Message from the Director

To say that 2020 has been unusual is an understatement. I have been tremendously proud of how all at the UWRL have persevered and kept our research active and moving forward during this difficult year. Featured in this issue, you will find research on drought vulnerability in the Weber Basin, as well as USU’s sewage surveillance efforts as part of the monitoring for COVID-19, an old and a new problem.

Drought is an age-old problem faced by water resources engineers. The first article in this issue describes the work of master’s student Jacob Everitt, mentored by faculty advisor David Rosenberg, which offers a bottom-up approach: six steps to identify and address drought vulnerability, a new take on this old problem. Check it out.

The coronavirus pandemic is a completely new problem that has upended so much of our world. UWRL faculty member Ryan Dupont, working with Keith Roper in Biological Engineering, identified the possibility of monitoring for virus particles in sewage from USU student housing. Their efforts in actively doing this during the fall semester have provided input to the university’s coronavirus response. Their measurements identified the presence of increased concentrations of coronavirus RNA remnants in sewage from specific dorms that then triggered a testing campaign to identify and isolate infected individuals to limit further spread. The second article in this issue tells this story.

We are also excited to welcome two new faculty to the UWRL. Kyle Moor is a specialist in chemistry and the environmental fate of contaminants. Colin Phillips is a specialist in river mechanics and sediment transport. It is a delight to welcome Kyle and Colin.

David Tarboton, UWRL/UCWRR Director

Welcome!

The Water bLog is the semi-annual newsletter of the Utah Center for Water Resources Research, 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:

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

INSIDE

Research Highlights:

- Weber Basin drought vulnerability study: a bottom-up approach
- Sewage surveillance for SARS-CoV-2: part of the plan to keep students safe during a pandemic

UWRL Welcomes New Faculty:

- New Faculty - Kyle Moor, Colin Phillips

Featured Researchers:

- David Rosenberg, Ryan Dupont

In the News
The future is, by definition, uncertain—it hasn’t happened yet! So how do managers at the Weber Basin Water Conservancy District (WBWCD) prepare and plan for events and conditions that may occur in the future, such as drought, variable streamflow, water demand, reservoir sedimentation and evaporation, and other impacts of climate change? All of these factors affect their ability to store and deliver water to agricultural and municipal customers.

In a recent project at the Utah Water Research Laboratory, masters student Jacob Everitt, along with his faculty advisor, Dr. David Rosenberg, used a bottom-up approach to identify the reasons a water system succeeds or fails to meet delivery criteria.

**Studying numerous uncertainties**

The bottom-up approach uses six steps to help identify key thresholds that tip the system from less vulnerable to more vulnerable states.

1. Identify uncertain streamflow, demand, sediment buildup, and evaporation factors.
2. Develop scenarios of possible future states for each uncertain factor.
3. Simulate scenario combinations using the Utah Division of Water Resources (UDWR) Riverware model for the Weber Basin system and a Riversmart extension Everitt and Rosenberg developed.
4. Define criteria for system success and failure.
5. Create contour and timeseries plots that help to visualize the combinations of factors and scenarios when the water system succeeds and when the system fails.
6. And finally, discuss findings with water system managers.

**System strengths and vulnerabilities**

Study results identified several system strengths and vulnerabilities to uncertain future hydrology,
demands, reservoir sedimentation, and reservoir evaporation.

- **Strength:** The system maintains total reservoir storage above the 380,000 acre-feet for historical inflows and demands, no sedimentation, and 3.2 feet per year evaporation from Willard Bay (bottom figure, blue square). The WBWCD’s moderate drought target is 380,000 acre-feet of storage.

- **Strength:** Demand must increase by about 160,000 acre-feet per year and/or inflow decrease by about 80,000 acre-feet per year from historical conditions for total reservoir storage to drop below the 380,000 acre-feet target in 10% of modeled years.

- **Strength:** Reservoir evaporation rates of 3.2 to 4.0 feet per year minimally impact storage.

- **Vulnerability:** Reservoir drought contingency plan targets of 380,000, 320,000, and 280,000 acre-feet are violated more frequently when sediment fills 30% of active reservoir storage.

- **Vulnerability:** A unit volume reduction in inflow leads to more violations in storage targets than the same unit volume increase in demand.

**Looking to the Future**

This approach gives WBWCD water managers more tools to manage for an uncertain water future. The same approach can be applied in numerous other basins and for water utilities who also face uncertain future climate, hydrology, demands, sedimentation, and other factors.

The Western Water Assessment will also include this study as part of a Climate Vulnerability Report given to the Weber Basin Water Conservancy District.

