June 2024

The Water bLog

newsletter

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

Message from the Director

David G. Tarboton, UWRL /UCWRR Director

Spring runoff is in full swing, and as the weather warms, our researchers take to the field and sky. In this edition of the Water bLog, we highlight a research grant program on the popular Bear Lake. These projects support the function of the lake and its surrounding communities. Two of our faculty received grants, both taking deep dives into water quality, one on microplastics and the other on irrigation. Examining the lake with many different lenses enables us to better inform management considerations and maintain the beautiful region.

To support field work across areas of study, AggieAir has a new lens of their own to add. This new, mountable LiDAR equipment enables our researchers in the sky to extend their field season and model the exact shape of the landscape even with vegetation on top.

Our researchers are always looking for ways to combine research lenses. In our third story, one of our faculty brings together science and engineering perspectives to explore the relationship between antibiotic-resistant genes and microplastics in wastewater.

The many research lenses at the Utah Water Research Laboratory enable us to address complex water problems with the innovative thinking necessary to find solutions. ■

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.

Photo by Alyssa Regis

Drone Pilot Bryce Lyon preps the new LiDAR sensor on an AggieAir drone.

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

INSIDE

Research Highlights:

In the News

UtahStateUniversity®

Bear Lake as a Living Laboratory:
research grants for water quality

Beautiful Bear Lake sits in a pristine location on the border of Utah and Idaho, surrounded by high mountains and sprawling farmland. A popular tourist site, Bear Lake and the rivers that feed it also provide water for irrigation and the surrounding community.

Understanding the relationship between the lake's natural ecology and human uses is vital to meeting the needs of the lake and the region. USU's Institute for Land, Water, and Air (ILWA), in collaboration with the Utah Division of Forestry, Fire, and State Lands, put together an "interdisciplinary research effort to help inform and impact future management actions on Bear Lake and surrounding areas," according to their site.

Eleven grants were awarded to USU researchers in fall 2023, with the projects concluding June 1, 2024. Two faculty with the Utah Water Research Laboratory received awards. Their teams worked throughout the year to collect and test samples at Bear Lake and add their findings to the Bear Lake Needs Assessment.

From Beach Toy to Microplastic

Yiming Su focused his research on the threat of microplastics on Bear Lake's beaches. He and his team arrived to sample in September, after the peak tourist season, and were greeted by food wrappers, empty water bottles, and kids' beach toys—all plastic items that will gradually break down into microplastics and, eventually, nanoplastics.

Nanoplastics are an emerging pollutant less than one micron wide. Su explained that there is very little information about these tiny plastic particles, so their project focused on the more easily identified microplastics, which are less than five millimeters wide.

His team collected samples at four beaches and in the lake's center. Although the levels found on the beach sites weren't concerning to the researchers, Su said growing summer tourism could increase microplastic impacts. "It's really important to have good management on a beach to take care of the plastics," Su said.

Moving forward, Su hopes ILWA will establish a relationship with state agencies in Idaho to collaborate since the lake and the rivers that feed it cross state lines. "That is critical for water quality, especially those emerging contaminants," Su said.

Sprinkler vs. Flood Irrigation

While many projects in ILWA's program focused on conditions at the lake

Photo courtesy Yiming Su

Su's team collects samples on Bear Lake's shores to test microplastic levels.

itself, one researcher looked farther afield. Burdette Barker and his team of USU extension researchers set their sights on farm- and pastureland surrounding Big Creek, one of the largest tributary rivers that feed Bear Lake on the Utah side.

"Agriculture is a source of livelihood, heritage, and aesthetic appeal," Barker said. How the land is irrigated has effects downstream, both in water quantity and water quality.

With surface irrigation, the field is flooded and all the water not used by plants or evaporated becomes runoff and returns to the creek where it is available for other water users.

With sprinkler irrigation, water droplets move through the air, and a portion of them evaporate. Sprinklers have less runoff than surface irrigation systems, but the water lost to evaporation cannot become return flow and be used elsewhere.

