WSP Water Sustainability Program
Our Water Future
Highlights
• Innovation • Collaboration • Education • Policy
SUMMER 2012

The Water Sustainability Program (WSP) funds strategic initiatives at The University of Arizona (UA) to leverage the University's recognized water expertise and generate innovative solutions to 21st century water resource challenges. WSP is meeting these challenges through interdisciplinary research, engagement of partners from the private/public sectors, and training of the next generation of experts. Recognizing that complex problems are at the water:environment:energy nexus, WSP is collaborating with the Institute of the Environment and the Renewable Energy Network under the UA TRIF (Technology and Research Initiative Fund) Water, Environmental and Energy Solutions (WEES) initiative to help sustain economic growth and the quality of life in Arizona, and to enhance Arizona's role in the global marketplace.

WEST Center becoming a reality

Ian Pepper, professor, Soil, Water and Environmental Science, and Shane Snyder, professor, Chemical & Environmental Engineering, both known world-wide for their work in water quality, treatment and reuse, have teamed up to create an unprecedented collaboration between the University of Arizona, Pima County Regional Wastewater Reclamation Department, and the City of Tucson. Through WSP-TRIF funding and industry match, the UA Water & Energy Sustainable Technology (WEST) Center, is positioned to become a world renowned venue for wastewater and water treatment and monitoring, alternative energy and related technologies, state-of-the-art research and innovative education and training. Final negotiations are underway to create a home for the WEST Center on the new Pima County Water Reclamation Campus under construction at I-10 and Roger Road in Tucson. Pima County is building the new campus in partnership with CH2M HILL to upgrade wastewater treatment in the county as part of their Regional Optimization Management Plan. Not only will the new facilities protect the environment and water supplies in Pima County for decades to come, but it will become an international hub for water/energy research and education.

Central to the WEST Center mission is the establishment of public/private partnerships that involve major private corporations and industries. Linkages to several of these entities have already been established through the National Science Foundation Water & Environmental Technology (WET) Center and the former Water Quality Center that Pepper directed for many years.

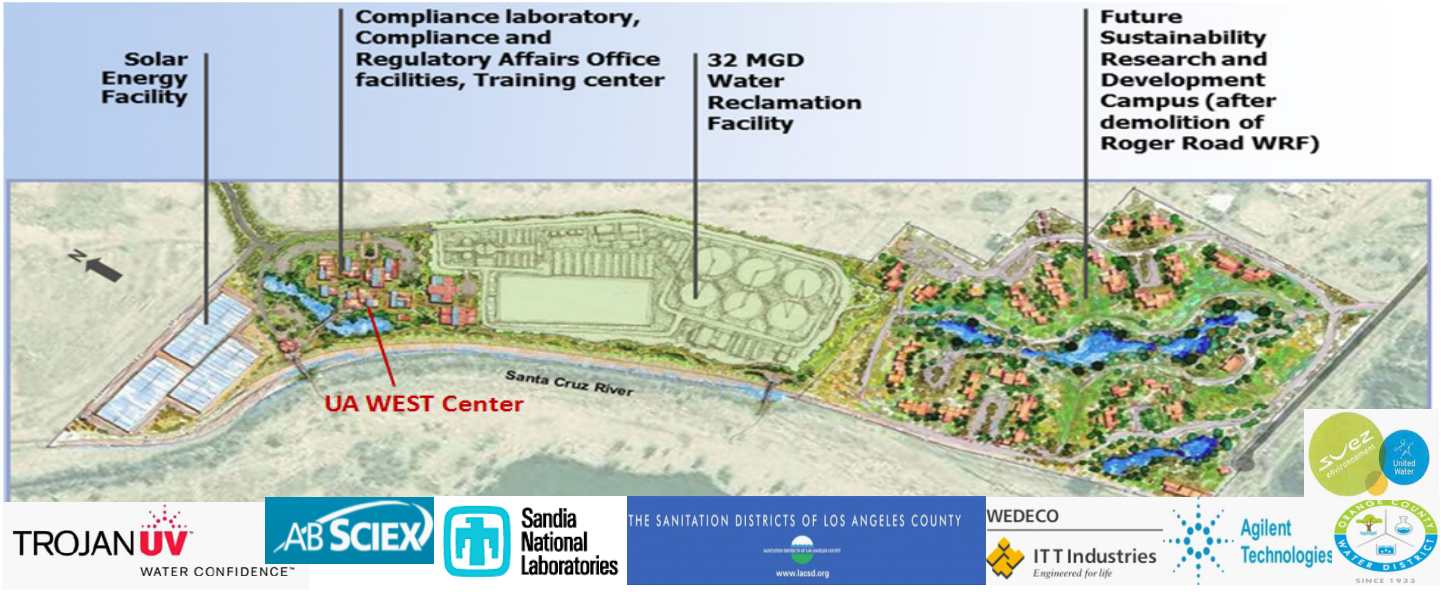
Objectives of the new center will be to:

- Develop, evaluate and demonstrate technologies that advance water sustainability solutions
- Provide a holistic view of the critical water:energy nexus through state-of-the-art research
- Facilitate technology transfer between UA, public utilities, and the private sector
- Promote jobs and economic growth within the community
- Educate and train technicians, utility personnel, and UA students
- Educate the community with respect to the water:energy nexus

Current projects include: real-time detection and destruction of contaminants in potable water; analysis of SCADA System computerized water quality control; studies on desalination and aquaculture; and solar projects initiated via Ardeth Barnhart and the UA Renewable Energy Network. UA faculty involved in WEST Center research cross many departments in the colleges of Engineering and Agriculture and Life Sciences: Bob Arnold and Wendell Ela, Chemical & Environmental Engineering, Kevin Lansey, Civil Engineering & Engineering Mechanics, Chris Choi, Agricultural & Biosystems Engineering; Chuck Gerba, Kevin Fitzsimmons and Channah Rock, Soil, Water & Environmental Science.

This is an exciting collaborative effort not only for the University, the City of Tucson, Pima County and Arizona; but for water resources research and technology across the nation and around the world. ♦

The design plans for WEST Center and beyond:



Sustainable mining

Raina Maier recently took over the top spot as director of the UA NIEHS Superfund Research Program (UA SRP). With a focus on hazardous waste risk and remediation in the Southwest, one way Maier is using TRIF funds is to help the UA SRP bring a larger focus to environmental issues in the mining industry. A new collaborative venture headed up by Maier, and enabled by WSP, is the creation of the Center for Environmentally Sustainable Mining (CESM) as the environmental arm of the Lowell Institute for Mineral Resources (LIMR) at UA. This effort is combining the talents of Maier, professor in Soil, Water and Environmental Science in the College of Agriculture and Life Sciences with Mary Poulton, chair of the department of Mining and Geological Engineering and director of LIMR, in the College of Engineering. Mining is an important economic driver in Arizona and CESM will work to address water use, environmental issues, energy use and economic development in siting and opening new mines and resolving the challenges posed by our mining legacy. CESM is building partnerships with the mining industry to help leverage the TRIF investment and to support the transfer of new technologies and strategies developed at UA directly into use by mining companies.

Phytostabilization plots at Iron King Mine. Photo Credit: R. Maier

A major environmental issue associated with mining is dust, a significant threat to public health. Dust is an increasing problem in Arizona linked to limited rainfall and land-use issues, as witnessed by last year's dust storms or "haboobs," that raged across the state. Specific to the mining industry, studies are on-going at the Iron King Mine Humboldt Smelter Superfund site to reduce wind and water erosion of mine tailings through phytostabilization, which means establishing a plant cover for long-term stabilization and containment of tailings. From another angle, a TRIF-funded interdisciplinary team from the College of Pharmacy and the College of Science is working to produce a non-toxic, sugar-based additive, that mining companies could apply to surfaces of mine tailings that are being actively deposited to help retain water and reduce wind-borne dust. A second TRIF-funded team from the College of Agriculture and Life Sciences is developing educational modules for use at the community college level to train students about mining; what the process is and the economics involved, understanding human and environmental health risks of mining, and remediation technologies used for acid rock drainage and mine tailings wastes.

Researchers cover up from blowing mine dust. Photo Credit: R. Maier

Maier also uses TRIF/UA-SRP funds for the continued development of the Arizona Laboratory for Emerging Contaminants (ALEC), an Arizona-wide (UA, ASU, NAU) analytical laboratory that specializes in analysis of organic and inorganic pollutants in complex environmental samples. ALEC serves as a centralized facility that supports the analytical needs of faculty across campus and offers training for students in separation techniques and the use of advanced instrumentation. The TRIF/UA SRP support ensures that there are trained staff available to help researchers develop new analytical approaches for emerging or very low concentration pollutants. These capabilities make ALEC an important component in many new granting efforts. ♦

From snow melt to aquifers

"SAHRA is helping to determine how much water there is now and for the future of Arizona," says Paul Brooks, SAHRA director. Working with researchers in Biosphere 2 and departments across campus, Brooks is building research collaborations in a new model for SAHRA, a former NSF funded center, focused on the cycling of water, from the top of mountains to the aquifers below.

