TEXAS WATER RESOURCES INSTITUTE

twri New Waves

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Less Brush, More Water

Examining the Effects of Brush Control in the Guadalupe River

By April Smith

There is potential for brush control to yield more water in the Guadalupe River watershed, and former Texas A&M University graduate student Jason Afinowicz has developed methods to better understand this potential by studying rangeland trends.

His research focused on refining high-technology mapping tools to display the extent to which juniper, mesquite and other brush species are present in the watershed. Afinowicz, a Master's degree recipient in the biological and agricultural engineering department, also used computer simulation models to investigate the potential benefits of clearing excess brush to reduce plant transpiration and increase runoff and aquifer recharge.

"The first part of the project demonstrates a methodology to be used by producers and landowners to get an aerial idea of brush cover. It minimizes the labor-intense activities of ground survey," said Afinowicz. "The second part of the project gives a framework for applying a model system in the real world."

Afinowicz applied the Soil Water Assessment Tool (SWAT) model to estimate the effects of brush. The work consisted of modeling the daily water balance to effectively monitor variations in surface runoff and groundwater flows. To develop the daily water balances, data had to be compiled about the nature and extent of brush infestations, rainfall trends, soil types, soil depths, land uses and slopes.

He verified and calibrated the model, finding it effectively predicted effects of brush on the water balance. In fact, the success rate was more than 80 percent for the classification process Afinowicz and his research group created.

"Next we used the model to ask 'what if' questions," said Afinowicz. "What if brush cover was removed altogether? What would happen if we removed it from certain locations?" He used the model to answer these questions by conducting simulations to estimate whether flows of water, both runoff and groundwater infiltration, might increase after brush removal.

Several management scenarios were studied to find which were best for increasing water yield. They removed: as much brush as possible; brush from sites with high brush densities; brush from areas with moderate slopes; and brush from areas with shallow soils.

Results of the Upper Guadalupe watershed study indicate brush control may contribute more water to deep infiltration and groundwater recharge than was previously believed, which brings up questions about the behavior of watersheds on the Edwards Plateau. Analysis also suggests the best sites to clear brush in order to boost water supplies may be areas with heavy brush infestation.

"I hope this research is a small step in helping to learn more about how water moves throughout rangeland watersheds as a result of brush management," Afinowicz said.

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Log onto http://twri.tamu.edu for more information on water resources issues

Fipps Named ITC Director

by Kellie Potucek

Professor Guy Fipps of the Texas A&M University Department of Biological and Agricultural Engineering was recently named Director of the Irrigation Technology Center (ITC).

Established in May 2002, ITC is a center under the Texas Water Resources Institute, administrated through Texas Cooperative Extension and the Texas Agricultural Experiment Station. ITC administers programs dedicated to research, development, and training of water conserving irrigation systems that preserve the profitability of agricultural production and quality of urban landscapes. As part of their efforts, ITC seeks to establish an equipment testing and verification program that will compliment its quest to develop minimum design and performance standards for irrigation systems. The center also serves to assist in the coordination of irrigation research and extension programs of the Texas A&M University System.

Fipps will be charged with implementing and expanding ITC's current missions and projects, including development of new facilities, capabilities and programs for irrigation research, education and service. ITC plans to build a 500-acre center hub in the San Antonio area and Fipps will be responsible for designing and testing its laboratories and training facilities. Fipps has a wide range of expertise involving research and Extension programs in water management, groundwater modeling, drip irrigation, salinity management, computer applications, and sensor technology.

USGS Research Grantees Named

by Kellie Potucek

The Texas Water Resources Institute (TWRI) has announced that it will fund 10 graduate student research projects for 2004–05. These projects are funded through the U.S. Geological Survey as part of the National Institutes for Water Research annual research program. These studies begin in March 2004 and run through February 2005.

According to TWRI Director Allan Jones, this year's recipients were selected from among more than 47 proposals that were submitted to this competitive program. The selected projects address a spectrum of key water resources issues within the state.

The winners, their university, department and project title can be found in a chart on page 8.

