New Waves
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"MesoNet" May Improve Weather Forecasts, TAMU Says

By Jennifer Robinson

TWRI Science Writer

Texas has some of the most varied weather patterns in the country, yet experts believe it may be severely lacking in resources to track the weather systems. To resolve this problem, researchers from Texas A&M University (TAMU) have proposed a plan for a Texas MesoNet, which is a dense network of meteorological monitoring stations.

The move to create the Texas MesoNet is being led by Gary Sickler and Bruce Gammon of the TAMU Meteorology Department.

Sickler and Gammon hope to involve Texas power companies in the project, and have been met with positive responses. Staff members of the Lower Colorado River Authority have observed that a natural fit exists between the electric power grid and the Texas MesoNet, Sickler said. Gammon explains that "power companies have their communications systems already in place, and a significant part of the cost of the MesoNet is the relaying of data back to a central system. In addition, the power companies' maintenance crews could maintain the MesoNet equipment for a small incremental cost."

Currently only 50 of Texas' 254 counties have the capability to observe and share weather information as it is happening, so naturally there are many large gaps in the system. The proposed MesoNet would have 330 inland stations and 30 offshore stations to provide this type of instant weather information, including rainfall and soil or water

temperature at 15-minute intervals to anyone with access to the Internet. As many as 86 inland and 4 offshore stations would provide essential forecasting information on wind and temperature profiles to as high as 10,000 feet.

Oklahoma has had a MesoNet in place since 1994. Oklahoma data suggest that Texas could potentially save around $100 million per year in the agriculture business alone, if a MesoNet were in place. For example, farmers and ranchers may benefit from having access to wind speed and direction data for pesticide applications. Being able to receive updated information on soil temperatures would indicate the best time to plant seed for proper germination.

Gammon and Sickler say that the MesoNet could benefit water conservation and improve flood control, because it would provide instantly updated measurements of rainfall. During floods, measurements from the MesoNet could assist hydrologists to better forecast runoff. During droughts, measurements from the network would contribute significant elements to the assessment of water conditions and short-term demands for water.

Texas has a large network of freshwater resources, but they too need to be conserved and protected. Irrigation accounts for 82% of freshwater use in the state. Because the MesoNet would better document local weather patterns, it could be used with computer modeling to schedule more water-efficient irrigation.

TAMU-Dallas Scientists Study Runoff Pollution from Landscapes

Can the use of water-efficient landscapes also lessen the threat of non-point source pollution? Based on research conducted at the Texas A&M University Research and Extension Center at Dallas, the answer may be a resounding "Yes."

At the Center, long-term studies of landscape pollution and water use have been conducted for many years by James Reinert and colleagues. He says the studies are important because it has been estimated that as much as 240,000 pounds of nitrogen and 24,000 pounds of phosphorus run off Dallas-area landscapes each year.

Often, field studies are conducted using a specially designed "microlandscape" that has been instrumented so that soil moisture, meteorological conditions, and pollutants in landscape runoff can be measured automatically and accurately.

In a recent study, the landscape was planted to either require high levels of inputs (Tifway Bermudagrass and yaupon holly) or as resource-efficient landscapes (Prairie Buffalograss and salvia). Each landscape type is planted with 75% turf and 25% mulched landscape plants.

Reinert and colleagues managed each landscape to match prescribed levels of pesticide inputs and water use to the landscape plants. The most input intensive landscape received nearly 400 pounds of nitrogen per acre (lb/a) annually, roughly 100 lb/a of phosphorus each year, and more than 150 grams per acre of the herbicide 2, 4-D annually. In

addition, irrigation matched 70% of annual pan evaporation. In contrast, at the other extreme of the four management systems, all nutrient inputs and water supplies were withheld from the Xeriscape. During the three-year study, the quality of each landscape was continually measured by examining the color and growth of its turf and plants.

According to Reinert, the research demonstrates that runoff water quality can be improved through the use of resource-efficient plants in the landscape, because fewer pollutants are needed to maintain an acceptable appearance. Additionally, the amount of runoff is greatly reduced because resource-efficient landscapes do not require significant irrigation.

The research was presented at a field day at the Center in 1997. For details, contact Reinert at (972) 231-5362 or j-reinert@tamu.edu.

Impacts of Diminished Water Quality on Municipal Water Treatment Costs

Researchers: David Dearmont, Nebraska Department of Revenue, Lincoln, NE; Bruce A. McCarl, Department of Agricultural Economics, Texas A&M University, College Station, TX; and Deborah A. Tolman, Department of Environmental Sciences and Resources, Portland State University, Portland, OR.

Problem: The cost of municipal water treatment due to diminished water quality represents an important component of the societal costs of water pollution. Efficient management of water supplies must balance the costs of cleaning, using, or avoiding use of polluted water. The marginal cost of improving raw water quality generally should not exceed the marginal benefit of such an improvement. An increase in municipal water quality standards, holding other things constant, will increase the benefits from improved raw water quality, but will also boost treatment costs.

Objectives: The goal of this study is to provide information on how the volume of pollutants affect the marginal costs of treating municipal water supplies.

Methods: The costs of municipal water treatment as a function of raw surface water quality were estimated. Sediment was utilized as a primary indicator of water quality. Fertilizers and pesticide levels were also measured because they attach to sediments. The study focuses on Texas cities that rely on surface water as their source of municipal water.

Background: Of 191 Texas cities that use surface water for municipal supply, 142 that treat surface water separately from groundwater supplies were identified. From these cities, systems were identified in the Red, Brazos, Colorado, and Rio Grande river basins. The researchers randomly selected two cities from each of the four river basins, except for the Brazos river basin where they chose four cities including Brenham, which served as the pilot plant for the study. Data on 12 water treatment plants for a three year period were used.

Results and Analysis: Results show that when regional raw water contamination is present, the chemical cost of water treatment is increased from a base of $75 per million gallons (mg) to $95 per mg. A 1% increase in turbidity was shown to raise chemical treatment costs by one fourth of a percent.

