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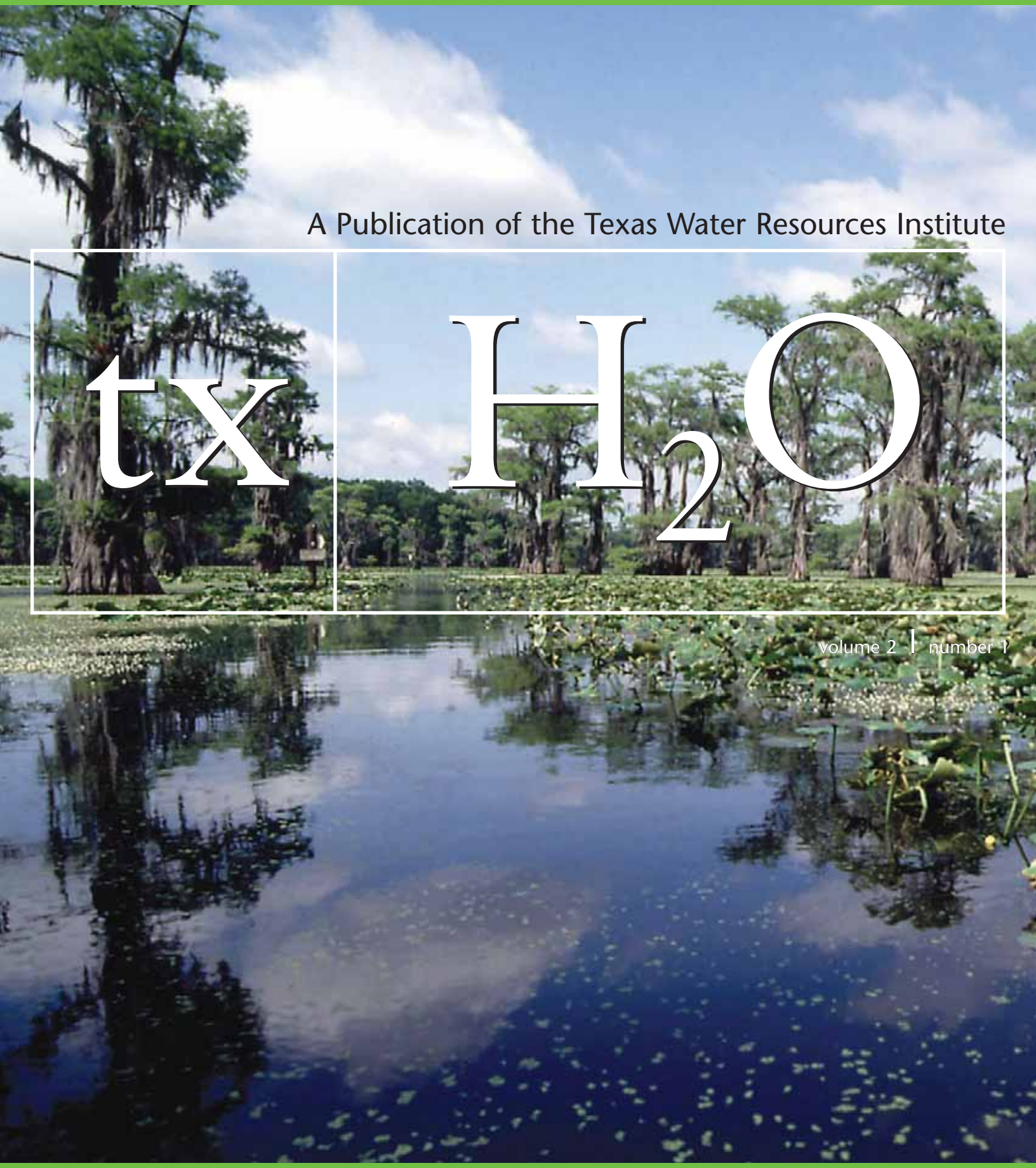

A Publication of the Texas Water Resources Institute

tx H_2O

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In This Issue:

Working Together for Texas Water

As you can see from the diverse story topics in this issue, the Texas Water Resources Institute works with many Experiment Station and university researchers and Extension specialists across the state to develop and promote water conservation and water quality research and outreach programs. We have also established positive working relations with most state and federal agencies in our role as the designated Water Resources Research Institute for the state of Texas.

It is our mission to continue these partnerships and collaborations through proposal development, grant management and multi-agency collaboration with university faculty, agency researchers and Extension personnel throughout the state.

We currently manage more than 50 projects involving some 150 faculty members with more than $8 million in research or outreach funds. We partner with more than 100 public and private institutions in Texas, the United States and internationally. The projects cover a broad spectrum of water issues—from seeking alternative sources of water to reducing the water needs of cities and farms to ensuring the quality of the water we have. Looking to the future, we administer scholarship programs for undergraduate and graduate students at Texas A&M and other Texas universities.

Because water resources issues are often complex, TWRI is committed to expanding and strengthening these partnerships and collaborations to ensure that our state, our nation and our world have needed water now and in the future.

tx H_2O

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On the cover:
Caddo Lake
Photo courtesy of Texas Parks and Wildlife Department © 2005

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The Texas A&M University System

Texas Water Resources Institute
make every drop count

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Story by Kathy Wythe

Texas' Natural Lake

Research to help restore environmental flows to Caddo Lake

Unique—a word frequently used to describe Caddo Lake on the border of Texas and Louisiana. Unique because it is the only natural lake in Texas, believed to have originally formed from a logjam on the Red River. Unique because it is one of only 19 wetlands "of unique importance" in the United States. Unique because of its bald cypress and tupelo trees that are Caddo's Lake signature.

This unique lake and its ecosystem, however, are being threatened.

Although the lake has developed several problems over time, the overriding concern, according to people involved in preserving the lake, is the amount of freshwater flowing from the Lake O' the Pines Reservoir to Caddo Lake. After the U.S. Army Corps of Engineers built Lake O' the Pines on Big Cypress Creek upstream of Caddo, the area no longer flooded as much. The regulated water flows from the dam stabilized lake levels, reducing regeneration of bald cypress forests. The cypress trees must have floods to distribute their seeds and dry spells that lower lake levels and allow seeds to germinate.

Flooding in the past also helped sweep sediment from the lake and inhibited plant growth. Invasive aquatic plants, introduced by man, are choking off water bodies; and heavy metals, including mercury found in the lignite coal used to power electricity-generating plants, are accumulating in fish tissues.

Scientists are developing plans to restore environmental flows to Caddo Lake, Texas' only natural lake.

But, efforts are under way to help the lake remain the diverse and economically important wetland that establishes its uniqueness.

