2024 ANNUAL REPORT

Utah Water Research Laboratory

UTAH STATE UNIVERSITY®

Message from the Director

David Tarboton
UWRL Director

One of the many factors that drive innovation in research is the forging of new connections. Connections between researchers and institutions challenge thinking and inspire greater leaps in insight and understanding. This is true of most research, and water research is no exception. As growth and environmental change increase pressure on future water resources in Utah, it is important for researchers to forge connections and examine problems from multiple angles.

The Utah Water Research Laboratory is at the forefront of forging these connections. As part of the Cooperative Institute for Research to Operations in Hydrology, or CIROH, UWRL researchers join other institutions across the country to share data and partner with federal and state agencies to make the most out of their research. UWRL researchers have multiple projects funded through CIROH and are working to strengthen the community and share insights into common water issues.

Some connections are within research itself, such as UWRL faculty member Ryan Dupont's work on forever chemical (PFAS) contaminants persistent in biosolids used in agriculture. Dupont and his team are looking at forging chemical connections to reduce PFAS in biosolids through high-temperature composting to retain their agricultural benefits, while reducing the risks from contaminants.

Connections between universities and government agencies are at the core of the UWRL mission, where we use research to inform management practices and enable Utah to move forward with confidence in water. To that end, two UWRL faculty members, Bethany Neilson and Jeff Horsburgh, conducted gap analyses with the Utah Department of Water Rights. They quantified gaps and opportunities within measurement and data infrastructure and provided a roadmap for the agency to upgrade their capabilities to meet future needs.

Future needs are also at the forefront of another major western water challenge: declining supplies in the Colorado River Basin. The UWRL provides important modeling and data insights for future management decisions in the basin. Steve Barfuss, David Rosenberg, and graduate student Homa Salehabadi, under the direction of David Tarboton, are working on three separate projects to model the basin's needs to meet future supply and demand. All these efforts are connected in their work with water managers and their focus on preparing for the future.

The projects highlighted in this report, though just a snippet of the research we do, are focused on future water needs in Utah, and around the world. It is gratifying to see the progress being achieved by all the UWRL's researchers as well as our connections at government agencies and other universities and institutions. Solutions to water issues are found through such connections, dedication and collaboration. ■

For more information, please visit our website:

http://uwrl.usu.edu/

Lake Mead intake model photo courtesy Alyssa Regis, UWRL

Contents

Research to Operations Cooperative Institute


Story photos courtesy USU Office of Research

Operational application of research knowledge is critical for decision-making when it comes to flooding and water resources, but to get there, researchers must build bridges with government agencies and private entities to share research and results with those who operate our water management systems.

The Cooperative Institute for Research to Operations in Hydrology, or CIROH, is one such bridge. CIROH is a national consortium committed to advancing water prediction and building community resilience to water-related challenges. It is made up of 28 academic, government, and private institutions, including Utah State University (USU).

CIROH's purpose is to link research at universities to the operational work of federal agencies like the National Oceanic and Atmospheric Administration (NOAA) office of water prediction and United States Geological Survey (USGS) who operate national-scale infrastructure for measurement and forecasting of streamflow, floods, drought, and water quality. Through CIROH, the Utah Water Research Laboratory (UWRL) partners with other universities on cutting-edge research and water resources technologies. Linked together, researchers are able to aid federal agencies in solving important water-related issues.

"CIROH is unique in that it has a specific focus on translating research to operations," said Professor Jeff Horsburgh, USU's CIROH representative. "It's about getting our work into the hands of the people who can benefit the most, and the national-scale collaborations across universities means that we can capitalize on the deep experience of a broad water science community."

CIROH is building on several ongoing initiatives involving the UWRL:

- **HydroServer:** An open-source software stack for collecting, storing, managing, and sharing observations from environmental sensors.
- **HydroLearn:** A platform with over 50 customizable courses, enabling instructors to collaboratively create, adopt, adapt, and share hydrology and water resources engineering learning resources.
- **HydroShare:** A web-based community Hydrologic Information System (HIS) for sharing hydrologic data and models. It enables collaboration on critical water issues across the country and enhances transparency and reproducibility of research.

The UWRL has multiple projects funded through CIROH, totaling over four million dollars in research funds focused on building research partnerships and expanding operational capabilities in the field. The following are highlights of some of the specific projects our faculty are working on. These projects inform water resources planning and strengthen the research community.

Developing lower-cost snow sensing stations

This multi-institution project focuses on developing lower-cost snow sensing stations to provide better data for modeling snow. These stations are designed to augment the current SNOTEL monitoring network and provide enhanced information about how snow accumulates and melts in different landscape settings (e.g., slope, aspect, vegetation canopy, etc.).

Data from the snow sensing stations are integrated with an operational hydrologic information system (HIS) to deliver near-real-time data. Models using this data can then be used to examine the impacts of snow processes on streamflow and water supply.

Geospatial framework for channel modeling

Realistic representation of channel and floodplain attributes is critical to understanding river networks, including accurate predictions of streamflow and inundation during floods.

Belize Lane and Colin Philips are developing a new geospatial framework that links directly with national-scale databases of river networks and catchments to improve the representation of channel and floodplain properties in hydrologic models. The researchers are creating regression models in this framework to estimate key channel and floodplain properties.

