the WATER CENTURY

BY KIPPRA D. HOPPER

SITUATED ON THE HIGH LLANO ESTACADO OF WEST TEXAS, Texas Tech University in Lubbock is adjacent to the desert regions of the United States and Mexico, making the region ideal for the study of arid and semiarid lands and water. More than half of Texas, one-third of the United States, and one-third of the Earth is arid or semiarid.

Researchers at Texas Tech have a long legacy of addressing water issues in the region and globally. In 1966, then-Texas Tech President Grover Murray, who had just arrived at the university, established the International Center for Arid and Semiarid Land Studies (ICASALS). The center's founders hoped to establish the comparative study of arid lands and how people relate to the land from an international perspective.

ICASALS was former President Murray's brainchild, an inspiration that came to him in the middle of the night during his travels in northern Africa as a consultant for Magnolia Oil. He wanted a program that would set Texas Tech apart and generate wide, perhaps international, recognition for the university. With an array of cross-discipline contributions from the campus, Murray was thinking of solving such problems as how to conserve resources and how to increase the productivity of land in dry climates.

Murray's early interest in water has continued throughout the university's research history, and current President Jon Whitmore has declared water to be a major research initiative at Texas Tech. The water initiative involves collaborative teams of faculty and students who represent law, public policy, economics, agriculture, geosciences, engineering, biological sciences, and health sciences, among others, and encompasses all colleges within the university.

ICASALS, with its international partners and in cooperation with other centers and departments across the university, has a huge potential, says Director A.C. Correa, Ph.D. "ICASALS is the only center in Texas and one of only a few in the United States dedicated to the study of all issues related to dry lands. With other centers in Nevada and Arizona, we want to become the third major center in the United States working on dry lands research and education projects. Texas Tech has strong research areas in agriculture, geology, remote sensing, water resource management, and wind energy, to mention just a few that define a university niche in dryland-related activities. Another characteristic of ICASALS is its close working relationship with faculty associates in different academic departments and research centers that have well-established connections in all continents. Our present programmatic emphasis is in Latin America, specifically in Mexico, Central and South America, as well as Africa."

ICASALS is part of the Office of International Affairs, and in 2006, ICASALS celebrated its 40th anniversary with an international conference focusing on water issues in arid and semiarid lands. Speakers at the meeting covered four main areas: water resources, agriculture in arid lands, water law and policy, and natural sciences. The conference was the center's first in the last 10 years. >

Texas Tech's water research is coordinated through ICASALS and other centers. The Water Resources Center was established as an interdisciplinary research center in 1965 and currently is led by Ken Rainwater, Ph.D., P.E. In 2005, the College of Agricultural Sciences and Natural Resources (CASNR) created the CASNR Water Center, with Director Marvin Cepica, Ed.D., and Associate Director Don Ethridge, Ph.D. The Center for Water Law and Policy was established the same year within the School of Law, with Director Gabriel Eckstein, J.D., LL.M.

The center directors are working together in leadership positions to raise public awareness of water, a main point of President Whitmore's directive for the multidisciplinary research initiative. The researchers associated with water issues know they are working against time in a world where water is becoming more and more precious across the globe.

"Some people argue that water is a source of conflict while others suggest that it can be a source of cooperation," Eckstein emphasizes. "While the water stress we now are encountering in Texas and globally is serious, in terms of the availability of fresh water, it is nothing compared to what may be in our future. And that stress could be the source of considerable conflicts around the world—among the states of the Colorado River, between the United States and Mexico, in the Middle East, and elsewhere. Yet, in various water conflicts in the past, we have seen that once the water stress level reached a breaking point, the parties realized that a peaceful solution was in everyone's best interest. Regardless, this is the water century. And we will certainly see breaking points in many parts of the world, including the United States. Whether they result in conflict or cooperation is yet to be seen."

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The Water Law and Policy Center strives to generate relevant and timely information to the public and to local, regional, state and national policymakers, legislators, and political, economic, and social interest groups to enhance water-related decision making processes.