Texas Agricultural Experiment Station (TAES) scientists along with the Caddo Lake Institute, The Nature Conservancy, the U.S. Army Corps of Engineers, Northeast Texas Municipal Water District, other federal and state agencies, and local citizens are working together to find solutions to the lake's problems.

The Caddo Lake Institute has worked on water quality and water flow research for the last 15 years, said Dwight Shellman, Caddo Lake Institute's former director. One question that needs to be answered, Shellman said, is "Would restoring the natural pattern of water flow help the ecosystem to respond better?

"The existence of the dam and reservoir gives us the opportunity of restoring the natural variability patterns even if we don't restore all of the water."

The Nature Conservancy's Sustainable Waters program, designed to protect river ecosystems downstream of dams, has sponsored two workshops within the last year to determine the research needed to develop ecologically based environmental flow recommendations for Caddo Lake. Environmental flows is the amount of water that needs to flow down the river to maintain the ecological system in the lake, river and flood plain.

Dan Weber, the Conservancy's northwest Louisiana program manager, said, "We recognize several problems downstream associated with both water quality and quantity. The effort under way is a science-based approach to determine exactly how much water is really required and under what conditions for the downstream environment to persist over time, while continuing to provide quality habitat for associated flora and fauna."

These flow recommendations, when implemented by the Corps, will enhance the ecological structure and function of Big Cypress Creek, its floodplain and

Caddo Lake's signature bald cypress trees need the high and low flow of waters for distribution and germination of their seeds.

greater Caddo Lake, according to a summary report presented at the second workshop by TAES researchers involved in the project.

Although other issues affect the lake, including nutrient and contaminant loading, logging, and agricultural and residential development, the consensus of the workshop participants was that some restoration of the timing, magnitude and duration of flows in Big Cypress Creek is critical to the sustainability of the lake's ecosystem.

Kirk Winemiller, a professor in Texas A&M's Department of Wildlife and Fisheries Sciences, said the summary report synthesizes the "state of knowledge" about the geography, hydrology, ecology and environmental impacts affecting Caddo Lake and Big Cypress Creek. At the second workshop, the group reviewed all the information and developed "building blocks," describing the expected ecological responses or conditions associated with specific river flows or lake level fluctuations for Big Cypress Bayou and Caddo Lake. Winemiller said the group came up with preliminary recommendations for researching environmental flows as well as research to fill information gaps and to improve estimates. (See sidebar for top research needs.)

A critically important next step toward implementing the building blocks identified for the creek and lake is to develop a plan for conducting necessary baseline monitoring of ecological conditions in Big Cypress Bayou in 2005 and implementing Big Cypress Bayou low-flow and high-flow management strategies beginning in 2006. In addition, the plan will examine the feasibility of modifying the Lake O' the Pines outlet to improve control of lake levels, nutrient flows and cypress regeneration.

Analyzing long-term changes in the lake's ecosystem will provide a scientific baseline for current and future studies. The TAES scientists involved in the workshops are Brad Wilcox, associate professor of rangeland ecology and management, studying the hydrology; Anne Chin, associate professor of geography, studying the fluvial geomorphology; and Dan Roelke, associate professor of wildlife and fisheries sciences and oceanography, concerned with nutrients, productivity and aquatic plants. Steve Davis, assistant professor of wildlife and fisheries sciences, is studying the riparian and floodplain vegetation, and Winemiller is studying the aquatic and terrestrial fauna.

"Hopefully the process will continue," Winemiller said. "We're limited in what we can learn in water responses in two years."

Shellman has organized a research coordination network for the Caddo Lake watershed. The network will regularly call for, and coordinate, needed field research by key agencies, scientists and stakeholders to establish a permanent process known as adaptive management.

"Research and adjustment, and then more research and adjustment" is what is needed, he said.

Once additional research is accomplished, Winemiller said, subsequent workshops will make recommendations for a watershed management plan that will advise agencies involved with water planning for Caddo Lake.

Scientists identify Caddo Lake's top research needs

Hydrology:

- Develop correlation between Jefferson flow gauging sites or re-establish gauge at old Jefferson site
- Determine gain/loss of water between Lake O' the Pines and Caddo Lake
- Assess floodwater accumulation and backwater hydraulics below confluence of Little Cypress and Black Cypress

Fluvial Geomorphology:

- Estimate sediment budget and develop better characterization of sediment composition along entire creek
- Collect baseline geomorphological data to better assess the responses during and following flow

Aquatic Ecology:

- Determine how much of the floodplain is inundated and how much fish access is available at various flow levels in different reaches of the creek
- Examine paddlefish and bluehead shiner ecology

Terrestrial ecology:

- Examine flood inundation-vegetation relationships

Story by Kathy Wythe

Panhandle AgriPartners

Program helps farmers manage farms, water more efficiently

After 33 years in agribusiness, Dennis Beilue found he wasn't ready to hang up his agricultural hat when he retired in 2000. Three years later he was back in the business as a Texas Cooperative Extension farm demonstration assistant with the Panhandle AgriPartners Program.

AgriPartners is a collaborative program between Extension, the Texas Agricultural Experiment Station, farmers, farm commodity groups, industry, water districts and other entities. The program, with its farm demonstration assistants, provides technical support to Texas A&M researchers and Extension specialists and agents while giving Panhandle farmers up-to-date information on their crops' growth, water use, and pest and disease control to help farmers make good farming decisions.

(Top) Dennis Beilue, a Panhandle AgriPartner farm demonstration assistant, checks on cotton grown by subsurface drip irrigation (left hand) and center point irrigation (right hand). The demonstrations are in a field near Etter in Moore County.

(Center) Dennis Beilue reads the water meter for Doug May's subsurface drip irrigation system. Drip irrigation systems, although more costly to install, are proving to be efficient irrigation systems.

(Bottom) Cotton, which takes less water than other crops, is becoming more popular as a profitable crop in the Texas Panhandle. The AgriPartners Program helps farmers make management decisions such as replacing other crops with cotton.

The AgriPartners demonstrations are tied to the Texas High Plains Evapotranspiration program, which provides daily information on irrigation schedules. Center pivot irrigation systems have become more efficient using the TXHPET.

Beilue, from Dumas, became one of five assistants who work part-time under the supervision of Texas Cooperative Extension agents in five Panhandle offices. The assistants visit participating farms twice a week to monitor the farms' water use, crop development and growth, and pest status. They calculate water use by measuring the moisture in the soil at 1, 2 and 3 feet depths, and use rain gauges to determine rainfall and water meters for irrigation water use.

"At the end of each growing season, we can account for all water use," said O. R. (Reggie) Jones, technical coordinator of the program.

