

# iUTAH 2013



iUTAH: Preserving Utah's Water Resources



Exploring Gradients Along Mountain to Urban Transitions



Education, Outreach and Diversity



Building the Workforce of the Future



Introducing Our Team



## Did You Know?

iUTAH EPSCoR is a collaborative effort encompassing several universities, K-12 schools, non-profit organizations, industries and governmental partners across the state. This diverse network is dedicated to monitoring and improving water sustainability as well as enhancing the research infrastructure in Utah.

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## Letter from the Directors

It has been an exciting first year for iUTAH! A tremendous amount has been accomplished since we received the NSF EPSCoR award in August 2012, and we are very grateful to all the participants who have helped us create such a large collaborative network statewide. This is a crucial time to confront water sustainability issues in Utah and we are excited to be able to bring together such a talented group of individuals.

During our first year, we have established a vast network of collaborators and partners across the region. As of April 2013, we acquired over 100 statewide participants in the iUTAH project, including 2 new faculty members, 3 post-doctoral scholars and over 20 graduate students. We have also initiated our undergraduate iFellows research program with a cohort of 10 students statewide and have placed 5 interns in Utah agencies and companies. Our first Summer Research Institute, involving K-12 students and teachers with iUTAH faculty and student mentors, will take place in July and promises to be a successful integration of research and education.

We are also pleased to announce that we have successfully submitted our 2013 annual report to the National Science Foundation, highlighting all that we have accomplished in iUTAH thus far. During this time our Strategic Plan was also submitted and approved. These are significant milestones for our organization. Our performance this year has indicated dedication to addressing water sustainability issues as well as the capabilities of collaborative research. As our presence grows statewide, so does our opportunity to augment the STEM workforce in Utah, strengthen research infrastructure, and encourage education, outreach and diversity.

We are very pleased with the work that has been achieved so far and look forward to reaching new goals in the years ahead.



Rita Teutonico  
iUTAH Associate Director  
Utah EPSCoR State Director



Todd Crowl  
iUTAH Director  
NSF EPSCoR Director



Visit our website at [iutahepscor.org](http://iutahepscor.org) today to learn more about water sustainability research.

Follow us on Facebook and Twitter!



## Preserving Utah's Water Resources

iUTAH is a statewide effort dedicated to maintaining and improving water sustainability in Utah. Funded by the National Science Foundation's EPSCoR program (Experimental Program to Stimulate Competitive Research) this five-year, \$20 million competitive award will assist in building the human and research infrastructure needed to sustainably manage Utah's water resources. The award went into effect August 1, 2012. Unique to traditional research grants, iUTAH is a collaborative effort amongst researchers statewide. Participating institutions include: Utah State University, the University of Utah, Brigham Young University, and multiple other Utah institutions of higher education, government, industry and non-profit organizations. EPSCoR partners in Alaska and Wyoming are also collaborating. The Utah EPSCoR office coordinated this multi-partner effort with the support of Utah Science Technology And Research (USTAR). iUTAH will build critical observatory and modeling facilities across three Utah watersheds and create research teams from many Utah institutions, government agencies and the private sector. We will enhance interdisciplinary expertise and diversity through strategic recruitment of faculty and students. By building a collaborative community of scholars, iUTAH will integrate education & outreach activities with water sustainability practices, allowing us to effectively communicate with stakeholders and policy makers.



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Water makes up approximately 70% of the Earth,<sup>1</sup> yet it is one of the scarcest resources for a large portion of the world's population. Oceans contain about 96.5% of this water,<sup>2</sup> while freshwater makes up a scant 2.5%.<sup>3</sup> For this reason, many people go weeks without access to clean, accessible water.

By the year 2025, 1.8 billion people will live where water is scarce.<sup>4</sup>

This is sobering news. Water touches every aspect of our lives. Not only do we need to drink water in order to survive, we also use it to grow our food, maintain our health and hygiene, produce goods and provide services to our nation and the rest of the world. We must have water in order to travel any great distances, regardless of the method chosen. This influences our ability to trade with others, thereby affecting our economy.

