New Waves
The Research Newsletter of the Texas Water Resources Institute
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TWRI Funds 11 Research Projects at 7 Universities

The Texas Water Resources Institute (TWRI) has selected 11 research projects it will fund during 2001–2002. The projects are more diverse than ever in two ways — they represent a variety of universities throughout Texas and they will explore a wide assortment of research topics. Research projects were selected at Texas A&M University, Texas Tech University, the University of Texas at Austin, Texas A&M University–Corpus Christi, the University of North Texas, the University of Texas at Austin Marine Science Institute at Port Aransas, and Texas A&M University–Galveston.

Some of the projects will explore groundwater policy, the fate of heavy metals in lake waters, the impact of wastewater releases on wetland ecosystems, and the affect of naturally occurring salinity on water availability. Other studies will examine how the economy of the Texas High Plains may be affected by declines in the Ogallala Aquifer, the use of remote sensing to better estimate evapotranspiration, how environmental factors influence the growth and survival of red drum along the Texas Gulf Coast, and whether strategies used to manage groundwater internationally may be applicable for Texas.

"In this year's funding cycle," said TWRI Director C. Allan Jones, "we fundamentally reexamined how the Institute's research program could accomplish the most. After meeting with university leaders from across Texas, we decided the way to make the greatest impact would be to provide small awards for graduate student research. This year's program reflects this new direction."

Photo Courtesy of G. Joan Holt/ UTMSI

Rafael Perez (above) and G. Joan Holt of the University of Texas at Austin Marine Science Institute at Port Aransas will study how environmental conditions affect the growth of red drum.

TWRI received 35 submissions in response to this year's request for proposals. The research program is funded by the United States Geological Survey. Research projects were developed by graduate students in collaboration with faculty members. The projects were evaluated by TWRI staff as well as key Texas A&M University faculty. Each project selected for funding will be awarded a $5,000 grant. Matching funds are provided by each cooperating university. The projects will start March 1, 2001 and run through February 28, 2002. At the conclusion of these studies, TWRI will publish a scientific paper or technical report describing the research.

The following projects were awarded funds from TWRI for 2001–2002:

• Jill Brandenberger (student) and Patrick Louchouarn (researcher), Conrad Blucher Institute for Surveying and Science, Texas A&M University–Corpus Christi, "Arsenic Concentration in Water Resources of the Choke Canyon/Lake Corpus Christi Reservoir System: Surface and Ground Waters." The research will investigate the cycling of arsenic and other trace elements in the waters of Lake Corpus Christi, Choke Canyon Reservoir, and points along the Nueces, Atascosa, and Frio rivers. The potential impact on groundwater quality will also be examined.

• Bryan Brooks (student) and Thomas La Point (researcher), Institute of Applied Science, University of North Texas, "Sublethal Effects of Cadmium and Linear Alkylbenzene Sulfonate Mixtures on *Pimephales promelas* Exposure and Effect Endpoints: Laboratory and Field Assessments." The researchers will investigate how fish and other aquatic organisms may be affected by exposure to cadmium and other pollutants in North Texas surface waters. Fathead minnows will be used as a test species.

• Yesim Buyukates (student) and Daniel Roelke (researcher), Texas A&M University (TAMU) Wildlife and Fisheries Sciences Department, "Plankton Succession: Investigation Regarding New Approaches to Management." This study will assess how releasing treated wastewater in pulses to the Rincon Delta may affect the flora and fauna of coastal wetlands. The project will examine how nutrients in wastewater effluents may affect the growth of phytoplankton.

• Richard Hoffpauir (student) and Ralph Wurbs (researcher), TAMU Civil Engineering Department, "Incorporation of Salinity in Evaluating Water Availability." This project will expand the modeling capabilities of a comprehensive water rights simulation modeling tool developed by Wurbs (the Water Rights Analysis Package or WRAP), to include the ability to assess issues related to natural salt pollution. The project will provide insights into how salinity affects the availability and reliability of water supplies.

• Jeffrey Johnson (student) and Phillip Johnson (researcher), Agricultural and Applied Economics Department, Texas Tech University (TTU), "Regional Economic Impacts of Aquifer Decline in the Southern High Plains of Texas." This project will investigate the short- and long-term economic impact of strategies to limit groundwater pumping in the Texas High Plains. This study will develop dynamic optimization models that can project the mix of irrigated and dryland crops that may be grown as a result of water conservation measures.

• Balaji Narasimhan (student), TAMU Agricultural Engineering Department, and Raghavan Srinivasan (researcher), TAMU Spatial Sciences Laboratory, "Determination of Regional Scale Evapotranspiration of Texas from a NOAA-AVHRR Satellite." This study will utilize an advanced very high resolution radiometer (AVHRR) sensor which is aboard an orbiting earth satellite to develop more accurate estimates of evapotranspiration (ET) from different land uses. The satellite is managed

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ABSTRACTS

Estimating the Hydrology of Urban Playa Lakes on the Texas High Plains

Researchers: David B. Thompson, Jennifer L. Elms, Eric L. West, and Timothy S. James, Civil Engineering Department, Texas Tech University, Lubbock, TX.

Problem: The City of Lubbock contains 100 playas within its limits that provide drainage for stormwaters and other ecological services. This is especially important since the topography of the High Plains is flat and, therefore, not inclined to produce significant amounts of runoff. There is little data about the hydrology of urban playa lakes and the interaction of stormwater runoff and groundwater flow in playa lake ecosystems.

Objective: To create a complete collection of hydrologic and meteorological data that can be used to estimate hydrologic budgets of six playa lakes in Lubbock.

Methods: The project was carried out from June 1995 to October 1997. Data were developed to compute hydrologic budgets and to generate evaporation and infiltration rates for each playa. Rainfall-runoff data were collected during the project to estimate runoff coefficients for each playa watershed. Six playas were chosen to represent lakes in the region. Playas were classified according to age, the extent to which they have been modified, land use of nearby lands (residential or commercial), and topographic features. Four of the lakes have been modified by residential development. All but two lakes have mild to flat bank slopes, while one lake is steep. Transducers and data loggers were positioned near the bottom of the lakes to measure pressure and water surface elevations. Data were collected for topography, hydrology, meteorology, and groundwater levels. Topography data consist of bathymetric and land surveys for each playa. Hydrologic data were based on the pressure readings from the data loggers at each playa. This data was combined with the known elevation of the pressure sensor to obtain a time-series of water surface elevations for each lake. Personnel of the National Weather Service station in Lubbock compiled daily meteorological data. Air and dew point temperatures, wind speeds, and sky coverage were downloaded from the National Climate Data Center website. Groundwater data and water table contour maps from 1937, 1981, 1987, and 1991-92 were obtained from the City of Lubbock. A water balance was created for each playa lake. To estimate the relation between evaporation and infiltration, the hydrologic budget was computed during times when there was no significant rainfall. To estimate runoff, the hydrologic budget was calculated during storms. Evaporation was estimated and subtracted from the change in storage over each time period to obtain infiltration data. Hydrologic budgets were computed for each playa using evaporation from lake surfaces and infiltration through bottom soils.

Results and Discussion: The average daily evaporation rates were 79 inches per year. During the winter, the daily evaporation rate was 0.08 inches per day, while in the summer it averaged 0.4 inches per day. Playa bed infiltration ranged 16 to 232 inches per year, with an average of 115 inches per year. When evaporation and infiltration were compared on a paired basis for each playa, 54% of incoming runoff evaporated, while 46% resulted in infiltration to playa beds. A total of 27 rainfall events were available to develop the runoff coefficient, with an average runoff coefficient of 0.30. Runoff coefficients often used for drainage designs within cities are typically in the range of 0.70, yet this value is more than twice the value observed in this study. There is a low probability that a runoff coefficient of 0.70 is correct in many instances. Results of this study show that significant amounts of water are infiltrated through playa lake bottoms into underlying aquifers, and that runoff coefficients are significantly less than those normally used for design purposes.

