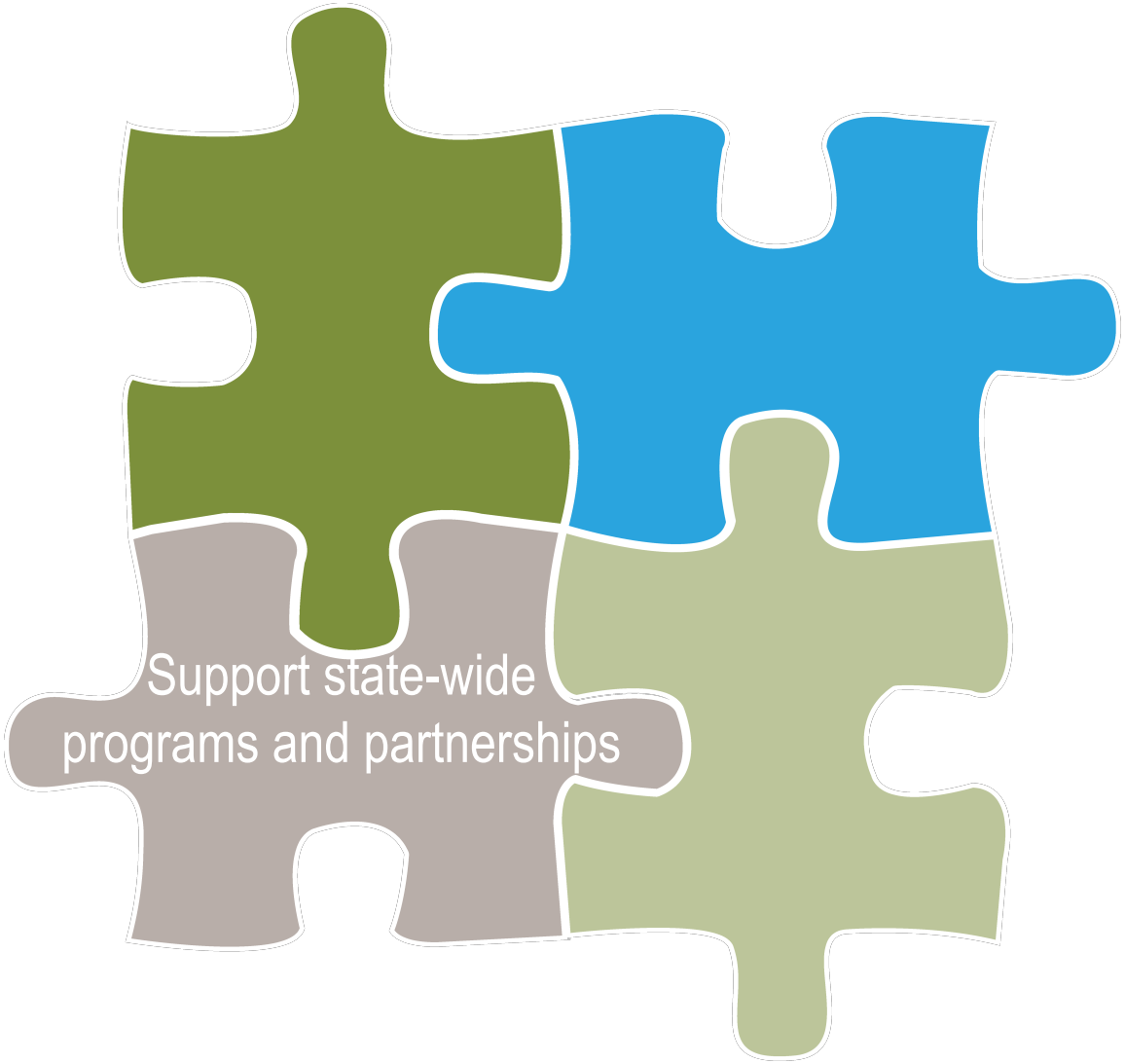

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