June 2018

The Water bLog newsletter

Utah Center for Water Resources Research at the Utah Water Research Laboratory

Message from the Director

There's no doubt about it; good data is essential to good water management. Increasing demands for water will be best addressed through more intensive and flexible management of the resource, and this will be best facilitated by acquisition and use of good data.

In this issue, we highlight two very different projects, both of which focus on meeting Utah's need for ongoing long-term data to inform future decisions about water resources management. The first discusses the establishment and the future of the Logan River Observatory's monitoring infrastructure—a valuable resource that is supporting local policy and water management decisions that address local water related challenges.

The second project uses tree ring data, combined with advanced computer modeling, to identify a wide range of drought scenarios that Utah may face in the future. Knowing the types and durations of drought events that have occurred in the past can help water managers project how such an event would affect water systems under current populations and demands and the actions that might mitigate those effects.

These projects represent only a fraction of the active research underway at the UCWRR aimed at solving water-related natural resources problems throughout Utah, the nation, and the world.

Mac McKee, Director

The GAMUT sensor network along the Logan River produces realtime data used in a wide range of water quality and quantity research and management.

Welcome!

The Water bLog is the semi-annual newsletter of the Utah Center for Water Resources Research (UCWRR), housed at the Utah Water Research Laboratory.

The Center supports the development of applied research related to water resources problems in Utah and promotes instructional programs that will further the training of water resource scientists and engineers.

Each issue of The Water bLog reports on a small selection of current or recently completed research projects conducted at the center. More information is available online at:

http://uwrl.usu.edu/research/ucwrr/

INSIDE

UtahStateUniversity

Going with the Flow:

from iUTAH to the Logan River Observatory

In 2012, a collaborative group of water researchers from northern Utah had the idea for a new project that would allow researchers to integrate and share social and biophysical water data and create infrastructure (human, observational, and cyber) that would lay a foundation for addressing water, population growth, and climate change issues that will confront the State of Utah in the coming years.

iUTAH and GAMUT

The resulting EPSCoR (Established Program to Stimulate Competitive Research) funding award from the National Science Foundation launched iUTAH (innovative Urban Transitions and Aridregion HydroSustainability), which was a 5-year, multi-institution, interdisciplinary project focused on water sustainability in Utah.

Over the past five years, iUTAH has been widely recognized for its well-established environmental sensor networks across the state. The GAMUT (Gradients Along Mountain to Urban Transitions) network is one of the project's lasting legacies. GAMUT has 42 aquatic and climate sensor stations, measuring and recording a wide range of climate, hydrology, and water quality parameters along the Logan River, Red Butte Creek, and the Provo River.

From diagnostics and restoration of impaired urban rivers to modeling future water availability, the data help identify irregularities and patterns in Utah's waterways. The sensor network logs and transmits the data, which is then stored in databases and made publicly available via web-based, open access cyberinfrastructure tools, such as the HydroShare online data repository. The sensor networks and information streams established by iUTAH have laid a solid foundation for better water management in Utah.

"One of the weaknesses that we as a city face is having good quality data to evaluate water quality impacts," says Lance Houser, formerly with the City of Logan as Assistant City Engineer. "The advantage of collaborating with iUTAH is that they provide us with a data management source for collecting data, including quality control. Then they store and warehouse it so that it is not just available to Logan City, but also to all of the irrigation and canal companies, state agencies, the EPA, and researchers who are concerned about water quality."

The Logan River Observatory

Now as the iUTAH project comes to a close, the Logan GAMUT network is transitioning to become the Logan River Observatory due to continued support from the USU Office of Research and Graduate Studies, the College of Engineering, the College of Natural Resources, the Ecology Center, and the Utah Water Research Laboratory. Drs. Bethany Neilson, Jeffery Horsburgh, and Michelle Baker are working to maintain and expand the partnerships forged over the past five years to ensure that the wealth of data continues to benefit the stakeholders who rely on it.

"Thanks to iUTAH, the GAMUT infrastructure is already in place and we have some key baseline data," says Dr. Neilson. "Now with the Logan River

Photo courtesy iUTAH

Observatory, we will be able to continue long-term data collection throughout the Logan River basin and expand the infrastructure in Cache Valley to address local water management questions. The Observatory will provide a foundation to develop new partnerships with various stakeholders and an opportunity to engage with the community to protect this valuable local resource."