The collaboration of Texas Tech researchers and their colleagues across the globe encompass studies of reclamation of polluted water and wastewater reuse, to conservation of playa lake wetland and the preservation of the Ogallala Aquifer, to the economics of water used by municipalities and farmers on the High Plains, to health problems related to water consumption, and to laws governing water worldwide.

The Water Resources Center research teams share resources and try to minimize the impact of detriments to the environment, a theme of the center since it was established. The CASNR Water Center researchers have done work related to water for decades, often in conjunction with College of Engineering faculty.

"Water issues are escalating in the state and in the world," Ethridge says. "The CASNR Water Center focuses on all aspects of water use and conservation in both the urban and rural landscapes through research and outreach. We want to educate our own students, but we also are providing information to the general public and policy makers. We think outreach is an extension of research so that people will be more aware of water issues. Agriculture has a long tradition of educational outreach to the general public."

Eckstein, the George W. McCleskey Professor of Water Law at the Texas Tech University School of Law, focuses on international issues, especially those dealing with transboundary freshwater resources, and he stresses that water is a global concern. Interdisciplinary researchers with the Law School Center for Water Law and Policy are studying, reviewing and offering recommendations for new regulations as well as amendments to existing laws. Eckstein's water issue research interests cover areas such as Europe, the Middle East and Mexico. He currently is advising the United Nations on developing rules for governing aquifers that straddle two countries or sit on the border, so that issues, such as who controls the aquifer, do not evolve into conflict.

"We have rules that make political sense, but they sometimes make no scientific sense at all. So, we are trying to bridge that gap and establish universal rules understood by all fields. This center is meant to be a place for learning and education, with think-tank capabilities, and operating on all levels from local to international. Water touches all aspects of society and is related to everything from personal use to agriculture to industry," Eckstein continues.

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One of the university's larger multidisciplinary projects is the Federal Ogallala Initiative in which Texas Tech is the lead institution. The university joined with the Agricultural Research Service of the U.S. Department of Agriculture, Kansas State University, West Texas A&M University, Texas Cooperative Extension, and the Texas Agricultural Experiment Station to collaborate their efforts on many different aspects of research on the Ogallala Aquifer. The Ogallala is an underground source of water that extends throughout the Great Plains.

"As soon as people started realizing that the Ogallala Aquifer was not everlasting, they started studying the processes of hydrology and agriculture and how they work together," Rainwater says. "People who have large amounts of land feel a sacred connection to it, and they are very different from urban people in terms of their views about agriculture, ranching and water conservation. A lot of work at Texas Tech focuses on irrigation, crop selection, and cultivation practices that affect how much water people take out of the aquifer."

The College of Agricultural Sciences and Natural Resources also is broad, including disciplines such as range and wildlife, and plant and soil sciences. The hydrologists housed in the College of Engineering have collaborated with the agricultural sciences researchers as long as Texas Tech has been doing research.

In the Ogallala Initiative, the collaborators have divided the aquifer into sections, with Texas Tech researchers studying the far southern portion of the Ogallala, West Texas A&M with the Agricultural Experiment Station working in the central portion, and Kansas State leading the research in the northern portion. Federal funding for the project comes through the U.S. Department of Agriculture.

"The researchers across the region are coordinating their models of each area of the aquifer. We already knew some things about the Ogallala, and we are building on that," says Ethridge, who is an agricultural economist. "On the economic side in the southern portion of the aquifer, we already have some results that compare different ways of regulating the pumping from the Ogallala, and how much effect the regulations would have on both water withdrawal and economic impacts. The Ogallala Aquifer's conditions are so different across the region that it may not be a 'one policy fits all' situation and probably is not. If you try to impose a one-policy scenario on the whole region, it probably is going to be what an economist would call a suboptimal solution. Then that raises the question of how can policymakers cope with that? We learn more as we go, and that is always the case with research."