For more information visit http://twri.tamu.edu and click on USGS Research Grants under the Funding Programs section.

*See **USGS** on page 8*

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North Central Texas Water Quality

Using simulation models to identify potential contaminant sources

by Clint Wolfe

Water quality in North Central Texas reservoirs is a growing concern. Six of the major reservoirs in the Trinity River Basin managed by Tarrant Regional Water District (TRWD) now serve 1.6 million people across 11 counties and are expected to serve 2.66 million by 2050.

TRWD has been concerned about the recent water quality issues caused by point and nonpoint source pollution in the Watershed. The District initiated efforts in 1998 to address water quality issues, developing a water quality monitoring program to collect data for these reservoirs and their associated watersheds for nearly 40 parameters. TRWD has made a notable effort to understand the mechanisms of how the pollutant loads reach the reservoirs and the hydro-dynamics taking place within the reservoirs.

The Texas Water Resources Institute is collaborating with TRWD to study water quality protection and improvements in area reservoirs with regard to problems of sediment and nutrient loading. Sediment loading affects capacity and water clarity while excessive nutrient loading results in algae growth that impacts water treatment and recreational use.

This four year study will focus on one reservoir annually, beginning with Cedar Creek Reservoir. Eagle Mountain, Richland-Chambers, and Bridgeport reservoirs will be studied in subsequent years.

The group plans to develop and use simulation models to identify potential contaminant sources, estimate the potential costs and benefits of best management practices (BMPs) to reduce contaminant loading and develop plans to improve water quality.

A team of Texas Agricultural Experiment Station researchers, Texas Cooperative Extension specialists and agents, Spatial Sciences Laboratory personnel, as well as the consulting firms of Alan Plummer Associates, Inc and Espey Consultants, Inc, will assist TRWD in obtaining data for the development and implementation of a watershed management plan.

Key objectives of this project include: assisting TRWD by assembling information on water quality and pollution loads for its reservoirs and their watersheds, analyzing the biophysical and economic feasibility of alternative management practices and structures, identifying key stakeholders in those watersheds and among the clients of TRWD, holding public meetings to educate stakeholders and clients in each watershed about their water quality and its protection and providing public educational programs to help achieve water quality goals.

See **NCTWQ** *on page 7*

Hands-on Learning

by Amy T. Williams

Texas Cooperative Extension Specialist Russell Persyn of the Department of Biological and Agricultural Engineering has constructed a demonstration "stream trailer" as part of the North Central Texas Water Quality project.

The engaging demonstration shows children and adults stream processes and how erosion and sedimentation occurs. It can also be used to demonstrate stream dynamics, watersheds, dam function and much more.

Curriculum for the stream trailer is under development. Additional programs are also being created to teach children about the water cycle, watersheds, water conservation, and of course, water quality.

If you are interested in having a program at your school or other functions contact Amy Williams in the Tarrant County Extension office at 817-884-3213 or atwilliams@ag.tamu.edu.

Remembering the Forgotten River

Examining virtually unexplored territory of the Rio Grande

by April Smith

The Rio Grande contains a 200-mile stretch of river that flows from El Paso-Juarez to its confluence with the Rio Conchos at Presidio-Ojinaga called the "Forgotten River." This name is due to the lack of scientific data available and the absence of cities along its path.

During the last few decades, many people have immigrated to the Forgotten River stretch leading to substantial population and industry growth in the cities. Consequently, water quality in and downstream of El Paso-Juarez has been declining because of effluent discharge from product assembly plants, irrigation return flow, raw municipal effluent from Mexico, and treated effluent from El Paso.

Because the Forgotten River flows undisturbed for such a long distance, receiving no municipal or industrial effluent and having no perennial streams, it is an exceptional and potentially valuable natural laboratory. Its value as a natural laboratory is that it can be used to study the ability of a desert river to "treat" or "assimilate" contaminants that have been produced by municipalities.

