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Looking Deeper

Groundwater Availability Models

By Ric Jensen

People who manage groundwater now have a better idea of the amount of water stored in aquifers throughout much of Texas, thanks to an ongoing computer modeling effort led by the Texas Water Development Board (TWDB).

In 2001, the Texas Legislature passed legislation to enable TWDB to develop and implement the groundwater availability modeling (GAM) program as part of Senate Bill 1 (SB1) planning activities. The Legislature required TWDB to complete GAM modeling for the nine major aquifers of Texas by October 2004. In addition, SB1 mandates that groundwater conservation districts must use GAM data to develop groundwater management plans.

Through the GAM program, TWDB is developing and testing state-of-the-art groundwater models that will help users better understand groundwater processes.

The goal is to provide timely and reliable data about groundwater quantity in specific aquifers that can be used to accurately estimate aquifer storage and the effects of long-term pumping on water yields. GAM methods can also help evaluate the merits of proposed groundwater management strategies.

In basic terms, a GAM model represents factors that influence the volume of water in an aquifer, including geology, hydrology, recharge rates, the volume of water pumped and interactions between ground and surface water. Steps involved in creating a GAM include developing the concept of flow for the aquifer; collecting and inputting data on aquifer characteristics, pumping and water levels; and testing the model to see that results can be accurately calibrated and verified. The model can then be applied to assess current conditions and to examine how future water use can affect aquifer levels.

TWDB is working with GAMs for several regions of Texas. The Board is now developing GAM tools for parts of the Trinity Aquifer, the Gulf Coast Aquifer and the Edwards-Trinity Aquifer. Portions of the Ogallala Aquifer, the Barton Springs portion of the Edwards Aquifer and the Gulf Coast Aquifer are being modeled as part of SB1 studies. The United States Geological Survey is developing a GAM for the Hueco Bolson Aquifer in El Paso and part of the Gulf Coast Aquifer, while the Edwards Aquifer Authority is creating a GAM for the Edwards Aquifer.

Scientists at universities throughout Texas are studying, evaluating and applying GAM models. Some examples are shown below:

- David Maidment and graduate students at the Center for Water Research at the University of Texas are developing a groundwater data model for the ArcGIS geographic information system that will represent data simulated by GAMs.

*See **GAM** on page 2*

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

GAM

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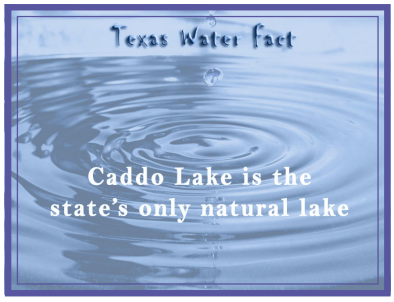
- Researcher Zhuping Sheng of the Texas Agricultural Experiment Station in El Paso is assisting in efforts to model the Hueco Bolson aquifer and Far West Texas Bolson and Igneous aquifers.
- Researcher Alan Dutton of the Bureau of Economic Geology at the University of Texas is working with the Panhandle Regional Water Planning Group, Freese and Nichols, Inc. and TWDB to develop GAM tools for the northern part of Ogallala Aquifer.
- Rick Hay, a researcher at Texas A&M University-Corpus Christi, recently participated in efforts to estimate water availability in the Gulf Coast Aquifer. He is now working to incorporate recharge data into a GAM for the region.
- Kevin Urbanczyk, a researcher at Sul Ross State University in Alpine, is developing GAM simulations for the Bolson and Igneous aquifers in Far West Texas.

For more information visit the TWDB Web site, http://www.twdb.state.tx.us/gam



Signature Program in Water

By Kellie Potucek

Cristine Morgan, associate professor in the Department of Soil and Crop Sciences, was recently named to the Signature Program in water. After earning her bachelor of science degree from Texas A&M University, Morgan went on to receive both her master's and doctorate in Soil Science at the University of Wisconsin. Her graduate research emphasized using landscape modeling approaches to address logistical, productive, and environmental issues in precision agriculture.

