Divining Rod

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John Hawley: A geologic resource for New Mexico

By Will Keener

John Hawley's work on a New Mexico Water Resources Research Institute (NM WRRI) groundwater project in the Lower Rio Grande Valley is occasionally taking a back seat to another project this spring. Hawley is being called upon to give presentations about a serious groundwater problem in Albuquerque. A jet-fuel plume in the aquifer underlying Kirtland Air Force Base is threatening city water supplies. John's talks describe the extent of the problem and suggest a treatment approach to remediate it.

John Hawley (here with his wife, Diane) at the 2006 GSA Annual Meeting in Philadelphia received a Distinguished Career Award from the Quaternary Geology and Geomorphology Division. The plaque with the (modern) horse jaw is an unofficial, but very special reward crafted by Fred Phillips (NMIMT) and NM Museum of Natural History paleontologist friends for the "Champion Jawboner of the Quaternary."

"Somebody younger should be doing this," says John, who turned 80 last October. But instead, he is doing it. There is a reason for that, one of his colleagues explains, "Sometimes it takes decades of experience in the groundwater realm to really understand the problems and be able to explain them and suggest ways to remediate them." John fits that set of criteria.

The story of these intertwining projects is, in microcosm, the story of John W. Hawley's career. A veteran environmental geologist, soil geomorphologist, and hydrogeologist, John has moved from one project and geologic discipline to another as opportunities and assignments dictated. Through it all, he has managed to assimilate and organize the concepts and the literature, and build upon them for whatever came next. As a result, he has come to be accepted among

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Divining Rod

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Alexander G. "Sam" Fernald
Director

Catherine T. Ortega Klett
Editor/Coordinator

Will Keener
Writer

Deborah Allen
Project Coordinator

Steve Walker
GIS Technician

Annette McConnell
Admin Assistant Associate

New Mexico Water
Resources Research Institute
MSC 3167
PO Box 30001
Las Cruces, NM 88003-8001

575-646-4337
575-646-6418 (fax)
nmwrri@wrri.nmsu.edu
http://wrri.nmsu.edu

The Rio Grande: Making a plan for the future

By Will Keener

A look at the Rio Grande reveals that the time has come to ask "what kind of society can we have with the water available?" That was the message of Fred M. Phillips, professor of hydrology at New Mexico Tech, in his keynote address at the spring meeting of the New Mexico Geologic Society. The alternative is to repeat history and continue to face a series of unintentional consequences by using a patchwork approach to allocating the scarce resource.

Phillips, who is co-author of "Reining in the Rio Grande: People, Land, and Water" with G. Emlen Hall and Mary E. Black, spoke to an audience of about 200 geologists and geology students from New Mexico and other states at the March talk in Socorro.

Painting a picture of a desert river with a restricted source—comprising a small fraction of the total drainage basin—running through an arid basin, Phillips noted that this "hydrological reality" poses serious questions for the future of residents in the Rio Grande Valley.

While the river has been "a living entity in the lives of people for more than 20,000 years," the modern river looks nothing like the one Native Americans and early settlers saw. As views of the river have shifted from a community-sustaining riparian corridor to an engineered conveyance to maximize water as a commodity, residents have gained and lost, Phillips said.

Looking at the river and its history from the perspectives of historical traditions, economic development, geology, and the law, Phillips briefly described some of the information he and his co-authors compiled as they examined changes and societal views of the river.

For most of the human part of its history, the river alternatively flooded and dried up and disappeared as climatic conditions dictated. The construction of railroads into New Mexico and the adoption by many Americans of the philosophy of "Manifest Destiny" in the mid-1800s, put new demands on the river. A historic version of "build it and they will come," Manifest Destiny suggested that the arid West could be tamed by hardy settlers in the same way lands east of the 100th parallel had been settled.

Although geologists like John Wesley Powell warned that a different approach was needed in the West, it took actual experience in attempting settlement and development to show the folly in this paradigm. Timber was harvested for railroad construction in the 1880s and grazing became a common practice as the trains opened new marketing opportunities. Erosion increased and sediment loads in the river spiked to ten times their modern levels. At the same time, development in the San Luis Basin at the upper end of the Rio Grande Basin depleted flows downstream drastically.

By the turn of the 20th Century, the Bureau of Reclamation was attempting to resolve water supply issues with the creation of large dam projects. Just as the railroad created unintended problems, so did the dams. Many of the losses that went with changes in

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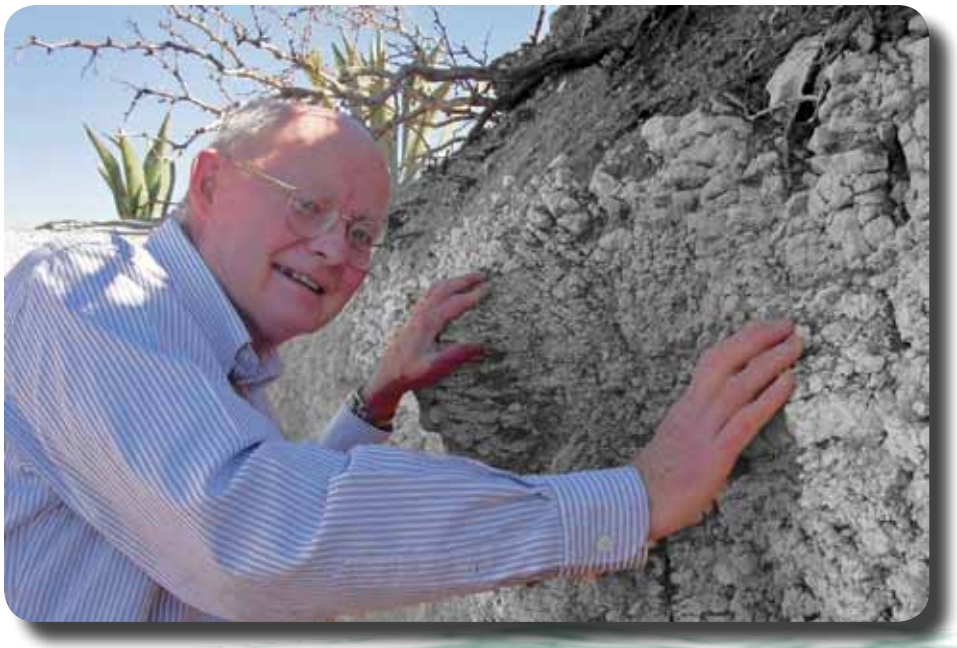
his colleagues and clients as one of the state's most valuable geologic resources.