Reference: Thompson, D. B., J. L. Elms, E. L. West, and T. S. James. "Hydrology of Six Urban Playa Lakes in the City of Lubbock, Texas," Report published by Water Resources Center, TTU, April 1999.

NOTE: Thompson can be contacted at thompson@shelob.ce.ttu.edu or (806) 742-3523.

Range Management for the Lower Rio Grande Watershed

Researcher: Gary McBryde, Agronomy and Resource Sciences Department, Texas A&M University–Kingsville, Kingsville, TX.

Problem: The Lower Rio Grande region of south Texas and northeastern Mexico is experiencing rapid population growth despite a limited water supply. The population is estimated to increase significantly within the next 20 years, further stressing water resources. Throughout the region, many lands are used to graze cattle and deer. The water use associated with these activities needs to be assessed and opportunities for water conservation need to be identified.

Objective: To address how rangeland management, particularly stocking densities, may affect water supplies in this region, and to examine the potential economic impact of water conservation measures associated with deer and cattle grazing.

Methods: The Simulation of Production and Utilization of Rangelands computer model (SPUR-91) was used to provide input data into an economic model of two representative ranches in Mexico and Texas. SPUR-91 uses two scales—one for individual fields and another for basins or watersheds. The model includes modules to represent climate and soil hydrology, as well as plant and animal water use. An economic module incorporates data on the cost of raising herds, water runoff, sediment production, plant biomass by species, and evapotranspiration. Input soil and hydrologic data were based on a representative 98-acre field composed of four ecological regimes ranging from bottomland drainage to upland sites. Each of the sites was from the Brennan-McAllen Soil group. Recommendations have been developed about the appropriate number of cows that should grazed over a given area, based on whether ranchers want to use low, medium, or heavy stocking rates. Currently, the stocking rate in Mexico is 12 acres per cow, while in Texas it is 20 acres per cow. Data parameters in the hydrology module are based on stocking density

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New Waves

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Full text of the *New Waves* newsletter is available on the World Wide Web at http://twri.tamu.edu.

Projecting Future Rice Irrigation Demands in the Lower Colorado River Authority (LCRA) Service Area

Researchers: David J. Eaton, Lyndon B. Johnson (LBJ) School of Public Affairs, the University of Texas at Austin (UT), Austin, TX, and Jobaid Kabir, Lower Colorado River Authority (LCRA), Austin, TX.

Problem: Agricultural irrigators, especially rice farmers, constitute the largest group of water users along the Lower Colorado River Basin. The LCRA asked the LBJ School of Public Affairs to assess the future water needs of rice farmers in Colorado, Matagorda, and Wharton counties throughout the next 50 years, in order to assist in planning efforts.

Objective: To evaluate the likely irrigation demands associated with rice production in the LCRA area throughout the next 50 years.

Background Information: Texans have been farming rice since the 1800s. In 1998, there were roughly 254,000 acres of rice being farmed. The average rice farm in Wharton, Colorado, and Matagorda counties consists of 534 acres, and nearly half (46%) of all Texas rice acreage is located in these three counties. The 1996 Farm Bill was created to replace a system of government payments based on floor and market prices with a program where fixed government payments are given to the landowner. The Farm Bill was intended to make the agriculture industry more market-based by minimizing financial assistance to farmers and ending planting restrictions. Texas has the highest production costs in the United States. Reasons for these high costs include problems with red rice (a weed that reduces yields and increases the need for chemical applications), unfavorable weather conditions, and high water costs. During the past 25 years, costs of production have consistently risen. Despite the increased production costs and declining prices, the Texas rice industry has consistently increased yield, roughly doubling the amount of rice produced during the last 50 years. The LCRA is the most important supplier of water for rice irrigation in Matagorda, Colorado, and Wharton counties. It provides irrigation water to rice farmers at cost on an interruptible basis (farmers only receive water after all of the LCRA's municipal and industrial water demands have been met). This has not been a problem in the past, but anticipated future increases in municipal demands will likely make water less available for rice farmers. Rice farmers depend on their second crop, known as ratoon crop, to make a profit.

Methods: Analyses were done to determine the extent to which prices received by producers have a direct effect on Texas rice production. The researchers used rice prices and the volume of rice produced throughout the past 100 years and adjusted it using the Consumer Price Index. Acreage and net revenues were compared based on data from 1975 to 1995. Because there were no data for exports from Texas to world markets, a comparison of trends in Texas rice acreage and total U.S. rice exports was performed. A linear forecast through the year 2050 was created to estimate rice production. A computer simulation model created at the University of Arkansas was used to project the economics, production, acreage, and yield of rice farming in Texas.

Results: Analyses showed there is a general trend linking decreasing prices with increased production. A similar trend results when price and harvested acreage are plotted together. Therefore, price is not a good indicator of production or harvested acreage. An analysis of the 1996 Farm Bill suggests rice farmers are taking land out of production to collect government payments, and that landowners are increasing rents to make rice farming as profitable as keeping lands idle. The study also suggests that, if the 1996 Farm Bill had not been passed, Texas could have seen an increase in acreage. Rice exports and federal embargoes were identified as two key factors that are relevant to the future of the Texas rice industry. The researchers found that it was not possible to associate changes in Texas rice acreage with total U.S. exports or specific embargoes. With limited quantities of water available, it will become more difficult to produce a ratoon crop. This will directly affect overall yields and net revenues and may be fatal to the Texas rice industry, Eaton suggests.

Discussion: Forecasting the future of the Texas rice industry is difficult because so many factors influence this industry. The best predictor of future rice acreage was shown to be net revenues (not the price paid for rice). Production costs, rice yields, and net revenues, play key roles in influencing rice acreage. All of these conclusions ride on the prospect that water will be available for rice farming. If water supplies are limited and there is not enough to plant a ratoon crop, the Texas rice industry may no longer be viable in the future.

Reference: Eaton, D., and J. Kabir. *Assessing Future Rice Irrigation Demands in the Lower Colorado River Authority Service Area*. Report Published by the LBJ School, UT, 2000.

Note: Eaton can be contacted at (512) 471-4962 or eaton@mail.utexas.edu.

Disinfection of Advanced Primary Treated Wastewater in Ciudad Juarez, Mexico

Researchers: Leirad Carrasco and Charles Turner, Civil Engineering Department, University of Texas at El Paso (UTEP), El Paso, TX.

Problem: Ciudad Juarez is a major city in Mexico, sited across the Rio Grande from El Paso. Two wastewater treatment plants in Ciudad Juarez were completed in 2000. Treated wastewater is used to irrigate non-edible crops. Chlorine is used to disinfect primary treated wastewater before it is discharged from these plants.

Objective: To develop and evaluate the effectiveness of alternative methods to disinfect treated wastewater from the Juarez area using "bench-scale" laboratory studies.

Methods: Raw wastewater samples were collected in late 1999 and 2000. Untreated wastewater was collected from an "agua negra" (blackwater) storm drain in the south part of Juarez. All wastewater in Juarez flows in combined sewers which collect both storm water and sewage. Concentrations of both fecal coliforms and *E. coli* bacteria were measured in the raw wastewater. Bench-scale reactors were used to simulate the primary treatment system used in Juarez. The Juarez treatment system uses aluminum sulfate as a coagulant to enhance the primary settling process. This was simulated using a jar test apparatus at UTEP. In this procedure, the wastewater was rapidly mixed for one minute, flocculated for 20 minutes, and

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Photo courtesy of Charles Turner/ UTEP

Leirad Carrasco obtains a water sample from the Acequia Madre in Juarez.