The Use of Efficient Water Pricing Policies as a Source of Municipal Revenue

Researchers: John Merrifield and Robert Collinge, Department of Economics, University of Texas at San Antonio, San Antonio, TX.

Problem: There is an emerging emphasis on promoting the efficient allocation of municipal water through the use of marginal-cost "conservation pricing," with a number of cities taking steps in this direction. Even so, efficient pricing policies are rare, with most utilities using average-cost pricing, and others using either inclining or declining block rates that do not present most users with the proper conservation incentives at the margin.

Objectives: Examine the perception that water fees are an unacceptably regressive revenue source, and suggest ways to reduce regressivity without sacrificing water market efficiency.

Background Information: Utilities have resisted marginal-cost pricing because of a perceived conflict with their goals of equity and revenue neutrality. Sometimes revenue neutrality is even codified in state laws or constitutions, although utilities often take a small percentage of water revenue for general budgetary purposes.

Solution: The researchers propose the Collinge Discount Coupon concept. Collinge suggests that a water utility should set a price equal to long-run marginal capacity cost, but distribute marketable discount coupons in a quantity that totals short-run capacity. He also suggests that they offer a water rate equal to short-run marginal production cost from existing facilities. In this manner the demand-determined market price of water discount coupons in conjunction with the rate offered on those coupons establishes accurate marginal-cost pricing that changes efficiently with changes in demand. In one variation, the water utility estimates that actual marginal cost sets the base rate at actual marginal cost, and then achieves equity and revenue goals by setting the quantity of discount coupons to issue and the rate on those coupons. However, the researchers leave it to the reader to decide whether the increase in progressivity is desirable given the consequences, including complexity, special interest politics, and revenue loss.

Conclusions: Reform would help municipal water managers promote water conservation. The use of traditional revenue-neutral rate structure changes raises some households' incentive to conserve only by lowering other households' incentive to conserve. Since the marginal price varies among users, block rates are not efficient. More efficient water use would further reduce fiscal and political stress by reducing the threat to springflows, and by easing the pressure to include economically and ecologically expensive water projects in the city's evolving water plan.

Reference: Collinge, R.A., "Revenue Neutral Water Conservation: Marginal Cost Pricing with Discount Coupons," Water Resources Research, 1992, pp. 617-622. A paper on this topic has been accepted for publication. For details, contact Merrifield at (210) 458-5310 or jmerrifield@utsa.edu.

Creating a Model to Help Negotiate Water Use Conflicts

Authors: Ximing Cai and Daene McKinney, Civil Engineering Department, University of Texas at Austin, Austin, TX.

Problem: In Texas and elsewhere, the limited amount of water available in some regions will inevitably lead to conflicts between various user groups. Traditionally, individuals have resolved water use disagreements based on available data and person-to-person and group discussions. Eventually, a negotiated agreement is developed. For many years, computer simulation models have been used to develop background information and supplemental data to support these negotiations. Recently, there has been substantial interest in developing computer-based models that would provide specific, comprehensive data needed to broker water use agreements. Specifically, a goal has been to develop tools to objectively analyze the comparative value and impacts of various water uses.

Objectives: To develop a multi-objective model to analyze negotiations for water resources allocation.

Developing a Framework for the Model: Many multiple objective models are based on a number of factors, including decision variables, constraints, and objectives. One option that is often used is to assign variable weights to each objective that reflect the relative importance of policy goals. Some of the constraints incorporate physical, policy, and system control limitations. The framework of the model developed in this study brought all the negotiators together to commonly define the problem, and integrated all the negotiators' expectations into an analytical formula. Simulations were conducted to simulate trade-offs between various policies, "what if" scenarios, and sensitivity analyses.

Case Study: A case study was conducted of the Sydarya River, which flows through Kyrgyzstan, Tajikistan, Uzbekistan, and Kazakhstan in the former Soviet Union, before flowing into the Aral Sea. Conflicting objectives in the region consisted of upstream areas wanting to maximize hydroelectric production, and increased flows of water in downstream areas for agricultural irrigation. The multi-objective model was utilized to help decision makers come to an agreement that everyone could support to manage the region's waters. In the case study, the model was run over a 3-year period. Information was generated on maximum and minimum amounts of hydropower that could be generated and its impact on irrigation water availability. Graphs were developed that depict the optimal allocation of waters in the region based on the effects of these trade-offs. Results suggest that this type of model could be very effective in helping different parties realize the impacts of various water management strategies and in weighing the arguments of using water resources for different uses.

Reference: Cai, X., and D. McKinney, "A Multiobjective Analysis Model for Negotiation in Regional Water Resources Allocation," in Aesthetics in Constructed Environments, American Society of Civil Engineers, Houston, TX 1997.

Using Surface and Ground Water Models to Site Waste Management Systems and Prevent Pollution

Authors: K.H. Wang, Civil and Environmental Engineering Department, University of Houston, Houston, TX; and C.C. Chang, Radian International, Houston, TX.

Problem: To protect ground and surface water resources, site assessments are critically important. Waste management strategies should be formulated and corrective measures should be identified before a facility potentially impacting water resources is constructed. Doing so will not only protect the environment, but will also reduce cleanup costs in the event remediation is required.

Objectives: To develop an integrated ground and surface water model to assist in the site assessment of a waste disposal facility sited near a surface water body.

Background Information: A case study was performed in which a waste disposal facility was to be sited near a ship channel. It is underlain by an aquifer, which is shallow (20 to 40 feet below the surface) at this location. The ship channel bisects the aquifer, leading to concerns that chemicals could flow from the site into the aquifer and be discharged into the ship channel. The site consists of several waste management units.

