tx H_2O

A Publication of the Texas Water Resources Institute

Spring 2009

In this issue:

Can't have one without the other

Water and Energy are Interdependent

Texas A&M University College of Agriculture and Life Sciences
Texas AgriLife Research
Texas AgriLife Extension Service

Working to make every drop count

As the new acting director of Texas Water Resources Institute, I look forward to continuing and expanding the institute's programs and impacts.

All of us at TWRI want to thank Dr. Allan Jones for his leadership and accomplishments during his tenure as director of the institute. It was an honor for me to serve as associate director with Dr. Jones. We had the opportunity to lead the institute during a period of tremendous growth in its programs and its collaborations with federal, state, and local agencies to solve water resources issues in the state and beyond.

TWRI manages a number of projects, involving faculty members from across the state. The institute maintains joint projects with several universities in Texas and some universities from other states. We work with federal, state, and local governmental organizations; consulting engineering firms; commodity groups; and environmental organizations.

I am pleased to announce that I have named Kevin Wagner, a TWRI project manager, as associate director. He will join me in leading the institute's focus on water resources research and educational programs for Texas AgriLife Research, the Texas AgriLife Extension Service, Texas A&M University, and other universities throughout Texas.

As climate change, population growth, water marketing and interbasin transfers, increasing energy needs and drought, and possible reduced funding put additional strain on water resources, finding research-derived, science-based solutions to water quality and quantity issues becomes imperative. We at TWRI plan to continue obtaining funding for research and education programs to help find solutions to these issues.

I am glad I will be a part.

B. L. Harris

B.L. Harris

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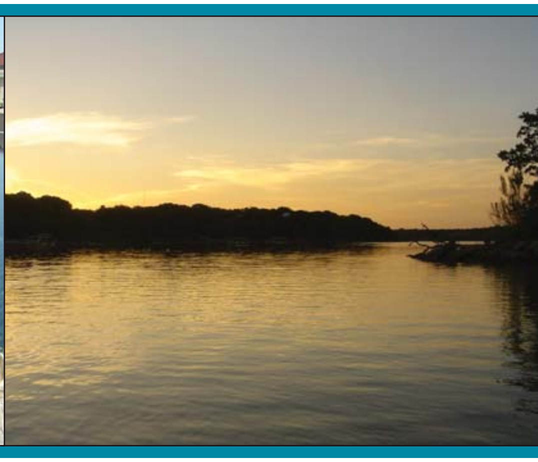
On the cover:
Water and energy: "You can't have one without the other."

Texas Water Resources Institute
make every drop count

Inside

volume 5 number 1, Spring 2009



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Story by Kathy Wythe

Can't have one without the other

Water and energy are interdependent

Just as Frank Sinatra once sang about love and marriage, when it comes to water and energy, "You can't have one without the other." Water is needed to produce most energy, and energy is needed to develop and use water.

Water is used to extract and process oil, gas, and other fuels, and is an integral part of electric-power generation. Energy, in turn, is needed to pump, treat, heat, and move water, and extract "new" water from desalination, reuse, and other sources.

As the United States develops new energy sources to replace imported petroleum and natural gas, the demand for water to produce these energy sources will grow significantly. And as the population grows, so does the need for more water and energy.

With the increased need for both, this water and energy nexus or interdependence is beginning to capture attention of policy makers and researchers throughout Texas and the nation.

"Water and energy are the two most fundamental ingredients of modern civilization," wrote Dr. Michael Webber in a *Scientific American* article in October 2008. Webber is an assistant professor of mechanical engineering at the University of Texas and associate director of the Center for International Energy and Environmental Policy. "Without water, people die. Without energy, we cannot grow food, run computers, or power homes, schools, or offices."

In an interview, Webber said: "We use a lot of energy for water and we use a lot of water for energy, so constraints in one become constraints in the other. If we don't have enough energy in some situations, we might not have enough water, and if we don't have enough water, we might not have enough energy. These interconnections or relationships present important opportunities, but they also present vulnerabilities or constraints."

David Burnett, director of technology for the Global Petroleum Research Institute within Texas A&M University's Department of Petroleum Engineering, agreed.

"Two of the most critical problems facing Texas, the United States, and indeed the world, are providing adequate energy and ensuring adequate clean water resources for society and doing so in a cost-effective and environmentally responsible manner," he wrote in a white paper on water and energy.

After agricultural production of food, feed, and fiber, energy withdraws the largest amount of freshwater in the United States, accounting for nearly half of all freshwater withdrawals, although not all the water is consumed.

"Texas represents a significant part of that use," Burnett said. "Such technologies as coal to electricity, coal to liquid, coal to hydrogen, natural gas to electricity, natural gas to liquids, nuclear, biofuel feedstocks, biofuel refining, oil production, oil refining, oil and gas petrochemicals all require copious amounts of water."

Recognizing the growing demand for both energy and water, in 2004 the House and Senate Subcommittees on Energy and Water Development Appropriations asked the Department of Energy for "a report to Congress on the interdependency of energy and water focusing on threats to national energy production resulting from limited water supplies…"

The resulting report, *Energy Demands on Water Resources* published in 2006, gave an overview of the connections between energy and water, identified concerns regarding water demands of energy production, and discussed science and technologies to address water use and management in the context of energy use and production.

The report recommended the federal government collaborate with regional and state agencies, as well as with industry and other stakeholders, on energy and water resource planning. The report added that science- and system-based natural resource policies and regulations need to be developed, as do energy-water infrastructure synergies such as coordinated infrastructure development.

In 2005 the Department of Energy began developing a National Energy-Water Science and Technology Roadmap "to establish a long-range research, development, and demonstration program to support the efficient use of water and energy resources and sustainable and cost-effective future energy production and electric power generation in the U.S." To date the final Roadmap report is not published.

In March 2009, U.S. Senators Jeff Bingaman of New Mexico and Lisa Murkowski of Alaska introduced a bill, titled *Energy and Water Integration Act of 2009*. The bill would authorize several studies to analyze water use in the production of transportation fuels and electricity, as well as other mechanisms to improve the understanding of the nexus between energy and water, according to a Murkowski news release. The bill would also direct the Department of Energy to complete the Roadmap.

For Webber, the recommendation of having collaboration or integration of water and energy planning into one planning process is key.

"The most important thing is to recognize the relationship of water to energy," Webber said, "and integrate that relationship into policy making to have a more integrated approach. We need to have water and energy planners sitting together, making decisions together."

"Many people are concerned about the perils of peak oil – running out of cheap oil," Webber wrote in the *Scientific American* article. "A few are voicing concerns about peak water. But almost no one is addressing the tension between the two: Water restrictions are hampering solutions for generating more energy, and energy problems, particularly rising prices, are curtailing efforts to supply more clean water."

On the state level, this need for coordination of energy and water planning is beginning to be discussed.

In September 2008, the Texas Senate Committee on Natural Resources had a hearing that in part focused on the energy-water nexus. During the meeting, Sen. Kip Averitt said he would like to see energy planning handled in much the same way as water planning is done by the Texas Water Development Board. ⇨

"I wish this state had some vision for energy like we do for water; that way it would make your job [the Texas Water Development Board] a lot easier and more effective if we had some kind of hint of what is going to happen in the future," he said.

That vision is Texas' state water plan, updated every five years, which provides water use projections, water availability, and water management strategies to meet state's water estimation needs.

For the Texas Water Development Board, the energy-water nexus becomes a reality when the board is planning for enough water to meet the state's electricity demands.

