New Waves
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TAMU Acquires Rights to Use Brazos River Waters; Will Serve as "Insurance" to Protect Future Needs

When most of us need an insurance, we contact an agent and take out a policy to protect our home, car, or family. When Texas A&M University (TAMU) recently sought "insurance" to ensure that the campus would continue to have adequate water supplies, it sought out the Brazos River Authority (BRA). In this case, the insurance consists of an agreement that provides TAMU with surface water for the first time.

"There's nothing wrong with the groundwater supplies we have now," says Tom Hagge, the Assistant Director of Utilities for the TAMU Physical Plant, "but we wanted an additional source of water that we could always tap into in case we ever run into water quality or water quantity difficulties in the future." Hagge notes that water demands from various units at TAMU typically average about 5 to 6 million gallons per day (mgd) in winter months, when there is little irrigation, to more than 10 mgd in the summer, when landscapes are watered frequently.

Texas A&M has acquired the rights to take water from Lake Limestone (above) in the future.

Under the agreement, which was finalized in late July, TAMU agreed to purchase the right to use as much as 6,945 acre-feet (AF) of water annually from BRA (or about 6.2 million gallons per day) over the next 50 years. TAMU will pay BRA $139,000 per year for the rights to use that water, which translates to roughly $20 per AF. TAMU will pay this fee whether or not the university actually uses the water.

The source of the water is Lake Limestone. If circumstances require the university to use surface water in the future, TAMU would likely take the water from the Navasota River a

few miles east of College Station. Before the surface water can be used on campus, a distribution system and treatment plant will have to be built.

If it ever becomes necessary to use surface water, one option could be to blend it with groundwater from local aquifers. One impact may likely be that the moderately high levels of total dissolved solids (TDS) now found in groundwater supplies (about 600 parts per million) could potentially be reduced when surface waters are introduced. For reference purposes, the Texas standard for TDS in drinking water is 1,000 milligrams per liter.

Another small change that various TAMU water users may feel is a slightly higher price. For example, many TAMU consumers of potable water actually pay the Physical Plant for metered water use. TAMU now charges these users $0.84 per 1,000 gallons. Hagge says the introduction of surface water may raise the cost by $0.03 per 1,000 gallons. However, the prices charged by TAMU would still be significantly less than the cost levied by other commercial water providers in the region.

TAMU is always working on ways to plan for the future needs of the ever-growing campus community, Hagge says. In fact, university leaders are now working with a consulting firm and area professionals to develop a regional water strategy that will benefit many users in the Brazos Valley.

"We can't reach the point where we don't have enough water," Hagge says. "Instead, we have to do proactive things that make sense over the long-term. This is one of those positive efforts."

Program Taking Shape for 25th TWRI "Water for Texas" Conference

The program for TWRI's 25th Water for Texas Conference is now taking shape and is will be interest to water managers, policy makers, and the public. The Conference will meet December 1-2 in Austin.

The theme of the Conference is "Water Planning Strategies for Senate Bill 1." Some of the topics that will be covered at the Conference tentatively include agency perspectives on water availability modeling, water supply options, water policy, agricultural irrigation, water supply dependability, drought planning, and water marketing. Some of the other featured subject areas that will be discussed include brush management, urban water conservation, public education, conservation pricing, groundwater resources and management policies, and environmental requirements.

At this time, TWRI is developing a list of speakers. Much of the work in creating the program has been undertaken by Wayne Jordan, Jan Gerston, and Debi Fisher of TWRI, and Bruce Lesikar of the Texas Agricultural Extension Service.

The draft program includes members of the Texas Legislature as well as key personnel from state agencies and other recognized Statewide water leaders.

Co-sponsors of the meeting include the Texas Agricultural Extension Service, and the Texas Water Conservation Association.

Do Dam Impacts in Texas-Mexico Border Region Violate Human Rights to a Healthy Environment?

Researcher: Raul M. Sanchez, Associate Professor and Director of Inter-Legal Studies Program, St. Mary's University School of Law, San Antonio, TX.

Problem: All levels of U.S. and Mexican governments consistently turn a blind eye to environmental degradation in the U.S.-Mexico border region, including contamination which crosses the border from the neighboring country. Transboundary contamination also violates international environmental law; however, border residents in the U.S. and Mexico have no effective legal recourse because their respective governments will not pursue international legal remedies against the neighboring government for the sake of trade and industrial development. The case-study of Mexico's El Cuchillo Dam project is an example of these problems.

Objectives: To advocate for a "right to a healthy environment" as an enforceable legal right in domestic and international legal tribunals, and to present the case-study of Mexico's El Cuchillo Dam Project as an example of why such an enforceable right is needed.

Background Information About International Law, Human Rights and the Environment: International Law concerns the regulation of relations among nation-states. International Environmental Law, even when egregiously violated -- as in the U.S.-Mexico border region and the case of the El Cuchillo Dam Project -- does not imply the violation of individual rights. Human beings do not possess the basic right to a court trial under international law, except for their individual human rights. International human rights law prescribes the fundamental rights possessed by individuals through the nation-state. When human rights are violated, victims or their survivors may file complaints against the violating government in diverse domestic and international courts. A "right to a healthy environment" is not universally recognized as a human right; however, strong legal arguments exist which support the existence of such a right as an independent human right and/or as a prerequisite for exercising other universally-recognized human rights, such as the "right to life." If a right to a healthy environment could be asserted and enforced in domestic and/or international courts by residents of the U.S.-Mexico border region, government complicity in fouling the environment would no longer preclude individuals from seeking legal remedies under international law.

Case Study of the El Cuchillo Dam Project: The Mexican government built The El Cuchillo Dam on the San Juan River, the second-largest tributary of the Rio Grande River, during the regime of President Carlos Salinas de Gortari to benefit the population and industry of the city of Monterrey in the state of Nuevo Leon. The El Cuchillo Dam is located approximately 48 miles south of the Rio Grande River. The author describes widespread environmental and social downstream impacts in the state of Nuevo Leon and

Texas which were not considered when decisions were made to construct the El Cuchillo Dam -- either by the Mexican government or the Inter-American Development Bank, which partially funded the project. Mexican victims of the El Cuchillo Dam Project have been unable to obtain legal remedies in Mexican legal tribunals, and international remedies are unavailable to Mexican and U.S. victims, notwithstanding violations of International Environmental Law. U.S. authorities have ignored impacts of the El Cuchillo Dam Project because they conveniently prefer to view the entire matter as wholly "Mexican."