In Karachi, Pakistan, water is improving health and saving lives. A simple hand-washing with soap and water helps children under age five to avoid diseases that kill more than 3.5 million of them worldwide each year.<sup>5</sup>

In Utah alone, 85% of the state's developed water supply<sup>6</sup> is utilized for agricultural purposes, which

means that Utah's population of almost 3,000,000 people<sup>7</sup> shares the remaining 15% of the water supply with the industry sector. Examples of industry are construction, mining, manufacturing, financial, education and health services, information, leisure and hospitality, and utilities.

Think about it. How many of these things are we willing (and able) to live without? As the nation's second-driest state, an accessible water supply is more crucial than ever for Utah's economic and industrial growth.

The driving force behind the iUTAH EPSCoR project is to combat these issues through improved knowledge and understanding of how we use water, how the hydrologic cycle is being affected by our choices and our current climate, and how we can maximize the precious resource. If we can find a way to conserve, preserve, and restore our watersheds, we can help bring hope to a very thirsty world.

Sources:

1. <http://ga.water.usgs.gov/edu/earthhowmuch.html>
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4. National Geographic April 2010, page 4.
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7. <http://quickfacts.census.gov/qfd/states/49000.html>



Did you know the average household in Utah consumes around 106,888 gallons of water on an annual basis?

# Water Shortage

# GAMUT

Samuel RIVERA

Photos by Omar PEREZ

## Gradients Along Mountain to Urban Transitions

The existence of water is essential for life on Earth. In fact, water approximates 66% of the human body. This water is made available to us through the water cycle, which involves water evaporating into the sky and then cooling and condensing into tiny drops or ice crystals that we see as clouds. It then falls back to Earth as rain, snow or hail before evaporating again and continuing the cycle. As soon as water touches the Earth's surface, it runs downstream following the terrain's natural channels until it is deposited into a larger body of water, using the stream network as a drainage system. Along the way, some of this supply is filtered into the ground, evaporated into the atmosphere, transpired by plants and contaminated by the different anthropogenic activities. Along this path, water is also diverted by humans for agricultural, domestic, industrial and recreational purposes. The main driving forces that move this cycle are gravity and solar energy.

As Utah is the second driest state in the nation and has a continuously increasing population and economy, an accessible water supply is critical. To address these issues, iUTAH seeks to better understand the interactions between urban form, environmental change, built water infrastructure, water use and decision-making. A central component

of iUTAH is to understand water cycle movements by building a network of climate and aquatic monitoring sensor stations called GAMUT (Gradients Along Mountain to Urban Transitions). The main purpose of GAMUT is to track every single drop of water that falls by method of precipitation, most often through rain and snow. The GAMUT network is designed to monitor this water movement along its transition from mountainous to urban environments.

GAMUT's climatic stations use state-of-the-art instrumentation composed of aquatic and terrestrial climate sensors which are being installed in three watersheds along the Wasatch Front: Logan river, Red Butte and Provo River. These sensors are a mix of fixed in situ sensors and several deployable or re-locatable sensors that are connected to a small computer known as the data logger. All devices are powered by solar energy and data can be seen in real time as it is acquired in the field.

This data is then remotely retrieved by cellular phone lines, telemetry (radio frequency) or satellite. For data storage purposes, iUTAH is also developing a cyber-infrastructure, which is a set of connected computers and servers. This is capable of retrieving massive amounts of water and climate data from the sen-

sors and storing it so it will be readily available for use by researchers, scholars, decision makers and the public. This historical climate and water data provides not only knowledge of prior water availability fluctuations, but also establishes a foundation for future predictions. By this method, scientists will be able to use computer models and other sophisticated techniques to forecast water availability under different scenarios. Possibilities include a doubled population size, an increased demand for agriculture and food, or a growth in urbanization. This information will also provide the basis for a better response due to a global warming effect, abrupt changes in temperature or precipitation regimes.