"The issue is, with the increase in electric demand, we are going to see increases in water used to produce electricity," said Carolyn Brittin, deputy executive administrator in charge of water resources planning and information for the Texas Water Development Board.

Brittin testified at the September 2008 natural resources committee meeting on the incorporation of steam-electric water demands in state and regional water planning. She also presented results from the study, *Water Demand Projections for Power Generation in Texas*, conducted by the University of Texas' Bureau of Economic Geology.

Brittin agreed that having more knowledge of electric and other energy demands would help the board in its water planning. When the state water plan is updated every five years, she said, "We look for changed conditions and adapt the process to that. If we get better information on power demands in the next cycle, we will incorporate that in the planning process.

"At the end of previous regional water planning in 2006, some water providers came to the board saying we are having requests for water for power generation that are greater than what is projected in the plan," Brittin said. "In one basin, the inquiries were ⇨

Alternative

While we don't yet have jet-powered flying cars like the old TV cartoon *The Jetsons*, research is producing new ways to fuel our cars and to use "new" water. Even these innovations, however, must consider the energy-water connection.

Hybrid and fully electric cars are getting favorable press as green machines that save energy. They may not, however, save water, according to research done by Dr. Michael Webber and Dr. Carey King of the University of Texas (UT).

In their research, Webber and King compared the amount of water used, withdrawn, and consumed during petroleum refining and electricity generation in the United States. They estimate that plugged-in hybrid and fully electric vehicles could increase the country's water consumption with each mile driven because electricity consumes roughly two times more water than gasoline, and more than eight times more water is withdrawn to produce the electricity.

The researchers note these concerns do not necessarily mean electric cars are undesirable. "It just means there might be some tradeoffs," Webber said.

Biofuels are another research area where this energy-water nexus is apparent. The production of ethanol from corn has come under criticism because of the large amount of water needed to produce the corn. According to Webber, recent analyses indicate that the entire ethanol production cycle, from growing irrigated crops on a farm to pumping biofuels into a car, can consume 20 or more times as much water for every mile traveled than the production of gasoline.

Recognizing this, Texas AgriLife Research's bioenergy program is committed to using rain-fed crops, rather than irrigated crops, in making biofuels from different types of biomass, according to Bob Avant, bioenergy program director.

AgriLife researcher, Dr. William Rooney, professor in the Texas A&M University Soil and Crop Sciences Department, and other researchers are developing a high-tonnage, drought-tolerant sorghum for biofuel production. Researchers are also studying sugarcane and switchgrass crops.

energy must consider water needs

By Kathy Wythe

Another area of bioenergy research is using microalgae to produce biofuels. Both Texas A&M and UT have research programs on growing algae with high oil content to be used in biofuels.

Algae can grow in brackish or salty waters not suitable for drinking or irrigation so it doesn't compete with agricultural, municipalities, and other demands for freshwater resources.

Avant said AgriLife Research has partnered with General Atomics, a technology company based in San Diego, California, to develop jet fuel from microalgae at the AgriLife Research Center at Pecos. In addition to salty water, these algae strains require large amounts of sunlight and carbon dioxide to grow and produce oil, all prevalent in West Texas. "We hope to have jet fuel in three years," Avant said.

UT scientists recently created a cyanobacteria that produces cellulose and secretes glucose and sucrose that can be turned into ethanol and other biofuels, according to a UT news release. The scientists, Dr. R. Malcolm Brown Jr. and Dr. David Nobles Jr., said the microbe could provide a significant portion of the nation's transportation fuel if production can be scaled up.

David Burnett of the Global Petroleum Research Institute at Texas A&M has been working for nine years to find a way to reuse oil field-produced wastewater or brine in an effort to save fresh water and reduce associated costs. Conventional production of oil and gas generates about eight barrels of water for every barrel of oil produced, Burnett said. This water usually is re-injected into the oil reservoir.

With the start of drilling for natural gas by unconventional production methods, such as that used in the Barnett Shale in north central Texas, water has become a critical issue, Burnett said. Unconventional production not only uses more water than conventional methods, but the wastewater created during the drilling process cannot be injected back into the reservoir. Instead, it must be hauled off by trucks to another site.

By using membrane filtration and desalination process technology developed by Burnett and the petroleum institute, this wastewater can be reused in the drilling process, thus saving fresh water, reducing costs, and lowering the impact of environmentally sensitive areas. Texas A&M has recently partnered with M-I SWACO, a worldwide oil field service company, to bring this technology to the market, Burnett said.

"In the Barnett Shale, wells require from 5 million to 7 million gallons of water per well to stimulate gas production from the tight gas-containing formation," Burnett said. "If treated to remove solids and other contaminants, much of this water can be reused, avoiding the competition with communities and agriculture for fresh water.

"In the Permian Basin, fields producing from conventional formations make seven times as much water as oil, with each barrel of water requiring re-injection for disposal. In an area plagued with droughts and water shortages, the potential for reuse of purified water is clear."

Combining "new" energy with "new" water, a Texas Tech University pilot project is using wind power to desalinate brackish groundwater for the city of Seminole. According to a Texas Tech news release, the project is the first in the country to use wind power to desalinate drinking water for an inland municipality. Tech's Wind Science and Engineering Research Center and the Water Resources Center are participating in the project, which will desalinate brackish water from the Santa Rosa Aquifer through reverse osmosis with power supplied by wind turbines.

greater than the total demand in the state. That is why we did the study, to see if we could get a better handle on what those projections were going to be in the state."

In the current legislative session, Rep. Charles Anderson introduced House Bill 366 that calls for a task force to study the state's long-term demand for electric generation capacity.

In addition to integrating energy and water planning policies, conservation of both energy and water is vital, experts said.

Webber suggested water-conserving solutions, such as research to develop more sophisticated ways to cool power plants with less water; use of power generators that use less water, such as wind or solar; and development of biofuels that do not require much water.

"We also need to develop less energy-intensive ways to clean water," Webber said.

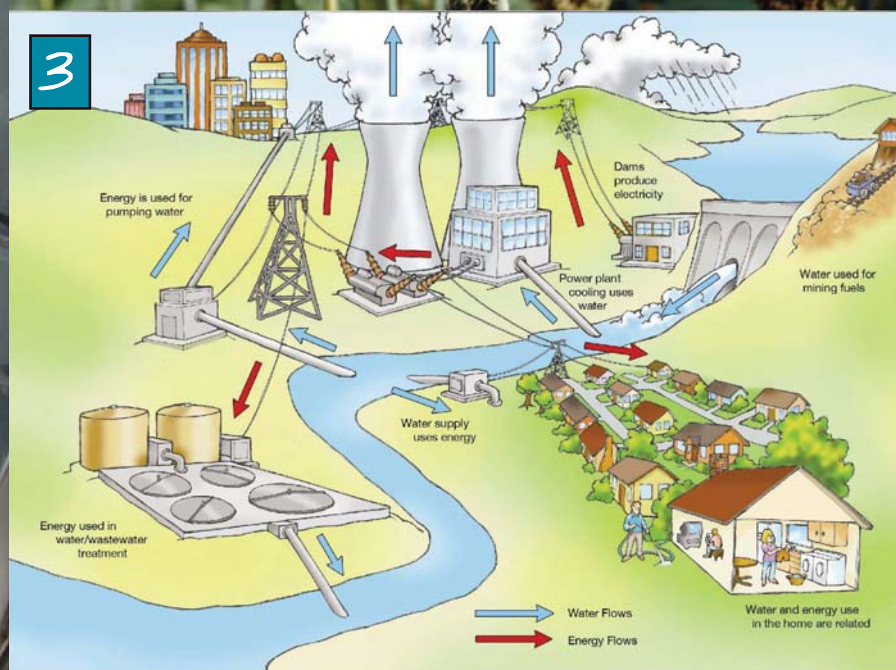
Energy and water expert Bob Gary, who previously worked for TXU, now Luminant, agreed that more innovative research is needed. He said more engineers specializing in water are also essential for the necessary innovation.

