Ecohydrology

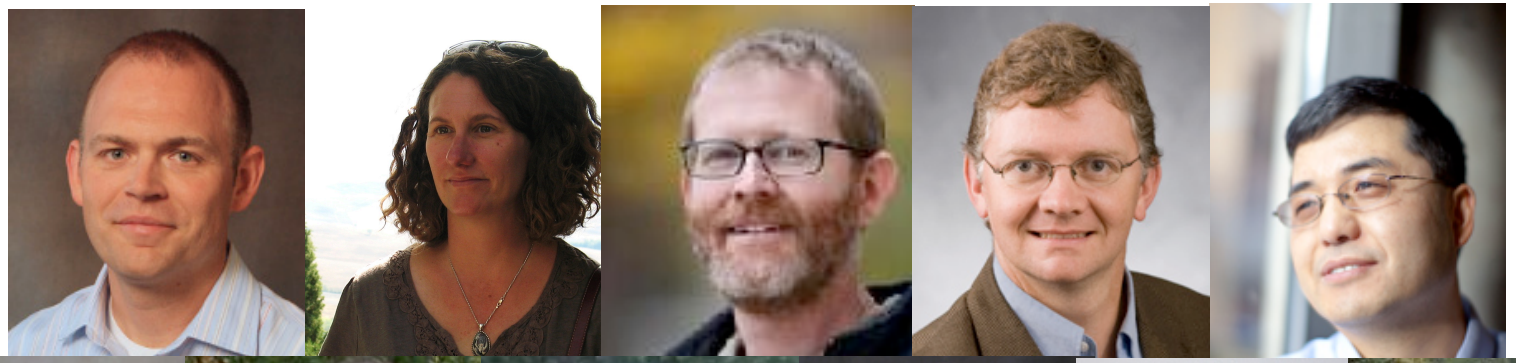
Research Focus Area 1

RFA1 - Ecohydrology

- Improve capacity to monitor and understand biophysical processes that influence our water resources

Faculty researchers

Microbial Ecology, Aquatic Biogeochemistry/Ecology, Ecophysiology, Plant Biology/Ecology, Climate Modeling, Soil Physics, Surface Hydrology, Geomorphology



Student Assistants and Partners

- Student Assistants

  Brian Bailey (UU), Carolina Gomez-Navarro (UU), Carolyn Stwertka (UU), Allison Chan (UU), Scott Christensen (BYU)

- Component Partners

  Salt Lake County, Utah DWQ, City of Logan, USDA Forest Service, Bureau of Reclamation

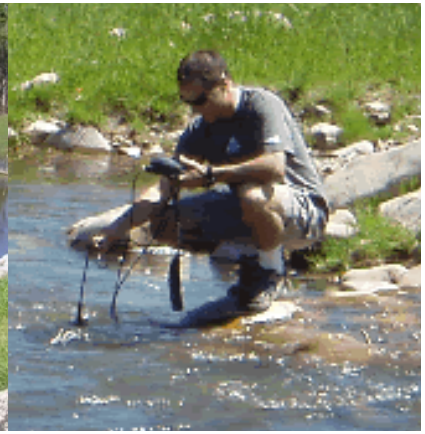
Goals

- Improve capacity to monitor WMRA 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.