Using a GIS to Analyze Flood Control Alternatives for the Clear Creek Watershed

Researchers: Philip Bedient and Jude Benavides, Environmental Science and Engineering Department, Rice University, Houston, TX.

Problem: The Clear Creek watershed is one of the last pristine bayous remaining in the Galveston Bay region, and is located 20 miles south of Houston. Clear Creek flows through four counties, at least four drainage districts, and 16 towns before entering Galveston Bay. The watershed contains a tidally influenced estuary of Galveston Bay and is flood-prone, in part because it receives roughly 47 inches of rainfall annually. One proposed flood control strategy is to construct concrete channels, replacing the existing bayou. However, this would likely jeopardize the area's sensitive ecosystem and may only provide limited flood protection. Recent advances in hydraulic and hydrologic models, geographic information systems (GIS), and the interaction between GIS and models make it possible to quickly and effectively analyze various flood control measures, including channelization, the voluntary buyout of properties in the floodplain, and the use of detention ponds.

Objective: To apply the latest hydrologic and hydraulic engineering models, modern weather forecasting technologies, and state-of-the-art GIS tools to evaluate flood control measures for the Clear Creek watershed.

Methods: The hydrology of the watershed was analyzed using models recently developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC), including the Hydrologic Modeling System (HEC-HMS) and the River Analysis System (HEC-RAS). These models include user-friendly graphical user interfaces that were previously unavailable to hydraulic and hydrologic modeling professionals. Next-generation radar (NEXRAD) was used to estimate rainfall in portions of the watershed where there are not a sufficient number of rain gages or other traditional monitoring devices. Previous research by Rice shows that NEXRAD can be used to develop accurate estimates of rainfall. The ARCView GIS was used to take water surface elevations generated through the computer models and overlay them onto a floodplain map of the watershed. Many of the data sets that were needed to create the GIS were obtained from regulatory agencies or through the Internet. Older versions of existing models (using HEC-1 and HEC-2) were imported to the newer HEC-HMS and HEC-RAS formats and were used to calibrate current watershed conditions and storm events. The October 1994 major flood, which produced roughly 20 inches of rainfall in four days, was analyzed as a case study. The project also sought to provide insights into the relative costs and benefits of proposed flood control alternatives.

Results and Discussion: Modeling results suggest that a feasible approach may be to combine upstream detention ponds, a very scaled-down channelization project, and buyouts of floodplain property. This strategy would allow the use of much of the undeveloped portions of the watershed to remain in its natural state and still control flooding. Importantly, it would limit the amount of channelization that needs to be done. In fact, channels would only be built in a reach of the creek that has already been developed near Friendswood. The models and GIS were used in tandem to delineate the 5-year, 10-year, 25-year, and 100-year floodplains for the watershed. This analysis allowed individual homes to be identified that could be vulnerable to storm events of varying magnitudes, thus helping prioritize sites that could be prime candidates for buyouts. Significantly, Bedient says, this study points out that there is a need to produce effective, community-supported, and sustainable solutions to flooding problems in the Clear Creek watershed and similar water bodies. This project shows that the latest technological advances in hydrologic sciences can be used to effectively evaluate alternatives and policy alternatives. In this instance, this research suggests that a watershed-wide channelization project may not be necessary, and that other less-engineered solutions may be the most effective way to protect the region.

Reference: Benavides, J., and P. Bedient, "Analyzing Flood Control Alternatives for the Clear Creek Watershed in a GIS Framework," Presented at the 2000 Texas Section Conference of the American Society of Civil Engineering.

Note: Bedient can be contacted at bedient@rice.edu or (281) 348-4953.

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and include the modified universal soil loss equation cover parameter, mulch cover, and the porosity of the top two soil layers. Generic plant groups developed for the models included three groups of grasses that are associated with good, fair, and poor ecological conditions; two woody species groups based on moderate and low palatability to cattle; and a group of forbs. The plant groups were used to validate whether the model could respond to wet and dry weather biomass production as well as litter accumulation and decomposition rates. The model was used to predict reasonable estimates of biomass production for brush and grassland species over a 15-year period. Two revenue functions were developed for deer hunting in South Texas.

Results and Discussion: Simulated rainfall averaged 23 inches per year. Throughout a 15-year period, simulated weather patterns were dry for the first five years, followed by four average-rainfall years, three wet-weather years, and three dry years. Each of the four stocking densities resulted in changes in vegetation. Light and moderate stocking rates resulted in the greatest diversity of plant species groups. Brush species gained a competitive advantage over grasses from a wet rainfall cycle followed by an average rainfall cycle. When too many cattle resulted in overgrazing, brush species benefited greatly. Heavy cattle stocking rates reduced grass biomass production from all four groups. As the stocking pressure increased, the resiliency of the vegetation was reduced. Heavy stocking created a 100% brush community, virtually eliminating grasslands. Runoff was greatest under heavy stocking rates (3 inches per year), and least under light stocking rates (2.7 inches annually). Sediments and soil evaporation showed similar correlations. Nine scenarios were generated by the economic model representing no deer leasing, alternative deer leasing practices, a baseline or present condition, imposed runoff limits with and without deer leasing, and imposed runoff increases. Without deer leasing, the net revenues were roughly $21 per acre for Texas and roughly $15 per acre for Mexico. When deer leasing was included, Texas revenue would increase by $8 per acre while income in Mexico would remain the same. Deer leasing in Texas acts as an economic incentive to lower cattle stocking, while in Mexico overstocking cattle is more prevalent. To increase water supplies, Texas ranchers may need to give up deer leasing and increase cattle stocking to increase runoff. In Mexico, ranchers may have to abandon the opportunity to develop deer leasing, because they are already overstocking cattle.

Reference: McBryde, Gary, "Effects of range management on the lower Rio Grande watershed," *Journal of Arid Environments*, Vol. 40 (1998): 217-233.

Note: McBryde can be contacted at G-McBryde@tamuk.edu or (361) 593-2113.

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settled for 30 minutes. Once the wastewater had coagulated and settled, it was decanted and used for the disinfection studies. Disinfectants selected for an effectiveness comparison with chlorine were peracetic acid (PAA), chloride dioxide, and ultraviolet light (UV). Disinfection was performed using sodium hypochlorite at doses of 4 to 15 milligrams per liter (mg/l), chlorine dioxide at doses of 2 to 20 mg/l, PAA, and UV light. Samples were analyzed for fecal coliforms and *E. Coli* concentrations.

Results and Discussion: Analyses of the raw wastewater show that the concentration of fecal coliforms ranged from 13.5 million colony forming units (CFU) per 100 ml in December 1999 to roughly 52.5 million CFU/ 100 ml in April 2000. These levels are considered to be normal. After disinfection, the curves for inactivation versus fecal coliform concentration were plotted. All disinfectants were effective at higher concentrations, while UV light proved to be effective at exposures associated with disinfection of secondary treated wastewater in the United States. Therefore, UV light may prove to be an economical and effective means of disinfecting primary treated wastewater.

Reference: Carrasco, L., and C. Turner, "Disinfection of Advanced Primary Treated Wastewater in Ciudad Juarez, Mexico," Proceedings of the 2000 Texas Section Fall Conference of the American Society of Civil Engineers, October 2000, El Paso, TX.

Note: Turner can be contacted at (915) 747-6908 or turner@utep.edu.

Texas A&M, Baylor, TAES, and USDA / ARS to Study Issues Related to Small Watershed Dams

TWRI STUDIES

An interdisciplinary team of researchers from Texas A&M University (TAMU), Baylor University (BU), the Texas Agricultural Experiment Station (TAES), and the United States Department of Agriculture Research Service (USDA/ ARS) are teaming up to study an array of key issues related to small watershed dams. Project leaders include Marty Matlock of the TAMU Agricultural Engineering Department, Raghavan Srinivasan of the TAMU Spatial Sciences Laboratory, Peter Allen and John Dunbar of the BU Geology Department, Joseph White of the BU Biology Department, Ranjan Muttiah of the TAES Blackland Research and Extension Center in Temple, and Jeff Arnold of USDA/ ARS in Temple.