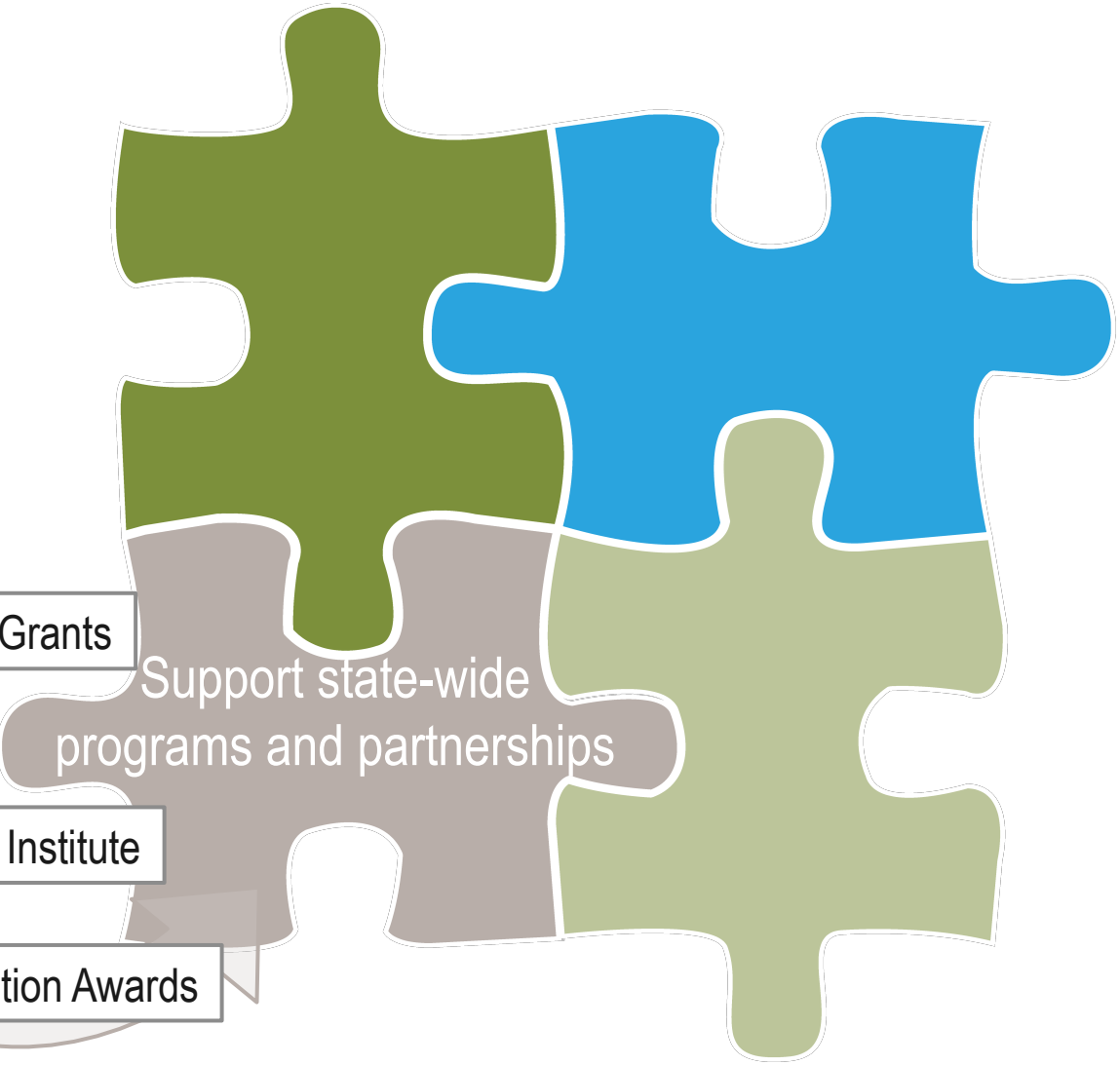
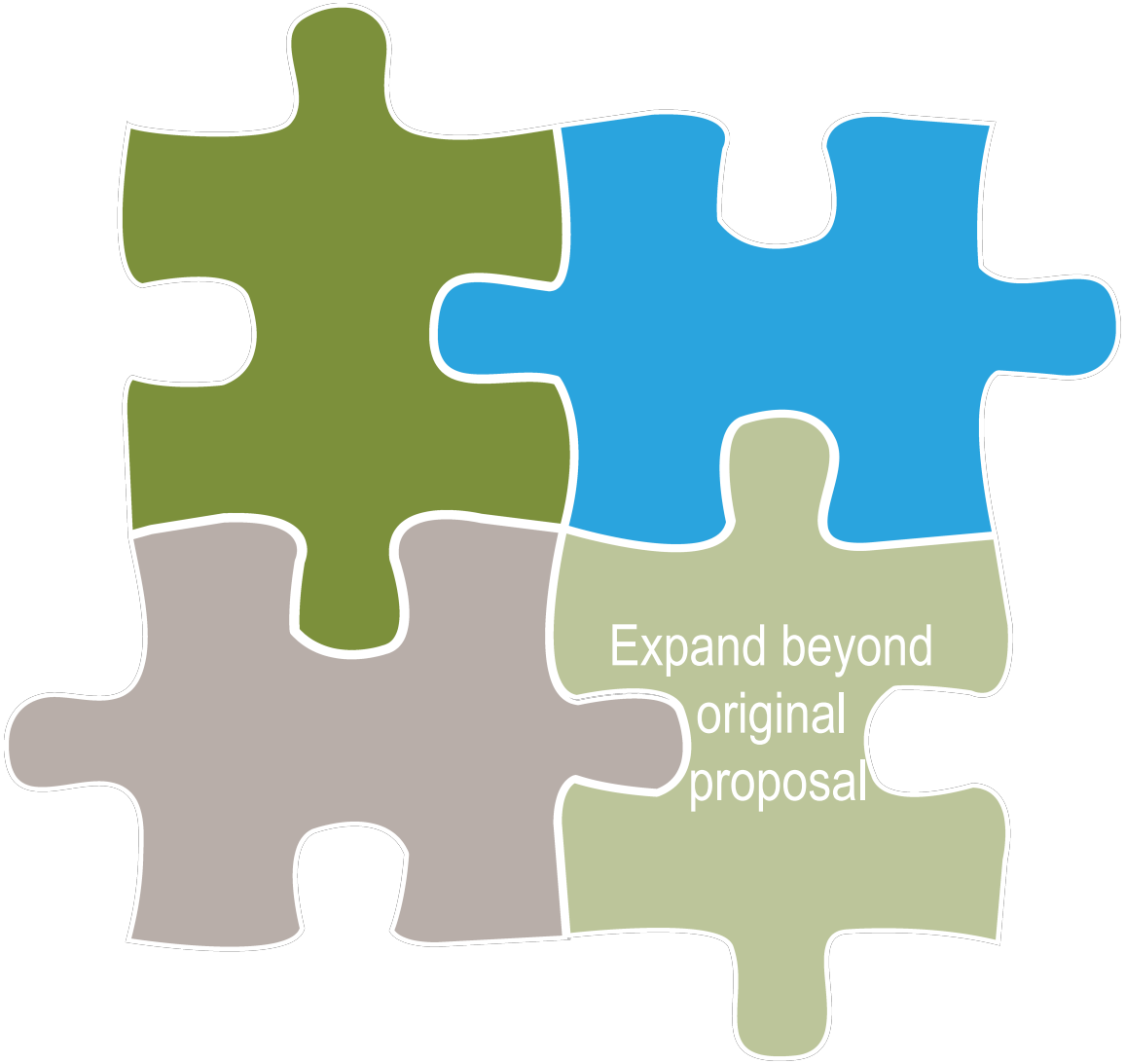