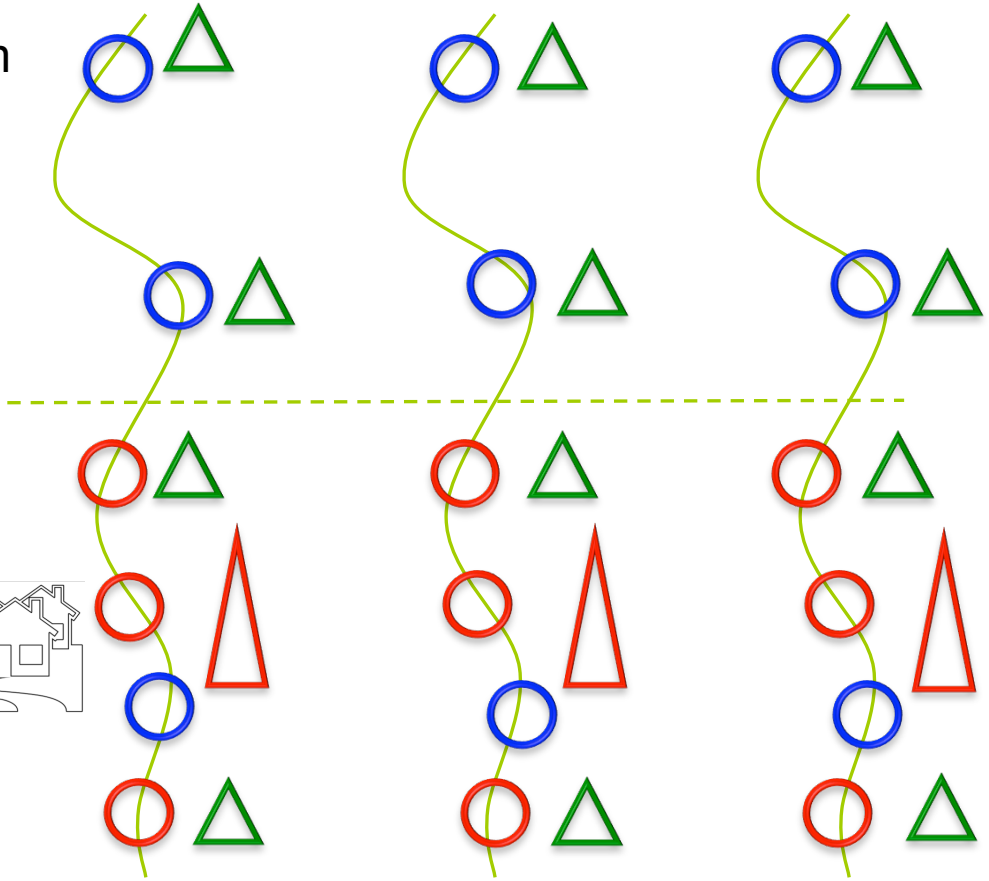
Objectives – Goal 1

- Design observatory
- Build observatory



GAMUT (gradients along mountain to urban transitions)

2500+ m



Mountain-to-Valley transition

Fundamental aquatic sensors, *in situ*

Fundamental aquatic sensors, relocatable

Enhanced aquatic sensors, *in situ*

Fundamental terrestrial sensors

Urban tower and sensors

Objectives – Goal 2

- What ecohydrological processes affect the water balance of forested, urban, exurban, and agricultural land covers?
- What determines water quality?
- How will availability of and demand for mountain water resources change as a result of climate and land use change?

Activities (Goal 2, Years 1-2)

- Begin to address research questions
  - Develop sample analysis (data collection) plans
  - Collect data for proposals and publications
- Train graduate students
  - Mentor fellowship applications
  - Engage students in research
- Provide undergraduate research opportunities
  - Propose research themes/potential projects
  - Match identified undergrads to mentors

Ecohydrology Outputs

- Goal 1: Improve capacity to monitor WMRA ecohydrologic system on mountain to urban gradient.
  - Instrumentation Plan for GAMUT (Draft complete)
  - Three successful hires (November 2012)
  - Instruments installed (July 2013)
  - SOPs approved and in use (July 2013)

Ecohydrology Outputs

- Goal 2: Enhance capacity to understand ecohydrology of the WMRA.
  - Sample analysis plans in place (July 2013)
  - Number of graduate students in research related to RFA 1 (2012-13= 5)
  - Presentations at Spring Runoff (Spring 2013)
  - Number of REU students and mentors
  - Number of presentations by REUs