**By collecting, storing and analyzing important water-related data, iUTAH will assist in preserving water resources in Utah.**

First, iUTAH will provide a baseline scenario about the current state of the water supply. Second, it will provide a scientific-based approach to the decision making process for current and future water use. Third, it will provide the basis for long-term decisions on water use for a rapidly

growing population. GAMUT climatic stations are equipped to measure many environmental variables such as:

- temperature
- relative humidity
- wind speed and direction
- solar radiation
- precipitation and snow depth
- soil moisture
- conductivity
- dissolved oxygen
- ph levels
- turbidity
- nutrients
- algae and dissolved organic matter
- sap flow to estimate transpiration or water loss to the atmosphere from surrounding trees.

Instruments are charged with solar power and data is retrieved remotely via cellular line, radio frequency or satellite signal. Underwater sensors are installed to measure water quality and quantity passing through each specific stream channel. For instance, flow velocity and depth are used to calculate the amount of water and how it can change seasonally. These sensors also measure water quality variables such as water temperature, dissolved oxygen, solid particles, etc. Recorded data is transmitted immediately to a central database, where data is sorted and stored for further scientific analyses and predictions.

*Climatic Station set up to measure different environmental variables*



# Graduate Research and Social Sciences

## Adapting Water Infrastructure for Land Use and Climate Change



**Andrea Armstrong**  
*Doctoral Student in Natural Resource  
Sociology, Utah State University*

Ann Armstrong is finishing her second year of doctoral studies in natural resource sociology at Utah State University. A central focus of her dissertation research explores the critical role that local organizations play in managing and developing the infrastructure to deliver water to consumers during a period of rapid population and climate change. Some of these organizations include city water utilities, canal and irrigation companies.

Armstrong's iUTAH PhD fellowship has allowed her to conduct semi-structured interviews with managers associated with a wide range of water supply organizations in the three GAMUT study areas.

Interviews focus on improving our understanding of how irrigation companies and public utilities approach decisions about major investments in improved water delivery infrastructure located in the Wasatch Range Metropolitan Area (WRMA). Using social theory about organizational adaptation, Armstrong explores the impact of these institutions using individual water use patterns, considering the role of changing land use & clientele on the behavior of these organizations.

Initial results point to a significant amount of influence irrigation and canal companies where the transition from agricultural to urban land use is taking place. In these areas, the potential for increasing co-management of water infrastructure between irrigation companies (who often seek to improve the efficiency of their conveyance systems) and cities (who are required to address growing problems with stormwater management) is great. Armstrong's work also points to potential pathways for building new partnerships among institutions that might help coordinate the efforts of these two types of water organizations.

One unexpected finding has been the major role that private engineering firms play in shaping patterns of water infrastructure development in this region. Armstrong expects that engagement of the engineering community will be critical to future efforts to promote 'smarter' coordinated water infrastructure development.



*An example of formerly agricultural irrigation systems using city street gutters as their distribution network in Logan, Utah.*

# Explaining urban water-use patterns and Envisioning “water-smart growth” in the urbanizing environment

A critical component of the iUTAH effort is to enhance the capacity of Utah’s environmental social science community to contribute to interdisciplinary research on complex water systems. During this first year, a number of exciting social science research projects have been launched. While there is not room to review all of the ongoing collaborative efforts here, the work of three iUTAH doctoral research fellows illustrates the depth and breadth of social science efforts.



**Philip Stoker**  
*Doctoral Student in City and Metropolitan Planning, University of Utah*

Philip Stoker is a second-year doctoral student in City and Metropolitan Planning at the University of Utah. Working under the mentorship of Arthur C. Nelson and Sarah Hinners, Philip’s research has explored the determinants of water

use across residential, commercial and industrial buildings in Salt Lake City. His data suggests that single-family homes are the single largest users of water overall. However they use the least amount of water per acre than any other type of building (Figure 1).

Stoker also found that residential household water-use could vary significantly across buildings. Using models that predict water-use based on explanatory variables, Stoker’s analysis found that monthly temperature and precipitation are key drivers of overall residential water-

use, but that housing characteristics (number of rooms, area of turf grass and trees, and building size) and demographic factors (housing value and age of housing) also shape water demand at the building scale. For example, a large house with a pool and expansive lawn would use more water than a smaller house with no pool. This research examines a detailed database to understand the key drivers of urban water use in Salt Lake City and can be used as evidence to support the desinging a built environment for water conservation.