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**PI:** David E. Rosenberg  
Associate Professor, (435) 797-8689  
david.rosenberg@usu.edu  
Utah Water Research Laboratory,  
Dept of Civil & Environmental Engineering  
Utah State University

**Partners/Collaborators:**  
**Weber Basin Water Conservancy District:** Jon Parry Ashley Nay, Derek Johnson, Darren Hess  
**Utah Division of Water Resources:** Candice Hasenvager, Scott McGettigan  
**Western Water Assessment:** Seth Arens  
**University of Utah:** Court Strong, Paul Brooks  
**Student:** Jacob Everitt

Graphical representation showing how the 6 steps are applied, with various uncertain factors used for scenarios (top), and an example of a visualization of the scenario results (bottom)

Additional major findings are available in Everitt’s 2020 thesis at:  
[https://digitalcommons.usu.edu/gradreports/1474](https://digitalcommons.usu.edu/gradreports/1474)

and in the project repository at:  
Sewage surveillance for SARS-CoV-2: part of the plan to keep students safe during a pandemic

Wastewater sampling isn’t a new idea. Public health officials used wastewater surveillance in the 1990s to locate and contain potential polio outbreaks. In locations where polio virus particles were found in wastewater, officials could target vaccination efforts to quickly address any resurgences before they could spread.

In 2020, sewage has again become a valuable source of information. Amid the COVID-19 pandemic, a number of USU researchers, led by Biological Engineering professor Dr. Keith Roper, have joined countless others nationwide and around the world in studying the potential of wastewater as a surveillance resource for locating SARS-CoV-2 virus particles to inform public health response to the pandemic. Currently, sampling is ongoing in many states, and here in Utah at more than 40 sewage treatment plants, which represents about 80% of the state’s population.

This research has shown that wastewater sampling can indeed serve as an early warning system for locating and containing potential outbreaks, identifying asymptomatic cases, and as a tool to guide community COVID-19 response. Concentrations of virus particles in sewage correlate with confirmed cases ~4-6 days in the future. Identifying cases early is particularly effective when it can be narrowed to high-risk facilities like senior living centers, prisons, nursing homes, and university on-campus housing facilities.

USU began routinely monitoring wastewater at student housing locations on the USU Logan campus in July and has since added sampling locations at other USU campuses. In a well-publicized case in late August, just as students arrived for
fall semester, SARS-COV-2 indicators were detected in samples from four student housing facilities on the Logan campus. University officials immediately placed students in those housing units under quarantine and took early action to coordinate testing for the students in those locations, thus averting a potential larger outbreak.

**Sampling Process**

It is clear that wastewater sampling is an effective tool for public health officials, but who actually does that sampling, and how do they do it?

We have Dr. Ryan Dupont and his students to thank for taking on the day-to-day challenges of collecting those important samples at USU.

**Setting up the Site**

Manholes offer easy access to wastewater, and a single high-quality manhole can “isolate” flows from several buildings at a single site. Dr. Dupont and his students have established 15 sampling locations using ISCO portable samplers that are programmable for sampling frequency, volume, start time, and duration. A weighted sample strainer is submerged within a wastewater collection system pipe for each sub-location, and flexible polyethylene or tygon tubing connects the strainer to the sampler’s peristaltic pump.

Small sample volumes collected every 15 minutes are composited into sample bottles that represent a 1- to 2-hour sample for a total of 96 samples over a 24-hour period. When these 96 samples are combined, the resulting composite sample represents a time-integrated average concentration over the sampling period.

Different units are equipped with 24- and 12-bottle configurations of 500 mL or 1 L volumes, or a single 8.5 L composite bottle.

**Collecting Composite Samples**

Wearing appropriate PPE, Dr. Dupont and his students carefully combine the individual samples into a larger mixing container and transfer approximately 500 mL samples of the completely mixed composite into sample bottles, and seal them tightly. Then they sanitize and label the bottles and store them in a cooler for transfer to Dr. Roper’s laboratory for analysis.

The excess volume is returned to the sewer, all containers and equipment are cleaned and sterilized, and the process begins again for another sampling cycle.

**Looking to the Future**

Despite the cold winter weather, sampling of dormitory waste discharge will continue from through Dec 18 and will pick up again at the beginning of spring semester until a COVID-19 vaccine is widely available.

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**PI:** R. Ryan Dupont, Professor, (435) 797-3227, ryan.dupont@usu.edu  
Utah Water Research Laboratory, Dept of Civil & Environmental Engineering, USU

**Partners/Collaborators:**

Dr. Keith Roper leads the USU campus effort to analyze and monitor for SARS-CoV-2 virus.  