Enhanced Probabilistic Flood Inundation Mapping

Flood inundation mapping is a key part of assessing flood risk during high flows. Colin Philips and Belize Lane are working to enhance the accuracy of this mapping process by incorporating hydraulic and river corridor terrain variability. This is accomplished through development of a probabilistic synthetic rating curve. Flooding rivers are described by a family of these curves, and incorporating variability and uncertainty via this probabilistic curve will improve flood inundation mapping and reduce the risk of flood hazards to the public.

Forecasting in managed watersheds

Humans affect streamflow through reservoir operations, diverting water, return flows, and more. The current national databases used to represent water flow within most hydrologic models only include natural flow pathways, but accurate forecasts require accounting for water management and the human influence on hydrology and water supply.

Pin Shuai is working to expand the existing database of river and watershed properties to include water management infrastructure such as reservoirs and canals and integrate that information in models for water management.

Improving low-flow groundwater estimates in the NextGen Framework

Groundwater contributions to streams are critical to sustaining streamflow during drought periods, but current NextGen Framework models rely on non-localized groundwater reservoir-discharge relations, and seasonal dry periods can create discrepancies in the system.

Pin Shuai is enhancing predictions of low flows by refining the concepts and parameters of subsurface flows. He is developing a dataset of subsurface hydraulic properties for the NextGen database of watershed properties across the continental US. This will provide more accurate insights for water management decisions.

Detecting harmful algal blooms using satellite hyperspectral data

Harmful cyanotoxins in aquatic environments often result in harmful algal blooms (HABs) that threaten public health. Sierra Young's project aims to advance harmful algal bloom detection and species classification using satellite hyperspectral data. Remote sensing is frequently used for HAB monitoring, but challenges remain in accurately determining abundance and species type. To identify HAB-causing species and improve accuracy, Young's team will integrate satellite imagery, drone imagery, and on-site field data into a machine-learning approach.

Cameras for hydrologic monitoring

Camera-based monitoring systems can complement and, in some cases, replace conventional streamflow measurement technology, but scientific and operational challenges hinder widespread implementation.

Sierra Young and Jeff Horsburgh are integrating computer vision algorithms and machine learning into a low-cost camera-based monitoring system. This system can collect data in difficult-to-access areas, intermittent streams, and areas where it may be difficult to install a more traditional gage.

HydroLearn: training workshop and models

There is a gap between what students learn in the classroom and the skills needed by government and industry organizations for operational hydrology forecasting. To teach students real-world skills in operational hydrology and support the educational mission of CIROH, David Tarboton is working with a team to create online learning modules for the HydroLearn platform. These modules connect theory to authentic problems and provide resources for faculty to elevate learning across the community.

HydroServer: improving collection and management of environmental sensor data

Cyberinfrastructure is essential for day-to-day management of large volumes of data produced by environmental sensors. Few software options exist with the capabilities to support a national network of real-time monitoring sites.

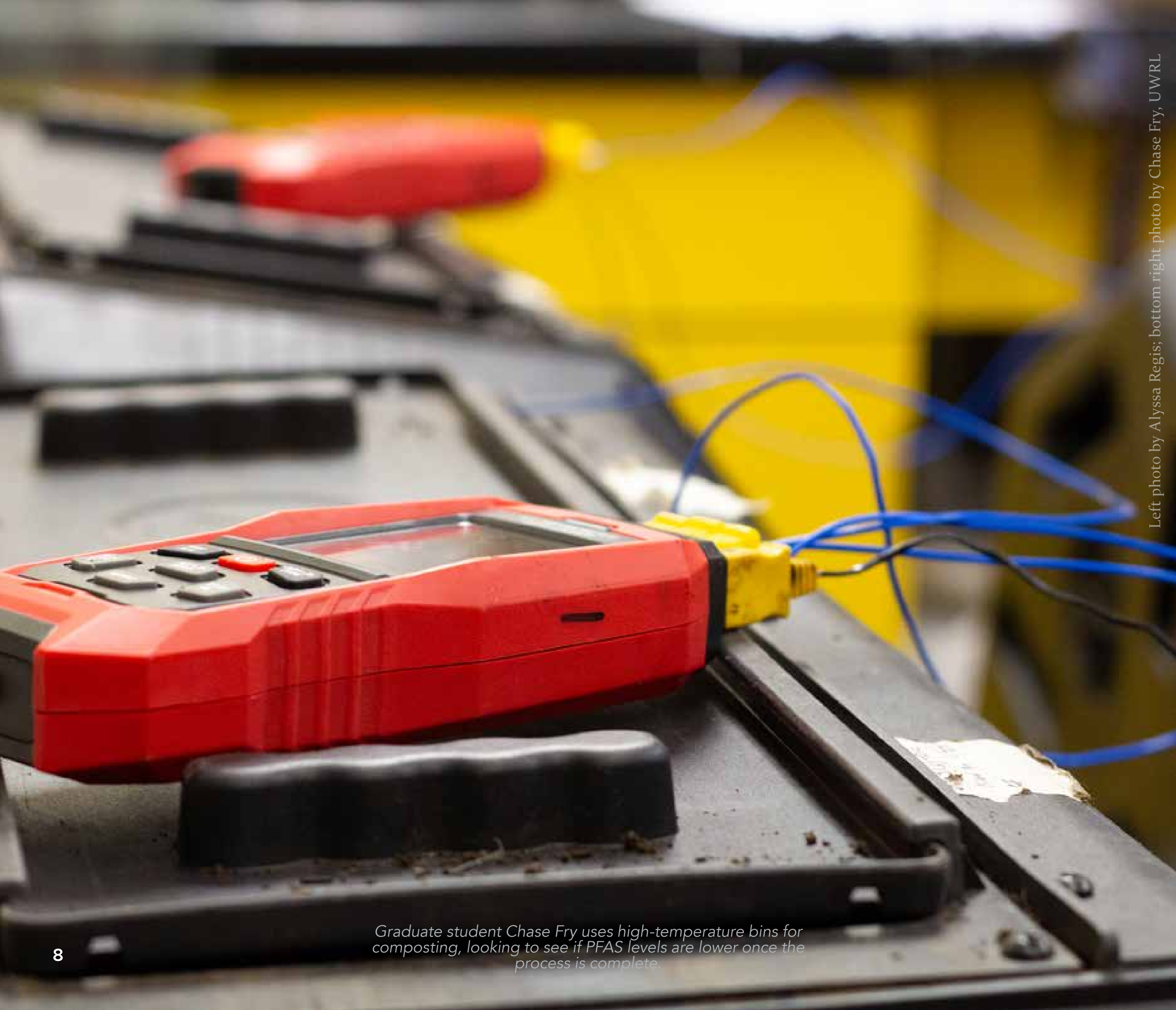
Jeff Horsburgh is working on a hydrologic information system that will enable researchers across the country to collect, manage, and share water data, augmenting the USGS stream gage network, and making more data available for operational modeling.