Possible Challenges

- Accessibility of potential sites (property ownership)
  - Strong potential delay in negotiating access in urban areas
- Telemetry/power
- Personnel to maintain sites in years 2-5
- Timing of research faculty – lose interest if not engaged till year 3, hinders collaborations
- No funds for groundwater monitoring
- Eddy covariance

Initial Outcomes

- Ecohydrologic observatory operational that will provide needed research infrastructure
  - Can be expanded based on observations
  - Useful preliminary data for proposals
  - Platform for hosting collaborative research and education

Ecohydrology Logic Model

INPUTS	ACTIVITIES	OUTPUTS	OUTCOMES	IMPACT
INFRA-STRUCTURE Preliminary data Existing sensor networks (LBR, RB) Preliminary models Faculty expertise Private enterprise Students	INFRA-STRUCTURE Design GAMUT Build GAMUT Incorporate GAMUT into Data Federation Maintain GAMUT	INFRA-STRUCTURE Sensor network Data repository Streaming data sets Collaborative research network across institutions Undergraduates and graduate students trained in research	INFRA-STRUCTURE Better data for ecohydrologic processes Stronger extramural funding base to support interdisciplinary research	Stronger capacity and competitiveness in applied interdisciplinary research Science-based water management decisions to enhance sustainability Economic development through increased extramural finding success, private partnerships and better educated and experienced STEM workforce
ENGAGEMENT Museums Extension programs Partners	RESEARCH Collaborate to address research questions Train technicians RC Grants for PUI faculty Collect data Write proposals	RESEARCH Collaborative proposals, presentations, and publications Increased PUI participation	RESEARCH Institutional programs to support interdisciplinary research Visibility and impact of research products	
FUNDING USTAR Institutions Planning grant White paper UT S&T Plan CI-WATER Track I award	INTEGRATION-EOD Train and mentor graduate students Research experiences for undergraduates Summer institutes Stakeholders/ partners	INTEGRATION-EOD Relationships with key stakeholders Water sustainability in K-12 curriculum Theses and dissertations	INTEGRATION-EOD Application of research to water management in Utah New K-12 materials	

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Social & Engineered Systems

Research Focus Area 2

Approach

- Focus on social and engineered aspects of water systems in urbanizing and urban environments
- Collaborate with Focus Areas 1 and 3 and Cyberinfrastructure to:
  - Co-locate instrumentation/monitoring/data collection
  - Develop models for coupled system dynamics
- Work closely with Education, Outreach, & Diversity and Focus Areas to:
  - Engage in collaborative discussions with water stakeholders and decision-makers
  - Train the next generation of water scientists

Team

Faculty/Researchers

D. Bedford (WSU), M. Buehert (UU), S. Burian (UU), R. Dupont (USU), J. Endter-Wada (USU), S. Hinners (UU), D. Jackson-Smith (USU), S. Li (USU), C. Licon (USU), Z. Ma (USU), C. Pomeroy (UU), C. Sims (USU), C. Trentelman (WSU), B. Yang (USU)

Graduate Students

A. Armstrong (USU), M. Burnham (USU), D. Houdeshel (UU), E. Li (USU), A. Odame (USU), K. Sandoval (UU), P. Stoker (UU), T. Walsh (UU)

Overarching Goals

- Improve capacity of Utah's science community to gather and analyze social and engineering system data on coupled water systems
- Understand the interactions between urban form, environmental change, built water infrastructure, and water use and decision-making

Overarching Goals, cont.

- Model the impact of alternative infrastructure designs and policy options on water use behaviors, the water cycle, water quality, and interconnected social and environmental systems

Guiding Research Questions

- What are the current drivers of water and land use management in the region?
- How does urban form interact with water availability?
- How can we design our built systems to enhance water sustainability?