- Research Catalyst Grants
- Summer Research Institute
- EOD Innovation Awards

EOD Goals Revisited



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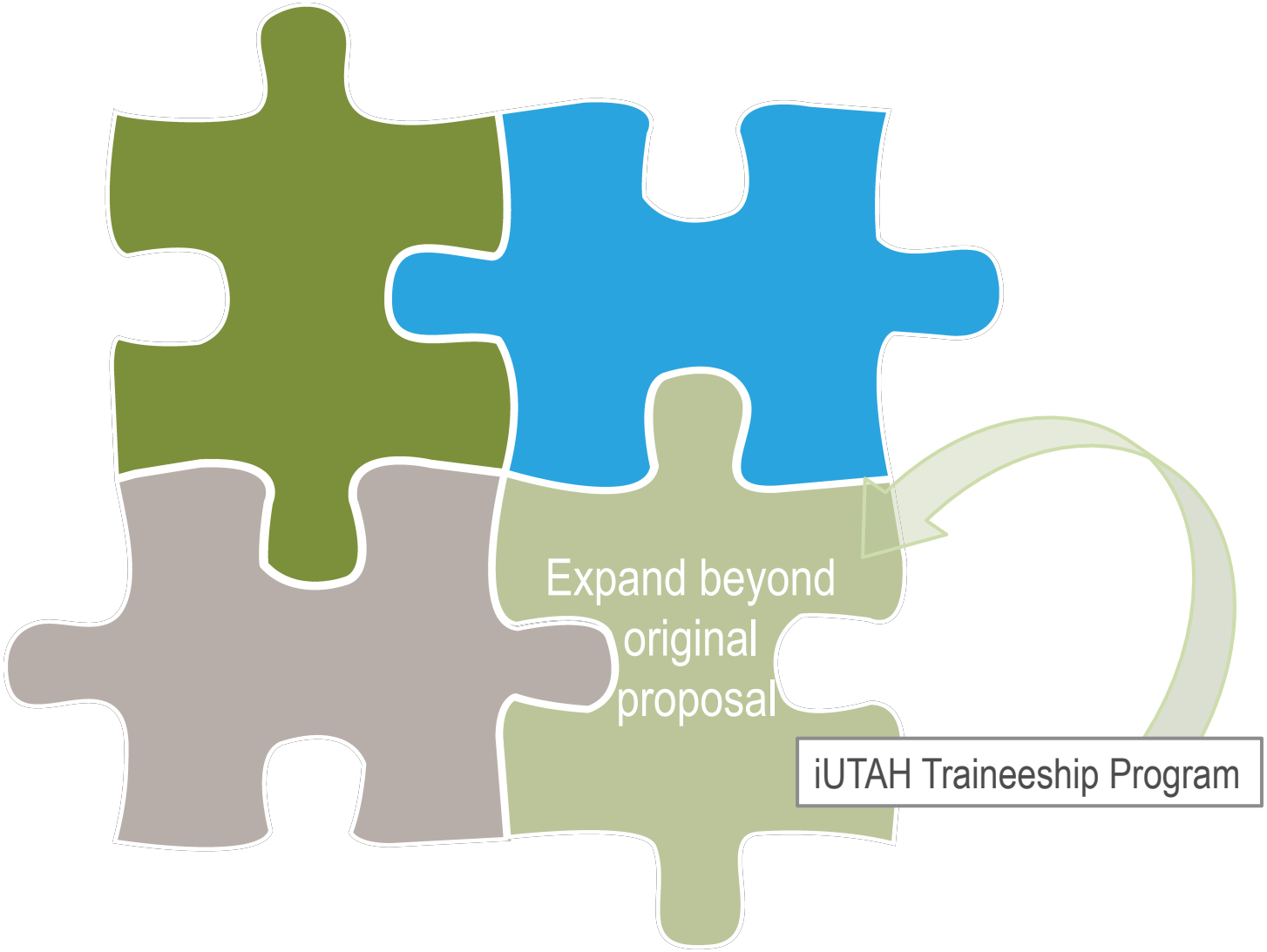

Plans and Considerations for Year 4

- Increasing engagement with industry, agencies
- Diversity theme for November “all hands” meeting
- Statewide Broader Impacts emphasis
- Fine-tuning our goals: Expansion vs. enhancement

Questions ?