In Bear Lake, water quality is the big issue. Runoff from irrigation carries nutrients from the field into the creek and eventually the lake. "When it comes to water quality, what might be considered effective or ineffective might be totally different than when you're talking quantity," Barker said.

Sprinkler systems might lose more water to evaporation but they generally have lower return flow and nutrient load compared to surface systems like flood irrigation. Barker set out to see if that rings true for the farmland near Big Creek. His goal with this study is to gather local data to help inform policy and incentive decisions on irrigation methods for sustainable agricultural practices.

Barker's team took soil and water samples this spring to get a base nutrient composition before irrigation began. They are looking for an association between nutrient load in the creek and irrigation return flows. They will be sampling for post-irrigation conditions in the late summer to finish up their work.

ILWA's grant projects end on June first, but the UWRL will continue research at Bear Lake with two USGS 104b grant projects—one on microbial dynamics at the Bear Lake shoreline and one to better represent groundwater in a watershed management model for the Bear River.

PI: Yiming Su
Assistant Professor, Dept. of Civil & Environmental Engineering, Utah State University
yiming.su@usu.edu

PI: Burdette Barker
Irrigation Specialist, Civil & Environmental Engineering
burdette.barker@usu.edu

ILWA
(435) 797-1632 ilwa@usu.edu


Photo by Alyssa Regis


Photo by Alyssa Regis

Reaching New Heights:
LiDAR capabilities at AggieAir

The drones of AggieAir have been leading the industry in remote sensing for years, but recent new equipment will take research to new heights.

The Utah Water Research lab has invested in LiDAR – Light Detection and Ranging. This technology is used to measure distances. It emits pulses of laser light from the sensor and measures the time it takes for the light to return after bouncing off objects. It's especially useful for snow pack measurements, river channel mapping, flood zone identification, and more.

AggieAir Service Center manager Ian Gowing has been in discussion with many researchers about using this technology. "For any of the work we do, it will provide a much more intense 3D view of all our flights," Gowing said.

With regular camera photogrammetry, you only see what the naked eye can see—the surface of the Earth, covered in bushes and grasses and other vegetation. This means sUAS (small Unmanned Aerial Systems) generally create digital surface models, showing the topography of the land according to the shapes of vegetation and other objects on the surface. In areas of research where seeing the bare ground is paramount, field work can only be done during leaf-off when the trees are bare.

LiDAR expands that field season. "With LiDAR, we're able to penetrate the vegetation to achieve a digital terrain model," Gowing said. The lasers push through the canopy to measure the bare ground and differentiate it from vegetation, buildings, and other objects.

Gowing is excited about the research capabilities of this new equipment. "Having this new capability will give us greater surface accuracy and the ability to penetrate canopy cover, providing more accurate models for our clients."

Sensing Snow

Several researchers have expressed interest in using AggieAir's LiDAR for their projects. Jeff Horsburgh, professor at the UWRL, and his graduate student are developing low-cost snow sensing stations to increase the number of measurement stations in a watershed.

Horsburgh said the best data available for snow is NRCS SNOTEL network, but there are very few stations in the Logan River watershed, making it difficult to characterize snow across the entire region.

The new low-cost snow sensing stations will increase measurements in the watershed to help categorize areas of snow and differences in accumulation and melt. But even with these new stations, there is need for more data.

"What the LiDAR data would allow us to do is look at areas and get some continuous measurements of the snow distribution over a landscape," Horsburgh said. LiDAR technology isn't new, but it requires significant work and planning to get plane fights.

Horsburgh said AggieAir's capabilities would allow them to get localized LiDAR data and generate useful results at more points in time. Combining LiDAR with SNOTEL and his new measurement systems, they could get estimates of the snow surface.

"Estimate how much snow is where—that's what we're thinking," Horsburgh said.

Eye on the Flood

The possibilities for this portable technology span across water-related issues and beyond. UWRL professor Brian Crookston and his student Ishwar Joshi are using it to improve and update flood models.

"River modeling is actually very difficult," Crookston said. Rivers are always changing, so getting all the data needed is difficult, and prediction models have to be updated as climate change affects flooding.

