

**Water Resources Research Center  
The University of Arizona**

**Annual Technical Report  
2019**

## Products

### Publications (By Author)

Bernat, R.F.A., Megdal, S.B. and Eden, S., 2020, Long-Term Storage Credits: Analyzing Market-based Transactions to Achieve Arizona Water Policy Objectives, *Water* Vol 12, p.568, 20 pp, 43880, <https://www.mdpi.com/2073-4441/12/2/568/pdf>

Bransky, N. D. (2020). Monitoring *Diorhabda carinulata* impacts on *Tamarix* using satellite imagery in Grand Canyon National Park, Arizona (Master's thesis). Northern Arizona University. ProQuest Dissertations Publishing.

Bransky, N. D., Sankey, T. T., Sankey, J. B., Johnson, M. J., Jamison, L. R., (2020). Monitoring *Diorhabda carinulata* impacts on *Tamarix* using WorldView-2 satellite imagery in Grand Canyon National Park, Arizona, USA. *Journal of Arid Environments (In Review)*

Cruz Ayala, M.B. and Megdal, S.B., 2020, An overview of Managed Aquifer Recharge in Mexico and its legal framework, *Water, Special Issue on Managed Aquifer Recharge for Water Resilience*, 43871, <https://www.mdpi.com/2073-4441/12/2/474/pdf>

Dillon, P., Enrique Fernández, E., Megdal, S.B., and Massmann, G., 2020, Managed Aquifer Recharge for Water Resilience, *Water* Vol 12 (7), 44010, <https://www.mdpi.com/2073-4441/12/7/1846>

Eisenberg, J., Megdal, S., Sundareshan, P., Braelan Barnett, D., Seiter, M., Ruyle, G., Sullivan, B., Davis, R., Mather, P., 2020, Analysis of the 2020 WOTUS rule & policy implications for ephemeral washes in Arizona, *The Water Report*, Issue #196, 43997, <https://wrrc.arizona.edu/2020-wotus-rule>

Fathabad, A. M., Yazzie, C. B., Cheng J., Arnold, R. G., (2020). Optimization of solar-driven systems for off-grid water nanofiltration and electrification, *Rev. Environ. Health*, 35, 211–217.

Maxwell, T., Megdal, S.B., and Ruiz, J., 2020, In a changing climate, Arizona is uniquely positioned to succeed, *Arizona Daily Star, Local Opinion*, 44139, [https://tucson.com/opinion/local/local-opinion-in-a-changing-climate-arizona-is-uniquely-positioned-to-succeed/article\\_5bbb10a5-c6fa-5198-90d1-7b46239ff689.html](https://tucson.com/opinion/local/local-opinion-in-a-changing-climate-arizona-is-uniquely-positioned-to-succeed/article_5bbb10a5-c6fa-5198-90d1-7b46239ff689.html)

Megdal, S.B, 2020, End of 2020 Reflections, *WRRC Weekly Wave*, Vol 8. Issue 40, 44183, <https://wrrc.arizona.edu/reflections-end-2020>

Megdal, S.B, 2020, Reflections: The Importance of Dialogue, Process, and Participation, *WRRC Weekly Wave*, Vol 8, Issue 36, 44148, <https://wrrc.arizona.edu/reflections-importance-dialogue-process-and-participation>

Megdal, S.B., 2020, Reflections: Being on Sabbatical During the COVID-19 Pandemic, *WRRC Weekly Wave*, Vol 8, Issue 11, 43910, <https://wrrc.arizona.edu/reflections-sabbatical-covid-19>, <https://judaic.arizona.edu/news/reflections-being-sabbatical-during-covid-19-pandemic>

Megdal, S.B., 2020, Reflections: Singapore – A Model for Integrated Water Management, *WRRC Weekly Wave*, Vol 8, Issue 5, 43868, <https://wrrc.arizona.edu/reflections-singapore>