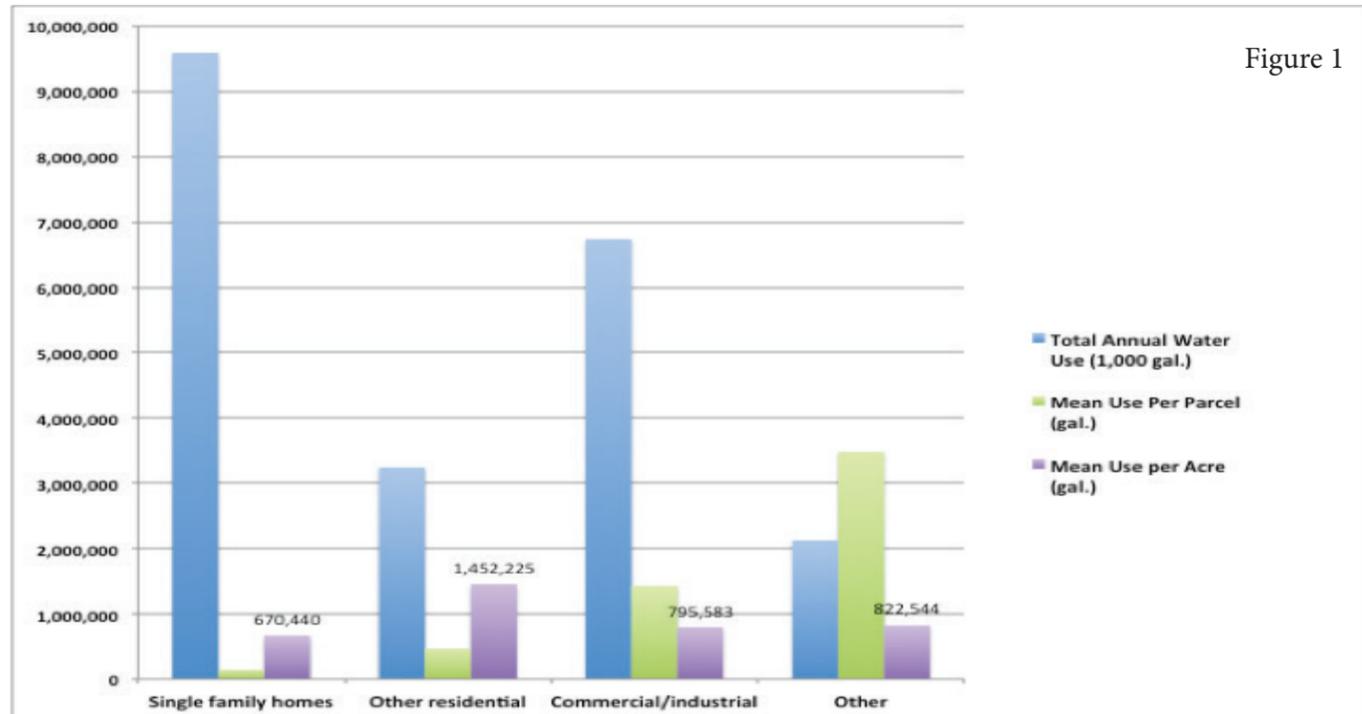


Figure 1



**Enjie Li**  
*Doctoral Student in Human Dimensions of Ecosystem Management, Utah State University*

Enjie Li is a third-year graduate student at Utah State University who completed her Masters in Bioregional planning before beginning her PhD studies in Human Dimensions of Ecosystem Management. During her first year with iUTAH, Li employed an urban growth model - SLEUTH, to simulate and visualize alternative futures for Cache County under a range of different planning and policy scenarios. Three alternatives were created to test different growth and policy theories: “currenttrends,” “smartgrowth”