Hawley's work on the Rio Grande project, a hydrogeologic atlas of the valley from Caballo Reservoir to El Paso and Juárez is nearing completion. Termed by some John's "legacy project," the work is an expansion of his efforts to create similar packages for the transboundary aquifer systems in southwestern New Mexico and reaching into adjacent parts of Arizona, Chihuahua, and Sonora. This has been a key focus since John formed his own company, Hawley Geomatters in 1997. He agreed to work with NM WRRI and the late Dr. Bobby Creel to get a more accurate picture of water resources in southwestern New Mexico.

"I concentrated on the transboundary areas for a long time," John says of his NM WRRI work, "and now I'm finishing up work in the Hatch-Rincon Valley area." To develop a basin-wide hydrogeologic framework, Hawley uses field maps, well logs and samples, and a variety of other information to integrate hundreds of geologic units, originally named by the geologists studying the area. "Instead of 14 different members or formations, you group units and describe them according to their properties as aquifers, " he explains. This mapping units approach has been used successfully in several basins along the Rio Grande, including the Albuquerque and Mesilla Basins, to support improved water-resource management. The approach is now being expanded into the Hueco Bolson of western Texas.

"John really understands what is below the surface, because he knows what's on the land surface," says Curtis Monger, distinguished professor of plant and environmental sciences at New Mexico State University. Monger first learned of John's reputation when he was a grad student at NMSU and heard a professor refer to Hawley as "Mr. Quaternary Geology." "He can look at a soil map and visualize the underground, jumping back and forth from the surface and what's buried and what might be a high yield aquifer and what might not be," Monger said.



John's PhD project at University of Illinois, fathoming the mysteries of the Quaternary period (roughly the last 2.6 million years of the Earth's history) and the groundwater geology of Nevada's western Humboldt River basin, led to an offer that brought him to the U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) office in Las Cruces in 1962. With him came his new bride, Diane Bandyk Hawley, and a piano from her home in Chicago. Half a century later, the piano sits in the living room of the Hawleys' home in Albuquerque. It spent nine years in Las Cruces and subsequently traveled to Lubbock (TX), Socorro, Portland (OR), Socorro (again), and finally Albuquerque. Also still in the family home is Diane, John's close partner for 51 years.

For the next nine years, Hawley led the SCS Desert Soil-Geomorphology Project, headquartered at NMSU. Emphasis of his work was on the relationships between geology, aridland soils, and hydrogeology. It involved collaboration with a variety of state and federal agencies in the U.S. and Mexico, and included training SCS Soil Survey teams in almost every county in the region. "It was a time when there was a lot of good science going on in various fields around the country and the same was true with the USDA," says Monger. "Scientists had the funding and time to pursue their own research interests as well as serve the public, and therefore did some classic work. The regional office was described by one government official as the crown jewel of Soil Survey projects."

Hawley's hydrogeologic research was recognized early by H. Ralph Stucky, founding director of WRRI. "You have been actively engaged in water resources research and we are pleased to name you as a charter member of the

Institute," Stucky wrote in 1964. One of WRRI's first funded projects involved John with faculty and student research at NMSU's then-new "Earth Science & Astronomy Department." Their work led to "Hydrogeology of the Rio Grande Valley and adjacent intermontane areas in southern New Mexico" by William E. King, Hawley, and graduate students Andrew Taylor and Richard Wilson, published as WRRI Miscellaneous Report No. 6 in 1969.

Research on desert soils by Hawley and his soil-scientist associate, Leland Gile has had "a tremendously beneficial impact on worldwide understanding" of soil development, wrote David W. Love, senior environmental geologist at the New Mexico Bureau of Geology & Mineral Resources (NMBGMR), in a 2005 essay. Monger, who went on field trips with Hawley as a graduate student in the 1980s, was called on in the 2000s to take scientists from throughout the U.S. and around the world on USDA tours to explain the research, which came to be known as the Desert Project. "John did the geology and I did the soils and sometimes we would have 100 people along, standing out in the desert talking to them," Monger recalls.

John joined NMBGMR in 1977, charged with the development of an environmental geology program and management of associated research. He later organized and managed the Bureau's Albuquerque office (1991 to 1997), which specializes in hydrogeology of aquifer systems, environmental geology, and geologic mapping. Early successes included developing guidelines to regulate and remediate coal surface mines and a practical definition of "alluvial valley floors" in coal-bearing regions that was adopted nationally. As a part of a team of scientists and students, he defined the baseline levels of radioactive elements and heavy metals downstream from New Mexico's uranium mining districts.

John's environmental and hydrogeologic projects included evaluating sites being considered for hazardous-waste disposal, evaluating water resources in several basins, and extending the Bureau's programs to meet the needs of the state's Native American communities.

Monger has suggested that "encyclopedic" is a must word for any description of Hawley's career. One of Hawley's more recent achievements, titled "Five Million Years of Landscape Evolution in New Mexico" has more than 1,500 references in it, he notes. "John understands the body of literature better than anybody. He often cites work that might be helpful to another geologist. He knows the literature from the mid-1800s to the 1990s better than anyone and he is able to get his arms around it and synthesize it."

Spencer G. Lucas, curator of paleontology at the New Mexico Museum of Natural History and Science and publisher of Hawley's "Five Million Years" article in the museum's Bulletin, said he and other geologists in the state "stand on Hawley's shoulders. . . . From major scientific advances, such as his research on desert soils, to expertise in the minutiae of local geological features, only a handful of scientists have ever or will ever have mastered the geology of this state as has John Hawley."

