Center for Water Resources Research
Utah State University

Annual Technical Report
2019

Products

Research Publications:

(2019UT255B) Cooper, I.; Hotchkiss, R.H.; Williams, G.P. Extending Multi-Beam Sonar with Structure from Motion Data of Shorelines for Complete Pool Bathymetry of Reservoirs. Remote Sens. 2021, 13, 35. https://doi.org/10.3390/rs13010035

(2018UT209B) Lane, B. and Rosenberg, D.E. 2019. "Promoting instream flows in the changing western U.S." J. Water Resources Planning and Management. DOI: https://doi.org/10.1061/(ASCE)WR.1943-5452.0001145

(2016UT203B) Endter-Wada, J. L., Rupp, L. A., Garrard, C., McGinty, E. L., McGinty, C. (2020). Research Project Report: Landscape Water Use Analytics for Institutional and Corporate Properties.

(2016UT203B) Endter-Wada, J. L., Garrard, C., McGinty, E. L., McGinty, C. (2020). Salt Lake City Department of Public Utilities WaterMAPS™ Analysis: Phase I Research Project Report.

(2016UT200B) Clark, Timothy R., "Impacts of Beaver Dams on Mountain Stream Discharge and Water Temperature" (2020). All Graduate Plan B and other Reports. 1485. https://digitalcommons.usu.edu/gradreports/1485

(2014UT193B) Majerova*, M., B.T. Neilson, B. Roper. 2020. Beaver dam influences on streamflow hydraulic properties and thermal regimes. Science of the Total Environment. V718 (May2020), 134863. https://doi.org/10.1016/j.scitotenv.2019.134853.

Research Presentations:

(2019UT255B) Pace, J., Ence E. (2020). UAV Photogrammetry Ground Truth Spacing Methodology to Accurately Model Reservoir Shorelines [Utah Conference on Undergraduate Research], Logan, UT, United States. https://2020ucur.sched.com/event/ZD3B/uav-photogrammetry-ground-truth-spacing-methodology-to-accurately-model-reservoir-shorelines

(2019UT255B) Eight students attended the Utah Conference on Undergraduate Research, with two of those students giving an oral presentation. February 7, 2020, Utah State University, Logan, UT.

(2019UT258B) Nassar, A., Torres-Rua, A.F., Kustas, W.P., Gowing, I., Keller, D., Hipps, L., Nieto, H. and Coopmans, C., 2020, December. Influence of Spatial Heterogeneity in Evapotranspiration Modeling at Natural Areas Using sUAS High Resolution Data. Presented at AGU Fall Meeting 2020.

(2018UT208B) Xu, T., Q. Longyang, C. Tyson, R. Zeng, B. T. Neilson and D. G. Tarboton, (2019), "Hybrid physically-based and deep learning modeling of a snow dominated mountainous karst watershed," Presentation H32D-02 at 2019 AGU Fall Meeting, San Francisco, CA, 9-13 Dec, https://agu.confex.come/agu/fm10/meetingapp.cgi/Paper/570583.

(2018UT208B) Longyang, Q., C. Tyson, T. Xu, R. Zeng, B.T. Neilson. "Effects of Climate Forcing Uncertainty on Snow Modeling and Streamflow Prediction in a Mountainous Karst

Watershed." 2019 Fall Meeting, American Geophysical Union, December 9-13, 2019. Abstract H33I-2033. San Francisco, CA.

(2017UT204B) Murray, D., Bouwes, N., Neilson, B., Brahney, J. (2019) Can Beavers Mitigate Non-Point Source Pollution? American Fisheries Society and the Wildlife Society Joint Meeting, Reno, NV 2019

(2016UT203B) Duer, S. and Endter-Wada, J., "WaterMAPS™ Analysis for Conservation Programming in Salt Lake City", Invited presentation for the Water Well with CWEL Webinar Series, Center for Water-Efficient Landscaping (USU), December 8, 2020.

(2016UT203B) Endter-Wada, J., "Water-Efficient Landscaping," Invited presentation for the Wasatch Front Land & Water Integration Webinar Series, Western Resource Advocates, October 9, 2020.