Megdal, S.B., 2020, Reflections: Spring 2020 and COVID-19 – The Work Must Go On, WRRC Weekly Wave, Vol 8, Issue 22, 43987, <https://wrrc.arizona.edu/reflections-spring-2020-and-covid-19-work-must-go-on>

Megdal, S.B., 2020, Reflections: Time to Retire the Water Buffalo Symbol?, WRRC Summer Wave, Vol 8, Issue 2, 44022, <https://wrrc.arizona.edu/reflections-time-retire-water-buffalo-symbol>

Megdal, S.B., 2020, Reflections: On Wicked Water Problems, WRRC Summer Wave, Vol 8, Issue 4, 44050, <https://wrrc.arizona.edu/reflections-wicked-water-problems>

Megdal, S.B., 2020, Reflections: Varying Views on My Water Buffalo Symbol Question, WRRC Weekly Wave, Vol 8, Issue 31, 44113, <https://wrrc.arizona.edu/reflections-varying-views-my-water-buffalo-symbol-question>

Megdal, S.B., 2020, Deadline Looms for Transboundary U.S.-Mexico Water Management: Experts weigh in on the potential for conflict and cooperation, Wilson Institute-Mexico Center, 44125, <https://www.wilsoncenter.org/article/deadline-looms-transboundary-us-mexico-water-management-experts-weigh-potential-conflict>

Ryan Lee, Ph.D.; Steven Arnquist; Kyle Hartfied, M.S.; Sharon B. Megdal, Ph.D.; Hans Skov-Petersen, Ph.D.; Christopher A. Scott, Ph.D., 2020, Social-Ecological Justice and Dryland Urban Greening in Tucson, Arizona, USA, Environmental Change

Schrag-Toso, S. (2020). Isotopes, Geochemistry, Citizen Science and Local Partnerships as Tools to Build Upon a Fractured Understanding of the Northern Patagonia Mountains. Master's Thesis. University of Arizona. Tucson, AZ.

Tapia-Villaseñor, E.M., Shamir, E., Megdal, S.B., and Petersen-Perlman, J.D., 2020, Impacts of Variable Climate and Effluent Flows on The Transboundary Santa Cruz Aquifer, Journal of the American Water Resources Association, Accepted subject to minor revisions, February 2020

Tapia-Villaseñor, E.M., Shamir, E., Megdal, S.B., and Petersen-Perlman, J.D., 2020, Impacts of Variable Climate and Effluent Flows on The Transboundary Santa Cruz Aquifer, Journal of the American Water Resources Association, 43992, <http://dx.doi.org/10.1111/1752-1688.12853>

Wilder, M., Varaday, R., Gerlak, A., Mumme, S., Flessa, K.W., Zuniga-Teren, A., Scott, C., Pineda-Pablos, N., and Megdal, S.B., 2020, Hydrodiplomacy and Adaptive Governance at the U.S.-Mexico Border: 75 Years of Tradition and Innovation in Transboundary Water Management, Environmental Science and Policy, October 2020, <https://www.sciencedirect.com/science/article/pii/S1462901120301052?via%3Dihub>

Wilder, M., Varaday, R., Mumme, S., Gerlak, A., Flessa, K., Zuniga-Teren, A., Scott, C., Pineda-Pablos, N., and Megdal, S.B., 2020, Hydrodiplomacy and Adaptive Governance at the U.S.-Mexico Border: 75 Years of Tradition and Innovation in Transboundary Water Management, Environmental Science and Policy, Under revision, February 2020.

Yazzie, C. B., (2020). Arizona Tribal Water Resources Assessment and Strategies for Groundwater Uranium Removal, Master's Thesis. University of Arizona, Tucson, AZ.

### **Presentations (Chronological)**

July 9, 2019, Sharon Megdal, Water Challenges and Solutions in Arizona and the West. Presentation, Sustainable Bioeconomy for Arid Regions Summer Education Program, University of Arizona, Tucson, AZ.

