The Water bLog

newsletter

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

Message from the Director

As 2022 comes to a close, concerns remain about the extremely dry conditions in Utah and the American west. The Great Salt Lake continues to shrink, threatening our air quality, the ecosystem, and the economic productivity the lake supports. These concerns, shared by leaders and researchers throughout the state, have led to the creation of the Great Salt Lake Strike Team, which I was invited to join, along with several USU colleagues. The Strike Team, featured in this edition of the Water bLog, is intended to provide guidance to decisionmakers concerned about the lake. I am glad the UWRL could have representation on this team, and I look forward to contributing to these difficult, but important, solutions.

David G. Tarboton,
UWRL /UCWRR Director

With so much of the water destined for the Great Salt Lake diverted before it gets there, it is important that we conserve by diverting only what we need and using that water efficiently. UWRL professors Cal Coopmans and Alfonso Torres-Rua are helping to increase agricultural efficiency through the use of small uncrewed aerial systems (sUASs), such as AggieAir, that better quantify and provide timely, accurate information on agricultural water use and demand. Coopmans and Torres-Rua are developing software to efficiently process data from UASs and quantify growers' irrigation needs right away, allowing them to irrigate more efficiently.

Another story highlights research on microplastics in remote mountain regions. Professor Kyle Moor is working with the UWRL's Logan River Observatory (LRO), which has extensive research stations throughout the Logan River watershed, to understand the prevalence and fate microplastics are in these waters.

Finally, we are pleased to welcome three new faculty—Joanna Hou, Pin Shuai, and Yiming Su—to the UWRL. We're glad you're here! ∎

David Tarboton, UWRL/UCWRR Director

The projects highlighted in this issue of the Water bLog represent only a fraction of the active research in which the faculty experts at the UWRL/UCWRR are engaged as they continue to generate the knowledge needed to solve water-related natural resources problems throughout Utah, the nation, and the world.

Welcome!

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

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:

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

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Research Highlights:

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⬥ **Breaking It Down:** *how microplastics degrade in high mountain regions*

In the News

Advances over the past decade have made AggieAir sUAS technology and data products increasingly valuable and accessible for precision agriculture and other scientific applications.

UtahState**University**

The Great Salt Lake Strike Team:

collaborative solutions for a shrinking Great Salt Lake

A new group of researchers and experts that will identify solutions to the ailing Great Salt Lake includes two UWRL faculty members

It is no secret that Utah's Great Salt Lake is facing unprecedented challenges. Over the course of the last two decades, the lake has shrunk to levels unseen since measurements were first recorded. This drop threatens the collapse of both an important ecosystem and Utah's brine shrimp and mineral extraction industries. The shrinking lake also exposes a drying lakebed, leaving behind toxic dust that is blown into the open air. A group of researchers and state leaders have come together in a joint effort to evaluate potential solutions as state leaders explore options for restoring the lake.

The resulting Great Salt Lake Strike Team involves three Utah research institutions and one state agency: USU's Janet Quinney Lawson Institute for Land, Water and Air; the University of Utah's Wilkes Center for Climate Science and Policy; the Utah Department of Natural Resources and the University of Utah's Kem C. Gardner Policy Institute. Each

individual member of the Strike Team hails from one of these institutions.

USU's contribution includes two UWRL faculty members: David Tarboton and Bethany Neilson. Additional members from USU include Anna McEntire, Associate Director of the Institute for Land, Water and Air; Joanna Endter-Wada and Sarah Null from the College of Natural Resources; and Matt Yost from the College of Agriculture. In addition, Brian Steed, who is the Executive Director of the Institute for Land, Water and Air, also serves as one of the four co-chairs of the Strike Team.

Having begun its work in August 2022, the Great Salt Lake Strike Team is not a typical academic research collaboration. The team's primary goal is to synthesize research, evaluate options, and inform policy under consideration by the Utah Legislature before 2023 General Legislative Session in January. The dimension of urgency in the group prompted the "strike team" moniker.

Before this, however, the Strike Team had the opportunity to present initial ideas and data at the second annual Great Salt Lake Summit hosted by Speaker of the Utah House of Representatives, Brad Wilson. The Strike Team spent the preceding weeks and months preparing their report for the October 13th event, which featured lawmakers, managers, and researchers from throughout the state of Utah discussing ideas for restoring the Great Salt Lake. Steed and William Anderegg, director of the Wilkes Center for Climate Science and Policy at the University of Utah, presented the Strike Team's report.