HydroShare: enhancing collaboration via data and model sharing

HydroShare enables researchers to more easily share digital products resulting from research—e.g., data, models, and other products. This project, headed by David Tarboton and Jeff Horsburgh, enhances the HydroShare repository's linkage with cloud storage and computational systems to make the use of these resources easier for researchers.

CIROH research is collaborative and seeks to produce results that are reproducible and reusable, and HydroShare provides tools that make this easier. Using HydroShare, researchers can analyze and integrate national-scale datasets into their research and increase collaboration.

Funding for these projects was provided by NOAA, awarded to CIROH through the NOAA Cooperative Agreement with The University of Alabama, NA22NWS4320003.



Graduate student Chase Fry uses high-temperature bins for composting, looking to see if PFAS levels are lower once the process is complete.

Left photo by Alyssa Regis; bottom right photo by Chase Fry, UWRL

Reducing PFAS in Wastewater Biosolids

They're called "forever chemicals"—found in grease-resistant packaging like fast food wrappers and used in construction, cosmetics, and clothing, as well as many other products. They're difficult to detect, difficult to remove, and persistent in the environment.

Polyfluorinated alkyl substances (PFAS) are a growing world-wide concern, causing known negative health impacts like increased cholesterol, low infant birth weight, thyroid disease, immune response repression, and cancer.

The UWRL is investigating PFAS occurrence in wastewater biosolids used in agriculture. Biosolids improve soil water holding capacity and soil organic content, as well as providing a wide range of nutrients necessary for plant growth such as phosphorus, and nitrogen.

While biosolids can be a nuisance to landfills in the quantities generated, they become a boon in the agricultural industry when turned into compost.

But that boon comes with an unwanted PFAS passenger.

These compounds linger in the biosolids, absorb into the plants, and cycle back through the system. "We need to break the cycle and destroy them," said Utah Water Research Laboratory professor Ryan Dupont.

Dupont and graduate student Chase Fry are working to reduce PFAS in biosolids through mixing different chemical compounds into a high-temperature composting process.

Dupont's team is taking samples from wastewater treatment plants in northern Utah and central Idaho and analyzing two possible compounds. One plant uses an iron oxide in the treatment process. The residual left after removal could potentially degrade PFAS.

"The theory is that it could help with immobilizing the PFAS through cation bridging," said Fry.

The other compound comes from a project headed by UWRL professor Yiming Su, who is looking at zero valent iron/zinc doped biochar.

Biochar is a porous sorbent, meaning it can absorb contaminants. Su's work focuses on the use of biochar in water, but Dupont and Chase are mixing different levels of doped or undoped biochar into compost to see how the concentrations affect PFAS levels.

Overall, the composting project is examining 32 mixes of compost, all with varying levels of one or both of the iron/zinc-based chemical compounds in an attempt to adsorb and sequester or degrade PFAS in the biosolids to reduce their uptake into crops grown on biosolids.

As concerns over PFAS in biosolids grow, research into minimizing the risks is crucial so land application of biosolids can safely continue, reaping the benefits of this soil amendment without future concerns for human health. ■

Slurries of doped and undoped biochar are added to the compost mix to see the effect on PFAS levels.

Focus on UTAH:

Two Logan River Observatory students take flow measurements.

Enhancing Water Measurement and Data Infrastructure in the Great Salt Lake Basin

Water has become an increasingly hot topic at the Utah legislature. With a mandate to administer the measurement and distribution of Utah's water resources, the Utah Division of Water Rights (DWRi) is focusing their attention on enhancing water measurement and data infrastructure. As water needs grow and change and the amounts of water data increase, the DWRi must modernize data systems and enhance infrastructure to ensure they can accurately quantify water use across the state.

With funding from the Utah legislature, the DWRi collaborated with the Utah Water Research Laboratory and other researchers at Utah State University to produce two gap analyses—one on measurement systems, and the other on data storage and management systems. A technology modernization roadmap was also produced to guide DWRi in addressing data management needs.