"Effective soil and water management at the landscape scale depends on high quality, cost-effective soils information, so farm and resource managers may successfully quantify biophysical processes," Morgan explained.

Morgan's modeling and measurement research focused on biophysical processes such as water transport and evapotranspiration in addition to mapping soil variability over agricultural landscapes. Her PhD research addressed understanding soil-water relations as affected by soil heterogeneity at two primary scales: 1) The mesoscale variability over farm fields that is associated with topography, land use, and soil formation processes, and 2) microscale variability related to macropores that strongly influence preferential flow of water and solutes through soil.

In her current position at Texas A&M University, Morgan's research goals encompass several vital aspects of the soil-water relationship. Initially, Morgan will identify water and solute transport processes in agricultural landscapes and quantify how spatial and temporal variability of soil properties affect these processes. Through this research, Morgan will advance the understanding of the soil-water interface that affects nonpoint source pollution.

Ogallala Aquifer

Using Improved Irrigation Technology and Water Conservation to Meet Future Needs

By Ric Jensen

The Ogallala Aquifer is one of the largest groundwater resources in the world and represents one of Texas' largest water sources. As a result, several innovative programs have been developed to conserve, manage and protect this critically important groundwater formation.

The Ogallala stretches across parts of eight states from South Dakota to Texas and covers 174,000 square miles, including 36,080 square miles in the Texas High Plains. According to recent estimates, the aquifer contains roughly 3.27 billion acre feet (ac-ft) of water, of which 417 million ac-ft are in Texas.

How important is the Ogallala to Texas and the United States? Most of the water pumped from the Ogallala is used for agricultural irrigation. Data from the U.S. Department of Agriculture show that farmland irrigated by the aquifer represents 65 percent of all the irrigated acreage in the nation.

Current irrigation water use for the Texas High Plains totals more than 6.1 million ac-ft but is predicted to decline to 4.8 million ac-ft by 2060, according to data developed by regional water planning groups.

Annual measurements of the depth to groundwater by the High Plains Underground Water Conservation District (HPUWCD) provide insights into trends throughout its 15 county service area. HPUWCD data show average declines of 1.28 feet per year from 1994 to 2004.

Thanks to the efforts of several organizations including groundwater conservation districts, Texas A&M University Agricultural Research and Extension Centers in Amarillo and Lubbock, U.S. Department of Agriculture - Agriculture Research Service (USDA-ARS), Texas Tech University and West Texas A&M University, many farmers throughout the Texas High Plains have adopted a variety of water-saving practices. These include low energy precision application (LEPA), center pivot irrigation systems, low elevation sprinkler application systems, subsurface drip irrigation, surge flow irrigation, the use of furrow dikes and reduced tillage.

As a result, overall water use efficiency among agricultural producers in the region has jumped from 50 percent in the 1970s to as much as 90 percent today. Research and Extension demonstrations with Texas farmers show that LEPA and subsurface drip irrigation systems are extremely efficient. Roughly 95 percent of water applied using these technologies contribute directly to crop growth.

The Ogallala Aquifer is located in a semi-arid region that receives limited rainfall, which provides little if any recharge. Only about 18 inches of rain falls in the region each year while potential evaporation losses from sustained high temperatures and winds total 70 to 80 inches annually. Therefore, the aquifer is a finite resource that is gradually being depleted.

Some of the challenges facing the Texas High Plains region today include increasing energy costs to pump groundwater, declining aquifer levels and proposed plans to market and export groundwater from the region.

Several programs are now underway that will influence the region's water quality, quantity and use.

Researchers at USDA-ARS, Texas A&M University, Texas Tech University, West Texas A&M University and Kansas State University are working to make agricultural water use more efficient, determine the economics of water conservation and educate farmers and other water users about conservation practices.