Gary pointed to desalination of oil field wastewater and other saline water as one innovation that holds promise. "There is a lot of saline water scattered throughout Texas," Gary said. "If we could clean it up and use it, we would be in great shape."

He gave an example of the West Texas farmer with too little water and the West Texas oil and gas company with too much produced water. "The economics of the state needs to have the technology linked between these two industries to keep them both healthy."

1. David Burnett, director of technology for the Global Petroleum Research Institute at Texas A&M University, works on the institute's mobile desalination trailer, adjusting the feed rate of the micro filter assembly. The unit is used to desalinate oil field wastewater. Photo by Texas Engineering Experiment Station Communications.

2. Texas AgriLife Research scientists are breeding sorghum for biofuel production.
The research effort is led by Dr. Bill Rooney, AgriLife Research plant scientist. Photo by Blair Fannin, AgriLife Communications.
3. Examples of Interrelationships Between Energy and Water.
From *Energy Demands on Water Resources*, report to Congress.
4. Wind and solar technologies could be integral components of the energy mix because of their water and fuel independence.



Story by Danielle Supercinski

Alternative water sources

Desalination model provides life-cycle costs of facility

Desalination can provide an alternative source of potable water for many communities, and agricultural economists are evaluating the construction and operation costs associated with all components required for an operating plant.

Through the Rio Grande Basin Initiative, a team of agricultural economists from the Texas AgriLife Extension Service and Texas AgriLife Research have developed the Microsoft® Excel® spreadsheet model DESAL ECONOMICS©. The team consists of Dr. Ronald Lacewell, Dr. Edward Rister, Allen Sturdivant and several graduate students in the Texas A&M University Department of Agricultural Economics who work hand-in-hand on these efforts. This program is designed to analyze and provide life-cycle costs for an entire facility, including up to 12 individual functional expense areas.

"To our knowledge, and from a literature search, this life-cycle cost capability to individually look at the well field, the main facility, other components, and/or the entire facility appears unique among economic and financial cost models directed at desalination facilities," said Sturdivant, AgriLife Extension associate at Weslaco. "DESAL ECONOMICS© is custom-built and useful for analyzing any desalination facility, regardless of size or location."

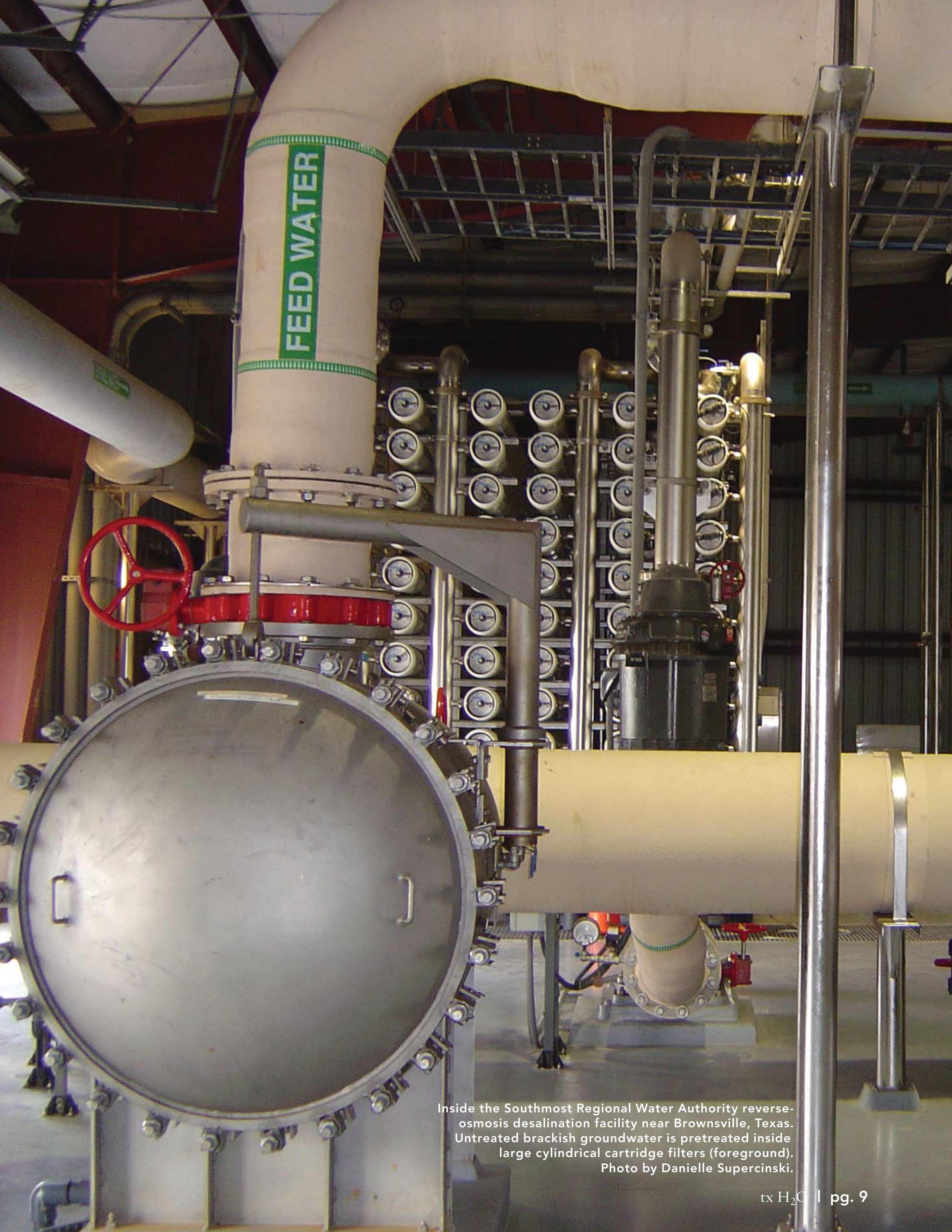
Having a flexible design and the solid economics and financial methodology embedded in DESAL ECONOMICS© permits this type of complete analysis, he said. In addition, the agricultural economists have built a related economic and financial model, CITY H_2O ECONOMICS©, on the same methodological platform and design standards as DESAL ECONOMICS©, but created to analyze conventional surface water treatment facilities. The models allow experts to analyze which technology and/or facility design and asset configuration provides the lowest long-term cost of potable water supplies.

Using these newly developed models, the team conducted case studies to determine the economic and financial life-cycle costs of building and operating four water treatment facilities in South Texas. One facility was the Southmost Regional Water Authority Regional Desalination Plant near Brownsville. Sturdivant said their specific results are only applicable to the Southmost facility, but do provide useful information regarding life-cycle costs for other desalination facilities.

"Though the case study provides a snapshot evaluation for the Southmost facility, DESAL ECONOMICS© has broad applicability," he said. "It really has its strength in providing information in the planning and design stages of future facilities – particularly when there are multiple alternatives amongst key facility characteristics affecting costs being considered."

The Southmost facility treats brackish groundwater and provides an alternative water supply for southern Cameron County.