Goal 1: Ensure our research activities are relevant to decision-makers

- **Objective 1.1: Initiate collaborations with water stakeholders**
  - Coordinate with Focus Area 3 and Education, Outreach, & Diversity teams to organize stakeholder interactions
  - *Hold 2 collaborative meetings with larger iUTAH team*
  - *Conduct 3-5 focus groups year 1*
  - *Establish formal partnerships with 2-5 local water system managers in each of the study sites*

Goal 2: Improve capacity to study human dimensions of water systems

- **Objective 2.1: Train graduate and undergraduate students**
  - *Fund average of 3-4 graduate fellows each year*
  - *Engage 4-8 undergraduates in research each year*

- **Objective 2.2: Facilitate cross-disciplinary and cross-campus collaborations**
  - Support meetings and networking among social scientists, planners, and engineers *(2-4 mtgs first year)*
  - Coordinate with ecohydrology team to develop integrated research plans *(weekly co-PI phone calls, 2 full group mtgs/yr; work on 1 new collaborative proposal)*

Goal 3: Ensure social and engineering data can answer research questions

- **Objective 3.1: Identify urban sites for intensive data collection**
  - Inventory and analyze spatial data for WRMA
  - Identify clusters of similar urban form types
  - *Coordinate with RFA 1 to pick common locations to instrument and monitor*
- **Objective 3.2: Assess existing social and engineering data in selected study sites**
  - *Build archive of social/eng.data for each location*
  - *Develop partnerships with local water system managers to coordinate data monitoring plan*

Conceptual Design of Social/Engineering Observatory in GAMUT

River

Mountain-to-Valley Transition

NEIGHBORHOOD TYPE A

NEIGHBORHOOD TYPE C

NEIGHBORHOOD TYPE D

NEIGHBORHOOD TYPE B

Irrigation canal

Social/Engineering Observatory Infrastructure

- Green Infrastructure Research Facility
- Small Lot Development
- Formerly Rural Development
- Large Lot Development
- Green-Infrastructure Development
- Private Water Wells
- Public Water Supply
- Neighborhood Boundary
- Water Supply Conveyance Systems
- Stormwater/Drainage Systems

Ecohydrology Observatory Infrastructure

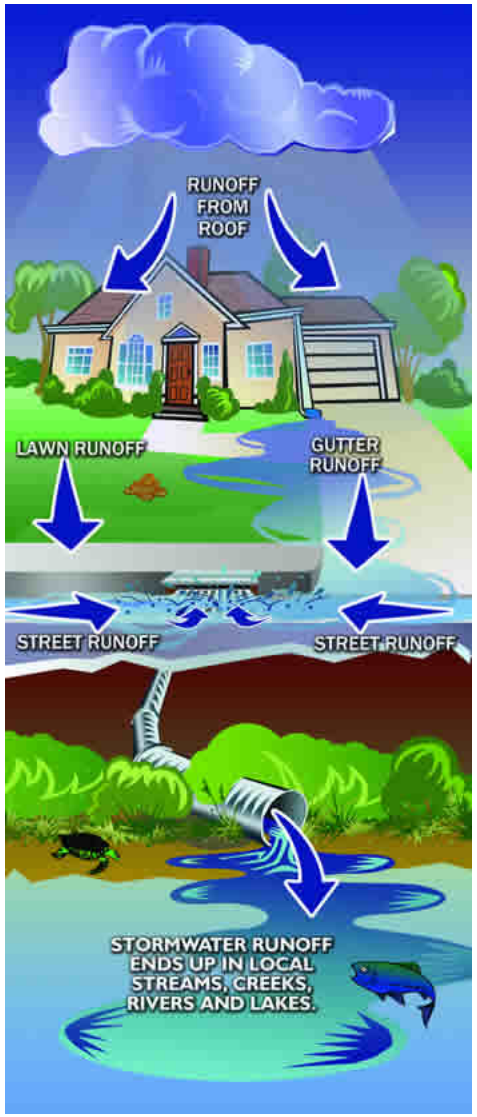
- Fundamental aquatic sensors, *in situ*
- Fundamental aquatic sensors, relocatable
- Enhanced aquatic sensors, *in situ*
- Fundamental terrestrial sensors
- Urban tower and sensors