What's Next?

The Logan River Observatory team will work with various stakeholders, including Cache Water District, Logan City, the Nature Conservancy, the Utah Division of Water Quality, and the Logan River Task Force, to build and support existing infrastructure. For example:

- An upcoming project is expanding the monitoring network to include stormwater monitoring in local canals.
- The team will further encourage the use of these data sets in K-12 and community education via educational outreach activities.
- They will also work to establish the Observatory as a teaching watershed to train university students in water-related fields.

After the iUTAH project ends this summer, the Logan River Observatory will continue to provide data to inform local policy and water management decisions to address water related problems (stormwater, Total Maximum Daily Load studies, etc.).

Over the coming years, the Logan River Observatory team will continue to develop partnerships with individuals and groups, both in the valley and across the state, who are interested in monitoring, understanding, and managing local water systems.

Water quality and quantity data from Logan River Observatory sensors are used by scientists and water managers to help them plan for Utah's future.

Photo by, Dane Brophy

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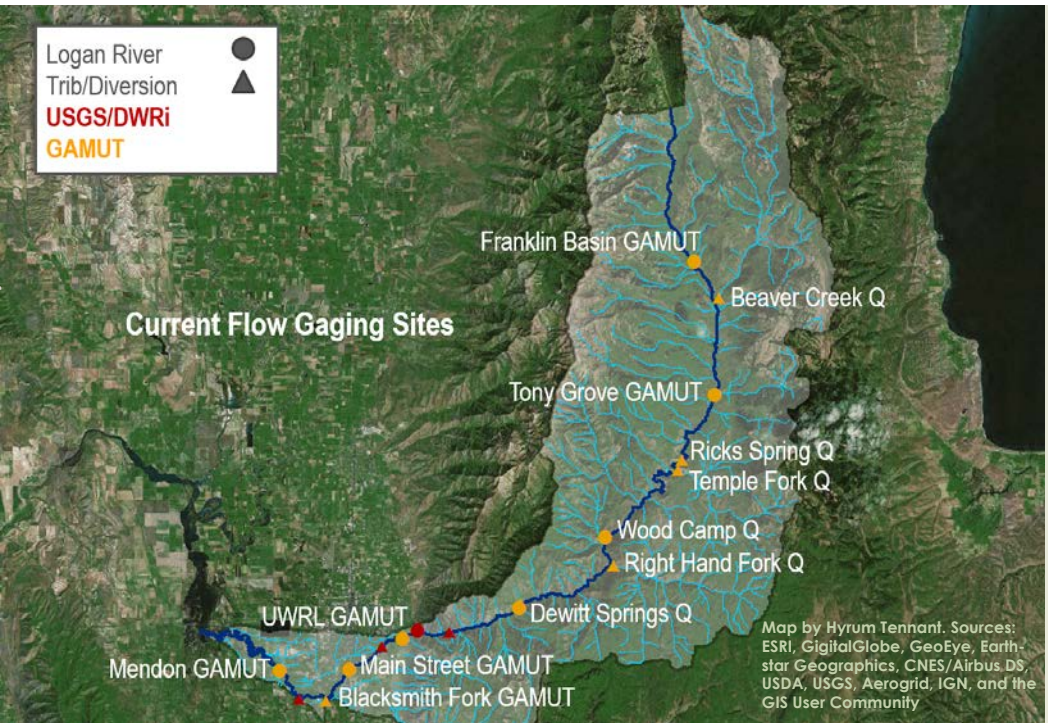
Collaborators: Jeffery Horsburgh, Michelle Baker

Logan River Observatory Watershed Technician: Patrick Strong



More information and access to Logan River Observatory data can be found at:

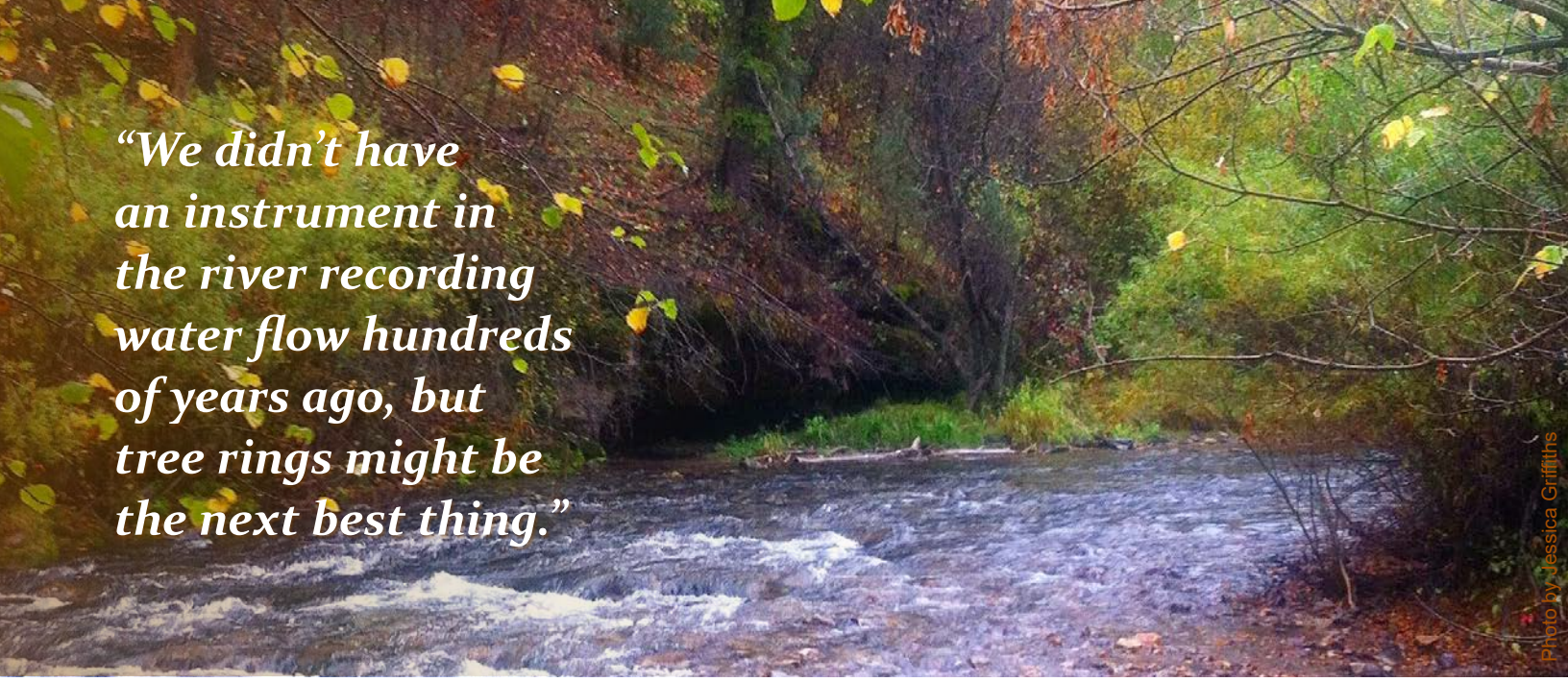
http://data.iutahepscor.org/mdf/Data/Logan_River/

See also:

http://iUTAHepscor.org

http://hydroshare.org

http://iutahepscor.org/data_modeling/gamut.shtml



Tracking Droughts with Tree Rings:

looking to the past to prepare for the future

Tree rings can offer a wealth of information stretching far into the distant past, well before any human thought about collecting river data.

Historical climate reconstructions from tree rings can help to characterize, as nearly as possible, natural climate variability, which can then provide context for climate change projections. By looking into the past at the data hidden between those rings, water managers can gain a sense of the magnitude, frequency, and duration of extreme events that we may face today or in the future.

Tree section from the USU collection (photo by Justin DeRose).

However, using annual reconstructed flow to estimate water vulnerability has been challenging because the reconstructions typically provide only one flow value per year (from a single tree-ring chronology). This limitation means that tree ring data have not been easily integrated into water systems models or drought planning efforts. Knowing monthly streamflow is key in Utah and around the world, where seasonal, not annual flow, often determines how reservoirs fill, when shortages happen, and the impacts to cities and agriculture.

A new solution

To address these challenges, Dr. James Stagge, post-doctoral fellow at the Utah Water Research Laboratory, has developed a novel modeling approach that reconstructs monthly streamflow from annual tree rings.