"Potable water from desalination is currently limited in the Valley, representing only about 3 percent of the region's supplies," Sturdivant said. "However, within the immediate service area, the 7.5 million gallons per day Southmost facility is capable of providing upwards of 40 percent of the total municipal and industrial potable water needs." ⇨



Inside the Southmost Regional Water Authority reverse-osmosis desalination facility near Brownsville, Texas. Untreated brackish groundwater is pretreated inside large cylindrical cartridge filters (foreground). Photo by Danielle Supercinski.

As part of conventional surface-water treatment, raw water is treated to remove any disease-causing organisms, silt, or grit, and to improve the taste. Information from the sedimentation tank and the McAllen South Water Facility is used as input for the CITY H_2O ECONOMICS© model. Photo by Danielle Supercinski.

The life-cycle costs addressed in DESAL ECONOMICS© (and CITY H_2O ECONOMICS©) include initial investment, annual operating costs, downstream reinvestment costs, capital replacement, and inflation through time, he said. By design, life-cycle costs are different than typical accounting department costs and serve a different purpose.

"There are initial investments going into the land, concrete, and construction of desalination plants; then there are operating costs incurred year after year that may go up as inflation impacts factors of production. Also, as the facility deteriorates, you are going to have capital reinvestment," Sturdivant said.

These case studies suggest the life-cycle costs of producing potable water are equivalent for groundwater desalination and conventional treatment. While desalination can be efficient as an alternative source for water in rural areas, energy costs are higher when compared to conventional treatment.

"Energy is a much larger proportion of cost on desalination than it is in the conventional treatment, so sensitivity of total costs is higher," Sturdivant said. "In the base analysis, if you look at all of the money spent building the facility and operating it over 50 years, energy is 26 percent of the total cost of the Southmost desalination facility. It is only 10 percent to 15 percent, however, of total costs for conventional treatment of Rio Grande surface water."

This problem has always been one of the drawbacks of desalination, he said.

"Engineers continue to look at trying to find ways to develop more efficient membranes to reduce the energy use in desalination," Sturdivant said. "Energy use means two things: First, with this brackish groundwater facility, they have to extract the water out of the ground, so there is a lot of pump energy required. Second, pumps within the desalination facility push the water through the membranes, which filter out the salts. This process pressurizes water up to 180 psi, which is where the largest energy use occurs. In addition, energy costs are highly dependent on the location, as power rates can vary greatly from region to region, state to state, and country to country."

"There has been a lot of development with membranes, and they are getting more energy efficient," said Rister, professor and associate department head for the Department of Agricultural Economics at Texas A&M. "You could probably track energy use over time on the membranes and would see that it has come down substantially in recent years."

Energy costs excluded, the cost per thousand gallons of water for desalination has dropped dramatically over the past 20 years.

"Looking back in the 1900s, the cost per thousand gallons of water was $5 or more, and now our case study results indicate the costs are $1.95," Rister said. "That speaks well to the work being done by engineers and technical specialists."

He said putting in a desalination plant instead of extending the traditional treatment network of piping can be economical, depending on location.

"Rather than trying to construct a pipeline from a big city or a conventional treatment plant to a distant rural community, which would be vastly expensive and not economical, they have the option of putting in a small desalination plant using brackish water," Rister said.

The agricultural economists agreed that pumping brackish water locally and putting it through a modular desalination plant — which can pump a million gallons a day or more — can be a method of drought-proofing for rural communities. The per-unit cost does not increase very much between 1 million or 8 million gallons, they said; it stays about the same. ⇨

"The chemical costs to treat surface water and the cost of purchasing water rights are increasing, which is making conventional treatment more expensive," Rister said. "Then, you have membranes becoming more efficient so it has reached the point where desalination has its place."

The DESAL ECONOMICS© model case study by the Texas AgriLife agricultural economists is specific for South Texas.

"Even though this analysis is concentrating on South Texas, when we look at Texas overall, there are serious water issues; we have limited surface water alternatives in many parts and a huge brackish water supply," Rister said. "When you talk about going from 22 million Texans to 40 million Texans during the next 30 years or so and the amount of extra potable water we are going to need, desalination appears to look like a good option to consider."

However, a downside of desalination when not located near the Gulf or an ocean is the concentrate discharge issue.

"For inland locations, it has to be deep-well injection for concentrate-waste disposal," Sturdivant said. "The economic feasibility of many of these facilities or locations is site-specific, and depending on that location, there may or may not be a competitive advantage."

Rister said that evaluating such issues is a strength of using the DESAL ECONOMICS© model. Their model was built so that one could look at the total facility, or individual components or cost centers, such as well field and concentrate-waste discharge. "You can see costs by function (component), helping to identify the major issues to consider in making them more economical, but a constant in all cases is discharge must be addressed," he said.

While numerous factors and costs must be considered prior to constructing, operating, and maintaining a desalination facility, the agricultural economists and their DESAL ECONOMICS© model have made it easier for a community or water supplier to review costs for desalination plants of the future.

The team of economists thanks Bill Norris, Jesús Leal, and Jake White with NRS Consulting Engineers in Harlingen; Judy Adams and Jose Garza with Brownsville Public Utilities Board; Javier Santiago with McAllen Public Utility Water Systems; Chuck Browning of North Alamo Water Supply Corporation; James Elium of Olmito Water Supply Corporation; and Orlando Cruz of Cruz-Hogan Consultants in Harlingen for their time and expert advising during development of the models and the case study analyses.

"Having the ability to objectively compare different water-supply projects and make capital investment decisions will become more important over time as populations increase, input costs rise, and water supplies become relatively scarcer," Sturdivant said. "As such, sound analyses of finance and economics should be considered an extension of engineering-related tasks for capital-project alternatives involved in a region's water-resource planning."

Water quality of individual pressure vessels is closely monitored. Inside each vessel, pressures reach 180 psi to separate salts from water. Photo by Danielle Supercinski.

Story by Caitlin Churchill

Engineering water for the world

Texas A&M University tackles a water crisis

Texas A&M University students and professors are helping shape the world, one pot at a time.

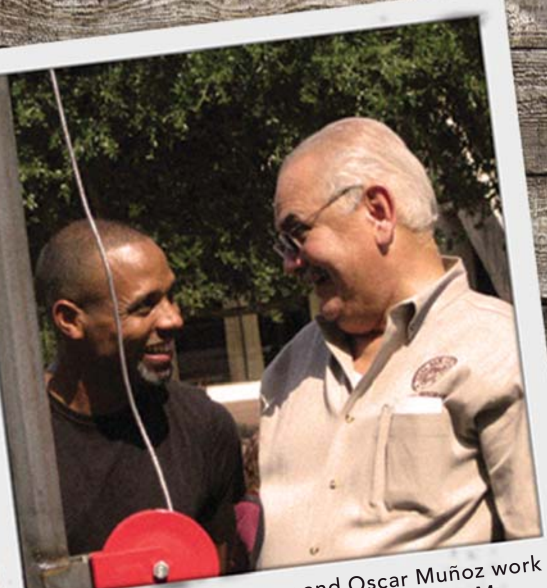
Since 2007, the Texas A&M University Water Project has been linking individuals in the Department of Teaching, Learning, and Culture with those in the Center for Housing and Urban Development and the Zachry Department of Civil Engineering to produce and distribute ceramic point-of-use water filters. These 'pots' are forms of low-cost water treatment that can be used anywhere in the world to prevent needless deaths and poor health.

The water filters are made from 50 percent clay and 50 percent sawdust and contain colloidal silver, which renders bacteria and microbes inert. It turns out something as simple as ceramic pots are one answer to the global potable water crisis.