Hawley's "stream of consciousness" style of communication is also legendary among his colleagues. When Monger first worked with Hawley, "I was at the point in my career where I was open to receiving a lot of information. It was the nature of John's personality that he was like a computer downloading. I was sponging in the information and trying to keep up. It was great," he said. Other colleagues adapted different strategies for communicating with him. "I learned I had to make a list of questions and after he answered one and then wandered off in another direction, I would have to blurt out another question," says Greg Mack, geology professor emeritus at NMSU. "John didn't mind and would switch gears, address my next question, then continue on."

John, a Certified Professional Geologist since 1971, has earned many professional awards and recognitions. He is a fellow of the Geological Society of America (GSA) and the American Association for the Advancement of Science (AAAS) and a past president and honorary member of the NM Geological Society. John has authored or co-authored more than 100 reports and maps on the New Mexico-West Texas-Chihuahua region. He received the AAAS Certificate of Merit "for distinguished contributions [to] arid zone research (1987)" and the Governor's "New Mexico Eminent Scholar" recognition (1989).

John earned the GSA-Quaternary Geology & Geomorphology Division-Kirk Bryan Award (1983) and the GSA-Engineering Geology Division-Distinguished Career Award (2005). An award he was especially pleased to receive was GSA's Quaternary Geology and Geomorphology Division Distinguished Career Award (2006). John is co-recipient of the 2005 New Mexico Earth Science Achievement Award for "outstanding contributions in

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(Rio Grande continued from page 2)

water flows and usage tended to be incurred by the poor and Hispanic peoples of the valley, while gains helped enrich the already wealthy, Phillips noted.

The 21st Century version of Manifest Destiny is called "economic growth," Phillips suggested. But the river is at the point where a "zero-sum game" exists. "If water is to be put to new uses, it has to be taken away from an existing user," he said. While water is allocated according to a doctrine of prior appropriation in theory, in practice a more band-aid approach is used, he noted. Senior water rights holders may not always prevail when junior holders turn out to be communities or other large groups.

This photo from the San Marcial flood of 1929 is an example of unintended consequences of other actions in the Rio Grande Valley. Overgrazing and clear cutting in the headwaters of the Rio Grande and heavy diversions of irrigation water in the San Luis Valley caused increased erosion and decreased flow. The result was river bed sediment raising the river level above the land surface (14 feet above the streets of San Marcial, for example). Loss of vegetation caused the river level to spike rapidly and made overtopping of the levees, followed by complete inundation, inevitable. (Photo courtesy of Socorro County Historical Society)

The question now is whether current dwellers in the river valley can recognize the limiting role of water and direct its use to achieve the best quality of life possible given the limitations. If valley inhabitants choose to continue the ad hoc reallocation of water to achieve goals like "economic growth" without considering what that goal really means, they can continue to expect unintended consequences, he predicted.

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areas of applied science and education; "and he has received Alumni Achievement Awards from Hanover College (2001) and the University of Illinois (Geology-2006). In 2007, the Santo Domingo Tribe honored John for "outstanding contribution to the improvement of [their] public water system."

He and Diane have three New Mexico-native children, and three grandchildren.

Editor's note: John is currently completing a project funded through the WRRI entitled "Updating the Digital Hydrogeologic-Framework Model of the Mesilla Basin Area with Specific Reference to the Transboundary Aquifer Assessment Project (TAAP)." Results will be reported in an upcoming WRRI technical report.

The New Mexico Water Resources Research Institute is extremely grateful for John Hawley's research contributions over many years. His diligence to detail, work ethic, positive outlook, and camaraderie with the staff is unparalleled. One of the founding members of the NM WRRI, John is truly a friend and partner of the institute.

58th ANNUAL NEW MEXICO WATER CONFERENCE

New Water Realities

PROPOSALS FOR MEANINGFUL CHANGE

Embassy Suites Albuquerque - November 21-22, 2013

Preliminary Program
Thursday Morning, November 21, 2013

8:30 Welcome
Sam Fernald, NM WRRI Interim Director

8:45 Opening Address
Lowell Catlett, New Mexico State University

9:15 Setting the Stage
John Shomaker, John Shomaker and Associates, Inc.

9:30 Changing Precipitation, Temperature, and Stream Flow Conditions
Dave Dubois, New Mexico State Climatologist
Greg Pederson, U.S. Geological Survey, Northern Rocky Mountain Science Center

10:30 Break

10:45 Western Perspectives
Water Transfers in the West, Tony Willardson, Western States Water Council
The Importance of Agriculture, Dan Keppen, Family Farm Alliance

11:35 New Mexico State Engineer Update, Scott Verhines

12:00 Luncheon
Albert E. Utton Memorial Water Lecture, Tanya Trujillo, Colorado River Board of California

Thursday Afternoon

1:30 Legal Realities and Solutions
Health of Settlements, Steven L. Hernandez, P.C.
Priority Administration, Dudley Jones, Carlsbad Irrigation District
Is Prior Appropriation Dead? Speaker To Be Announced

2:30 Forgotten Rivers
Clean and Healthy Rivers, Chris Canavan, NM Environment Department
Healthy Watersheds and Water Quality, Steve Wilmeth, Doña Ana County Soil and Water
Riparian Areas, Steve Harris, Rio Grande Restoration

3:30 Break

3:45 Stakeholders Panel: Proposals for Meaningful Change moderated by Jose Rivera, UNM
Frank Chaves, Sandia Pueblo
Quita Ortiz, NM Acequia Association (invited)
Juan Garcia, El Rito Regional Water and Wastewater Association
Dan Guevara, NM Environment Department
Steve Guldan, NMSU Sustainable Agriculture Center, Alcalde
Matt Holmes, NM Rural Water Association

Friday Morning, November 22, 2013

8:30 Legislative Perspectives, introduced and moderated by John Fleck, *Albuquerque Journal*
Federal View, Kris Polly, editor-in-chief, *Irrigation Leader*
State View, NM Senator Peter Wirth, NM Senator Joseph Cervantes, (invited)
NM Senator Steven Neville, and NM Representative Don Tripp

10:15 Break

10:30 Economic Impact of New Water Realities
The Relationship Between Energy and Water, Scott Backhaus, Los Alamos National Laboratory
Economic Impact of Western Agriculture: Focus on New Mexico, Darryll Olsen, Washington State