The assistants also help with demonstrations of new or improved farming and irrigation practices, crop genetics and technologies on participating farms.

Doug May of Dumas is one farmer who has new irrigation practices being tested on his farm. In its first year as a demonstration farm, half of May's cotton crop is being irrigated by the traditional pivot sprinkler system while the other half is irrigated by a new subsurface drip irrigation method.

Dr. Bob Robinson, Extension regional agriculture program director and one of the founders of AgriPartners, said Extension and research programs had never had the capability to monitor the crops so closely and integrate applied research so quickly before the start of this program.

"Our agents are so busy," Robinson said. "They couldn't visit the same farm at the same time twice a week for the entire growing season."

Since its inception in 1998, the program members have conducted 498 demonstrations on about 54,835 acres with more than 389 farmers.

In 2005, the Panhandle AgriPartners program conducted 40 cropping and irrigation demonstrations with cotton, wheat, corn, sorghum, silage, soybean and peanuts, involving more than 4,000 acres and 32 farmers in 14 counties.

Likewise, in 2004 the program conducted 44 on-farm crop and irrigation demonstrations involving seven crops, 4,716 acres of cropland and 29 cooperating producers in 17 Panhandle counties.

All demonstrations are tied to the Texas High Plains Evapotranspiration (TXHPET) research program, aimed at providing daily information on the water needs of the crops so farmers can adjust their irrigation schedules for efficient irrigation water use. The TXHPET network is a series of weather stations that measure daily evaporation and rainfall and it predicts the transpiration of a well-watered plant throughout its typical growing season.

Information gathered by the assistants is put in databases for developing and calibrating crop, pest and economic models used in PET and other production agriculture modeling and prediction efforts.

With this increased monitoring and more rapid application of research and technology, Panhandle farmers have seen increases in the efficiency of irrigation, improved yields of their crops and better economics of their production systems.

"Water is precious," Robinson said. "By using our monitoring system and the PET, farmers are able to strategically apply the correct amount of water to maximize yields, but also conserve water."

Farmer and AgriPartner demonstration assistant Dan Krienke agreed. Before he started participating in the program in 1998, Krienke said he was "shooting from the hip" to determine how much to irrigate his wheat crops.

"Now I have a plan," he said. "I've learned that I can water at 70 percent of PET and get 70 bushels of wheat per acre."

The program has also helped Krienke time the watering of his crops.

"I can start and stop watering a little earlier now because I have confidence that the moisture sensors will tell me the amount of water in the soil," Krienke said. "I can definitely say I've saved water. The groundwater district says we can use no more than 24 inches per acre each growing season and I use about 13 inches by better managing my water use."

Leon New, Extension irrigation specialist at the Texas Agricultural Research and Extension Center in Amarillo, said production of crops per inch of irrigation has increased over time through better management of irrigation water and adopting better irrigation techniques.

New, who compiles all data gathered by the AgriPartners program each year, said over the years the numbers have shown that center pivot irrigation is more efficient than furrow irrigation. In 2004, for corn production, center pivot used 7.5 inches per acre less water than row water and produced 349 pounds of corn per acre inch of rainfall, irrigation and soil water compared to 252 pounds using row water.

He said he has documented similar results for cotton with subsurface drip irrigation proving to be another efficient irrigation system.

"For 2004, a cooperating grower produced 148 pounds of cotton per inch of irrigation using subsurface systems and 53 pounds per inch of rain, irrigation and soil water. Another grower using center pivot irrigation produced 115 pounds of cotton per inch of irrigation and 56 pounds per inch of total water," New said, interpreting his research data collected each year. Average cotton production for 71 field tests is 86 pounds from each inch of irrigation and 41 pounds per inch of rainfall, soil water and irrigation measured.

AgriPartners Demonstration Assistant Dan Krienke and Extension agent for agriculture Scott Strawn examine maturing cotton on an irrigated demonstration farm near Perryton in the upper Texas Panhandle.

"The AgriPartner program uses leader growers who show the way. Some growers are doing a better job of managing their irrigation water," New said. "And it must continue due to the price of irrigation, fuel, and declining available water. Growers here are aware they must continue to produce more with less to survive."

Information gathered from demonstration farms is shared with other farmers in the area. New said farmers not participating directly in the program are more likely to accept the irrigation and crop management information collected from their neighbors than from other research results.

Seito Mellano, a Dalhart farmer, said this local information is the best part of the program because it helps farmers make better management decisions that result in greater profitability.

"What works in Corpus Christi doesn't work in Dalhart," Mellano said.

Dumas farmer Keith Watson agreed. "A lot of very important information comes out of that (the water monitoring)," he said.

Watson is working with AgriPartners to determine which varieties of cotton work best in the Panhandle because the area is "new cotton country." AgriPartners provides the computer programs, equipment, technology and knowledge to supply comprehensive research to the farmers, he said.

The PET program is especially important to new cotton farmers, Watson said, because the tendency might be to overwater since cotton takes about one-third less water than other crops like corn.

The AgriPartners information is also valuable for state water planning, New said. When Region A's water planning group wrote the state-mandated water plan, the AgriPartner data provided accurate irrigation demand data, he said. The program has soil water information for each grower demonstration that no other area in the state has collected as well as irrigation and rainfall measurements.

"No other state water planning region has this quality of data to use in their planning process," he said.

Texas Cooperative Extension and the Texas Agricultural Experiment Station have funded the AgriPartners program along with major agricultural industry partners and Texas farm commodity groups. Major commodity groups include the Texas Wheat Producers Board, Texas Corn Producers Board, Texas Grain Sorghum Board, Texas Soybean Board, Texas State Support Committee of Cotton, Inc. and the Texas Peanut Producers Board.

In the big picture, Robinson said, the farm-based projects serve as building blocks to advance The Texas A&M University System's initiatives in water conservation and improved production agriculture.

"AgriPartners is working to build partnerships that strongly support and benefit Panhandle agriculture," Robinson said. "We have just scratched the surface with this unique and productive partnership program, and so much remains to be done."

Beilue is glad he is involved in AgriPartners.

"It allows me to help, in some small way, the local farmers cope with a difficult, changing agriculture environment," Beilue said. "The AgriPartners program has been a win-win for me, the area's farmers and Texas Cooperative Extension."

Story by Kathy Wythe

Computerized Waters

Model changes management of Texas surface waters

In an office on the second floor of a Texas A&M University building, on a desktop computer operating with the popular Microsoft Windows, Dr. Ralph Wurbs has designed a computer modeling system that has changed the way Texas manages its rivers, streams and reservoirs.