Goal 4: Improve our capacity to collect data about water use and decision-making

- **Objective 4.1: Develop appropriate methods and instruments to document drivers of variation in water use behaviors**
  - Inventory existing data on water use
    - *Develop relationships with local water system managers to share data and address local water mgt challenges*
  - Develop methods, instruments, and produce specific research plans/protocols for use in Years 2-5
    - *Hold 2-4 methods workgroup meetings*
    - *Approve collaborative research plans/protocols*

Goal 5: Improve our knowledge of the built water infrastructure in our study sites

- **Objective 5.1: Begin inventory of built infrastructure in Red Butte Creek and Logan River sites**
  - *Collect and archive baseline data on water infrastructure*
  - *Find examples of green infrastructure to track pre- and post-implementation*



Goal 6: Improve our capacity to use information about built infrastructure to model water system outcomes

- **Objective 6.1: Develop methods to assess sustainability of current built infrastructure**
  - *Define sustainability outcome metrics*
  - *Inventory range of infrastructure practices and regulations in region*
  - *Evaluate alternative modeling approaches for simulating impacts of built infrastructure*
  - *Train 1-3 graduate students in water system modeling*

Goal 6, cont.

- **Objective 6.2: Design and prepare to construct Facility 2 (GIRF) on U.U. campus**
  - *Refine design plans, prepare to order equipment*
  - *Develop methodological approach to incorporate distributed network of GI sites with work at GIRF facility*
  - *Initiate discussions with Education, Outreach, and Diversity team to use facility for education and outreach work*

Anticipated Outputs

- Summary report from focus groups
- Map of WRMA neighborhoods showing distribution of different types of “urban forms”
- Creation of common spatial database archive on social and engineered variables for full WRMA
- Approve research protocols to collect social and engineering data in Years 2-5

Anticipated Outputs, cont.

- Detailed inventory and archive of built water infrastructure and social and engineering data in selected RBC and LR sites
- Selection of modeling approaches for simulating impacts of infrastructure, water behaviors, and policies
- Complete GIRF design plan
- 3-6 student presentations at spring runoff conference and participation of 4 graduate fellows in Summer Institute

Possible Challenges

- Availability of data on water infrastructure and water use
- Coordination with ecohydrology observatory network when selecting and instrumenting study sites
  - Some interesting urban neighborhoods may not be proximate to instrumented river reaches
  - Location of in-stream monitoring stations to best capture urban effects may be constrained by access to good sites

Anticipated Outcomes (year 1)

- Better data availability and sharing for Utah science community
- New collaborative relationships among scientists and students across campuses
- New collaborative relationships between scientists and water stakeholders
- Better trained undergraduate and graduate students in social and engineering sciences
- Clear planning guidelines for work to be done in Years 2-5

Anticipated Long-Run Impacts

- Improved data to enhance understanding of human aspects of coupled water systems
- Improved economic development through increased funded research and a better educated and experienced workforce
- Improved science-based water management decisions

RFA 2 Logic Model

EPSCoR iUTAH

INPUTS

INFRASTRUCTURE

Physical
- Preliminary data
- Existing research and partnerships
- Preliminary models

Human
- Faculty with disciplinary expertise
- Disciplinary technical expertise
- Private enterprise (ET+)
- Students

ENGAGEMENT
- Museums
- Extension programs
- Agency partners
- Local water system manager partners

FUNDING
- State EPSCoR Office (USTAR)
- Institutional Support (UU, USU)
- EPSCoR Planning Grant
- EPSCoR White Paper
- UT Science & Tech. Plan
- CI-WATER Award
- EPSCoR Track I Award

ACTIVITIES

INFRASTRUCTURE
- Construct and operate Green Infrastructure Research Facility
- Provide research catalyst grants for PUI faculty
- Hire and train post-doctoral scholars
- Train and mentor graduate fellows
- Train and supervise technicians
- Provide research experience for undergraduates