Methods: The site assessment was conducted to determine whether current site conditions could pose environmental and human health concerns. Another purpose was to evaluate the effectiveness of proposed corrective measures to minimize or eliminate the potential effects of pollution from the site. First, previous examinations of this site were reviewed. Then, existing soil and water data and results of previous studies were compiled into a comprehensive database which supported groundwater quality analyses, modeling, and potential impacts on human health and the environment. Later, data on groundwater flow patterns and quality as well as discharge rates, were evaluated and interpreted. Pathways through which chemical constituents could flow from the site were identified. A major task in this study was to develop a computer model to simulate and predict likely chemical exposures from waste discharge. Models were created and utilized to estimate the level and distribution of chemicals of concern that could potentially flow off the site and flow into the ship channel. The model that was developed for this project includes a one-dimensional groundwater fate and transport module, a three-dimensional surface water hydrodynamic module, and a surface water module that simulates the fate of chemicals and how they are likely to move through this system. Model results were used to conduct a site evaluation that met standards of regulatory agencies. In this formal site evaluation, environmentally acceptable concentrations were developed for various chemical constituents and compared to results predicted by the model.

Results: Flows in this reach of the ship channel were accurately predicted in the model and suggest that most of the flow in the ship channel is influenced by tidal forces. Pulses

of chemical constituents that seep from the site into the ship channel were successfully simulated. The likely levels of dissolved chemicals that seep into the ship channel were estimated within a 95% confidence level. The model results suggest that recharge from the waste disposal basins is likely to be the main driving force that influences whether or not potential contaminants will flow into the ship channel. If more wastes are trapped and remain on the site, it is less likely that contaminants would run off into the ship channel.

Reference: Wang, K.H., C.C. Chang, and K.C. Lee, "Site Baseline and Corrective Measures Assessments for Water Resources Protection by Applying Ground Water and Surface Water Modeling," in Aesthetics in the Constructed Environment, ASCE, 1997

TAMU Studies Reaction of Roots of Seedlings to Salt Stress

Researchers: Humberto Gonza‡lez oRdrr'guez and Wayne Jordan, Soil and Crop Sciences Department, Texas A&M University (TAMU), College Station, TX; Justin Roberts, Biochemistry Department, University of California, Riverside, CA; and Malcolm Drew, Horticultural Sciences Department, TAMU, College Station, TX.

Problem: Salinity, whether natural or induced by agriculture, is a widespread environmental stress that can limit growth and development of salt-sensitive plants. Studies of responses of vegetative plants to salt stress have focused mainly on leaf tissue. However, the root is the first organ of the plant to become exposed to salinity, and in some instances it plays a role in exclusion of salt from the leaves.

Objectives: To improve understanding of the response of maize primary roots to salt shock or to a more gradual increase in salt that might allow roots to adjust progressively. Specific objectives were to: 1) determine whether salt shock and salt acclimation at the same final concentration of salt had equally damaging effects on root extension; 2) quantify changes in osmotic relations of root tips during salt stresses to determine whether there were marked losses in pressure potential that might account for inhibition of extension of the roots; and 3) estimate the contributions of inorganic solutes, including sodium and chlorine, and organic solutes to changes in the osmotic potential of roots.

Methods: Seedlings were grown from seed at ±25°C in the dark to minimize transpiration and the transfer of salts to leaves. This method reduced the possibility of an indirect effect of salinity on root growth. Salt was introduced into the standard nutrient solution fed to the seedlings to induce salt-shock and salt-acclimation. The rate of root growth was measured by marking the root 10 millimeters (mm) from the tip with charcoal powder. The increase in length of the root was measured from this reference point.

Results and Analysis: When intact seedlings were salt-shocked by exposure to 50, 100, or 150 millimolar (mM) of salt, root extension was initially slowed, with greater inhibition at higher salt concentrations. This was followed by recovery of root extension rates. After 24 hours, roots of salt-treated seedlings and nontreated control seedlings had reached similar extension rates. In the salt-acclimation experiments, no significant differences in extension rates were observed between unsalted control seedlings and plants exposed to 50 or 100 mM of salt for 144 hours. In all three treatments, sugars and ions accumulated

to allow maintenance of turgor pressure and growth. Measurements of water and solute potential of root tip segments clearly demonstrate that these cells are able to adjust osmotically in response to salt treatment, and that such adjustments involve both inorganic and organic solutes. Near the tip, the organic ions Cl-, Na+, and K+ dominated the adjustment, but a few mm behind the tip, adjustment was dominated by an accumulation of sucrose and proline. Accumulation of these solvents in the zone of cell expansion allowed maintenance of both turgor pressure and growth in the saline environment.

Reference: Gonza‡lez Rodir'guez, H., J. Roberts, W. Jordan, and M. Drew, "Growth, Water Relations, and Accumulation of Organic and Inorganic Solutes in Roots of Maize Seedlings during Salt Stress, Plant Physiology, Vol. 113 (1997) pp. 881-893.

Note: Jordan is the Director of TWRI. Gonza‡lez Rorig'guez was a graduate student funded by TWRI, earned his Ph.D. at TAMU, and is a researcher at the Autonomous University of Nuevo Leon in Mexico.

Texas A&M University-Corpus Christi Scientist to Use Global Positioning System for Geoid Model

Traditionally, the process of conducting coastal surveys is slow and expensive. As a result, it is difficult to develop effective coastal management programs.

Gary Jeffress of Texas A&M UniversityÐCorpus Christi (TAMUCC) has received a research grant from the Texas Higher Education Coordinating Board. Jeffress will develop technology for high accuracy surveying using global positioning system (GPS) methods. The GPS data will be used to create a new high resolution geoid model for the Texas coastal zone.

Using the new geoid model, GPS users will be able to estimate elevations along the Texas coast with respect to mean sea level with as little as 3 centimeters of vertical error. Gravity data provided by Exxon Corporation and Oryx Energy Company will be combined with GPS ellipsoidal heights to create a much more refined geoid model for the Texas coastal region.

"This is the first time we know of that companies have volunteered their gravity data for research," Jeffress says. "It is a unique partnership that could benefit many."

Using GPS and the Texas geoid, surveyors will be able to rapidly measure the boundaries of floodplains, shorelines, dune complexes, and wetlands, because they will be able to easily convert ellipsoidal heights into accurate elevations above mean sea level. Littoral boundary recognition could also greatly benefit from the new technology.