August 26, 2019, Sharon Megdal, Exploring the Essential Nature of Water for Sustained and Resilient Manufacturing. Panelist, Congressional Conference on Water, Arizona State University, Tempe, AZ.

September 11, 2019, Sharon Megdal, Video remarks. Presentation, Arizona Israel Technology Alliance, Phoenix, AZ.

September 12, 2019, Sharon Megdal, Report of the Science Committee. Presentation, JNF-University of Arizona-Arava Region Joint Institute for Global Food, Water and Energy Security, Washington, DC.

September 21, 2019, Sharon Megdal, Award Acceptance Remarks on behalf of the University of Arizona. Arizona Forward's 39th Annual Environmental Excellence Awards and 50th Anniversary Gala and Video, Phoenix, AZ

September 25, 2019, Sharon Megdal, Institutional Setting for Upper Santa Cruz Watershed Binational Groundwater Assessment. Presentation, Geological Society of America (GSA) Annual Conference, Phoenix, AZ.

September 25, 2019, Elia Tapia, Impacts of Variable Climate and Effluent Flows on the Transboundary Santa Cruz Aquifer. Presentation, Geological Society of America (GSA) Annual Conference, Phoenix, AZ.

September 25, 2019, Jacob Petersen-Perlman, Institutional Frameworks for Effluent Water Use in the Ambos Nogales Region of Arizona and Sonora. Presentation, Geological Society of America (GSA) Annual Conference, Phoenix, AZ.

October 4, 2019, Sharon Megdal, Water for Agriculture and Other Water Challenges in the West. Presentation, National Young Farmer's Alliance, Tucson, AZ.

October 12, 2019, Susanna Eden & Claire Zucker, Know About Your Water Green Valley – Sahuarita. Presentation, Democratic Club of the Santa Rita Area, Green Valley, AZ.

October 17, 2019, Claire Zucker & Susanna Eden, Arizona Runs on Water - Water 101. Presentation, Maricopa County Cooperative Extension, Phoenix, AZ.

October 18, 2019, Sharon Megdal, Water in Region. Presentation, Metropolitan Pima Alliance Monthly Breakfast Meeting, Tucson, AZ.

October 25, 2019, Sharon Megdal, Academia's Role in Science Diplomacy-Connecting Regions: Bridging through Water. Presentation, Conference on Sustainable Development for the Americas: Science, Health and Engineering Policy and Diplomacy, Tucson, AZ.

October 25, 2019, Elia Tapia, The U.S.-Mexico Transboundary Aquifer Assessment Program: Implementation, Evolution, and Lessons Learned. Presentation, Conference on Sustainable Development for the Americas: Science, Health and Engineering Policy and Diplomacy, Tucson, AZ.

October 30, 2019, Sharon Megdal, Closing Reflections, Panel presentation, Colorado River Conversations: Integrating Science and Identifying Solutions Conference, The University of Arizona, Tucson, AZ.

November 1, 2019, Susanna Eden & Claire Zucker, Know About Your Water Green Valley – Sahuarita. Presentation, Town of Sahuarita Council Chambers, Sahuarita, AZ.

November 5, 2019, Sharon Megdal, Getting to Yes in Arizona on the Lower Colorado River Drought Contingency Plan. Presentation, American Water Resources Association Annual Conference, Salt Lake City, UT.

November 7, 2019, Sharon Megdal, Arizona Water Policy and the Drought Contingency Plan. Lecture, University of Arizona (LAW 669: Environmental Law, Professor Kirsten Engel), Tucson, AZ.

November 15, 2019, Elia Tapia, Elia, Determinación del impacto del cambio climático y decisiones binacionales de manejo de agua en el Acuífero Transfronterizo Río Santa Cruz, en la frontera Sonora-Arizona. Lecture, Semana Cultural de Geología, Universidad de Sonora, Hermosillo, Mexico.