RESEARCH
- Facilitate collaborative meetings across disciplines and campuses
- Help design GAMUT
- Develop protocols and collect primary and secondary data on social and engineered aspects of urban water systems
- Use data to answer core research questions

INTEGRATION-EOD
- Hold focus groups and networking meetings with local, regional, and state partners
- Participate in Summer Institute
- Participate in diversity training and awareness activities

OUTPUTS

INFRASTRUCTURE
- Co-locate measurements of water infrastructure, water use, and impacts on urban ecohydrology
- Share repository for data on land use, infrastructure, and water use patterns in WRMA
- Increased scientific capacity and diversity of workforce
  - Faculty
  - Postdoctoral scholars
  - Graduate students
  - Undergraduate students
  - Technicians
- Increase collaboration across disciplines and campuses

RESEARCH
- Develop appropriate models to simulate sustainability outcomes associated with alternative infrastructure and water management decisions
- Collaborate on research proposals
- Deliver presentations
- Publish research

INTEGRATION-EOD
- Engage stakeholders and decision-makers.
- Engage public
- Engage K-12 students and teachers

OUTCOMES

INFRASTRUCTURE
- Enhanced capacity to monitor social and engineering processes
- Improved collaborations across disciplines and campuses

RESEARCH
- Enhanced scientific capacity to understand social and engineering aspects of water systems
- Improved knowledge of water infrastructure designs on water cycle, water quality, and connected social and biophysical processes
- Increased success in collaborative research grant competitions
- Increased visibility for Utah science in national and international meetings

INTEGRATION-EOD
- Improved ability to address challenges and opportunities for sustainable water management in Hispanic and Native American communities
- Improved engagement with stakeholders and public

IMPACT
- Improved data to enhance understanding of human aspects of coupled water systems
- Improved economic development through increased funded research and a better educated and experienced workforce
- Improved science-based water management decisions

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The Coupled Human-Natural System

Research Area Focus 3

Overarching Goals

- Study the water system as a whole, including the linkages between biophysical and social dynamics, using results from Focus Areas 1 and 2

- Facilitate interactions with stakeholders and linkages among disparate datasets and models to improve our capacity to study the complexity of local water issues