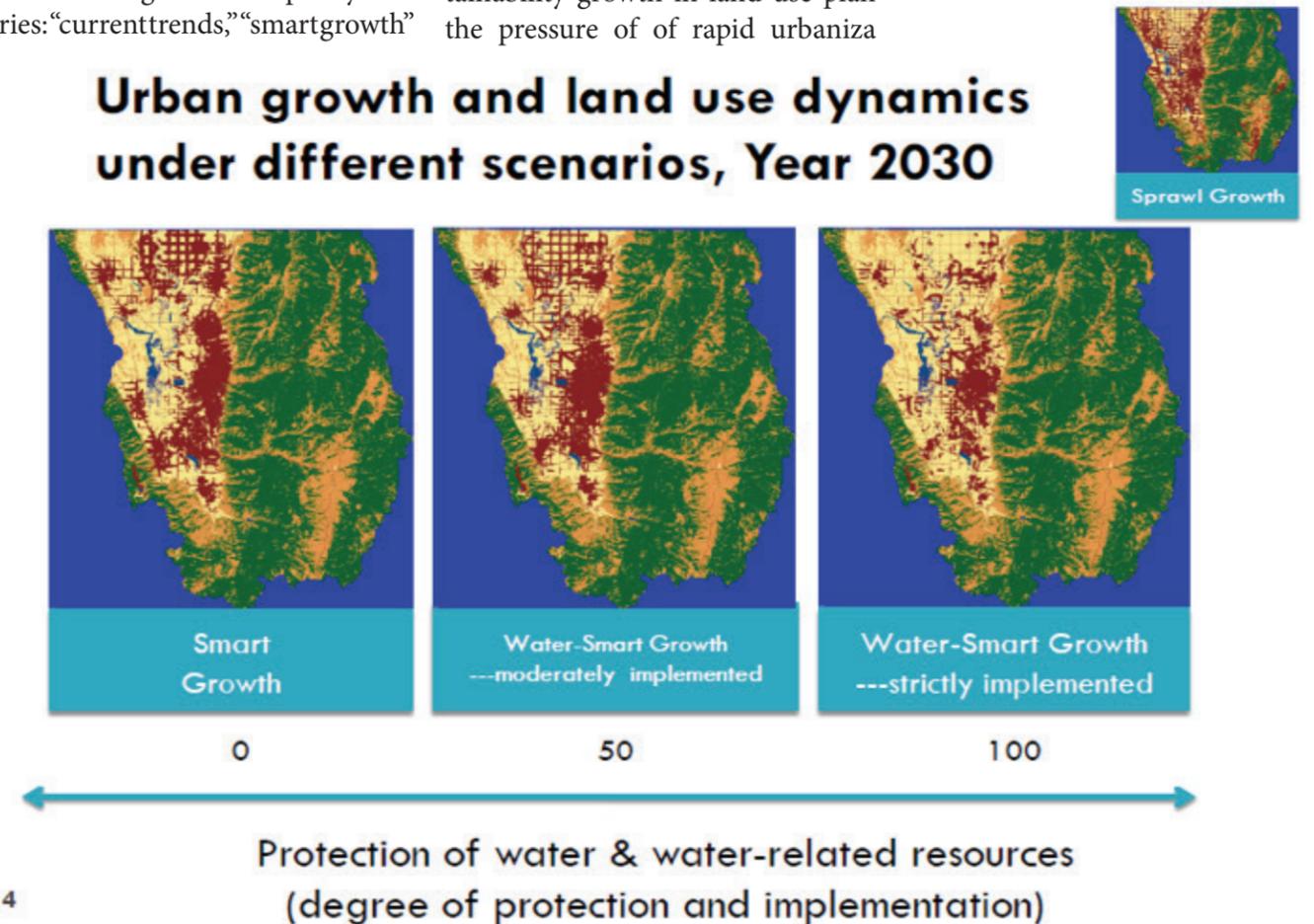
and “water-smart growth” in Cache Valley between 2007 and 2030 (a period of time in which the population is expected to almost double). The term “current trends” describes a baseline scenario in which growth and development will occur under current land-use regulations and management plans, with no further policy and regulation restrictions. “Smart growth” steers new urban development close to existing urban center and encourages high-density infill development and low rates land conversion of greenfield to urban. Smart growth is widely and popularly adopted in the real world urban planning practices all over the world. What makes her work unique is the development of a ‘water smart growth.’ She points out that little attention has been paid to water-sustainability growth in land-use plan the pressure of of rapid urbaniza-

tion and water shortage. The ‘water smart growth’ scenario, based on ‘smart growth,’ maximizes the potential to conserve water-related land resources and minimizes the amount of developed land. When she includes water factors in her growth simulations, she finds that the spatial pattern of development looks very different (see Figure 2).