The modeling system called Water Rights Availability Package, or WRAP for short, is a set of computer programs developed by Wurbs, a professor of civil engineering, and his graduate students that simulates management of the water resources of river basins. The model helps determine how much and at what level of reliability water will be available for environmental and human needs.

The Texas Commission on Environmental Quality (TCEQ) uses WRAP in its Texas Water Availability Modeling (WAM) system to evaluate and approve surface water right permits in Texas. Any water resources development project or water use action involving the streams and lakes of the state requires either a new permit or modification of an existing permit. The WRAP/WAM modeling system determines whether sufficient water is available for a proposed new or expanded water use and assesses the impacts on all the other water uses in the river basin.

Dr. Ralph Wurbs, professor of civil engineering, examines the Texas river basin maps with Richard Hoffpauir, graduate student. These maps were developed, using the WAM/WRAP modeling system. Hoffpauir traveled to Armenia to help that country work on water modeling and availability.

Dr. Ralph Wurbs of the Department of Civil Engineering has published five technical reports on the WRAP modeling system with the Texas Water Resources Institute.

Currently, the state has about 8,000 active water right permits.

TCEQ requires that permit applicants and their consultants use the WRAP/WAM system in preparing their applications.

"Discussion of pertinent issues is significantly enhanced by both the water right permit applicant and regulatory agency staff using the same modeling system," Wurbs said.

TCEQ and its partner agencies—Texas Water Development Board and Texas Parks and Wildlife Department—and consulting firms developed the WAM system after the Texas Legislature enacted Senate Bill 1 in 1997, following the drought of 1996.

In addition to the generalized WRAP simulation model, the WAM system has specific information (or datasets) for all 23 river basins in the state.

Ten consulting engineering firms, under contract with TCEQ during 1997–2003, developed the individual datasets and simulated a set of alternative water-use scenarios. The Center for Research in Water Resources at the University of Texas provided geographic information system (GIS) support for developing the datasets. During the same time Wurbs and his graduate students, working under a contract between the commission and the Texas Water Resources Institute, expanded WRAP methodologies and software from earlier versions.

The state currently has active permits for about 3,500 reservoirs, thousands of water supply diversions, several hydroelectric plants and numerous environmental instream flow requirements. Each of these active permits is included in the datasets.

Besides the commission using the WAM/WRAP modeling system in water rights permiting, the Texas Water Development Board and its 16 regional planning groups use the modeling system for developing its water plans, which were also mandated by Senate bill 1. TCEQ's approval of water right permit applications requires that proposed actions be consistent with relevant regional plans.

River authorities, water districts and other water management organizations are beginning to use the WRAP model in operational planning studies to optimize operations of their facilities and available water resources, Wurbs said.

"The Texas experience has also generated interest in similar applications of WRAP in other states and countries," he said, including a project in Armenia by one of his graduate students.

Twenty years of refining

The WRAP modeling program and its widespread use did not get where it is overnight. Dr. Ralph Wurbs and his stream of graduate students have tweaked and fine-tuned WRAP for 20 years.

The original WRAP, initially called TAMUWRAP, stemmed from a 1986–1988 research project at Texas A&M University titled, *Optimizing Reservoir Operations in Texas,* sponsored by the federal/state Cooperative Research Program administered by the U.S. Geological Survey and Texas Water Resources Institute. The Brazos River Authority served as the nonfederal sponsor.

Some of the newest changes to WRAP, developed during 2002–2005 and documented in TWRI's Technical Report 284 released in January 2006, include:

- Capabilities for short-term reliability analyses based on current storage conditions (Or what is the likelihood of meeting water needs in the near future knowing storage conditions today?)
- Flood control operations
- Salinity tracking motivated primarily by natural salt pollution problems in several Texas river basins
- Daily or other sub-monthly time steps
- Disaggregation of monthly naturalized flows to daily flows
- Flow forecasting
- Flow routing
- Calibration of routing parameters

Other recent updates to WRAP with significant enhancements can be found in the following publications:

- *Water Rights Analysis Package Modeling System Reference Manual.* TWRI Technical Report 255, Second Edition, April 2005.
- *Water Rights Analysis Package Modeling System Users Manual.* TWRI Technical Report 256, Second Edition, April 2005.
- *Fundamentals of Water Availability Modeling with WRAP.* TWRI Technical Report 283, April 2005. This report serves as an introductory tutorial to help new users apply the model quickly for basic water availability modeling applications.
- *Comparative Evaluation of Generalized Reservoir/River System Models.* TWRI Technical Report 282, April 2005. This report combines a broad coverage of reservoir/river system modeling in general with a focus on the SUPER, RiverWare, MODSIM, HEC-ResSim, and WRAP modeling systems.

These technical reports are available at http://twri.tamu.edu/reports.php.

The software and documentation are also available at http://ceprofs.tamu.edu/rwurbs/wrap.htm. The public domain WRAP software and documentation, along with input datasets for all the river basins of Texas and other WAM information, are available under the heading *Water Availability Modeling* at the TCEQ Web site: http://www.tceq.org.

Development and expansion of WRAP has been sponsored by:

- Texas Commission on Environmental Quality
- U.S. Army Corps of Engineers Fort Worth District.
- Texas Water Resources Institute
- U.S. Department of the Interior
- Texas Advanced Technology Program administered by the Higher Education Coordinating Board

Story by Kathy Wythe

Preparing for the Future

University establishes water management degree program

Texas A&M University launched an interdisciplinary water management degree program during the fall 2005 semester with 12 students seeking either master's or doctorate degrees in water management and hydrologic sciences.

The degree program, the first in Texas, includes 42 faculty members in 12 departments from four different colleges, said Ron Kaiser, program chairman.

"Our program is unique because it is not housed in one department. It's not department-specific, but degree-specific," Kaiser said.

Kaiser, a professor in the Department of Recreation, Park and Tourism Sciences, said the degree program will prepare high-quality graduate students for careers in the critically important areas of water management and hydrology, and will serve as the cornerstone of the university's new water program.

Kaiser said the interdisciplinary character and practical orientation of this degree program reflects the growing complexity of water issues.

"In an increasingly complex world, seeking solutions to water problems requires crossing traditional departmental and disciplinary boundaries," Kaiser said. "This program achieves that goal by bringing together faculty from across the university community to guide students."

Kaiser and John Giardino, dean of graduate studies and a professor in the Department of Geology and Geophysics, worked with a team from the Colleges of Agriculture and Life Sciences, Engineering, and Geosciences to develop the curriculum and program. Using information from a National Science Foundation report that recommended an integrative approach, they developed the multi-college, multi-department water program.

"There will be tremendous job opportunities for A&M graduates of this program," Giardino said.