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The iUTAH Socio-Environmental Observatory

Data Collection

- Surveys
- Interviews
- Neighborhood Typology

Integrated Observation Networks

- GAMUT
- BUGI
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Cyberinfrastructure

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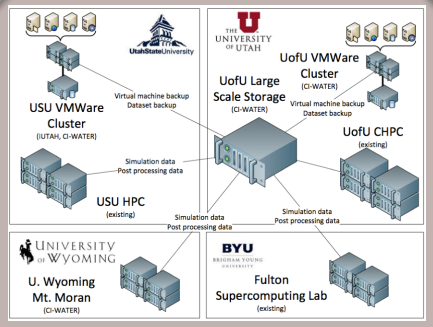

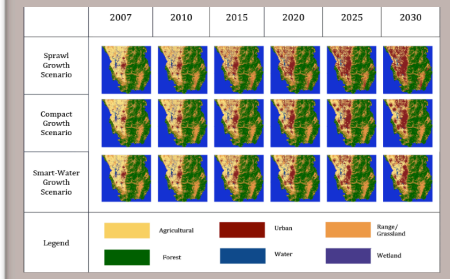

Office of Broader Impacts

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Year 1 Building Blocks

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Building across
Institutions and Departments

Year 1 Building Blocks

Building across Institutions and Departments

Building Intellectual Infrastructure

Year 1 Building Blocks

Building across Institutions and Departments

Building Intellectual Infrastructure

Designing and Building an Environmental Observatory

Year 1 Building Blocks

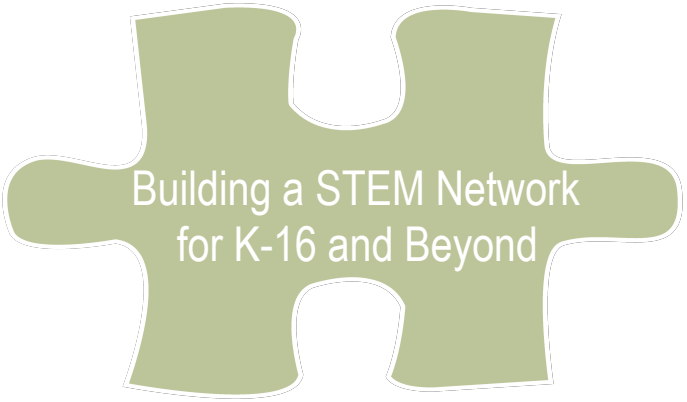
Building across Institutions and Departments

Building Intellectual Infrastructure

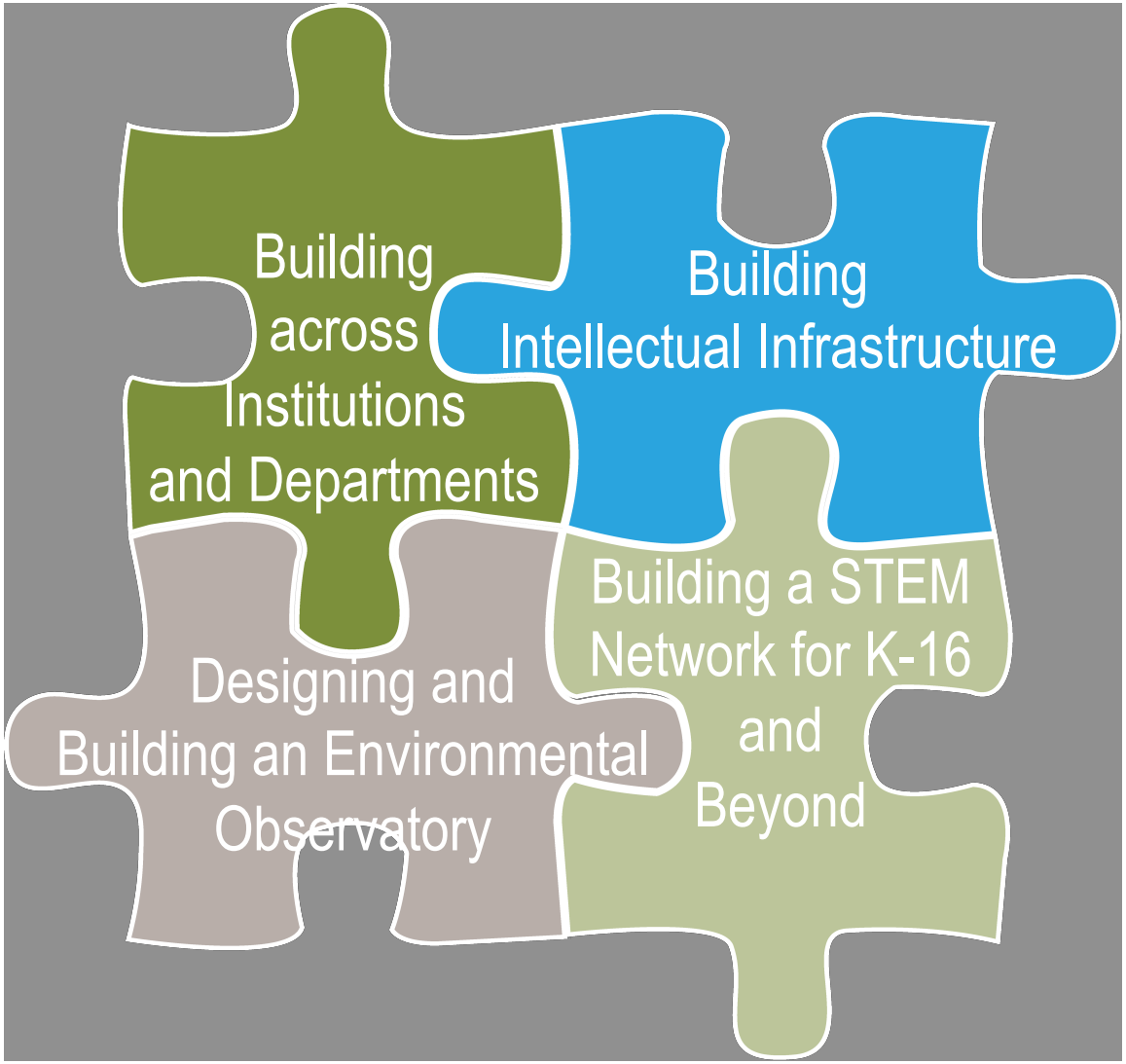
Designing and Building an Environmental Observatory