"Our earliest river gauges are about 70 to maybe 100 years old," noted Stagge. "That gives us a relatively small catalog of drought events to compare against. We didn't have an instrument in the river recording water flow hundreds of years ago, but tree rings might be the next best thing. We are very fortunate to have some of the oldest trees in the world here in the western U.S."

Dr. Stagge, along with his advisor Dr. David Rosenberg and fellow USU colleagues from the Department of Geology and the US Forest Service, used tree-ring chronologies from seven tree species at various locations and elevations. The different species at different elevations respond to the changing seasons at different times of the year and in distinct ways and record unique parts of the seasonal flow. Their model overlaps the tree-ring chronologies and combines annual streamflow and climate data to arrive at monthly streamflow estimates. To date, Dr. Stagge has reconstructed monthly streamflow series dating back to the year 1605 CE on the Logan River and 1400 CE for both the uppermost Bear River gage on the Utah-Wyoming border and the Weber River at Oakley, UT.

"We can now reconstruct 500–600 years or so more streamflow beyond

our gauges, giving us seven times more drought events," said Stagge. "Now we can test our system see how we would fare in a major drought from the past."

Managing drought impacts

The Bear River water systems model expanded for this research can simulate the likely impacts if these distant historical droughts were to re-occur in the near future. The model can show managers how susceptible our water supply might be to these historic droughts at current populations. It can also suggest reservoir, diversion, and water demand management strategies to reduce any identified risks.

Dr. Stagge has collaborated extensively with water managers and other Utah stakeholders to develop and make better use of this new data source, such as:

- Adding reconstructed droughts to the Weber Basin Water Conservancy District Drought Contingency Plan.
- Expanding the Bear River water supply model upstream from the Cub River to include demand and reservoir operations up to and including Bear Lake.
- Validating model results and model assumptions with PacifiCorp and Utah Division of Water Rights.
- Creating a web platform to make the streamflow reconstruction data publicly available.

What's Next?

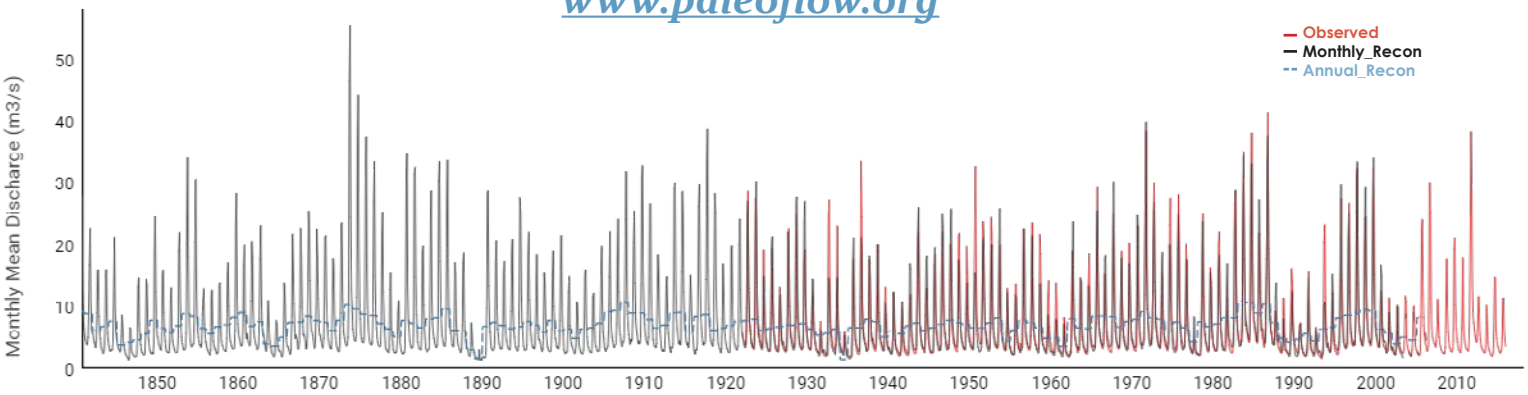
On the PaleoFlow website, visitors can access the flow reconstruction data to:

- visualize reconstructed flows over multiple centuries and interact by zooming in on specific periods.
- find extreme flows below a threshold,
- easily compare any two historical periods, and
- visualize the goodness of fit, relative to observed flows.

