



Research Highlights

• Innovation • Collaboration • Education • Policy

SUMMER
2013

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 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 (IE) and the Renewable Energy Network (REN) under the Water, Environmental and Energy Solutions (WEES) initiative of the UA TRIF (Technology and Research Initiative Fund) to fund new interdisciplinary research relevant to Arizona.

Seed grants are an important mechanism for jump starting new innovative research projects because they provide funds to generate new data, develop prototypes, and demonstrate and test new technologies. Four new projects were selected through a competitive process for WEES funding in 2013-2014 for research related to water, energy and the environment. The researchers chosen represent multiple departments and colleges across campus.

One WEES-funded project, by **Greg Barron-Gafford** (Geography and Development), **Mitch Pavao-Zuckerman**, **Nate Allen** (B2 Earthscience) and **Alex Cronin** (Physics), proposes a "proof of concept" study that will take a novel ecosystems approach, grounded in a desire to implement water-smart design, to create a hybrid of "green" and "grey" infrastructure to increase photovoltaic efficiencies. The goal of another project, by **Mark Brusseau** (Soil, Water and Environmental Science) and **Denise Moreno Ramirez** (Superfund Research Program), is to conduct a demonstration test of an innovative, cost-effective

characterization tool (phytoscreening) that will permit rapid screening of sites to delineate soil and groundwater contamination. It is anticipated that substantial cost savings will accrue if phytoscreening is demonstrated to be an effective tool for Arizona site conditions. Another project, by **Manish Keswani**, **Pierre Deymier** (Materials Science and Engineering) and **Shane Snyder** (Chemical and Environmental Engineering), will look at an approach to improve the efficiency of sonolytic degradation of trace organic contaminants in wastewater effluent. This project supports the growing interest in use of sonolysis as an effective alternative to existing advanced oxidation processes (AOPs) for degradation of trace organic contaminants in water. Finally, another research team, including **Shane Snyder** (Chemical and Environmental Engineering), **Walter Klimecki** (Pharmacology and Toxicology), **Gerardo Lopez** (Public Health) and **Erin Snyder** (Soil, Water and Environmental Science), will develop and demonstrate a metabolomic approach to comprehensively evaluate the potential for biological impacts from contaminant mixtures in regional water sources.

Graduate Student Research Support

In spring 2013, WSP funding was provided to faculty-graduate student research teams to stimulate major proposal development and to give students important training opportunities. Awards were made to 13 graduate students in six departments across three colleges to study a broad range of topics relevant to water issues in Arizona. It is anticipated that more than 20 major proposals for significant funding will be submitted to external agencies as a result of this funding. View details on the WSP.arizona.edu website under "Research."



Biosphere 2 solar array project site. Photo credit: Biosphere 2.



Effluent Discharge.

Seven of the nine projects funded through WEES in 2012-2013 were related to water, and they wrapped up in June. Highlights are noted below.

1) *Collaborative Water Management Planning Under Climatic and Non-Climatic Stressors: Navajo Nation and Little Colorado River Watershed.*

Karletta Chief (Soil, Water, and Environmental Science), **Alex Serrat-Capdevila**, **Juan Valdes** (Hydrology and Water Resources) and **Diane Austin** (Anthropology)

This multi-disciplinary study integrated quantifiable impacts of climate change on water and environment in the Little Colorado River Basin, within a stakeholder collaborative process focused on finding viable alternatives and trade-off solutions to existing problems. Conclusions were that it is critical to establish and foster partnerships with Navajo central government and local Navajo citizens, to promote open and constant communication, and for Navajo citizens to take the lead in watershed management workshops.

2) *Membrane Distillation with Energy Recovery for Inland Desalination.*

Wendell Ela (Chemical and Environmental Engineering)

This project has developed, tested, and scaled-up to field implementation an autonomous, solar-driven membrane distillation process for brackish water desalination. Early testing suggested that the prototype is conceptually sound and uses substantially less net energy per unit volume of pure water produced than earlier versions.



Pilot solar desalination installation on the Navajo Nation. Photo credit: Ardeth Barnhart.

3) *Sustainable Algae Biodiesel Production: Nutrient Recycling with Wastewater Reuse and Anaerobic Digestion of Residues.*

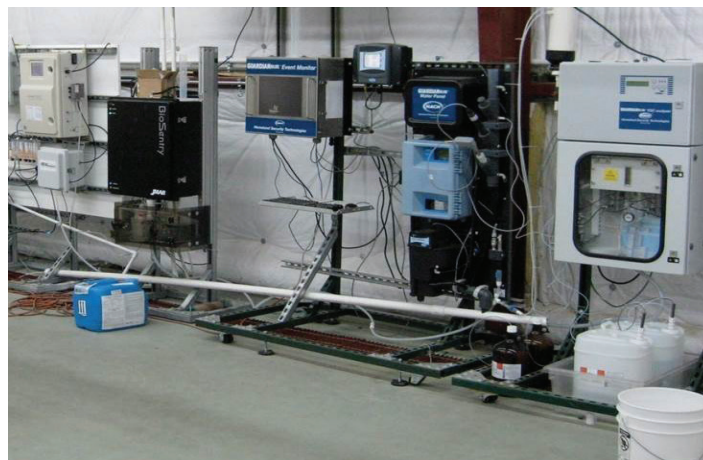
Jim Field, **Paul Blowers** (Chemical and Environmental Engineering), **John Kyndt** (Chemistry and Biochemistry) and **Randy Ryan** (Agricultural Experiment Station)