"Littoral boundary recognition has typically been extremely painstaking because you need to observe water levels for several days before you can begin to measure boundaries," Jeffress explains. "The geoid model will allow us to recognize boundaries much faster than before."

Other benefits of the project could include improved predictions of coastal storms and floods as well as hurricanes. "These phenomena could be better predicted with this model by observing changes in normal levels of water on the coast," Jeffress says.

For more information, contact Jeffress at (512) 994-2720 or jeffress@falcon.tamucc.edu.

Texas Tech Scientists Examine Use of Facultative Pond to Treat Wastewater, Produce Food for Fish

In some areas of Texas, pollution from intensive livestock feeding operations may be a major contributor to water pollution. Treating this kind of wastewater can be an expensive task. Recently, Clifford Fedler and Nick Parker of Texas Tech University received a research grant from the Texas Higher Education Coordinating Board to examine the benefits of producing products from wastewater. The researchers will use a new type of natural waste treatment system called an integrated facultative pond (IFP) to anaerobically treat high-strength animal wastes and use the effluents to feed fish a high protein diet.

The study will utilize three ponds with four stages of wastewater treatment. The first pond will be the IFP, which will incorporate the first two stages of treatment. Animal wastes will be deposited in the pit of the IFP where anaerobic digestion will take place. Water in the pit will then flow into the outer pond of the IFP where aerobic digestion will take place. The outer pond will have an overflow pipe which will allow water from the IFP to flow into a second pond that will contain algae and duckweed, an aquatic plant. The plants will continue the anaerobic degradation process by removing ammonia and other forms of nitrogen. As a byproduct, they will produce oxygen which will enhance aerobic treatment of the effluent stream. Overflow pipes from the duckweed pond will be connected to several tanks which will each contain a species of fish. The fish will be examined to see which species grows best with protein and nutrients from the treated wastewater.

The goal of the project is to demonstrate that wastewater can be used to produce valuable products such as a different protein sources for animal feeds or ornamental fish for the aquarium market.

"What we would like to show people is that waste isn't really a problem because it can easily be reused in some form or another," explains Fedler. "We don't need to

automatically dispose of treated waste. It can be used to produce products such as fish and other protein,"

Another goal of the project is to develop a less expensive way of harvesting duckweed for use as animal feed. Because duckweed roots often become intertwined, a machine will be placed at one point in the pond to reel in and harvest the entangled plants.

For more information, contact Fedler at (806) 742-2801, ext. 255 or cfedler@coe2.coe.ttu.edu; or Parker at (806) 742-2851 or n6nan@ttacs.ttu.edu.

Texas A&M University-Galveston Researcher Seeks to Develop Method to Make Oysters Safer to Eat

Vibrio vulnificus, a naturally occurring estuarine bacterium found in oysters, can cause blood infections to develop in some people after they eat raw oysters. For example, individuals with impaired liver function or compromised immune systems may be especially susceptible to the bacterium.

Recently, John Schwarz, a researcher at Texas A&M University-Galveston (TAMUG), was awarded a research grant by the Texas Higher Education Coordinating Board, to examine solutions to the Vibrio problem. In the project, Schwarz wants to determine if rapidly chilling oysters after they have been harvested may lessen the ability of the bacteria to make those who eat the oysters ill.

Because Vibrio is a naturally occurring bacterium, it cannot be removed or even reduced from the waters where oysters are harvested. "That is why we are trying to attack the problem after the oysters have been harvested," explains Schwarz.

During the colder months of the year, Vibrio is not a problem in many estuaries because it does not survive in cool temperatures. However, when water temperatures rise above 65° F, populations of Vibrio can reach infectious levels. Schwarz explains that "we don't know what an infectious level of Vibrio is, and the levels of the bacterium can vary wildly from oyster to oyster. The only way to determine the level of Vibrio in an oyster is to open the shell, take out the oyster and analyze it, but then you have destroyed what you were trying to sell."

Currently, oysters are stored in a cooler where it may take two to three days to lower their temperatures. Unfortunately, it is during this time of slow cooling that most oysters are shipped to consumers. However, it doesn't allow enough time for the cool temperatures to reduce the levels of Vibrio. "A method of rapid cooling may eliminate or significantly reduce the populations of Vibrio in harvested oysters destined for raw consumption," Schwarz explains.

Schwarz proposes to rapidly lower the temperature of oysters to below 45° F by immersing the oysters in large, rigid plastic bins containing an ice-water mixture immediately after they are unloaded at dockside, but before they are placed in refrigerated storage units. This method may significantly reduce the populations of Vibrio

in warm-water harvested oysters, while keeping the oyster in the same condition that consumers have come to expect.

UT-Pan American Scientists Study How Nutrient Levels Influence Brown Tide

Since May of 1990, the Laguna Madre ecosystem has been plagued by a phenomenon known as the Texas brown tide. In January of 1990, a hard freeze caused a dramatic die-off in the fish and benthic communities of the Laguna Madre, because the native species were not used to cool temperatures. The decomposing organisms released ammonia nitrogen, which the brown tide thrives on. Since that time, the water has suffered a loss in transparency which results in less sunlight reaching seagrass beds. The seagrasses, which need sunlight to flourish, provide a protected habitat for many juvenile forms of estuarine life.

Recently, Hudson DeYoe, a biologist at the University of Texas at Pan American, received a research grant from the Texas Higher Education Coordinating Board, to examine the relative importance of the nitrogen-to-phosphorus ratio and zooplankton grazing of phytoplankton in controlling the Texas brown tide.

The study will consider the relative concentrations of nitrogen and phosphorus in the water which can help determine which algae become dominant. Zooplankton grazing will also be considered. "Other researchers have found that not a lot of the zooplankton like to eat the brown tide, and the brown tide actually appears to inhibit the growth of the zooplankton and its ability to eat plankton," he adds. Researchers will extract one-liter samples of Laguna Madre water collected from high and low density brown tide areas. Each sample will be treated with five nitrogen-to-phosphorous supply ratios and three grazer treatments for a 30-day period. This differs from earlier approaches in that nitrogen and phosphorus will be supplied to brown tide samples at different but constant ratios over the 30-day period.