Analysis: The author asserts that numerous human rights have been trampled by the El Cuchillo Dam Project, including a right to a healthy environment, and rights to life, health, justice, proper working conditions, and political participation. If a right to a healthy environment does not exist, the author urges that resources be marshaled to recognize and enforce such a right. If a right to a healthy environment does exist, existing legal instruments and forums should be used to enforce such a right.

Reference: Sanchez, Raul M., "Building Dams and Damning People in the Texas-Mexico Border Region: the El Cuchillo Dam Project," presented at the Southwest Environmental History Symposium, Trinity University, San Antonio, TX, May 1998.

Note: Sanchez can be contacted at sanchezr@law.stmarytx.edu.

Assessing Pollution Risks from Agricultural Operations

Researchers: Andrew Johnson, Agricultural Economics Department; and Donald Vietor and Amy Thurow, Soil and Crop Sciences Department, Texas A&M University, College Station, TX.

Problem: Throughout this Century, many experts believe that public support for agriculture has eroded significantly, based on public opinion surveys and portrayals in the news media. Many people regard agriculture as part of the environmental problem, rather than part of the solution. There is a challenge to accurately present information about the potential impact of agricultural practices on the environment, while, at the same time, establishing clear and accurate communications with stakeholders. If this can be done, it may alleviate situations in which agriculture is inaccurately portrayed as contaminating or harming the environment.

Objective: To demonstrate how framing a key issue relating to the impact of agriculture on the environment as a risk problem may improve communications between agricultural interests, regulators, the media, and the public, with a special emphasis on management of manure from Central Texas dairies.

Methods: A case study was conducted based on two confined dairies in Central Texas as well as one forage-based dairy in East Texas. Event and fault "trees," which are diagrams that clearly demonstrate a series of related actions, were developed which describe waste management systems as well as the associated probability of system failure. The event

trees link an initiating event (for example, wastewater production from a milking parlor) to subsequent processes that may work, alone or in combination, to create a system failure. For each initiating event, the probability of failure was computed, based on the frequency that a pollution event could be expected to occur as well as the magnitude of pollution that may be likely. Many scenarios and comparisons were developed. Event trees were developed and shown to dairy operators for their reaction and comment. The researchers explored the economics of two management strategies that could reduce pollution risks -- recycling wastewater and thus reducing the amount of effluents that need to be irrigated, and expanding the amount of land used for irrigation.

Results and Discussion: Use of probabilistic risk assessment resulted in a number of benefits. First, comparisons of risk reduction and cost ratios gave agricultural producers information that helped them in decision making. The analysis also showed that expanding irrigation resulted in a greater risk reduction than the development of a wastewater recycling system. Because risk reduction was incorporated into the analysis, the results were different than they would have been if only economic criteria were used. In addition, the event and fault trees developed for the risk assessment were helpful to agricultural producers and other parties because they helped make complicated scientific processes more easily understood. The authors suggest that risk assessments provide a new and useful way to frame complex environmental issues, that integrating cost-effectiveness with risk assessment is critically important in shaping management decisions, and that incorporating the use of event and fault trees as part of the risk assessment procedure greatly improves communication and, perhaps, public opinion.

Reference: Johnson, Andrew, Amy Thurow, and Donald Vietor, "Dairy Manure Management: An Application of Probable Risk Assessment," *Journal of Environmental Quality*, Vol. 27, pp. 481-87, 1998.

Note: Vietor can be contacted at dvietor@tamu.edu.

Conjunctive Use of Ground and Surface Water in the Edwards Aquifer Region

Researchers: Todd Votteler, Geography and Planning Department, Southwest Texas State University, San Marcos, TX.

Problem: Current Texas surface and groundwater law ignores the hydrologic links between surface and ground water. In Texas, water has different legal status depending upon whether it is surface water (a lake, a river, or a pond) or groundwater (in an aquifer). In order to successfully deal with the projected future water demands on the Edwards Aquifer for continued municipal and agricultural growth, it may make sense to collectively manage the Edwards Aquifer, reservoirs, and rivers throughout the region.

Objective: To examine the need for the conjunctive management and use of surface and ground water in the Edwards Aquifer.

Background Information: The Edwards Aquifer is a complex groundwater formation in South Central Texas which provides all the water used in San Antonio and most of the water for surrounding counties (1.75 million people). Since water from the Edwards is known for its high quality and quantity, water pumped from the aquifer is used for municipal, industrial, and agricultural purposes. San Antonio is the only major city in the U.S. whose water supplies totally depend on a single aquifer. Until recently, San Antonio's water rates were among the least expensive of any Texas city. The aquifer provides the water that emanates from Comal and San Marcos springs, which in turn feeds the Guadalupe River. Therefore, water levels in the aquifer directly affect flows to the Guadalupe River, and pumping from the aquifer can affect surface water availability in the Guadalupe River Basin. Complicating matters, the springs are the home to one threatened and seven endangered species. Therefore, unregulated groundwater use has the potential to disrupt the habitats these species need and puts them at risk. Data from the U.S. Geological Survey suggest that flows at Comal Springs had not fallen below 200 cubic feet per second (cfs) from 1927 to 1951. Since the end of the drought of the 1950s, however, flows at Comal Springs have been less than 200 cfs roughly one out of every three years. Because of increased groundwater demands and pumpage from the aquifer, it is likely that the risk of less than adequate springflows will continue to increase. Finally, Votteler comments on a new Texas law, Senate Bill (SB) 1477, which was passed by the Texas Legislature in 1993. The goal of SB 1477 is to limit groundwater pumping to 450,000 acre-feet (AF) per year by 2007. However, potential pumpers have filed requests to withdraw as much as 852,000 AF annually.

Analysis: Conjunctive management of water resources in the Edwards Aquifer region may be the best way to provide water for the region in the light of increased water demands due to population growth. A free market which allows permit holders to lease or sell excess water saved by the adoption of efficient agricultural irrigation may be an effective method to make up for anticipated water shortages faced by cities and industries. Unfortunately, Votteler says, SB 1477 does not take advantage of the hydrologic characteristics of the aquifer. A crucial weakness, he notes, is that the amount of water that can be pumped is not allowed to increase, even in years when rainfall is plentiful. As an alternative, Votteler suggests that the law could perhaps be modified to allow for additional storage of water in years when there is excess water.

