Message from the Director

I will retire from Utah State University on June 30, 2019, and step down from the position of Director of the Utah Water Research Laboratory and Director of the Utah Center for Water Resources Research. It has been my distinct honor to serve these organizations for 16 years, and I will greatly miss the students, staff, and faculty that have made my job exciting and fun.

All of us at the UWRL/UCWRR are extremely proud of the amazingly creative and important applied research that happens here every day, and I will miss being a part of all of that. Dr. David Tarboton, Professor of Civil and Environmental Engineering at USU, will replace me. He brings extraordinary experience and competence to the job, is an internationally recognized expert in hydrology, and has the energy and insight to move water research in new and exciting directions at USU. I wish him luck in the position and hope he will enjoy it as much as I have.

Mac McKee, Director 2003–2019

Welcome!

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

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

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

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

INSIDE

Research Highlights:

- UWRL Hydraulics Lab: testing a new turbine design and much more
- The Water Management Data Model: an open source tool for water data

Featured Researchers:

- Mac McKee
- Mike Johnson, Adel Abdallah

In the News
Where do you go to test a 42-ft, 22,000-lb, full-scale prototype turbine? Percheron Power of Kennewick, Washington, had just such a question when they were ready to validate their turbine design modeled after the ancient Archimedes screw. Building their own test rig would have been extremely expensive, and installing it in an existing waterway would not allow for the controls that a laboratory setting would provide. Instead, they turned to the Utah Water Research Laboratory (UWRL), one of the few laboratories in the U.S. with the facilities to accommodate them. “We’ve done turbine testing in the past, and we have the experience and knowledgeable staff to accomplish this type of testing at a much lower cost,” says project lead and UCWRR faculty member Michael Johnson. “We have the capability to deliver 100 cu ft/s of water all day, 24/7 with no river impact, even during summer irrigation season.”

The turbine is the first of its kind to be tested in the U.S. at full scale inside a laboratory environment. This hydrodynamic screw was designed and developed by Percheron Power under a cooperative agreement supported by the U.S. Department of Energy. Johnson and his team constructed a custom test rig inside the Hydraulics Modeling Lab at the UWRL to:

- test the turbine at low head to validate the company’s numerical modeling,
- prove the efficiency of their design, which is above 90%, and
- provide proof of concept for their variable frequency drive, which regulates the rotational speed and synchronizes the power generated with power on the electrical grid. When the variable frequency drive senses that synchronized power from the turbine exceeds the power coming from the grid, the drive sends the power back to the grid.

This type of turbine provides an opportunity to distribute power in many smaller locations rather than relying on a centralized power plant. The turbines can be installed in a variety of locations where water is flowing, which spreads power production out and brings it closer to consumers. This concept can
increase the security of the power grid, while reducing power delivery costs. 

Unlike solar and wind power, hydro-turbines produce continuous energy as long as water is flowing. The company is reviewing existing manmade structures, including canals, dams and weirs, as potential locations for its hydro turbines. Percheron says the turbines are rugged and easy to operate and are proven to have very little impact on fish.

A turbine of this size can produce about 35 KW of power—enough energy to power several homes in the US or a small village or mill in a developing country. Percheron has similar turbines more than twice as large that produce more than 350 KW. Archimedes’ screw turbines can be used as stand-alone power sources or they can be connected to the grid.

"It was exciting for all of us to see water flowing through the new turbine and producing power for the very first time," said Sharon Atkin of Percheron. "We feel fortunate to have a world-class resource like the Water Lab (UWRL) as a partner for testing our turbine."

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**Since 1965, the UWRL has modeled a wide range of spillways, energy dissipators, channels, chutes, pipes, valves, pumps, turbines, and other hydraulic structures, including very large dams and spillways.**

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**PI: Michael Johnson**  
Research Professor  
Utah Water Research Laboratory  
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**Collaborators:** Percheron Power

**Hydraulics Faculty:** Steven Barfuss, Brian Crookston, Michael Johnson, Blake Tullis, and Zac Sharp

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*Photo by Brittanie Carter*
Since the 1960s, water resources managers have relied on models to make water management decisions, whether they are related to allocating water for agricultural or urban water uses, energy generation, the environment, or other needs.

The data needed to populate these models are numerous and in the hands of local, regional, and national water management agencies, each of which use different formats, metadata, and terminology to organize and store their data. It becomes a time consuming and error prone process to identify needed data and transform the data into the format needed by a model. Required transformations can include manipulations, joins, pivots, sorts, aggregation, and visualization using various existing tools and workflows that are often source- and model-specific.

**WaMDaM model**

Adel Abdallah, recent PhD graduate student working with Dr. David E. Rosenberg led the development of the Water Management Data Model (WaMDaM) which is a set of tools to organize, join, compare, and analyze water resources data sets and models, and run a model regardless of the data source or study area.