An agricultural water conservation initiative enabled by Senate Bill 1053 was passed in the 78th session of the Texas Legislature. The bill is designed to transfer water-saving technologies to agricultural producers. The Texas Water Development Board will work with cooperators to demonstrate water conservation methods at large-scale sites involving several farmers.

The Role of Groundwater Conservation Districts

Groundwater Conservation Districts (GCD) are the preferred method of management of groundwater resources according to Texas legislators. In 1949 the Legislature created a process for designating groundwater management areas and authorizing formation of special underground water conservation districts. More recently, the Texas Legislature passed additional laws to establish more GCDs. GCDs operate under guidelines of Chapter 36 of the Texas Water Code.

Groundwater Conservation Districts strive to maintain a balance between protecting the rights of private landowners and conserving water resources. By law, GCDs must develop, adopt and coordinate with other agencies to create a groundwater management plan. Although they are not required to regulate groundwater, most districts have implemented some type of groundwater regulation.

The goals of a management plan include adopting rules for the governance and establishment of administrative and financial procedures. Other issues that can be addressed include providing for the most efficient use of groundwater, controlling and preventing waste of groundwater, and addressing conjunctive surface water issues, natural resources issues, drought conditions, and conservation.

Besides the creation of a groundwater management plan, other mandated duties of a GCD include keeping records of drilling, equipping and completing water wells, permitting and registering wells.

As part of a management plan, the GCD also has the authority in the following areas:

- Buying and selling, transporting and distributing groundwater
- Acquiring land by use of eminent domain
- Conducting surveys, research and monitoring programs
- Providing for the spacing of water wells and regulating the production of wells
- Exempting wells from requirements to obtain a drilling or operating permit
- Requiring owners of uncovered or abandoned wells to keep the well closed or capped
- Requiring a person to obtain a permit to transfer groundwater out of the district
- Engaging in projects to recharge aquifers
- Levying taxes and setting fees

A GCD may make and enforce rules—including those limiting groundwater production based on tract size or the spacing of wells—to conserve, preserve, protect and recharge groundwater or a groundwater reservoir. It also may set rules to control subsidence of land, prevent degradation of water quality and prevent waste of groundwater. Generally, GCDs can not prevent the export of water out of the district. But they can charge an export fee.

Groundwater is and will continue to be a major source of water for Texans. GCDs serve to manage groundwater resources and protect them locally.

Guarding Groundwater

The Texas Groundwater Protection Committee

By Ric Jensen

Working to safeguard groundwater quality and conserve groundwater for future users are the goals of the Texas Groundwater Protection Committee (TGPC).

The committee was created by the Texas Legislature in 1989. It has no regulatory authority, but works with existing state agencies, academic institutions and groundwater districts to encourage groundwater protection. The focus is to help coordinate the development and implementation of statewide policies and projects that ensure groundwater quality is not degraded.

The committee has the responsibility to compile data from state agencies and groundwater districts about identified cases of groundwater contamination. This information is provided to state officials, state and federal agencies and local governments.

Because of the committee's coordinating role, the legislature directed the TGCP to include representatives from several state agencies. The committee is chaired by a representative of the Texas Commission on Environmental Quality and the vice chairman is a staff member of the Texas Water Development Board. Other agencies represented on the TGPC board include the Texas Agricultural Experiment Station, Texas State Soil and Water Conservation Board, University of Texas Bureau of Economic Geology, Railroad Commission of Texas, Texas Department of Health and Texas Department of Licensing and Regulation water well driller and pump installer program.

Reports published by the committee include the state groundwater protection strategy, results of monitoring and assessments of groundwater contamination and a landowner's guide to plugging abandoned wells. The committee was also instrumental in the development of the state's pesticide management plan for groundwater.

Much of the committee's work is accomplished through subcommittees that focus on research needs, public education, agricultural chemicals, legislative issues and data management. The committees identify needed projects and sources of funding to support these activities.