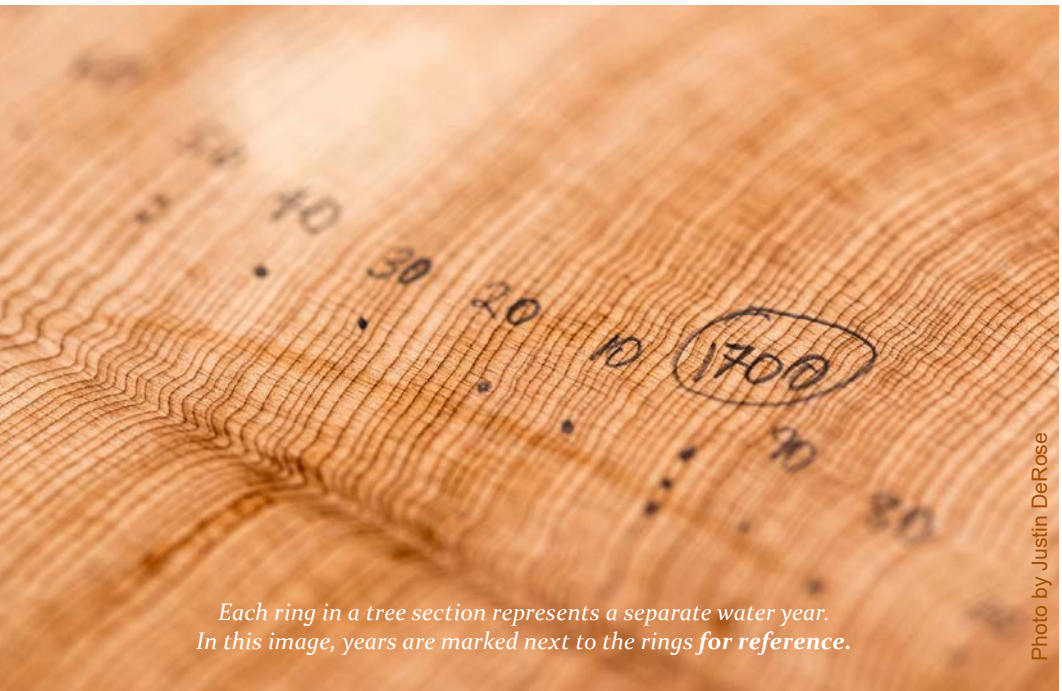
The site (www.paleoflow.org) currently includes the three monthly reconstructions created by Dr. Stagge and more than 100 annual reconstructions, with more added all the time.

With this new online tool, water managers can start looking at what major droughts from hundreds of years ago might mean for today's water supply.

www.paleoflow.org



Example of a reconstructed monthly time series overview for the Logan River at State Dam from the PaleoFlow website.



Each ring in a tree section represents a separate water year.
In this image, years are marked next to the rings ***for reference.***

Photo by Justin DeRose

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Co-Authors: Tammy Rittenour (Geology), R. Justin DeRose (USFS)

Collaborators: Derek Johnson and Darren Hess, Weber Basin Water Conservancy District; Connely Baldwin and Eve Davies, PacifiCorp

Darwin Sorensen:

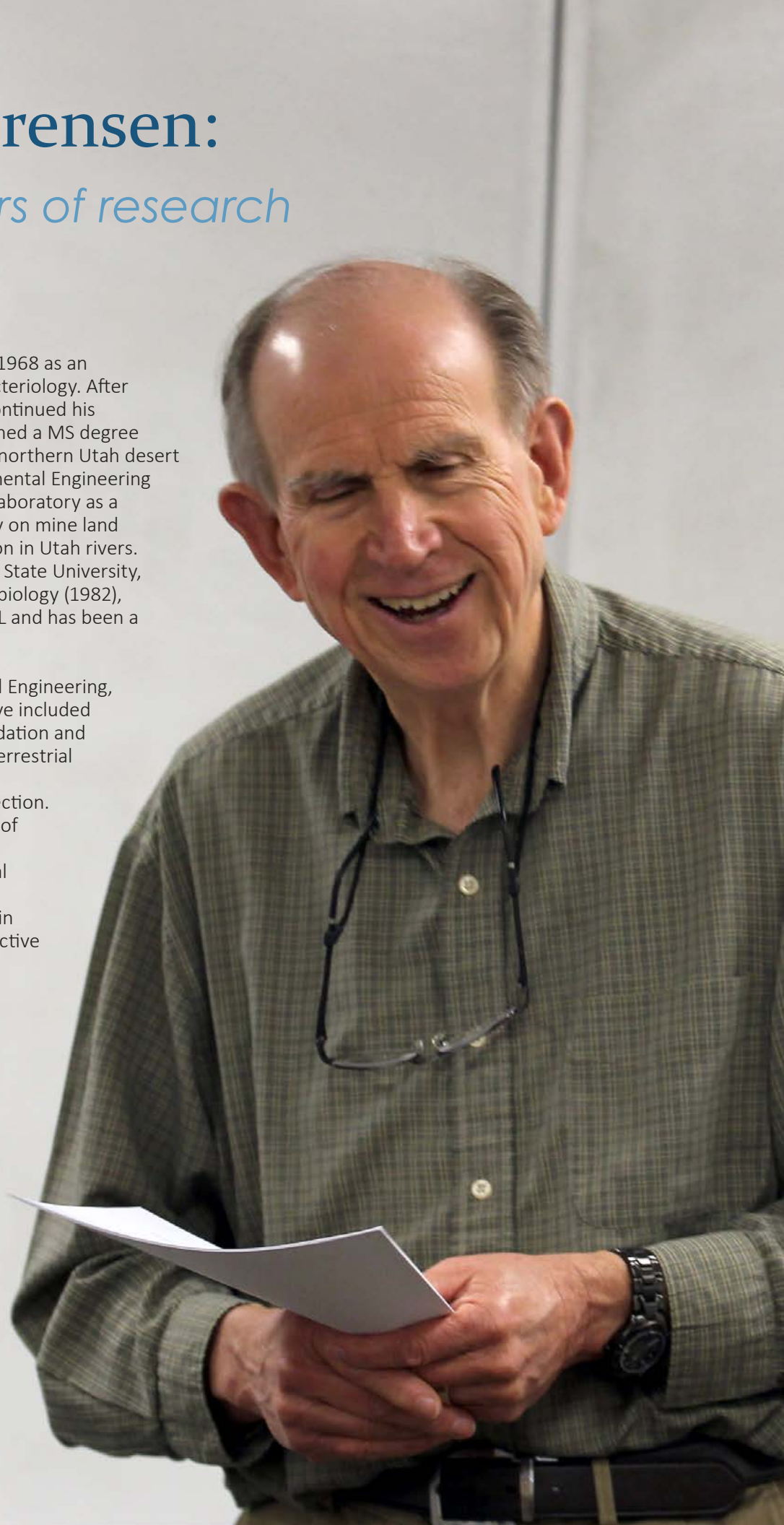
43 great years of research and teaching

Darwin L. Sorensen came to USU in 1968 as an undergraduate student studying bacteriology. After receiving his BS degree (1972), he continued his bacteriology studies at USU and earned a MS degree (1975), studying nitrogen fixation in northern Utah desert soils. In 1974 he joined the Environmental Engineering group at the Utah Water Research Laboratory as a Research Scientist, working primarily on mine land reclamation and waste load allocation in Utah rivers. In 1979, Darwin headed to Colorado State University, where he completed a PhD in Microbiology (1982), after which he returned to the UWRL and has been a fixture here ever since.

As a Research Professor of Biological Engineering, Dr. Sorensen's research interests have included microbiological ecology of biodegradation and bioremediation, nutrient cycling in terrestrial and aquatic systems, and watershed management for water quality protection. He has expertise in characterization of organic contaminated water and soil environments; aquatic and terrestrial microbial assays; biodegradation of polynuclear aromatic hydrocarbons in land-based treatment systems; reductive dehalogenation of trichloroethene in contaminated aquifers; source water protection assessments; and nitrate contamination susceptibility assessments for shallow aquifers.

After nearly 43 years of tireless research and dedication to training the next generation of environmental engineers, Dr. Sorensen has decided to finally hang up his water engineer's hat.

Along with the multitude of students and colleagues you have influenced with your patience, kindness, and expertise, we thank you, Darwin, for a great 43 years at the UWRL. We wish you all the best!



what students and colleagues say...

"My experiences with Darwin span my entire career as a college student and a good chunk of my professional career. I remember Darwin as the instructor of my undergraduate Environmental Management and Regulations class where I got a great base in the laws and regulations that I would encounter as an Environmental Engineer. Darwin was very supportive as a member of my Master's committee; I very much appreciate his role in shaping me as a student and helping to direct me in the trajectory that I am now on."