With these tools modelers can:

- Organize water management data such as for water supply and demand sites and their natural and built networks and operation rules.
- Synthesize data across domains and sources.

WaMDaM is part of a software ecosystem that helps users to visualize, edit, run, repository, reproduce, and discover the data for water resources systems models (diagram shown with developer Adel Abdallah)
Visualize models and data online

Compare data from different scenarios

Edit model input data online and serve data to run a model

Repository model input data with metadata in HydroShare for others to discover

How it works

The WaMDaM model is implemented in a relational database, which allows users to organize water management data with contextual metadata using controlled vocabularies.

The associated WaMDaM Wizard was developed to auto-read input data from an Excel template into a physical WaMDaM database implemented on the user’s local computer.

WaMDaM enables users to answer questions such as:

- What data are available to develop a model in a particular watershed?
- What are the differences across datasets in connectivity of natural and built infrastructure components in a particular area?
- How do data values for properties of system components differ across datasets?
- How do differences in network topology, metadata, and input data affect model results?

The WaMDaM data model and supporting software tools have been tested on 13 data sources in the Bear River basin spanning Wyoming, Idaho, and Utah and Water Evaluation and Planning (WEAP, simulation) and General Algebraic Modeling Systems (GAMS, optimization) models of parts of the basin. The WaMDaM is a key piece of a software ecosystem that allows users to move data to Hydra Platform and OpenAgua to view data online in map format, edit data, and launch model runs. The software ecosystem also allows users to move data to HydroShare to repository model data, run reproducible scripts in Jupyter notebooks, and other HydroShare users to discover these systems modeling data sets.

What’s Next?

The team is looking to apply WaMDaM and the software ecosystem to other models and basins. If you think WaMDaM may help your work, please contact us!

This project marks another step toward making water resources management more sustainable through open, shared, and integrated water data and information.

Read more about WaMDaM at:
http://wamdam.org

or at:
https://doi.org/10.1016/j.envsoft.2019.02.005


Required hardware / software:

WaMDaM data model can be implemented in any relational database management system or platform.

WaMDaM Wizard executable (.exe) is available for use with Microsoft Excel (2007 and later) and SQLite3 on Windows 64-bit computers.

Input data and directions

Documentation of all source code, datasets, use cases, and instructions to use WaMDaM and replicate results are available on GitHub and facilitated by Jupyter notebooks at

http://doi.org/10.5281/zenodo.1484581

Programming Languages:

Python 2.7
Structured Query Language (SQL)

Cost and license:

Free.

(Software and source-code are released under the New Berkeley Software Distribution (BSD) 3-Clause License, which allows for liberal reuse)

This work is the product of a National Science Foundation funded project to advance the cyberinfrastructure to better understand the interconnectivity of natural and human water resources systems.

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Mac McKee
UWRL Director, 2003-2019
After just over 16 years at the helm of the Utah Water Research Laboratory at Utah State University, Dr. Mac McKee will retire effective June 30, 2019. His tenure as Director of the UWRL began in April 2003, and since that time, he has worn the hats of administrator, professor, and researcher.

**Education**

Mac grew up on a farm in Utah’s Uinta Basin, where he learned the value of both water and hard work. Later he earned his BS (Philosophy), MS (Plant Ecology), and PhD (Civil and Environmental Engineering) here at USU. After teaching at Humboldt State University in Arcata, California, and participating in extensive international consulting work, he rejoined USU as a professor in Civil and Environmental Engineering in 1999, where he has taught courses in water resources systems analysis, water resources engineering, open channel hydraulics, and water resources planning and management.

**Research**

His research over his career has covered a wide range of water resources management topics, with his recent research focusing on development and deployment of small autonomous aircraft for remote sensing in scientific problems and on the improvement of large water supply system operation efficiency through the use of statistical learning theory and remote sensing.

**Leadership**

Throughout his career, Mac has used his expertise to advance water management close to home and around the world. In addition to his UWRL leadership, he served in a number of state and national capacities. A few examples are as:

- a member of the Utah Governor’s Unmanned Aerial Systems Test Site Advisory Board, which sought to establish Utah as a player in the development of UAV technologies;
- president of the Universities Council on Water Resources twice and on the board of directors for nearly a decade; and
- a member of the United States Presidential Advisory Committee on Water Information.

**International Impact**

Mac has been active in domestic and international water resources planning and management projects for more than 30 years. His diverse experience has included assignments in more than 30 countries. Some examples include:

- flood control planning and design (Philippines),
- development of a national environmental baseline document (Uzbekistan),
- water quality management (Samoa),
- integrated river basin planning and management (India),
- advisor to the US Department of State on water and wastewater issues in support of the Oslo II Peace Accord and the Israeli-Jordanian Peace Treaty negotiations
- development of a comprehensive water resources master plan (West Bank and Gaza Strip), and
- consultant to Amnesty International on water-related human rights violations (Middle East)

**Research and Mentoring**

Mac’s 13 MS students and 14 PhD students from 7 different countries have gone on to successful post-doctoral fellowships, faculty positions at universities around the world, employment in the private sector and international research facilities. He and his students have published countless papers in more than 20 different high impact journals for water, irrigation, and remote sensing.