LiDAR gets the terrain data they need, but traditional planes are expensive. This new technology uses three channels to collect data instead of five, which means the system is smaller and mountable on AggieAir drones.

"It's quite cheaper, but we get the same data as the traditional LiDAR," Joshi said. "And also we can do all the processing of the data in-house within the [Utah] Water Research Laboratory."

Joshi's work around the Logan and Blacksmith rivers has garnered interest as the surrounding communities look to mitigate future flooding hazards.

"Especially here at the water lab," Crookston said, "we really try to do studies that benefit people in Utah. And by purchasing this piece of technology, it lets us not only do better work for the people of Utah, but for our very community where we live."

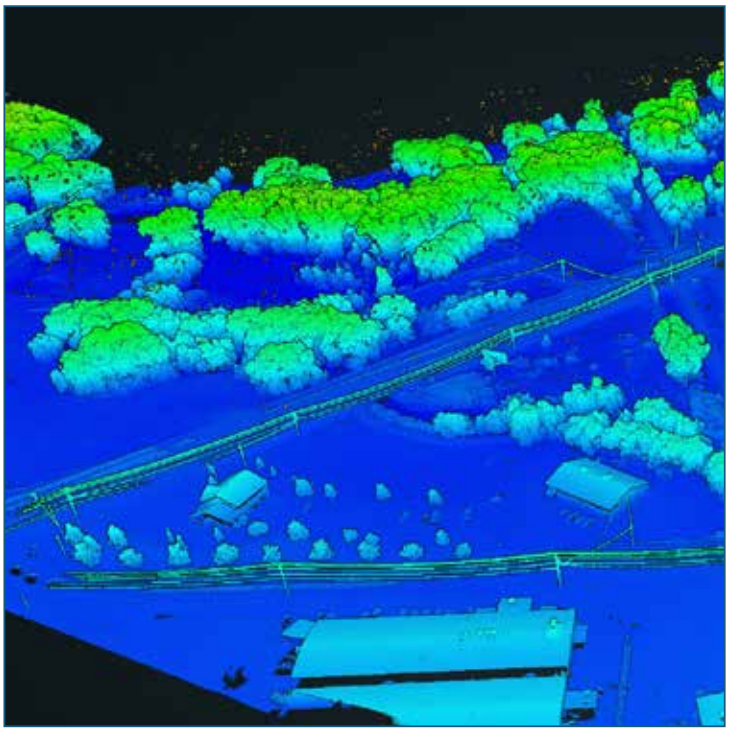
Mounted on their NDAA-certified UAVs, AggieAir's LiDAR is ready to take off for the summer field season and model the terrain from a birds-eye view. ■

Ian Gowing
AggieAir Service Center Manager
Utah Water Research Laboratory
ian.gowing@usu.edu

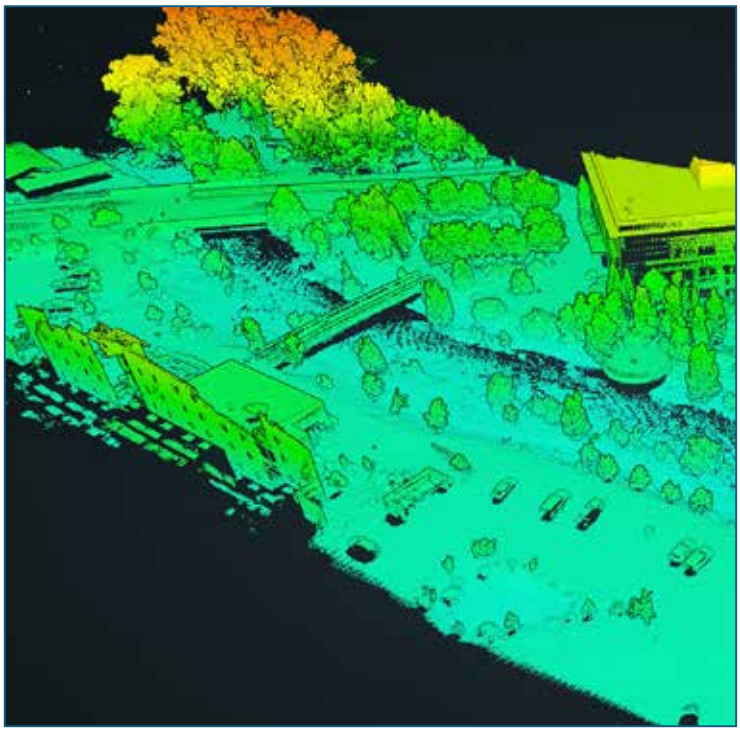
Jeff Horsburgh
Professor, Civil and Environmental Engineering
Utah State University
jeffrey.horsburgh@usu.edu