**Students:** Grant Mauk helped establish the sampling protocols and Abby Englund and Mariah Brotherson continue to collect and process the samples.

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**Find out more about this process in a USU TODAY video**

Sampling setup (right), collection (bottom left), and analysis results (bottom right) for detecting SARS-CoV-2 virus particles in wastewater on the USU Logan campus.
The UWRL Welcomes

Kyle Moor

Assistant Professor

BS - Chemistry
Virginia Tech

MS & PhD - Chemical and Environmental Engineering,
Yale University

ETH Post-Doctoral Research Fellow
studying pollutant transformation in aquatic environments at the Institute of Biogeochemistry and Pollutant Dynamics
ETH, Zürich

Experience & Expertise:

After earning his BS degree, Kyle wanted to shift his focus to more applied systems. As an avid hiker in the Appalachian Mountains that surround Virginia Tech, he often thought about the chemistry happening in the environment while out on the trails. This sparked his curiosity in environmental systems and led him to pursue advanced degrees in environmental engineering, where he could use his chemistry background to create new environmental technologies. In graduate school, Kyle became enthralled by research and the prospects of teaching, which set his path toward a career in academia.

His research focuses on applying chemistry principles to tackle challenges related to water quality and scarcity. His research efforts have spanned engineered and natural systems, from developing nanomaterial technologies for solar disinfection to investigating aquatic pollutant transformation processes with laser spectroscopy.

In his lab, Moor uses materials science, laser spectroscopy, and an overall mechanistic viewpoint to catalyze new environmental technologies and to deepen our understanding of pollutant transformation in environmental systems. His research interests include inexpensive carbon materials for water purification, new advanced oxidation processes, and the fate of environmental plastic.

Teaching:

Dr. Moor is currently teaching:

- Process Dynamics (CEE 6630), Fall 2020

Looking to the Future:

Kyle is excited to join the UWRL, where he will broadly work on the environmental fate of contaminants. He is most excited about working with faculty at the UWRL and drawing on the collective expertise in hydraulics and water resources to help expand his mechanistic, molecular level research focus to larger scale environmental systems.

Other Interests:

Kyle enjoys hiking, swimming, and all things fermented, including doing his own fermentations. He and his wife, Emily, (who are east-coasters) are looking forward to exploring the outdoors in Logan and the West.
Colin Phillips

Assistant Professor

BA - Geology
Earth & Planetary Science
University of CA, Berkeley

PhD - Earth & Environmental Science,
University of Pennsylvania

Post-Doctoral Research Fellow
studying water quality and river mechanics at the University of
Minnesota & Northwestern University

Experience & Expertise:
With research experience spanning astronomy education to pyroclastic flows and the role of floods in eroding mountain ranges, Colin found himself becoming increasingly interested in research with the potential for societal impact in the near-future. This led him to pursue postdoctoral experience within Civil and Environmental engineering focusing on river mechanics and fine particle transport dynamics forming the basis for understanding many physical water quality and particulate contaminant problems.

His research focuses broadly on water and sediment, with an emphasis on the fundamental processes through which they are transported through the environment and respond to change resulting in the evolution of river corridors, watersheds, and landscapes.

In his research, Colin uses a mix of field and laboratory experiments combined with the synthesis of large environmental data streams and seeks to address problems of water and land sustainability, management, and conservation of natural and human resources over societally relevant timescales.

Teaching:
Dr. Phillips is currently teaching:
- Fluid Mechanics (CEE 3500)
- Open Channel Hydraulics (CEE 5500), Fall Semester.

Looking to the Future:
Colin is looking forward to leveraging the excellent hydraulics and data informatics expertise at the UWRL to utilize laboratory experiments to build physical models that can provide the key to harnessing the ever-growing streams of environmental data collected within US watersheds. Ultimately, the combination of these methods may allow researchers to identify areas where the greatest change in rivers and landscapes threaten people and society.

Other Interests:
Colin enjoys all manner of outdoor activities and working closely in the lab or field with graduate and undergraduate students. He and his family are thrilled to be back in the West after 11 years in the Midwest and on the East Coast and look forward to seeing what Logan and the Cache Valley area are like when it isn’t a pandemic.

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Featured Researchers

David E. Rosenberg
Professor, Utah Water Research Laboratory
Civil and Environmental Engineering

David earned his PhD in Civil and Environmental Engineering from UC Davis in 2008 and joined the UWRL that same year. His research incorporates systems analysis—optimization and simulation modeling and data management—into the planning, management, and improvement of water resources systems. His work spans spatial and temporal scales from measuring water use by individual users every 5 seconds to reconstructing hydrology from tree rings going back millennia to planning for future droughts in transboundary river basins.