Reference: Votteler, Todd, "The Conjunctive Use of Ground and Surface Water in the Edwards Aquifer Region." This paper will be presented at the Applied Geography Conference in Louisville, KY, later this year.

Note: Votteler is a Ph.D. student at Southwest Texas State University. He is the Court-appointed Master who provides relevant information about the hydrology, management, and regulation of the Edwards Aquifer, in response to current lawsuits regarding the Endangered Species Act. Votteler can be contacted at TV20935@swt.edu.

Agricultural Conservation Policies and Streambank Erosion

Researchers: Ramesh Chintala and Dudley Burton, Center for Environmental Studies; and Peter Allen, Geology Department, Baylor University, Waco, TX.

Problem: It has been reported that agriculture is the human activity that has the most profound influence on erosion and sedimentation. Erosion and sedimentation are major concerns for water managers because they represent a major source of pollution, lessen the quality of aquatic life, make waters more turbid, and clog rivers, lakes, and drainage channels. Although many past efforts focused on understanding and controlling erosion from agricultural watersheds, only a relatively few investigations have examined sediment production from streambank losses. Increased understanding of stream bed and bank erosion is needed to better assess the causes of erosive losses and to develop management strategies to control them.

Objectives: 1) To examine how stream channels in the Blackland Prairie have evolved over the past 50 years, and 2) to assess how agricultural, land, and water management practices have influenced those changes.

Methods: The study focused on erosion and sedimentation in the 16-square mile Brookeen Creek watershed, which is near the town of West, TX roughly 15 miles north of Waco and near Interstate Highway 35. This ungaged watershed is representative of small, intensively cultivated, Central Texas watersheds, in terms of geology, soil types, and land use. The streambed of this watershed is comprised of Taylor Marl, which is a marine shale. Results of this study were compared to similar studies conducted in the gaged Pin Oak Creek watershed near the town of Hubbard, TX. Work tasks in this study involved collecting physical data on streambed characteristics and flows and thorough assessments of the physical environment (including physiography, geography, soils, vegetation, climate, and land uses). In addition, many hydrologic studies were conducted to develop relationships between storms and sediment production as well as information on sediment yields and channel losses, watershed hydrology, stream hydraulics, and the transport of streambed materials. Computer simulation models were utilized to verify the processes that were thought to be occurring in the field, including the Modified Universal Soil Loss Equation (MUSLE) and the HEC software developed by the U.S. Army Corps of Engineers. Finally, a timeline was developed which displays various agricultural water management strategies which have been emphasized from the late 1800s to the late 1980s.

Results and Discussion: This research suggests that the stream bed and banks of the Brookeen Creek watershed have been steadily degrading for at least the past 50 years. As a result of high levels of erosion, the river's bedrock has been damaged and exposed and the creek has widened its banks. Peak discharges have nearly doubled (from 2,800 cubic feet per second or cfs to 5,000 cfs) with the onset of widespread agricultural production in the area. Following the cultivation of tallgrass prairies in the late 1800s, early agricultural activities and programs have increased peak discharges and washed huge quantities of eroded sediments into creeks, the authors suggest. Interestingly, the

introduction of conservation practices in the 1930s following the Dust Bowl may have generated mixed results relating to the stability of stream channels, beds, and banks. For example, soil conservation programs (which were usually accompanied by the building of drainage channels and small, erosion control dams) did dramatically reduce sediment loads that would otherwise flow from bare soils. However, the authors note that they may have increased the likelihood that streams will erode by diverting more clear runoff water, with fewer sediments, towards them. MUSLE modeling efforts show that roughly half the sediment yields from storm events in this watershed may be caused by channel erosion. Total sediment yields in this watershed ranged from 40,000 to 55,000 parts per million. Finally, the authors suggest that there are relationships that can be drawn from the linkages between agricultural and water management policies and water quality. For example, flooding, soil erosion, and channel erosion were major problems in the late 1800s. To combat these problems, programs were introduced in the mid-1900s to conserve soils by contour plowing, terracing, crop rotation, the development of flood control reservoirs and check dams, and straightening and deepening channels. Unintended results of these seemingly beneficial (but incomplete) soil conservation measures, the authors suggest, may include such detrimental impacts as increased channel erosion and degradation, scouring of hydraulic structures, and losses of stream habitats and arable lands. Other adverse consequences that may result from agricultural management practices may include many related problems, such as increased sediment buildup in reservoirs and elevated pollutant transport via sediments.

Reference: Chintala, Ramesh, *Stream Channel Response in the Blackland Prairie, Central Texas*, M.S. Thesis, Center for Environmental Studies, Baylor University, 1997.

NOTE: Burton can be contacted at Dudley_Burton@Baylor.edu, and Allen can be reached at Peter_Allen@Baylor.edu. Chintala can be contacted at rsc@westca.com.

Texas' Land Ethic - Implications for Environmental Policy

Researchers: Pete Gunter, Philosophy Department, University of North Texas, Denton, TX, and Max Oelschlaeger, Humanities Department, Northern Arizona University, Flagstaff, AZ.

Problem: Today's current generation of Texans faces environmental challenges every bit as real as the pioneers who first settled the state. The challenge for today's Texans is sustainability and whether we can shape a sustainable future. This paper examines the many factors that shape the environmental ethic that many Texans share and assesses what can be done to get the citizens of the state to create a more sustainable future.

Objective: To examine the many ways in which Texas' land ethic has influenced the lifestyles of the people of the state and its environment, and to articulate a new land ethic that can be advocated to promote sustainability.

Background Information: The authors argue that, at the beginning of Anglo-American settlement and extending until very recently, Texas' land ethic can be characterized as a

frontier mentality. The notion was that nature's bounty is unlimited and that land and resources are virtually free for the taking. As a result of that way of thinking, many Texans believed that new resources would always be found to meet the virtually unlimited demands of an expanding society. The Texas land ethic also manifests itself in many commonly held notions about the environment, many of which may be only partially true, the authors argue. For example, many Texans may feel that the economy and job creation are fundamentally at odds with environmental protection and the well-being of the ecology. At the same time, they ignore the reality that devastated environments nearly always ruin the societies that depended on them, as well as their economies. The authors comment on many environmental issues and their implications including the following: 1) How is it that humans can live on the earth without spoiling it?; 2) A description of the diversity and limits of Texas' landscape; 3) Ways in which Texas' environment is being disturbed, with special attention paid to groundwater depletion of the Ogallala Aquifer, pollution of coastal areas, and habitat modification; 4) Discussions of environmental economics and how economic principles can drive ecological protection; 5) How the Texas land ethic has been translated into institutional policy relating to the environment; and 6) A case study of how, positively and negatively, land ethics have affected the Texas Big Thicket.