The focus of this effort is to comprehensively examine the thousands of small watershed dams located in rural areas throughout Texas. Small watershed dams are a major concern, Dunbar says, because so many of them are reaching the end of their projected 50-year "useful life." Many areas where these dams were built have changed from rural to urban land uses. As a result, it is suspected that several small watershed dams may need structural repairs or may have filled with sediments.

Photo Courtesy of Joseph White/ BU Biology Department

Baylor University graduate student Jacquelyn Dyke downloads data groundwater data at the Cow Bayou site. Dyke is working with BU Joseph White in the project.

One of the first tasks of this research team was to conduct a case study of a representative small watershed dam. They selected Cow Bayou, which was built in 1956 in McLennan County, as a site that could provide insights into the hydrology and ecological impact of small watershed dams.

"The team is taking a holistic approach to small watershed dams to find out how they've held up, to determine what the hydrological impact would be if they were removed, and to learn how these dams may be influencing riparian zones and nearby water bodies," Muttiah said. "We also want to look at the amount of sediments in the system and to develop a comprehensive water balance."

Each member of the team is working on specific aspects of the project. Arnold, Muttiah, and Srinivasan are conducting watershed-scale water balances on the areas influenced by these dams, using data from geographic information systems, remote sensing, and hydrology models. Dunbar is measuring the sediment volume in these reservoirs and the amount of water that enters the watershed. Allen is monitoring water levels, both in the small watershed dam and in nearby hydrologically-connected aquifers. White is interested in the ecological changes and riparian growth that occur near the dam and the waters flooded by it. White is investigating if succession patterns of trees and vegetation may indicate whether a dam break may have occurred. White's research will be to identify if evapotranspiration from trees, brush, and grasses can be used to determine groundwater flows near the dam. Matlock is studying dissolved oxygen levels throughout the ecosystem created by the dam.

"These dams were built to control flooding, designed to last about 50 years, and are rapidly filling with sediments," Dunbar says. "In the next 10 to 20 years, some of them may simply wear out or no longer be useful. At some point, we will have to decide what to do with these lakes. Should we remove them? Reclaim them? Before we make decisions like this, we need to know how these dams may be influencing the environment and what may occur if these facilities are removed.".

Note: In 2000, TWRI funded this research group as one of six faculty incubator grants. The grants provide start-up funding for the team to meet, develop proposals for comprehensive research projects, conduct literature searches, and meet with funding agencies to discuss ideas. For more information contact Matlock at (979) 862-7476 or m-matlock@.tamu.edu, Muttiah at muttiah@brc.tamus.edu at (254) 774-6103, Allen at Peter_Allen@baylor.edu or (254) 710-6803, Dunbar at (254) 710-4148 or john_dunbar@baylor.edu, White at (254) 710-1038 or joseph_white@baylor.edu, Srinivasan at (979) 845-5069 or r-srinivasan@tamu.edu, or Arnold at (254) 770-6502 or arnold@brc.tamus.edu.

Developing an Electron Beam to Treat MTBE is Goal of TAMU Scientists, Engineers

A team of scientists and engineers at Texas A&M University are working to ascertain whether the power of high-strength electron beams ("e-beams") can be harnessed to destroy a commonly-found water pollutant. The research is led by Bill Batchelor of the Civil Engineering Department, Bruce Herbert of the Geology Department, and Peter McIntyre of the Physics Department.

According to McIntyre, the overall goal of this project is to determine if an e-beam can be developed to treat methyl tertiary butyl ether (MTBE) and other toxic contaminants. MTBE is an additive that was created to boost octane levels and help gasoline burn more cleanly, but it is also a toxic substance that may cause cancer and nervous system damage in humans. Because MTBE is a hydrophilic chemical, and is chemically attracted to water molecules, this pollutant tends to flow rapidly and easily through soils into groundwater supplies. Because MTBE is water-soluble and degrades slowly, it has been difficult to remediate through the use of conventional methods.

In this project, Batchelor, Herbert, and McIntyre hope to develop and test the extent to which a high-powered e-beam can remove MTBE from water supplies. The system will be tested using MTBE-contaminated waters from industries along the Houston Ship Channel.

According to McIntyre, the e-beam technology being developed produces highly reactive species in the water called free radicals. These compounds can react with a wide range of contaminants and destroy them.

"The e-beam will be a compact megavolt accelerator, producing about 100 kilowatts of power," McIntyre said. "We recently learned that roughly 76% of the power supply will be usable by the e-beams, which is very efficient. It increasingly appears that this technology may be a practical way to remove MTBE and other pollutants."

McIntyre is now constructing a prototype that will allow water to flow through the e-beam. Goals of this aspect of the project are determining how much water flows through the system, the effects of turbulence and flow patterns on the performance of the e-beam, and developing a specific design that will treat MTBE most efficiently and economically. Hun-Young Wee, a graduate student in the TAMU Civil Engineering Department, is conducting a literature search to identify typical approaches to apply e-beam technology to treat water and wastewater, as well as ways to make the process more effective and efficient.

Herbert is working to determine how to treat the products of the irradiation created by the e-beam. He is deciphering the chemical reactions of different contaminants as they pass through and are treated by the e-beam. "We need to quantify the amount of contaminant that is destroyed and the formation of any by-products, which may be more toxic than the pollutant that is being treated," Herbert said. In the future, the researchers hope this technology can be used to treat many other toxic pollutants, including trichloroethylene (TCE) and perchlorate.

Note: The project is funded by the Texas Water Resources Institute (TWRI) faculty incubator grant program. For details, contact Batchelor at (979) 845-1304 or at bill-batchelor@tamu.edu, Herbert at (979) 845-2405 or herbert@geo.tamu.edu, or McIntyre at (979) 845-7727 or at p-mcintyre@tamu.edu.

TAMU Study to Assess Biological Effects of Releasing Wastewater to Corpus Christi Delta

Examining strategies that may be useful in implementing wastewater reuse in the Corpus Christi area is the goal of a Texas A&M University (TAMU) research project recently funded by the Texas Water Resources Institute (TWRI).

The project, "Plankton Succession—Investigations Regarding New Approaches to Management," will be carried out by graduate student Yesim Buyukates and researcher Daniel Roelke of the TAMU Wildlife and Fisheries Sciences Department. It is one of 11 studies funded by TWRI for 2001.

Currently, the City of Corpus Christi is evaluating whether releasing treated wastewater to the Rincon Delta has the potential to adversely affect coastal ecosystems. One way to possibly minimize negative environmental consequences may be to release treated wastewater in pulses.

Buyukates' research will complement a series of recent and ongoing studies by Roelke and others that have investigated whether wastewater reuse may potentially benefit wetlands, estuaries, and coastal water bodies. The goals of this project are to learn the best pulsing mode in which to cycle wastewater to the Delta and to evaluate how the nutrient composition of effluents promotes phytoplankton growth. Another objective is to develop management strategies that foster the growth of edible algae species that are most preferred by fish in the region.

Photo by Dan Roelke/ TAMU Wildlife and Fisheries Sciences Dept.

TAMU graduate student Yesim Buyukates filters a water sample from the Rincon Bayou near Corpus Christi.

"Ultimately, we want to promote forms of phytoplankton that fish prefer to consume such as various diatoms, cryptomonads, and other species," Roelke says, "while discouraging less desirable forms such as dinoflagellates and species that form algal blooms. At the same time, we want to increase the nutrient levels in phytoplankton as much as possible by manipulating wastewater releases to the best extent possible."