10:50 Urban Solutions, the El Paso Example, John Balliew, El Paso Water Utilities

11:10 Conjunctive Use of Surface and Groundwater on the Pecos,
Greg Lewis, NM Interstate Stream Commission, Pecos River Basin

11:30 Implementation of Restoration Sites on the Lower Rio Grande,
Elizabeth Verdecchia, International Boundary and Water Commission

12:00 Luncheon
Reflections from Water Careers in the Ivory Tower
Retiring faculty Bruce Thomson, University of New Mexico
and Adrian Hanson, New Mexico State University

Global Perspectives

Expert panelists weigh in on the future of the acequia in the face of climate change, drought, urbanization

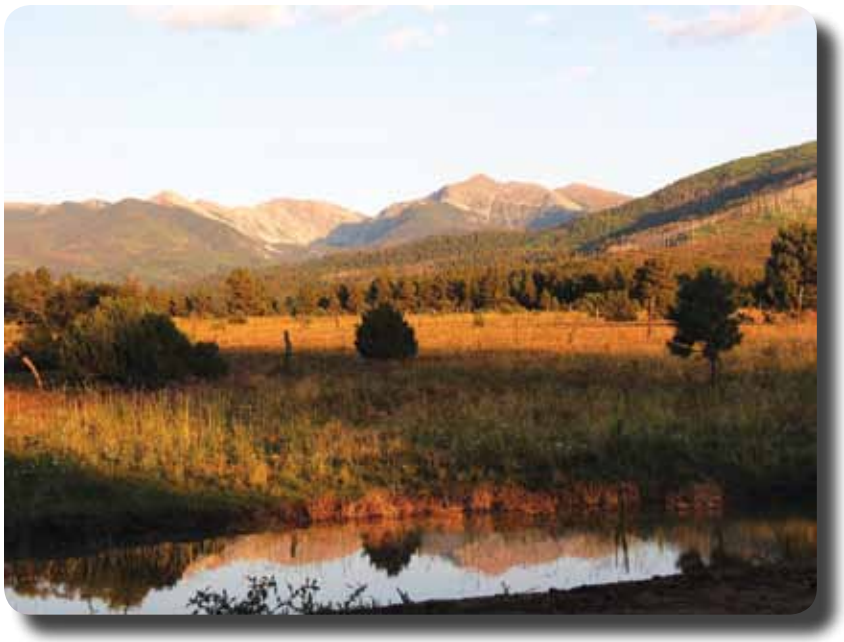
By Will Keener

Can the traditional acequia system survive the pressures of climate change, drought, and modern urbanization? Scientific researchers, acequia system users, and a multinational, multidisciplinary team of scholars examined that question at an early March conference in Las Cruces.

The Global Perspectives conference was sponsored by the New Mexico Water Resources Research Institute (NM WRRI) and seven other sponsors. The conference examined ways to study, measure, model, and calculate value for the unique resilience and adaptability shown by these systems, historical mainstays of community stability and effective water usage on several continents.

"I would call the conference very successful on all accounts," said Sylvia Rodríguez, professor emeritus from the University of New Mexico and conference co-organizer with Sam Fernald of NM WRRI and New Mexico State University. "I learned a lot in this symposium. I already knew how important and interesting the work was, but I wanted to bring people into a single space for the synergy that could create." Organizers at New Mexico State University, also a conference sponsor, estimated the meeting attracted about 100 participants, including 10-20 students who were admitted free for the lectures. Other sponsors included New Mexico Tech, Sandia National Laboratories, the New Mexico Acequia Association, New Mexico EPSCoR, and the National Science Foundation. EPSCoR is a federally funded program to stimulate competitive research in New Mexico on climate change and related subjects.

Defending acequias as sustainable, efficient water use systems in a modern world is easier than one might think, Paul Trawick, professor of anthropology at Idaho State University told the assembly. Citing examples from Peru and Spain, Trawick told the group "We know more than we think we do about acequias." There are hundreds of acequia systems around the world, some have been transplanted and others have evolved independently, he said.



Truchas Peak in northern New Mexico is reflected in the acequia water. (Photo by Will Keener)

Using a rural system in Huaynacotes, Peru, and a much larger system in Valencia, Spain, Trawick compared ten different traits to show similarities among the systems. "There is a strong incentive to obey the rules in these systems," he said. "Cooperation is the only rational way to behave because individual self interest and common good are basically one in the same thing."

Trawick noted that water theft frequency is "virtually nil" in both systems, something that is "unprecedented in irrigation and in the literature of law enforcement," he said. Citing systems in New Mexico, Bali, and Nepal, Trawick told the group the same model has emerged repeatedly in many many parts of the world. "This is a moral model, uniquely based on assumptions of water scarcity. It is a social and moral model about sharing water fairly," Trawick said.

UNM Professor Emeritus Sylvia Rodríguez, co-organizer of the Global Perspectives Conference, addressed participants.

Scientists from several institutions spent the first morning of the conference reviewing their approaches to understanding how acequias work from a multi-disciplinary viewpoint and identifying work yet to be accomplished. (See "Researchers" on page 10.) In another session, experts from several different nations and continents reviewed problems and possible solutions they face in examining acequia systems. (See "International Scholars" on page 14.)

Views of the future of New Mexico's acequias, painted against the broader international scene, varied from hopeful to discouraging. In a concluding panel discussion, Paula Garcia of the New Mexico Acequia Association, told the group she was very hopeful. "Hearing about research around the world was very reaffirming." Garcia said research done to date that shows how the river and groundwater benefit from the way acequias are designed and operated. "This gives us more credibility than we have by ourselves. We have to make a case about why we are important," she said.

Estevan Arellano, who works with acequias in the Embudo-Dixon area of northern New Mexico, expressed concerns over crumbling ditches, losses of knowledgeable leadership, and a loss of Spanish. "We are losing knowledge because we are not passing it on in Spanish," he said. "Everyone is looking at the romantic version of the acequia. We are not there for artists, but to grow food," he said.