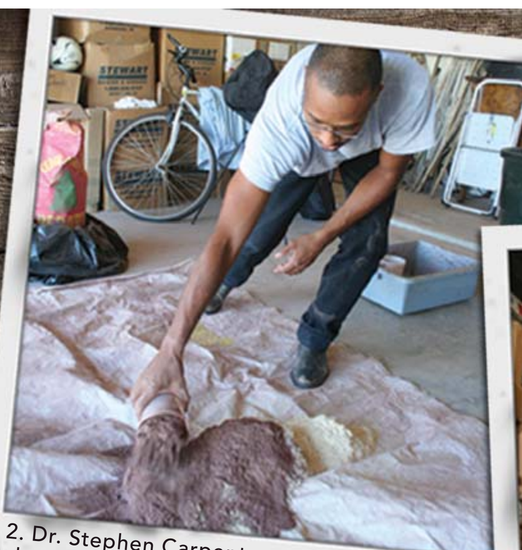
"Three hundred children across our globe die every hour from diarrheal diseases caused by a lack of access to clean water, sanitation, and adequate healthcare" said Dr. Bryan Boulanger, assistant professor in the Zachry Department of Civil Engineering at Texas A&M. "The overwhelming majority of these deaths are 100 percent preventable through improved access to potable water and sanitation."

Boulanger became involved in the water project in 2007 when he met Dr. Stephen Carpenter, associate professor of Art Education and Visual Culture at Texas A&M, in a grant writing workshop. Carpenter was writing a proposal to fabricate ceramic point-of-use water filters and distribute them for use in the colonias.

Carpenter had already begun the water project with his co-director, Oscar Muñoz, deputy director of The Colonias Program in the Center for Housing and Urban Develop-



1. Dr. Stephen Carpenter and Oscar Muñoz work on water filters displayed at the Texas A&M campus.



2. Dr. Stephen Carpenter pours a 50 percent clay and 50 percent sawdust mixture in the group's garage workroom during Filter Fridays.

3. Dr. Stephen Carpenter and Dr. Bryan Boulanger combine the mixture.

ment at Texas A&M. "Our program works with communities known as colonias," Muñoz said. "There are approximately 2,300 communities along the 1,434-mile Texas border in 14 counties contiguous to the Rio Grande." In the colonias, more than half a million people live without running water in their homes or proper sewage.

"I was also familiar with the water quality challenges in the colonias, but I was concerned about the levels of arsenic and other contaminants in the water that might pass through filters," Boulanger said.

Carpenter introduced Boulanger to Muñoz, and from then on, the three have become "partners in crime," as Muñoz calls them. But really, they are partners in a vision to address community-specific water and energy needs by developing programs that couple innovative education approaches and technology-based solutions to improve communities and achieve sustainability.

Boulanger said the filter project is a good start for that vision. "I believe we can reduce diarrheal disease by 65 percent or more in communities just by introducing these filters with appropriate education materials. That equates to millions of lives saved within my own lifetime, which is something worthy of spending time, energy, and effort on."

The water project didn't invent ceramic point-of-use water filters. "We have based our work on the international work of Potters for Peace," Carpenter said. Potters for Peace is a U.S.-based non-profit network of potters, educators, technicians, and volunteers who work primarily in Central America training organizations to operate filter making facilities.

"Ceramic artist Richard Wukich, a friend and mentor, first introduced me to the water filters, and as I read about the work of Potters for Peace, I thought about how this technology might be applied here in Texas to help people who need access to clean drinking water," Carpenter said.

According to the Potters for Peace Web site, studies done by Massachusetts Institute of Technology, The United Nations Children's Fund, and the University of Colorado have proven that the filter is effective at eliminating at least 99 percent of *E. coli*, coliform, and *Streptococcus* organisms. ⇨

4. Dr. Bryan Boulanger shapes the clay and sawdust mixture.

5. A finished filter.

6. The finished product: a ceramic filter rests on the rim of a 5-gallon water container.

Several hundred thousand of these potable water filters are already used globally, but Boulanger said these existing filters have limitations. "An inability to remove arsenic is just one limitation," he said.

Boulanger and Ishan Desai, a graduate student and research assistant, have begun experimenting with nanotechnology-based treatment alternatives, an emerging field of water purification science.

"Metal oxide nanoparticles have a high potential to bind and effectively remove arsenic from contaminated water," Boulanger said. "If we can get the nanoparticles to stay on the surface or within the body of the filter, the filter will have the capacity to remove arsenic."

Other limitations the project is facing include breakage, cost for production ($5 per filter is too expensive for many across the globe), and transportation costs of both materials and finished products if not made locally. Each limitation is being addressed as project members change filter design and develop educational materials that will allow people to reproduce filters using existing cultural and community knowledge.

The group was recently granted space by the Webb County Commissioners Court to build a point-of-use ceramic water filter production and education center at the Highway 359 Self Help Center in Laredo, Texas.

Currently Carpenter, Muñoz, Boulanger and eight student volunteers meet weekly in Carpenter's garage for "Filter Fridays," but a site at the Texas A&M Riverside campus has recently been granted to create a water filter facility. The gentlemen hope to begin building the facility and their first kiln later this spring.

To see a short documentary video about the Texas A&M Water Project, visit *http://itunes.tamu.edu/*, enter the iTunes U Web page, and type "Clean Water for Texas" in the search tool.

To learn more about the project, visit *http://tamuwaterproject.wordpress.com/*, and to read about international efforts of potters visit *http://www.pottersforpeace.org/*. For more information about the Colonias Program, go to *http://chud.tamu.edu*.

Story by Kathy Wythe

Turning a negative into a positive

Researchers find promising use for excessive nitrate

For 30 years, farmers in northwest central Texas have known that high level of nitrates in irrigation water from the Seymour Aquifer is a problem. Now, with research conducted by Texas AgriLife Research scientists, that problem may turn into a benefit.

Nitrate is the most common chemical contaminant in groundwater. For the Seymour, a shallow aquifer underlying about 300,000 acres in 20 counties, more than 50 percent of groundwater nitrate measurements exceed the federal drinking water standard of 10 parts per million, according to Texas Water Development Board data.

Although that level is too high for drinking water, AgriLife researchers recently found that excess nitrate in irrigation water can be a source of nitrogen for crops in place of fertilizer.

"Water in the Seymour that is high in nitrates and does not meet water quality standards for domestic use can be considered a valuable resource for agriculture," said Dr. John Sij, professor at the Texas AgriLife Research and Extension Center at Vernon.

Sij and AgriLife Research scientists Dr. Cristine Morgan and Dr. Paul DeLaune have studied nitrates levels in irrigation water from the Seymour Aquifer for three years.

Sij said 90 percent of the water pumped from the Seymour in Knox, Haskell, Baylor, Wichita, Wilbarger, and Fisher counties is used for irrigation.

Based on estimates prepared by DeLaune, each part per million of nitrate/nitrogen in irrigation water will add 0.23 pounds per acre of nitrogen for each inch of water applied. ⇨

Dr. Cristine Morgan, Texas AgriLife Research soil scientist, takes soil cores for nitrate analysis before the drip irrigation system was installed.

"Assuming the irrigation water has a 20 parts per million nitrate concentration and 12 inches of irrigation water per acre is applied over the growing season, approximately 55 pounds per acre of usable nitrogen can be applied to a cotton crop," said DeLaune, assistant professor at the Vernon center. "This is more than the nitrogen requirement for a bale of cotton. At nearly $1 per pound for fertilizer nitrogen this past year, 55 'free' pounds of nitrogen can add up to significant cost savings for producers who irrigate their crops with high nitrate groundwater.

