SUSTAINABILITY OF SEMI-ARID HYDROLOGY AND RIPARIAN AREAS SAHRA

HOW'S YOUR HYDROLOGIC LITERACY?

HYDROLOGY AND RIPARIAN AREAS

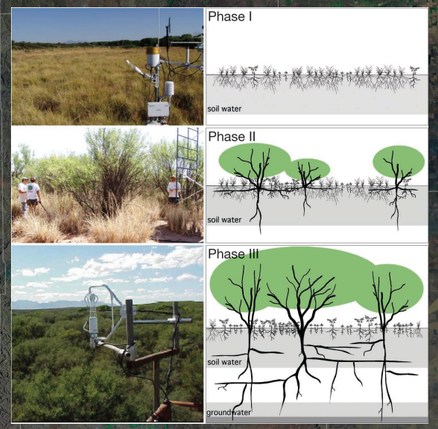
Santa Fe

Albuquerque

Alamogordo

Las Cruces

Collecting water samples in the Upper Rio Grande of Colorado for geochemical studies on water and salt sources.



SAHRA researchers have found that encroachment of shrubs into grasslands has increased water loss from the sub-surface.

One-quarter of the contiguous U.S. is semi-arid or arid land;

The most rapidly growing U.S. states are in the semi-arid Southwest;

Many rapidly growing countries are concentrated in semi-arid regions of the world;

Climate change and variability are making a growing percentage of the Earth's population vulnerable to drought and flood.

These are just some of the challenges faced by planners and stakeholders in the U.S. and around the globe when it comes to water resources.

Improving the sustainability of these resources is a job that rests with elected officials, water managers, and policy experts at local, state, and national levels. The mission of the Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA) is to furnish new knowledge to support their efforts in this regard.

"Part of the point of a center like ours is to provide understanding and decision support so that those responsible for taking decisions have the information and tools they need," says Jim Shuttleworth, SAHRA director and professor of hydrology and water resources and of atmospheric science at the University of Arizona. "We're trying to aid decision-makers."

The center has identified a slate of "tough questions that require center-mode science, and which are stakeholder-relevant," says Shuttleworth. Among them: What are the costs and benefits of riparian restoration and preservation? Under what conditions are water markets and water banking feasible? What are the impacts of vegetation change on the basin-scale water balance?

SAHRA researchers frame their studies in the context of the river basin—an approach they believe will facilitate the transition of results into practice. The center's primary geographical focus is on two river basins: the Rio Grande/Rio Bravo and the Upper San Pedro river basin in Arizona.

Concentrated along river systems are human population centers, agricultural activities, and regional biodiversity. The San Pedro river basin in Arizona is a case in point. It includes the growing town of Sierra Vista, a military base, and an expanding population. "It's one of the last remaining riparian ecosystems in the desert Southwest—used by migrating birds en route from North America to Mexico," says Shuttleworth. "If there is much more pumping of the groundwater to service the military base and growing township, the riparian ecosystem will disappear."

The San Pedro Partnership brings together over 20 stakeholder organizations to deal with these issues. In 2004, a law passed by Congress defined a timetable for bringing the basin into water balance by 2011, notes David Goodrich, a researcher with the USDA Agricultural Research Service and an adjunct faculty member at the University of Arizona who co-leads the River Systems Macro Theme of the center. SAHRA interacts with the San Pedro Partnership by providing scientific results and models it can use to evaluate possible future scenarios for developing and sustaining the ecosystem.

Center researchers are working to understand the effects of vegetation changes on water resources in the San Pedro basin. In the Southwest in recent decades, shrubs have invaded grasslands; pinyon-juniper and mesquite ranges have expanded; ponderosa pine forests have thickened; and fires and bark beetle infestations have caused large-scale changes. Center researchers have found that encroachment of shrubs into grasslands has increased water loss from the sub-surface. Along river corridors, shrub encroachment has doubled the evaporation, which is primarily derived from groundwater.

Furthermore, SAHRA researchers have discovered to their surprise that some 50 percent of the river water in the San Pedro comes from monsoon rainfall rather than groundwater, as was previously thought. "There is a great deal of persistence of water in soils along the banks and in shallow sediments that helps to sustain river flow in dry times," says Goodrich. This mechanism is different than in other regions of the country—rivers don't act the same everywhere, he notes. Understanding the mechanisms of groundwater recharge will be critically important to making management decisions in this region.