SAHRA which stands for Sustainability of semi-Arid Hydrology and Riparian Areas, promotes and facilitates the development of cutting edge, stakeholder-relevant, water-related basic research projects by integrating UA's disciplinary strengths in hydrological, ecological, and physical sciences. Serving as an incubator for new approaches to pressing questions of water availability and quality, the center addresses research of critical importance to the State of Arizona, the southwest in general, and the nation as a whole.

Krystine Nelson working with a remote camera to record snow accumulation Photo Credit: S. Papuga

A key project, funded through TRIF and NSF, is the Jemez-Santa Catalina Critical Zone Observatory (CZO) to study interactions that help drive models of carbon/water cycling, arid/semi-arid ecohydrology and landscape evolution. Much of the CZO research is designed to examine hydrological partitioning, including stream flow, reservoirs, in-stream processes, and ecosystems against the backdrop of climate change.

Starting with the snow pack, high up in the mountains of Colorado, Wyoming, and New Mexico, that melts and feeds into the Colorado River, Krystine Nelson (pictured left) works with a remote camera that records snow accumulation and ablation to quantify what fraction of that snowfall is available to generate river flow, recharge groundwater, and support the production of forests or grassland ecosystems in rural areas. In rapidly growing urban areas, TRIF, NSF, and DOE are funding graduate researchers, (pictured above) David Huber, Sarah Tepler, and Allison Peterson who are studying the ability of different types of urban washes to attenuate pollutants in monsoon runoff before it recharges groundwater.

David Huber, Sarah Tepler, and Allison Peterson study the ability of urban washes to attenuate pollutants in monsoon runoff. Photo Credit: P. Brooks

A third major project linked to SAHRA is the largest fully controlled and contained experimental soil, water, and ecosystem development study in the world. Stephen DeLong is the lead scientist heading up development of the Landscape Evolution Observatory (LEO) at Biosphere 2. Three massive climate controlled landscapes loaded with sensors will be the basis for a 10-year project to address how water, energy and carbon move through landscapes, and how changing climate conditions will impact the atmosphere and water resources in the future.

These projects attract researchers from around the world to study and learn about unique approaches to earth science research and how to find the answers to big questions about resource sustainability and water security in an uncertain future. ♦

Transferring water know-how

The Water Resources Research Center's policy focus adds value to more technical types of university research. Investigating the science of water reuse and reclamation, the hydrology of groundwater and surface water, and project engineering and costs are not sufficient to implement solutions. Understanding and addressing institutional capacity, stakeholder involvement, and partnership development are also key factors. Policy analysis and state-of-knowledge evaluation equally require research that supports water management.

For example, TRIF funds supported graduate student investigations that respond to the research recommendations of the Governor's Blue Ribbon Panel on Water Sustainability. This high level panel met for a year focusing on issues of water reuse and the water-energy nexus and produced a series of recommendations including a list of research needs. One TRIF-funded project, carried out by Jeremy Cusimano under the supervision of the WRRC's associate director, Jean McLain, was aimed at estimating the quantity of water reused for agriculture in Arizona, including both permitted and unpermitted reuse. The research involved study of relevant laws and regulations, permit records, dischargers of wastewater, and agricultural irrigation districts, among other sources of data. A second project estimated the amount of water and energy used in mining, including the water embodied in energy use, and set the estimates in the context of water use in Arizona. Pratt Rogers, advised by Mary Poulton, (see Sustainable mining), developed a unique method for calculating energy embodied water in mining that will be reviewed by industry experts. Among other state and regional projects, the WRRC is working on rainwater harvesting, water reuse and reclamation, incorporating environmental water needs into water planning, and will soon begin a project related to the groundwater-surface water connections in the upper Santa Cruz River region. Grants from the U.S. Bureau of Reclamation, the Nina Mason Pulliam Charitable Trust, the Arizona Department of Agriculture and a pending grant from NOAA are leveraging the WRRC-TRIF funding to expand applied research programs and deliver high quality education and outreach products under the leadership of Sharon Megdal, WSP and WRRC director.

