New Waves
The Research Newsletter of the Texas Water Resources Institute
Volume 7, Number 1, March 1994

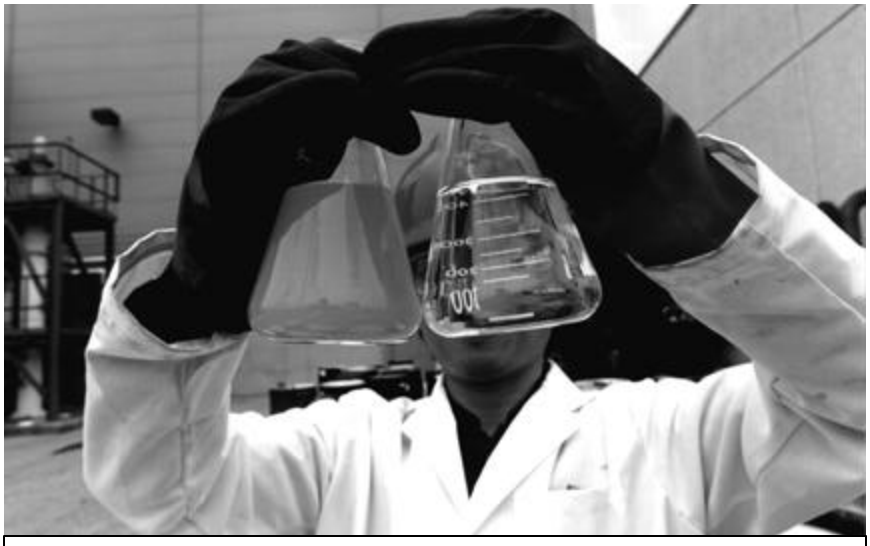
UT Studies Focus on Supercritical Water Oxidation

Researchers at the University of Texas at Austin are leading the way in developing and refining technologies that use water at high temperatures and high pressure to destroy wastes.

This hydrothermal process is called Supercritical Water Oxidation (SCWO). In laymen's terms, it involves subjecting pollutants to water that has been heated to critical temperatures (above 705deg. F), high pressures (more than 3,200 pounds per square inch), and an oxidant. The process, which operates in a totally enclosed system, has been likened to putting wastes in a "pressure cooker." SCWO is remarkable because it can transform toxic wastewaters and organic sludges into non-hazardous by-products like water, carbon dioxide, and ash. For example, pollutant levels have been reduced by more than 99% after only seven seconds of treatment by a SCWO unit.

Earnest Gloyna, a professor in the Civil Engineering Department, has been leading UT's work in SCWO for the past five years. UT's research team now includes six researchers and nine graduate students. At last count, 13 theses and dissertations had been published as a result of the research as well as numerous technical reports and scientific papers.

So far, most of the SCWO research has taken place on the UT's Balcones Research Center in northwest Austin. The largest UT reactor treats 40 gallons of waste per hour. A commercial SCWO plant is now being built in Austin that will be able to handle 300 gallons of waste per hour.



Lixiong Li compares beakers of industrial waste before (left) and after they were treated with supercritical water oxidation.

Backers of the

technology point out that it has many potential uses. For example, UT is participating in studies sponsored by the U.S. Department of Defense to design, develop, and operate a mobile SCWO unit that could be taken to U.S. military installations that have large stockpiles of hazardous wastes. SCWO may also be to used to treat wastewater sludge being generated by cities and industries.

For details, contact Gloyna or Lixiong Li at (512) 471-7296.

A&M Helps Cities Cut Energy Used to Pump, Distribute Water

Researchers at Texas A&M University are developing and field testing a "knowledge based" management system that may allow water utilities to significantly reduce the amount of energy used to pump water to customers. The result could be lower operating costs for utilities and smaller monthly bills for consumers.

The research, which is being led by Tep Sastri and Joseph Foster of the Industrial Engineering Department, produced a "knowledge-based energy management systems" (KBEMS). The overall goal of the studies is to lower the cost of energy used to pump and lift water to and from elevated storage tanks. Typically, water utilities make up roughly 7% of the power consumed in the U.S.

The cost savings come from two main areas. First, peak electrical demands can be lowered, which lessens the need to build new hydroelectric dams and power plants over the long-term. Second, the total amount of energy consumed also declines.

Input to the KBEMS is provided by real-time data about elevated storage levels, pressure readings, and flows. Forecasting models are then utilized to predict short-term water demands. Finally, cost effective schedules for operating pumps are generated. Throughout the procedure, water utility managers are expected to provide their inputs and best judgment when appropriate. Recently, Sastri has been working to fine tune the demand forecasting models. Better techniques have been developed to improve the accuracy of seasonal variations and to identify and eliminate data that may not be accurate ("outliers").

KBEMS is being field tested in cooperation with the City of Arlington, while a commercial product is being developed and tested in Irving. Results of the Arlington field tests show the system has the potential to reap significant benefits. For example, simulated case studies show that utilizing KBEMS decreased peak energy use by 29%, lowered total energy use by 10%, and would have cut electrical costs by 18 to 21%.

A paper about the research was featured in the May 1993 issue of the *American Water Works Association Journal*.. More details about the project can be obtained by calling Sastri at (409) 845-5448 or Foster at (409) 845-5400.

Revised Estimates of the Amount of Water Stored in the Edwards Aquifer

Researcher: S. D. Hovorka, S. C. Ruppel, Alan Dutton, and Joseph Yeh, Bureau of Economic Geology, University of Texas at Austin, Austin, TX.

Problem: Accurate estimates of the amount of water available from the Edwards Aquifer are vital, because the region has been ordered to develop a water management plan to limit pumping to protect springflows. The pumping limits were based on previous estimates of the amount of water in the aquifer, which may have underestimated how much water is actually available. Past estimates of the amount of water stored in the Edwards Aquifer were made by extrapolating porosity values from a few cored wells. These studies produced subjective values that may not be accurate.

Objectives: To calibrate the porosity of the aquifer; to develop a three-dimensional cellular model of porosity in the aquifer; to enter the information into a Geographic Information System (GIS); and demonstrate the use of water level changes to measure hydrologic properties in the aquifer.