"It is important to note that other nutrients like potassium and phosphorous must also be adequate to take full advantage of nitrates in the irrigation water and any applied fertilizer nitrogen," he said. "Nitrate crediting is a sound economic and agronomic practice. By taking credit for the free nitrogen in irrigation water, farmers may be able to reduce nitrate in groundwater while maintaining yields and realizing significant financial benefits over time."

"We don't know what percentage of the nitrate is geologic in nature or what percentage is due to farming operations," Sij said. "But if we take it into consideration in our fertility programs, we can mine the nitrogen and use it as a resource."

"Producers should have their irrigation water analyzed for nitrate annually and make allowance for this free nitrogen source when determining crop fertilizer needs," DeLaune said.

The researchers compared the amount of nitrate in water from center pivot and subsurface drip irrigation systems. Subsurface drip irrigation systems provide water and nutrients directly to the plant root zone by applying small amounts of water frequently to maintain soil moisture content at an optimal level for plant growth and root development.

According to Sij, previous research has shown that properly designed and managed drip irrigation systems reduce deep percolation losses and runoff, and drip irrigation improves crop yields and quality and saves water, fertilizer, energy, and money.

Morgan, assistant professor in Texas A&M University's Department of Soil and Crop Sciences, compared the nitrate balance in drip and pivot irrigation to determine whether drip irrigation helped nitrate stay in the soil profile instead of leaching into the soil and aquifer. For three years, she monitored three fields of drip and three fields of pivot irrigation.

Morgan said her fieldwork showed no significant difference between subsurface drip irrigation and pivot irrigation in reducing nitrates. "Model results, however, suggest that leaching into the groundwater is approximately twice as likely under pivot irrigation."

"Based on results of this project, conversion from pivot to drip irrigation without better nutrient management will not significantly affect nitrate levels in the aquifer," she said. "To reduce inorganic nitrogen in the Seymour Aquifer, the inorganic nitrogen being delivered to the field through irrigation must be accounted for in nutrient management plans."

Morgan said soil water storage, not irrigation method, was a dominant factor influencing leaching potential of a given area.

"The sandier soils store less water and have higher leaching potentials," she said. "This finding suggests that future implementation of best management practices, such as drip irrigation, should be prioritized towards those soils with low water storage capacity and high leaching potential."

Project participants also conducted water quality education and provided technical assistance to irrigators. With financial and technical assistance offered by local soil and water conservation districts, 17 farmers installed drip irrigation systems through the project. Irrigation management was implemented on more than 1,800 acres and nutrient management was implemented on about 2,500 acres. More than 670 participants attended education program and demonstrations.

"This project served as a catalyst to encourage the installation of subsurface drip irrigation systems," said Kevin Wagner, associate director for Texas Water Resources Institute (TWRI). "Considerable interest has been generated in drip irrigation and other more efficient irrigation methods through the efforts of project partners."

Continued work, however, is needed to improve conditions in the Seymour Aquifer, Wagner said. "Educational programs on irrigation and nutrient management are needed to encourage regular soil testing, better managed irrigation systems, and account for nitrate levels in irrigation water when determining nitrogen fertilization needs."

Other agencies involved in the project were local soil and water conservation districts, U.S. Department of Agriculture's Natural Resources Conservation Service, the Texas AgriLife Extension Service, and Rolling Plains Groundwater Conservation District. The project was managed by TWRI and funded by the Texas State Soil and Water Conservation Board through an Environmental Protection Agency §319(h) grant.

(Portions of this story were from an AgNews release.)

Omar Harvey, graduate student in the Department of Soil and Crop Sciences, creates a bulk soil electrical conductivity survey to identify soil variability in one of the fields used in the Seymour Aquifer Water Quality Improvement Project. Photo by Cristine Morgan.

Story by Kathy Wythe

TNRIS serves as source for digital geographic information

Want to know if your home is in the 100-year flood plain or see what your city looked like from the air during the 1920s? Check out the Texas Natural Resources Information System (TNRIS) Web site at *http://www.tnris.state.tx.us/* for the answers.

TNRIS, a unit of the Texas Water Development Board (TWDB), provides a centralized location for digital geographic information on natural resources, including water, socioeconomic information, transportation, political boundaries, and other related information. The entity provides a valuable service to Texans, saving money, fostering use of valuable information, and saving agency personnel time.

Established by the Texas Legislature in 1968 as the Texas Water-Oriented Data Bank, TNRIS was created to gather and coordinate water information after the severe droughts in the 1950s to better understand and monitor the state's water resources, said James Scott, TNRIS director.

Today, TNRIS collects much more than water information.

"Anyone who wants any information about Texas digital geography can come to the TNRIS Web site," Scott said.

TNRIS has a historical collection of aerial photographs from different state and federal agencies that go back to the 1920s. "TNRIS is the state archive or clearinghouse for map data and aerial photos," he said.

The historical images can be accessed to see how land was previously used or what the conditions were on the ground. "[The old aerial photos] continue to provide value to the state as a critical resource to make assessment of what the condition of the environment is," he said.

TNRIS' Strategic Mapping Program, or StratMap, was started in 1997 with the passage of Senate Bill 1 that established Texas' state water planning process. One of the mapping program's first tasks was converting U.S. Geological Survey paper maps into digital maps. These digital maps can be overlaid with data sets such as digital imagery, census information, watershed boundaries and other hydrological information, political boundaries, and transportation. TNRIS is continually updating these maps with help from other federal and state agencies, Scott said.

Common uses of StratMap include hydrologic modeling, vegetation analysis, transportation routing, land use planning and management, environmental assessment and monitoring, crime analysis, homeland security evaluations, economic development assessment and planning, and business applications.

"These types of analytical tools really help people in decision-making and executive and leadership positions," Scott said. "Instead of having to go out and look for the raw data to build maps themselves for large-scale projects or land development, they can get most of what they need and start using the same common reference."

As part of the StratMap program, a new statewide aerial map was created through collaboration with the U.S. Department of Agriculture's Farm Services Agency, several state agencies, and technical partners. This new aerial map has one-half-meter resolution, increased from the previous map's one-meter resolution.

One of TNRIS' newer responsibilities is creating the Digital Flood Insurance Rate Maps for the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program. Established in 1968 by Congress, the National Flood Insurance Program enables property owners in participating communities to purchase insurance as a protection against flood losses.

"The state has recognized that Texas has one of the largest frequencies of disasters," Scott said, and wanted the TWDB to play a stronger role in the base map development process.

Using information collected from StratMap, digital flood hazard maps document 100-year flood zones. Scott said TNRIS will continually refine the maps because flood zones change as land use changes.

"The maps are the critical baseline feature used for reference from a legal standpoint of whether to purchase flood insurance if one's house is in the flood plain," he said.

Through the years, the TNRIS staff has adopted the newest technologies, from collecting historical aerial photos to using satellite imaging from the Landsat program launched in the 1970s. From its inception, TNRIS has been a leader in using geographic information systems (GIS) technology to document and monitor the state's geographic data, Scott said.

"There is quite a legacy here at TNRIS for being in the forefront of developing geographic information technology over the last three or four decades," he said.

Scott said TNRIS is evaluating different options for making maps and data more easily accessible on the Internet.

"We want to make our information accessible to all Texans."

Story by Caitlin Churchill

School's ~~out~~ for summer

It's been said there are three good reasons to be a teacher: June, July, and August. But, this summer a group of science teachers aren't straying from their work in the classroom.

Teachers become students at the 2009 Summer Science Teacher Academies, two-day programs sponsored by Junior Master Gardner (JMG) that provide training in core science content for elementary and junior high teachers.