Catalina Ordonez, a doctorate student at the University of Texas-El Paso, hopes to find out more about the Forgotten River by conducting research in five sites along its 200-mile stretch from Fort Quitman to Presidio. She is focusing on the impact of heavy metals on the river and its biology. Metals are good indicators of the level of contamination being retained throughout the segment's length as heavy metals do not decompose but rather can be absorbed by plants or adsorbed by minerals.

In each of the five testing sites, Ordonez collected quarterly samples of water, sediment, fish and macroinvertebrates. She will continue to conduct sampling in each season throughout the next year. This allows her to obtain samples that reflect changes in the river throughout the year.

In addition to testing heavy metal levels, Ordonez tests chemical parameters in water and sediment, such as dissolved oxygen, salinity, conductivity and temperature. These results will reveal the river's ability to support biodiversity, a good indicator of the river's health.

Because there has been very little research performed in the Forgotten River stretch, Ordonez hopes to provide baseline data that identifies the river's existing conditions. "We all depend on the river, and it will disappear if we don't take care of it," she said.

Ordonez received a grant from the Texas Water Resources Institute, to support sampling activities related to her research project.

For more information on research topics addressed in this issue, visit the following Web sites:

http://twri.tamu.edu
http://compost.tamu.edu
http://nctx-water.tamu.edu
http://riogrande.tamu.edu
http://baen.tamu.edu/users/munster/

High-Tech Lagoon Management

Real-Time Monitoring System Under Development

by Kellie Potucek

Livestock, poultry and dairy producers may soon have the option of installing a high-tech, real-time system to monitor lagoons and other liquid waste retention structures used to store and treat animal manure and wastewater. The system, under development by Texas Agricultural Experiment Station researchers, will help reduce accidental lagoon overflows and discharges associated with impaired water quality.

Drs. Saqib Mukhtar (Biological and Agricultural Engineering), Raghavan Srinivasan (Forest Science), and Brent Auvermann (Amarillo Agricultural Research and Extension Center) comprise the research team.

Permitted animal feeding operations must abide by stringent lagoon design, operation and management standards mandated by the Texas Commission on Environmental Quality (TCEQ) and the Environmental Protection Agency (EPA). Though the standards were established to prevent overflow under most rainfall conditions, lagoon discharges continue to occur in Texas. More careful lagoon management can reduce the frequency of discharges. Animal feeding operators may allow their lagoon or waste retention structure to approach the overflow mark because traditional monitoring devices, such as depth markers, do not automatically record water levels and are not equipped with warning alarms. The new real-time system addresses these shortcomings by keeping the manager well informed of the liquid level and sounding an alarm when safe levels are exceeded.

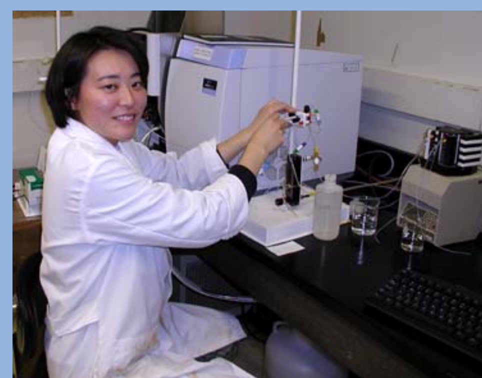
Powered by solar panels, the system uses a pressure transducer probe (PTP) to accurately measure lagoon liquid levels. A rain gauge is also included so the relationship between rainfall and lagoon liquid level increases can be analyzed. The data loggers, which record measurements, are connected to a modem, giving operators the ability to download and access real-time data via phone or Internet. The data recording feature is extremely advantageous because TCEQ requires that operators keep detailed records of lagoon conditions. By automating the record keeping process, human errors are minimized, and complete accurate data are maintained.

Additionally, the system is equipped with alarms that alert the operator of problematic liquid levels. When the PTP measures the predetermined level, a strobe light begins to flash and a phone call is automatically placed to the lagoon operator or owner. The level that triggers the alarm can be assigned by individual operators. This flexibility is important because some operators prefer to be notified well in advance of a critical level, particularly in areas where rainfall is frequent.