Methodology: Geophysical log data were compiled from more than 200 porosity and resistivity logs that were obtained from the U.S. Geological Survey (USGS), the Texas Natural Resource Conservation Commission (TNRCC), and the Edwards Underground Water District (EUWD). More than 300 porosity and permeability analyses were performed on plugs from available cores to create porosity logs. These data were used to calibrate geophysical porosity logs in aquifer wells. Data from the geophysical logs were used to construct a stratigraphic model of the aquifer. The model was refined with data from outcrop formations that were examined at four sites. The model was used to measure the total thickness of the aquifer, to control porosity between wells, and to guide assumptions made during log calibration. A series of cross-sections and isopach maps were prepared and used to construct the model. The *Geologic Atlas of Texas* provided values to assess the volume of the unconfined portion of the aquifer. A map of water levels in 1972 was used to define the upper surface of the unconfined aquifer (this data was chosen to represent average water levels).

Results: Modeling results suggest that the average porosity is 22%, and ranges from 16 to 28%. The total water-filled pore space in the aquifer is estimated to be 215 million acre-feet (MAF), with most of this (156 MAF) being in the confined zone. The upper zone of the aquifer contains an estimated 103 MAF, while the lower zone holds roughly 112 MAF. If porosity is limited to log values from 10 to 50% of total porosity, the estimated amount of water in the aquifer is 208 MAF. Changes in water levels in the confined zone reflect regional changes in pressure, resulting from water filling and draining in the unconfined zone.

Reference: Hovorka, S. D., S. C. Ruppel, Alan Dutton, and Joseph Yeh, *Edwards Aquifer Storage Assessment: Kinney County to Hays County,* Edwards Underground Water District, San Antonio, TX, December 1993. NOTE: More details about the study can be obtained by calling the EUWD at (210) 222-2204.

Use of EPA's Qual-2E Model to Predict Water Quality in an Arkansas River System

Researchers: G.R. Thakar and Jerry Rogers, Civil Engineering Department, University of Houston, Houston, TX.

Problem: The U.S. Environmental Protection Agency has developed the Qual-2E model to simulate complex flows in river systems. Calibrating the model using case studies can provide insights into how valuable the model can be in real world situations.

Methodology: River water quality was obtained by analyzing samples taken from U.S. Geological Survey gauge stations along the North Fork Saline River (Arkansas) system. Data were collected in July and September, 1992 for such parameters as temperature, dissolved oxygen (DO), biochemical oxygen demands (BOD), suspended solids, nitrogen, phosphorus, fecal coliform bacteria, and sodium. Water quality and flow data were input to Qual-2E to simulate steady state conditions along 12 distinct reaches of the river system. Each reach was subdivided into individual compartments. Two "worst case" scenarios, which involved the discharge of large amounts of treated and raw sewage from a wastewater treatment plant, were also simulated for planning purposes.

Results: The simulation of the treated sewage discharge was estimated to have a BOD of 20 mg/L and lowered DO levels to 7.5 at the point it was discharged. The simulations show that the discharge of raw sewage (BOD of 200 mg/L) would lower DO levels to 4.2 mg/L. Because most aquatic species need at least 5 mg/L of DO, the raw sewage could result in fish kills as far as 22 miles downstream. The modeling exercise shows that Qual-2E is a user friendly model that is very useful for plotting predicted BOD and DO levels. Qual-2E can be especially useful for simulating the impact of pollution in complex river systems that include many tributaries.

Reference: Thakar, G.R., and Jerry Rogers, "North Fork Saline River Water Quality Analysis Using Qual-2E," Presented at the American Water Resources Association Texas Section Symposium, Austin, TX, November 1993.

NOTE: This paper was included in the Proceedings from the AWRA Symposium. Limited numbers of the proceedings are still available for purchase. If you are interested, call Eve Kuniansky of the U.S. Geological Survey Austin office at (512) 873-3020.

Analyzing the Success of Austin's Xeriscape Program

Researchers: Kariann Sokulsky, Texas Natural Resource Conservation Commission (TNRCC), Austin, TX; Michael Nieswiadomy, University of North Texas, Denton, TX; Tony Gregg, Becki Cobos, and John Gleason, City of Austin, TX; and Nora Mullarkey, Lower Colorado River Authority (LCRA), Austin, TX.

Problem: Xeriscapes are promoted by many utilities to conserve water and lower peak demands. The effect of xeriscape programs on water use has received little detailed scientific study. This paper reviews the results of the 1991 survey and subjects the 1985-91 survey data to additional economic analysis.

Background Information: In 1984, Austin began a xeriscape program. Since then, Austin developed a xeriscape newsletter and tracked homeowners' interest in adopting xeriscapes. In 1991, Austin, LCRA, and TNRCC investigated if homeowners who implemented and used xeriscape principles used less water than those with traditional

landscapes. Data were collected on the price of water, rainfall, temperatures, income levels, xeriscape use, and number of residents per household. A scoring system with a high score of 100 points was developed to rank if landscapes were xeriscape. The system emphasized the amount of turf area and the types of plants used. The initial survey classified landscapes with scores of 60 or higher as xeriscapes. Homes with landscapes of less than 9,000 square feet used an average of 3,700 gallons less per month (gpm) when xeriscapes were installed. Questions remained after the study about whether the test to classify xeriscapes was valid, if sample bias existed, and the impact of xeriscapes on water use.

Methodology: The 1985-91 data were used to ask the following questions: 1) Was the landscape test a valid measurement? 2) Was the sampling valid? 3) Was there a change in water use after xeriscapes were implemented? and 4) Did persons with xeriscapes who received the newsletter lower their landscape water use? Water demand equations were modeled using regression analysis. Data on the price of water, minimum charges, lot sizes, rainfall, temperature, income, the number of persons per household, and the use of an irrigation system were analyzed without using the xeriscape classification system, which was analyzed separately.

Results: The landscape test was shown to be a valid measure of xeriscapes. Higher scores show that more xeriscape principles are being used correctly. The tests indicated that two distinct populations were sampled in the first study. This means that comparisons between those with xeriscapes and those that do not use them can't be performed without more socioeconomic data. As a result, the focus shifted to only those who implemented xeriscapes. Homeowners with xeriscapes decreased their household water use by 2,024 gpm. Households that install xeriscapes typically have higher incomes than those who do not and are less sensitive to the price of water. Newsletter recipients are more likely to utilize xeriscape methods, and are less sensitive to rain because they use xeriscapes that are more drought resistant. Analyses of the xeriscape classification test show that an increase of one point results in a reduction in water use of 33 gallons per day (gpd) for those who installed xeriscapes and received the newsletter. For those who did not install xeriscapes, an increase of one point in the classification test predicts in an average water savings of 116 gpd. The differences are more pronounced at the low end of the scale.