Manage more with increased measurement infrastructure

The "Measurement Infrastructure Gap Analysis in Utah's Great Salt Lake Basin" is a comprehensive inventory and analysis of existing measurement infrastructure along 19 primary river systems in the GSL basin.

The researchers—a collaborative effort between the DWRi and Utah State University researchers Eileen Lukens, Eryn Turney, Sarah Null, and Bethany Neilson—focused their gap analysis on understanding which areas of the basin need more stream and diversion flow gaging instrumentation.

The project involved more than 160 stakeholders, including the DWRi, private water users, individuals at public and private organizations, and representatives of city, state, and federal entities.

"The sheer volume of stakeholders throughout the basin that were excited to participate in the Gap Analysis was far beyond what we thought we were getting into when we started this effort, but that is what made an effort of this scale possible," said Turney. "It was clear to us after interacting with so many people with such diverse backgrounds and needs for these water resources that, despite their varying objectives, everyone is genuinely interested in having more data to fairly and responsibly manage water."

The team analyzed common issues including insufficient measurement devices, lack of telemetry, and inadequate data record intervals. They found that approximately one third of existing diversion measurement devices were insufficient, indicating a need for upgraded technology. Another third of diversions and 10% of stream gages needed telemetry for automating data retrieval. Additionally, stakeholders recommended 50 new or updated measurement infrastructures for diversions, 95 for streams, and 39 for continued funding of existing infrastructure.

These results, compiled in a report for the use of DWRi and other stakeholders in the GSL basin, are a first step towards identifying locations where new or improved flow data could enhance water management throughout the basin. This information will also enable the State Engineer to make informed decisions about Utah's precious water resources.

Manage better with modern data infrastructure

Once DWRi has all these crucial measurements, the data has to be stored somewhere for convenient use. Data quantifies our water resources and ensures everyone gets the water they have rights to. This is a massive amount of information to store. Measurement data infrastructure in the state includes around 1,500 active surface water diversion stations, 900 surface water sources, and 1,700 wells, as well as other water user data.

Just like gaps in measurement, gaps in hydroinformatics—the cyberinfrastructure needed to efficiently collect, manage, and use water data—need to be addressed to ensure that the agency can continue to function smoothly in the future.

"The infrastructure and effort needed to do comprehensive data management is sometimes overlooked," said USU professor Jeffery Horsburgh. "Water Rights has successfully operated their existing systems for many years, but just like any other infrastructure, updates are needed to keep up with changing technologies and to meet new requirements and growing data collection needs."

The "Hydroinformatics and Technology Gap Analysis" is a result of DWRi's focus on modernizing its data and information technology (IT) infrastructure to effectively manage all of this data and, by extension, Utah's water resources. USU researchers Jeffery Horsburgh, Daniel Slaugh, and Kenneth Lippold identified disparities between DWRi's current capabilities and its operational goals and made recommendations to close the gaps.

With 41 gaps and 66 specific recommendations to sort through, the team compiled a second report entitled "Technology Modernization Roadmap," which laid out a sequenced plan of action to help DWRi advance their data management infrastructure based on the gap analysis conclusions, focusing on priority needs.

Key gaps included inflexible software and database designs, difficulty in handling inconsistent data collection methods, and dated systems that hinder efficient operations and limit DWRi's ability to respond to growing data collection needs. Recommendations emphasized modernizing DWRi's data systems, adopting modular software designs for greater flexibility, standardizing data formats for easier use, and collaborating with other state agencies having similar data collection and management needs.

Grow to meet needs

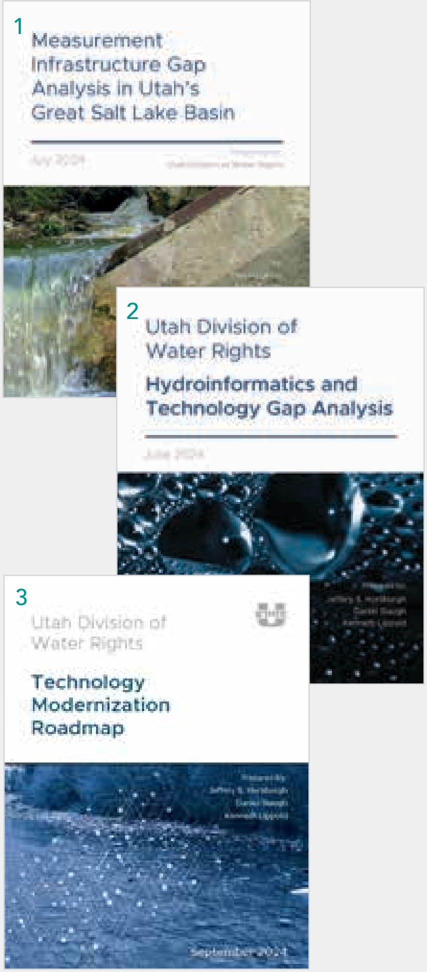
DWRi is tasked with the efficient use of Utah's valuable water resources. As Utah grows, so do water needs. With the implementation of new programs such as the Agricultural Water Optimization Program, more data is reported to the agency, requiring greater ability to store and share that information.

"Accurate quantification of how much water there is, how much people are using, and how much is available to be allocated is important to everybody who depends on that water for their livelihood," Horsburgh said.