Installation is not difficult as the PTP can even be attached to existing lagoon structures, such as the depth marker staff. The estimated $4,000 cost of the system pales in comparison to its numerous managerial and environmental advantages.

"Operators are proactive and they will readily accept and adopt the technology when they see its benefits," explained Mukhtar.

The team is researching whether long-term exposure to lagoon constituents damages the PTP. Now in the seventh month of operation, results have suggested the system can withstand the harsh environment.



New EPA Arsenic Standard Challenges Water Treatment Plants

by Kellie Potucek

Derived from both human and natural sources, arsenic contamination presents a danger to humans, livestock, and pets. Due to its cumulative effect on metabolism, small amounts of arsenic can be harmful to those who ingest the toxin.

In January of 2001, the United States Environmental Protection Agency lowered the amount of allowable arsenic in municipal drinking water to 10 ppb from the previous 50 ppb standard. Compliance with this 80 percent decrease presents a challenge to water treatment systems due to toxicological, economic, and infrastructural implications. Researchers are struggling to establish methodology that will cost-effectively ease compliance and guarantee water quality.

At Texas A&M University, graduate researcher, Yoko Masue, and her advising professor, Richard Loeppert of the Department of Soil and Crop Sciences are working to improve arsenic removal procedures through fundamental chemistry. By collaborating with Department of Civil Engineering Professor Timothy Kramer, the team hopes to identify a complete and efficient arsenic waste management system that can be implemented in water treatment plants.

See **Arsenic** *on page 6*

Rainfall Simulation Shows Ground Water Flow Patterns

Determining the Water Budget in Comal County's Honey Creek

by April Smith

Current and projected water needs for the state of Texas are rapidly growing. The Edwards Aquifer Area and upstream "contributing zone" exemplify those needs. Population pressures, in-stream flow, endangered species and irrigation are putting pressure on regional water resources.

One potential management strategy for increasing stream flow and ground water recharge in the area is vegetation management. Much of the region is covered by a dense canopy of juniper and oak, which has increased substantially during the last century. For this reason there is a high level of interest in using brush control as a mechanism to increase recharge.

"We want to know if vegetation management can increase the amount of stream flow or recharge," said Dr. Brad Wilcox, associate professor in the Texas A&M University Department of Rangeland Ecology and Management.

Wilcox is conducting a field study in the Edwards Plateau with Dr. Clyde Munster, associate professor in the Texas A&M Department of Biological and Agricultural Engineering. Their research will help determine management strategies to increase water recharge by using brush control.

Wilcox and Munster have set up a research area seven meters wide and 14 meters long in the Guadalupe State Park's Honey Creek Natural Area to conduct rainfall simulation. Their research group dug a trench approximately eight feet deep in order to view and measure subsurface water flow. The group also measured surface runoff, interception, transpiration and interflow to document how water flows through the system.

In August 2003, approximately eight inches of rainfall, which translates to 6, 980 gallons, was applied to the site during a period of 51 minutes using rainfall simulation equipment. There was no observed surface runoff during or after the rainfall simulation, which is unusual. The theory behind this is that the water moves below the surface, potentially promoting recharge into the aquifer.

"We saw a lot of water coming out at different faces in the trench," said Shane Porter, a biological and agricultural engineering graduate student working with Wilcox and Munster. "It flowed predominantly from soil areas and places with heavy limestone or root fractures." According to Wilcox, this kind of rapid water movement through the system is called preferential flow.

"This field study will allow us to quantify a water budget for the area in real time," said Porter. "We can determine how much water brush species use, and whether brush control is necessary."

Wilcox and Munster have also designated a paired plot that resembles the first research area in slope and soil type, but does not have any brush growth. Doing field studies allows comparison of surface and ground water flow with and without brush. The group's field study in the paired plots began in March, and they have already seen a larger amount of surface runoff without brush present. Long-term plans include removing brush on the first plot and measuring the resulting flow patterns through simulation.