The Taos Valley system of acequias went dry in mid-June last year, said Miguel Santistevan, a system commissioner. "What's an acequia without water?" The water system has three times as much 'paper' water as it does 'liquid' water, he told the group. "The most important lesson from our culture is the aspect of faith. I have that. It's going to be all right. We are going to learn how to respect water and respect each other. But it looks like it's going to be tough getting there."

Global Perspectives

Arnie Valdez: "Think globally, plan regionally, act locally"

By Will Keener

Arnold "Arnie" Valdez, a San Luis, Colorado, resident who has returned to farming after many years in government and academia, provided an interstate perspective to the global conference during a brief talk at the conference in Las Cruces. "It is good to return to my roots, but also good to have regional and global perspectives. Without that, we become very tunnel-visioned in our views," he said.

Valdez lives in "occupied New Mexico," a part of Colorado that is historically and culturally closer to New Mexico, he told the group. In addition to his farming activities, he is an adjunct professor of architecture and planning at UNM. It is important for New Mexicans to include the four Colorado counties that comprise the headwaters of the Rio Grande in their regional planning, he suggested. "Watershed planning is really important. Without it, systems are not going to be able to support themselves. We need the broader view of what's going on with the water."

In the San Luis Valley of southern Colorado, there are ". . .thousands of center pivot sprinklers, yet they have the audacity to blame the small farmers for the consumption of water," he said. Valdez said the New Mexico Acequia Association has been helpful in an effort to organize Colorado acequias into collaborative partnerships.

Valdez said an improved legal framework is needed for acequias in Colorado. "We are adopting the model from New Mexico to give us more local governance to become more effective in Colorado," he said.

Global Perspectives

Researchers probe acequias from many perspectives to understand future challenges and likely outcomes

By Will Keener

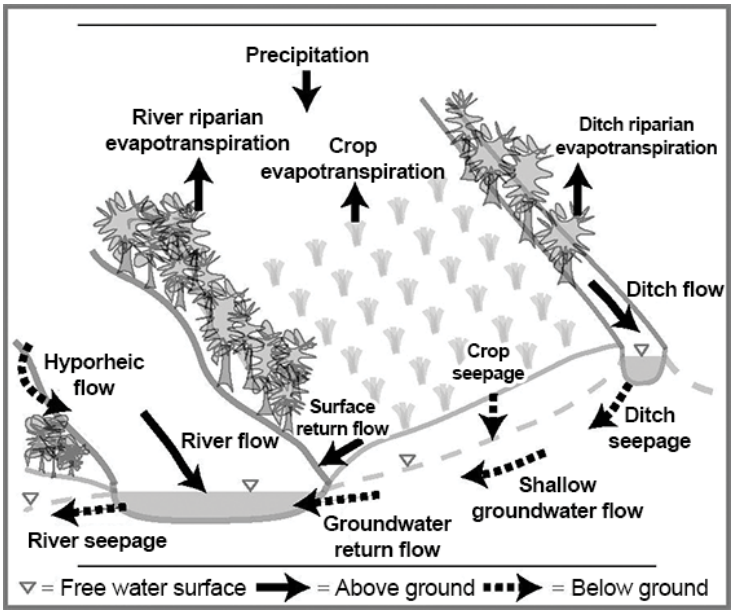
Understanding how northern New Mexico's acequia systems have lasted for four centuries is easier said than done. But doing so—a complex multidisciplinary problem—may lead to an understanding that will allow the systems to continue into an uncertain future. Researchers at the Global Perspectives 2013 conference outlined some of the progress they are making in studies of the hydrological, social, cultural, and agricultural responses to drought and climate change in the acequia communities.

"When we started in 2002, people were telling us that there were 'a lot of benefits' to acequias, but there was no data," said Sam Fernald, professor of watershed management in the department of animal and range sciences at New Mexico State University (NMSU) and Interim Director of the New Mexico Water Resources Research Institute (NM WRRI.) "We said 'let's find out how groundwater and surface water are connected and get some really good information.' But in the case of the acequias, you can't characterize the hydrology without knowledge of the community and similarly, the community needs to know about the hydrology," he said.

Traditional acequias are important to New Mexico because the northernmost part of the state has no large federally operated water projects by the standards of other western U.S. states. "If you look at (satellite images) of northern New Mexico there are all these ribbons of green valleys," Fernald said. Those are the acequia systems and they are "particularly well suited for semi-arid climates with high inter-annual variability of precipitation," he said.

The hydrological data collected by Fernald and other colleagues show benefits to the environment from acequias, he said in his conference-opening talk. A multi-year study, after carefully monitoring the Alcalde acequia at the NMSU Science Center, showed that only about seven percent of the water used is consumed by plants or goes out into the atmosphere. "The rest goes back to the river or the groundwater," he said.

"More than just the irrigation of crops and providing water for animals, it is a very important function of the acequia