This research compared the conversion of whole cell (WC) algae (*Chlorella sorokiniana*) with oil-extracted algae (OE) and algae subjected to a sonication treatment (ST). The conversion of algae biomass energy to methane energy fuel during the digestion process indicated that cell lyses improves the energy conversion. The results demonstrated that anaerobic digestion can be utilized to recover energy and fertilizer from spent algae residue and improve the sustainability of algae biodiesel production.

4) *Real-time Documentation of Contaminant Destruction in Potable Water.*

Ian Pepper, **Chuck Gerba** (Soil, Water and Environmental Science) and **Shane Snyder** (Chemical and Environmental Engineering)

This project demonstrated that oxidation and on-line sensor technology can be used for real-time documentation of microbial contaminant destruction in potable water within distribution systems, ensuring safe contaminant-free drinking water for consumers. The efficacy of such treatment was verified through the use of real-time sensors, which detected microbes through laser light scattering and a computerized database.



Sensor lab at the Water and Energy Sustainable Technology (WEST) facility. Photo credit: Ian Pepper.

5) *Fate and Toxicity of Emerging Contaminants in Effluent-Dependent Streams.*

Eduardo Saez, **Robert Arnold** (Chemical and Environmental Engineering) and **David Quanrud** (Natural Resources and the Environment)

This project evaluated the endocrine disruption activity and cytotoxicity associated with liquid and solid phase sources and sinks in an effluent-dependent stream (Santa Cruz River). The concentration of estrogenic activity in secondary effluent discharged from the Roger Road wastewater treatment plant into the Santa Cruz River was well above the levels known to elicit serious physiological disruption to any exposed fish, but it decreased more than 95% after 7.2 kilometers of downstream travel distance from the plant.

6) *Hydrologically-Driven Spatial Heterogeneity of Tree Productivity and Tree Climate Sensitivity in the Southwest.*

Valerie Trouet (Laboratory of Tree-Ring Research) and **David Moore** (Natural Resources and the Environment)

An analysis of tree ring increments, isotopic variation in wood, eddy covariance measurements and ancillary meteorological observations in two forests in the Southwest demonstrated that moisture availability exerts strong control over growth in these forests, with significant positive correlations throughout much of the year. Observed flux measurements were consistent with reconstructed biomass estimates, but further work is needed to determine if the climate response seen in the tree-ring and isotope chronologies can be discerned from the flux data.

7) *Development of Novel Water-Conserving Management Strategies.*

Markus Tuller, Donald Slack (Agriculture and Biosystems Engineering), **Paul Brown** (Soil, Water and Environmental Science), **Mohammad Pessarakli** and **Michael Ottman** (Plant Sciences)

The researchers conducted numerical simulations to optimize broader irrigation strategies that lead to conserving water resources while maintaining high salt leaching efficiencies. The researchers developed and coded a software package that allows geospatial analyses of resistivity measurements, with a DUALEM Electromagnetic Induction instrument, that will be applied to assess the leaching efficiencies for the field trials. The simulation results will be used as basis for field trials in Fall 2013.



Irrigated cotton fields.

For more information on WEES projects, visit the website at wees.arizona.edu.♦

2013 Distinguished Speaker Series

The Water Sustainability 2013 Distinguished Speaker Series brought three diverse speakers in water resource management to UA. The speakers included Justice Gregory J. Hobbs, Jr., Colorado Supreme Court, *Living the Four Corners: Honoring Our Water Short Character - Preserve, Conserve, Sustain and Inspire*; Patricia Mulroy, General Manager, Southern Nevada Water Authority, *Las Vegas: Navigating the Perfect Water Resources Storm*; and Mark Lambert, CEO, IDE Americas, *Innovations in Desalination Technology and Financing*. The series will continue in the Fall.♦



2013 Distinguished Speakers: Justice Gregory Hobbs, Pat Mulroy and Mark Lambert (from left to right)

Water Expertise Directory

The Water Resources Research Center and the Water Sustainability Program have compiled a searchable expertise directory of the 300-plus UA faculty and staff who specialize in all things water. These recognized experts cover the entire spectrum of water – from hydrology and technology, to sustainability and governance – spanning more than 50 subject areas and 70 UA departments. Complete with contact information, links to homepages and research specializations, you can explore this wealth of knowledge by name, categorized subject area, or department. The directory can be accessed at <https://wrrc.arizona.edu/experts>, or from the WRRC website under the Resources tab. For additions, please send an email to: jmoxley@cals.arizona.edu.♦



For more information visit wsp.arizona.edu

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Water Sustainability Program

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Student Fellowships

WSP annually awards Fellowships to outstanding students studying any aspect of water resources relevant to water issues in the state of Arizona. The fellows each presented their research in April.