These gap analyses shine a light on the path toward ensuring all water in the state can be accounted for and distributed accurately in a future of evolving needs and technologies. ■

Further Reading:

1. https://doi.org/10.4211/hs.8bf055dbe78b46d184cc7a4bb53931c7
2. https://doi.org/10.4211/hs.9d02ff3c946249fe9cbc3 9b2a16c 829e
3. https://doi.org/10.4211/hs.6bb192887d474555a75 f1df86e9a9f66



Story photos courtesy USU Office of Research

Colorado River photo courtesy USU

A Story of Adaptation:

managing the Colorado River in an uncertain future

The Colorado River supplies water for forty million people in the West. The basin stretches from Wyoming and Colorado all the way to the Gulf of California in Mexico, winding through several states that rely on its waters for irrigation, drinking, recreation, treatment, and more.

Within that map lies a story—a story of changing landscapes as climate change and human consumption gnaw at the edges of the Colorado River Basin. The story of the Colorado is one of myriad questions for the future, and water researchers approach these arising issues from several angles in order to provide greater understanding to those charged with finding solutions.

The story begins with the agreements that govern water resource allocation in the basin—agreements that are expiring in 2026. With all eyes on new management options, Utah Water Research Laboratory faculty and students are addressing a variety of research needs.

Assessing streamflow data for an uncertain future

To find water management solutions for new Colorado River Basin agreements, decision makers run simulation models to evaluate alternative management options. They look at the impact of drought and declining runoff in the face of growth and environmental change, working to understand the availability and variability of future water resources in the basin. To run these models, they need streamflow data that reflects the uncertain future.

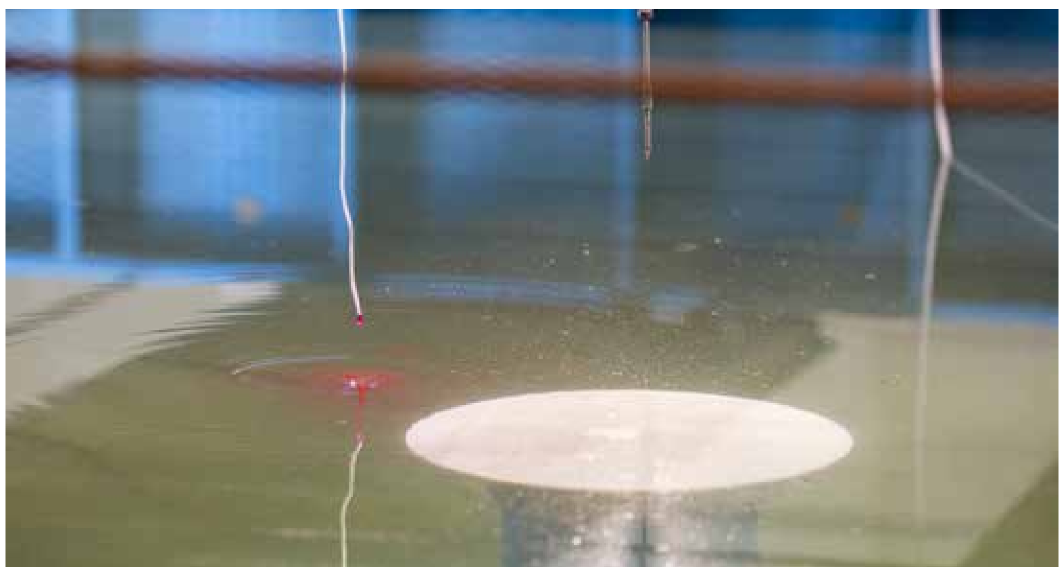
Working on a project funded by the US Bureau of Reclamation, UWRL graduate student Homa Salehabadi developed a structured framework for assessing streamflow data to inform management options post-2026.

Planning and operation models require inputs of streamflow ensembles—sets of data over a period of time. "Right now, there is no agreement on the best representation of future hydrologic conditions, and so there is no single best streamflow ensemble," Salehabadi said.

Ensembles based on historical data may not be sufficient for the future because climate is changing. Those based on climate change models give a wide variety of projections for the future, showing uncertainty in the models. Planners and decision makers must face and accept this uncertainty. The storyline approach was developed to do just this. "A storyline is a set of assumptions that describe plausible future conditions," said David Tarboton.

Under Tarboton's guidance, Salehabadi developed storylines describing plausible future conditions in the Colorado River and sought out ensembles that matched the storylines. Tarboton explained, "Storylines can be based on the past, climate model projections, a combination of these, or any other future conditions that the system may need to cope with."

Salehabadi assembled statistical metrics to evaluate available ensembles and quantify differences, searching for those



Bright dye is used to observe vortices in the Lake Mead intake model.

matching storyline characteristics like persistent drought conditions.

She developed four storylines but couldn't find a matching ensemble for one. So, she and Tarboton took a new approach, mixing historical information with paleo-reconstructed data and combining it with estimates for future streamflow decline to create a new ensemble representing a warming-driven declining streamflow future with increasing variability.

"We generated a new ensemble by considering future changes and non-stationarity along with the rich information from historical and paleo-reconstructed streamflow data," Salehabadi said.

Her work has been published in Water Resources Research and data are available in the HydroShare repository. The Bureau of Reclamation is using her research as inputs in planning models and using her metrics to evaluate other data.

Salehabadi hopes her work can help decision makers find the best alternative management for the uncertain future. "Hopefully, together we can find a way to sustainably manage and preserve this beautiful river."