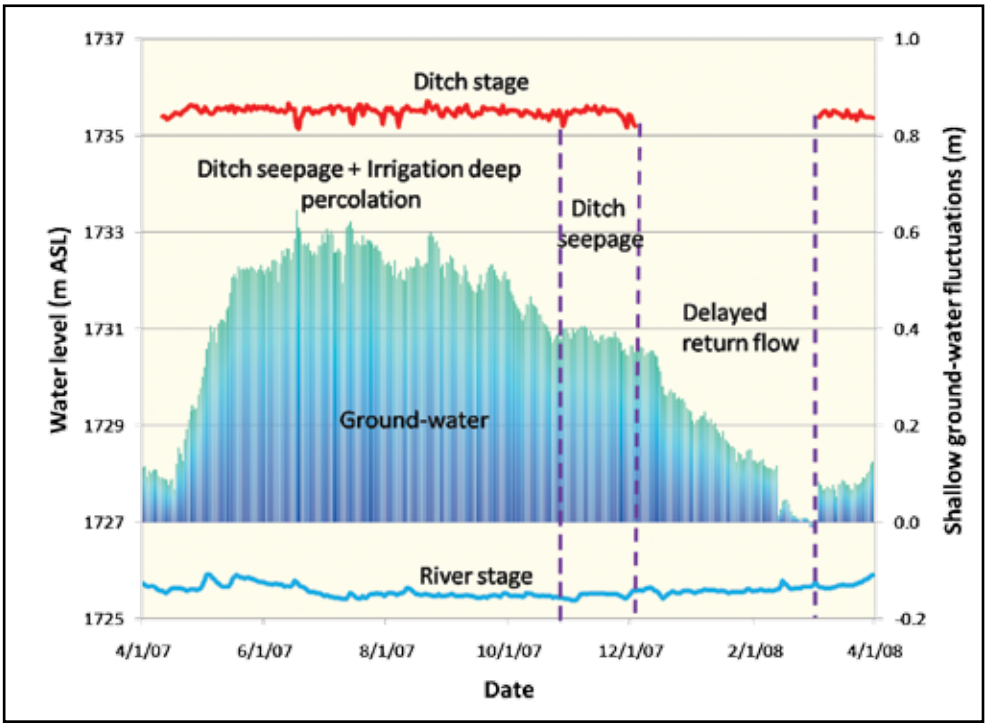


Researchers studied the Alcalde acequia by measuring each of the key pathways for water shown in this diagram. This "hydrologic budget approach" used sensors to keep a detailed account of how much water was used by the system and where it went.

that it allows storage underground, where the water doesn't evaporate and it actually goes back to the river," Fernald said. This "gaining river" concept, where the water table is above river surface and provides water to the river, could become even more valuable with the continuation of the present drought or in the event of predicted climate change.

Measurements show that groundwater levels respond to canal seepage beginning in March and continue through the end of the irrigation season, Carlos Ochoa, research assistant professor of watershed management and hydrology at NMSU, told the conferees. Seepage from ditches and delayed groundwater flowing back into the river have the effect of keeping the river stage higher through summer and fall, he said.

In addition to understanding the hydrology, Jose Rivera, research scholar for the Center for Regional Studies and professor of planning at the University of New Mexico (UNM), told the conference that one of the goals of the



This diagram shows one year of the groundwater cycle. The water table (blue) increases when irrigation begins in the spring and then gradually declines (ditch seepage area) after the irrigation season. The seepage and delayed return flow have important implications for preserving stream flows in drought or climate change situations.

multi-year project now underway is to better describe how acequia systems adapt to changing conditions and persevere when threatened. Funded by the National Science Foundation, the work is expected to provide new insights into the relationships between traditional water management systems, communities, and landscapes, Rivera said.

Findings based on focus group sessions conducted at three sites in 2012 show that the northern New Mexico acequias are resilient institutions that adapt to stresses in the environment, Rivera said. Key factors in this resilience are community cohesiveness, attachment to land and place, and the ecological knowledge embedded in the collective memory of the parciantes, or acequia members. The focus groups—from the Rio Hondo, Alcalde, and El Rito communities—also examined threats to the acequias as they perform the valuable tasks of linking valley irrigation with upland watersheds.

Data gathered in this effort, part of an acequia model, will be incorporated into a system dynamics architecture for modeling linked natural and human systems, he said. A final report on the project—now in its last year of funding—will include an analysis of the socio-ecological history and current conditions of the Rio Chama watershed. "This is an attempt to tie together quantitative data and translate it into the language on the ground, where the acequias are," he said. (See page 12 graph.)

From a plant and wildlife standpoint, acequias and the watersheds that flow into them create environments that encourage a diversity of plant species and attract animals large and small, said Ken Boykin, research associate professor with the USGS's New Mexico Cooperative Research Unit and the Department of Fish, Wildlife and Conservation Ecology at NMSU. Boykin is working on simple metrics to identify what services these ecosystems provide and assign human values to the services. These metrics, in turn, can help explain likely outcomes in cases of climate change or urban encroachment, he said.

"How do precipitation, temperature, and soil moisture content change vegetation, which changes habitat, which affects animal species, which changes our environmental capital?" Boykin asked. While some species can easily adapt to intermittent stream-flow conditions or ephemeral flows, others cannot. "Acequias can help us avoid some of those loses, but we need to better define what services acequias provide to wildlife," he said.

Brian Hurd, associate professor of agricultural economics and business at NMSU, and graduate student Laura Mayagolita, examined the challenges facing acequia systems in New Mexico, and the community perceptions on what strategies might work to battle them. "Farmers deal with complex issues in making a living," Hurd told the group.

Data from the survey—collected by Mayagolita in an interview format—showed that community members believe that maintaining local knowledge, such as how water is shared within the systems, increasing public awareness about the value of the acequias, and providing training and education on crop selection, irrigation and water conservation were among the best defenses against the challenges they are facing.

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Global Perspectives

Got Research? Where do we go from here?

By Will Keener

Here are some of the areas identified by conference participants where scientific research may be of value to the acequia systems.

How many acequias are there in New Mexico? How many acres are covered? How many parciantes (acequia members) are there in the state? We really don't know. Paula Garcia

We talk about local knowledge, but we don't observe it. Our distribution is inequitable now because of a loss of our language. We need a way to transmit knowledge to the newcomers. Estevan Arellano

What is the role of drip irrigation? Will it destroy the aquifer by watering only the top few inches? We need to know the impact of drip on a massive scale to the aquifer. Estevan Arellano

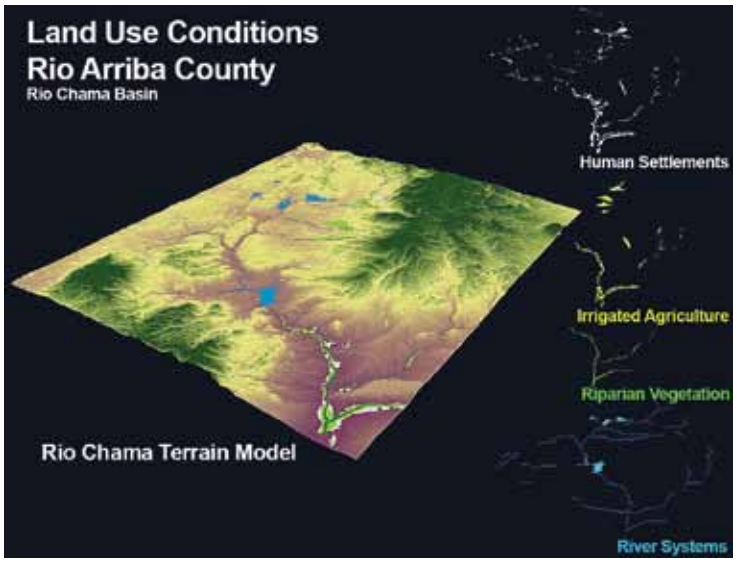
We must understand the acequia system so we have arguments to present to decision makers to show why we should keep them. We must understand the whole watershed basin system to show cause and effect. Carlos Ochoa