In this project, Buyukates is conducting field studies and collecting samples at Rincon Delta. At the same time, she is conducting laboratory experiments that use water from the Delta, nutrients, and phytoplankton samples to mimic what may be expected to occur in the field. The laboratory experiments utilize both flow-through incubators and batch cultures.

Ultimately, the study should provide data that can be useful to implement pulsed wastewater releases in the Corpus Christi area, thus benefiting the environment and reusing scarce water resources.

Note: For details, contact Roelke at (979)845-0169 or droelkeunix.tamu.edu, or Buyukates at (979) 847-9328 or yesim@labs.tamu.edu.

UNT Study To Examine Long-Term Effects of Multiple Pollutants on Aquatic Organisms in Streams

Most of the methods now used to gauge the effect of pollutants in rivers on aquatic organisms center on acute, short-term, toxic, effects of single chemicals. In contrast, a new study funded by the Texas Water Resources Institute (TWRI) will allow researchers at the University of North Texas to investigate the chronic, long-term impact of heavy metals, acting in concert with other pollutants, on fish in wastewater-dominated streams.

The project, "Sublethal Effects of Cadmium and Linear Alkylbenzene Sulfonate Mixtures on *Pimephales promelas* Exposure and Effect Endpoints," will be conducted by graduate student Bryan Brooks and researcher Tom La Point of the Institute of Applied Sciences at the University of North Texas (UNT).

The need for this type of study, La Point explains, is that fish are exposed to complex mixtures of pollutants and other environmental stressors in the real world. Traditional tests for aquatic toxicity only measure the influence of a single pollutant on aquatic life.

In this project, La Point and Brooks will evaluate how a heavy metal (cadmium) and pollutants called surfactants (which are commonly found in detergents, soaps, and fabric softeners) can influence the behavior of fathead minnows. Through the use of laboratory and field studies, the researchers will evaluate the relationships between these contaminants and many aspects of the overall health of fathead minnows, including hormone levels, bone strength, and the amount of cadmium that builds up in gills. The researchers will also examine how well the fish swim and reproduce as well as how long they survive. The goal of the project is to determine how levels of other pollutants may determine the amount of cadmium taken up by these fish.

Photo Courtesy of UNT News/ Public Affairs

Tom La Point (left) and Brian Brooks will investigate how multiple pollutants affect stream ecosystems.

Laboratory experiments will be conducted in 10-gallon aquariums on the UNT campus, while simulated field studies will take place in an artificial stream recently constructed at UNT. "This study will provide comprehensive information about how aquatic organisms are impacted by chronic, long-term exposure to a mix of pollutants in rivers and streams," La Point said. "This will be especially important in the future as many Texas waters will become dominated by wastewater and other pollutants."

Note: For details, contact La Point at lapoint@unt.edu or at (940) 369-7776, or Brooks at bwbrooks@unt.edu.

Southwest Texas State Investigation Tests Use of Observation Wells to Estimate Trinity Aquifer Recharge Rates

A recent study at Southwest Texas State University shows how collecting groundwater data in the field may lead to a better understanding of actual recharge rates.

The investigation, "Determination of Recharge to the Middle Trinity Aquifer of Central Texas," was carried out by researchers Marshall Jennings of the Edwards Aquifer Research and Data Center (EARDC) and Lance Lambert of the Biology Department, as well as graduate students Chad Thomas, John Burch, and Brian Creutzburg. The project was funded by the Texas Water Resources Institute (TWRI).

Typically, groundwater recharge rates in Texas are estimated based on baseflows from streams and aquifers. Throughout the more than 4,500 square miles covered by the often arid Trinity Aquifer (which stretches over the South Central Texas Hill Country), rivers are often intermittent or suffer through long periods with little rainfall. As a result, the use of streamflows may not yield the most accurate results in this region. Further complicating matters, there simply are not enough stream flow gages in the region to adequately cover this area.

As an alternative, the EARDC worked with the Texas Water Development Board and many local groundwater districts in 1999 and 2000 to establish a monitoring well network that consists of 23 sites located over the middle reach of the Trinity Aquifer. TWRI funds were used to install five new monitor wells in the region. Throughout this study, the research team obtained data from each of the 23 monitoring wells at least six times a year. Ultimately, data from these observation wells were combined with estimates of the amount of water that could be stored in the aquifer (storativity) and anticipated well yields. The research team utilized the well data, storativity, and well yields to assess recharge rates.

Unfortunately, the years in which the study was conducted were very dry, so little rainfall occurred. This made it difficult to collect recharge data from the monitoring wells. Additionally, computing the storativity values proved to be difficult to define, in large part because more data is needed about the geologic properties of the aquifer. Consequently, recharge values produced through the use of the monitoring wells proved to be significantly less than those calculated by the use of baseflows.

Photo courtesy of John Burch/ SWT

SWT graduate student John Burch measures water levels at this USGS groundwater monitoring site in Hays County.

Still, EARDC Director Glenn Longley says the research was productive. "Field studies like this are critically important because they show the limitations often imposed by models," he said. "The best way to learn more about the recharge characteristics of the Trinity Aquifer may well be to go out and establish more sites where field data can be gathered." Longley also suggests that more research needs to be conducted to better learn about the properties of this karst aquifer system that may influence aquifer storage characteristics.

Note: A technical report describing this project will soon be published by TWRI. A world wide web site has been developed about this project, which is at http://www.eardc.swt.edu/Trinity/trinity.html. For details, contact Jennings at mj09@swt.edu or (512) 245-3544, or Lambert at ll07@swt.edu or (512) 245-2917.

TAMU Researchers Participate in Project to Examine Drought Responses for the Rio Grande Watershed

What management strategies make the most sense to deal with the impacts of drought in the often-arid Rio Grande watershed? That's the emphasis of a recently completed research project by researchers with Texas A&M University (TAMU), New Mexico State University (NMSU), Colorado State University (CSU), the University of New Mexico (UNM), and the University of Colorado (UC).

The project, "Institutional Adjustments for Coping with Prolonged and Severe Drought in the Rio Grande Basin," is a collaborative study that was led by Frank Ward of the New Mexico Water Resources Research Institute at NMSU. Co-authors include Ron Lacewell and John Ellis of the TAMU Agricultural Economics Department, Raghavan Srinivasan of the TAMU Spatial Sciences Laboratory, Robert Young and Marshall Frasier of CSU, J. Phillip King and J. Thomas McGuckin of NMSU, Charles DuMars of UNM, and James Booker of UC. Texas efforts associated with this project were administered by TWRI.

Many experts feel that the Rio Grande watershed is becoming more vulnerable to droughts because the region is naturally arid and growing populations are increasing water demands. The overall goal of the study was to examine the economic and hydrologic viability of several water management options facing river basin managers in the region during droughts of various magnitudes. In this study, the simulated drought would lessen water flows into the basin from 1.57 million acre-feet (AF) to 1.4 million AF.

The research team represented strategies used to manage rivers, as well as the economic impact of those choices, through complex computer models. The water supplies of the region were modeled based on actual hydrologic data throughout a 40-year period. The investigation involved estimating drought impacts on agriculture, municipal use, hydropower, and recreation in the region. The results of the project examined such wide-ranging issues as the need for new management approaches in the area, likely changes between historical and future water use, and contrasting water needs of humans and the environment.

Three alternative policies that could potentially alleviate droughts in the watershed were examined—storing more water in the Elephant Butte Reservoir in New Mexico during wet years for use in droughts, investments to improve agricultural irrigation efficiency in the Middle Rio Grande Conservancy District in New Mexico, and building 100,000 AF of new reservoir capacity above Cochiti Lake in northern New Mexico. Economic analyses show that increasing irrigation efficiency would have a minimal annual positive economic impact for Texas, while building the Cochiti Reservoir would produce $685,000 in benefits each year for West Texas water users.