(Left) Water Management and hydrologic sciences graduate student Alyson McDonald downloads data from a data logger. McDonald is studying groundwater and surface water hydrology at Texas A&M to compliment her background in soils and plant ecology.

(Right) Master's degree candidate Nick Russo works with the Harris County Storm Water Quality program and oversees the construction enforcement and post-construction storm water controls for new developments or significant redevelopments.

"We're preparing students for being water leaders for tomorrow."

One of the master's degree graduate students, Nick Russo, already works in water management for the Harris County Storm Water Quality program. When searching for a graduate program to pursue, Russo said he examined A&M's new program. "I felt that this (program) was my shot at completing a master's degree in this growing field."

Russo agreed with Giardino about the job opportunities for water managers.

"I believe that water quality and quantity needs will be in the forefront in the coming years," Russo said. "Demand is obviously going to be high for those willing to attempt solving our water needs."

Doctoral student Alyson McDonald, who works as an Extension assistant in hydrology for Texas Cooperative Extension in Ft. Stockton, said the degree program was "a perfect fit with my degree plan."

After receiving her doctoral degree, McDonald plans to continue hydrologic research in arid environments in southwestern United States and northern Mexico.

Kaiser said this master's degree will prepare students to manage public water systems and water resources in cities, counties, river authorities and other entities.

The doctoral degree is designed to give students a thorough and comprehensive knowledge of water science and hydrology and training in methods of research.

"Over the past 25 years, population shifts, industrial developments, changes in water law and advances in technology have intensified competition for water resources and place new burdens on planners, policy makers and managers," he said.

In addition to the graduate degrees, the water program consists of integrative water research and outreach programs, Kaiser said.

Objectives of the program are:

- To foster faculty collaboration in developing a state, national and internationally recognized program in water management and hydrology,
- To prepare students for professional and academic careers in the water management and hydrological sciences in Texas and at the national and international levels,
- To create and sustain a teaching and research environment that brings together a variety of professions and disciplines for an exchange of knowledge about the unique attributes of managing water,
- To provide a teaching and research base for an ongoing series of research collaborations, lectures, seminars and workshops that will improve communication and exchange of knowledge between Texas A&M University students, faculty and professionals around Texas and the nation, and
- To assist in protecting homeland security of public water supplies.

The Texas A&M University System Board of Regents approved the degree program in December 2004 with a $2.5 million, five-year budget and the Texas Higher Education Coordinating Board approved the program in March 2005.

For more information, go to **http://waterprogram.tamu.edu** or contact Dr. Val Silvy, **vsilvy@tamu.edu**.

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Story by Kathy Wythe

Putting Dollars to Work

319(h) projects help control nonpoint source pollution in Texas

Protection of our water resources is one of the most significant environmental challenges of the new millennium. Nonpoint source (NPS) pollution (pollution from rain or snowmelt runoff containing natural and man-made pollutants) from urban and agricultural activities represents a major pollution source.

Congress enacted Section 319(h) of the Clean Water Act in 1987, establishing a national program to control nonpoint sources of water pollution. Through Section 319(h), the Environmental Protection Agency provides federal funds to states for the development and implementation of the state's Nonpoint Source Management Program. The 319(h) funding in Texas is divided between the Texas Commission on Environmental Quality (TCEQ) and Texas State Soil and Water Conservation Board (TSSWCB).

Kevin Wagner, project manager for Texas Water Resources Institute's 319(h) projects, said the long-term goal of the state's NPS pollution program is to protect and restore water quality from NPS pollution through assessment of pollution sources, implementation of improved management practices and education.

(Above) The Pecos River in West Texas is the focus of one of TWRI's nonpoint source pollution projects.

TWRI, in collaboration with TCEQ, TSSWCB and other groups and agencies, manages several projects designed to reduce pollution in priority areas.

Current TWRI-led 319(h) projects

Evaluation of Best Management Practices in the Arroyo Colorado Watershed
This project helps restore the Arroyo Colorado, the most important stream draining the delta formed by the Rio Grande in South Texas. The program will educate farmers on how to produce crops while managing their land to reduce the potential for NPS pollution. The project also supports and promotes associated programs that implement best management practices (BMPs) related to water quality protection.

Seymour Aquifer Water Quality Improvement Project
This project provides water quality education to increase farmers' awareness and use of irrigation and nutrient BMPs to help reduce the nitrate levels in the aquifer. This project also estimates the reductions

in nitrate concentrations resulting from ongoing BMP efforts and provides an analysis of additional measures needed to achieve water quality standards in the aquifer.

The Impact of Proper Organic Fertilizer Management in Production of Agriculture
The Leon River Basin is adjacent to the Bosque River Basin, where excess nutrients have impaired water quality. Because the Leon River Basin contains similar nutrient sources, stakeholders in the Leon River watershed are paying careful attention to emerging water quality issues. Agriculture has the potential to contribute to the problems of excessive nutrients and bacteria in surface water, especially if recommended management practices are not used. This project assesses the effectiveness of BMPs then educates farmers to facilitate BMP implementation.

Buck Creek Watershed Water Quality Sampling/Assessment Project
This project monitors 12 different sites on Buck Creek to determine the extent to which bacteria are present. If these data demonstrate the need for an assessment of total maximum daily loads, experts in bacterial source tracking will help plan and implement appropriate follow-up.

Dairy Compost Utilization
This project addresses the elevated concentrations of ammonia, nitrogen, phosphorus and fecal bacteria found in parts of the North Bosque River, Upper North Bosque River and Leon River. Texas A&M agricultural scientists are working with composters and the dairy industry in Central Texas to expand the marketing of dairy compost in this area. TCEQ is providing incentive payments to state agencies, local governments and other public entities to expand purchases of their dairy compost. The project is also providing research data and education demonstrations on dairy compost usage, emphasizing cost-effectiveness, product safety and environmental sustainability.

Improving Water Quality by Developing, Implementing and Field Testing Innovative Methods
In this project researchers identify, evaluate, and field-test new technologies for reducing high levels of phosphorus in runoff from dairies. Once these assessments are completed, project members will communicate the results to dairy managers and other stakeholders, who can implement the proven technologies to reduce water pollution by dairy wastes.

Watershed Protection Plan Development for the Pecos River
Flows of the Pecos River have dwindled due to man-induced causes. This project evaluates the physical features of the Pecos River Basin, educates rural and urban stakeholders on water quality and quantity issues and develops a watershed protection plan for part of the river basin.