Modeling Lake Mead Water Intake

Situated on the Colorado River just outside Las Vegas, Lake Mead is an important water resource for people in the valley. Intake structures beneath the lake take in water and pump it several hundred feet up to be treated and distributed to residents.

But as Colorado River flow and, subsequently, Lake Mead water levels decline, that infrastructure will need to be modified to function at lower levels.

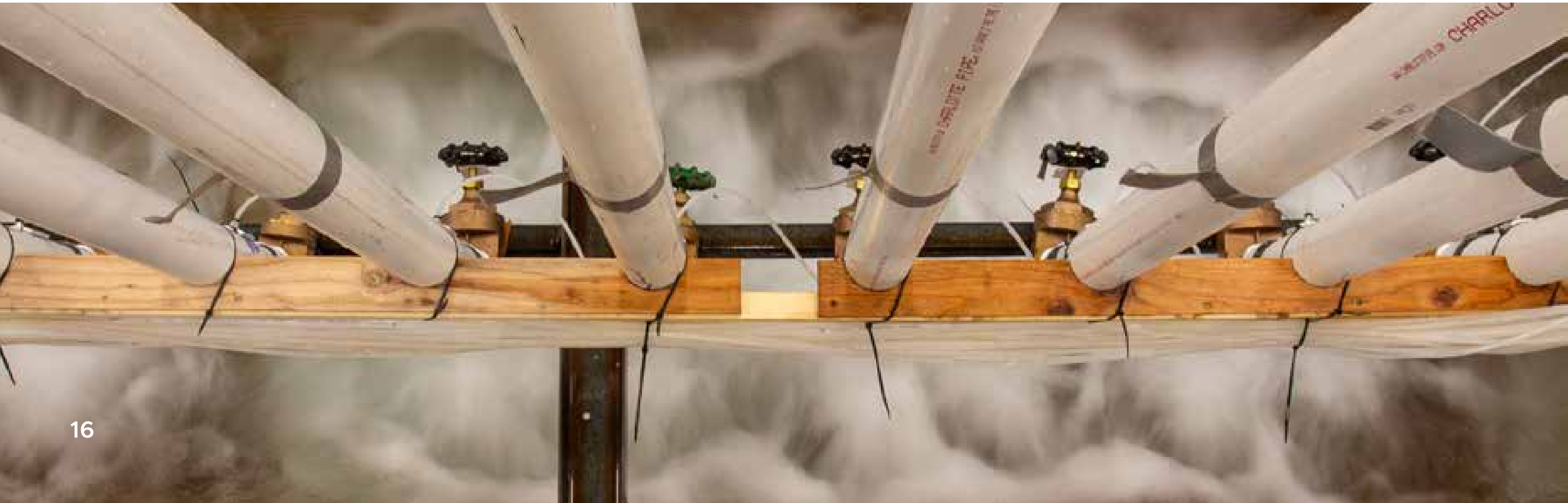
UWRL professor Steve Barfuss is building physical scale models of one of the intakes and the low lake level pumping station, which is used when water levels are too low for the other two pumping stations.

Using 3D printed parts to increase detailed accuracy of the models, Barfuss examined flows at the current intake elevation and within the proposed range of lowered elevation, which means dropping the head of the intake where it sits at the bottom of the reservoir.

"The physical model allowed us to establish how low we could take the intake before we started sucking in gravel and rocks, and how low we could take the water level and not be dealing with vortices," Barfuss explained.

Like the drain of a bathtub, when the water level gets too close to the intake, it can create vortices, up to six feet in diameter, which start sucking air and debris into the system that then has to be dealt with.

Lake Mead model photos by Alyssa Regis



Although a gentle vortex isn't a problem for the system, it can still cause a disturbance on the surface of the water. The ideal for Barfuss and the managers at Lake Mead is to get the intake as low as possible to avoid these vortices on top, without picking up sediment from the bottom.

When the lake level is low, the pump stations have to lift water much higher than they were designed for. A 9:1 scale model was used to observe how water levels are affecting the approach conditions to the pump, depending on how low the 32 pumps are extended.

Barfuss is ensuring the new extensions meet hydraulic standards, including potential for vortices, velocity profiles and fluctuations, and flow circulation.

As climate change and human consumption continue to affect the Colorado River, its story will include adapting infrastructure to serve needs. "As long as people live there and people need water, there will be these kinds of studies to evaluate how to get it from the river to the people," Barfuss said.

Adapting to low flows and storage

The story of the Colorado is a story of less.

"We have to figure out how to live within our means," explained UWRL professor David Rosenberg, "while giving basin partners more flexibility and autonomy to manage their conflicting interests."

Rosenberg's team has three projects that seek to provide insights to turn win-lose tradeoffs on the Colorado into wins.

A first effort is adapting Lake Powell releases to low reservoir inflow and low storage. This may occur increasingly as the basin becomes more arid.

"Inflow becomes really, really important at low reservoir elevations because more of the water available for release comes from inflow rather than storage," Rosenberg said. He and his colleagues found that reducing releases to 95% of reservoir inflow can stabilize and recover storage. Tying releases to physical inflow also allows Reclamation to separate their interest to protect critical reservoir elevations from users' interests to divide the flow above Lake Powell.

A second effort quantified tradeoffs at Glen Canyon Dam where days of steady low releases allow aquatic invertebrates (bugs) to lay and hatch eggs but reduce hydropeaking value and lower funds to maintain infrastructure. "We are suggesting that Federal or state agencies such as Reclamation, National Park Service, or state fish and game agencies give ecosystem managers a budget to choose the number and timing of steady low releases and compensate hydropower producers for lost value," Rosenberg said.