At the end of the experiment, it is anticipated that the brown tide will decline in some of the treatments. DeYoe explains that "if nitrogen-to-phosphorus levels that influence the formation of brown tide can be identified in the laboratory, we can compare them with natural conditions to better understand why the brown tide persists and to learn what type of management options are available." Interestingly, DeYoe notes that "based on recent samplings the brown tide is not very abundant, although it is common for it to be less abundant during the colder months."

For details, contact DeYoe at (956) 381-3538 or hdeyoe@panam.edu.

TNRCC Uses Pollution Fines to Protect Environment

The Texas Natural Resource Conservation Commission (TNRCC) has implemented an innovative system in which fines levied against polluters can be used to protect the environment.

This effort is titled the "Supplemental Environmental Projects" (SEP) program and was begun by TNRCC in 1996. Individuals and organizations which have been fined by the TNRCC for water or air pollution can decide to direct up to 50% of the amount of the penalty to SEP projects. Generally, the SEPs benefit the TNRCC region in which the environmental violation occurred. TNRCC staff then work with the company and local officials to identify a suitable SEP project and to develop a strategy to solve a particular problem. "Often, the individual or company which was fined feels better about supporting a project that will improve a community than just paying the fine and having funds go into the State's general revenues," says Gregary Warmink, who directs the TNRCC SEP efforts. It should be noted that companies which fund SEP programs cannot publicize their efforts, unless they also acknowledge the environmental problems they created.

SEPs can be utilized for a wide range of purposes including pollution clean-up, protecting and improving habitat, research and environmental education. Recently, funds from part of a fine levied against a petrochemical refinery were used to replace more than 40 failing on-site wastewater systems in Orange County in Southeast Texas.

For details, contact Warmink at (512) 239-0612 or gwarmink@tnrcc.state.tx.us

Texas Parks and Wildlife Commission Passes Tough Aquaculture Rules to Protect Native Shrimp

The Texas Parks and Wildlife Commission passed strict new aquaculture regulations to regulate the growing number of aquaculture facilities in Texas. The goal is to prevent possible contamination of wild, native shrimp from diseases that may be spread by exotic, non-native, species.

The new regulations allow Texas Parks and Wildlife Department (TPWD) biologists to quarantine diseased exotic shellfish such as shrimp at aquaculture facilities, and require aquaculture operators to immediately notify TPWD when any die-offs of farm-raised exotic shellfish occur. The rules also require aquaculture professionals to have their exotic shellfish certified as disease-free by a TPWD-approved disease specialist and mandate that operators show they have applied for Texas Natural Resource Conservation Commission wastewater discharge permits.

"We designed these regulations to avoid unnecessary impact on aquaculture facilities while protecting wild shrimp in Texas waters," said Larry McKinney, who is the TPWD senior director for water policy and resource protection. "We worked closely with the aquaculture industry and others in this process, and are open to continuing that dialog

with an eye to further refining a workable set of regulations. But, we remain firmly committed to protecting Texas natural resources."

The Texas shrimp industry, which harvests wild shrimp, generates about $600 million per year for the state economy and employs 15,000 Texans. There are currently eight shrimp farms in production on the Texas coast, and two more are proposed.

For more information, contact Steve Lightfoot of the TPWD News Office at steve.lightfoot@tpwd.state.tx.us or (512) 389-4701.

High Plains Water District Evaluates Results of 1997 Cloud Seeding Program

Even though cloud seeding missions have ended, work continues on the 1997 precipitation enhancement program sponsored by the High Plains Underground Water Conservation District No. 1 (HPUWCD) of Lubbock, TX, and the Llano Estacado Weather Modification Association of New Mexico.

High Plains District officials are now evaluating the program to determine what refinements are needed before the 1998 program begins in May.

"The 1997 precipitation enhancement program has been a learning experience for all involved," says High Plains District manager A. Wayne Wyatt. "I believe we had a successful program and we will do even better next year as we apply what we learned from the 1997 program."

Since May of 1997, 86 cloud seeding missions were flown within the 15-county High Plains District area of Texas as well as over three counties in eastern New Mexico. A total of 1,514 silver iodide flares were fired into developing rain clouds during the four-month program. The silver iodide particles released from these flares served as additional condensation nuclei that allowed more moisture to be converted into large raindrops that fell through the dry subcloud layer and reached the ground as precipitation.

High Plains District field personnel have read 300 rain gauges installed at soil moisture monitoring sites throughout the District. This information will be used to construct three maps showing the amount and location of rainfall within the target area from January to June, the amount and location of precipitation during the four months the cloud seeding program was in operation, and long-term precipitation averages.

For details, contact the District at (806) 762-0181 or e-mail hpwd@worldnet.att.net. The District's WWW site address is http://www.hpwd.com.

UT LBJ School Reports Focus on Water Management

Two recent reports from the LBJ School of Public Affairs at the University of Texas at Austin (UT) address key Texas water issues.

Scarce Water: Doing More with Less in the Lower Rio Grande was written by Jurgen Schmandt of the Houston Advanced Research Center, Chandler Stolp of the LBJ School, and George Ward of the UT Center for Research in Water Resources. The report provides information on the authority, organization, and tasks of water management institutions, relationships between them, and the major issues they face. Individual chapters present an overview of the Rio Grande and the Lower Rio Grande Valley, and describe international institutions and agreements that govern water use in the region and the Rio Grande Valley Watermaster. The book also describes urban water management in McAllen, Brownsville, and Donna, and outlines the Valley Water Policy and Management Council. Chapter Seven concludes the report with recommendations.

Squeezing a Dry Sponge: Water Planning in Texas, was written by Susan Hadden of the LBJ School and former Texas Lieutenant Governor William P. Hobby. The report reviews state water management agencies and compares Texas policies to innovations in other states. It identifies incentives and barriers to adopting those innovations in Texas.