November 16, 2019, Susanna Eden & Claire Zucker, Know About Your Water Green Valley – Sahuarita, Presentation, Green Valley Recreation East Campus, AZ.

November 19, 2019, Sharon Megdal, Implementing Technologies Across Borders. Session moderator, WATEC 2019, Tel Aviv, Israel.

November 19, 2019, Sharon Megdal, Water and Politics. Panelist, WATEC 2019, Tel Aviv, Israel..

December 3, 2019, Sharon Megdal, Tribal Water in Arizona and the Colorado River Basin. Presentation, The National Academies of Sciences, Engineering, Medicine Board on Agriculture and Natural Resources, Ak-Chin Hotel and Casino, AZ.

December 4, 2019, Sharon Megdal, Water Issues in Israel and Arizona. Discussion Leader, Jewish Federation of Greater Phoenix, Scottsdale, AZ. January 20, 2021, Shamir, Eylon and Elia M. Tapia-Villaseñor, Desarrollo de un modelo conceptual –balance de agua- para la porción Mexicana de la Cuenca Transfronteriza Río Santa Cruz y Evaluación del Impacto Hidrológico para el Siglo 21, Universidad de Sonora. Hermosillo, Mexico

January, 2020. Schrag-Toso, Sean, Climate Assessment of the Southwest Fellowship Presentation, University of Arizona.

January 20, 2020, Sharon B. Megdal, Wicked Water Problems and Bridging through Water, Lecture, Lim Thiam Seng Lecture Series, Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore, Singapore

January 20, 2020, Tapia-Villaseñor, Elia M. and Eylon Shamir, El Programa de Evaluación de Acuíferos Transfronterizos: Esfuerzos en el Acuífero Transfronterizo Río Santa Cruz, en la frontera de Sonora y Arizona, , Universidad de Sonora. Hermosillo, Mexico

January 22, 2020, Sharon B. Megdal, Arizona (USA) and Colorado River Basin Water Issues, Lecture, National University of Singapore Lee Kuan Yew School of Public Policy Lecture, Singapore

January 28, 2020, Sharon B. Megdal, Workshop on the Challenges for Sustainable Management of Aquifers, Keynote Presentation, National Autonomous University of Mexico (UNAM), Mexico City, Mexico

February, 2020, Schrag-Toso, Patagonia Area Well Owner Training

February 6, 2020, Susanna Eden, Michael Seronde, Water Harvesting for Desert Gardens, Presentation, Green Valley Gardeners Seminar, Green Valley

February 9, 2020, Sharon B. Megdal, Bridging through Water (with a focus on the Jordan region), Fulbright-Hays Group Project Abroad to Jordan, , Video-Recorded Invited Background Presentation, Funded through a grant to the University of Arizona Center for Middle Eastern Studies,

February 24, 2020, Sharon B. Megdal, Central Arizona Water Issues, Presentation, Tucson, Arizona

March 5, 2020, Sharon B. Megdal, Wicked Water Problems and Addressing Regional Water Stress, Presentation, Tel Aviv, Israel

April 21, 2020, Sharon B. Megdal, Water Management in the Tucson Region, Presentation - Remote, Guest (remote) lecture University of Arizona ENVS 270 class

April 23, 2020, Sharon B. Megdal, Groundwater Governance and Management in the U.S. – and Beyond, Presentation - Webinar, University of Virginia

May, 2020, Schrag-Toso, Sean, Presentation of Research Results and Next Steps, Town of Patagonia, Arizona

May 6, 2020, Sharon B. Megdal, Developing Pathways to Solutions to Wicked Water Problems, Presentation - Webinar, University of Arizona Water Resources Research Center Brown Bag Seminar

May 6, 2020, Tapia-Villaseñor, Elia M., Eylon Shamir, and Sharon B. Megdal, Impacts of Variable Climate and Effluent Flows on the United States-Mexico Transboundary Santa Cruz Aquifer, EGU General Assembly 2020