Analysis: If Texans continue to believe in this mythical frontier mentality, the authors argue, there is a great likelihood that serious and perhaps irreparable damage to the environment may be inflicted. On the other hand, realizing that the era of unlimited environmental resources is over is one of the keys to having people begin to think in terms of greater economic and ecological sustainability. It is especially critical that the way that Texans feel about the environment must change within the next 20 or 30 years. The authors say the issue is to begin changing the way Texans live and work, manage our land, secure our food, and transport ourselves. Gunter says that, "If enough of us came to perceive the world and our relations to it through a land ethics frame, then sustainability would be within reach." The most positive outcome, Gunter argues, would be to have enlightened citizens who are guided by a new Texas land ethic, centered around sustainability, who would work to create a better, more ecologically secure, Texas. The best, most effective, situation involves human beings who deeply care about nature, make an effort to understand it, and who work to apply that understanding to protect the environment and strive for sustainable solutions. Three points need to be emphasized if sustainability is to occur: 1) Cleaning up the environment will not necessarily threaten the economy; 2) Current ways of measuring environmental costs need to revised so that "hidden" costs are revealed; and 3) A middle ground needs to be explored in which environmental and economic issues will both benefit.

Reference: Gunter, Pete, and Max Oelschlaeger, *Texas Land Ethics*, University of Texas Press, 1998. Gunter can be contacted at gunter@unt.edu. The book can be ordered from the UT Press at (800) 252-3206.

Texas A&M-Galveston to Examine Predator-Prey Relationships in Marine Environments

Recently, the introduction of satellite telemetry and other new technologies has increased the ability of scientists to learn more about the feeding ecology of marine mammals. The use of satellites has allowed researchers to gather valuable information about the geographic location of marine mammals and where and how long they dive. One critical piece of information is missing -- researchers still do not know which species many marine mammals prey upon and consume. Recently, Graham Worthy of the Texas A&M University-Galveston Marine Biology Department was awarded a grant from the Texas Higher Education Coordinating Board to study naturally occurring carbon and nitrogen stable isotopes and fatty acids as ways to trace ecosystem dynamics and predator-prey relationships.

Traditionally, researchers have depended on only three ways to determine what a marine mammal has eaten -- they can observe what these animals eat, they can examine fecal samples, or they can analyze stomach contents of a dead animal. However, these techniques yield limited results, experts say.

Previous studies have shown that the isotopic composition of a prey item is reflected in the tissues of the predator. In this project, the first task will be to map the variability of isotope ratios and fatty acid signatures throughout the body of marine mammals. More than 1,500 samples of blubber, fur, skin, muscle, and organs have been taken from dolphins and northern fur seals to serve as the basis for the map. "The map of the body will be able to be used across species, but the interpretation of particular feeding habits will be species-specific. To study an individual species' feeding habits, you need to gather information on the fish which share the environment with that species," notes Worthy.

A recent innovation is the use of fatty acids as tracers. Carnivores and marine mammals deposit dietary fatty acids in body tissue without modification. Therefore, it is possible to trace fatty acids obtained from the diet and to compare the signatures in the tissues of the predator with those of potential prey. Currently several research groups are using isotope ratio techniques as well as fatty acid signature analysis. Worthy will combine the two techniques to assess the isotope ratio of each fatty acid and to define and identify prey species which are consumed by marine mammals.

"One application of this technique can be seen in the example of steller sea lions of the Bering Sea," explains Worthy. Currently, steller sea lion populations are only 20% of historic levels. It has been suggested that the decline of sea lion numbers may be linked to overfishing of pollock, which the mammals prey upon. Worthy suggests the techniques being developed in this study can be used to determine the sea lion's food source and to examine possible solutions. Because these methods are not invasive, they can also be used to gather life history information about endangered species.

For details, contact Worthy at (409) 740-4721 or worthyg@tamug.tamu.edu.

Stephen F. Austin Biologists Study East Texas Streams to Determine Impact of Oil Production

A comprehensive study of the possible impact of oil and gas production on stream ecosystems in the Sabine National Forest has just been completed by a team of biologists and graduate students at Stephen F. Austin State University in Nacogdoches.

Stephen F. Austin State University student Boyd Guthrie gathers water quality data from an East Texas stream.

The study, which was sponsored by the National Forest Service, focused on whether the water quality of streams could be negatively affected by the horizontal drilling activities near the town of Hemphill. The goal of the study was to develop baseline data on the water quality and biology of streams in the forest and to assess whether limited oil and gas activity was contaminating the area. Streams that were sampled include Big Sandy, McKim, and Curry Creek.

Jack McCullough of SFA's Biology Department was the lead faculty member in the project. Separate components of the study were conducted by graduate students. For example, Greg Rogers inventoried fish species and Boyd Guthrie focused on macroinvertebrates. Uli Martin investigated heavy metal concentrations in the streams and Lance Mason performed physical and chemical tests.

In general, the results suggest that existing oil and gas activities are not degrading the streams or harming the ecosystem. However, McCullough said that increased oil and gas activity will need to be monitored to make sure the forest streams remain unpolluted.

UT Examines Connection Between CO_2 and Plant Production

Atmospheric concentrations of carbon dioxide (CO_2) have increased 30% since the beginning of the Industrial Revolution and are projected to double by the end of the next Century. For arid and semi-arid ecosystems, it is becoming increasingly clear that changes in water dynamics with elevated CO_2 may be as important as the direct effects of CO_2 on photosynthesis. In addition, many experts feel there is a clear need to combine data from CO_2 experiments with climate change information.

This system will be used near Temple, TX, to gather data on the impact of increased carbon dioxide levels on grassland plants.

Recently, Robert Jackson of the University of Texas at Austin (UT) Botany Department was awarded funds from the Texas Higher Education Coordinating Board to study the effect of increased CO_2 and climate change on grasslands, plant production, and the water balance.