Beyond the modeling efforts, her study recognizes the necessity of linking water and land in the planning arena. The next phase of her work is to develop a comprehensive and integrated water-land planning model to explore options to promote ‘water-smart’ oriented growth.

Figure 2

## Urban growth and land use dynamics under different scenarios, Year 2030





Top Left: Students filter nutrients from streams

Top Right: Hands-on water activities with the Natural History Museum of Utah

Bottom Right: Pie chart representing K-12 Teachers and Students who were directly reached by iUTAH's External Engagement programs in the first year.

# Education Outreach and Diversity

Ellen BURNS  
Photos by The Leonardo

It has been an exciting year for iUTAH Education, Outreach and Diversity (EOD). We are proud to report many successful outreach programs, and a continually growing list of collaborators statewide.

iUTAH has partnered with several museums in the state for the purposes of creating beneficial, authentic, and exciting engagement activities. Taking Learning Outdoors (TLO) is one such program. Developed and led by the Natural History Museum of Utah, TLO engages Utah teachers and students with NHMU staff, materials and science programming. iUTAH partnered with NHMU for the 2012-2013 school year in order to bring Utah EPSCoR researchers and graduate students to TLO pro-

grams in the Jordan School District. During this time, TLO made contact with more than 8,000 students and teachers in the district. Focusing on watershed issues, district educators were provided opportunities to study water resources in the field, following a single drop of water through the natural system and discovering local impacts to water from a variety of scientific topics.

Taking Learning Outdoors fosters an authentic outdoor learning experience and links local educators with scientists and watershed issues in their community. iUTAH hopes these interactions will better prepare them for integrating outdoor learning and hydro-sustainability in their own science curriculum.

iUTAH is working to engage the community through a variety of citizen science programs such as Utah State University's Utah Water Watch. Utah Water Watch has partnered with iUTAH to assist in bringing successful water monitoring to the Utah public. It conducted a series of training sessions to teach

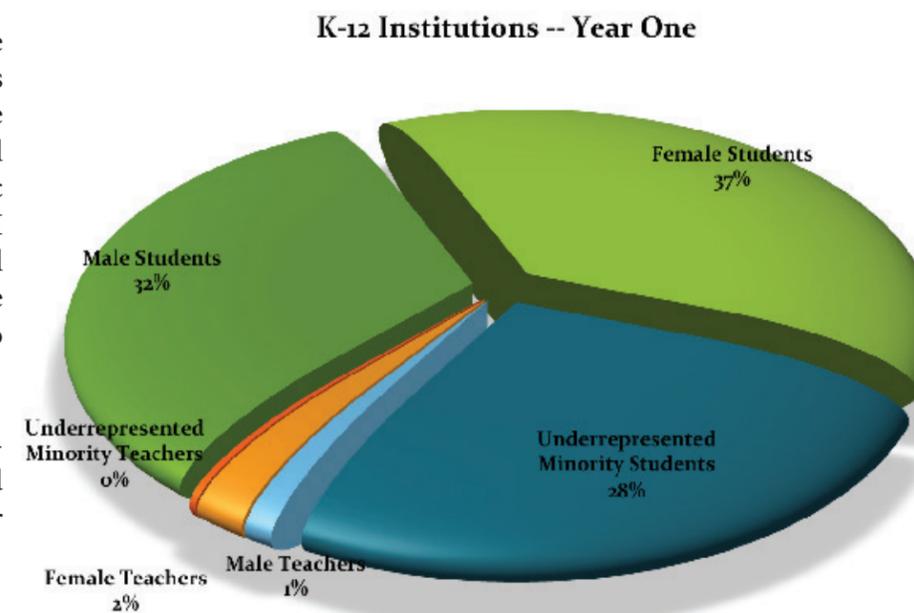
volunteers about water science, water laws, and how to conduct water quality monitoring. Utah State's Water Quality Extension also partnered with iUTAH to bring Citizen Science to high school students and educators in five schools statewide that represented a geographic, climatic, or cultural diversity. Through this program, students and teachers were able to learn about watershed science, climate change, and mathematics through monitoring rain barrels and gauges installed at each school.