Much of the report focused on trends affecting lake levels, flows into the lake, precipitation, and air temperature in northern Utah. Since the highest recorded levels in the mid-1980s, the lake has undergone a steady decline. With the surface at 4,189 feet above sea level, 2022 has been the lowest year for the lake yet. While the three major rivers that flow into the Great

Estimated Contribution to Current Record Low Elevation

Policy Lever

Natural Variability	Direct Evaporation from Climate Warming	Natural and Human Consumptive Use
Estimated Impact: 15–23%	**Estimated Impact:** 8–11%	**Estimated Impact:** 67–73%

Salt Lake (Bear, Weber and Jordan) experience a great deal of variation in streamflow year-to-year, they have been slowly declining on average over the last century, coincident with increases in air temperatures starting in the mid 1980s and ongoing depletion through diversions and water use.

While preparing for this initial report, the Strike Team concluded that reducing water use could save the lake. While presenting the findings at the Great Salt Lake Summit, Steed explained that "from our brief time together, we've come to the strong conclusion that interventions will work."

Human and natural consumption are primary components of the declining Great Salt Lake that account for about 67–73 percent of all impacts on the lake's current low elevation. UWRL Director and Strike Team member David Tarboton explained that, while this should be concerning, it also means that much of the impact can be mitigated through conservation.

The task force is drawing significantly upon prior research published by Tarboton and fellow USU researcher Sarah Null. Tarboton and a graduate student used modeling to quantify the sensitivity of lake level changes associated with changes in streamflow and precipitation inputs, as well as temperatures, which affect evaporation. This information is helping the Strike Team quantify the effectiveness of conservation alternatives being evaluated.

Neilson's contributions involve water monitoring and management. She directs the Logan River Observatory (LRO), an interdisciplinary project monitoring the Logan River watershed through permanent sensors and regular field work. It collects thorough data on a major tributary to the Bear River, which, in turn, is the largest contributor to the Great Salt Lake.

When asked about how the LRO work relates to the issues concerning the Great Salt Lake, Neilson explained that

"there is a clear need to determine how to get more water to the Great Salt Lake, but we have to establish methods for ensuring any water saved within the watershed will make it to the lake. The existing LRO data and infrastructure provides an opportunity to first, understand how water moves through managed portions of watersheds and second, test approaches to shepherd water through series of diversions to ensure that water allocated to the lake makes it there."

Collecting accurate and detailed data on an important watershed is only one example of how the UWRL conducts research crucial to improved management of Utah's water and environment. As the Great Salt Lake Strike Team develops more detailed recommendations for state leaders, research like that done at the UWRL will prove more valuable than ever. ■

Graphic (above) provided by Anna McEntire and the Great Salt Lake Strike Team.

USU Great Salt Lake Strike Team Contributors

Joanna Endter-Wada	Anna McEntire	Bethany Neilson	Sarah Null	Brian Steed	David Tarboton	Matt Yost

The
Need for Speed:
streamlining drone technology to get crop data to farmers faster

Researchers at the UWRL are streamlining the process by which growers can use small uncrewed aerial systems (sUAS, or drones) to improve their irrigation and farming efforts. This will make technology that previously was only helpful for scientific research more readily available to growers.

The data gathered by these drones is highly detailed and informative, but it often takes days to analyze and deliver after the flight is complete. While this delay is acceptable for scientific research, it makes the data impractical for farmers, as

conditions in their fields or orchards inevitably change during that time and the window of opportunity for crop stress decisions has closed.

UWRL professors Alfonso Torres-Rua and Calvin Coopmans, as well as USU computer science professor Steve Petruzza, are looking to change that. By developing mapping algorithms that produce useable data in real-time, the project is hoping to develop a way for growers to quickly access the data that researchers use. This data would help growers know which parts of their fields or orchards need more irrigation, and

which parts need less. The potential improvements to efficiency could save on both water and cost.

In the last decade, commercial drone technology has evolved by leaps and bounds. Drones today can be equipped with a wide range of sensors capable of operating on different optical spectra. When used in an agricultural context, they can provide multispectral and thermal information down to the individual plant, even across massive tracts of land. Despite the incredibly useful information they offer, these sensors provide little assistance to the actual

Photo by Micah Safsten

aggieair.usu.edu

growers who might benefit from them, and the use of commercial drone technology in agriculture has not been widely adopted.

A major reason this technology has not taken hold in agriculture is the high-performance computing needed to process the data from these sensors. For example, consider the average 0.25 sq mile center pivot field that might benefit from this data. To collect the most accurate data, drones are flown at midday, when shadows are the smallest. This means that data processing can begin, at the earliest, by mid-afternoon, after the drone pilot delivers the data to the office. Data processing for this field can take hours, meaning it may be dark by the time any information is ready. By then, the producer has already made a decision about irrigation or agricultural activities at the farm. If a much larger field or many fields were flown, then the data would take even longer to process—sometimes three or four days.