Increasingly, water markets and water banking are being considered in the Southwest as mechanisms for allocating water resources. The approach requires a detailed knowledge about factors that affect water supply and demand. Center researchers are developing new ways to improve estimates of precipitation and snow pack, and they are shedding light on the factors that affect residential and industrial demand for water. The results are being integrated into models that allow water resource managers to evaluate the potential of market-based mechanisms. "We're getting to the stage that we can run simulated markets on the computer and identify problems before people try to implement these approaches in practice," says Shuttleworth. He notes that state engineers in New Mexico have commissioned the center to do a trial in one of the catchments there and to explore the feasibility of a water market.

"Trading in water is provocative," Shuttleworth acknowledges. "We will hold a demonstration of the system with state officials and stakeholders and critics there who may be apprehensive about it so they can try it and play 'what if' scenarios—'If you do this, that stream will dry up, these people will be short of water, these ones will be fine.' The idea is to take the bite out of the tough decisions by creating something that stakeholders can use to understand what the consequences are."□

Landsat image of New Mexico. *Photo: Image courtesy of USGS National Center for EROS and NASA Landsat Project Science Office, http://eros.usgs.gov/Imagegallery/*

SAN PEDRO: BIRDING HOTSPOT

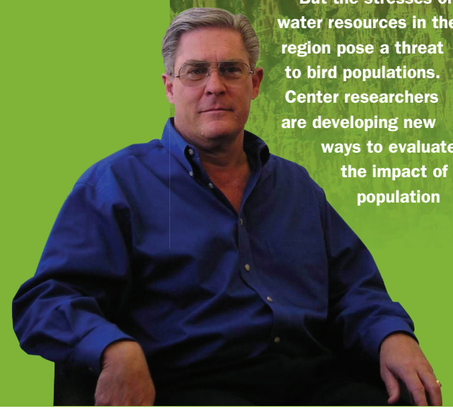
"People from all over the country flock to San Pedro to view the birds. They bring a lot of economic value to the area in the form of tourism dollars," says SAHRA assistant director James Hogan.

But the stresses on water resources in the region pose a threat to bird populations. Center researchers are developing new ways to evaluate the impact of population and water use on the regional hydrology, how in turn those changes will affect vegetation and bird diversity and abundance, and ultimately, how tourists and residents respond to those changes.

Work by SAHRA researcher David Brookshire and colleagues is aimed at developing these so-called "nonmarket valuation" methods. Brookshire is an economics professor at the University of New Mexico in Albuquerque.

With support from a $385,000 grant from the U.S. Environmental Protection Agency, the researchers have been constructing scenarios based on anthropogenic or climatic changes in the ecosystem and estimating the societal and economic ramifications of those changes.

"What's unique about this project is that the valuation study is directly driven by the science models," says Brookshire. Having access to better underlying science developed through SAHRA has enabled the researchers to "move the state-of-the-art in nonmarket valuation methods significantly forward," he notes. "What SAHRA did was to bring this along at a more rapid pace—the center catalyzed and accelerated this work."



SAHRA assistant director James Hogan

SAHRA researcher David Brookshire and colleagues are developing "nonmarket valuation" methods. Brookshire is an economics professor at the University of New Mexico in Albuquerque.

CONVERSATION WITH THE DIRECTOR

Jim Shuttleworth

WHY A CENTER?

"It takes a big proportion of my time just to run the show," says SAHRA director Jim Shuttleworth. "I've had to give up a fair amount of my teaching and research.

"But on the other hand, what excites me is that we really do have benefit, we do address major problems that really are going to be beneficial. We're going to leave a legacy, and the world will be a better place for having done this job. And to see the young people that are growing in the job and getting more and more capable."

Having a center helps to provide the glue that makes things happen, he says. "You need a glue—and the glue is money. It motivates people to make the effort and spend the time learning the language of other disciplines. How else would you get an economist talking to a hydrologist? You wouldn't. But you can if you define a problem that needs the both of them, and you provide the resources. And when you provide resources for a more sustained period, you can hit harder problems.

"I would never have been able to write a proposal to study water markets, because the problem is too multidisciplinary. But once you have established the team, the credibility, and the capability, you can start to write proposals like that."