May 13, 2020, Schrag-Toso, Sean, Thesis Defense, University of Arizona

June 5, 2020, Sharon B. Megdal, Effective Water Management Strategies: Technological, economic, legal, water quality, and other considerations when weighing water supply augmentation opportunities, Presentation - Webinar, Law Seminars International 7th Tribal Water in the Southwest Conference

June 5, 2020, Sharon B. Megdal, Cities and Towns engagement in renegotiation of Colorado River Basin shortage sharing guidelines, Webinar Panel, Sonoran Institute Board Academy

June 18, 2020, Sharon B. Megdal, Colorado River Basin Drought Planning and International, Federal, State, and Indigenous Nation Collaboration, Webinar Accent Presentation, Ozwater'20 Conference, Australia

June 18, 2020, Sharon B. Megdal, UCOWR talks networking, professional growth with Sharon Megdal, in recognition of being awarded the UCOWR Warren A. Hall Medal, Published interview in lieu of conference address, circulated by UCOWR

June 18-19, 2020, Sharon B. Megdal, Policy Makers Choosing a Route Panel and Keynote Speakers, Moderator, WRRRC (Virtual) Annual Conference

June 28, 2020, Sharon B. Megdal, Water as an Instrument for Peace: Middle Eastern Cooperation in the Face of COVID-19, Panelist, Friends of the Arava Institute Virtual Water Town Hall

June 29, 2020, Sharon B. Megdal, Wicked Water Problems and Bridging through Water, Webinar, H2O'Lyon, University of Lyon School for Research in Water and Hydrosystems

August 12, 2020, Sharon B. Megdal, Strengthening US-Israel Relations through Agricultural Partnership, Arizona-Israel, Webinar Panelist, sponsored by the Arizona Israel Trade and Investment Office and BARD (Binational Agricultural Research & Development Fund)

August 25, 2020, Tapia-Villaseñor, Elia M, The TAAP case of Transboundary Groundwater Collaboration, International Association of Hydrogeologists-Transboundary Aquifers Commission Meeting.

August 27, 2020, Sharon B. Megdal, Overview of the Water Resources Research Center, Navajo Nation Water Access Coordination Group Research Sub-group, Webinar Panelist, via AdobeConnect

September 17, 2020, Tapia-Villaseñor, Elia M., Eylon Shamir, and Sharon B. Megdal, Update on issues related to water use and climate uncertainties on the Transboundary Santa Cruz Aquifer, Online Seminar. WRRRC-Universidad de Sonora

September 29, 2020, Sharon B. Megdal, Coffee Break: US-Mexico transboundary groundwater resources: withdrawals and binational implications, Webinar Panelist, <https://binationalwaters.tamu.edu/coffee-breaks/past-coffee-breaks/> [https://www.youtube.com/watch?v=TEtFIRHxHc0&feature=emb\\_logo](https://www.youtube.com/watch?v=TEtFIRHxHc0&feature=emb_logo)

October 1, 2020, Sharon B. Megdal, Climate and Arizona's Future: A Conversation About the Nexus Between Environment, Economy, and Innovation, Webinar Panelist, <https://tinyurl.com/climate-convo-webinar>

October 6, 2020, Sharon B. Megdal, Water Updates, Collaboration Opportunities, and Q&A with the Water Resources Research Center, Arizona Cooperative Extension Annual Conference Breakout Session, Speaker, [https://arizona.zoom.us/rec/play/KSweWwImMzyfKlfuiC0D7tpK6s88SIMXLij2kxz1BVEXQaqNzeyYD9vzUQlb0cOP7Blzi0ownsn3E7wcj.gLIHXw\\_8cW2cPhsa?continueMode=true](https://arizona.zoom.us/rec/play/KSweWwImMzyfKlfuiC0D7tpK6s88SIMXLij2kxz1BVEXQaqNzeyYD9vzUQlb0cOP7Blzi0ownsn3E7wcj.gLIHXw_8cW2cPhsa?continueMode=true)