In this project, Jackson will collaborate with U.S. Department of Agriculture Research Service (USDA/ ARS) researchers H. Wayne Polley and Hyrum Johnson. Field studies will be carried out at a USDA/ARS grassland on the Blackland Prairie near Temple, TX. The researchers will utilize a water balance model combined with field experiments to compare the effects of elevated CO_2, plant production, and variability in the climate. The model will generate data on soil parameters, plant variables, and daily weather data. Model results will include such outputs as evaporation, transpiration, soil water content, and drainage. Because the model is flexible, it can be adjusted to any given site or situation, Jackson says.

"CO_2 allows plants to close pores to evaporation and use less water, but increased CO_2 in the air generally makes the air temperature rise and the resulting warmer air generates higher pressure for evaporation," Jackson says. "An individual leaf might lose less water, but a plant might grow more rapidly and create more leaves and thus larger water losses," Jackson says. Jackson will test three hypotheses in his project: 1) the total water flux to the atmosphere, and the ratio of soil transpiration to evaporation, will decrease as CO_2 increases; 2) deep percolation or drainage of soil water will increase in elevated CO_2; and 3) plant growth and production will increase, and plant water use will decrease, in elevated CO_2.

For details, contact Jackson at (512) 471-5209 or rjackson@mail.utexas.edu.

Texas A&M - Kingsville Researchers Get Up Front Look at Drought Impacts

South Texas has been particularly hard hit by this year's drought -- crops, range lands and landscapes have all been devastated by the lack of rain and scorched by higher than normal temperatures. Texas A&M University--Kingsville, which is sited between Corpus Christi and the Lower Rio Grande Valley, is in the eye of the storm. As a result, the drought has given researchers at Texas A&M -- Kingsville an opportunity to examine this natural disaster first hand and to examine its impacts and offer recommendations to those who are affected by it.

Robert Morgan, an assistant professor in the Agronomy and Resource Science Department, reports that "the only crop that held up relatively well under the drought this year is grain sorghum, but most of it has been harvested so the rain wouldn't do it any good." He added that corn yields and grain sizes were lower than normal.

This photo shows a South Texas cotton crop that has been withered by the 1998 drought.

Kleberg County Agricultural Extension Agent John Ford is working with many Texas A&M - Kingsville agricultural researchers. He said cotton yields are likely to be only 40 to 50% of normal because of the drought and could dip to a meager 20% of normal if the drought continued during the growing season. In contrast, grain sorghum yields could be only 60% of normal because of the low amounts of rainfall. Part of the reason, Morgan and Ford agree, is that significant improvements have been made to develop sorghum species that are resistant to drought, heat, and other stressors.

Range and grazing lands are also feeling the pinch caused by the lack of rain. "Range management is always the key in drought situations like this," said Timothy Fulbright, a professor in the Animal and Wildlife Sciences Department. During a drought, Fulbright says ranchers have two choices if they have overgrazed lands -- they can either purchase commercial feeds, which is costly, or can sell off part of their herd.

"Ranchers often raise too many head during a good wet season and then find themselves in trouble during dry weather," he said. "They must raise a manageable number for the amount of rangeland they have." Most of the rangeland in South Texas is overgrazed, Fulbright says, "When land is overgrazed, many times cattle have been allowed to eat everything and not enough of the good plants can come back on their own when we finally do get rain."

The hot, dry weather has been taking its toll on lawns and landscaping in South Texas. Joseph Kuti, an associate professor in the Agronomy and Resource Science Department,

said that drought-resistant plants that are native to South Texas may not require as much water as many other varieties. "Xeriscape has become more popular in the last 15 years," he said, "and is a way to have a beautiful landscape while conserving water." Cenizo, sago palms and boxwood shrubs are native to South Texas that also save water.

For details, contact Morgan at (512) 593-3953 rnmorgan@tamuk.edu, Fulbright at (512)593-3714 or t-fulbright@tamuk.edu, or Kuti at (512)593-3978 or j-kuti@tamuk.edu.

Tarleton State U. Student Assesses Improved Methods to Determine Aquifer Permeability in Difficult Settings

What is the best way to calculate the permeability of groundwater formations? Recently, a graduate student at Tarleton State University investigated this issue.

The research was conducted by Lynn Smith, a Physical Sciences Department major who received a Master's degree earlier this year. Much of the work was done in cooperation with Hughbert Collier, who was a Tarleton researcher at the time and is now a private consultant who works with Smith.

According to Smith, the basic problem is that it is difficult to calculate the permeability of groundwater formations which have not been cored or for which there is little available data. Smith's project investigated the use of a technical method, "Stonely permeability logs," as an alternative way to estimate groundwater permeability. The objective of this project was to assess whether the Stonely method would be useful in difficult hydrogeological settings -- for example, sites that are difficult to core or are not open to a borehole.

In the project, Smith and Collier performed pump tests during 1996 and 1997 at sites in the Trinity Aquifer. Based on the data they collected, they calculated values for transmissivity, aquifer storage, permeability, and other factors.

Smith says the results are promising. They suggest that the Stonely method may yield accurate estimates of permeability while providing additional insights into such related issues as lithology, features of unsaturated zones, and porosity. In addition, the Stonely technique may be less expensive than currently used methods and may reduce the need for drilling a second test well or carrying out another pump test.

For details, contact Smith at lynn@collierconsulting.com or (254) 968-8721.

Tarleton State U. Reports Discuss Central Texas Water Quality; Livestock Management

Many new reports dealing with water quality issues in Central Texas have recently been published by the Texas Institute for Applied Environmental Research at Tarleton State University in Stephenville.

Livestock and the Environment: Expanding the Focus was written by Staci Pratt and Ron Jones of TIAER, and C. Allen Jones of the Texas Agricultural Experiment Station. The report focuses on nutrients in the Upper North Bosque River watershed and discusses monitoring and modeling results, strategies to improve the environment, costs to industry, and institutional considerations.

Other recent TIAER technical reports include *Stream Water Quality in the Bosque River Watershed* by Anne McFarland and Larry Hauck; *Prediction of Effects of Best Management Practices on Agricultural Nonpoint Source Pollution in the Arroyo Colorado Watershed* by Joan Flowers, Nancy Easterling, and Hauck; and *Lake Waco/ Bosque River Watershed Initiative Report: Determining Nutrient Contribution by Land Use for the Upper North Bosque River Watershed* by McFarland and Hauck.