References: Sokulsky, K., M. Nieswiadomy, T. Gregg, B. Cobos, J. Gleason, and N. Mullarkey, "The Effectiveness of Xeriscape Practices: Questions Regarding Research Method, Policy and Planning," Presented at Conserv '93, Las Vegas, NV. **Note:** Nieswiadomy can be reached at (817) 565-2573.

Effectiveness of Vegetative Buffer Strips to Treat Non-Point Source Pollutants: An Austin Case Study

Researchers: Roger Glick, Agricultural Engineering Department, and Thomas Thurow, Rangeland Ecology and Management Department, Texas A&M, University, College Station, TX; and Mary Leigh Wolfe, Agricultural Engineering Department, Virginia Tech University, Blacksburg, VA.

Problem: Many urban areas are trying to reduce the levels of nonpoint source pollutants. One treatment technique that has been proposed is to plant vegetative buffer strips of grass and shrubs between pollutant sources and nearby lakes and rivers. Few studies have been done to quantify the effectiveness of these buffers, or to develop science-based design guidelines for such systems.

Objectives: 1) To determine the influence of the type of vegetation, slopes, the width of the buffers, and infiltration rates on the performance of the buffer strips in reducing levels of key nonpoint source pollutants; 2) To evaluate and refine mathematical buffer strip models for urban areas; and 3) To perform sensitivity analyses of buffer strip simulation models to determine key variables that most influence model results.

Methodology: Test plots were established to monitor the water quality of runoff from an Austin parking lot. Four treatments were tested: mowed and unmowed Bermuda and Johnson grasses, and existing and cleared woodlands that consisted mainly of common red cedar, live oak, Ashe juniper and winter grass. Water samples were collected by using a series of overland flow flumes that were placed at regular intervals between the entrance and exit of the buffer zones. Water quality samples were taken and analyzed for such parameters as total suspended solids (TSS), ammonia nitrogen (NH3), Kjeldahl nitrogen (KN), nitrate (NO3), phosphorus (P), lead (Pb) and fecal coliform bacteria. Infiltration was determined through the use of a rainfall simulator. A physically based simulation model was developed to estimate the volume of sediment in runoff. The model was tested using field data collected in the study.

Results: Concentrations of TSS, Pb, KN, NO3, and P were significantly reduced by the type of vegetation used and the width of the buffer strips. Mowed and unmowed grassy areas showed the lowest levels of pollutants, while woody areas showed much higher concentrations. Infiltration capacity was highly correlated to the type and amount of vegetative cover. The influence of slopes was not statistically significant. Contrary to results from other studies, the research showed that pollutant levels became greater as the width of the buffer strips increased. This may be because of excess transport capacity. In other words, as the runoff moves through the buffer strips, pollutants were detached and transported within the strips. If the buffer strips are sufficiently wide, pollutant levels may decrease. The simulation model predicted the long-term average results of a series runoff events, but did not perform well in estimating the results from individual storms.

Reference: Glick, Roger, Mary Leigh Wolfe, and Thomas Thurow, *Effectiveness of Native Species Buffer Zones for Nonstructural Treatment of Urban Runoff* (TR 156), Texas Water Resources Institute, Texas A&M University, College Station, TX, 1994.

NOTE: This study was funded by TWRI and a technical report about the project (TR-156) is available free by calling TWRI (409) 845-1851.

Impact of a West Texas Sludge Application on Infiltration and Erosion

Researchers: Richard Zartman, Plant and Soil Science Department, and David Wester and Ron Sosebee, Range and Wildlife Management Department, Texas Tech University, Lubbock, TX.

Problem: Sludge, also known as biosolids, is now being applied at the MERCO site near Sierra Blanca in West Texas. Although the program appears to be beneficial for the environment, there is a great deal of anxiety in the general public as to whether such land application practices will cause increased runoff and non-point source pollution. More information is also needed on how sludge applications influence the amount of available soil moisture.

Methodology: A portable, single nozzle, rainfall simulator was constructed. Runoff was collected from four groups of 10 plots. Five of the 10 plots were vegetated and five were bare. Each of the five plots in each treatment were treated with sludge applications of 0, 3, 8, 15, and 40 dry tons per acre. Runoff flowed from individual plots into a collection pan. The volume of runoff, infiltration, and absorption were measured. Water samples were filtered in the lab to remove sediments and such parameters as biomass, bulk density, and particle size distribution were measured.

Results: Plots with vegetation experienced 12 times as much infiltration as plots that were bare. More infiltration was recorded as sludge application rates increased. Roughly 1.34 mm of water was absorbed in the sludge for every 10 tons that were applied. Erosion from the bare soils was 1.88 tons per acre, but was much less in soils with vegetative cover. In general, runoff, infiltration, and erosion were influenced much more by the existence of vegetative cover than by sludge application rates. However, the amount of water absorbed is a function of sludge application rates.

Reference: Zartman, Richard, David Wester, and Ron Sosebee, "Biosolids Application: Effect on Infiltration and Erosion," in *Basic and Applied Research on the Beneficial Use of Biosolids on the Sierra Blanca Ranch*, Texas Tech University, Lubbock, TX, 1993.

Editor's Note

Research projects in this section were funded by the Texas Higher Education Coordinating Board through its Advanced Technology and Advanced Research Programs. Most of the studies have just begun. Follow up information is provided on a study which was funded in 1992. We will continue to publish research results from previous ATP/ARP studies as they become available.

Understanding Spread of Turtle Grass Along South Texas Coast is Goal of UT MSI, UT-PA Researchers

Along some parts of the lower Laguna Madre, scientists with the National Biological Survey have noted that seagrasses are being replaced by turtle grass. A study that will be carried out by researchers at the University of Texas Marine Science Institute (UT MSI)

at Port Aransas and the University of Texas Pan American (UT-PA) aims to better understand the conditions that cause turtle grass to grow and thrive.

Kenneth Dunton of the University of Texas Marine Science Center collects seagrasses from the Laguna Madre

The lead researchers in the study are Kenneth Dunton of UT MSI and Frank Judd of the UT- PA Coastal Studies Laboratory on South Padre Island. The overall goal of the study is to learn more about the light requirements and carbon budgets for a turtle grass, *Thalassia testudinum*, that has increased by 800% in the Laguna Madre, and has largely displaced a shoalgrass (*Holdule wrightii*).