One potential experiment is to move days of steady low flows from summer to spring/summer months when hydropeaking value is lower and bug flows are not currently conducted. Managers can then monitor whether shifts increase algae production as the primary food for bugs, help small larvae in fall months, or support larger larvae right before they emerge in spring months.

In a third effort, Rosenberg and a colleague are looking at the strengths of the existing Lake Mead water conservation program and opportunities to improve. "In my view, the Lake Mead water conservation program is the most successful and adaptive component of current Colorado River management," Rosenberg noted. "The program is also based on the assumption that annual Lake Mead inflow is 9 million acre-feet or larger."

That assumption is challenged as the basin becomes more arid.

"Giving all users more flexibility and autonomy to manage their vulnerabilities to water shortages while stabilizing and recovering reservoir storage, that's a win," Rosenberg said.

They will soon test the approach using an immersive, online, and collaborative model. Basin partners immerse in and personify water user roles. A model for Lake Mead divides reservoir inflow and subtracts evaporation. Partners then make choices to consume and conserve water in response to their available water, other's choices, and the real-time discussion of choices.

"We are interested in why" Rosenberg said. "Why do partners make decisions to manage their vulnerabilities and how do they adapt their strategies to changing available water?"

This immersive modeling follows a first use with 26 basin partners in Summer and Fall 2021 for a combined Lake Powell-Lake Mead system. That model also divided the inflow to Lake Powell and gave managers more flexibility to make pulse flows to the Colorado River delta. Tribal water users had more autonomy to use or lease their settled water rights, and basin managers had more flexibility to release water from Lake Powell to advantage native fish of Grand Canyon.

Rosenberg added, "Some of those ideas made it into proposals for new Colorado River operations post 2026 when the current guidelines expire."

Facing the future

It takes a village—or in this case, a combination of universities, state and federal agencies, and water rights users—to find solutions for this precious resource. As reservoir storage and inflows continue to decline, that village looks to reliable research for insights into the current and possible future scenarios.

The story of the Colorado is a variable one, but it is not yet a tragedy. Research informing management decisions will help guide the future of the basin, and all those who rely on it. ■

Further Reading:

Research Brief

Quantifying and Classifying Streamflow Ensembles Using a Broad Range of Metrics for an Evidence-Based Analysis: Colorado River Case Study
https://doi.org/10.26077/c01c-ea60

Papers

Developing Storylines of Plausible Future Streamflow and Generating a New Warming-Driven Declining Streamflow Ensemble: Colorado River Case Study
https://doi.org/10.1029/2024WR038618

Quantifying and Classifying Streamflow Ensembles using a Broad Range of Metrics for an Evidence-Based Analysis: Colorado River Case Study
https://doi.org/10.1029/2024WR037225

Lessons from Immersive Online Collaborative Modeling to Discuss More Adaptive Reservoir Operations.
https://doi.org/10.1061/JWRMD5.WRENG-5893

Adapting Colorado River Basin Depletions to Available Water to Live Within Our Means
https://doi.org/10.1061/JWRMD5.WRENG-5555

Awards and Achievements

Putting the "Water" in "Land, Water & Air"

The Janet Quinney Lawson Institute of Land, Water & Air (ILWA) at USU released their 2024 Report to the Governor, a snapshot of key issues and concerns around Utah's shared resources, along with a collection of some of the many research projects going on at USU that impact and inform decisions on Utah's land, water, and air.

Seven UWRL authors contributed five unique research summaries to the report: three in the water chapter and one each in the air and Bear Lake chapters.

These projects focus on real problems and real solutions—human-impacted and human-driven. With research on water conservation, streamflow and snowpack, PFAS, air quality, and nanoparticle pollution, our faculty and students address a wide variety of Utah concerns.

Photo by Jared Ragland

The following represent some of the many projects and grants awarded to UWRL faculty in FY 23–24:

- Outlet works physical model study of the West Parish filters raw water conveyance system. *(Sharp, industry client)*
- CAREER: integrating hyperspectral data, advanced algorithms, and community observations to uncover the effects of increasing dust deposition on the environment. *(Young, NSF)*
- Physical model study of the Venice and Sepulveda Pump stations. *(Barfuss, Tetratech)*
- Establishing a functional flows framework for the Great Salt Lake Basin. *(Lane, DWR)*
- Unveiling the interactions between antimicrobial resistome and microplastics influenced by heavy metals and antimicrobics in wastewater treatment plants in Utah. *(Hou, USGS)*
- Cache Valley groundwater assessment. *(Neilson, DWRi)*
- Collaborative Research: Wastewater Exposome as an Untapped Source for Understanding Air Pollution Burden in Environmental Justice Communities. *(Martin, NSF)*

Photo courtesy USU Office of Research

With over 15 stories published in Utah State Today, the UWRL is in the know and in the news. These headlines are a sample of our research:

- UWRL Grad Student Research Informs First-in-Texas Freshwater Mussel Conservation
- NSF CAREER: New Methods for Monitoring Dust-Exposed Vegetation Around the Great Salt Lake
- Discovering the Plastisphere: USU Examines Antibiotic-Resistant Genes on Microplastics in Wastewater
- New USU Study Illuminates Subsurface Dynamics in Karst Mountain Watersheds
- New Report Says Lack of Funding for Critical Water Mains is $452 Billion in U.S., Canada
- USU-Inspired Labyrinth Weir Takes Shape at California's Isabella Dam
- Strike Team: No Single Solution Will Cure Great Salt Lake
- Water Intelligence: Connecting the Dots between Snowpack and Streamflow in Mountainous Watersheds