I think you need to include the headwaters of the Rio Grande in the regional approach. We need to include four counties in Southern Colorado, where they too have the acequia culture and where the headwaters are. Arnie Valdez

One of the things we need to capture is the value of work done by hand, work done with respect for tradition. Working with a shovel doesn't make something less beautiful. Manuel Montoya

We need collaboration across traditional divides, institutional, generational, urban-rural divides. People say that on a grand scale this isn't going to work... We need to imagine a system where we can adapt. Collaborating across the board and understanding the questions others have about their situation is very important. Sylvia Rodríguez

(acequias continued from page 11)



This 3-D terrain model is an example of an effort to visualize findings of current research. Here human settlement, irrigated areas, natural streamside systems, and the Rio Chama with its storage reservoirs are layered onto the same model.

The job for Vince Tidwell, at Sandia National Laboratories in Albuquerque, is to take the information being gathered and organize it into a formal mathematical framework that will allow multiple systems to be addressed as they interact. His goal is "a model that allows problems to be discussed in an interactive environment and where all of the disciplines—hydrology, economics, ecology—can be integrated," he said. "There is feedback across all of these disciplines and they affect each other."

Tidwell, who is an adjunct professor at UNM, New Mexico Tech, and the University of Arizona in addition to his research duties at Sandia, said details that impact water levels are critical to the modeling process. "What influences decisions landowners make about water? Neighbor influences, downstream urbanization? We recognize very strongly that decisions landowners make are not just economic. There are very strong values also involved," he said.

Tidwell is constructing a model that will "work from high in the watershed downstream to the urban areas." The model will also reflect different components for each community, reflecting differences in individual systems. "Ultimately we will calibrate the model and try to project forward, understanding land use changes over time, land ownership, cropping patterns, and grazing measures," he said.

NMSU initiates new graduate water degree program

By Desa Daniel, Student Coordinator, NMSU Water Sciences and Management

Water research is an emerging field striving to create new and innovative ways to preserve our world's water resources for future generations. A major need exists to train the next generation of water resource researchers, educators, and managers to address these challenges, both inside and outside New Mexico.

New Mexico State University is pleased to offer an interdisciplinary experience to graduate students through its newly created Water Science and Management (WSM) program. Master's and doctoral students can choose from one of five fields of study including Agricultural Water Resources; Watershed, Riparian, and Aquatic Systems; Water Quality and Treatment; Water Economics and Policy; and Water Informatics. WSM is supported through the collaboration of five academic departments and over 80 faculty staff members.

Currently the program has accepted 21 students from Colorado, Washington, New Mexico, and Ohio as well as international students from Iran, India, Nigeria, Australia, Turkey, Ghana, Mexico, Afghanistan, and the Republic of Cameroon in Africa. WSM's first graduate, Hussein Abdallah Abd-Elaziz who is originally from Egypt, completed his doctoral degree in May 2013. Mr. Abd-Elaziz has focused his research in water economics and is advised by Professor Frank Ward.

Professor Kenneth "KC" Carroll came to New Mexico State University as part of the formation of the WSM degree. Dr. Carroll has over 15 years of industry and research experience covering a broad range of cross-disciplinary areas spanning both organic and inorganic geochemical hydrogeology. His industrial experience focused on some of the largest metal mines in the world. He has investigated sub-surface heterogeneity impacts on groundwater contamination remediation performance. Dr. Carrolls experience also includes technology development and feasibility/treatability assessments for environmental-remediation, carbon-capture, and energy-production alternatives. KC will be teaching Geohydrology 452 during fall 2013 and will be offering a new course in Southwest Water Resources during spring 2014. NMSU's new Water Science and Management Program was a major reason Dr. Carroll's decided to settle with his family in the Land of Enchantment. He is particularly interested in helping to train students across multiple scientific and engineering disciplines preparing them for careers in water resources.

Celebrating Earth Day

The impact of water flow is demonstrated by WSM Student Coordinator Desa Daniel (left) during Earth Day 2013. (Photo by KC Carroll)

On April 21st 2013, Water Science and Management Professor KC Carroll and Student Coordinator Desa Daniel joined in celebrating Earth Day at Young Park in Las Cruces. The WSM team helped inform the Las Cruces community about the importance of water research. An interactive water table was set up to teach children about water erosion and the impact water has on the surrounding areas. A special thank you goes to Dr. Chris Brown, NMSU Geography Department, for use of the water table and to OASIS for including WSM in this community outreach opportunity.

Global Perspectives

International scholars provide worldwide perspective for examining problems, successes with acequia systems

By Will Keener

Global Perspectives 2013 lived up to its name. Guest speakers with expertise in acequia systems in South America, Spain, Morocco, Mexico, and as far away as Bali provided an international view of their problems and successes during the two-day meeting March 2-3 at the Las Cruces Convention Center.

In Valencia, Spain, it is telling that one of the oldest of the community's surviving documents is a parchment from the acequia, said Luis Pablo Martinez, Inspector of Cultural of the Directorate General of Cultural Heritage of the Valencian regional government. Tracing its roots to a renaissance in the 10th Century, the Valencian acequia is based on a Muslim concept and is a model in many ways for integration of the modern and the traditional. Yet it too faces challenges in today's world.

The system in Valencia, which has been recognized by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) for its water management practices, shares agricultural waters with industry, the village and other users, when supplies allow, Martinez said. By-pass canals can deftly re-route the flow when supplies are short to make irrigation sustainable. A book of agreements, written in 1363, outlines the organizations to be included in the system.