"In most places, water is way too cheap," Ethridge comments. "We talk about water scarcity, but scarcity is only created by prices being too low. Fundamentally, you create scarcity by anything being underpaid. So, should we charge more for water? 'Should' is value judgment. Water issues are extremely complex, and we have to look at water in a social context."

"We can look at the evolution of the Plains here, just as a microcosm of the world, which is just a tiny speck on the globe. Before Western Europeans came to the United States, only Native Americans occupied the land. In certain localities, water may have been scarce, but in general, there was plenty of water," Ethridge says. "But thinking about the population that later lived upon the Plains, we see that the numbers of persons did not grow very much until the population really expanded when irrigation was introduced after World War II. The greater population and agricultural production now here is using that water. When the water is used up, are we going to import water, or is the population going to go down?"

Heavy irrigation of the region began in the 1950s. Rainwater makes the point that the current United States farm legislation encourages crop irrigation. "We must recognize that in some places, we will not be able to irrigate forever," Rainwater

says. "The reality is that we have not run out of water as fast as we thought, and the aquifer is down a little bit. How good are we doing in research in getting conservation news out to those folks?"

Rainwater's opinion about how long the region will have sustainable water to continue current agricultural production depends on what "sustainable" means. In the mid-1990s, when the Water Resources Center began its involvement in regional groundwater modeling for the High Plains of Texas, Rainwater asked irrigation experts to predict how much water per year would be needed to grow cotton and to maximize the yield.

"We were told to plug into our model the figure of 18 inches per year in places where irrigated cotton was grown. We found that the pumping rates required for that amount of irrigation would lead to virtually complete depletion of groundwater in 15 or 20 years in some parts of the aquifer," he says. "Based on the model results, it was apparent that, for the aquifer to still be here, that irrigating farmers have been using significantly less than that high irrigation estimate, and it also is likely that recharge of the aquifer has been greater than previously estimated. So, the region's groundwater is not necessarily going away as fast as people might have predicted."

Texas Tech researchers Lucia Barbato and Kevin Mulligan with the Center for Geospatial Technology have made maps of how much depletion the region has each year. The researchers can compare water depletion to how much water people have in current storage based on the depths of water tables and the base of the aquifer across the region.

"There is a big difference in how much saturated thickness that exists from place to place in the region. Some places do not have much saturated thickness, while other places have a couple of hundred feet, so the answer to sustainability is very different," Rainwater explains. "How much pumping the water from the ground costs depends on how deep the water is. If we are depleting the aquifer, that distance gets further, and the amount of money it costs to pump the water is directly proportional to that distance."

The economists in the College of Agricultural Sciences and Natural Resources focus partially on water use efficiency. "Given the quantity of water available, how do you spread it among the various competing uses to create the most income, the greatest economic benefit?" asks Ethridge. "And, how do you allocate the water over time so as to extract the most economic benefit? We are sitting on top of a ground water resource here that we are mining. To not mine it at all means we derive no economic benefit from it, so that doesn't make any sense. But if we have a finite resource that can't last forever if we use it, what's the optimal time path to use it so as to extract the most from it? Those are questions of economically efficient utilization of the resource."

Another multidisciplinary project involves researchers along with producers who are looking at improving groundwater management on the South Plains Texas Tech is working with the Texas Agricultural Experiment Station, the Texas Agricultural Extension Service, the U.S. Department of Agriculture, the High Plains Underground Water Conservation District, and the Natural Resource Conservation Service and involves 26 sites, explains Ethridge. In the demonstration project, funded with $6 million from the Texas Water Development Board, researchers are collaborating with 26 cooperating farms with the most diverse sites in one locality on the High Plains, Ethridge says.

"We have everything from straight cotton production to diverse operations with some cotton and hay and livestock operations," he says. "I'm impressed with what our researchers have been able to put together to gather massive amounts of data, and therefore, many possibilities. A lot of this type of precise data has not been obtained under field conditions before, so water efficiency up to now has been more hypothetical."