To order either book, contact the Office of Publications at the Lyndon B. Johnson School of Public Affairs at (512) 471-4218. Information about the LBJ School is available on-line at http://www.utexas.edu/lbj/.

TNRCC Report Lists Texas's Key Environmental Issues

What are the most critical environmental priorities facing Texas? The Texas Natural Resource Conservation Commission (TNRCC) has recently published four detailed reports that summarize the opinions of key state leaders about pressing environmental issues. The series is titled The State of Texas Environmental Priorities Project. Separate reports present an overview of the project and cover findings of working groups that discussed ecological, human health, and socioeconomic issues.

The project was led by Sylvia Amaya of the TNRCC Water Resources Management Office. Key input was provided by other TNRCC staff members as well as representatives from many state and federal agencies, corporations and special interest groups.

According to the report, the most important ecological issues Texas must deal with are (ranked in priority order) habitat alteration, the loss of biodiversity, global climate change, surface water quality, air quality, waste issues, pesticide contamination, and water availability. Indoor air pollution was ranked as the top human health issue and habitat alteration and pesticide contamination topped the list of socioeconomic concerns.

For details, contact Amaya at (512) 239-4811 or Samaya@tnrcc.state.tx.us. To order the publication, contact the TNRCC Publications Office at (512) 239-0028.

USDA Study Examines Agriculture Impact on Water Quality

A new report from the U.S. Department of Agriculture/ Economic Research Service (USDA/ERS) provides in-depth information on the relationships between agriculture and water quality. Agricultural Resources and Environmental Indicators (1996-97) is a 347-page report which was edited by Margo Anderson and Richard Magleby.

Major sections of the report discuss such broad natural resources areas as water and land resources, agricultural inputs, agricultural management practices, and conservation and environmental programs. The report also discusses water use and pricing, water quality, irrigation water management, and water quality programs. Many charts, graphs, and maps are included.

For details, visit the USDA/ERS WWW site at http://www.econ.ag.gov/epubs/pdf/ah712/index.htm. To purchase the report, call USDA/ERS at (800) 999-6779.

UT-Arlington Researcher Publishes Manual of Texas Environmental Rules

A new manual summarizing Texas environmental regulations has been written by Joel B. Goldsteen, a researcher in the School of Urban and Public Affairs at the University of Texas at Arlington (UTA).

Texas Environmental Regulations Manual covers such broad topics as air, water, solid waste, hazardous waste, radioactive materials, land protection, health, natural resources, oil and gas, pipelines and wells, agricultural chemicals, animal diseases, and hazard communications.

The manual provides a consolidated source for understanding and identifying critical regulatory details necessary for environmental compliance in Texas. It incorporates information about programs, controls, standards, and federal and local agency relationships, as well as how and where to find state agencies and offices that control several environmental areas.

Texas Environmental Regulations can be purchased from Government Institutes, Inc. at (301) 921-2355 or giinfo@govinst.com. Goldsteen can be contacted at (817) 272-3306 or goldsteen@uta.edu.

UH Searches for Methods to Prevent Corrosion in Municipal Wastewater Pipes

What causes wastewater pipes to corrode and what can be done to fix the problem? These are some of the key questions being investigated by a University of Houston (UH) researcher.

Deborah Roberts of the UH Civil Engineering Department is one of the leaders of a nationwide study to develop new methods to rehabilitate failing wastewater systems.

Roberts' role in the project is to identify factors that cause pipes to corrode. She and her students are conducting laboratory experiments to test the amount of corrosion that would develop in three concrete materials now widely used to manufacture wastewater pipes.

Much of the research was conducted in one-of-a-kind "environmental chambers" at UH. Follow-up studies are examining whether specific viruses called phages can be developed that would attack the bacteria that cause corrosion.

Ultimately, Roberts hopes that cities will be able to use this information to better estimate the usable lifespan of wastewater pipes before corrosion occurs and to project when pipes will likely need to be replaced.

The study is funded by the National Science Foundation. For details, contact Roberts at (713) 743-4281 or djroberts@uh.edu.

TAMUCC Teams Up with State Aquarium to Boost Education

The Early Childhood Development Center (ECDC) at Texas A&M University-Corpus Christi (TAMUCC) has launched a partnership with the Texas State Aquarium to help familiarize families across South Texas with the mysteries of the ocean and the importance of marine environments.

Under the partnership, Aquarium staff are working with faculty and staff at ECDC to train teachers how to integrate coastal themes into the school curriculum. Students and their families have been given Aquarium memberships, which allow unlimited admission and access to the numerous workshops and educational programs the Aquarium sponsors. Companion classrooms--teachers and their students from area schools who regularly visit the ECDC and hold class there with TAMUCC faculty--will be exposed to the marine curriculum and take what they learn back with them to their schools. The Aquarium's traveling exhibit, "Ocean in Motion," will be used in the effort.

The partnership is being funded by a four-year grant from the Howard Hughes Medical Institute and began earlier this academic year. For details, contact Kathy Tallent or Jane Wilhour at ECDC at (512) 980-3366, or the Aquarium at (800) 477-GULF.

TAMUK Scientist Named VP of Arid Lands Consortium

Donald Hegwood, Director of the Texas A&M UniversityÐKingsville (TAMUK) Jack Welhausen Water Resources Center, has been named executive vice president of the International Arid Lands Consortium (IALC).

IALC is a non-profit organization that consists of TAMUK, the University of Arizona, the University of Illinois, New Mexico State University, South Dakota State University and the Jewish National Fund. It is dedicated to developing sustainable solutions to the problems unique to arid and semiarid lands. IALC actively forges partnerships between scientists, land managers, and students.

Hegwood, who will remain on the TAMUK faculty, will manage and promote the scientific and academic work of the consortium. He will lead the coordination of the IALC research programs, demonstration projects and educational efforts, which include workshops and seminars aimed at training people, and managing resources that are on semiarid and arid lands.