Arsenic

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Current water treatment systems utilize aluminum or iron salts, coagulated by sodium hydroxide, to adsorb and remove arsenic. Though relatively effective, both adsorption agents have disadvantages. In aerated environments, iron oxides retain arsenic very well. However, when in a reduced environment, such as a landfill, iron oxides become soluble and adsorbed arsenic can be leached. Conversely, aluminum oxides have a lower adsorption capacity for some arsenic species but are unaffected by redox processes.

Masue and Loeppert's research is based on the logic that combining iron and aluminum methods will reciprocally maximize the advantages and minimize the deficiencies of each compound. Additionally, the use of calcium hydroxide during coagulation, versus the traditional sodium hydroxide, may result in a system which provides higher retention of arsenic.

"We are working on a fundamental level to understand the processes that control arsenic removal by the mixed iron and aluminum systems and the optimization of arsenic retention in the coagulated product to prevent leaching of arsenic into groundwater," explains Masue.

Since the project was launched in March 2003, Masue's research has suggested that the presence of calcium during arsenic removal better prevents arsenic leaching. Additionally, aluminum substituted iron oxide resulted in a product that maintains higher adsorption capacities during incubation in land fills. Furthermore, the mixed iron and aluminum system was found to be more resistant to transformation into an unfavorable crystalline product.

Research is ongoing and future plans include study of heat-treated iron, aluminum, and silica complexes to create an adsorbent with even greater arsenic binding capabilities.

Offset Compost Costs

by Kellie Potucek

Use of composted dairy manure is an exciting prospect to agriculturalists and environmentalists alike. Research suggests that compost is an economically viable soil amendment that promotes plant growth and by export out of the watershed can improve water quality in areas where large amounts of manure are generated. However, the high cost of shipping compost can deter its use. At Texas A&M University, a team of scientists is attempting to overcome the economic obstacle by investigating utilization of compost to produce valuable turfgrass sod.

The research, conducted at a large plot near the Brazos River, is led by Professor Don Vietor of the Soil and Crop Sciences Department, Associate Professor Clyde Munster of the Biological and Agricultural Engineering Department, and several graduate students. The team hopes to ascertain whether composted dairy manure can be used to grow large amounts of quality turfgrass sod capable of satisfying urban landscape needs. Furthermore, they seek to confirm that composted dairy manure does not adversely affect water quality. The research compares sod production responses to composted dairy manure phosphorus and inorganic phosphorus fertilizers. In this way, the team can evaluate compost as a possible substitute to traditional inorganic phosphorus fertilizers.

The project area, measuring 1.3 hectare with a 1 percent slope, was established in June 2002. Graduate researcher and TWRI USGS grant recipient Brandon McDonald analyzed nitrogen and phosphorus partitioning in soil samples at various depths before compost was introduced, during the growing season, and after the trufgrass sod was harvested. Phosphorus and nutrient levels in water runoff from the site were monitored by graduate researchers George Stewart, I. Choi, and Chad Richards, a TWRI Mills grant recipient.

One of the most encouraging aspects of the research is the extent of collaboration between the turfgrass industry and scientists. Turfgrass America contributed to the research's large scale by helping the team plant, harvest, and export the sod for commercial landscape use. "The collaboration with turfgrass industry partners not only fosters sharing and leveraging of resources, but will enhance the rate of adoption of the systems for compost export out of the watershed through sod," explained McDonald.

Though analysis of collected data is not yet complete, preliminary observations indicate that composted manure assists in producing exceptionally high quality turfgrass that quickly re-establishes after harvest. Additionally, the research suggests that runoff from sod grown on clay soil with composted manure does not harm water quality.

NCTWQ

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Because of the complexity of the hydrologic processes that take place in watersheds, it is highly desirable that several complex models be used in an integrated strategy to fully capture the impact of point and nonpoint source loadings on the water quality of the region. While some limited water quality modeling has been done in the region, this project represents one of the first comprehensive efforts to utilize a series of models to provide a thorough assessment of point and nonpoint source pollutants of all watersheds and to determine the effectiveness of proposed management measures to address water quality concerns.