Building a STEM Network for K-16 and Beyond

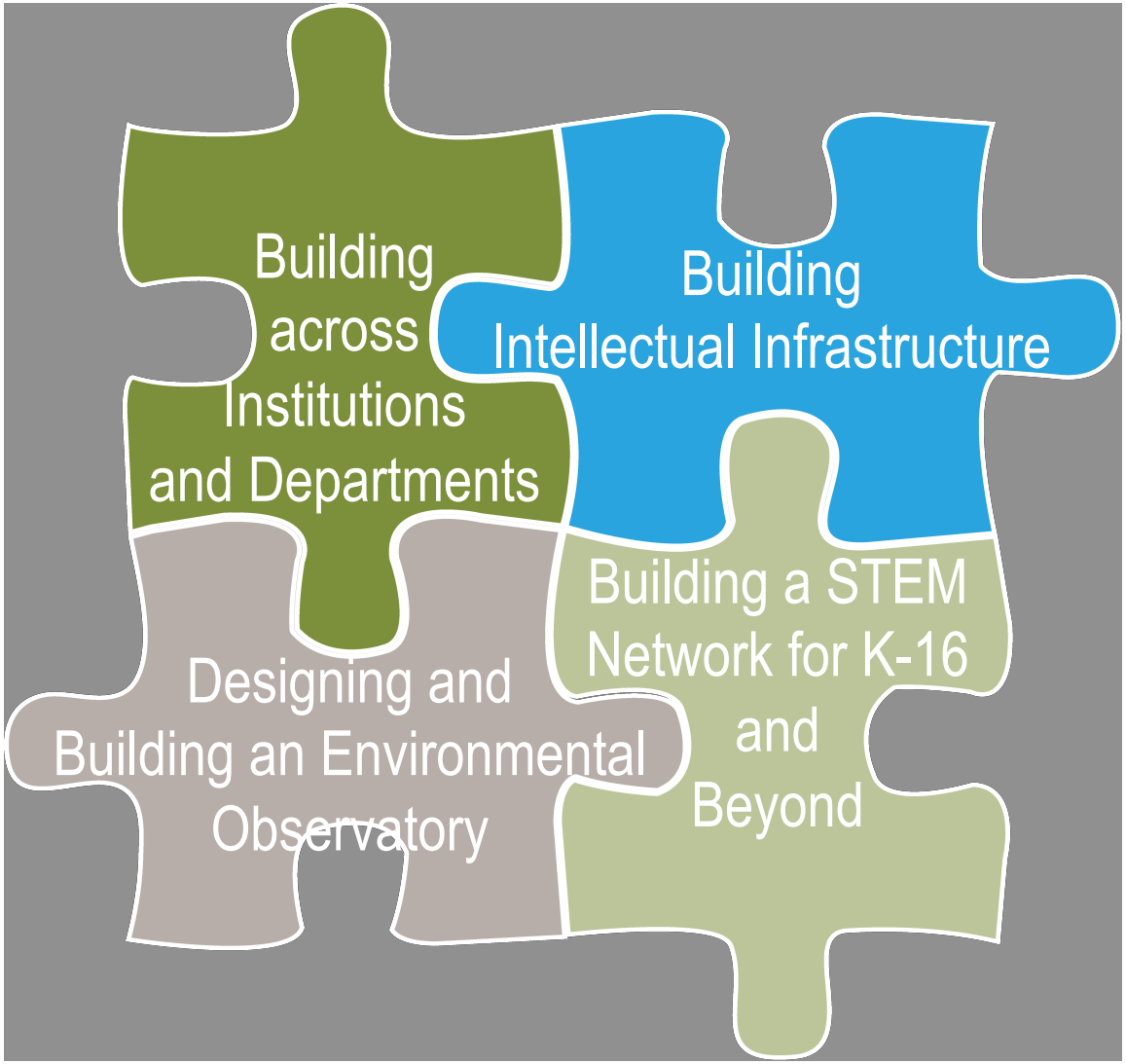
Year 2–Laying a Foundation for Integration



Year 3–Integration



Year 3–Translation



Year 3–Translation

Cross-campus Courses

Building across Institutions and Departments

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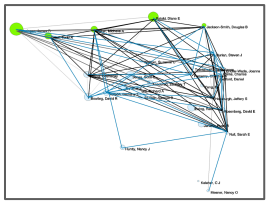
Year 3–Translation

Cross-campus Courses

Co-actors to Collaborators



Building across Institutions and Departments

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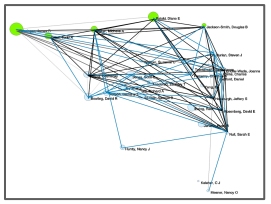

Building across Institutions and Departments

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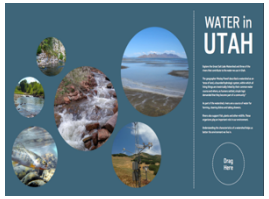
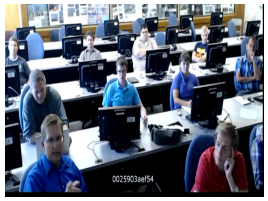