"This project is important," Ellis says, "because it documents the so-called 'Law of the River' for these three states and Mexico. It then links these institutional rules to hydrology. The composite system may then be used to examine management and policy options and their economic impact on the region."

Note: The New Mexico Water Resources Research Institute recently published a 239-page technical report that summarizes this project. The report is available on the WWW at http://wrri.nmsu.edu. Ellis can be contacted at (979) 845-6095 or j-ellis@tamu.edu, or Lacewell at r-lacewell@tamu.edu or (979) 862-7138.

RESEARCH NEWS

WTAMU Biologists Study Populations of Cagle's Map Turtles Throughout Guadalupe River Basin

The Guadalupe River ecosystem is home to many diverse threatened and or endangered aquatic organisms, including the Texas Blind Salamander, the San Marcos Salamander, the Fountain Darter, and others. Unfortunately, there may be a need to add a species to this list, based on results of an on-going assessment of the Guadalupe River being conducted by a West Texas A&M University biologist .

Flavius Killebrew, a researcher in the WTAMU Life, Earth, and Environmental Sciences Department and the Provost and Vice President for Academic Affairs at the university, is leading efforts to study the population of the Cagle's Map Turtle (*Graptemys Caglei*) in the Guadalupe River watershed. Researchers Joel Babitzke and Jim Rogers of the WTAMU Life, Earth, and Environmental Sciences Department are also working on the project.

First discovered in 1974, Cagle's Map Turtles are thought to only exist in the Guadalupe River system. "Cagle's Map Turtles usually occur only in the river, and they are rarely ever found on the bank," Killebrew said. "They don't wander too far from the river."

Photo Courtesy of Flavius Killebrew/ WTAMU

Dan Porter and Flavius Killebrew (to right) of WTAMU obtain water samples from the Guadalupe River near Cuero.

Killebrew said that one of the problems facing continued survival of the turtle is the presence of dams along the Guadalupe River. Male Cagle's turtles eat insect larvae which are usually abundant in pools and on rocks in areas with riffles. Female Cagle's turtles eat clams and snails. When dams are present, the water quality in the river is altered. Silt covers rocks and decreases the number of riffles in the ecosystem, thus reducing the foodstuff for male turtles.

The last assessment of the range and population of Cagle's turtles in the Guadalupe River basin was done in the early 1990s. This new assessment will be focused on abundance, habitat characteristics, and instream flow requirements of the turtles. By determining the flows the turtles need, scientists can identify the volume and timing of flows that will allow the best chance for the turtle to survive. Similarly, learning more about habitat characteristics (for example, the kind and size of rocks the turtles utilize most) will help biologists and planners identify which reaches along the river may need to be preserved.

Preliminary results suggest that the areas in which the turtle is now found are more limited than the range identified in previous studies. As a result, Killebrew says the turtle may potentially be threatened or endangered unless critical habitats are protected.

Note: This study was funded by the Edwards Aquifer Authority, and will be completed in 2001. Information from the study will be used by the Authority to make informed decisions about how the Guadalupe River system could be managed to let turtle populations flourish. Killebrew can be contacted at (806) 651-2044 or fkillebrew@mail.wtamu.edu.

A&M–Galveston Examines Effects of Shrimp Trawling, Storms, on Sediment Movement in Galveston Bay

The potential effect of shrimp trawling, winds, and storms on sediment resuspension in Galveston Bay is now being studied by researchers at Texas A&M–Galveston and Tulane University. The study is led by Gary Gill and Tim Dellapenna of the A&M–Galveston Oceanography Department and Mead Allison of the Tulane University Geology Department. The research is funded by the Texas Sea Grant Program.

Photo courtesy of Gary Gill/ A&M–Galveston

A&M–Galveston researchers Mead Allison, Gary Gill, and Keith Kepple take a water quality sample near a shrimp trawling boat in Galveston Bay.

Pollutants such as trace metals (copper, cadmium, mercury, and silver) and petroleum hydrocarbons tend to collect in bay sediments. These pollutants, may be natural or industrial, and can enter the bay through river runoff or direct discharges into the bay.

Typically, pollutants accumulate and remain trapped in bay sediments. However, they can pose a threat to the environment if they are disturbed and become mobilized. "Texas estuaries tend to be traps for pollutants," Gill said. "The degree to which any contaminant is retained in the estuary depends on numerous factors, including the degree to which pollutants adhere to sediments and suspended particles."

Gill, Dellapenna, and Allison believe shrimp trawlers and storms may be resuspending these sediments back into the water column, thereby reintroducing contamination into the bay. They have tested this theory by conducting experiments with a shrimp trawling boat in a 164 square foot test area within Trinity Bay. The site is ideal since it is an open bay habitat, and because the sediments there have a fine grain size. Consequently, the research team theorized the impact by trawling and winds could potentially be significant.

Samples were taken before, during, and after the trawl traveled through the test site. Two experiments were conducted in the summer of 1997 and 1998. In order to determine the volume of seabed resuspension caused by the shrimp trawl, an instrument deployed on the bottom of the boats took water samples and measured flows, suspended sediments, and related water quality and hydrologic parameters. At the same time, divers collected intact sediment cores immediately before and after the shrimp trawler passed through the test area. The sediment cores were used to measure oxygen and sulfide levels in the near-surface pore fluids of the sediment, to determine sediment mixing rates using short-lived radionuclides, and to characterize the sediments.

Currently, Gill, Dellapenna, and Allison are working to understand the role of storms in influencing sediment transport and pollutant behavior in the bay. "Storms most likely only resuspend a few millimeters of sediment, but do so over a majority of the bay area, while dredging activities or trawling can reach deeper into the sediments, but only affect limited geographic areas," Gill said.

For details, contact Gill at gillg@tamug.tamu.edu or (409) 740-4710.

Effectiveness of Texas Water Bank Evaluated by Texas A&M International University Researcher

In 1993, the Texas Legislature passed legislation to create the Texas Water Bank, which is now a part of the Texas Water Development Board (TWDB). The idea was that the water bank could promote the buying and selling of water supplies and water rights, thus possibly alleviating water shortages. The legislation (Texas Senate Bill 1030) was intended to create a market atmosphere in which the bank would bring together sellers and buyers.

Recently, an economist at Texas A&M International University (A&M–International) evaluated the structure of the water bank and how it has operated. The goal is to determine the extent to which the bank has been effective at facilitating water marketing. David Yoskowitz, a researcher in the Economics and Finance Department at TAMIU, conducted these studies.

Some of the broad issues being investigated include assessing whether the bank can be flexible in how water trades are allocated, if the tenure of water rights holders is secure, and whether opportunity costs are taken into account. The project is also studying the fairness of the overall water banking process, the parties that participate in the bank, and effects on third parties. Much of Yoskowitz's research involves comparing the Texas Water Bank to California's Drought Water Bank, which was established in 1991.

So far, Yoskowitz notes, there has been little participation in the Texas Water Bank. For example, bank users so far include only one depositor, 14 registered sellers, and just 2 registered buyers. Individuals may contact the TWDB or visit a World Wide Web page to obtain a list of buyers and sellers and where the water source is located. However, pricing information is not shown.

In general, Yoskowitz says the characteristics of the Texas Water Bank reflect a well-defined commodity market that allows water to be easily bought and sold and moved to areas with higher-valued uses. Unlike the California water bank, the Texas bank allows prices to be determined by potential buyers and sellers. Additionally, Yoskowitz found that the Texas Water Bank is much more open-ended about who can participate. For example, non-profit associations can trade water supplies in Texas, while the market was limited to government agencies and cities in California.