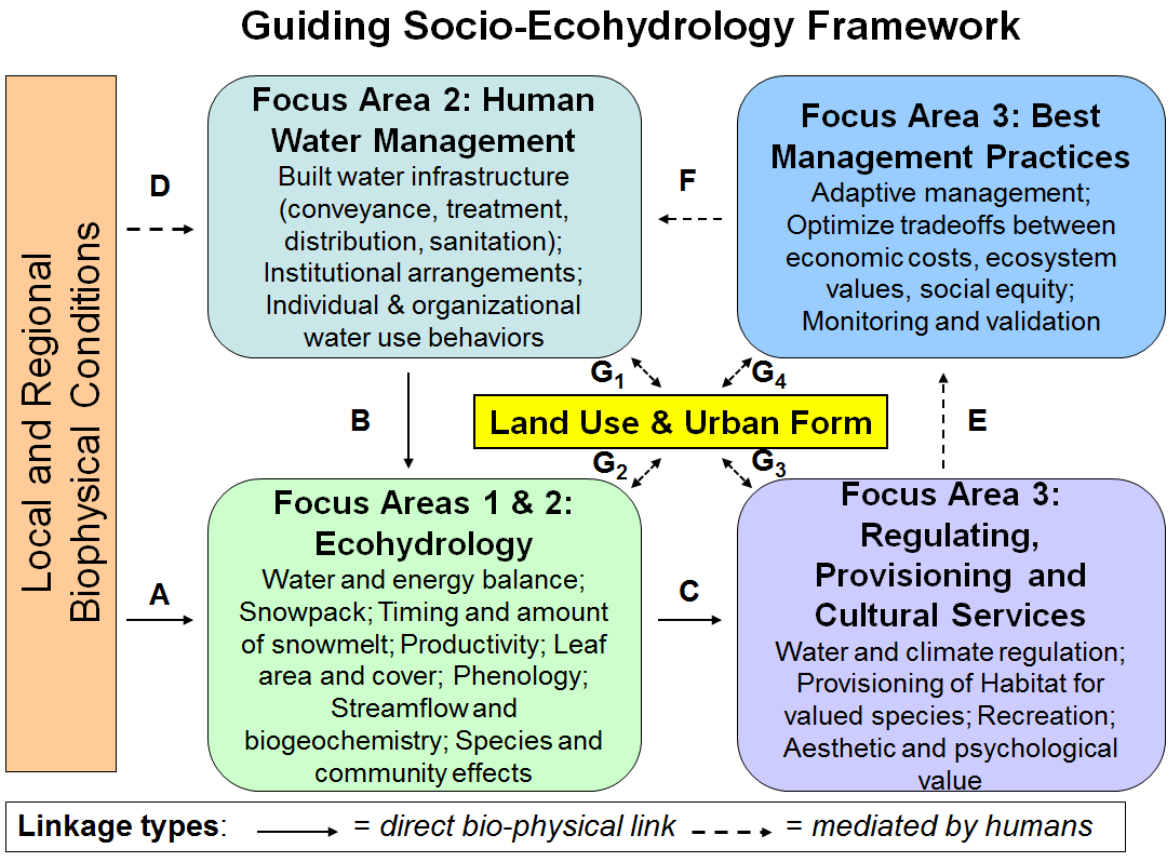
Team & Disciplines

- **Component Faculty/Researchers:** Diane Pataki (UU), Doug Jackson-Smith (USU), Reid Ewing (UU), Sarah Hinners (UU), Jeff Horsburgh (USU), Ryan Jensen (BYU), Chris Nelson (UU), Sara Null (USU), David Rosenberg (USU), Bo Yang (USU)

- **Component Disciplines:** Ecology, sociology, urban planning, hydrology, landscape architecture, engineering, climate science

Goal 1

- Integrate results from Focus Areas 1 and 2 to better understand the water system as a whole



Goal 1 Objectives & Activities

- Objective 1.1: Identify, categorize, and centralize relevant datasets and models
  - Define and scope the coupled water system
  - Create data inventory
  - Create model inventory
- Objective 1.2: Link disparate models and datasets
  - Link data to models
  - Improve model coupling

Goal 1 Outputs

- Detailed conceptual framework (manuscript)
- Web-based data inventory and archive
- Documentation of iUtah models with their domains, inputs and outputs, and platforms
- Enhanced capability of existing models to utilize new datasets
- Coupling of existing models that represent different aspects of the water system (e.g., climate, hydrologic, and agent-based models)

Goal 2

- Goal 2: Enhance capacity for interdisciplinary research and training

Goal 2 Objectives and Activities

- Objective 2.1: Link researchers, teachers, students, and stakeholders interested in water sustainability
  - Build collaborative relationships across campuses
  - Scenario scoping
  - Evaluate water system change
- Objective 2.2 :Enhance data/model visualization capacity
  - Scope and build the Environment Situation Rooms

Goal 2 Outputs

- Meetings, workshops, and teleconferences
- Interdisciplinary working group to establish common scenarios
- Modeled scenarios of water system change
- Environment Situation Rooms constructed at UU and USU

Possible Challenges

- The campus and disciplinary silo problem
- Relevant datasets are held by different agencies with varying degrees of public access
- Disparate model inputs, outputs, spatiotemporal domains, and platforms
- Need for more interdisciplinary training programs (IGERTs are pending)
- Lack of funding for personnel

Anticipated Outcomes or Impacts

- **Short-term:** Increased communication and collaboration across disciplines and campuses
- **Mid-term:** Identified and centralized datasets and models relevant to studying the natural-human water system
- **Long-term:** Improved understanding of the complex, coupled human-natural water system