Petruzza, Coopmans and Torres-Rua are simplifying this process by developing a new algorithm that requires a small, lightweight computer attached directly to the drone's multispectral camera, in contrast with the high-powered computers currently used that are rich in detail but have long post-production times.

"The most accurate results require large computation capabilities and time, which growers don't have," says Petruzza, "We are trying to simplify the process of creating large scale orthomosaics by using fast 2D stitching techniques and new incremental and scalable analysis pipelines that can produce the most actionable data in the shortest time."

The new algorithm will process useable data in real time, and, while the data will not be as detailed as that produced currently using the high-powered computers, it will suffice for what growers need when making decisions.

"While it might not be the most precise result, you still get a good approximation of the conditions of the farm in real time," explains Torres-Rua.

This development will benefit all crop types, but the first adopters will inevitably be growers of high-value crops such as vineyards, fruits and nuts who can afford to invest earlier. This is significant because these high-value crops are common in California, where water users of all kinds are feeling immense pressure to conserve the limited water available there.

Although the project is still in the developmental stages, initial results from off-line testing are positive. Soon, Petruzza, Coopmans and Torres-Rua will be ready to test this new technology with actual drone flights.

"We are comparing the heavy-duty results with the simple, lightweight computing device, and the results are surprisingly good. Soon we will be conducting our first test while flying over [the USU] campus to produce a map in real-time and will have it ready when we land," explains Torres-Rua.

The thermal and multi-spectral maps produced from the test can be compared to the richer and more detailed map produced with heavy-duty computing. If the results produce a sufficient approximation of crop conditions that can help growers to make informed irrigation decisions, the team will have broken new ground toward improving water management in agriculture. ■
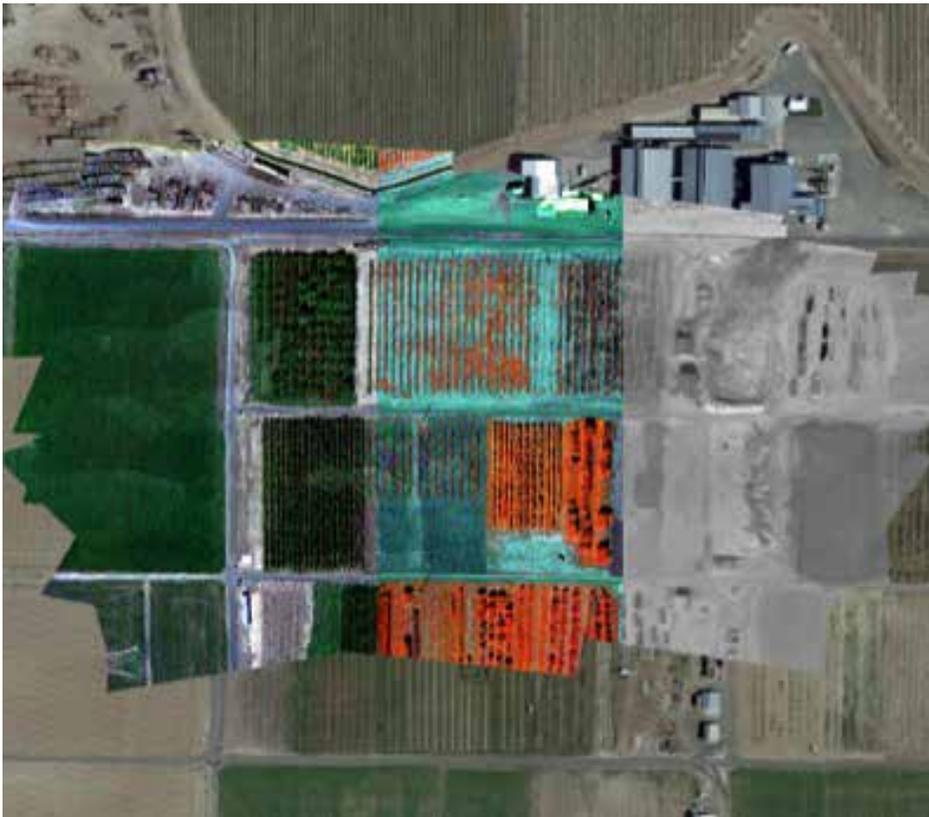

Image courtesy Steve Petruzza

Preliminary example of the real-time image generation by this project using multispectral and thermal information coming a scientific camera sensor onboard a sUAS. Image sections (left) red, green, blue image, (center) infrared image (right) thermal (in grey scale).