For information on how to order these reports, contact TIAER at (254) 968-9567 or visit their web site at http://tiaer.tarleton.edu.

Proceedings from "Source Water 98" Examines Water Quality

The proceedings of *Source Water Assessment and Protection `98* are now available. The proceedings include papers that were given at a water quality conference which met in Dallas in May, 1998. The proceedings cover such topics as delineation of water protection areas, monitoring source waters, data management and use, and implementing source water protection programs.

The conference was sponsored by the National Water Research Institute, the U.S. Environmental Protection Agency (EPA), the U.S. Geological Survey, and TWRI.

Papers by Texas authors or about Texas topics include "Wellhead Protection Area Delineation Using Numerical and Neural Network Models" by Ranjan Muttiah of the Texas Agricultural Experiment Station at Temple, TX; "A Source Water Vulnerability Assessment for TX, OK, ARK, LA, and NM" by Mike Bechdol of EPA in Dallas, and "the Texas Source Water Assessment and Protection Program for Drinking Water" by Brad Cross of the Texas Natural Resource Conservation Commission.

For details or to order a copy of the proceedings, visit the NWRI web site at http://www.ocwd.com/nwri.

New Book Describes Diving Opportunities in Texas Parks

Scuba diving and snorkeling enthusiasts will enjoy *Underwater Wonders of the National Parks: A Diving and Snorkeling Guide,* a new book compiled by the National Park Service and written by Daniel Lenihan and John Brooks.

The book covers approximately 45 different diving sites in U.S. national parks in great detail and with spectacular photography. Each section of the book covers a different National Park in depth and provides a park map, diving rules and regulations, details about diving conditions and the surrounding area, and descriptions of unusual features such as shipwrecks, underwater structures, and unique aquatic fauna.

The book provides many details about Amistad National Park, which is located on Texas-Mexico border. Diving opportunities exist at Lake Amistad, which was formed by damming the Pecos, Devils, and Rio Grande rivers. Since the region was flooded to form the lake, unique underwater attractions abound, such as a ranch house and natural springs that warm the water to 70° F.

The book can be ordered from Fodor's Travel Publications, at (212) 572-8784. You can visit their World Wide Web (WWW) site at http://www.fodors.com.

Texas Comptroller's Office Report Describes Environmental Issues Along Texas - Mexico Border

A new report which describes many issues facing the Texas - Mexico border, including environmental affairs, has been published by the Texas Comptroller's Office. The 233-page book is titled, *Bordering the Future: Challenge and Opportunity in the Texas Border Region*.

This book focuses on many critical issues facing the border region, including water quality and the environment, poverty, population growth, and the lack of health care and education. The report thoroughly analyzes these problems and their implications through 2025. *Bordering the Future* also recommends specific short and long-term strategies to address these problems.

One chapter of the book, "Common Ground," discusses many environmental problems plaguing the border region, including pollution, widespread occurrences of water hyacinth and hydrilla which block the flow of water in irrigation canals, high levels of fecal coliform bacteria, and increasing salinity of the Rio Grande. This chapter also analyzes the problem of colonias, which are border communities that do not have adequate and safe facilities for drinking water and wastewater treatment. El Paso, Hidalgo, and Cameron counties contain the some of the highest numbers of people living in colonias in the U.S. The report also analyzes the success of the Economically Distressed Areas Program, which was created by the Texas Legislature in 1989 to fund water and wastewater services to colonias.

Copies of this publication can be obtained by contacting the Comptroller's Office at (800) 531-5441. The report can be viewed on the World Wide Web at http://www.window.state.tx.us/border/border.html.

A&M - Commerce Creates "Hands-On" Hydrology Field Lab

A new outdoor hydrology field laboratory will provide excellent opportunities for students at Texas A&M University - Commerce to gain first-hand experiences in hydrological analyses, environmental monitoring, groundwater modeling, water quality sampling, and related efforts.

This photo shows the installation of the hydrology field lab at Texas A&M University - Commerce.

The outdoor laboratory was developed by Haydn "Chip" Fox of the Geosciences Department and John Harrison of the Agricultural Sciences Department. The purpose of the hydrolab is to give undergraduates practical, hands-on experience in hydrogeology through practical applications. Each semester, 15 to 19 students enroll in courses using the laboratory facility.

Recently, students have worked on several projects associated with the outdoor lab, including mapping the water table by constructing a rough topographic map; using a water level meter to measure the depth to water in each well, and designing a hypothetical well for a small town based on soil sieve tests from aquifer sands. Other current activities involve conducting pump tests to determine hydrologic properties of the aquifer, and obtaining and using field data to produce a groundwater computer simulation model and to develop a groundwater remediation plan.

Several fortunate circumstances made it easier for Fox and Harrison to make the lab a reality. A faculty member identified a site on university farm property that was close to campus. The university farm donated the land and a building, which lowered project costs.

The site also features many hydrological characteristics that make it ideal for use as a groundwater testing facility. For example, a farm pond and streams facilitate field surface hydrology studies and a slow-moving, shallow aquifer reduces pumping costs. Because land is plentiful, a new well can be dug for each class. Future plans for the site include the addition of a metal detector to instruct students in techniques for finding buried storage drums and the acquisition of a ground-penetrating radar.

For more information about the laboratory, contact Fox at haydn_fox@tamu-commerce.edu or (903) 886-5442, or Harrison at john_harrison@tamu-commerce.edu or (903) 886-5354.

Texas A&M - Kingsville Citrus Center Studies Whether Fertigation of Grapefruit Can Boost Yields

Can you grow a bigger, better grapefruit through "fertigation" (applying fertilizers at the same time citrus crops are being irrigated)? That's the focus of on-going research by scientists with the Texas A&M University - Kingsville Citrus Center at Weslaco and Israeli counterparts. The research is led by Bhimu Patil of the Citrus Center and Yair Erner of the Volcani Center in Israel. The study is funded through the Texas-Israeli Exchange program, which is administered by the Texas Department of Agriculture.

Yair Erner (Center) of the Volcani Center is working with John Watson (left) and Elias Hernandez in the fertigation of grapefruit.