The acequia system works well with few disputes among water users serving 18,000 small farms and providing food for a metropolitan area of about one million. However speculative pressures on the agricultural lands are threatening the systems, Martinez said. Defenders of the system are reminding residents that it is a source of healthy food, quality of life, and intertwined with the culture and history of the city. One campaign reminds residents "asphalt is not edible," he said. Another approach has been to organize tours to allow visitors to the acequia to learn about the benefits and actually bring tourist dollars to the area.

Researchers are also getting involved, he said, working to understand the magnitude of the environmental contributions made by the acequias and identifying efficient crops for the region.

A lesson from Jose Luis Arumi Ribera, professor and chair of the Water Resources Department at the Universidad de Concepción, Chile, is the importance of cooperation and communication between those in the upper watershed and those downstream. "Where there is a lack of understanding, there are going to be conflicts with stakeholders," he said. In the Diguillin watershed, a lack of roads connecting upper and lower parts of a watershed has eliminated any social connections. "The people in one territory don't think

Valencia irrigators receive water after human use, community use, and industrial use, but physical systems are in place to ensure that irrigators have top priority in times of water scarcity. Note two canals allowing water to turn a water mill inside the building in the picture and a third canal to the left of the structure for by-passing the mills. (Photo courtesy of Luis Pablo Martinez)

they are in the same one as the people below there," he said.

A difficult volcanic terrain and a location in an active tectonic area have confounded the situation, he said. At the same time, Chile is strongly affected by La Niña currents and is facing a seventh consecutive year of drought conditions. Further, economic and social expansions are putting pressure on Andean watersheds. Research continues in the watershed to better understand the geologic factors that are diverting groundwater from one valley into another.

Acequia tourism is a solution that a number of communities in Bali are now pursuing, Steven Lansing told the conferees. Lansing is an anthropology professor at the University of Arizona and an external professor at the Santa Fe Institute. The introduction of modern farming with nitrogen and phosphorus fertilizers has endangered rice growing on irrigated terraces in Bali, a province of Indonesia. Bali is noted for its water temples, gatherings of farmers who make democratic decisions about water allocations in a non-centralized way. Despite the beauty of the area and its allure for tourism, most of the 19 villages in the area are very poor and receive little remuneration from the million plus visitors to the area each year, Lansing said. Designation as a UNESCO site in 2012 will help give control back to the water temples, Lansing believes, instead of keeping it with the central government.

Government control compared to independent control, or self-management, was an issue studied in detail by Jacinta Palerm, professor of rural studies at the Colegio de Posgraduados in Mexico. In Peru,

Ditch cleaning day near Guerrero, Mexico. Shared labor is a hallmark of most acequia systems. Research in Mexico shows that many unofficial organizations have sprung up to resolve disputes in larger districts where self-management is preferred to strong central control. (Photo courtesy of Jacinta Perez)

Chile, Argentina, Mexico and Spain, there is a strong correlation between stability and self management of irrigation systems, she said.

In a review of 35 case studies, including four very large systems, Palerm expected to find that the smaller systems adapted better to a series of changes in Mexican government regulations. "We expected the large systems to run into trouble," she said. What investigators found was that an extensive web of informal organizations occurred in most systems. "These organizations have succeeded in holding on to older organizational forms and also have created new organizations with no official framework in second or third tiers," she said.

"My impression is that in Mexico, at least, government policies that make community level organizations more fragile are more dangerous to self-management than those dealing with larger systems," she said.

Hsain Ilahiane, associate professor of anthropology at the University of Kentucky, warned the group that self-management was not always the best form, especially when it was used to manage ideologies instead of water. Ilahiane has studied extensively a small system in an oasis at a Berber village where he grew up in Morocco. The

system is an exploitive system built on social stratification," he told the audience.

A sizeable slice of Moroccan population, the Haratin people, are required to contribute labor to the acequia system, which provides water for date palms and olives in a microclimate that also permits vegetable cultivation, he said. Some of the Haratin have moved to cities, moved upward socially, and returned to the village with college degrees and "rebellious ideas," Ilahiane said. These modern educated youth represent a majority of the population in the village, but are unable to get a place on the management council. As a result, they are contesting "every aspect of the management," he said.

The legal framework for the system is crumbling and water theft is rampant, he said. "This is a system that deserves more research," he said.

NMSU Professor Phil King, one of the workshop participants who helped develop the report, remarked "There hasn't been such a drought like this since the Rio Grande Project was created in 1916." (Photo by P. Hemp)

Senator Tom Udall announces availability of water conference report

On April 30, New Mexico Senator Tom Udall, NM WRRI Director Sam Fernald, and others gathered alongside a dry Rio Grande in Las Cruces to announce the availability of the 2012 Water Conference Report.

Senator Udall and New Mexico State University co-hosted the 57th NM WRRI Annual New Mexico Water Conference held in Las Cruces in August 2012. The conference brought together over 500 participants to address the impact of water scarcity and explore solutions to help New Mexico adapt to the ongoing drought. Participants were encouraged to provide their comments and suggestions. The following day, a diverse group of water policy experts met to begin working on the report.

The report contains 40 proposed actions developed from the conference and discussion afterwards. These proposals fall into seven categories: research, water infrastructure, water transfers and markets, environmental restoration, agricultural practices, water conservation, and water resource planning. It also contains an additional 40 recommendations by conference audience members.

Senator Udall said, "As the conference title suggested, Hard Choices will need to be made if we are to avoid divisive conflicts as a result of the devastating drought. And that requires cooperation and collaboration. That is how we move forward. That's what this conference report is all about."

The Water Conference Report and related information is available on the Senator's website: http://www.tomudall.senate.gov/?p=blog&id=1282 and on the NM WRRI website: http://wrri.nmsu.edu/. The conference proceedings will be available this summer and will be posted on the NM WRRI website.

Senator Tom Udall (left) and NM WRRI Director Sam Fernald present the Water Conference Report, which compiles strategies and policy proposals discussed at WRRI's annual water conference in August 2012. (Photo by J.P. King)

Senator Udall announces the water conference follow-up report detailing 40 proposed actions on dealing with New Mexico's scarce water supplies. (Photo by P. Hemp)