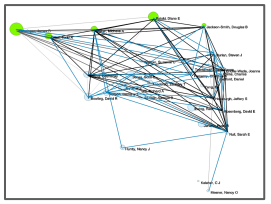
Innovative Visualization

Year 3–Translation

Cross-campus Courses



Co-actors to Collaborators



Building across Institutions and Departments

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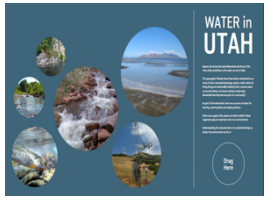
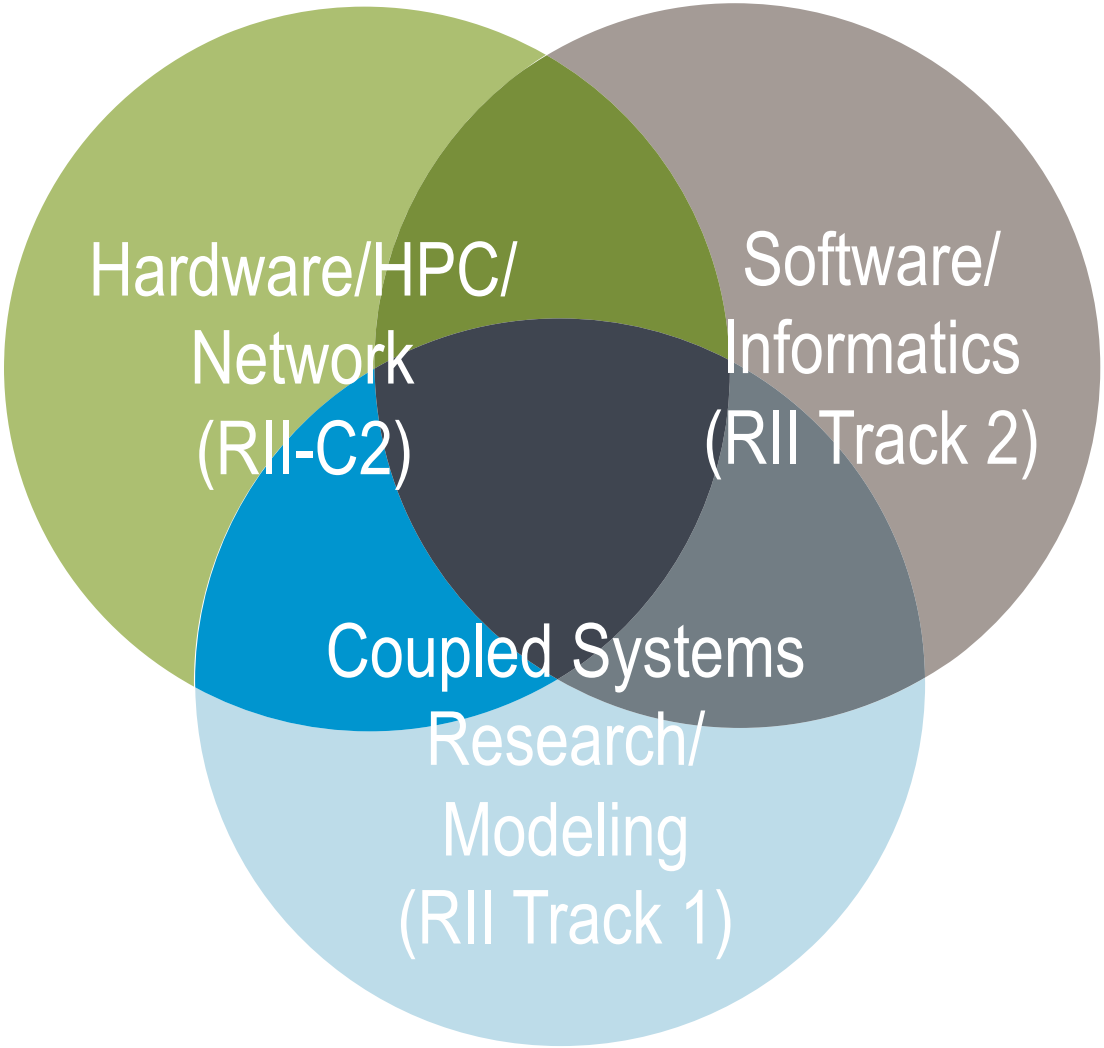


iUTAH STEM Pipeline

Year 3–Transformation

RII synergies in Utah



Core Facilities

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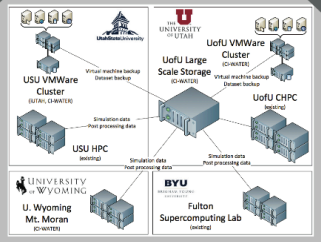
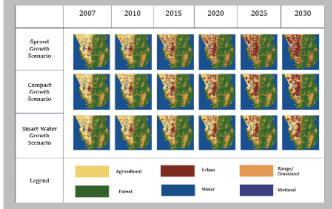
- iUTAH Visualization Lab