A key issue being studied centers around the best way to apply potassium and nutrients. Potassium applications typically increase grapefruit size, but the nutrient often moves slowly through the soil and grapefruit leaves may not absorb as much potassium as is desired. Patil and colleagues at the Center have tested applying potassium nitrate to Ruby Red grapefruit through irrigation and the application of foliar sprays during growth periods. They are also determining potassium needs of individual trees and applying the appropriate amount of nutrients. The scientists are now trying to correlate fruit growth with potassium levels in leaf and fruit tissues to determine when the critical growth periods occur and nutrients are needed.

Patil says that important strides have been made in increasing grapefruit size through fertigation by Dariusz Swietlik, the former Center Director. Even though a drought occurred during the studies, fertigation still increased yields. In the future, Patil wants to study if applying potassium through fertigation and foliar sprays may produce grapefruit that fight cancer by elevating levels of nutraceuticals, which are food composites that contain natural and biologically active phytochemicals that may prevent diseases and sustain life. For details, contact Patil at (956) 968-2132 or b-patil@tamu.edu.

UT Engineer Studies Why Ship Channel Bridge Wobbles

The Fred Hartman Bridge, which is the most expensive ($117.5 million) highway contract in Texas history, has a case of the wobbles. Recently, a researcher at the University of Texas at Austin (UT) worked with the Texas Department of Transportation (TxDOT) to identify the source of the shakiness and to identify potential solutions. This bridge connects Baytown and La Porte and crosses the Houston Ship Channel. Its main cable-supported span runs for 2,475 feet, its towers rise 45 stories into the air, and 192 supporting cables reach up to 650 feet.

The problem is that high-tension steel cables, which connect the road with the tower, can sway as much as 20 inches when there is light rain and winds are 15 to 30 miles per hour. The oscillation occurs when raindrops run down the cables. The raindrops change the aerodynamic profile of the cables and exert a lifting action on them (like an airplane flap). The raindrops only affect the bridge during lower wind speeds, because stronger winds blow raindrops off the cables. Roughly 28 bridges utilize this cable-stay design in the U.S., and many of them have experienced similar problems.

For the past six months, Karl Frank of the UT Civil Engineering Department has been studying this issue and how to correct it. TxDOT is now attempting to fix the problem using two methods -- installing shock absorbers where the cables anchor into the bridge deck, and attaching horizontal steel cables perpendicular to the affected cables.

Frank and other experts agree this wobbling action will likely eventually shorten the life of the bridge if it goes untreated and could mean the cables may eventually have to be replaced. The problem does not come as a surprise to the bridge's designers, as engineers detected the problem during construction. However, they thought that the oscillation would stop once construction was completed. Still, experts emphasize that motorists need not worry about its safety because the bridge is designed to remain standing, even if a supporting cable strand snaps.

For details, contact Frank at (512) 471-7259 or frank@uts.cc.utexas.edu.

UT--MSI Studies Blue-Green Algae Bloom In Coastal Bend

Throughout much of the 1990s, the waters of Texas' Coastal Bend, which stretches roughly from Corpus Christi to the Mexico border, have been afflicted by an intermittent series of algal blooms. A seven-year brown tide (*Aureoumbra lagunensis*) persisted from the early 1990s until heavy rains occurred in the Fall of 1997. Shortly thereafter, an infestation of "red tide (*Gymnodinium breve*), was killing millions of fish in the Gulf of Mexico.

This spring, however, a blue-green algae bloom (*Synecococcus sp.*) infested the waters of the Coastal Bend. According to Edward Buskey, a researcher at the University of Texas Marine Science Institute in Port Aransas (UT--MSI), the blue-green algae bloom followed larger than normal rains that hit South Texas last October. Apparently, the rains

lowered brown tide populations in Baffin Bay and the Laguna Madre to relatively normal levels (a few hundred cells per milliliter).

In January, a huge diatom bloom occurred in Baffin Bay, followed by a blue-green algae bloom in March. Local fishermen first discovered the blue-green algal bloom, which spread from the Laguna Madre to the JFK causeway near Corpus Christi to Port Mansfield. Buskey explains that the real danger posed by the blue-green algae bloom is that it may threaten seagrass populations by reducing the amount of sunlight that penetrates coastal waters. Sunlight is needed by the seagrasses so that photosynthesis will occur. The blue-green algal bloom occurred when salinity concentrations in area waters became much lower than normal.

"The blue-green algae acts like a dense cloud of confetti suspended in water, blocking out sunlight," Buskey says. Adds UTMSI biologist Tracy Villareal, "the algae causing these blooms are not just invaders from another region, but they are always present in Coastal Bend waters, just not in such high concentrations." For details, contact Buskey at (512) 749-6711 or buskey@utmsi.zo.utexas.edu.

Tarleton State U., TWRI, to Create TMDL Manual

Developing an easy-to-read handbook that guides water managers through the total maximum daily load (TDML) process is the goal of a project involving the Texas Water Resources Institute (TWRI), Tarleton State University (TSU), and Texas A&M University (TAMU). The project is led by Jan McNitt of the Texas Institute for Applied Environmental Research (TIAER) at TSU. Participants include Chris Rottler, Erinn Wilcznski, and Richard Kiesling of TIAER; Ric Jensen of TWRI; and Marty Matlock of the TAMU Agricultural Engineering Department.

The project is funded by the Texas Natural Resource Conservation Commission (TNRCC), which has the regulatory mandate to implement TDMLs in Texas. In broad terms, TDMLs are a process to establish water quality goals by establishing limits for specific pollutants that can be discharged into a watershed. In the project, team members will work extensively with Mel Vargas, Daren Harmel, and Adrienne Boer of the TNRCC TDML staff. The goal of the project is to produce a reference document that can assist local governments who are involved in TDML activities. Some of the broad topics that will be covered in the book include how to develop and implement TDMLs, the importance of public participation, methods to gather water quality data and monitor watersheds, and how to identify funding sources and external resources.

For details, contact McNitt at (254) 968-9578 or Mcnitt@tiaer.tarleton.edu or Jensen at (409) 845-8571 or Rjensen@tamu.edu.

Impact of Federal Policy on Rice Farming is Aim of TWRI Study

How will changes in federal price support policies affect the amount of lands utilized for rice production and how might these changes affect the environment? These are the issues being explored in a multidisciplinary research project being funded by TWRI.