Photo by Matt Jensen

The UWRL at The Leonardo

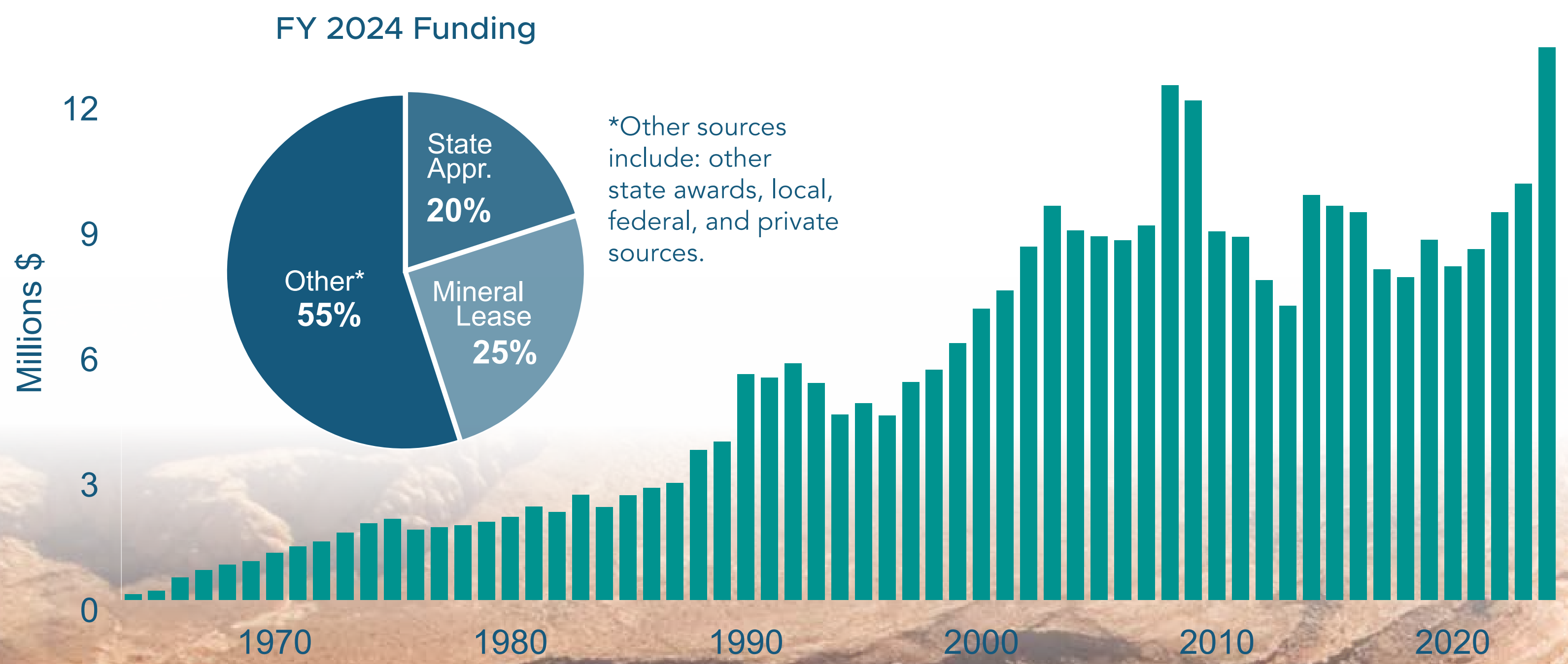
A new art installation at The Leonardo museum in Salt Lake City features a custom exhibit from the Utah Water Research Laboratory presenting the hydrology of the Great Salt Lake and our human connection to it.

The exhibit includes a large 3D topographical map depicting the three watersheds that supply a majority of water to the lake, as well as an interactive touchscreen with digital content from the Utah Division of Water Resources and the Great Salt Lake Strike Team. David Tarboton, director of the UWRL, and professor Bethany Neilson oversaw the project, and USU doctoral student Hyrum Tennant developed the interactive map on the touchscreen.

The exhibit is a way for people in the Great Salt Lake Basin to interact with and understand the water flowing through their watersheds and into the Great Salt Lake. The lake is at critically low levels, and this exhibit highlights the ongoing need for conservation across Utah.

FY 2024 Financial/Academic Summary

UWRL Funding History:



$13,217,502

Total Annual Expenditures FY 2024

Research and Training Products:

191
Active projects

83
Scholarly publications in peer-reviewed journals

25
Short courses & training activities

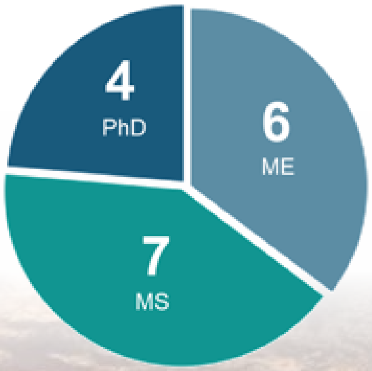
118
Scholarly presentations at professional conferences

Student Outcomes:

67
Graduate research assistantships funded

81
Undergraduate students supported

17
Graduate degrees granted



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