Recently supported activities include:

- TGPC facilitated a project for collecting data on the occurrence of atrazine in the state's aquifers. The committee's atrazine work includes both data collection and assessment of groundwater in aquifers of the Texas Panhandle.
- Project by Drs. Dana Porter and Monty Dozier of Texas Cooperative Extension to educate agricultural producers about best management practices to prevent atrazine contamination of groundwater in the High Plains.
- Design of an enhanced statewide strategy to obtain data on groundwater quality led by Lynne Fahlquist of the United States Geological Survey. The network will build upon existing groundwater monitoring programs.
- Publication of fact sheets about wellhead protection developed by Drs. Dozier and Dennis Hoffman, Blackland Research and Extension Center at Temple, Texas.
- Programs led by Drs. Dozier and Bruce Lesikar of Texas Cooperative Extension to demonstrate how to plug abandoned groundwater wells.

To learn more, visit the committee's home page at http://www.tgpc.state.tx.us

Securing South Central Texas' Water Supply

Conservation Efforts of the Edwards Aquifer Region

By Ric Jensen

Several innovative programs are being developed to optimize water use throughout the Edwards Aquifer region—the primary source of drinking water for San Antonio and much of the surrounding area.

The Edwards Aquifer covers an area that is 180 miles long and 40 miles wide and stretches from Brackettville in Kinney County to Kyle in Hays County. More than 1.7 million people live in the region and the population is growing rapidly. Urban, agricultural, and industrial users depend on the Edwards as the major freshwater source in the area. The aquifer provides flows to Comal and San Marcos Springs, which are home to threatened and endangered species.

In the upper parts of watersheds, the aquifer is recharged by streams and rivers from which waters percolate into the fractured karst limestone formations. Furthermore down the watershed, rivers and streams in San Antonio, San Marcos and New Braunfels are fed by Edwards spring flows.

The volume of water withdrawn from the Edwards Aquifer has varied over time. Regional pumping reached a peak of 542,000 acre-feet (ac-ft) per year in 1989. Thanks to groundwater management and conservation plans, pumpage for permitted water users averaged roughly 394,000 ac-ft annually over the last decade. The exact amount of water that can be pumped from the aquifer without threatening springflows is dependent on regional rainfall amounts and the resulting recharge.

The Edwards Aquifer is one of the few groundwater systems in Texas where users must obtain a water rights permit to pump. Senate Bill 1477, passed in 1993, required that groundwater rights in the region must be allocated based on historic pumping levels. Municipal and industrial water users were guaranteed rights to the amount of water they historically used from 1972 to 1993. Agricultural users were guaranteed two ac-ft per acre for the largest number of acres they irrigated during that same period. Senate Bill 1477 also allowed the transfer of water rights. Holders of irrigation permits may transfer one ac-ft per acre of their rights, but one ac-ft per acre must be retained on their land for irrigation. Over the years, municipalities throughout the region have leased more than 190,000 ac-ft of groundwater withdrawal rights.

The Edwards Aquifer Authority (EAA) is developing a groundwater management plan required by Senate Bill 1, passed in 1997. The plan encourages efficient groundwater use and conjunctive management of surface and ground waters. The regional water plan developed through the Senate Bill 1 planning process suggests that more efficient water use and conservation will make up 21% of the area's water supplies by 2050.

Several entities in the region are encouraging water conservation. San Antonio Water System (SAWS) and EAA have developed education and awareness programs to increase water conservation inside and outside the home, and have created rebates to foster use of water-efficient technologies. Through conservation, SAWS has reduced average water consumption from 231 to 132 gallons per person per day. SAWS is working with golf courses to help them develop and implement water conservation and water quality protection programs.

Additionally, water suppliers in the region are considering innovative approaches to develop future water sources for the region. SAWS implemented an aquifer storage and recovery project to store water in a groundwater formation in Bexar County, where water will not be lost to evaporation. This will allow for the reserve storage of more than 3.5 billion gallons of water for later use.