Under his leadership, the UWRL has gained 12 new faculty; expanded large-scale physical modeling capacity with a new hydraulics building; increased support of graduate students; instituted an internal seed-grant program to jump-start new research ideas; and made substantial investments in emerging research areas.

**Looking to the Future**

As he wraps up his work here at the lab, Mac is looking forward to working on technical challenges that face UAV-based remote sensing, authoring an introductory text in fluid mechanics, a reference book on remote sensing in precision agriculture, and a historical fiction novel. He plans on more international travel, but this time to places “where the food is good and they don’t shoot at you.”

Mac has been a dynamic leader and a tireless advocate for the students, faculty, and staff at the UWRL. Thank you, Mac, for everything! We will miss you greatly, but we wish you all the best in your future endeavors.
Featured Researchers

Michael C. Johnson
Research Professor,
Civil and Environmental Engineering

Michael C. Johnson is a Research Professor of Civil and Environmental Engineering and at the Utah Water Research Laboratory at Utah State University. His research includes physical and numerical hydraulic modeling and analysis of dams, spillways, stilling basins, energy dissipators, outlet works, channels, intakes, and flow regulating structures. He has a particular interest in energy dissipation and low level outlet works. In addition, his research also includes valve performance investigation, flow meter performance evaluation, pump performance verification, and the development of an innovative energy dissipating hood to be used with fixed cone dispersion valves. He has received the Outstanding Teacher Award for the USU College of Engineering. He has received multiple division best paper awards from AWWA and serves on several AWWA committees for valves, gates and water meters. Michael is a licensed professional engineer in the State of Utah.

Adel Abdallah
Research Assistant,
Utah Water Research Laboratory

Adel defended his PhD research this past spring at USU in which he designed the Water Management Data Model (WaM-DaM). This model provides water managers and researchers a single database management system to organize, interpret, and compare multiple water resources datasets for study areas. He also designed data workflows to automate preparation of input data and reuse of output data for multiple water management models, as he has demonstrated for the Bear River Watershed. Adel’s research repositories are on GitHub @ https://github.com/amabdallah. In January, Adel was hired as a full-time Senior Hydroinformatics Specialist for the Water Data Exchange (WaDE) Program as part of the Western States Water Council in Salt Lake City, and has been promoted recently to be the WaDE Program Manager. Adel has a passion for cooking; loves skiing and hiking; and likes to read about history. Adel is married to Allia and they have a son, Kareem.
In the News:

**New UWRL Director**

After an extensive national search, longtime UWRL faculty member David Tarboton was selected as the UWRL's 7th director beginning July 1, 2019.

Read more about Dr. Tarboton

**Student Scholarships**

The American Water Works Association selected UWRL/USU graduate students Karl Christensen and Ayman Nassar to receive scholarships this year for their studies in water resources. Karl received the AWWA Intermountain Section Scholarship, and Ayman received both the AWWA Intermountain Eva Nieminski Honorary Graduate Science Engineering Scholarship and the 2019 UWWA Scholarship.

Mahyar Aboutalebi received the Best Paper award at the SPIE Conference in Baltimore, MD, and was a winner of the Cyberinfrastructure for Intelligent Water Supply Data Visualization Challenge.

Read more about the CIWS Challenge

**AggieAir & NASA**

UWRL's AggieAir program was selected to participate in a NASA-led operation in Reno, Nevada. Over the course of this summer AggieAir's team will fly two UAVs over Reno to help evaluate unmanned aerial traffic in a large city setting.

See details about AggieAir's role

**2019 UCOWR Conference**

The 2019 UCOWR Annual Conference took place on June 11–13, 2019 at Snowbird, UT. USU sponsored the event, with UWRL faculty member and UCOWR lead delegate David Stevens serving as Committee Chair. Seven of the nine USU delegates are UWRL/UCWRR faculty members and helped with conference planning.

Read more about the conference

**Faculty Award**

Dr. Judy Sims received the Calvin K. Sudweeks Award from the Utah Division of Water for her service as coordinator of the Utah On-Site Wastewater Treatment Center based here at the UWRL.

Read more about Sims' award

**Future Issues**

“Health impacts of exposure to reclaimed wastewater in urban agriculture”

(This project explores the microbial and chemical hazards in reclaimed wastewater and how to safely manage this risk)

“Modeling the Ituango Dam diversion tunnel”

(This unique model is helping dam managers in Colombia to plan the most effective way to seal off a tunnel that was partially blocked by a landslide in 2018)

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Snowbird, UT—the location of the USU sponsored 2019 UCOWR Conference