A basic academy will be June 23-25, and this year's first water-intensive academy will be June 1-3. Both will be presented at the Texas 4-H Conference Center on Lake Brownwood.

The academies are designed to empower teachers' confidence in relaying scientific knowledge to their students, said National JMG Coordinator Lisa Whittlesey.

The basic academy, which 34 teachers attended last year, covers such topics as 4-H science, engineering, and technology curricula; global positioning systems for classrooms; plant and garden science; aquatic biology; and entomology.

Water education and rainwater harvesting were also included in the basic curriculum last summer, but Whittlesey said these topics have been expanded to create a separate Water Academy that includes lessons on watersheds, water systems, properties of water, Earth-Kind principles to conserve landscape water use, and water movement through soil.

"Topics will be covered in a very hands-on manner, and teachers will leave with practical science experiments and activities that can be done in the classroom," Whittlesey said. Experiments planned for the Water Academy include building a rainwater collection system; building a drip irrigation system for a garden; and collecting macro-invertebrates, vertebrates, and vegetation.

Whittlesey hopes the Water Academy will encourage teachers to educate their students about saving water resources in their own communities, while providing knowledge of local aquifers, watersheds, rivers, and streams. "High quality water is a critical issue in many communities and also a topic covered in many of the Texas Essential Knowledge and Skills tests (TEKS) for public schools, particularly in science," she said.

The Summer Science Teacher Academies were developed by the Texas AgriLife Extension Service and promoted through the Texas Education Agency science coalition, Regional Texas Education Service Centers, and county Extension program offices.

Registration for the 2009 Summer Science Teacher Academies is limited and is available through the Junior Master Gardner Web site at *www.jmgkids.us/texas.*

1. Sunset over Lake Brownwood.

2. Dr. Clay Robinson introduces teachers to soil profiles by determining the different texture of soils.
3. Students learn about collecting water from roof surface areas and various types of rainwater harvesting collection devices.
4. Texas AgriLife Extension specialist Larry Hysmith instructs students on how to collect water samples and aquatic life from Lake Brownwood.
Photos by Megan Meier.

Story by Kathy Wythe

New program investigates public health and water link

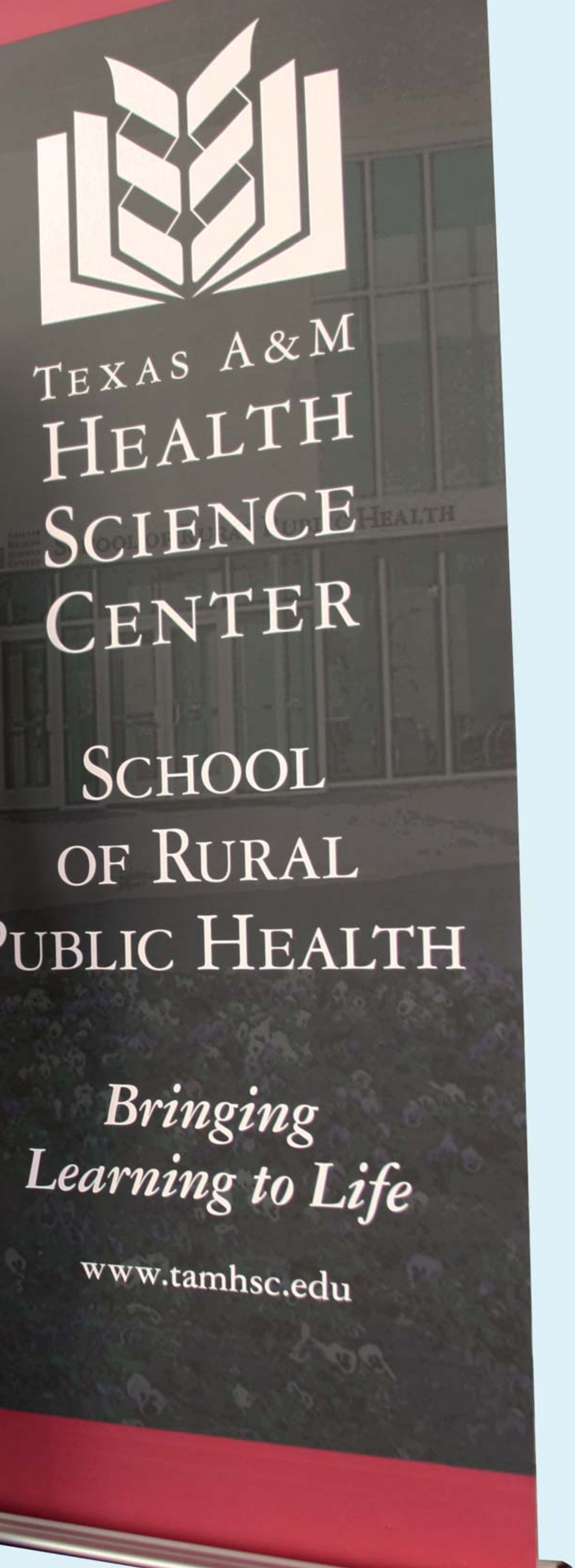
Thousands of cases of waterborne and water-related diseases worldwide are related to drinking water. A new program in the Texas A&M Health Science Center's School of Rural Public Health is working to understand this link between diseases and water and educate the public about this connection.

The Program in Public Health and Water Research was established in October 2008 within the rural public health school's Department of Environmental and Occupation Health. Dr. Vincent Nathan is its director.

This program's efforts are important because water is a necessity across the world, Nathan said. "In developing countries, we still have a high percentage of people who die from water-related diseases that are very, very preventable and curable," he said. "Not only are water-related diseases a problem but access to fresh clean water is insurmountable in some cases."

Along with the establishment of the program, the School of Rural Public Health signed an affiliation agreement with the Institute for Public Health and Water Research, a nonprofit science and education organization that relocated to College Station from the University of Illinois at Chicago School of Public Health. The institute provides scientific direction, funds, and other support to investigators to encourage research, publications, and meetings. Dr. Jennie Ward Robinson is the executive director.

The Program in Public Health and Water Research, directed by Dr. Vincent Nathan, is part of the Texas A&M Health Science Center's School of Rural Public Health. The program researches the link between public health and water. Photo by Kathy Wythe.



Nathan, former director of environmental affairs for the city of Detroit, said the institute chose to relocate to College Station because of the diversity of water resources researchers at Texas A&M University. He said generating ideas and opportunities from the health science center and Texas A&M in public health, environmental science, engineering, veterinary and human medicine, and international business in support of water and public health is among the program's goals.

Because many issues of public health and water are interrelated, an interdisciplinary institution is important, Nathan said. "It's important to get the engineering, medical, and agriculture community sitting down at the table discussing issues that individually they don't usually concern themselves with."

Nathan said the public health and water research program will focus on not only water-related diseases, including emerging infectious diseases, but also environmental factors that may be connected to diseases. Because 90 percent of chronic diseases are environmentally associated, he said, the program will research environmental indicators that can link a disease to aspects of the environment.

"There is some interaction of the environment on genes," he said. "We would like to help put that puzzle together."

Other focus areas include critical structures for water and public health needs such as daycares, schools, rental properties, and well water; workforce development; curriculum for health care professionals; and bottle water issues.

After approval by The Texas A&M System Board of Regents, the program will become the Center for Excellence in Public Health and Water Research, Nathan said.

Story by Kathy Wythe

Smarter Cropping

Internet program helps farmers make decisions about crops

Along the coastal plains of Texas, farmers and crop managers are using the Internet to make more informed decisions about growing cotton.