The research will consist of studying the turtle grass at Corpus Christi Bay near East Flats and in the Lower Laguna near Port Isabel. Monthly measurements will be made of photosynthetically active radiation and leaf growth. Samples were be taken quarterly for in situ photosynthesis, plant biomass, carbohydrate reserves, sediment and water column biogeochemistry, and chlorophyll content.

The studies will be important because turtle grass could be more vulnerable to a large scale die-off. Also, shoalgrass is the most important food source for redheaded ducks.

For details, call Dunton at (512) 749-6744 or Judd at (512) 761-2644

Lamar, Texas A&M-Galveston Study Examines Carbon Cycling, Biological Productivity, in Sabine-Neches Estuary

Relationships between the levels of carbon, plant pigments, and radionuclides and biological productivity in the Sabine-Neches estuary were the focus of a project by researchers at Lamar University (LU) and Texas A&M University at Galveston (TAMU-G).

Thomas Bianchi of the LU Biology Department and the Center for Coastal and Marine Studies, and M. Baskaran and of the TAMU-G Oceanography Department were the lead researchers in the study. Others that participated include Joseph DeLord of LU, and M. Ravichandvan of TAMU-G.

The study was conducted from March 1992 to October 1992. Samples were taken at nine stations representing the upper, lower, and mid regions of the estuary. Data were collected on freshwater inflows, chlorophyll, particulate organic carbon (POC), dissolved organic carbon (DOC), and other parameters. Baskaran and Ravichandvan performed radionuclide analyses using lead-210, berelium-7, and thorium-234 to determine sedimentation rates and residence times of particulates.

Thomas Bianchi of the Lamar University Biology Department examines sediments from the Sabine-Neches Estuary

Fisheries in the Sabine-Neches estuary have declined during the past 30 years.

The study suggests that part of the problem may be that dam construction and management releases too much water at the wrong times of the year, creating what is in reality a freshwater system. The large freshwater releases also create short residence times of 8 to 10 days and low carbon production. The study also showed that levels of chlorophyll-a and POC were extremely low in comparison to other shallow estuaries. The unusually high carbon to chlorophyll-a ratios indicate that much of the POC contains low levels of chlorophyll that originated in wetlands in the watershed. The average sedimentation rate in the estuary is about 0.2 inches per year.

For details, call Bianchi at (409) 880-8253 or Baskaran at (409) 740-4515.

SWT, UTA Researchers to Study Impact of Prehistoric Vegetation Change on Global Climate, Hydrology

Researchers from Southwest Texas State University (SWT) and the University of Texas at Arlington (UTA) have been awarded a grant to determine how vegetation changes in prehistoric times affected global climate. Information from the study will provide insights into how current global deforestation could alter future climates.

The project leaders are Garland Upchurch of the Biology Department at SWT and Bette Otto-Bliesner and Christopher Scotese of the Geology Department at UTA. The goal of the project is to identify the climatic impact of ecosystem changes that occurred with mass extinction at the boundary between the Cretaceous and Tertiary periods 66 million years ago. Specifically, the investigators want to learn whether dinosaurs ate enough vegetation to increase the amount of arid and subhumid land, and to determine how a

mass kill of woody vegetation and a subsequent re-establishment of ferns at the end of Cretaceous period affect the global climate.

The researchers will utilize a global climate computer simulation model called GENESIS to explore the role of vegetation in hydrology, climate change, and other ecosystem parameters. The model will be installed and run on a Cray Supercomputer. Boundary conditions will be established by entering data on CO^2 levels, land elevation, vegetation, and land-sea interfaces for the prehistoric period. Simulations will be performed for scenarios dealing with forests, tundra, and fern recolonization.

For more details, call Upchurch at (512) 245-2178 or Otto-Bliesner at (817) 273-2987.

UT Dallas Study to Measure Water Quality by Testing Oyster Shells

A project by scientists at the University of Texas at Dallas will examine isotopic and trace element chemistry of oyster and barnacle shells to establish historical records of pollution and other environmental stressors.

The study will be led by Scott J. Carpenter of the Geosciences Program. In the study, Carpenter will collect oysters and barnacles from Galveston Bay sites where sludge is now being dumped. This will provide a detailed record of environmental events from a nearby oyster reef that died in the last decade. Cadmium levels and stable isotope ratios of carbon and oxygen in shell calcite will be measured to determine a detailed (biweekly to monthly) record of environmental changes during the past decade. The analyses will also provide information on the basic mechanisms responsible for biomineralization.

The oyster and barnacle shells are good indicators of local pollution, because they are not mobile and live near the sediment-water interface where pollution buildup is often elevated. Rather than measuring for trace elements in the soft tissue of oysters, as is currently done, this study will examine the oyster shell. The advantage of this method is that the organisms regularly purge the soft tissue of unhealthy cations such as cadmium. As a result, oyster meat analysis may only reflect a few months of contamination. In contrast, oyster shells record several years of contamination. The study may provide a new method of monitoring pollution in shellfish producing areas like Galveston Bay.

For details, call Carpenter at (214) 690-2481 or via E-mail at SCarp@utdallas.edu.

Texas Tech, TAES Assess Cattle Waste Management

Researchers at Texas Tech University and the Texas Agricultural Experiment Station (TAES) are determining the economics of environmentally friendly methods to manage feedlot wastes. Lead scientists in the study include Eduardo Segarra of Tech's Agricultural Economics Department and Wyatte Harman, an agricultural economist with the TAES Blackland Research Center.

The problem is that roughly 10 million dry tons of manure is being generated by the estimated 5 million head of beef cattle that are produced annually at High Plains feedlots. There are concerns that the nitrate and fecal bacteria in the manure could pollute nearby

groundwater systems and rivers and could be a significant source of non-point source pollution.

Segarra and Harman hope to evaluate if it is feasible to apply much of the manure to 1.1 million acres of irrigated land in the region. The manure could provide needed fertilizers, and has the potential to reduce irrigated farming costs by roughly $18 per acre. It's now hard to link feedlot managers that produce the waste with the farmers who need it.

The research will focus on using simulation models to develop supply and demand forecasts for manure. The models will estimate conditions for sustainable and environmentally safe cropping systems that encourage conservation. The goal is to develop a spatial optimization model that will include seasonal supply and demand information.

For details, call Segarra at (806) 742-2821 or Harman at (817) 770-6600.

UH Study Examines if Geothermal Wells Can Help Aquaculture Work Year-Round

For some time, year-round aquaculture production in Texas has been hindered by cold winter temperatures. A project by engineers at the University of Houston will explore a potential solution -- the use of warm geothermal well water.