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Breaking It Down: how microplastics degrade in high mountain regions

Microplastics are a growing area of concern in the environmental sciences. These small plastic particles are easily transported through rivers, oceans, and the atmosphere and have been found in all these places. However, little research has been done on microplastics in high mountainous regions, even though these areas are where so many rivers in the American west begin.

A team of USU researchers, led by UWRL faculty member Kyle Moor, is looking to explore this new space. Moor is collaborating with the Logan River Observatory (LRO) to collect samples of Logan River water and then studying how the high levels of solar radiation present in these mountain regions affects the degradation of microplastic. Moor is working with Bethany Neilson (UWRL) and Janice Brahney (USU Department of Watershed Sciences), who are studying how microplastics travel through these high mountainous

environments. This will provide new insight into both the transport and fate of microplastics in an environment that has been understudied.

A central part of this project is determining how these microplastics degrade as they are exposed to sunlight. This photodegradation is distinct from the fragmentation that takes place as microplastics are broken into even smaller pieces due to the abrasive forces from waves, water movement and wind. Rather, photodegradation changes the chemical makeup of the plastic itself. The solar energy absorbed by microplastic causes chemical bonds to break and new bonds to form. Typically, plastic is thought of as a long-lived material with high persistence in the environment, yet photodegradation may be a loss pathway for plastic in the environment. This research aims to answer how quickly microplastic might photodegrade in surface waters, with the goal of connecting results

to another project led by Janice Brahney on sampling microplastics across the Logan River basin.

"Sunlight could be a major driver for plastic degradation in the environment and we now know more about the kinetics—or how quickly degradation occurs. Our work is filling this gap by measuring photodegradation rates of microplastic in the laboratory to determine the importance of sunlight on the fate of microplastic in rivers," explains Moor.

Thus far, samples collected throughout the Logan River watershed have contained significant amounts of microplastics. Moor and his students are now studying the photodegradation processes of commercial plastics to estimate the photodegradation rates of real microplastic in the environment. The team is accomplishing this by measuring the production of dissolved organic carbon generated when plastics are exposed to LED light. They

are also comparing how different types of postconsumer plastics photodegrade, such as those from water bottles and plastic bags.

Outdoor recreation is an important part of Utah's economy and identity. High mountain wilderness areas found throughout the state are also important to the water quality and ecosystems of the broader watershed. This research is improving understanding about the scope of microplastic pollution as an emerging environmental concern. ∎
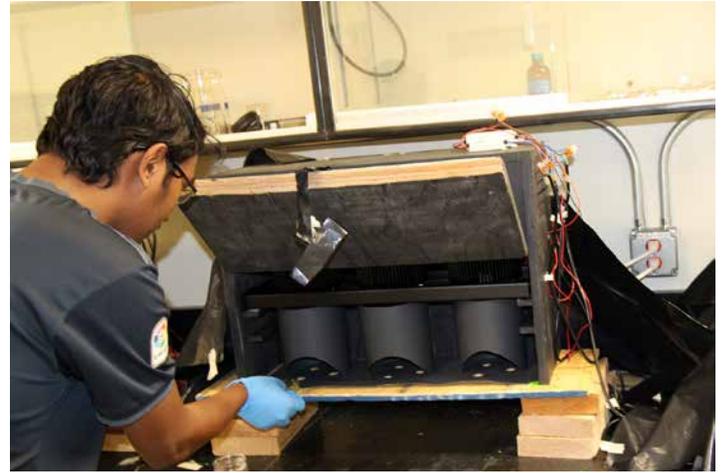
Previous Page: The photodegredation of plastics in water are studied in an LED photoreactor. Left: Graduate student Shahin Ahmed Sujon collects a sample of commercial plastic that has been exposed to sunlight for an extended period. Right: Shahin Ahmed Sujon places a sample under the LED photoreactor.

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Abby Englund (undergraduate)

Other USU Researchers:
Janice Brahney, Associate Professor, Watershed Sciences
Bethany Neilson, Professor, Civil & Environmental Engineering and UWRL

The Utah Center for Water Resources Research (UCWRR), housed within the Utah Water Research Laboratory, is one of 54 state water institutes authorized by Congress in 1964. The UCWRR supports water research projects each year on topics relevant to the needs of the State of Utah with funding administered through the USGS 104b program.