Brian Crookston
Associate Professor, Civil and Environmental Engineering
Utah State University
brian.crookston@usu.edu

Photos courtesy Ian Gowing



LiDAR imagery of the Logan River and teh Utah Water Research Laboratory



LiDAR imagery of the Logan River separated by elements.

Photos by Alyssa Regis

Discovering the Plastisphere:

antibiotic resistance and microplastics in wastewater

Microplastics—they're everywhere. As plastic production around the world increases exponentially, the reach of these broken-down, less than five-millimeter-wide plastic particles surges. We ingest them through our food and drink, the air we breathe, and the products we put on our skin.

The effects of microplastics on human health have been researched across the globe. At the Utah Water Research Laboratory, Joanna Hou is exploring the joint effect of microplastics with another complex harmful substance: antibiotic-resistant bacteria.

And her lab is a wastewater treatment plant.

Wastewater is a melting pot of different contaminants—heavy metals, antibiotics, and microplastics. As all these things enter a treatment plant, they aid in the development, persistence, and transport of antibiotic-resistant bacteria, which is harmful for humans.

"The problem is that disinfection can do the work, but the microplastics can become an umbrella for those microbes," Hou said.

Hou explained that antibiotic resistance is carried in genes. The bacteria harboring these genes prefer to live in a biofilm—a thin layer of life on the outside of an object, such as a rock or a tiny piece of plastic.

Biofilms increase the bacteria's tolerance to antibiotics. As the bacteria grows, those antibiotic-resistant genes grow too. These genes aren't just passed to new daughter cells. They can be pass horizontally across the bacteria community to other pathogens.

"If we have a higher abundance of antibiotic-resistance genes, we will have a higher chance of pathogens to pick up those genes," Hou said.

At a wastewater treatment plant, microplastics carry and shield bacteria from the disinfection process, allowing them to travel to far away places where they can pass their antibiotic-resistant genes to other bacteria.

"They become like a car for them," Hou said. "Even if the environment outside is not the ideal environment, [the bacteria] can still survive on the surface."

The goal of Hou's research is to identify the microplastics and antibiotic-resistant bacteria in the wastewater and then test different levels of heavy metals, antibiotic drugs, and other nutrients to see how much biofilm forms and target specific antibiotic genes.

Tahira Rahman, a civil and environmental engineering graduate student working with Professor Hou, sampled two wastewater treatment plants in Utah, extracting MPs from the treated effluent and identifying them. The treatment plant managers expressed support in the project and interest in the results.

In their work so far, Hou said disinfection at the plant didn't decrease the amount of microplastics very much. They found nine antibiotic-resistant bacteria and a plethora of the genes.

Part of Rahman's work includes looking for natural molecules that could prevent biofilm formation on these microplastics. She is looking at eleven options from plants and fungi and has found three successful molecules, including curcumin, a compound found in turmeric.

After identifying the microplastics and bacteria still present after treatment, Hou and Rahman will run the second stage of their work this summer to test biofilm formation under different wastewater nutrient recipes.

Studying this intersection of two harmful contaminants helps to see the complexity of the issue, and it requires many different perspectives and minds.