Megdal lectures on Arizona water management at Arab high school in Nazareth.

There is great interest in Arizona's water management policies, and their relevance to resolving similar challenges around the world was made clear during the first half of 2012 sabbatical travels of Megdal. On her travels she has had multiple opportunities to offer insights and information on Arizona practices through involvement in the Global Groundwater Governance Project; in Israel at The Hebrew University, Ben Gurion University and an Arab high school in Nazareth; at the World Water Forum in Marseille, France; in Australia at university and public venues; and for the Organization for Economic Cooperation and Development (OECD) in Paris, France. Everywhere, the relevance of Arizona's water management policies was acknowledged as beneficial to others with similar challenges worldwide. International networking of the WRRC and others across campus enables us to showcase, and transfer the know-how and experience gained by TRIF-funded water research, education and engagement efforts. ♦

Environmental gains for high-tech

High-technology, dependent on semi-conductors for electronics, photonics, and their applications in medical/health-care areas, are the fastest growing manufacturing industries in Arizona but are also significant consumers of both water and energy. Millions of gallons of water per day of ultrapure water are used in rinsing processes and energy is used to treat water to a high standard for these processes. At the UA Engineering Research Center (ERC) for Environmentally Benign Semiconductor Manufacturing, research projects are focused on reducing the high inputs of water and energy and associated costs to help keep this industry in the forefront of Arizona's economic future.

A sensor to monitor water use and improve efficiency is in final testing stages and will soon be available to the industry. Funded through Intel and TRIF, this process took fundamental ideas and successfully scaled them up for real-world application. It is estimated that water savings of 50% could be realized.

Two teams are working on other new technologies through TRIF support and industry match. Farhang Shadman and Reyes Sierra are advising grad students Jeff Rottman and Hao Wang, and post-doc Jun Yan in the department of Chemical & Environmental Engineering, on development of low-energy water purification and wastewater treatment processes. The key component of this process is a novel photo-catalytic membrane for low-energy removal of organic impurities in water. A test-bed and a pilot unit for this process have been designed and set up. The next step is to validate the concept in a larger pilot unit in the lab.

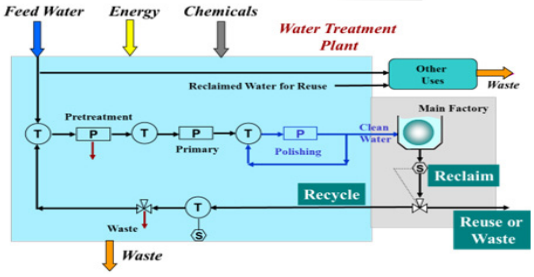


Photo-catalytic membrane diagramed and seen above, is a very promising and attractive method of removing low level organics from water in water purification systems. Photo Credit: F. Shadman

In a second project, Manish Keswani and Srini Raghavan in the department of Materials Science and Engineering are working with grad students Davoud Zamani and Roy Dittler to develop integrated water and energy recycling methods that recover and reuse both of these natural resources in an optimum way. An example of this is a method for capturing unused radiant energy and directly converting it to electrical energy instead of heat. Another example is the use of a mega-sonic source instead of using electrical heating of water to enhance the wafer rinsing process.

Development and application of these technologies will yield true environmental gains for high-technology manufacturing in Arizona. ♦

Funded through the state Technology and Research Initiative Fund (TRIF), created by passage of Proposition 301 in 2000.

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Impact of WSP Fellowship Funding

The 2011-2012 WSP Student Fellows discuss their TRIF funded research experiences:

"The fellowship has provided me with the freedom to work creatively and bring professors from various disciplines together to guide my research. As a researcher, I am now better equipped to think holistically about the objectives and outcomes of my current and future research activities." –Monica Ramirez with her project titled: Gardenroots: A Citizen Science Program to Empower Communities Neighboring Contamination, Department of Soil, Water and Environmental Science- Advisors: Janick Artiola, Mark Brusseau, Raina Maier♦

*Front: Monica Ramirez, Rachael Maxwell, Becky Witte Back: Berenice Rivera, Lucia Rodriguez-Freire, Brian Scott Shepard, Kevin Ray, Emerson Patricio**