Office of Broader Impacts

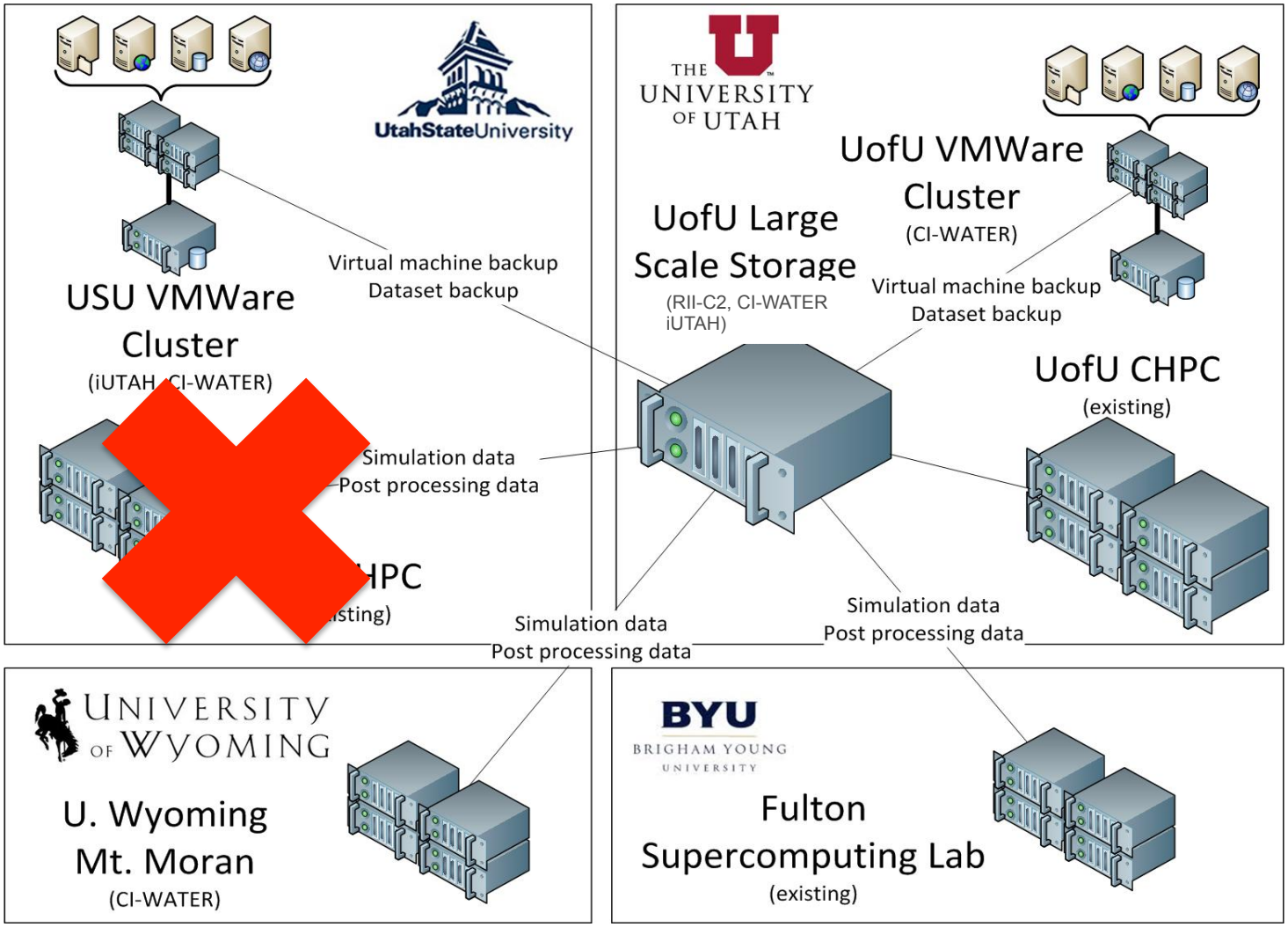
- Collaborative Research
- Stakeholders
- Outreach
- Workforce Development