Richard Bannerot and Stan Kleis of UH's Mechanical Engineering Department are the lead scientists in the study. Research will be conducted at Redfish Unlimited's aquaculture plant at Palacios. The project will consist of pumping up to 800 gallons per minute of warm (73deg. F) brackish water into two 6.45 acre ponds. Two scenarios will be tested: an open-ended refuge where well water will freely flow into an aquaculture pond, and a pond that utilizes a partial curtain that will retain warmer and less salty water on the surface of the refuge area. Low-cost heat exchangers will also be investigated.

The success of the project will be determined by measuring temperature and oxygen conditions, the number of fish that are produced, the number of fish that are killed, energy consumption (for aeration and pumping) and energy costs. If successful, the research could be applicable for sites with geothermal groundwater throughout Texas.

For more detailed information, call Kleis at (713) 743-4536 or Bannerot at (713) 743-4511.

TAES, Texas A&M, Researchers to Use Real Time Data, Simulation Models, to Control Drip Irrigation

Researchers with Texas A&M University and the Texas Agricultural Experiment Station (TAES) are conducting a study to instantly measure crop water use and control the amount applied through drip irrigation.

Principle investigators in the project are Robert Lascano of TAES in Lubbock and Jim Heilman of the Texas A&M Soil and Crop Sciences Department. Other cooperators include Soil and Crop Science Dept. emeritus researcher Cornelius van Bavel (now a consultant), Steven Evett of the USDA/ Agricultural Research Service in Bushland, and private companies.

The overall goal is to implement a system that combines "real time" knowledge about crop water use to accurately apply irrigation water. The system is expected to provide improved estimates of agricultural water use. It is also much easier to use the system than existing methods, such as weighing lysimeters.

Initially, software will be coded to collected and process data, run the simulation model, verify calculated values, and activate the drip irrigation system. Later, case studies will be conducted using irrigated cotton near Lubbock. Plant water use will be measured with electronic gauges that are attached to the stem of the plants. Soil water data will be measured using time domain reflectometry. This information will be compared with values for crop water use calculated through a Texas A&M University simulation model called "ENWATBAL." The system will then determine how much irrigation is needed and will control how much water is distributed through a drip irrigation system.

For additional information, call Lascano at (806) 746-6101 or Heilman at (409) 845-7169.

UT, UT-Pan Am, UT-Brownsville to Develop GIS for Lower Rio Grande

A Geographic Information System (GIS) that concentrates on environmental information in the Lower Rio Grande Valley is being developed by researchers at the University of Texas at Austin (UT), the University of Texas-Pan American (UT-PA) and the University of Texas Brownsville (UT-B).

The overall objective of the study is to produce an environmental baseline of the region that reflects the current status. The data in the GIS can then be used to compare to future changes. Initially, the GIS will focus on Cameron and Hidalgo counties. Ground and surface water resources, geology, geography and other natural resource issues will be included in the GIS. Information from Mexico that affects resources along the border will be included.

After the project is completed, it should constitute a planning tool that could be utilized to site needed infrastructure (bridges, roads, and treatment plants), as well as parks and wildlife refuges. The GIS will be available both as a computer file and as a printed document.

Lead scientists on the project include Jerry Wermund of the UT Bureau of Economic Geology (BEG), Bob Rodgers of the Geology Department at UT-PA, and Gene Paull of the Geography Department at UT-Brownsville. Collaborators include Tom Tremblay, and Diane Spinney of the UT BEG. For details, call Wermund at (512) 471-7721 or Rodgers at (210) 381-3523.

Texas A&M Project to Help Pecan Growers Access Doppler Weather Data

Providing agricultural producers with rapid access to improved weather forecasts is the goal of a project being conducted by scientists at Texas A&M University.

Project leaders are Michael Biggerstaff of the Meteorology Department and John Jackman of the Texas Agricultural Extension Service. Michael Flynn of the National Weather Service Agricultural Service Center will be a cooperator in the study.

The research involves taking advantage of new Doppler weather radar technology, which provide accurate information on precipitation with high temporal and spatial resolution. The researchers hope to produce high resolution daily maps showing how much precipitation had occurred. The maps would be distributed to county extension agents, who would then pass along the information to pecan and sorghum producers. Drought often delays the emergence of pecan weevils and requires that targeted control programs be implemented. Similarly, midge emergence in sorghum is delayed by drought, but heavy rainfall may actually kill them. In both cases, rainfall data coupled with predictions from models will help agricultural producers better time pest management activities.

The researchers hope this will be a model for future studies involving other crops that can also be rapidly transmitted to agricultural producers.

For details, call Biggerstaff at (409) 847-9090 or Jackman at (409) 845-7027.

UT Scientists Develop New Method to Measure Sediment Buildup

An improved, "high tech," method to survey the buildup of sediments in lakes and rivers is being developed through a research project at the University of Texas at Austin.

Bob Morton and Jim Gilbeau of the UT Bureau of Economic Geology are the lead investigators in the study. The research will develop a high resolution bathymetric surveying system that will consist of a global positioning system (GPS), electronic motion sensors, digital fathometers, and portable computers. The GPS will provide accurate reference data about the exact three-dimensional position at which soundings are taken. Digital fathometers will produce data on the speed of sound in the water column. The system could improve upon existing methods used to gather information on sedimentation rates and to determine the shape of lake and river bottoms. For example, current methods often over- or -underestimate shoreline erosion rates and sediment buildup. The new system could be used on small boats (less than 18 feet long) and in rough waters.

Morton hopes to attach the system to a lightweight 20-foot pole. The fathometer and electronic motion sensors will be lowered to within three feet of the bottom of a lake during each survey. Continuous data will be logged into a portable computer. The system will first be synchronized and tested under controlled conditions in an artificial pond. Plans also call for tests on lakes and open bay waters.

For details, call Morton at (512) 471-1534.

Texas A&M Study Reviews Water Quality in Parks

Research by a Texas A&M University scientist helped lead to improved water quality standards that were recently adopted for three national parks in Texas.

Ronald Kaiser of the Recreation, Parks, and Tourism Sciences Department recently led a team effort to assess whether existing state water quality standards were adequate to protect the waters and related resources at nine national parks in Texas. The study, which was funded by the National Parks Service (NPS) and the Environmental Protection Agency, involved reviewing master plans for each park to determine water dependent activities and resource needs. Texas Natural Resource Conservation Commission (TNRCC) water quality standards above and within each park were then evaluated to determine if they protected aquatic ecosystem and recreation needs.