October 7, 2020, Sharon B. Megdal, Long-Term Storage Credits: Analyzing Market-based Transactions for Achieving Water Management Goals in Central Arizona, Co-author student-delivered presentation, Rebecca Bernat, Binational Symposium on Managed Aquifer Recharge

October 9, 2020, Sharon B. Megdal, Managed Aquifer Recharge in Mexico and Science-Policy Interactions, Co-author student-delivered presentation, Mary Belle Cruz Ayala, Binational Symposium on Managed Aquifer Recharge

October 14, 2020, Sharon B. Megdal, Groundwater depletion and water security in the Rio Grande/Bravo Basin vs Colorado River Basin, Webinar Panelist, Conference on United States -Mexico Transboundary Groundwater Conference Innovation and Creativity: Strategies for Unprecedented Challenges

October 16, 2020, Sharon B. Megdal, Forum of the graduate students in Master of Environmental Management and Master of Public Policy programs, Keynote Speaker, Webinar, Fall Symposium, Water and Borders, Nicholas School of the Environment, Duke University Water Network

October 21, 2020, Sharon B. Megdal, "Deadline Looms for Transboundary U.S.-Mexico Water Management: Experts weigh in on the potential for conflict and cooperation, Featured interviewee, published online by the Mexico Institute of the Wilson Center

October 23, 2020, Sharon B. Megdal, Desalination Innovations in Israel, Webinar Panelist, Western Municipal Water District (WMWD), Eastern Municipal Water District (EMWD), and the Western Riverside Council of Governments October Breakfast Speaker Forum

October 23, 2020, Sharon B. Megdal, Wicked Water Problems: Scarcity, Sharing, and Sustainability, Featured Speaker, Webinar, Webinar sponsored by Tucson Great Decisions

November 3, 2020, Sharon B. Megdal, Drought, Non-soon, and Water Uncertainties, Featured Speaker, Webinar, Green Valley-Sahuarita Association of Realtors

November 3, 2020, Sharon B. Megdal, Drought, Non-soon, and Water Uncertainties, Featured Speaker, Green Valley-Sahuarita Association of Realtors

November 9, 2020, Sharon B. Megdal, Wicked Water Problems – An Interactive Panel, Session organizer, moderator, and panelist, , American Water Resources Annual Conference (virtual)

November 17, 2020, Sharon B. Megdal, Water and Society, Presentation, CNRS (France) -University of Arizona Meeting

November 18, 2020, Sharon B. Megdal, The Central Arizona Groundwater Replenishment District (with Laura Grignano), Presentation, CAP University

November 18, 2020, Sharon B. Megdal, Water Issues of Relevance to Pinal County Agriculture, Presentation, Meeting of the Advisory Board to the Sustainable Bioeconomy for Arid Regions, The University of Arizona

November 20, 2020, Sharon B. Megdal, Water and Agriculture in Israel, Presentation, Water Management Certificate Program, Cohort VIII, Arizona State University

December 14, 2020, Sharon B. Megdal, "Wicked Water Problems" and the need for long-term concerted efforts to address them, Webinar, Western Regional Partnership Webinar

December 15, 2020, Sharon B. Megdal, Wicked Problems of Water Availability, Recorded Presentation, Session H179: Sociohydrology and an Improved Understanding of Water Availability, Abstract ID: 668765, Fall AGU Conference, Shaping the Future of Science

December 15, 2020, Sharon B. Megdal, Water issues of the coming year, Presentation, Tucson Regional Water Coalition



## Information Transfer Program

Between June 18, 2019 and December 31, 2020, the WRRC's Information Transfer Program conveyed water resources information through a variety of established programs and new initiatives to a range of audiences in Arizona and beyond. Continuing components of the Information transfer program include the Annual Conference, the Brown Bag seminar series, electronic and print publications, a dynamic website, and frequent communications through email and social media. Due to the COVID-19 pandemic, the 2020 Annual Conference was postponed from March until June 2020 and transformed to a virtual format. The conference drew nearly 500 participants and featured more than 30 speakers and panelists, including Bureau of Reclamation Commissioner Brenda Burman and Former Secretary of the Interior Bruce Babbitt.