SAWS and other entities are considering plans to import groundwater from Goliad, Refugio, and Victoria Counties as well as working with the Guadalupe-Blanco River Authority to divert water from the region's rivers to reduce stress on groundwater supplies.

At Texas State University, the Edwards Aquifer Research and Data Center has established a network of groundwater wells throughout the region to monitor changes in water levels and springflows. They are also characterizing the ecology of the Blanco River watershed, and developing education programs for public schools.

Texas Cooperative Extension is encouraging efficient water use in landscapes through the Seasonal Irrigation Program (SIP) and Master Gardeners. SIP provides homeowners with daily advice about the amount of water to apply to specific landscapes from March to October. Master Gardeners provide classes with information about efficient water use and pesticide management practices.

In the Uvalde region, Texas Agricultural Experiment Station and Texas Cooperative Extension professionals are engaged in research and demonstration programs to help agricultural producers use water most efficiently. Efforts, in many cases joint with USDA Natural Resources Conservation Service, involve evaluating use of center pivot and drip irrigation for crops and improved pastures, developing new irrigation strategies to grow crops when water is limited, and eliminating water waste.

Meeting Water Needs: TEXAS in 2055

Regional Water Planning

By Ric Jensen

Stakeholders constituting 16 regional water planning groups (RWPGs) that cover the State are engaged in a planning process to anticipate water demands and evaluate strategies to meet future water needs. The process is coordinated by the Texas Water Development Board (TWDB), the agency charged with reviewing and approving plans developed in each region and compiled into a state water plan.

Water planning is important for Texas because the process identifies trends that can be acted upon to prepare for the future. The 2002 Texas Water Plan shows that overall water demands will grow from current levels of 15.7 million acre-feet (ac-ft) to more than 20 million ac-ft in 2050. Regional water studies identify changes that may occur in different water use sectors throughout Texas.

"Regional water planning groups are in the process of preparing their 2006 regional water plans," said Kevin Ward, executive administrator of TWDB. "Better data, increased involvement with local interests, and the strong partnerships that have been developed since the first round of regional water planning will serve as a strong foundation for producing a comprehensive, viable 2007 Texas Water Plan."

The cornerstone of current water planning efforts in Texas is Senate Bill 1, passed by the Legislature in 1997. This bill made significant changes to water planning in Texas, because it emphasized involving local stakeholders. Previously, water resources' planning was largely carried out by TWDB staff and consultants, after obtaining input from citizens, agency personnel and technical advisory committees.

Senate Bill 1 is significant in that each RWPG is required to develop a plan to address water supply and demand issues for their region for the next 50 years. The first plans were approved in 2002 and address water needs through 2052. Every five years, a new plan has to be created for each region. The process allows stakeholders to decide how water supplies and demands will be balanced in their region. Financial assistance from TWDB can only be provided to projects that are consistent with recommendations in regional water plans.

In creating a regional water plan, stakeholders examine water demands, identify areas where there is a shortage or surplus of water and determine whether there are sufficient supplies during droughts.

Each plan must include specific strategies to meet future water needs and may identify ecologically important stream segments and proposes sites for future reservoirs. RWPGs are encouraged to consider coordinated water supply and demand management efforts that include cooperation with neighboring planning groups.

Regional water planning is now entering a new phase to develop revised plans by 2006. These plans will address water supply issues through 2055. Some of the changes in the planning process are being implemented due to Senate Bill 2.

- Water demand and population estimates are being revised using data from the 2000 Census.
- New groundwater and surface water availability models are being used to refine water demand and supply estimates.
- RWPGs are placing a greater emphasis on water conservation to reduce water demands and to assess how management measures may affect the environment.
- Recommendations are being sought regarding changes to Texas water policies and laws that may make it easier to meet future water needs.

Additional information about regional water planning is available from the TWDB website, http://www.twdb.state.tx.us.

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