"This is really a combination of engineering perspective and science perspective," Hou said. "And so I hope this project can encourage more female engineers to do research on the wastewater field." ■

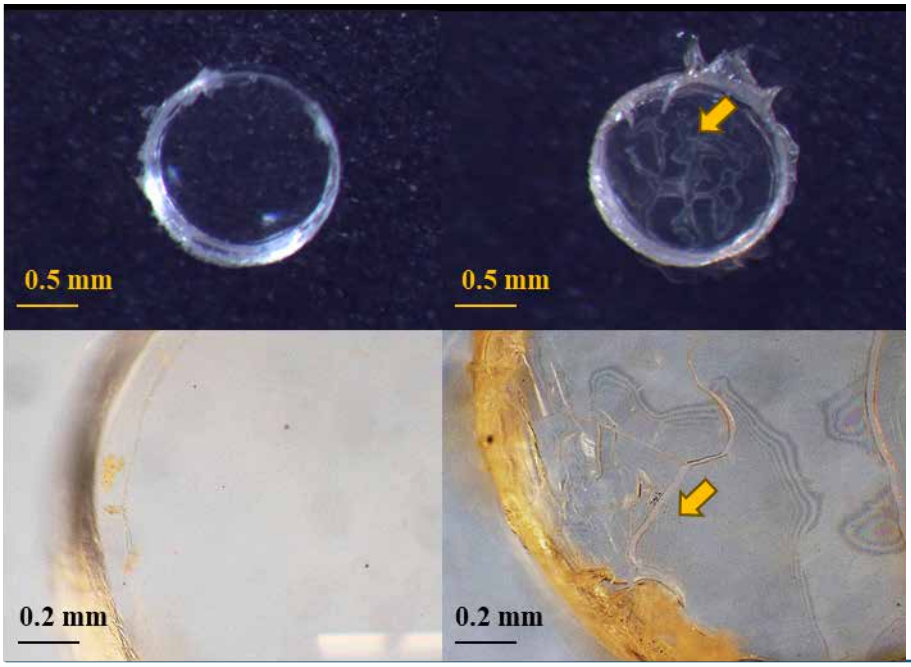


Photo courtesey Joanna Hou

PI: Joanna Hou
Assistant Professor, Dept. of Civil & Environmental Engineering, Utah State University
joanna.hou@usu.edu

Student: Tahira Rahman
Graduate Student, Civil & Environmental Engineering, Utah Water Research Laboratory,
tahira.rahman@usu.edu

In the News:

Faculty and Student Achievements

Faculty

Randy Martin was named Person of the Year by the Utah Center for Advanced Imaging Research

He also partnered on behalf of USU with other Utah colleges and the Utah Division of Air Quality to put on the Air Quality: Science for Solutions conference, which was a huge success with over 175 attendees.

Students

Two UWRL graduate students won awards from the College of Engineering. Karem Meza Capcha was the outstanding PhD scholar for 2024.Anderston Safre won an award for the graduate poster contest. Both are students with Alfonso Torres-Rua.

UWRL Expertise in the Newsroom

The UWRL has been making headlines across newsrooms with expert opinions and research conclusions over the past six months. View some of the stories below.

Strike Team: No Single Solution Will Cure Great Salt Lake

Isabella Dam 10 Years Later

Streaming Wars

Collaboration is Key to Finding Solutions to Utah's Water Challenges, Panelists Say

2023 D Wynne Thorne Career Research Awardee David Tarboton Emphasizes Importance of Data

Breaking Water Mains Present US, Canada With $452B Problem

World Water Day

Future Issues:

"Community Vulnerabilities to Water Disasters"

(a UWRL researcher is using hydrologic modeling to assess community vulnerabilities to future possible water disasters.)

Contact:

Utah Water Research Laboratory
Utah State University
Logan, UT 84322-8200
(435) 797-3157

Director:
David Tarboton

Associate Directors:
Steven Barfuss
Jeffery Horsburgh

Writer:
Alyssa Regis

Publication Editor:
Carri Richards

uwrl.usu.edu

Utah Water Research Laboratory
UtahStateUniversity