TAMUK has been a member of the IALC since its inception, a relationship that is beneficial to the university and to South Texas, according to Hegwood. "The IALC links the university on a global basis to institutions and scientists who are addressing arid and semiarid land issues that are very appropriate to South Texas," Hegwood says. "I'm excited about the opportunity to work with the consortium and to be a factor in linking the university to this global science and technology."

Hegwood can be contacted at (512) 593-3994 or kfdah00@tamuk.edu.

UT Studies How Oak Wilt Affects Understory Vegetation

How does oak wilt influence the amounts of water, light, and nutrients available to plants under oaks? That was the focus of a recent study conducted by Laurel J. Anderson, M. Shawn Brumbaugh, and Robert B. Jackson of the University of Texas at Austin (UT) Botany Department.

The researchers wanted to study whether leaves lost from trees afflicted with oak wilt would increase the amount of water available to the vegetation that grows beneath them. Pairs of plots were cleared under healthy and diseased oaks in a Central Texas savanna. One plot of each pair was shaded with shade cloth to maintain similar light levels under diseased and healthy trees. Mesquite seedlings were planted in the plots and their growth and survival was monitored. Regrowth of grasses and forbs was measured by regular clipping of above-ground biomass.

Research results showed that substantially more mesquite seedlings survived in shaded plots under trees suffering from oak wilt than in plots under healthy trees receiving similar light levels. Forb and grass regrowth was greater under diseased trees than under healthy ones.

The researchers feel plants had greater growth and survival under trees with oak wilt because of increased water availability. Transpiration in diseased oaks decreased due to leaf loss, and led to greater soil moisture. Measurements of soil moisture confirmed this pattern, suggesting that healthy savanna oaks often reduce water availability for understory plants in the Texas Hill Country.

For details, contact Anderson at (512) 475-7851 or ljanders@uts.cc.utexas.edu.

AWWA Research Foundation Issues 1998 RFP

The American Water Works Association Research Foundation (AWWARF) Board of Trustees recently issued a major request for proposals (RFP). University scientists and others are urged to reply.

For 1998, AWWARF has issued RFPs for 35 projects. Roughly $6 million is available for solicited research projects, $40,000 for applications projects, $1.3 million for collaborative research, and $205,000 for expert workshops. In addition, roughly $1.3 million was appropriated for unsolicited projects.

Requests for proposals (RFPs) for solicited projects are now available. Proposals submitted in response to RFPs must be postmarked by May 4 for perchlorate projects and projects with budgets up to $250,000 in AWWARF funds. Proposals seeking $250,000 or more in AWWARF funds must be postmarked by July 15. Guidelines for preparing unsolicited research proposals are now available from AWWARF. Unsolicited proposals must be mailed to AWWARF and postmarked by April 1.

Contract awards for all solicited projects will be determined by an AWWARF project advisory committee appointed for each project. Proposal evaluations will be based on responsiveness to the RFP, scientific and technical merit, and qualifications of the researchers. Unsolicited proposals are evaluated by AWWARF's Unsolicited Proposal Review Committee using similar criteria.

AWWARF has issued RFPs for the following areas:

- Protect the drinking water consumer from microbial risk,
- Protect the drinking water consumer from adverse health effects due to chemicals,
- Improve utility management to obtain optimum water quality and system reliability,
- Improve utility infrastructure for the reliable delivery of high-quality water to the customer's tap, and
- Provide science and technology to improve public and customer relations.

In addition, many RFPs have been issued to examine percholate issues. Other RFPs have been approved through AWWARF's Tailored Collaboration Program Awards.

A partial list of research topics requested by AWWARF is shown above. For a complete list of RFPs, contact AWWARF at (303) 347-6117 or visit their World Wide Web site at http://www.awwarf.com. You can also receive more information by e-mailing Donna Hughston at dhughston@awwarf.com or Gladys Preston at gpreston@awwarf.com.

TAMU Agricultural Program to Increase Water Conservation Education Efforts

As a result of Senate Bill 1 (SB1), a comprehensive water resources management bill passed by the Texas Legislature in 1997, the Texas A&M University (TAMU) Agricultural Program and the Texas Water Resources Institute (TWRI) will become more involved with water supply and conservation training and educational programs.

Part of the Bill requires that the Texas Agricultural Extension Service (TAEX) cooperate with other state agencies and water districts to expand and enhance existing water conservation education and to initiate other efforts. This comprehensive TAEX program is being coordinated by TAEX Associate Director Bill Harris and Bruce Lesikar of the Texas A&M University Agricultural Engineering Department as well as many other key people.

As part of the TAEX project, TWRI was provided funds to expand its work with water conservation technology transfer and information programs. The funds will allow Jan Gerston of TWRI to increase her work with the Texas Water Savers newsletter. In addition, Gerston will lead efforts to develop a World Wide Web site that will provide comprehensive information on water conservation efforts in Texas. TWRI has also initiated an electronic mailing list that will allow people to share information about conservation issues.

The TAMU Department of Agriculture Communications is coordinating a groundswell of water conservation educational events planned for May.

For details, contact Lesikar at (409) 845-7453 or B-Lesikar@tamu.edu, or Gerston at (409) 845-1852 or Jan@twri.tamu.edu. You can subscribe to the electronic mail list by e-mailing tx-water-ed@twri.tamu.edu.

TAMU Researcher Evaluates Methods to Determine Streamflows from Ungaged Sites

A Texas A&M University (TAMU) researcher has begun a project to better estimate the amount of water flowing through streams for which no data currently exists. Ultimately, the study may lead to more accurate methods to develop streamflows for "ungaged areas," and may provide new insights into how much water is actually available at specific sites.

The investigation is being conducted by Ralph Wurbs of the TAMU Civil Engineering Department with funding provided by the Texas Natural Resource Conservation Commission (TNRCC). The basis for the study results from Senate Bill 1 (the state comprehensive water planning legislation that was passed in 1997). That bill mandates that TNRCC conduct thorough analyses of water availability, water use, and water rights in most of Texas' river basins.