Researchers are trying to find a balance of the best water conservation technology – the most efficient, economically feasible, water efficient technology – that will sustain agricultural income over a long period of time. One answer may involve the integration of crop operations with livestock operations, he suggests. The 26 farmers involved with the project also are closely observing the research and making their own recommendations. The farmers will make the decisions about what changes to make in their own operations next year, and the team of researchers will track the changes, collecting data again next year. College of Engineering and Agricultural Sciences researchers are monitoring each one of the 26 sites to measure the water amount that goes on each crop.

Another project is examining aquifer recharge from playa lakes. A hydrologist, Rainwater suggests that the measurements taken at the sites likely will indicate that people have underestimated how much water returns to the Ogallala Aquifer as recharge. Water reaches the underground water source through either natural recharge of infiltrating rainfall or before the crops can use the water. Researchers from the civil engineering, plant and soil science, and natural resource management departments, in cooperation with the USDA-ARS, are placing instrumentation at as many playa sites as possible in hopes that they can see playas fill in the rain and then drain to understand where water goes under different conditions. The water projects are multi-year studies.

"We actually need some of the irrigation water to go past the roots because otherwise salts will increase, and the fertility of the soil will decrease," Rainwater says. "When people got worried about the aquifer being depleted, they realized that we were producing water from the aquifer faster than water was recharging the aquifer. The estimates for the recharge were based on calculations that predicted regional recharge was less than half an inch a year. Now we will have more hard data observations. We don't want to see just one event; we want to see enough data so that we get something that we can statistically compare."

Rainwater's job in the project is trying eventually to see how long water stays in the playas after filling, how much evaporates, and how much seeps into the subsurface soils. He is doing the modeling to calculate how much water actually makes it past the root zone and heads toward the aquifer. "Just because water is going into the soil, it does not mean that the water is available for recharge. What we are comparing in each county is one playa that is in a non-cultivated area still surrounded by grasslands, and then one in a cultivated area," he says. "In areas where we cultivate – where we loosen up the soil – the soil tends to run off into the playas and fill them up. The playas do not hold water as well because more sediments are taking up space. There are techniques that farmers can use to set a buffer strip around the playa where it will catch the sediment before it can enter the playas."

Groundwater processes in general are slow, Rainwater says. "We can take water out, but we cannot put it back into the aquifer very quickly. We have to remind people that this is not a quick thing you can do in the lab. We hope that when we put these instruments out that we can watch them for five or 10 years. If we are going to do something different and we want to change the way something works, we want to watch that for a while also. The research is a slow process."

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"We need to get a better handle on how we manage our freshwater resources, especially transboundary sources," Eckstein says. "We need to develop the law as it applies to surface and ground water resources based on sound scientific understanding and principles of hydrogeology. The objective is the development of clear, logical, and science-based norms of state conduct as they relate to freshwaters that traverse political boundaries."

He notes that the work to define management schemes, commissions, or best practices for transboundary waters is very important. "It is also why the initiative to come up with an international treaty on transboundary aquifers is so important," Eckstein says. "We need to avoid situations like the one the United States and Mexico find themselves in. I see that situation as the poster child for the potential positive and negative. The United States is extremely water rich, although not in the South or Southwest, but Mexico is water poor throughout. Population growths are different, and water needs are different in the two countries. So, how much do we allocate to each country? Do we do it based on need? Well, that means Mexico should get most of it. Do we do it based on geography, where most of the water is? Well, the Rio Grande originates in Colorado and New Mexico. Does that mean that the United States should get the majority of water? Should we base allocation on some other principle of law? While there is some international law on this topic, the matter is far from settled."

Texas Tech is continuing its heritage of exploring issues important not only to the Southwest region, but to the world as well. Early pioneers of the university, like Grover Murray, recognized that water was and always will be a major factor in West Texas. Today's researchers know that the century is upon us for dealing with water as our life source.