Texas Phosphorus Index
The Texas Phosphorus Index relies on a number of factors including soil testing, fertilizer application rates, and whether phosphorus is applied near streams to provide a basic assessment of the sources of phosphorus in water bodies. The index also helps predict phosphorus and nutrient runoff. The Texas Phosphorus Index 319(h) projects evaluate the ability of the index to estimate phosphorus losses in different field conditions. Researchers then develop recommendations to improve the index.

Other TAMU water-related 319(h) projects

Texas Watershed Steward Program
This pilot project will develop a community-based water quality curriculum to increase local stakeholder involvement in watershed protection programs. The curriculum will increase local understanding of the forces that can adversely impact water resources and the tools to prevent them, including effective watershed plans.

Texas Stewards of Ag-land Resources: T-STAR
This project develops and tests the education component of the T-STAR program in a pilot watershed. The T-STAR program provides agricultural producers and related industry with a combination of production and environmental training to better manage and protect their land and water resources.

Story by Kathy Wythe

Got Manure?

Technologies reducing phosphorus in dairy wastes

By the end of 2007, dairy farmers in Central Texas may have several new technologies to help them reduce phosphorus in dairy manure wastewater. Too much phosphorus runoff from the over 165 dairies in the area contributes to poor water quality in the North Bosque River, Leon River and Lake Waco.

Dr. Saqib Mukhtar, a Texas Cooperative Extension specialist in animal waste management, and his team are providing third-party evaluation of the six technologies. Although results are very preliminary, Mukhtar said some of the results are encouraging.

Currently, many dairy farmers flush the manure and its wastewater into lagoons or man-made ponds where it is stored. This wastewater, called effluent, is used for irrigating pastures or crops not consumed by humans and supplies essential plant nutrients including phosphorus to the soils. If the wastewater contains more phosphorus than the crops can use, however, excess phosphorus may eventually end up in the areas' streams and rivers. Too much phosphorus in water can cause algal growth and toxicity in surface waters, killing fish. The EPA has mandated that phosphorus levels in the North Bosque and Leon River watersheds be reduced by 50 percent.

Mukhtar and his Extension team are currently working with two companies—Envirotech, Inc. and Envirolink—to evaluate and demonstrate their technologies. The Envirotech technology uses Bauxsol, a soil-like material, in a filtration system to pull out the phosphorus. Envirolink is using bacteria to reduce phosphorus in the wastewater.

(Top) In the first stage of the electrocoagulation process, dairy effluent enters the mixing tank and lime, coagulants and an emulsion polymer are added and agitated.

(Center) After going through the electrocoagulation process, the effluent passes through the dissolved air flotation clarifier, sludge is removed, and treated water is discharged.

(Bottom) Dairy farmers and other stakeholders observe the Geotube demonstration at the Triple X Dairy in the Leon River watershed.

The first year's technologies—electrocoagulation, developed by Ecoloclean Industries, and geotextile solids separation systems (Geotube™), developed by Miratech Division both appear to reduce phosphorus levels in the processed water, Mukhtar said.

With electrocoagulation technology, dairy wastewater is processed, separating the solids from the liquid. Aluminum and/or iron electrodes are placed in the wastewater stream to attract and coagulate the negatively charged ions of phosphorus. The system then removes the coagulated phosphorus-containing particles, leaving treated water ready to irrigate forage and pasture land.

The Geotextile solids separation system uses large, porous tubes (up to 45 feet in circumference and up to 400 feet long) made from a heavy-duty fabric. The lagoon effluent is pumped into these "large socks" after adding alum or other chemicals to bind and precipitate the phosphorus. As the liquid leaves the porous tubes, solids larger than the pore size of the tube are trapped. Once the tubes are full, the solid waste is hauled off and used as compost or fertilizer in fields with low soil phosphorus and the liquid out of the tube with reduced amount of phosphorus is routed back to the lagoon or to a waste application field.

Dairy producers are positive about learning about the technologies.

"Nearly 100 dairy producers attended a Geotube technology demonstration in the spring and producers were very interested in learning more about the performance and economics of this technology," Mukhtar said.

Mukhtar said each technology company selected for the project will prepare reports, including costs, of its technology. Extension and Texas Water Resources Institute staffers will develop fact sheets on each technology for producers, regulators and agricultural businesspeople so they can make their own decisions about the performance and cost effectiveness of each technology.

Mukhtar sees the technology advisory committee established to review and select technologies for this project as perhaps serving as a clearinghouse for technology providers and producers on future technologies developed.

"The committee could continue to look at new technologies and select the most suitable technologies that have the potential to decrease phosphorus from dairy effluent," he said.

John Cowan, executive director of the Texas Association of Dairymen, agreed.

"Dairymen need good science-based evaluations for any technology they use," Cowan said. A clearinghouse for different technologies, Cowan said, would provide "the farmer some sense and confidence the technology is beneficial and doable."

Before the project, Ned Meister of the Texas Farm Bureau said the bureau was constantly being contacted by vendors who said they had products or processes to help with the dairy wastewater,

"We did not have the capability to validate any of their claims and therefore could not and would not refer the vendors to anyone in the dairy business," Meister said. "Now, when we are contacted by the vendors, we refer them to the program, thus providing them the opportunity to demonstrate their product or process."

The U.S. Environmental Protection Agency, Texas State Soil and Water Conservation Board, Texas Commission on Environmental Quality, Brazos River Authority, Texas Farm Bureau and USDA's National Resources Conservation Service are represented on the technical advisory committee in addition to TWRI, Extension and Texas Agricultural Experiment Station scientists.

Story by Danielle Supercinski

West Texas Rain

Rainwater harvesting demonstration sites save water and money

Rainwater, one of the purest sources of water available, is scarce in West Texas. Residents in this arid land must use all available methods of saving water. Rainwater harvesting, a common water resource used in the early 1900s, is becoming one such option.

The Texas Water Resources Institute (TWRI) and Texas Cooperative Extension, working with several partners, are planning and constructing rainwater harvesting demonstrations in West Texas to educate the public about its potential as an alternative and inexpensive source of high-quality water.

Most rainwater harvesting systems in the past were for personal use, but some businesses, industries and public institutions are beginning to use these practices as well.

The Culberson County Courthouse in Van Horn, the Ward County 4-H Center in Monahans, and the Hudspeth County Extension Office in Sierra Blanca have or will soon have rainwater harvesting demonstrations, some of the first in this area.

These West Texas demonstrations help promote the systems in the area, said Mike Mecke, Extension water program specialist with TWRI in Far West Texas.

"Rainwater harvesting is of special interest in the drier half of Texas and is being promoted through the *Water for West Texans* program, headquartered at the Fort Stockton Extension Center," Mecke said.