Recently, the TNRCC utilized the report as part of its tri-annual review of water quality criteria. The TNRCC agreed with a conclusion in the report that streams in the Guadalupe Mountains National Park be designated as "outstanding natural resource waters." As a result, these waters will receive special anti-degradation protection. The TNRCC and the NPS are now considering if water quality standards in the Big Thicket and Big Bend national parks need to be strengthened.

For details, call Kaiser at (409) 845-5303.

TEEX Course Teaches How to Identify Wetlands

A new course offered by the Texas Engineering Extension Service trains participants how to identify regulatory wetlands.

The five-day, 36-hour course, which includes 14 hours of practical field methods, is taught by TEEX instructors Nancy V. Smith and John Jacob.

Participants in a TEEX wetlands course get extensive hands-on training on how to identify specific plants and soils.

Basic components of the course include training on wetlands hydrology and vegetation, hydric soils and general soil classification, and wetland identification and delineation techniques.

The course follows guidelines set forth by Corps of Engineers in their 1987 training manual. A certificate of training will be awarded to each student that successfully completes the course and passes a written test. The course is one component of the Corps'

proposed requirements for certified wetlands delineators (other requirements are 1 year of practical experience and a field test that demonstrates competence).

The course is being offered May 23-27 in Lubbock and June 27 to July 1 in Houston. For more details, call Smith or Jacob at 1 (800) 252-2420 or (409) 845-3418.

USGS Uses Satellite Data to Estimate Edwards Aquifer Irrigation Use

The U.S. Geological Survey (USGS) is testing the use of satellite images to estimate how much groundwater is being used for irrigation along the Edwards Aquifer.

Lee Raymond and Scott McFarlane of the USGS Austin recently performed a case study to determine if Landsat Thematic Mapper (TM) data would accurately estimate the amount and type of irrigated crops grown in Uvalde and Medina counties. Typically, irrigation water use is estimated by interpreting aerial photographs or by time-consuming field surveys and farmer interviews.

The case study used Landsat TM data from August 1991. The image included several spectral wavelengths to identify vegetation types, biomass content, soil moisture, and plant vigor. The information was imported into a Geographic Information System so that maps could be prepared showing irrigated and non-irrigated areas with corn, cotton, and grain sorghum. Site visits helped calibrate Landsat data and well records provided water application rates.

Results show that irrigated acreage dropped by 35% in Uvalde County and 14% in Medina County, compared to a 1989 study that used Landsat multi-spectral (MSS) images. The total acres of irrigated crops were 9% less in Uvalde County and 13% less in Medina County than previous estimates. Groundwater use was estimated to be 28% less in Uvalde County and 56% less in Medina County than results from the 1989 MSS survey. This may be due to above average rainfall that occurred in 1991.

For details, call the USGS Austin office at (512) 873-3020.

San Angelo Asked to Lower Water in Twin Buttes Dam

The City of San Angelo has been asked by The U.S. Bureau of Reclamation to reduce the amount of water stored in Twin Buttes Reservoir, because of fears the dam may leak. The Bureau is asking that the amount of water stored be limited to 66% of the "conservation level" or 110,000 acre feet (AF). The dam was designed to hold 186,000 AF for conservation storage and 640,000 AF overall. In 1984, the Bureau had drilled 60 wells to catch water that flowed through the soil and under the dam. Now, the Bureau is proposing to build a 19,000 foot long cutoff wall to intercept the seepage.

San Angelo officials say the reduction in the conservation pool could increase the risk of a water shortage, especially during a drought.

Texas A&M Researchers Seek Possible Link Between Pesticides, Birth Defects, in Lower Rio Grande Valley

Texas A&M University researchers are conducting a study to determine whether environmental and/or occupational exposure to specific pesticides may be associated with an increased risk for anencephaly (babies born with partially formed brains) and other birth defects in the Lower Rio Grande Valley.

Stuart Shalat of the Texas A&M Health Science Center and Bruce Herbert of the Geology Department are leading the study. The research will concentrate on the primarily Hispanic population in South Texas known to have elevated rates of neural tube defects (NTDs).

The study will focus on Cameron and Hidalgo Counties, which have recently reported higher than normal cases of some birth defects. Cameron County has been the recent target of a cluster evaluation by the Texas Department of Health and the National Centers for Disease Control, which reported that cases of anencephaly were 300% times greater where mothers reported they were exposed to aerial spraying of pesticides. Nueces County will used as a control group.

The study will test whether environmental exposure to specific pesticides may increase the risk of anencephaly, spina bifida, and other diseases; and whether deficiencies in dietary folic acid levels increases the risk of NTDs in the study group. Exposure to pesticides will be assessed using water and household dust. Rapid bioassays will be performed to screen for the presence of six pesticides: atrazine, 2-4 D, cyclodienes, methyl parathion, benomyl, and urea herbicides. Preliminary testing will begin in this summer in Cameron County. Detailed information on medical, occupational, and dietary histories will be obtained by personal interviews of mothers in Spanish and English. Folic acid levels in diets will be determined by 24-hour recall questionnaires. Environmental exposure will be evaluated by testing water and soil samples by immunoassay, gas chromatography, and mass spectrometry for specific pesticides.

For more details, call Shalat at (409) 845-3295 or Herbert at (409) 845-2405.

TNRIS Establishes Texas-Mexico Clearinghouse

The Texas Natural Resource Information System (TNRIS) has established a clearinghouse that will provide natural resource and demographic data for the Texas-Mexico border region.

The Borderlands Data and Information Center will collect and distribute data related to environmental, public health, infrastructure, and urban planning issues along the border. Data on such subjects as water quality and quantity, surface water development, wetlands, streamflows, and weather are available. The Center also houses aerial photographs, satellite images, digital maps, and geographic information support services.

More details can be obtained by dialing an electronic bulletin board at (512) 475-2089 or by calling (512) 463-8337.