(2016UT203B) McGinty, C., Garrard, C., McGinty, E. L., Endter-Wada, J., Duer, S. "WaterMAPS™: A Mapping Tool for Promoting Urban Landscape Water Conservation," Contributed (referred) presentation to UGIC 2020 Virtual Conference, Utah Geographic Information Council (UGIC), September 2, 2020 - September 3, 2020.

(2016UT203B) McGinty, C., Garrard, C., McGinty, E. L., Endter-Wada, J. "WaterMAPS™: Insights into Urban Landscape Water Use Patterns," Contributed presentation to Virtual Field Days, USU Center for Water-Efficient Landscaping, June 18, 2020.

(2016UT203B) Endter-Wada, J., "WaterMAPS™," Contributed (refereed) presentation at the Annual Meeting, American Water Resources Association, Salt Lake City, UT, USA. November 3-6, 2019.

(2016UT203B) Endter-Wada, J., "Water Smart Cities," Invited presentation at the Joint meeting of Salt Lake Chamber and Utah League of Cities and Towns, September 13, 2019.

(2016UT200B) Alger, S.M., Lane, B., Neilson, B.T. "Lateral return flows control summer stream temperature patterns in irrigation-depleted streams," American Fisheries Society Utah Chapter Meeting. St. George, UT. February 27, 2020.

(2016UT200B) Tennant, H., B.T. Neilson, M.P, Miller, T. Xu, P.D. Brooks. "Using Naturally Occurring Tracers to Quantify Components of Urban and Agricultural Streamflow." 2019 Fall Meeting, American Geophysical Union, December 9-13, 2019. Abstract H23D-02. San Francisco, CA.

(2016UT200B) Alger, M., B. Lane, B.T. Neilson. "Controls on Summer Stream Temperature Patterns in Irrigation-Depleted Streams." 2019 Fall Meeting, American Geophysical Union, December 9-13, 2019. Abstract H23K-2049. San Francisco, CA.

Additional Project Awards:

(2016UT203B) Endter-Wada, J. L. (PI), Kopp, K. (Co-PI), Johnson, P. G., Sun, Y., Garrard, C., Buffler, S., Harris, P., Gillies, R. R., Carlisle, J., Briefer, L., Duer, S., Kryger, N., Wambeam, T. "Weather Stations to Support Water Conservation in Salt Lake City", Sponsored by USU

Extension Water Initiative and Salt Lake City Department of Public Utilities, (April 2020 – May 2022), $46,400.

(2016UT203B) Endter-Wada, J. L. (PI), Kopp, K. (Co-PI), Johnson, P. G., Sun, Y., Garrard, C., Buffler, S., Harris, P., Ramsey, R., McGinty, C., McGinty, E., Briefer, L., Duer, S., Kryger, N., Wambeam, T., "Identifying and Meeting Salt Lake City's Landscape Water Conservation Potential-Phase II", Sponsored by USU Extension Water Initiative and Salt Lake City Department of Public Utilities, State, (April 2020 – May 2022), $150,000.

Earned Degrees:

(2017UT204B) Two MS students, Watershed Sciences—Fall 2019, Summer 2020

Professional Placement of Graduates:

(2016UT201B) PhD student became Water Quality & Treatment Administrator in Salt Lake City, Utah

(2014UT193B) Three graduate students found employment at Jordan Valley Water Conservancy District and consulting firms in SLC, UT, and in Idaho

Teaching Assistantships:

(2019UT255B) Fifteen students participated in the project, some in a freshman mentoring program and others as research assistants.