In order to accurately model water availability, information on long-term streamflows is needed. For many sites in Texas, gages have been placed in stream segments and historical flows are available since about 1940. However, there are many remote sites for which no streamflow data exist, because no gages have been installed.

The thrust of Wurbs' work will be to evaluate methods that are now available to estimate long-term streamflows from ungaged areas and to recommend the best techniques that TNRCC staff may want to use. Some of the methods that Wurbs will investigate include flow distribution equations that utilize ratios for various watershed parameters, use of curve numbers developed by the U.S. Department of Agriculture/ Natural Resources Conservation Service, developing regression equations based on sites that have stream gages, and the use of rainfall runoff estimates.

TWRI is administering this project. For details, contact Wurbs at (409) 845-3079 or r-wurbs@tamu.edu.

TWRI Participates in Regional Project to Develop Database About Gulf of Mexico Resource Issues

What are some of the major environmental and regulatory issues facing the Gulf of Mexico region? A multi-state research and public education project has been launched to answer some of these questions. The project is led by Jeff Ballweber of the Mississippi State University Water Resources Research Institute and includes cooperators from the Texas Water Resources Institute (TWRI), Auburn University, the University of Florida, and Louisiana State University.

In the study, cooperators from Gulf Coast states will compile resources that describe the policies, legislation, and court cases that impact how coastal waters are managed in their state. It is expected that both printed and Internet-based information will be identified. Information will also be gathered on such Gulf-wide issues as nutrient enrichment, the use of total maximum daily loads and other watershed management strategies, and the impact of water quality and freshwater inflows on shellfish resources.

As part of the project, TWRI Information Specialist Ric Jensen will develop information on resources that affect the Texas portion of the Gulf, including the roles of various state agencies, the implementation of Senate Bill 1, and management strategies developed through the Texas Coastal Zone Management Act.

Ultimately, Ballweber will utilize this data to develop, update, and maintain a database and World Wide Web site that summarizes these issues throughout the region.

For more details, contact Ballweber at (601) 325-3620 or ballweber@engr.msstate.edu, or Jensen at (409) 845-8571 or rjensen@tamu.edu.

Detailed Information About TWRI Projects Now Available on the WWW

Detailed information on research and education projects funded by the Texas Water Resources Institute (TWRI) is now available on the Institute's World Wide Web site.

This new project information was summarized by Jennifer Robinson, a TWRI student worker and Texas A&M University student who also wrote many of the articles in this issue.

The new listing includes summaries of research that were originally in TWRI annual reports published since 1966. The project pages are unique because they include information on TWRI research that was not available previously. For example, many of these projects did not result in the publication of TWRI technical reports or were conducted before TWRI began publishing the New Waves newsletter.

The TWRI projects main page lets users select projects from a five-year interval (1965-70, for example). From that page, users can select project summaries, technical reports, or articles published in TWRI newsletters.

Projects summarized on the Web page include such wide-ranging topics such as agricultural irrigation, water treatment, institutional factors influencing water development, and recreational water use. Interestingly, many projects funded during the energy crisis of the 1970s focus on the concerns of the time, such as the economic impact of the energy shortage on pumping costs and water use for agricultural irrigation.

Corpus Christi Bay Featured at CCBNEP WWW Site

A World Wide Web site at Texas A&M University Ð Corpus Christi contains comprehensive information about the Corpus Christi Bay National Estuary Program (CCBNEP).

The site, located at http://www.sci.tamucc.edu/ccbnep, includes a description of the region's environmental and water resources, technical publications and newsletters, summaries of research and demonstration projects, and upcoming meetings and conferences.

Many of the publications can be viewed on-line or can be electronically downloaded.

On-line research reports cover the characterization of non-point pollution sources, the current status and historical trends of the estuarine resource, and bay management strategies. The WWW site also includes comprehensive descriptions and summaries of research, demonstration, and public outreach projects. Fact sheets include popular articles describing the changing landscape of the area, issues facing the bay system, the historic development of the region, and habitat issues. Issues of the CCBNEP Around the Bend newsletter are also on-line.

For details, contact the CCBNEP at (512) 980-3420.

UT LBJ School WWW Site Provides Water Policy Resources

Information about many water policy research issues is available from the World Wide Web site of the Lyndon B. Johnson (LBJ) School of Public Affairs at the University of Texas at Austin (UT).

Two parts of this site are especially interesting for those exploring water resources issues. The research projects pages describe work by LBJ School faculty and graduate students into many Texas ÐMexico border issues, including wildlife habitats in the region, border health issues, and the lack of proper water and wastewater facilities in colonias. Summaries of many water resources reports published by the LBJ School are also on-line and cover such topics as how to manage water supplies in arid areas, water marketing, sustainable development, and the impact of the North American Free Trade Agreement on the environment.

The WWW site address is http://www.utexas.edu/lbj.

West Texas A&M WWW Site Focuses on Dryland Farming

Information about research and training programs related to water-efficient agriculture is available from the Dryland Agriculture Institute's (DAI) World Wide Web (WWW) site. The Institute is located at West Texas A&M University (WTAMU) and is directed by Bobby Stewart.

The WWW site describes the mission of the Institute, provides information on recent research projects, and presents information on training programs provided by the DAI.

As an overview, the WWW site presents information on DAI's wide-ranging mission, including increasing water use efficiency in agriculture, preventing wind and water erosion, the use of deficit irrigation, and the development of drought resistant crops.

Titles of recent Institute research projects are listed on the site. Summaries of some reports are available on-line and all reports can be ordered through the Web site. Research reports cover topics such as the impact of tillage and cropping systems on soil organic matter, evaluations of dryland corn and grain sorghum production, studies to increase drought resistance in wheat, and the use of grazing wheat pastures as an alternative to grain production.

The Web site also offers an overview of recent international workshops offered by the Institute, which focus on sustainable agricultural ecosystems and environmental issues.

The DAI WWW site is located at http://www.wtamu.edu/research/dryland/.