Echoing those sentiments is David Goodrich, a researcher with the USDA Agricultural Research Service and an adjunct faculty member at the University of Arizona who participates in SAHRA. "I've done a fair bit of interdisciplinary work, and I saw the center go through some of the same pain that we did when you get economists, social scientists, and hydrologists in a room together. They don't know how to talk to one another," he says.

"Getting this mix of disciplines to address complex physical, social, and economic issues wouldn't happen without a center. I could never go into the literature of economics, for example, and get up to speed. There are very few Renaissance people around. I can't get up to speed in plant physiology, riparian ecology, avian science, and economics—all of those things. But we can put those pieces together in an intelligent fashion in a center."

Moreover, the longer horizon of a center grant is essential for projects involving interactions with community and government officials, says Goodrich. "You can't build trust with decision-makers in the three-year time frame of a typical NSF grant."

SAHRA director Jim Shuttleworth

SAHRA ENGAGES CITIZENS IN SCIENCE PROJECT

In many towns, rainfall totals are measured at the local airport or other official weather stations. But those data may not reflect how much fell in particular neighborhoods. "What rainfall actually hits the ground—and its variability—is really a big unknown," says James Washburne, SAHRA associate director for education. A project managed by the center is engaging volunteers in an effort to fill in the knowledge gap. Data collected by volunteers from over 600 rain gauges in Arizona are posted on the Web at www.rainlog.org. The site has an interactive map displaying rain totals for each of the gauges by day or year.

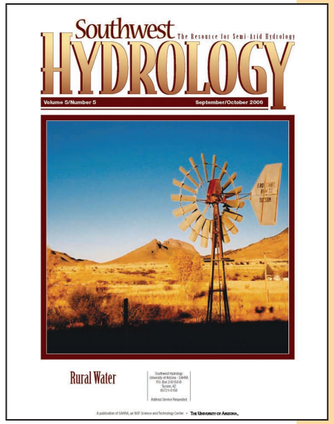
Data from more widespread observers, particularly in the mountains, are particularly important because rainfall amounts change dramatically as you go up in elevation, explains Washburne. "Typically, we've had a rain gauge at the bottom of the mountain and at the top, but never really in between to address what the real differences are in rainfall amounts across a range of elevations. These data have the potential to address that question."

SOUTHWEST HYDROLOGY MAGAZINE AND WEB SITE

Outreach and education are a particular emphasis of SAHRA, and a regional magazine published by the center features prominently in that mission.

"We recognize that we can produce good science and good tools, but ultimately, you have to involve the people who are actually going to use these tools," says Shuttleworth. "So we have an enormous outreach program. We're trying quite hard to share results from other sources in addition to center results," he emphasizes.

Southwest Hydrology is a trade magazine published by SAHRA to inform and connect the water communities of the semi-arid and arid Southwest. It is written by and for consultants, regulators, researchers, water managers, lawyers, policymakers, and industry representatives who work with water issues in semi-arid regions. The magazine is distributed free of charge six times per year to nearly 6,000 subscribers in the Southwest and throughout the U.S.



In 2006, it received awards from the Tucson chapter of the International Association of Business Communicators, from the Southwest Region of the Society for Technical Communication, and from Communications Concepts Awards for Publication Excellence.

WATER TEACHING KITS

The WATER project is a standards-based water education program for use in 5th through 12th grade classrooms in Arizona. Materials from a variety of sources have been incorporated into the kits, each with inquiry-based activities that meet state standards in different subject areas. Participating teachers receive audio visual aids and water testing equipment, the opportunity to attend training workshops for professional development, and the chance to receive classroom support from water education specialists. For more information, contact Jim Washburne at jwash@sahra.arizona.edu

SAHRA MAKES A SPLASH

SAHRA's Student-centered Program for Learning About Semi-arid Hydrology (SPLASH) is a collaborative effort among high school science and social science teachers and science educators to create and implement a regionally focused water curriculum. Materials are currently being refined and are expected to be available on the SAHRA Web site by the beginning of 2008 or sooner. http://www.sahra.arizona.edu/education/

INTERDISCIPLINARY MASTER OF ENGINEERING DEGREE IN WATER RESOURCES.

An interdisciplinary master's degree program in water resources is offered by Arizona's three state universities: Arizona State University, Northern Arizona University, and the University of Arizona. The degree program is flexible and is designed to meet the needs of mid-career professionals. For more information, contact Gary Woodard at gwoodard@sahra.arizona.edu.