WSP 2012-2013 Fellows and SARSEF winners

Graduate Fellows included:

Joel Biederman, Hydrology & Water Resources, *Hydrologic Response to Forest Disturbance: Implications for Water Resources*.

Biederman's research investigated changes to the coupled cycles of water, energy and biogeochemicals in a montane ecosystem with extensive tree mortality that has resulted from mountain pine beetle infestation.

Jake Davis, Chemical & Environmental Engineering, *Electrochemical Processes for Removing Dissolved Minerals from Potable Water*.

Davis' research investigated two electrochemical processes for removing dissolved minerals from potable water to address the problem of increasing water supply salinity.

David Love, Mathematics, *A Data-Driven Method for Robust Water Allocation under Uncertainty*.

Love's research developed models to solve and analyze a robust water allocation problem in southeastern Tucson, and determined the best places for an additional waste water treatment plant to increase the use of reclaimed water in the most cost-efficient manner.

Science Fair Awards

WSP gave out three water-related awards at this year's Southern Arizona Regional Science and Engineering Fair (SARSEF). First Place was awarded to Stephen Yao, University High School, *An Experimental Study of Vadose Zone Flux Meter*; Second Place to Bradley Lewis, Empire High School, *Perception of Water Quality*; Third Place to Anna Woolridge, Makayla Moore and Chelsea Shoreder, Flowing Wells High School, *Water Desalination*.♦

Zachary Sugg, Geography & Development, *Governing the Unseen: A Comparative Analysis of Arizona and Texas Groundwater Institutions*.

Sugg researched the Edwards Aquifer in south-central Texas as a case study, and investigated the potential for groundwater governance via a cap and trade program in Arizona.

Undergraduate Fellows included:

Adam Karczynski, Hydrology & Water Resources, *Determining Soil Hydraulic Conductivity from Cosmic-ray Neutron Data*.

Karczynski's research quantified hydraulic conductivity with the recently developed cosmic-ray soil moisture method, which resulted in data that revealed three possibly distinct groupings of soil moisture and hydraulic conductivity relationships.

Samantha McEntire, Hydrology & Water Resources, *Understanding Salinity Stress in Citrus*.

McEntire's research identified a new citrus variety with higher salinity tolerance that can now be tested out in the field. If similar results of salinity tolerance are obtained, the new citrus can then be approved for mass production.

Stephanie Ruehl, Chemical & Environmental Engineering, *Use of Wastewater to provide Nutrients for Algal Growth as Biofuel*.

Ruehl's research examined the natural attenuation of estrogenic compounds in surface waters; the highest estrogenic activities were found in wastewater effluent.

Aaron Zhang, Chemical & Environmental Engineering, *Microbial Fuel Cells*.

Zhang's first run of the experiment clearly showed that bacteria (*Shewanella putrefaciens sp. 200*) can act as a catalyst to aid the oxidation of a chemical(s).♦

FELLOWSHIP AWARDS

2013-2014

Graduate Students

Carlos Carillo

Generating a More Unified Perspective of the North American Monsoon Variability and Change: from the Paleoclimate to Climate Change Projection Timescales. Atmospheric Sciences. Advisor: Chris Castro



Corin Hammond

Phytostabilization of Mine Tailings: The Impact of Plant Growth and Irrigation on the Fate of Metal(loid) Toxins in Porewaters. Soil, Water and Environmental Science. Advisor: Jon Chorover



Lily House Peters

Scenario Planning for Future Water Demand in the Transboundary San Pedro Watershed: Incorporating Improved Spatial Data and Modeling. Geography and Development. Advisor: Chris Scott



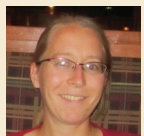
Kerton Victory

Risk Perception, Drinking Water Source and Quality in a Low-Income Latino Community Along the US Mexico Border. Public Health. Advisor: Paloma Beamer



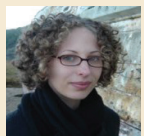
Gwen Woods

A Tool for Integrating Planning of Water Infrastructure. Chemical & Environmental Engineering. Advisors: Bob Arnold, Kevin Lansey



Sonia Ziaja

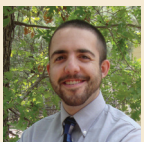
Arizona's Water-Energy Nexus. Geography and Development. Advisor: Carl Bauer



Undergraduate Students

Jeremiah Taeger

Removal of Trace Organic Compounds from Wastewater Effluent for Aquifer Recharge. Chemical & Environmental Engineering. Advisor: Eduardo Saez



Manuel Vasquez

Recycling Water: One Step to Making Algal Biofuels a Reality. Chemical & Environmental Engineering. Advisor: Kim Ogden