HARC Studies Impacts of Global Warming

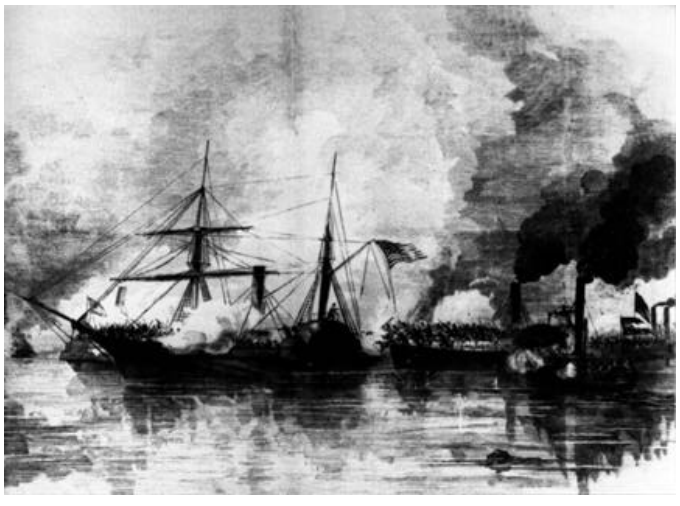
A new study coordinated by he Houston Advanced Research Center (HARC) suggest that global climate change may significantly change rainfall and temperature patterns in Texas. The study, which was released in December, was an effort between HARC, the Texas Natural Resource Conservation Commission, the Texas Water Development Board, the Environmental Protection Agency, and other groups.

The studies assessed the potential impact of global warming on Texas' water supplies. A scenario was evaluated in which temperatures would rise by 3.5deg. F and precipitation would change by 20% by the year 2050. The report suggests that water supply shortages could severely affect agriculture and municipal demands if those climate changes occur. Global warming could create many water-related problems throughout Texas. Along the coast, fresh water inflows could decrease and the level of the Gulf of Mexico is likely to rise. If global climate change occurs, it may also produce some benefits. Global warming could boost carbon dioxide levels. Increase levels of carbon dioxide could be beneficial for barley, wheat, cotton, rice and other crops. The study also explored if a "carbon tax" could slow the impact of global warming.

Researchers that participated in the study include Jurgen Schmandt and John Wilson of HARC, John Griffiths of the Texas A&M University Meteorology Department, Bruce McCarl of the Texas A&M University Agricultural Economics Department, and Dick Richardson of the Zoology Department at the University of Texas of Austin.

For details, call Carol Flores at HARC (713) 367-7913.

Maritime Museum Exhibit Focuses on Texas' Coastal Civil War Battles



An exhibit that features battles fought along the Texas coast during the Civil War is being shown at the Texas Maritime Museum in Rockport. The exhibit, titled "The Texas Coast in the War for Southern Independence," depicts the naval battles and military campaigns associated with the invasion and defense of the Texas coast during the Civil War. The display features the battles of Sabine Pass, Galveston, and Corpus Christi; skirmishes between the Union blockade and Confederate blockade runners; and coastal land battles. The exhibit includes numerous photographs, as well as a sword worn at the Battle of Sabine

Pass, and a cannon ball fired by a Union ship at the Battle of Corpus Christi. The exhibit runs through April 30. For details, call (512) 729-1271.

New TWRI Reports Deal with Vegetative Buffer Zones, Water Flows Through Clay Soil

Three new technical reports are available from the Texas Water Resources Institute.

Effectiveness of Native Species Buffer Zones (TR 156) was written by Roger Glick of the Texas A&M University Agricultural Engineering Department, Mary Leigh Wolfe of the Virginia Tech University Agricultural Engineering Department, and Thomas Thurow of the Texas A&M University Rangeland Ecology and Management Department. The report describes a research project that was conducted in Austin to assess the performance of woody and grassy vegetative filter strips in controlling nonpoint source pollutants. The result also describes a physically based model that was developed to simulate sediment yield through the buffer strips that were studied.

*Water and Solute Flow In A Highly Structured Soil (*TR 160*)* was written by Willem Heuvelman, Kevin McInnes, Larry Wilding, and C. Tom Hallmark of the Texas A&M University Soil and Crop Sciences Department. The report focuses on research that was conducted to measure how cracks and channels in clay soils may increase the risk of groundwater contamination. The report contains information on a flow interceptor that was developed to measure the movement of water through different soil horizons. Field measurements and modeling results are also included.

Farmers, Lenders and Water Districts Response to Texas' Low Interest Program for Water Conservation in Agriculture (TR 161) was written by Ron Lacewell of the Texas A&M University Agricultural Economics Department and Eduardo Segarra of the Texas Tech University Agricultural Economics Department. The report describes a joint effort between Texas A&M and Texas Tech to survey farmers, lenders, and water district managers about the low-interest loan program. Texas Tech researchers surveyed these entities on the High Plains, while Texas A&M scientists conducted similar surveys for the Winter Garden Region and the Lower Rio Grande Valley. One key finding of the report is that the requirement for a water district to serve as a banker is a major limitation. There was also a strong interest in increasing education and technical support about the program in the Rio Grande and Winter Garden areas.

TWRI has also begun producing another newsletter series titled *Texas Water Savers*. This newsletter series will focus on urban, industrial, and residential conservation. To receive a free subscription to any of TWRI's newsletters or for information on any other TWRI publication, call the Institute at (409) 845-1851.

Information About Water Institutes Now Available on Internet

People needing information about current water research can now obtain it electronically, thanks to a computer database established by the Universities Council for Water Research

(UCOWR). The database is supported by UCOWR and the U.S. Geological Survey (USGS).

The program is known as the University Water Information Network (UWIN). Currently, users can search for information from USGS Selected Water Resources Abstracts, the National Institutes for Water Research Directory, a Directory with U.S. and international experts, meetings and conferences, job listings, and funding opportunities. A directory that lists the expertise of university researchers is available for a few states. TWRI hopes to include the *Directory of Water Related Researchers at Texas Universities* on UWIN when it is published this summer.

To access UWIN with Gopher, type in "Gopher Gopher.C-WR.SIU.EDU". UWIN can be accessed via telnet at "Telnet Gopher.C-WR.SIU.EDU". If you have a modem and communications software, you can dial into UWIN at (618) 453-3324. A brochure that explains the details of how to access and use UWIN is available by writing: UWIN, UCOWR Headquarters, 4543 Fanner, Southern Illinois Univ., Carbondale, IL 62901. Their e-mail address is Faye@uwin.c-wr.siu.edu.

Galveston Bay NEP Reports Focus on Wetlands, Other Issues

A new report on wetlands and habitats in Galveston Bay that was conducted by University of Texas researchers has been published by the Galveston Bay National Estuary Program (GBNEP). The study, *Trends and Status of Wetland and Aquatic Habitats in the Galveston Bay System* (GB 31), was written by William White, Thomas Tremblay, and Jerry Wermund of UT's Bureau of Economic Geology, in cooperation with Lawrence Handley of the U.S. Fish and Wildlife Service's National Wetlands Research Center.