Through direct interaction with the water monitoring process, students and teachers are able to experience data collection first-hand and feel like they are part of the scientific process. By this method, iUTAH hopes participating students will discover how science is accessible and a subject they have the ability to pursue in the future.

Along with Citizen Science programs, iUTAH EOD has engaged the public through various other events such as:

- Involvement with Utah State University's *Science Unwrapped*
- A screening of the documentary *Watershed* in conjunction with USU's Spring 2013 Runoff Conference
- The iFellow program, which partners undergraduate students with research mentors
- The development of the first annual iUTAH Summer Institute for Utah educators and students
- The sponsorship of speakers focusing on Science, Technology, Engineering and Math topics
- A Diversity Conference focused upon approaching teaching science from a culturally diverse standpoint
- The maintenance of a vast amount of communication resources

Over the next year, as iUTAH further develops its research infrastructure, we look forward to expanding our impact by broadening our reach across the state of Utah and engaging a diverse Utah population in water-related issues.





## Lauren PETTY

Photos by Omar PEREZ

Our Diversity Team is actively involved with promoting education and outreach activities to ensure that we recruit and retain participation and dedication from a diverse group of institutions and individuals across the state.

iUTAH funds support:

- Research fellowships for faculty at Primarily Undergraduate Institutions (PUIs)
- Reserach grants for middle school and high school teachers
- Collaborative research opportunities for undergraduate and graduate students
- Interdisciplinary postdoctoral fellowships
- Summer research institutes for teams of K-12 students and teachers, undergraduate and graduate students.

Advancements in water sustainability research are designed to have a measureable impact on diversity, education and outreach opportunities within the state through building greater connectivity with the public, creating jobs and strengthening infrastructure.

This year, iUTAH funded a scholarship for 500 elementary students to attend a series of in-depth water workshops hosted by the Leonardo Museum. The 90-minute workshops were associated with the museum's Water Exhibit, which featured a series of photographs by Australian photographer Paul Blackmore who focused primarily upon spirituality, recreation and conservation.

Blackmore's photos were spread throughout the museum gallery illustrating water consumption around the world and allowing visitors to visualize the dangers of water shortage. The correlating water workshops exposed visiting students and teachers to a number of water activities emphasizing the importance of water both locally and worldwide. These critical messages underlined why water is so important by drawing attention to the fact that, for many people, water is not available anymore. Classes from the Salt Lake City area were invited to take part in these workshops to learn about water and how we can better conserve this finite resource.

The messages highlighted by the Water Exhibit and illustrated in Black

more's photographs were remarkably similar to the underlying mission of iUTAH, which is to better understand how to preserve Utah's water resources. An important component of this mission is to develop hands-on learning activities for K-12 students and teachers for the purposes of faciliating and maintaining an interest in Science, Technology, Engineering and Mathematics education (STEM).

Through tactile interaction students can become directly involved with the process of scientific discovery, enabling them to form their own inferences of the world around them. iUTAH hopes to cultivate these attributes in order to build the next generation of researchers and increase the STEM workforce. This goal can be achieved through raising awareness, igniting interest and facilitating scientific engagement.

During its first active year, iUTAH-successfully provided a number of educational activities for the purpose of introducing students and teachers to potential STEM-related fields. The Natural History Museum of Utah sponsored a series of outdoor learning activities for K-12

students, providing them with an opportunity to conduct their own hands-on water research at the Bear River Watershed in Northern Utah. Activities included a series of water workshops, tests and scientific discussion focused on the topic of water sustainability. These water topics are among numerous subject areas

that can be integrated through outdoor learning activites, where students have the ability to acquire research, math and analytical skills as they explore scientific procedures. iUTAH participants consider it highly important that students can connect with Science, Technology, Engineering and Math education and not feel that it

is beyond their depth or understanding. Consquently, future Education, Outreach and Diversity activities will strive to promote messages that can help make scientific concepts and procedures more approachable to students and teachers. iUtah seeks to recruit and retain participation from educational institutions and stakeholders statewide.