During the reporting period, the WRRC presented 24 Brown Bag seminars by speakers who covered a range of water resource-related topics to a broad spectrum of audiences. With the transition to an online-only format, average participation in the seminars more than tripled by the end of the reporting period. The distribution list for the Weekly Wave—an e-news digest that includes WRRC news and updates, community events, and water news and opportunities—included more than 2,800 subscribers by the end of the reporting period.

During the reporting period the WRRC produced three public information presentations on area-specific water information with support from local industry and other stakeholders. A second set of three presentations was planned in collaboration with Maricopa County Cooperative Extension, however the third was cancelled due to COVID-19 meeting restrictions.

Collaborations with the WRRC-based Arizona Project WET (Water Education for Teachers) have expanded the reach and effectiveness of outreach and education projects of both partners. This collaborative relationship continued through the reporting period, as Arizona Project WET successfully redesigned many in-person programs for virtual platforms and developed new innovative programs to take advantage of home-learning environments.

In addition to all the above, WRRC personnel were called upon regularly to give lectures and make presentations to diverse audiences across Arizona and to respond to inquiries from the public on issues of concern. They collaborated with local, state, regional, and federal agencies and organizations, as a resource for general water resource related information and as partners on specific projects. WRRC personnel participated on community and regional boards and commissions and served on state and local task forces and study committees. The WRRC facility, which normally is open to the public, offers informational materials on water-related topics, and provides a space for water-related meetings, has been closed due to COVID-19 restrictions.

## Student Support

The FY2019 Section 104(b) Program supported eight students through small student research grants and WRRRC Information Transfer. The following summarizes the students supported:

2 PhD students

4 Masters students

1 Research technician

1 Undergraduate student

## Notable Achievements and Awards

In November 2019, John Polle was awarded a quarterly College of Agriculture and Life Sciences Outstanding Staff Award in recognition of his great work.

In 2020, WRRRC Director, Sharon B. Megdal was awarded the 2020 Warren A. Hall Medal from the Universities Council on Water Resources (UCOWR). The award is UCOWR's lifetime achievement award in water resources.

As part of the project "Isotopes, Geochemistry, Citizen Science and Local Partnerships as Tools to Build Upon a Fractured Understanding of the Northern Patagonia Mountains" the PIs won Best Graduate Poster Presentation at the Arizona Hydrological Society 2019 Annual Conference, and Best Virtual Oral Presentation at the El Dia del Agua y la Atmósfera 2020 Annual Conference.

The project "Solar nanofiltration for off-grid water purification in Navajo Nation" supported by the 104(b) program was a steppingstone to progress solar enabled desalination. DOE RAPID awarded the PI over \$500,000 to develop an off-grid solar desalination system for concentrate management. The Agnese Nelms Haury Program in Environment and Social Justice awarded \$30,000 to the co-PI and other collaborators to support additional work with Navajo communities to access potable water in the Navajo Nation.