"This project has enhanced my ability to effectively communicate with community stakeholders, and the importance of community input and public perception. This study illustrates the development of innovative techniques and tools that characterize sources of water quality impairment." - Berenice Rivera with her project titled: Analyzing Water Samples for Sources of Contamination Using PCR and qPCR, Department of Soil, Water and Environmental Science - Advisor: Channah Rock♦

"The WSP Fellowship allowed me to really learn how the average consumer views both the value and the price of water. Given how tricky those questions are to answer, it gives me greater appreciation for the difficulty faced by water regulators nationwide." - Kevin Ray with project titled: Can Desert Dwellers Afford Lush Lawns: Analyzing Consumer Response to Rate Changes in Four Phoenix Suburbs, Department of Agricultural and Resource Economics - Advisors: Satheesh Aradhyula, Gary Thompson♦

"Throughout this year, I have worked with different experimental conditions, and thus far I have been able to remove almost 70% of the initial arsenic concentration from water. I think it is going to be a very important process in the bioremediation of arsenic from groundwater." -Lucia Rodriguez-Freire with her project titled: Arsenic biomineralization: The role of the sulfur cycle in preventing arsenic groundwater contamination, Department of Chemical and Environmental Engineering - Advisor: Reyes Sierra♦

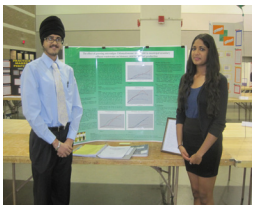
"While researching I have made helpful contacts with professionals at the Water Resources Research Center, Tucson Water, Arizona Department of Water Resources, and Veolia Water. Next, I will perform a case study on the Tucson AMA to determine the water stress index." -Becky Witte with her project entitled: Probabalistic Risk Assessment to Determine Possible Failures in the Tucson, Arizona Water Supply, Department of Hydrology and Water Resources - Advisor: Larry Winter♦

"I learned patience. Creating a research project takes time – it was difficult for me to grasp the idea of how challenging it was to determine the most efficient way to analyze samples and get reliable results." -Rachael Maxwell with her project entitled: Investigating the Accumulation of Polychlorinated Biphenyls in a Mixed Conifer Forest, Santa Catalina Mountains, Tucson, AZ, Department of Soil, Water and Environmental Science - Advisor: Jon Chorover♦

"The WSP fellowship has motivated and encouraged me to provide a quality product. The results show an interesting relation between grassy areas and shrubby areas on rangelands during the years following a fire."-Brian Scott Shepard with his project titled: The Affect of Wildfire on Rangeland Sustainability in the San Rafael Valley, Department

SARSEF Awards

WSP is pleased to announce the top three water-related award winners in this years Southern Arizona Regional Science and Engineering Fair.


1st Place: Sumedha Ravishankar & Sirtaj Singh Empire High School.

2nd Place: Emerson Patricio* & Dayanara Sixkiller Baboquivari High School.


3rd Place: Stephen Yao, University High School.

FELLOWSHIP AWARDS 2012-2013

Graduate Students

Joel Biederman
Improved Predictive Tools for Water Availability Following Forest Disturbance. Department of Hydrology and Water Resources. Advisor: Paul Brooks

Jake Davis
Electrochemical Processes for Removing Dissolved Minerals from Potable Water. Department of Chemical & Environmental Engineering. Advisor: Jim Baygents

David Love
A Data-Driven Method for Robust Water Allocation under Uncertainty. Department of Systems & Industrial Engineering. Advisor: Güzin Bayraksan

Zachary Sugg
Governing the Unseen: A Comparative Analysis of Arizona and Texas Groundwater Institutions. Department of Geography & Development. Advisor: Carl Bauer

Undergraduate Students

Adam Karczynski
Determining Soil Hydraulic Conductivity from Cosmic-ray Neutron Data. Department of Hydrology and Water Resources. Advisors: Martha Whitaker & Marek Zreda

Samantha McEntire
Understanding Salinity Stress in Citrus. Department of Hydrology and Water Resources. Advisor: Martha Whitaker

Stephanie Ruehl
Use of Wastewater to Provide Nutrients for Algal Growth as Biofuel. Department of Chemical & Environmental Engineering. Advisor: Bob Arnold

Yiming Zhang
Microbial Fuel Cells and Corrosion Testing of Water Delivery Pipelines for the Tucson City Water System. Department of Chemical & Environmental Engineering. Advisor: Dominic Gervasio