In Culberson County, Extension partnered with the Rio Grande Basin Initiative through TWRI, the International Boundary and Water Commission, Culberson County Underground Water District and county officials to install a 2,500-gallon rainwater harvesting tank at the Culberson County Courthouse.

(Above Left) One of the three rainwater harvesting demonstrations is located at the Culberson County Courthouse in Van Horn. This 2,500-gallon tank has been installed to catch and store the rainwater.

(Above Right) Landscape irrigation using the harvested rainwater can help maintain nice looking landscape plants, as well as conserve water.

A 2,000-gallon tank and 3,000-gallon tank at the Ward County 4-H Center is planned. The Hudspeth County Extension Office is planning a 1,000-gallon tank for inside drinking water and a 3,000-gallon tank for outside landscape irrigation.

Although harvesting rainwater for drinking water complicates installation and raises the cost of treatment, Mecke said the Extension agent for Hudspeth County, Cathy Klein, wants the demonstration to show its viability to residents who currently must haul water or buy bottled water.

Mecke said more demonstrations are tentatively planned for the West Texas region including the Alpine Library, McDonald Observatory in Fort Davis, several locations in Fort Stockton, Sanderson, San Angelo, Alpine, Ozona, Midland and El Paso.

The largest planned project is for Baptist Memorials Center, a nursing home in San Angelo. A team is developing a long range plan to install a rainwater harvesting system, drip irrigation system, in-home water conservation and low water-use landscapes at that site.

Mecke said the nursing home rainwater harvesting project will be a three- to five-year project, working with staff from Baptist Memorials, the City of San Angelo, Extension, and Texas A&M University System scientists and engineers from College Station and San Angelo. Billy Kniffen, Extension agent for agriculture in Menard County, and John Begnaud, an Extension agent for Tom Green County, are also working on the project with Mecke.

Begnaud is guiding the planning and installation of water-efficient drip irrigation and landscape plantings. Janie Harris, Extension housing and environment specialist, is working with Kathlene Aycock, Extension agent for family and consumer sciences in Tom Green County, to set up an in-home water conservation demonstration to complement the other efforts and to monitor effectiveness.

Other rainwater harvesting demonstrations throughout other parts of Texas include the Lady Bird Johnson Wildflower Center in Austin, Wells Branch Municipal Utility District in North Austin, Advanced Micro Devices fabrication plant in Austin, and Reynolds Metals in Ingleside.

More information on designing and constructing rainwater harvesting systems is available. A new *Rainwater Harvesting* Extension publication by Russell Persyn, Dana Porter and Valeen Silvy can be found at http://tcebookstore.org/pubinfo.cfm?pubid=1979.

The Texas Water Development Board has recently produced the *Texas Guide to Rainwater Harvesting Third Edition*. This publication can be downloaded free of charge from either the TWDB Web site, www.twdb.state.tx.us, or from the American Rainwater Catchment Systems Association Web site, www.arcsa-usa.org.

Extension agent for agriculture Billy Kniffen has constructed a rainwater harvesting system for his own home. These catchment tanks are used to hold up to 16,500 gallons of rainwater, providing enough water for his indoor and outdoor uses all year.

Story by Kathy Wythe

Investing in the Future

TWRI awards Mills Scholarships to graduate students

The Texas Water Resources Institute recently awarded Mills Scholarships to 11 Texas A&M University graduate students and four Texas A&M University–Galveston graduate students for the 2005-06 academic year to pursue water-related research.

TWRI's Mills Scholars Program, an endowed fund that supports research in water conservation and management, provided the $1,500 scholarships to each student to use for education-related expenses. The scholarship program supports graduate students in diverse water research programs at Texas A&M University and Texas A&M University-Galveston.

Students receiving the scholarships include: Omar Amawi, Scott Beech, Larry R. Demich and Aarin Teague, Department of Biological and Agricultural Engineering; Elizabeth Bristow, Department of Civil Engineering; Regan M. Errera and Danielle M. Rutka, Department of Wildlife and Fisheries Sciences; David Hansen, Stephen Lichlyter and Douglas S. Sassen, Department of Geology and Geophysics; and Shelli L. Meyer, Department of Oceanography.

Graduates students from Texas A&M–Galveston are Charlotte Hieke, Joe Mikulas, Kimberly A. Roberts, all of the Department of Marine Geology; and Linda R. Roehrborn, Phytoplankton Dynamics Laboratory.

Mills Cox, a former chairman of the Texas Water Development Board, endowed the Mills Scholarships. For more information on the Mills Scholarship program or to learn more about the projects, visit our Web site at http://twri.tamu.edu/mills.php.

Story by Kathy Wythe

(Above Left) Lake Granbury and the communities around it have flourished since the lake was completed in 1969. The population on or near Lake Granbury is increasing 16 percent every year.

(Above Right) Lake Granbury serves as the critical water supply in North Central Texas, providing water for more than 250,000 people in more than 15 cities.

What's the Plan?

Groups tackling water quality problems on Lake Granbury

The lake glistens, fish jump, and people swim. But not if the water quality of Lake Granbury—a popular tourist attraction and critical water supply to some 250,000 people in 15 cities—continues to decline.

In recent years, toxic blooms of golden algae have caused fish kills, and *Escherichia coli* bacteria have invaded some of the lake's coves, limiting their recreational use.

After meeting with the area's stakeholders, State Sen. Kip Averitt and U.S. Rep. Chet Edwards both solicited federal funds to help correct the problems. Now federal, state and local entities are working together on two projects to ensure the lake retains its water quality and its recreational appeal.

For one project Sen. Averitt obtained $1.4 million from the U.S. Environmental Protection Agency for Brazos River Authority (BRA) and Texas Commission on Environmental Quality(TCEQ) to develop the watershed protection plan, focusing on the *E. coli* found in the lake.

Monitoring studies conducted by the BRA have shown that some of Lake Granbury's coves—shallow bodies of water with little interaction with the main lake—are contaminated with *E. coli.*

"A possible source (of the *E. coli* contamination) is the large population of septic systems," said Tiffany Morgan with the BRA. Unincorporated subdivisions that rely on septic systems make up a large part of the developed area around the lake. Some contamination, Morgan said, may also be coming from wildlife in the area. Research is needed to positively determine the source, she said.

Morgan, manager for BRA's project, said the first step is identifying the sources of the *E. coli* contamination and then identifying solutions to the problem.

BRA's project will estimate the decrease in bacteria concentrations expected through identified best management strategies and will develop criteria that can be used to determine if progress is being made.

Morgan said the river authority will seek public input through stakeholder participation meetings to help develop the watershed protection plan. Stakeholder participation is key to the success of the implementation of the plan, she said.