# Solar Nanofiltration For Off-grid Water Purification In Navajo Nation

**Project Type:** Annual Base Grant

**Project ID:** 2019AZ003B

## **Project Impact:**

The overall objective of this project was to design, model, and build a household-scale, solar-nanofiltration (NF) system of (i) photovoltaic (PV) solar array, (ii) high-pressure pump, (iii) NF membrane, (iv) batteries and (v) water storage tanks (one for the feed and one for the product water) subject to constraints on (i) daily water treatment quantity and quality (namely removal of uranium and arsenic), (ii) excess energy production/storage for nighttime use, and (iii) minimized present-value cost (PVC). Through this funding we were able to build and test a small scale (50-120 gallon per day (gpd)) solar NF system for one household for potential use at the Navajo Nation. We increased the relevance of solar-NF systems for off-grid water purification, by sizing the PV and energy storage system via battery storage beyond the energy required to operate the NF system, thus providing a limited amount of excess energy (1-3 kWh per day) for nighttime lighting or home heating. The total PVC for the household-scale system with and without additional electricity storage was approximately \$2,800 and \$1,100, respectively. Ongoing work includes system testing in real environmental conditions, and electro adsorption and electrocoagulation of uranium and arsenic removal, respectively, from the product water and brine. The main impact of our work was in developing the blueprint for a point-of-use household-scale solar-NF system for water purification and partial household electrification.

# A Citizen Science Approach To Monitoring Water Resources In A Vulnerable Aquifer

**Project Type:** Annual Base Grant

**Project ID:** 2019AZ018B

## **Project Impact:**

The rural Town of Patagonia in Southeastern Arizona is facing uncertainty around the future availability of groundwater resources in the area. This uncertainty is due to extended drought and increased groundwater extraction by the mining industry in the Northern Patagonia Mountains, which are located south of the Town.

To better understand groundwater movement in the mountains, the authors analyzed isotope ratios and geochemistry of springs and wells in the Northern Patagonia Mountains. The results indicate that major mapped faults within the mountain block, including the Harshaw Creek Fault, appear to be conduits of groundwater movement. The Mountain Front Fault, which separates the mountains from the basin, appears to obstruct groundwater flow, resulting in distinct water chemistry and Pleistocene-aged groundwater in select areas on the basin-side of the fault. Mountain front recharge and focused mountain block recharge via Harshaw Creek partially recharge the Sonoita Creek alluvial aquifer from which the Town of Patagonia pumps for its municipal water source. The results of this research indicate that drought is the primary concern for springs in the study area and the secondary concern is the resultant impact on groundwater flow in stream channel sediments around Harshaw Creek and its tributaries.

This improved conceptual understanding of groundwater flow informed recommendations for continued monitoring of groundwater resources. Regular collection of data by local stakeholder groups will allow for monitoring of groundwater resources by residents living in the watershed and improved management of groundwater resources by the Town Council.

# Detecting Colorado River Tamarix Phenology Using Publicly Available Satellite Images

**Project Type:** Annual Base Grant

**Project ID:** 2019AZ019B

## **Project Impact:**

Tamarisk is an invasive plant spreading along many Southwestern riparian areas. We mapped healthy tamarisk, defoliated tamarisk, and tamarisk canopy dieback resulting from tamarisk beetle herbivory in Grand Canyon National Park in May and August of 2019 using WorldView-2 (2 m spatial resolution) imagery. The classifications in May and August, 2019 produced overall accuracies of 80.0% and 83.1%, respectively. Change detection indicated that 47.5% of the healthy tamarisk detected in May, 2019 had defoliated by August, 2019. Using 2009 and 2013 tamarisk maps, we found that 29.5% of healthy tamarisk canopy cover declined between 2009 and 2019, and more tamarisk declined than recovered between 2013-2019. We also assessed Landsat satellite imagery (30 m spatial resolution) in mapping 2011 and 2019 tamarisk defoliation and canopy dieback between 2000-2019. The Landsat image classifications produced 50% overall accuracy, and estimated 66.2 - 90.2 ha of defoliated tamarisk throughout the 363.5 km study area, and 6.1 - 9.8 ha of defoliated tamarisk within the WorldView-2 image analysis areal extent. The large pixel size of the Landsat images made it challenging to detect small patches of tamarisk and changes within them. These results highlight the importance of high spatial resolution satellite imagery in topographically complex areas, and illustrate that Landsat is not a suitable image source. Additionally, the maps and methods provide a tool for land managers to determine where tamarisk is affected by tamarisk herbivory and where restoration is needed.