The project is being led by a team of Texas A&M University researchers including Doug Slack and Thomas Lacher of the Wildlife and Fisheries Science Department, Richard Woodward of the Agricultural Economics Department, and Arnie Vedlitz of the Center for Public Leadership Studies in the Bush School of Government. Graduate students participating in the study include Kelly Mizell, April Henry, Patricia Canzoneri, Yong-Suhk Wui, Elizabeth Kennedy, and Jeanine Harris. The goal of the project is to estimate the environmental, economic, and policy consequences that are likely to occur as a result of decreases in federal crop supports. The research will also investigate whether public and private institutional arrangements can be developed to help preserve the environmental benefits brought about by rice farming such as the creation and maintenance of wetlands, the provision of habitats for migratory birds and aquatic species, and water quality improvements.

For more information about this project, contact TWRI at (409) 845-1851 or twri@tamu.edu.

New TWRI WWW Site Focuses on Water Conservation

The Texas Water Resources Institute (TWRI) has developed a new World Wide Web site that is dedicated to water conservation education issues. The WWW site, "Water Supply and Conservation Education Program - Senate Bill 1," was developed by TWRI science writer Jan Gerston and student worker Eric Hinesley. The WWW site supplements efforts by the Texas Agricultural Extension Service (TAEX), and the Texas A&M University System Agricultural Program, to incorporate updated water conservation information into many existing programs and training modules.

The WWW site leads users to a wealth of information about agricultural and urban water conservation as well as industrial, commercial and institutional conservation and reuse. The site also provides details about volunteer opportunities, environmental information, groundwater issues, and details about Senate Bill 1. Links take users to home pages of many agencies including TAEX, the Texas Water Development Board and the Texas Natural Resource Conservation Commission. Visitors can also view archived messages that were sent out through the "Tx-Water-Ed" list server.

The address of this WWW site is http://tx-water-ed.tamu.edu. For details, contact Gerston at (409) 845-1852 or jan@twri.tamu.edu.

TTU to Teach Advanced Waste Treatment via WWW

Texas Tech University's Chemical Engineering Department will offer an interactive Internet course on Advanced Industrial Waste Treatment this fall. The graduate course for engineers and environmental scientists will focus on evaluation techniques for new waste treatment .

The entire course will be on the Internet. The Internet site will provide students with current data and contextual information. A hyper-linked glossary and encyclopedia will provide additional information for the students.

The interactive course will take place in an asynchronous mode to provide flexibility for those participating in the class. Students will be expected to have discussions with the professor and other class members every week as they would in a physical classroom, making this course truly interactive.

Harry Parker of the Chemical Engineering Department will conduct the course. For details, prospective students can link to the course World Wide Web site at http://www.coe.ttu.edu/che/hwp/preview/. Parker can be contacted at (806) 742-3553 or parker@coe1.coe.ttu.edu.

UT Class Allows Students to Use WWW to Learn GIS Skills

The University of Texas at Austin (UT) is offering an on-line course in geographic information systems (GIS) this fall.

The class, "GIS in Water Resources -- A Virtual Course Presented through TeleCampus," is an effort of the Civil Engineering Department and the Office of Continuing Engineering Studies. It will be taught by David Maidment of the Civil Engineering Department.

Major topics that will be covered in the class include use of ARCView and HEC PREPRO GIS software, digital watershed delineation, building a watershed base map, working with the Statsgo Soils and land use data, and mapping environmental data in a relational database.

It is recommended that students who want to participate in the class should have the ARCView and ARC/Info GIS systems running either on Windows NT or Unix workstation. The course runs from August 28 to December 4.

For details, contact the UT Continuing Engineering Studies at (512) 471-3506 or market@uts.ce.utexas.edu or visit Maidment's home page at http://www.ce.utexas.edu/prof/maidment.

A&M International U. WWW Site Focuses on Droughts

A World Wide Web (WWW) site is being developed at Texas A&M International University that is intended to provide comprehensive information about the impact of droughts along the Texas-Mexico border.

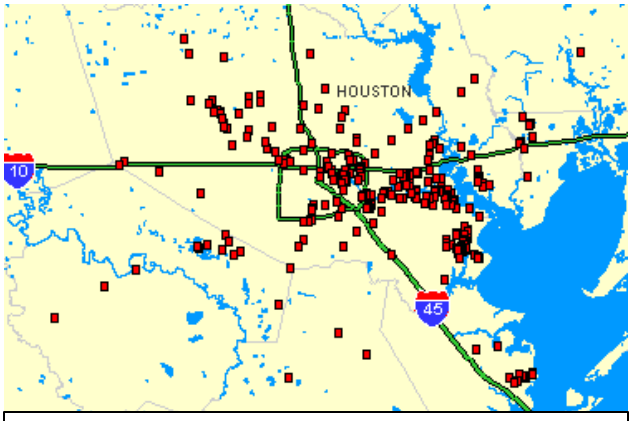
The WWW site is being developed by the A&M International Drought Relief Information Center, which was created earlier this year. The Director of the Center is Duane Burdorf.

Information currently on the WWW site includes discussions of some of the impacts of droughts, how water conservation can lessen drought impacts, a description of federal and state agencies that offer drought assistance, and recent news updates. In addition, the site displays updated maps and satellite images that illustrate drought conditions.

The WWW site address is http://www.tamiu.edu/coba/drought/index.htm. You can e-mail the Center at drought@tamiu.edu.

EDF "Chemical Scorecard" Helps Users Track Toxic Pollutants

An innovative World Wide Web site developed by the Environmental Defense Fund (EDF) puts detailed information about toxic chemical releases and their impact on human health and the environment at the fingertips of the public.



The "EDF Scorecard" WWW site allows users to generate maps showing industries that release toxic chemicals into the environment (shown here for the Houston area).

The WWW site, termed the "EDF Chemical Scorecard," is at http://www.scorecard.org. EDF's main WWW site is located at http://www.edf.org.

The site lets users view data from the U.S. Environmental Protection Agency (EPA) toxic release inventory (TRI) at the state, regional, county, or city level. An especially useful feature allows users to enter a zip code and then view an interactive map showing the manufacturers and industries that reported TRI data to EPA. Users can then click on the icon for a specific site and view information about the amount and type of toxic chemicals that were released to water and air resources, as well as the adverse environmental health effects of specific contaminants.

Other features of the site provide resources citizens can use to take action to voice concerns about environmental degradation, as well as a description of appropriate legal and regulatory resources that apply to specific groups of toxic chemicals.