The Soil Water Assessment Tool, or SWAT model, developed by the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) will be used to simulate watershed processes and pollutant loads from subwatersheds. SWAT was selected for this study because of its capabilities to appropriately represent landscape processes and agricultural management. Major components of the model include hydrology, weather, erosion, soil temperature, crop growth, nutrients, pesticides and agricultural management. Additionally, SWAT has the ability to predict changes in sediment, nutrients such as organic and inorganic nitrogen and organic and soluble phosphorus, pesticides, dissolved oxygen, bacteria and algae loadings from different management conditions in large ungauged basins.

Loading estimates from subwatersheds using SWAT will be input into the QUAL2E steady state in-stream dynamic model to simulate water quality in river and stream segments. QUAL2E has built-in options to depict the major reactions of nutrient cycles, algal production, benthic and carbonaceous oxygen demand and atmospheric reaeration. Outputs from these models will drive the Water Quality Analysis Simulation Program (WASP) model to simulate reservoir water quality.

Spatial Sciences Laboratory personnel will lead SWAT watershed modeling efforts while Espey Consultants, Inc will lead QUAL2E and WASP modeling efforts.

This project will also develop a database of wastewater plants in the region as well as management strategies for these facilities. Alan Plummer Associates, Inc will lead tasks related to wastewater treatment plants.

"The goal of this project is to accommodate varied activities such as a growing population and increased urbanization without sacrificing water quality," said Clint Wolfe, research assistant and project manager at the Texas Water Resources Institute. Watershed management is the first, and often most cost-effective step to ensure a safe and reliable public water supply."

Watershed management is a holistic approach defined by hydrologic boundaries and integrates water quality impacts from both point and nonpoint sources. Key objectives of watershed management plans include identifying potential contaminant sources, evaluating costs and benefits of implementing management plans and/or constructing facilities to reduce loadings and producing useful watershed planning tools.

Information gathered from this research study will allow TRWD and cooperating agencies to use scientifically based methods to not only identify sources for water quality impairment, but also to evaluate the costs and benefits of addressing these sources by developing and implementing a watershed management plan.

The U.S. Environmental Protection Agency and the U.S. Department of Agriculture Natural Resources Conservation Service are funding the project.

USGS

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2004 USGS Research Grantees

Name	University	Department	Project Title
Adrian Dongell	Southern Methodist University	Environmental & Civil Engineering	Removal of Hormones through a Conventional Wastewater Treatment System
Timothy Goebel	Texas A&M University	Soil & Crop Sciences	Novel Polymeric water treatment for in situ removal of organic contaminates from water bodies
Vivekanand Honnungar	Texas A&M University Kingsville	Environmental & Civil Engineering	Estimating Water Availability and Sustainable Yield in Coastal Semi-arid Region of South Texas
Greg Landreth	University of Texas	Environmental & Water Resources Engineering	Assessment of Four Economic/Managerial Models for Operation of Public Water Systems in Texas
Eva Lovelady	Texas A&M University	Chemical Engineering	Development of Optimal Water Conservation and Management Stratagies for Industrial Facilities
Hector Olmos	Texas A&M University	Civil Engineering	Improving Capabilities for Dealing with Key Complexities of Water Availability Modeling
Bakkiyalakshmi Palanisamy	Texas A&M University	Spatial Sciences	A Near Real Time Flood Prediction using Hourly NEXRAD rainfall for the state of Texas
Itza Sanchez	Texas A&M University	Civil Engineering	Effect of flow velocity on biodegradation of trichloroethene (TCE) and perchloroethene (PCE) during restoration of contaminated groundwater aquifers
Philip Taucer	Texas A&M University	Biological & Agricultural Engineering	Development of Smoke Tracer Instrumentation for Groundwater Recharge Investigations in the Edwards Aquifer Region
Erin Williford	Rice University	Civil & Environmental Engineering	Radar Based Flood Alert System for Austin, Texas

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