Current projects include targeting water conservation actions and messages to users who can save the most water, keeping water instream to enhance river ecosystems, and managing Lake Powell and Lake Mead in the Colorado River basin for uncertain future hydrology, demand, and ecosystem conditions. David is also working with USU and Iranian colleagues to restore Lake Urmia in northwest Iran for multiple water quality, ecosystem, human health, and recreation objectives. In all these efforts, it is very important to organize and share the data, models, and code so others can access, use, and extend the work.

R. Ryan Dupont
Professor, Utah Water Research Laboratory
Civil and Environmental Engineering

Ryan received his PhD in Environmental Health Engineering from the University of Kansas in 1982 and has been a faculty member in the Department of Civil and Environmental Engineering and at the Utah Water Research Laboratory for over 38 years. His teaching interests include remediation engineering, solid and hazardous waste management, wastewater engineering, accident and risk management, pollution prevention, industrial ecology, and green infrastructure, while his research and consulting experience has focused on bioremediation, wastewater engineering, stormwater treatment, emerging contaminants, green infrastructure, and water reuse. He has authored numerous books and book chapters, along with dozens of articles published in leading environmental engineering journals.

Ryan enjoys training his students in proper field and lab-scale sampling and measurement techniques, and watching them develop confidence and technical skills to be able to troubleshoot and successfully complete difficult field and laboratory projects, and navigate complex organizational challenges, all for the betterment of public health and the environment.
Future Issues

“Improving hydraulic models of urban flooding”

(A case study on the Logan River is using LIDAR and CFD to develop improved hydraulic modeling techniques that predict urban flooding before it happens.)

“Estimating Snow Depth at a Low-Cost and High-Resolution”

(This project aims to transform how spatial snow depth is estimated by integrating existing LIDAR terrain attributes with citizen-science snow-depth data.)

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In the News:

Faculty Achievements

♦ In a 5-year cooperative agreement that became effective September 1, 2020 The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) became the coordinating hub for the Critical Zone (CZ) Collaborative Network. UWRL faculty members Jeff Horsburgh and David Tarboton are active partners in this collaboration that will substantially enhance existing CUAHSI water data services and grow the user community, broaden the CUAHSI community, and build on CUAHSI strengths of education and community support.

Learn more here

♦ The American Society of Civil Engineers (ASCE) recently announced a new program that will recognize and reward authors who make their research results more reproducible. As an associate editor at ASCE and Professor in civil and environmental engineering at USU and the UWRL, Dr. David Rosenberg was instrumental in creating this new program. The include awarding papers badges for meeting reproducibility criteria, publishing those articles open-access free for the next year in the Journal of Water Resources Planning and Management, and granting awards for outstanding efforts in reproducibility.

Read more about this program

♦ The UWRL’s AggieAir research lab recently partnered with USU Aviation Technology to present a “Drones and Ag” demonstration day at the USU Agricultural Experimentation Center. The event showcased the future of drones in agriculture, and featured AggieAir’s newest hybrid VTOL/Fixed wing aircraft, GreatBlue, which can take off and land vertically and is capable of more than 2.5 hours of fixed-wing flight time, collects field images during flight, which can be pieced together by algorithms to help farmers manage crop health and water usage.

View the demonstration here

♦ Student Awards

Dr. Jeff Horsburgh recently announced the winners of the second annual Cyberinfrastructure for Intelligent Water Supply (CIWS) Data Visualization Challenge. The challenge gives students an opportunity to develop potentially novel and innovative visualizations of high-resolution residential water use data to provide visual feedback directly to residential water users about their own water use. Congratulations to the winners! Amber Jones (PhD - 1st place), John Akagi (PhD - 2nd place), Nathan Guymon (MS - 3rd place), with Jesse Rowles (MS), Andres Duque Correa (PhD), and Tyler Daines (ME) as honorable mentions.

Check out the Challenge results

♦ Graduate student Jade Snyder Echard was awarded a $10,000 stipend from the Environmental Engineers of the Future (E2F), a national organization that encourages students to pursue Master of Science degrees in environmental engineering. The stipend is sponsored by public agencies and private engineering firms to prepare students for successful environmental engineering careers. After completing their education, recipients then apply for positions at firms that support the stipend program. Jade’s career goal is to design innovative solutions for drinking water and wastewater problems.

Read full news article

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