Information Transfer Program

The Utah Center for Water Resources Research (UCWRR) at the Utah Water Research Laboratory (UWRL) is the designated Water Resources Research Institute for Utah. The Center supports and promotes responsible and sustainable water resource management and stewardship in the State of Utah. Water is an essential resource for the economic, social, and cultural well-being of the State, and the Center plays a vital role in disseminating information in support of these goals. This is accomplished mainly through (1) the UCWRR web page (http://uwrl.usu.edu/research/ucwrr/) and (2) a semi-annual newsletter (http://uwrl.usu.edu/research/newsletter), which highlights recent research projects and their findings along with other water-related activities in the State by researchers affiliated with the Center. The digital newsletter is sent to approximately 350 readers and is freely available online. This publication highlights research projects and their findings, often of interest and value to constituents within the State of Utah, as well as nationally and internationally. Other publications appear regularly as technically reviewed project reports, professional journal articles, other publications and presentations, theses and dissertations, papers presented at conferences and meetings, and project completion reports to other funding agencies. Many are available in USU's Digital Commons (http://digitalcommons.usu.edu/water/). The UWRL annual Mineral Lease Funds Report, submitted to the Utah Office of the Legislative Fiscal Analyst, reports on wide-ranging research projects ongoing at the UCWRR and UWRL specifically benefitting the State of Utah (http://uwrl.usu.edu/research/mlf-reports).

Project-specific Information Transfer activities:

(2019UT255B)—The research team collaborated with the Bureau of Reclamation, the Central Utah Water Conservancy District, and the Utah Division of Water Resources to share final models of the three reservoirs surveyed and a guide that explains the drone and sonar survey process.

Student Support

8 graduate students and 23 undergraduates received support during the 2019-20 plan year:

(2019UT255B) - 1 graduate student, 14 undergraduate students

(2019UT257B) - 1 full-time graduate student

(2019UT256B) - 5 graduate students, 9 undergraduate students

(2019UT258B) - 1 graduate student

Notable Achievements and Awards

Faculty and students affiliated with the UCWRR received the following awards and recognitions during the 2019 reporting timeframe:

- Several supported students were selected as AWRA student paper competition finalists and gave presentations on their contributions to the project.
- PI Dr. Brian Crookston and his students received the following: ASDSO Student Paper Competition Winner (Research Advisor), 2020, from the Association of State Dam Safety Officials; ASDSO Student Model Competition (Advisor), 2020, from the Association of State Dam Safety Officials; and 2019-2020 CEE Undergraduate Research Mentor of the Year from Utah State University - Dept. Civil and Environmental Engineering
- PI Dr. Alfonso Torres-Rua and his students were awarded the following during the 2019 plan year: CEE Department Undergraduate Research Mentor of the Year, 2020, at Utah State University; (Student) Best Paper Award SPIE Conference, 2020, from SPIE in 'Autonomous Air and Ground Sensing Systems for Agricultural Optimization and Phenotyping V'; (Student) Outstanding Pre-Professional, 2020, from the USU College of Engineering; (Student) received National Science Foundation FAIR Cyber Training , 2020, from the National Science Foundation / Purdue University
- Dr. Ryan Dupont was awarded, Life Member, 2020, from American Society of Civil Engineers

Bathymetric Surveying Using Sonar And Drones For Recurring Data Analysis

Project Type: Annual Base Grant
Project ID: 2019UT255B

Project Impact:

Sedimentation reduces water storage capacity in reservoirs and can significantly increase following fires. This research advanced methods for measuring bathymetry using a drone and using sonar from a boat and quantifying storage reductions. Primary findings of this project showed that the collected data can be combined successfully to create a bathymetric map of a reservoir that extends from the lowest elevation in the reservoir to the top of the dam. This surveying method will allow managing agencies to perform recurring bathymetric surveys regardless of the water level at the time of the survey because drone data can supplement the above-water portion of the reservoir not inundated at the time of the bathymetric survey. These bathymetric maps can be used to create storage capacity curves, contour maps, digital elevation maps, and other useful products. This method will be of primary interest to managing agencies at reservoirs that experience high sedimentation rates due to forest fires and large storm events. Since new surveys can be done relatively quickly, managers can understand how and where reservoirs are changing due to sedimentation, scouring, and other natural processes. The drone survey of the reservoir shoreline includes regions of specific interest including exposed depositional deltas and dams, while the sonar survey includes regions of interest such as thalwegs. The method was tested and applied at three reservoirs in Utah: Newcastle, Gunlock, and Starvation. All three reservoirs have been surveyed, and full pool bathymetric maps and storage capacity curves have been made for Newcastle and Gunlock reservoirs.