—Jeff Horsburgh, Associate Professor, UWRL/CEE

"I have known, worked with, and respected Darwin for more than 30 years since the first day I set foot in the Water Lab. Darwin and I have worked on a variety of projects over the years and I have truly valued his science approach to problems we've tackled together."

—R. Ryan Dupont, Professor, UWRL/CEE

"I appreciate that he guided me toward interesting research questions, but still allowed me to be independent and pursue topics interesting to me. He made my graduate experience rich and rewarding."

—Christine Rumsey, former graduate student

"Dr. Sorensen has many admirable qualities that have made our collaborations enjoyable. He is a patient man, and willing to take time to talk things through to achieve understanding for the listener. I have also seen acts and attitudes of kindness in his interactions with students, which I not only admired but also try to emulate in my own relationships with students."

—Joe Stewart, Research Engineer, UWRL

"I had the privilege to work with Darwin many different times when I served as a committee member in graduate student committees. ...Darwin is genuinely a caring person and wants to help students advance in the research area and provides the best help needed to achieve research goals."

—Jagath Kaluarachchi, Dean, College of Engineering , USU

I have known Darwin for many years and always have appreciated the opportunity to work with him on various research projects... I have developed a great respect for his high level of professional integrity, for his conscientious devotion to his profession, and for his ability to work effectively with others. He has been a wonderful colleague and friend."

—J. Paul Riley, Professor Emeritus, UWRL/CEE

"Dr. Sorenson... was one of the first Environmental Engineering faculty I interacted with as an undergraduate. His extraordinarily positive attitude and dedication to students made me want to continue in Environmental Engineering. To this day, I hope I can display many of the same qualities to my students and encourage them to want to continue learning."

—Bethany Neilson, Associate Professor, UWRL/CEE

"Dr. Sorensen was continually a great support. He was always willing to discuss ideas or roll up his sleeves and get to work in the lab or field. Not only did he teach by what he said, but also by what he did. I am very grateful for his guidance and example."

—Lindsey (DeBoer) Carrigan, former graduate student

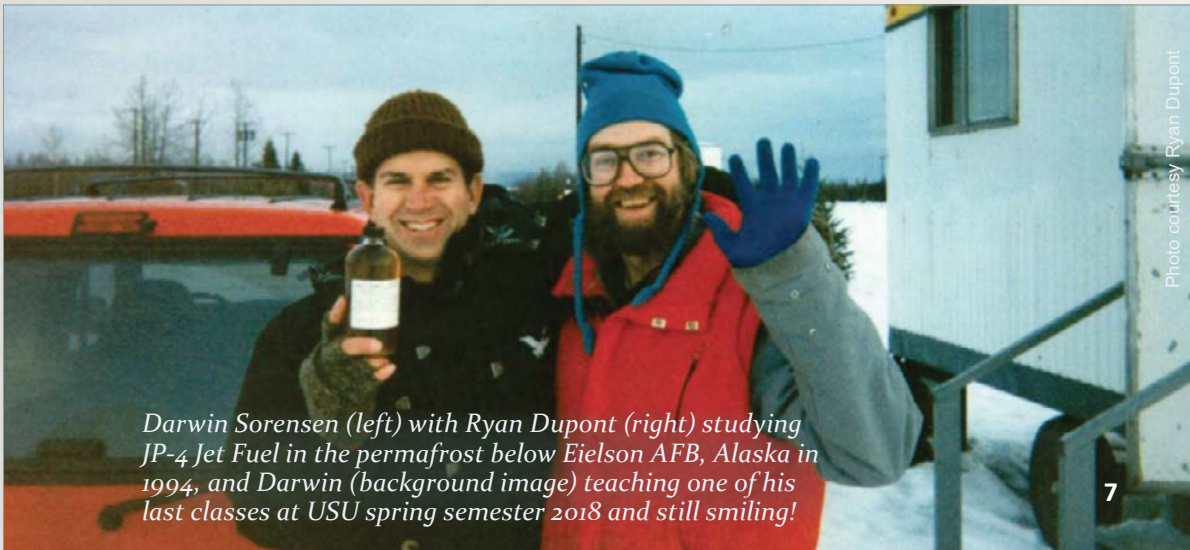


Photo courtesy Ryan Dupont

Darwin Sorensen (left) with Ryan Dupont (right) studying JP-4 Jet Fuel in the permafrost below Eielson AFB, Alaska in 1994, and Darwin (background image) teaching one of his last classes at USU spring semester 2018 and still smiling!