A key obstacle that needs to be overcome, Yoskowitz says, is that the amount of groundwater that is available to be bought and sold needs to be quantified in greater detail. "In both Texas and California the availability of surface water supplies is relatively well-known. But the groundwater is difficult to measure and can only be estimated in terms of well yields. This makes it difficult to bank groundwater rights," he said.

Yoskowitz also suggests that the TWDB needs to publicize the Texas Water Bank more effectively, and recommends the Board work with river authorities and groundwater districts to educate potential users. He also recommends that questions regarding the cancellation of water rights need to be addressed. "Water may be put to beneficial use by a lease, but this does not necessarily protect the water right holder from the possibility of cancellation," he said.

Note: For details about this project, contact Yoskowitz at yosko@tamiu.edu or (956) 326-2509. To learn more about the Texas Water Bank, visit their web page at http://rio.twdb.state.tx.us/assistance/WaterBank/waterbankMain.htm or contact Bank manager Dan Beckett, at (512) 463-9893.

NEWS BRIEFS

A&M–Commerce Develops Environmentally Sound Way to Compost Poultry Carcasses

Making the composting of poultry waste more economical, simple, and environmentally sound is the focus of research at Texas A&M University–Commerce. The research is led by Don Cawthon of the Agricultural Science Department.

Typically, Texas produces about 400 million chickens or "broilers" each year. However, in the process as many as 20 million birds die before they can be harvested. The result is that poultry producers need to dispose of roughly 400,000 tons of dead birds each year. Until recently, poultry producers disposed of litter through mass burial and incineration, which could potentially be harmful to the environment. In 1997, Texas passed legislation restricting the mass burial option of poultry carcasses.

Photo courtesy of Don Cawthon/ A&M-Commerce

Finding environmentally sound ways to dispose of poultry carcasses is the goal of A&M-Commerce research.

In this project, Cawthon is working with Wilhite Farms (a broiler producer in Mount Vernon) to create an in-vessel composting system that uses a rotating tank. This in-vessel composting system allows dead birds to be loaded daily into a horizontal grinder. Carcasses are then placed into an in-vessel composter, which measures 6 feet in diameter, is 16 feet long, and turns at 4 revolutions per hour. The composted wastes are mixed with a bulking agent, usually poultry litter, sawdust, or trash from cotton gins. Poultry carcasses usually stay in the machine for three or four days. During this time, the temperature inside the composter reaches 140° F.

"The heat is generated naturally by microorganisms which decompose the carcasses and reduce pathogens, like *Salmonella* and botulism." Cawthon said. "When the product is unloaded from the composter, it is environmentally friendly," Cawthon said. After being taken out of this unit, the composted poultry wastes are placed in a series of covered static bins that measure 60 feet long by 20 feet wide. The compost remains in these bins for at least three weeks to let the materials decompose fully.

According to Cawthon, the best bulking agent may be to mix 25% of poultry carcasses with 75% sawdust. Cotton gin trash may be used instead of sawdust if the goal is to use the finished product to feed cattle. In the future, Cawthon will be testing the use of soybeans and peanut hulls as bulking agents. The research team is also investigating if the compost can be used to produce fertilizers.

"We think that using an in-vessel composting system is economical and environmentally friendly," Cawthon said. "Options now used to dispose of poultry carcasses can pose a threat of microbial contamination and nutrient loadings to watersheds, and can also be costly and labor-intensive. In-vessel composting can remedy many of these problems."

The Texas State Soil and Water Conservation Board provided funding for this project. Details about the project are available on the WWW at http://www.tamu-commerce.edu/coas/agscience/res-dlc/poultry/wilhite.html. For more information, contact Cawthon at Don_Cawthon@tamu-commerce.edu or (903) 886-5350.

UH Engineers Test Biological and Ion Exchange Methods to Remove Perchlorate from Polluted Groundwaters

Scientists at the University of Houston (UH) are investigating two methods to remove perchlorate from ground and surface waters. The project is led by Deborah Roberts and Dennis Clifford of the UH Civil and Environmental Engineering Department.

Various government programs and the private sector use perchlorate to produce rocket fuel and other propellants. Already, perchlorate contamination has been found in ground and surface waters in Texas and 14 other states. The problem is that there is currently no proven cost-effective method to treat perchlorate in drinking water supplies.

"The problem with perchlorate is that it is extremely water soluble," Roberts said, "so when it leaks it moves quickly through the soil. It ends up staying in the ground and has the potential to contaminate aquifers." If perchlorate contaminates water supplies, it can inhibit the uptake of iodine by the thyroid gland in humans.

In both projects, Roberts and Clifford are trying to determine the functionality of a system that combines ion-exchange treatment and biological reduction to remove perchlorate on-site from groundwater supplies. They are attempting to determine the effectiveness of using naturally occurring microorganisms to reduce perchlorate while consuming hydrogen. They are also testing resins that have an affinity for perchlorate. Tests are now being conducted using soil samples from several perchlorate-contaminated sites.

In areas where there are very low concentrations of perchlorate, microorganisms often cannot get enough energy to grow while reducing perchlorate. The researchers theorize that resins with an affinity for perchlorate can concentrate the pollutant, thus enhancing the ability of microorganisms to reduce it.

"The microorganisms have the potential to convert the perchlorate into such harmless end products as chloride ions," Roberts said. "As the microbes destroy the perchlorate, they are effectively regenerating the resin for another cycle of perchlorate removal." In the near future, Roberts and Clifford will place perchlorate selective resins into contaminated and pristine soils in laboratory column studies. Results of the soil column tests will yield insights into how this process may work in the field.

"We intend to pass perchlorate-contaminated water through the soil columns to prove if the resins and microorganisms are working beneficially and to document removal rates. We want to see how fast the process is," said Roberts. The next phase will include larger demonstrations to determine how well this technology may work in pilot-scale and field-level applications.

Note: The project is funded by the Texas Higher Education Coordinating Board Advanced Research Program and the American Water Works Research Foundation. For details, contact Roberts at djroberts@uh.edu or at (713) 743-4281.

REPORTS

TWRI Report Discusses the Feasibility of Brush Control to Boost Water Yields Throughout Texas

A new technical report from the Texas Water Resources Institute (TWRI) and the Texas Agricultural Experiment Station (TAES) provides a comprehensive assessment of the feasibility of using brush management to increase water yields throughout Texas.

The report, "Brush Management/ Water Yield Feasibility Studies for Eight Watersheds in Texas," was developed by the TAES Blackland Research Center (BRC) in Temple, Texas in conjunction with the Texas A&M University Rangeland Ecology and Management and Agricultural Economics Departments. The report was published for the Texas State Soil and Water Conservation Board.

Authors include J. Richard Conner of the Texas A&M University (TAMU) Agricultural Economics Department; Joel Bach of the TAMU Rangeland Ecology and Management Department; Bill Dugas, Ranjan Muttiah, and Wesley Rosenthal of TAES; and Steven Bednarz and Timothy Dybala of the U.S. Department of Agriculture Natural Resources Conservation Service (USDA/ NRCS). "This project is very important in that it contains detailed estimates of the amount of water that can be saved throughout Texas, as well as the cost of these activities," said Dugas, who is the Director of the BRC. "The report shows that brush control is potentially a viable method to produce significant amounts of water in many Texas watersheds."

The report presents an overview of how brush control has the potential to improve water yields, as well as strategies to assess the economic feasibility of brush control projects. Hydrologic analyses were conducted using the Soil Water Assessment Tool (SWAT), a computer simulation model developed by USDA/ARS at Temple, Texas.

Perhaps most importantly, the report contains detailed hydrologic simulations and economic analyses for many regions of Texas, including the watersheds of the Canadian, Frio, the Main Concho, the Nueces, the Pedernales, the Upper Colorado, and the Wichita rivers. Analyses were also developed for the Twin Buttes Reservoir/ Lake Nasworthy watershed as well as the Edwards Aquifer Recharge Zone. Each chapter presents site-specific information on the cost of brush control measures, how landowners will benefit from these programs, the amount of water that could be saved through these practices, and the cost to produce water yields. The report includes maps, illustrations, charts, and tables.