This Web-based decision support system, the Crop Weather Program for South Texas (CWP), is stationed out of the Texas AgriLife Research and Extension Center at Corpus Christi.

The program provides easy access to historical and current weather data as well as calculators and other tools that generate useful field-specific information about the crop and its environment, said Dr. Carlos J. Fernández, associate professor and the Plant Physiology and Cropping Systems Program's leader at the Corpus Christi center.

Using CWP, farmers and others can access data from an 18-weather station network that extends from Fort Bend County to Kleberg County. This data includes air and soil temperature, relative humidity, solar radiation, wind speed and direction, and rainfall. Fernandez said the program's fully automated system collects, inspects, uploads, and makes weather information easily available on the Web.

Management tools include weather data search, daily rainfall, reference potential evapotranspiration, soil moisture content, pre- and post-planting soil temperature, degree-day calculator, crop development, defoliation, crop water use, and irrigation monitor.

Registered users enter information about their acreage in field profiles that are kept in a database. They can then access the management tools to perform calculations or simulation of crop and environmental variables that are field-specific, Fernandez said.

When designing CWP, Fernandez said the program developers considered the types of questions farmers and crop growers would have. From there, the developers considered the tools necessary to answer those questions. Fernandez said additional tools have been added through the years based on feedback from farmers and crop managers.

The program, launched in 2000, is growing in popularity. In 2008, CWP's suite of tools was accessed 20,400 times, up from 12,375 times in 2007, Fernandez said. From 2006 to 2008, registered users increased from 396 to 743.

The CWP program replaced the Weather Station Network Program, created by Dr. Juan Landivar in the 1990s. Landivar is currently director of the Corpus Christi center.

Fernandez said that the main rule in planning the program was to make it both useful and user-friendly. The Web pages use simple point-and-click interfaces with user entry provided through drop-down menus wherever possible.

"I think we have succeeded very much," Fernandez said. "Our system is very sophisticated behind the screen display but very simple to use."

In the future, Fernandez said he hopes to expand the program to other crops and areas. The Web site for the program is *http://cwp.tamu.edu/*.

The Crop Weather Program for South Texas makes data from 18 weather stations scattered along the coastal plains of Texas available to users of the program. Photo by Carlos J. Fernandez.

Harris named TWRI acting director

Dr. B.L. Harris was recently named acting director of the Texas Water Resources Institute. Harris replaces former director Dr. C. Allan Jones, who took a faculty position at the Texas AgriLife Research and Extension Urban Solutions Center at Dallas.

Harris joined the institute in 2001 as associate director and project director for the *Efficient Irrigation for Water Conservation in the Rio Grande Basin* project, also known as the *Rio Grande Basin Initiative*. This joint federal initiative with New Mexico State University is working on strategies to meet present and future water demand in the Rio Grande Basin by expanding the efficient use of available water and creating new water supplies.

Under Harris' leadership, the *Rio Grande Basin Initiative* has won numerous awards. In 2008, the project won the Texas Environmental Excellence Award in the agriculture category. This award, the state's highest environmental honor, is presented each year by the Governor's Office and Texas Commission on Environmental Quality.

Harris is a professor in Texas A&M University's Soil and Crop Sciences Department, where he has been a faculty member since 1974.

Before joining the water institute, Harris was associate director for agriculture and natural resources for the Texas AgriLife Extension Service, then Texas Agricultural Extension Service, and associate director for Texas AgriLife Research, then Texas Agricultural Experiment Station.

Harris earned a bachelor's degree in agronomy and a master's degree in soil sciences from Texas Tech University and a doctorate in soil mineralogy from Oregon State University.

Wagner named TWRI associate director

Kevin Wagner has been named associate director of the Texas Water Resources Institute (TWRI) by Dr. B. L. Harris, acting TWRI director.

Wagner has 15 years experience in watershed assessment and planning, project implementation, and program management. Since 2005 he has been a project manager for TWRI, where he has planned, developed, and implemented water-related research and education projects. He has managed and helped develop a watershed planning education program and served as the institute's quality assurance officer.

Before joining TWRI, Wagner was nonpoint source team leader and assistant director of programs for the Texas State Soil and Water Conservation Board, overseeing the board's Water Quality Management Plan Program, Texas Brush Control Program, and the Statewide Nonpoint Source Management Program as well as the Coastal Management, Total Maximum Daily Load, and Watershed Protection Programs.

Wagner earned a bachelor's degree in biology from Howard Payne University and a master's degree in environmental sciences from Oklahoma State University. He is working on his doctorate in agronomy from Texas A&M University.

TWRI welcomes Hoffpauir

Richard Hoffpauir, a Texas Engineering Experiment Station (TEES) research engineering associate, began working with Texas Water Resources Institute (TWRI) in December 2008.

Hoffpauir specializes in water resources related applications of civil engineering, water availability modeling (WAM), hydrologic data analysis, and computer programming for modeling hydrologic processes.

Since 2001, Hoffpauir has been a graduate student programmer for the Water Rights Analysis Package (WRAP) under Dr. Ralph Wurbs, professor in the Zachry Department of Civil Engineering and a part-time associate director of TWRI. His current dissertation research involves adding daily time-step simulation capability to WRAP as well as developing pre- and post-simulation data analysis tools.

Hoffpauir earned a bachelor's degree from McNeese State University and a master's degree from Texas A&M, both in civil engineering.

Ride *New Waves*

If you like the *tx H_2O* magazine, you can receive more water news every month with the Texas Water Resources Institute's electronic newsletter, *New Waves*.

New Waves provides brief, timely information about university-based water resources news, results of projects and programs, and new water-related publications and faculty.

Visit *http://twri.tamu.edu/newsletters.php* to view the latest issue of *New Waves*, or subscribe to have the newsletter e-mailed to you each month.

Check out water resources training courses

Since its inception in June 2008, the Water Resources Training Courses Program, coordinated by the Texas Water Resources Institute (TWRI), has marketed and administered short courses on water-related geographic information systems (GIS), remote sensing technology, and computer simulation models. The program has collaborated with Texas A&M University's Spatial Sciences Laboratory, Zachry Department of Civil Engineering, and the Texas AgriLife Blackland Research and Extension Center at Temple on these courses.

Short courses offered include introductory and advanced courses on the Soil and Water Assessment Tool (SWAT), a River/Reservoir Modeling with the Water Resources Analysis Package (WRAP), courses on the Agricultural Policy Economic Extender (APEX) model, modeling of water distribution systems using EPANet, and a floodplain delineation course using GIS.

"Training courses are one of the most effective methods of transforming scientific knowledge from the universities so it can be used by the public," said Courtney Swyden, program coordinator, "and continuing education is essential to professional practice. TWRI's training courses create an excellent learning opportunity that brings together the scientists who are creating modeling tools and the experts who use them."

For more information on the training course program, courses offered, and online registration, visit: *http://watereducation.tamu.edu*.

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Fort Hood teams wins Excellence Award

The Fort Hood Training Lands Restoration and Management Program Team won the 2008 Vice Chancellor's Award in Excellence for the Industry/Agency/University/Association category. Dr. Mark Hussey, far left, vice chancellor and dean of agriculture and life sciences, presented the award to team members. From left are Jerry Paruzinski of Fort Hood Integrated Training Area Management, Dr. Dennis Hoffman of the Texas AgriLife Blackland Research and Extension Center at Temple, Dr. William Fox of the Texas AgriLife Blackland Research and Extension Center at Temple and the Texas Water Resources Institute, Brian Hays of the Institute of Renewable Natural Resources, and Robert Ziehr of the U.S. Department of Agriculture's Natural Resources Conservation Service.