Other new reports published by GBNEP include: *Non-Fishing Human Induced Mortality of Fisheries Resources in Galveston Bay* (GB 20), *Probable Causes of Trends in Selected Living Resources in the Galveston Bay System* (GB 33), *Trawling Bycatch in the Galveston Bay System* (GB 34), *Recreational Fishery By-Catch in the Galveston Bay System* (GB 25), *Sediment Quality Assessment Survey of the Galveston Bay System* (GB 30), and *Sources and Distribution of Debris in the Galveston Bay Estuary* (GB 35).

To order any report, call the GBNEP at (713) 332-9937.

Proceedings Focus on Use of Biotechnology for Arid Plants

A conference proceedings that focuses on the use of biotechnology for plants in arid regions has been published by the IC^2 University of Texas (UT) at Austin.

The 370-page report, *Biotechnology for Aridland Plants*, was edited by Tom Mabry and M.S. Bonness of the UT Botany Department, Henry T. Nguyen of the Texas Tech University Institute for Biotechnology, and R.A. Dixon of the Samuel Roberts Noble Foundation. The proceedings contains papers that were presented at a conference titled "Applications and Prospects of Biotechnology for Arid and Semi-Arid Lands" that was

held at Texas Tech in November 1992. Topics include physical adaptations, genetic analyses, drought resistance, salt stress, and disease resistance.

The proceedings cost $30. To order a copy, contact Mabry at the UT Botany Department at (512) 471-1900.

Concordia Lutheran Studies Impact of Water Supplies On Cotton Production

The history and water use of cotton in Texas is the focus of studies by Thomas Orton of the History and Geography Department at Concordia Lutheran College in Austin.

Orton's studies analyzed how the major cotton growing areas in the U.S. shifted over time. For example, his studies show that dryland cotton production in the "Old South" (east of the Mississippi River) declined dramatically after World War II and all but disappeared by the 1970s. It was replaced by irrigated cotton in the Texas High Plains and California. Some scholars had claimed that cotton production in the Old South had "reclaimed its legacy" in the 1980s and early 1990s.

Orton says the major reason for the shift in production is the sure supply of water in the High Plains, which guards against drought and provides irrigation when farmers need it. The ability to irrigate made cotton production viable in areas with less than 40 inches of rain per year. For example, the High Plains often gets an average of only 20 inches of rainfall per year, and the Gulf Coast only about 25 inches annually. Orton has also compared the areas in Texas where cotton is irrigated and concludes they haven't changed dramatically since the 1920s and are not likely to change anytime soon.

An article on the subject is featured in the Spring 1992 issue of *Agricultural History*. For details, call Orton at (512) 406-3126.

Baylor Biologist Studies Tadpoles, Salamanders to Assess Acid Rain Damage

For many years, scientists studying acid_rain kept track of numerical data. For example, how was the pH of rainfall changing? Now many biologists, including Benjamin Pierce of Baylor University, are looking at the life cycles of amphibians to determine how acid precipitation is affecting aquatic species.

Pierce believes that amphibians such as tadpoles and salamanders may be particularly vulnerable to acid rain because they often live in small ponds that are refilled after storms. Because of the rapid recharge, the waters may not come in contact with soils and other buffers for a sufficient time to modify acidic pollutants. Other reasons for concern are that ponds are often low in calcium and alkalinity and that many amphibian species breed in early spring when pH levels are lowest.

Pierce's studies also show that low pH levels often decrease hatching rates and increase the risk of physical and behavioral abnormalities. However, the effect of pH varies

somewhat by species. His research also suggests that amphibian larvae are more tolerant of acid waters than embryos and typically are not killed until the pH drops below 4. Acidic soils may also have similar detrimental effects.

For more information, call Pierce at (817) 755-2911.

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.

For details, call McCullough at (409) 568-3601.

Texas A&M Galveston Scientists Use Caves to Measure Climate History

Scientists at Texas A&M University-Galveston have found a new method to determine the age of limestone deposits in caves that may yield clues about the earth's climate history.

Mahalingham Baskaran of the Marine Science Department and Thomas Iliffe of the Marine Biology Department are leading the project. They collected limestone deposits including "soda straws" and stalagmites from caves in San Saba County in West Texas. They later performed detailed chemical analyses. The researchers found that the deposits contain excess amounts of a radioactive isotope of lead (Pb 210) that could be used to confirm paleoclimatic records developed by other methods.

Recently, Baskaran and R. V. Krishnamurthy of Western Michigan University determined that these cave limestone deposits can be used to determine historic levels of atmospheric carbon dioxide. This could provide baseline data for studies dealing with global warming caused by the increased use of man-made greenhouse gasses. Baskaran's research shows that the use of such limestone deposits yields more accurate data than tree rings or ice cores, which are other commonly used methods to estimate historical climate records.

The research was featured in the December 23, 1993 issue of *Geophysical Research Letters*. For details, call Baskaran at (409) 740-4515.

Texas A&M-Kingsville Citrus Center, TAES, Researchers Study if Sodding Orchards Improves Drainage Water Quality

Researchers with the Citrus Center at Texas A&M University-Kingsville (TAMU-K) are working with scientists from the Texas Agricultural Experiment Station (TAES) at El Paso to determine if planting grass between rows of orchard crops can lessen nutrient and pesticide leaching.

The project is being carried out by Dariusz Swietlik of TAMU-K and Seiichi Miyamoto and Lloyd Fenn of TAES in El Paso. The goals of the study are to evaluate if sodding improves drainage water quality by filtering out pollutants, to evaluate the impact of slopes on the amount and quality of runoff, and to assess if microsprinkler irrigation is more efficient than furrow irrigation, which is now used widely in the Valley.

The researchers are now evaluating the use of different sods (Buffalo, orchard, and bahia grass and white clover) in citrus orchards in the Lower Rio Grande Valley and pistachio orchards and the El Paso area. A component of the studies involves measuring the amount of pesticides that drain from the orchards.

Preliminary results suggest that sodding is highly effective at reducing nitrate leaching into groundwater, but can also increase water use and nitrogen consumption unless properly managed. The use of microsprinkler irrigation may improve drainage water quality and conserve water.

The project was funded by the Texas Water Development Board. For details, call Swietlik at (210) 968-2132 or Miyamoto or Fenn at (915) 859-9111.