Note: This report was published by TWRI as TR-182 and by the BRC as Report 01-01. Individual copies of the report are available free from TWRI while supplies last. To place an order, contact TWRI at (979) 845-1851 or twri@twri.tamu.edu. You can view the table of contents on-line at http://waterhome.brc.tamus.edu/researchcenters/blackland/dugas/.

TWRI, ISTPP Technical Report Discusses Ecological, Policy Issues that Affect Texas Rice Production

TWRI, the TAMU Agriculture Program, and the George Bush School's Institute for Science, Technology and Public Policy (ISTPP) recently cooperated in a major multi-disciplinary study of the ecological value of rice ecosystems. The goal was to evaluate the extent that declines in rice acreage may result in a loss of wetlands functions. The study investigated economic and policy issues that are adversely affecting the rice farming industry. The project identified opportunities for rice farmers to work with government programs, non-profit organizations, and the private sector to obtain additional resources. The investigation is unique in that it combined the talents of agricultural researchers with scientists involved in policy making.

A report that summarizes the results of this project, *Ecological, Economic, and Policy Alternatives for Texas Rice Agriculture*, was published by TWRI as TR-181.

Lead researchers in the project include Letitia Alston of ISTPP; Thomas Lacher and R. Douglas Slack of the Wildlife and Fisheries Sciences Department; Arnold Vedlitz of ISTPP and the Political Science Department, and Richard Woodward of the Agricultural Economics Department. Other contributors to this project include James Franklin, a post-doctoral research associate with ISTPP and the Political Science Department, and research assistants Nicole Canzoneri and Jeanine Harris of the Political Science Department; April Ann Torres Conkey, Deborah Cowman, April Henry, and Kelly Mizell of the Wildlife and Fisheries Sciences Department; Elizabeth Kennedy of the Forest Sciences Department; Yong-Suhk Wui of the Agricultural Economics Department; Kelly Tierce of the George Bush School of Government and Public Service; and Michelle Krohn and Jill Nicholson of ISTPP.

Note: Printed copies of the report are available by contacting TWRI at (979) 845-8571 or twri@tamu.edu. The full report can also be viewed on the World Wide Web as an Adobe Acrobat file at http://twri.tamu.edu/reports/2000/181/tr181.pdf.

MEETINGS

• The American Water Resources Association will host a conference on freshwater quality April 30–May 2, 2001 in San Antonio. The Conference will examine issues related to water quality modeling and monitoring. For details, visit their WWW site, http://www.awra.org.

• The University Council on Water Resources Annual Conference will be June 27–30, 2001 in Snowbird, UT. The Conference theme is decision support systems for water resources management. For details, visit their WWW site at http://www.uwin.siu.edu/ucowr.

• Texas A&M University–Kingsville is sponsoring the 2nd Annual Rio Bravo/ Rio Grande Environmental Conference. The Conference meets April 26–28, 2001 in Weslaco, TX. The Conference will cover a broad range of issues related to water resources and the environment. To learn more, visit their WWW site at http://even.tamuk.edu/REC2001.

• The National Ground Water Association is sponsoring two short courses in San Antonio this fall. Aquifer testing, operation, and parameter estimation will be taught September 10–11, 2001, and well construction and design will meet September 12–13, 2001. For details, visit the Association WWW site at http://www.ngwa.org.

• The Annual Conference of the American Water Works Association will meet June 17–21, 2001 in Washington, DC. The Conference theme is "New Horizons in Drinking Water." To learn more, visit the AWWA world wide web site at http://www.awwa.com.

• The U.S. EPA Region 6 Nonpoint Source Watershed Conference will meet September 18-19, 2001 in Dallas. The theme is "Water Quality for the Future; Learning from the Past." To learn more about the Conference, contact Sarah Griffith of the Texas Institute for Applied Environmental Research at info@tiaer.tarleton.edu or (254) 968-9586.

by the National Oceanic and Atmospheric Administration (NOAA). Better estimates of ET could improve the accuracy of models currently used to simulate water balances, to generate drought indices, and to schedule irrigation.

• Rafael Perez (student) and G. Joan Holt (researcher), The University of Texas at Austin Marine Science Institute at Port Aransas, "Fluctuating Environmental Parameters in Red Drum Nursery Habitats: The Influence of Habitat Quality on Larval Growth and Endocrine Function." The goal of this project is to examine how natural variations in temperatures and storm cycles may affect the growth of larval stages of red drum, which is a commercially important fish in the region. The research will use laboratory studies to examine how climatic variables influence the endocrine functions of these fish.

• Andres Salazar (student) and Ralph Wurbs, (researcher), TAMU Civil Engineering Department, "Conditional Reliability Modeling to Support Short-Term River Basin Management Decisions." This investigation focuses on conducting case studies of the San Antonio, Guadalupe, and Nueces River basins in order to identify how the WRAP computer modeling software tools can be expanded and improved to better manage surface water supplies. The research will develop the capability of WRAP software to estimate the likelihood that water supplies may be available at specific diversion points, based on storage levels in reservoirs, streamflows, and related factors.

• Daniel Stein (student) and David Eaton (researcher), the Lyndon B. Johnson School for Public Affairs, the University of Texas at Austin (UT), "Texas Groundwater Management and Global Applications." The emphasis of this study is to carry out a comparative analysis of how multiple political jurisdictions have tried to manage transboundary groundwater supplies. Transboundary aquifers that will be analyzed are shared between France and Switzerland; the United States and Canada; and The Palestinian Authority and Israel. The researchers will identify alternate management plans that will be tested in a drought simulation game that will be conducted on the UT campus.

• Kevin Yeager (student) and Bruce Herbert, TAMU Geosciences and Geophysics Department and Peter Santschi, Texas A&M University–Galveston Oceanography Department (researchers), "Resolution of Fluvial Sediment Sources, Residence Times and Resuspension Using Lithogenic, Atmospheric and Cosmogenic Radionuclides, Bayou Loco, Texas." This study will utilize radionuclide fingerprinting to provide insights into sediment production, transport, and deposition within Bayou Loco, which is a coastal watershed near Galveston Bay. The goal is to determine the extent to which radionuclides associated with beryllium, lead, thorium, radium, and cesium can be used to distinguish between newly eroded and older sediments.

• Biswaranjan Das (student) and David B. Willis (researcher), Agricultural and Applied Economics Department, TTU, "Towards an Integrated Water Planning Model for the Texas High Plains." The project will develop a water policy planning model that can be used to evaluate proposed water resources policies and their long-term effects on the Ogallala Aquifer.

Note: For details on any of these projects contact TWRI Information Specialist Ric Jensen at (979) 845-8571 or rjensen@twri.tamu.edu. We will feature many of these projects in future issues of *New Waves*.

Tell Us How You Feel About *New Waves*!

We continue wanting to get feedback from readers about whether they find this newsletter to be useful and how we can improve it. Please fill out this form, along with your name and address, and fax it to us at (979) 845-8554. We will draw an entrant at random, and the winner will receive a free copy of *Isaac's Storm*, a book about the great Galveston hurricane of 1900. This issue's winner is Jimmy Apel of Sweetwater, TX.
Ric Jensen, Editor, *New Waves*

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4. If *New Waves* were published only on the WWW (not printed), would you still read it? (Y/N)
5. Which sections of *New Waves* do you read most often? (Please circle 1 for very often, 2 for sometimes, and 3 for never)

Abstracts	1	2	3
Research News	1	2	3
Reports	1	2	3
Meetings	1	2	3

6. Do you want to learn more about how universities in Texas are working to solve water issues? (Y/N)

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