Build across institutions and departments

Intellectual infrastructure

Workforce development, education, diversity

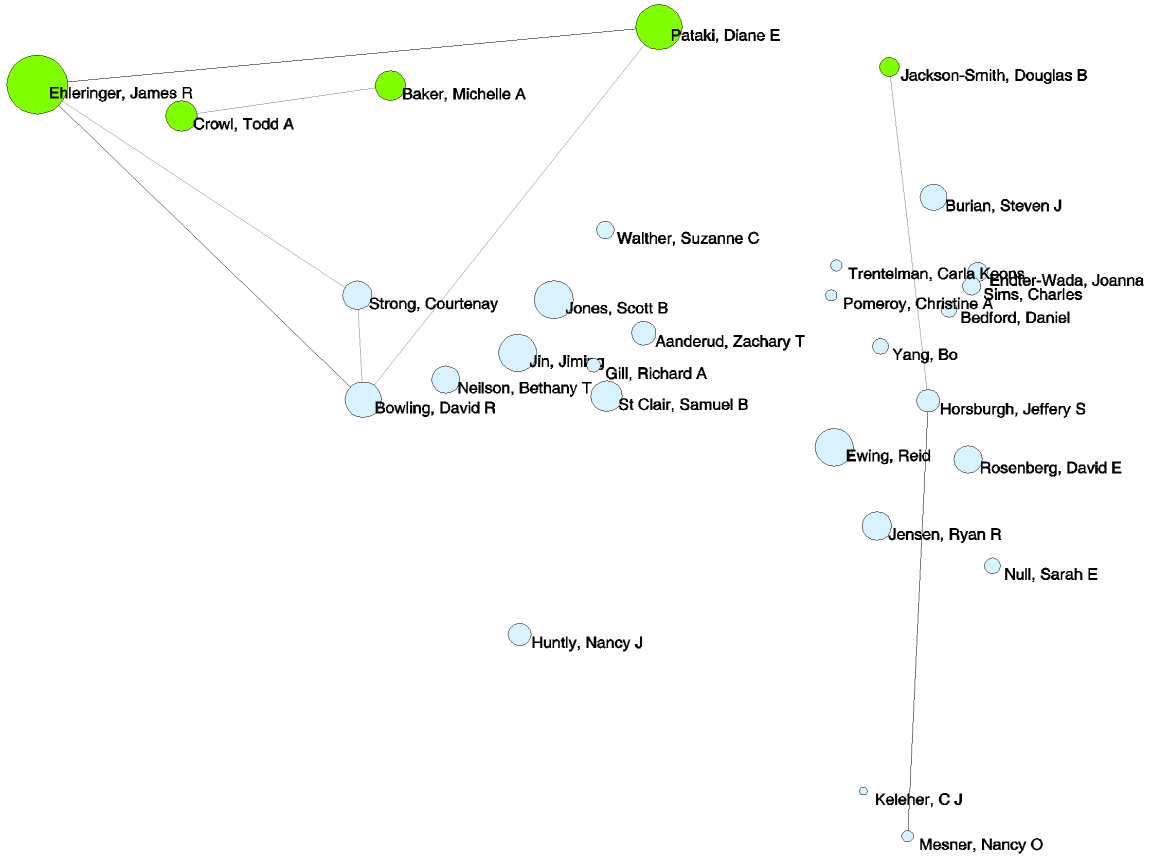
Cyberinfrastructure



Graduate training

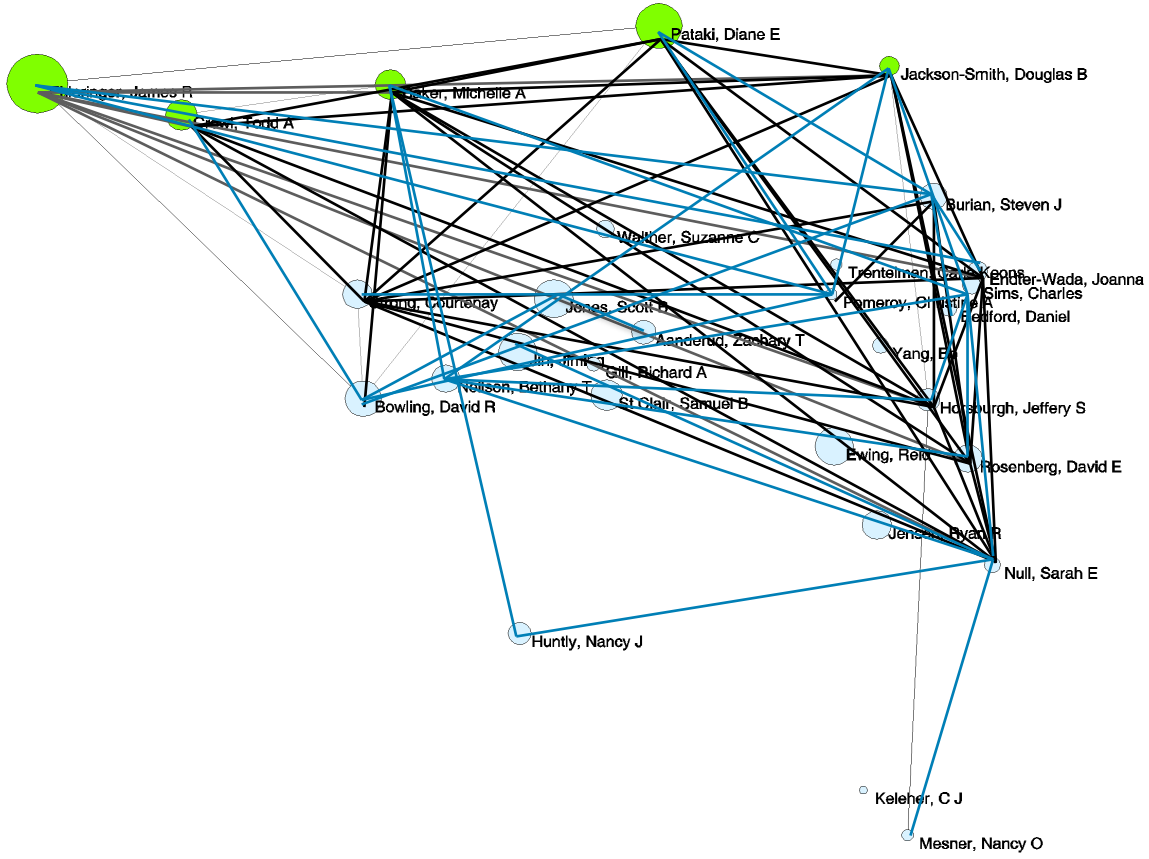
Enhancing PUI Research + STEM Pipeline

Scholarly Collaboration



Co-authoring among EPSCoR authors 2012-2015

Scholarly Collaboration



Co-authoring among EPSCoR authors 2012-2015

Collaborative proposals among EPSCoR authors 2012-2015

Sustainability

1. The iUTAH Socio-Environmental Observatory has been visioned into a world-class facility that engages and integrates physical and human infrastructure from EPSCoR funding.
2. We have established a 5-year plan of potential external funding mechanisms that will be topics of discussion at 2 breakout sessions during Friday's All-hands Meeting.
3. The VPRs of Utah's R1 institutions have signed an MOU to further support collaboration on external funding calls such as LTER, CZO, REU, etc.
4. We have begun the scoping process with university government relations officers to approach the legislature in 2017.
5. We have secured verbal agreements for continued support of physical infrastructure beyond that described in the original proposal.

Future Plans

1. iUTAH will continue to aggressively implement its strategic plan goals.

2. iUTAH will further enhance these goals to:
   - enable future inter-campus synergies by co-advisement of graduate students and co-teaching of classes
   - enable continued interdisciplinary work by co-authoring of proposals and publications
   - encourage continued co-advisement of undergraduate researchers and referring these students to graduate opportunities in Utah and elsewhere
   - build on new diversity partnerships to recruit underrepresented groups into iUTAH programs.

Lessons Learned

Common vision

Clear, consistent communication

Core facilities and programs

www.iUtahEPSCoR.org