Edwards obtained $500,000 in the 2006 federal budget for a consortium to develop water quality education for local stakeholders and conduct research on control of golden algae. The Texas Water Resources Institute is teaming with Texas Agricultural Experiment Station, Texas Cooperative Extension, BRA, TCEQ and local stakeholders to work on this project.

Extension, led by Dr. Bruce Lesikar, Extension specialist in the Department of Biological and Agricultural Engineering, will conduct water quality education programs for adults and schoolchildren to help minimize the impacts on water quality of bacteria, golden algae, nutrients, pesticides and stormwater.

The golden algae study is led by Dr. Daniel Roelke from Texas A&M University, and team members include scientists from Baylor University, University of Texas-Arlington and U.S. Geological Survey. The research will determine how golden algae blooms are affected by inorganic nutrients, dissolved organic matter and microbes, including *E. coli*. Scientists will use high-resolution spatial mapping and water sampling to identify sources of inorganic nutrients and dissolved organic matter, and to predict the impacts of best management practices on golden algae blooms.

Both Edwards and Averitt are pleased these two projects will help solve the lake's problems.

“Lake Granbury is a tremendous asset for the city of Granbury and for all of Hood County, and I believe protecting the quality of water in the lake is an important investment in the future of the area,” said Rep. Edwards. “I am gratified that we now have significant funding for the Texas Water Resources Institute and other state agencies to work with local officials in planning how to best protect Lake Granbury for years to come.”

Sen. Averitt agreed. “Lake Granbury is crucial to Hood County and its citizens,” said Averitt. “Our area relies on the lake for its drinking water, industry and recreation. I look forward to working with stakeholders to protect and improve the quality of this valuable resource.”

(Below Left) In recent years, *Escherichia coli* bacteria have been found in the coves and canals of the lake. Faulty septic systems, found in unincorporated subdivisions around the lake, are a potential source of the *E. coli*.

(Below Right) Lake Granbury and the town of Granbury with its historic buildings including the town's courthouse have grown into a popular tour destination.

New Faculty Expand Water Resources Expertise

Agricultural Economics and Recreation, Park and Tourism Sciences


Shaw

W. Douglass Shaw, professor, joined the Departments of Agricultural Economics and Recreation, Park and Tourism Sciences in 2004.

Dr. Shaw received his doctorate in economics from the University of Colorado in December 1985.

His expertise is the area of valuation of water quality and quantity changes, with an emphasis on health risks and uncertainty, value of health risk reductions associated with arsenic in drinking water and value of increased water supply at recreation areas.

Specific research includes arsenic in drinking water. A competitive grant from the U. S. Environmental Protection Agency will assess perceived risks that households have relating to arsenic exposure. The focus is on children's health risks.

Another research project involves the economics of perceived risks, which is an investigation into economic risk models that incorporate the idea that individuals often have difficulty expressing and processing information relating to risks and uncertainty.

Two of his recent papers involving research on arsenic in drinking water are published in the *Journal of Water and Health* (September 2005), and *Risk Analysis* (December 2005).

Biological and Agricultural Engineering

Dr. R. Karthikeyan joined the Department of Biological and Agricultural Engineering in 2005 as an assistant professor.


Karthikeyan

Dr. Karthikeyan received his bachelor's degree in agricultural engineering from Tamil Nadu Agricultural University in 1993 and his master's degree in 1997 from the University of Georgia. His doctoral degree in engineering is from Kansas State University in 2001.

His research involves application of spatial science tools (GIS and remote sensing) in agriculture, biological and homeland security, disease (human and animal) tracking and control, disaster management and response, natural resources management and water quality. He is also involved in research in the fate, transport, and removal of contaminant's in terrestrial and aquatic environments.

Rangeland Ecology and Management


Moore

Dr. Georgianne Moore, an assistant professor with expertise in ecohydrology and woody vegetation management, joined the Department of Rangeland Ecology and Management in February 2005.

She received her bachelor's degree in applied biology from Georgia Institute of Technology in 1995 with emphases in ecology and environmental science; and her doctorate in interdisciplinary environmental sciences in 2003 with an emphasis in small watershed hydrology and forest ecology.

Her particular interest is the role of vegetation in the water cycle and how vegetation management/change affects water resources. Dr. Moore is conducting research in Texas and New Mexico comparing water use by native and invasive woody species in riparian

ecosystems under different management regimes. She is also investigating the effects of brush clearing on spring flow and surface runoff from small watersheds and initial and long-term effects of root plowing mesquite on groundwater dynamics and aquifer recharge.

Wildlife and Fisheries Sciences


Peterson

Dr. Tarla Rai Peterson joined the Department of Wildlife and Fisheries Sciences as the Boone and Crockett Wildlife and Conservation Policy Chair at Texas A&M University in January 2006.

The chair was established with a $500,000 gift from the Boone and Crockett Club and a matching $500,000 from the Texas A&M Development Foundation. The purpose of the chair is to help to close the gap between the knowledge of wildlife science and the implementation of wildlife policy, according to Dr. Robert Brown, department head for the Department of Wildlife and Fisheries Sciences.

Dr. Peterson was chosen for the Texas A&M position because of her academic background; her successes in teaching, grantsmanship, publication and graduate student mentorship; and her enthusiasm and dedication to sustainable conservation and sound wildlife policy on private lands, Brown said.

Peterson received a bachelor's degree in history from the University of Idaho in 1976. She earned a master's degree in speech communication in 1980 and a doctorate through the interdisciplinary program in environmental conflict in 1986, both from Washington State University.

TWRI Welcomes New Faces

Kevin Wagner joined the Texas Water Resources Institute in July 2005 as a project manager in charge of directing 319(h) projects funded by the Environmental Protection Agency through the Texas State Soil and Water Conservation Board and Texas Commission on Environmental Quality. He oversees the development of project research and educational programs and is responsible for project reporting.

Kathy Wythe began at Texas Water Resources Institute in July 2005 as the communications coordinator. Wythe will provide leadership for TWRI communications, including newsletters, brochures, presentations, media relations and special projects.

As a business coordinator, Sarah Erwin handles all payroll and human resources processing at Texas Water Resources Institute. She maintains accounts for travel and purchasing and assists with handling other TWRI accounts.

Erwin joined TWRI in December of 2005 and was previously employed as a benefits assistant by the TAMU System Human Resources office.

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Panhandle AgriPartners

The Panhandle AgriPartners program uses farm demonstration agents to provide up-to-date information on water use, crop development and growth, and pest status to participating farmers. Since AgriPartners' inception in 1998, the program has conducted around 500 demonstrations of improved farming and irrigation practices, helping farmers increase their irrigation efficiency and improve crop yields (see story on page 5).