Featured Researchers:

Bethany Neilson

is an Associate Professor in Civil and Environmental Engineering. Her current research centers on developing new data collection and modeling approaches to quantify groundwater/surface water interactions and the associated influences on in-stream water quality and temperature regimes. Her research has spanned desert rivers, arctic river systems, low gradient agricultural rivers, and high gradient mountain streams. Many of her projects focus on advancing our understanding of dominant processes in natural systems, however, her research group also seeks to find ways to apply the resulting knowledge and tools to assist in watershed management decisions.

Her recent research projects have focused on understanding the role of groundwater/surface water exchanges on instream temperatures and carbon fluxes in areas of continuous permafrost, longitudinal solute trends in a karst mountainous watershed, instream temperature and habitat in areas influenced by beaver dam complexes, and nutrient transport in regulated river reaches.

James Stagge

is a hydrologist and civil engineer with a primary research focus on understanding hydrologic extremes, with the goal of decreasing drought vulnerability. He currently works as a post-doctoral researcher in the Department of Civil and Environmental Engineering at USU and at the Utah Water Research Laboratory generating paleo-streamflow time series and applying these to a water systems model.

Prior postdoctoral work at the University of Oslo dealt with quantifying observed and projected drought risk across Europe as part of the EU-funded Drought R&SPI project. James received his PhD in Civil Engineering from Virginia Tech University, focusing on water resources optimization in the Washington DC area and received his MS and BS degrees in Civil Engineering from the University of Maryland.

Dr. Stagge recently accepted a faculty appointment at Ohio State University's Department of Civil, Environmental, and Geodetic Engineering for Fall 2018.

In the News:

2019 UCOWR Conference

USU is pleased to be sponsoring the UCOWR Annual Conference in summer 2019 at Snowbird, UT.

The Universities Council on Water Resources (UCOWR) is an association of universities and other organizations leading out in water resources education, research, and public service.

The eight UCOWR delegates at USU, Jeff Horsburgh, Jagath Kaluarachchi, Mac McKee, Laurie McNeill, Bethany Neilson, David Rosenberg, David Stevens, and Joe Wheaton, represent a wide range of water resources expertise and research. Seven of the eight delegates are UWRL/UCWRR faculty members.

Fulbright Fellowship

In January 2018, Dr. Randy Martin headed to Nablus, West Bank, Palestinian Territories to begin his Fulbright Fellowship there. In this combined teaching/research fellowship, Dr. Martin is working with Dr. Abdelhaleem Khader at An-Najah National University to develop an air pollutant monitoring program for the city and Governorate of Nablus, West Bank, Palestinian Territories and establish an active and sustainable air quality education and research program at the University in Nablus.

Dr. Khader is a former USU graduate student and visiting scholar and will return to USU next summer on his own Fulbright Fellowship to continue his collaborations with Dr. Martin.

Faculty/Student News

Faculty promotions:
Congratulations to Dr. Neil Allen for achieving tenure as a full professor and to Dr. Jeffery Horsburgh for his early promotion to Associate Professor. We are delighted to recognize their hard work and dedication.

New College of Engineering Dean:
The UCWRR is pleased to welcome Utah State University professor and administrator Jagath Kaluarachchi as the new dean of the USU College of Engineering. Dr. Kaluarachchi brings extensive expertise and leadership to the position, including several years as associate and interim dean.

Student Award:
USU/UWRL graduate student Adel Abdallah received the American Water Works Association Intermountain Section 2018 Diversity Scholarship. This scholarship is presented annually to one outstanding minority student pursuing education in the field of conservation, water quality, supply, resources, reuse or treatment.


Photo by Jessica Griffiths

Future Issues

"Tracking and transforming toxic algae blooms"

(AggieAir remote sensing and anaerobic digestion help to manage toxic algae blooms at Scofield Reservoir while the algae generates power)

"Assessing the effects of OSS adjuvants on bee colony health"

(Identifying the pathways of pesticide spray from plant uptake to pollen and potential impacts on bee mortality)

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