New Design And Analysis Guidance Regarding Potential Scour Of Hydraulic Structures Located In Canals, Rivers, Dams, And Levees

Project Type: Annual Base Grant
Project ID: 2019UT256B

Project Impact:

Hydraulic structures located in rivers and canals for flood protection and water supply need to be designed and maintained to be safe and sustainable. Downstream scour can undermine foundations and lead to failure or instability in hydraulic structures. This project focused on the problem of scour downstream of hydraulic structures known as piano-key (PK) weirs, an area where design guidance is limited. The project used physical hydraulic modeling to study scour in non-cohesive sediments below a piano key weir. Main findings included the following: (1) Scour increases proportionally with discharge but inversely with increased tailwater. (2) Scour evolution for both non-cohesive gravels occurred over 4 main phases, with phase 1 being most intense and lasting less than 1 hr. (3) Temporal evolution and maximum scour geometry can be predicted via figures provided in Lantz (2020). (4) A horizontal apron is an excellent mitigation strategy, with an average decrease in scour depth of 60 percent and a maximum reduction exceeding 80 percent. (5) In the three apron lengths tested, minimal benefits were provided for apron lengths exceeding the height of the weir.

Characterizing Streamflow And Temperature Patterns To Determine Impacts Of Summer Dewatering On The Blacksmith Fork River

Project Type: Annual Base Grant
Project ID: 2019UT257B

Project Impact:

In the arid western US, major landscape modifications like flood control and land use conversion have reduced the natural pathways of recharge and return flows to streams in agricultural river valleys. Combined with direct irrigation diversions, these modifications can result in depleted streamflows during the critical summer low flow period; thousands of stream miles in the western U.S. are now chronically depleted. Depleted streams are much more susceptible to extreme temperature variability, which is inextricably linked to aquatic habitat suitability. This research improved quantitative understanding of relationships between climate, streamflow depletion and water temperature over three summers, using the irrigation-dominated Blacksmith Fork River in northern Utah as a case of study. Summer stream temperature patterns were found to be very sensitive to changes in channel morphology and groundwater inputs. Channel morphology varies naturally but is also often highly altered for flood conveyance and land conversion. Similarly, groundwater contributions to base flow can occur naturally, but also include irrigation seepage lateral return flows that are influenced by irrigation practices and canal networks. This research highlights temperature sensitivity to land and water management decisions and identifies opportunities to enhance baseflow and maintain suitable stream temperature through the summer low flow period.

Use Of SUAS For Mapping Wetland Flow Paths And Consumptive Use On The San Rafael River, Utah

Project Type: Annual Base Grant
Project ID: 2019UT258B

Project Impact:

This project investigated water consumption of Tamarisk (Tamarix spp.) and native vegetation in the San Rafael River, Utah, using unmanned aerial technologies and energy balance models. Tamarisk is an invasive species that consumes water that otherwise would be available for natural or human use. The project demonstrated the suitability of the technology and algorithms for assessing crop evapotranspiration typically used in agriculture and needed analysis for an adequate estimation of native and Tamarisk biomass. The project used Utah State University's AggieAir drone technology. The drone-collected information consisted of optical, infrared, and thermal information; the atmospheric parameters were obtained from a local weather station; and the algorithm was previously tested on agricultural sites in California. Due to the San Rafael River's heterogeneous landscape, a new methodology was developed based on wavelet energy theory to adequately quantify energy balance components and biomass. The results of a separate analysis conducted for the two major vegetation environments present in the San Rafael River (vegetation along the river stream and across the landscape) also indicate the suitability of the UAV-derived water consumption for Tamarisk and native vegetation. Water consumption was found to be higher along the river stream as vegetation roots have direct access to higher water content in the soil. In other locations, Tamarisk and native water use will depend on the recovery or growth stage (represented by the biomass). Further work can address additional sources of validation and extend the conducted analysis to other similar river landscapes.