2021-22 USGS 104b Projects *(G21AP10623-01):*

▶ Real-time generation of multispectral and thermal aerial maps for immediate Utah water decision-making activities in urban, agricultural and natural environments *(S. Petruzza, C. Coopmans, A. Torres-Rua)*

▶ Quantifying the impact of reservoir sedimentation on water security in the Weber River watershed *(Patrick Belmont, Justin Stout, Ian Gowing, Alfonso Torres-Rua)*

▶ Assessing the sources, transport, and fate of microplastic in the Logan River watershed *K. Moor, J. Brahney, B. Neilson)*

▶ Public views on water strategies for protecting the Great Salt Lake and its wetlands *(J. Endter-Wada, L. Welsh, K. Kettenring)*

2022-23 USGS 104b Projects, current *(G21AP10623-02)*:

▶ Understanding pollutant mobilization at the water-shore interface of a drying Great Salt Lake *(S. Young, J McLean)*

▶ Developing high-resolution seasonal snow forecasts for Utah's watersheds *(W. Zhang, Y. Chikamoto, S. Wang, H. Karimi)*

▶ Quantifying the effect of potential submerged control structures on density-driven exchange flows through the breach of the Great Salt Lake *(B. Crookston, S. Dutta)*

▶ Monitoring for assessment of cyanobacterial hazards in five drinking water reservoirs in Utah *(D. Stevens, J. McLean)*

Read more about the UCWRR at:
https://uwrl.usu.edu/research/ucwrr/

New Faculty

Liyuan (Joanna) Hou

Assistant Professor, Utah Water Research Laboratory

Civil and Environmental Engineering

Joanna earned her PhD from the University of Missouri, and completed Post-Doctoral Fellowships at the SUNY-ESF and University of Wisconsin-Madison. Her research focuses on investigating and utilizing functional microbial communities to promote water quality and resource recovery. Joanna will be teaching Biological Processes (CEE 6930) and Environmental Engineering Microbiology (CEE 2620). Joanna is excited to build up collaboration with faculty at the UWRL and the CEE department where she will dedicate herself to researching applied environmental microbiology to monitor, minimize or valorize both contaminants and waste. She enjoys hiking and cooking and looks forward to exploring different trails and the mountains in the Cache Valley area.

Pin Shuai

Assistant Professor, Utah Water Research Laboratory

Civil and Environmental Engineering

Pin earned his PhD from Texas A&M University was previously a Post-Doctoral Associate and Staff Scientist at the Pacific Northwest National Laboratory. Pin is a groundwater hydrologist with extensive experience in groundwater and surface water interactions. Pin will be teaching Groundwater Engineering and hopes to develop new courses related to his field. Pin is also working on a project that aims at advancing watershed system science using machine learning and data-intensive extreme-scale simulations. In his leisure time, Pin enjoys playing tennis, hiking and other outdoor activities.

Yiming Su

Assistant Professor, Utah Water Research Laboratory

Civil and Environmental Engineering

Yiming earned his PhD from Tongji Univeristy in Shanghai, China, where he also completed a Post-Doctoral Fellowship, before completing a second fellowship at the University of California Riverside. He also worked as a Lecturer at the University of California Los Angeles. Yiming's research interests broadly cover nano-bioremediation, environmental applications and implications of engineered nanomaterials, conductive membrane development for water purification and resource recovery and nano-agents development for crop growth and disease control.

In the News:

Jeff Horsburgh launches first project under new water institute

Jeff Horsburgh

Earlier this year, USU joined the newly formed Cooperative Institute for Research to Operations in Hydrology (CIROH). USU's Institution Lead is the UWRL's Jeff Horsburgh, who recently secured USU's first grant through CIROH. This grant will fund ongoing work in developing the cyberinfrastructure tools needed to integrate water data from collectors across states, utilities, watersheds, and more.

Read More

Current and former UWRL directors awarded endowed professorships

Thanks to the generous support of donors, two new endowed professorships were created this summer in the USU College of Engineering. Dr. Ron Sims was named the Huntsman Endowed Professor of Biosystems and Environmental Engineering, while Dr. David Tarboton was named the Sant Endowed Professor of Water Resources Engineering. Dr. Ron Sims served as UWRL director from 1996-2003, while Dr. Tarboton was named dirctor of the UWRL in 2019.

Read More

David Tarboton   Ronald Sims

Egyptian students and researcher participating in exchange at the UWRL

Nashwa Shaaban

The UWRL welcomed seven students and a researcher through the Center of Excellence for Water, based in Cairo, Egypt. With a mission to improve water management and research in Egypt, the Center of Excellence for Water facilitates exchange programs for Egyptian students and researchers to study in the United States. Visiting from Egypt's University of Alexandria, Nashwa Shaaban is currently working with UWRL faculty members David Stevens and Ryan Dupont and will be teaching a seminar during the fall semester. Visiting with Nashwa are seven students, who each come from one of five universities in Egypt that are part of the Center of Excellence for Water.