## Miss America promotes Utah Women in STEM

Utah EPSCoR, along with USTAR, Prosperity 2020 and The Leonardo Museum hosted Mallory Hagan, the reigning Miss America in Salt Lake City on May 10, 2013. The event was organized in an effort to promote Utah women in Science, Technology, Engineering and Mathematics (STEM) education. Ms. Hagan, who studied biomedical science at Auburn University for one year before changing directions, spoke on the importance of igniting an interest in science at an early age.

"There are so many kids across the nation who don't have a favorite subject, who don't enjoy school, and they are in the first, second and third grade," she said. "That's really disheartening because we want kids to want to learn. We need to catch them early on, otherwise there's no hope for the rest of their education process."

Ms. Hagan specifically stressed the importance of providing strong mentors who have the ability to illustrate the diverse opportunities available to students through science. According to Ms. Hagan, science is often perceived to be difficult and therefore out of reach for most students. Consequently, she addressed the need to make science more approachable by

connecting it to activities and topics that would interest young people.

"We can do that by showing them the really cool careers that come out of STEM," she said. "There are so many kids who just don't know. They don't understand that there's so much they can do."

Ms. Hagan was able to interact with a diverse group of students, beginning with Utah State University's Sunrise Session at the Little America Hotel. During a private breakfast with female undergraduates, Ms. Hagan discussed her personal experiences with higher education and the importance of STEM. She later spent the afternoon at the Leonardo Museum with K-12 students, exploring science at designated workstations, where students were able to explore art, physics and digital design.

Miss America's visit to Salt Lake was a valuable addition to a larger campaign designed to encourage STEM education statewide. The 2013 Legislature recently appropriated 10 million dollars for a STEM Action Center, which will be used to enhance STEM education in K-12 institutions across the state. During her stay, Ms. Hagan also participated in a Prosperity 2020 press event at the Salt Lake Chamber

of Commerce, where the Executive Board of the STEM Action Center was announced. These members later spoke on the importance of STEM education in Utah.

Utah EPSCoR was delighted with the success of the day spent with Miss America 2013, promoting STEM education in Utah.



# Building the Workforce

# of the Future

Jennifer SCHULTZ  
Photos by Ellen BURNS

iUTAH currently supports 20 graduate students and 10 undergraduate research fellows (iFellows). The iUTAH project sponsors these students in academic research, providing valuable training and experiences that transcend traditional university-level curriculum.

Undergraduate iFellows are the beneficiaries of near-peer and formal mentoring from a research professor or industry professional in their respective fields. Near-peer mentoring is one-on-one guidance offered by a graduate student in the same research focus area as the iFellow. This type of mentoring provides iFellows with an opportunity to interact with and learn from someone who is nearer their level of understanding. The near-peer mentor is also able to offer more individualized support in areas such as fieldwork and data coll-

ection. This method is a very important aspect in building a greater STEM workforce.

iFellows have the chance to give back some of what they have learned via the Summer Institute Program. Summer Institute (SI) participants are 9-12 grade students and Earth Science teachers who work with undergraduate and graduate students to conduct research in the Red Butte Watershed. They also aid in the development of curriculum materials that will help tie information gained through the SI experience to what is taught in the classroom.

iUTAH graduate students have been hard at work studying the various aspects of hydro-sustainability this year. Their research covers everything from snowmelt, runoff and groundwater, to water management, decision-making and everyday uses of our water in residential, urban and agricultural settings. Through these projects, iUTAH

hopes to gain a better understanding of how we can more effectively utilize the water resources we currently have in order to sustain a growing population. Some of these projects focus more on data collection and storage via urban growth, water demand modeling and cloud-based computing. Others take more nature-based approach, studying snowmelt, evaporation, precipitation and how we can affect the urban water cycle by the strategic use of certain types of trees.

iUTAH's Graduate Fellows present their research findings at various conferences throughout the school year. In addition to this, many are involved in writing research papers for publication and presentation. We hope to inspire these students to continue on their paths toward joining the STEM workforce and advancing STEM research.



# iUTAH Team

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