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Background Information

When the Texas Legislature enacted Senate Bill 1 (SB 1) in 1997, it dramatically revolutionized the way Texas conducts water planning studies. While previous efforts concentrated on centralized water planning, the new paradigm required local groups in each of 16 regions (see map) to carefully assess their own water needs over the next 50 years, and develop solutions tailored to their region.

In January 2001, regional water plans were finalized and approved by the Texas Water Development Board (TWDB). The State Water Plan will be published by TWDB in January 2002.

A case-by-case review of each of the region's water plans is outside the scope of this newsletter, due to space limits. A 41-page summary of the regional plans is available from the TWDB WWW site.

In several instances, university researchers became involved in the regional water planning process. In this issue, we identify examples of how researchers, extension specialists and agents, and graduate students associated with higher education supported these planning efforts.

Involving higher education faculty in these studies provided benefits to the regional planning groups. It makes sense to employ he state's investment in scientists at colleges and universities to seek out solutions to pressing problems. Challenging projects like this provide stimulating opportunities for researchers, extension specialists and agents, and graduate students to become enga ged in meaningful research and outreach activities.

Studying Policy Issues

University researchers have examined how the water planning process works, as well as policy issues related to SB 1 activities.

A team of graduate students at the University of Texas at Austin (UT) Lyndon B. Johnson School of Public Affairs (LBJ School) worked with the TWDB to identify potential performance measures that could be used to evaluate strategies created by the regional water planning groups. The work was coordinated by LBJ School researcher David Eaton. In 1998, Eaton and LBJ school students interviewed staff members from TWDB, the Texas Natural Resource Conservation Commission (TNRCC), the Texas Parks and Wildlife Department (TPWD), and river authorities to gain their perspectives on what types of studies may benefit SB 1-related planning activities. Later, field interviews were conducted with individual water users, including farmers, municipal and industrial customers, recreational users, and environmentalists. The perspectives of stakeholders and the state agencies were compared.

According to Eaton, the results suggest that individual water users were much more optimistic about the future availability of water supplies than were agency officials. Each user group identified specific water-related needs that were most important to them, a distinction that was not reflected by agency officials. "All the people we interviewed believed that allowing those at the local level to be involved in water planning would help assure that each region's water needs will be met," Eaton said. "They said that planning at the local level fosters more cooperation and allows different types of water users to understand each other's needs." The report found that the public believed that basic, simple measures would be adequate to determine the effectiveness of water plans, while agency personnel favored specific, detailed outcomes.

Observing the regional water planning process to learn more about the organizational structure within groups was the emphasis of a Ph.D. dissertation by Valeen Silvy, a graduate student in the Planning Department at UT. Her research was chaired by Robert Mugerauer of the UT Philosophy Department. Silvy used a conceptual framework (Habermas' communicative action theory) to identify who participated, how the planning process was socially constructed, and how legitimacy was determined within four regions. She observed several meetings of planning groups throughout 1999 as a member of the audience, reviewed minutes, reports, articles in the press, and WWW sites, and interviewed planning group members and others who attended these meetings. The data were aggregated and sorted chronologically and by region. From this data, a typology of regional planning groups was created that was used to classify the structure, funding, administration, representation, and composition of each group, as well as how plans were reviewed.

Silvy's results provide insights into the dynamics of group leadership, how each organization responded to tensions created in preparing plans, the extent that groups were willing to cooperate with adjacent regions, and how dissent within groups was resolved. "It is naive to believe any of the regions involved in the SB 1 planning efforts will create

a process so effective that everyone in each group will be completely satisfied," Silvy said. "But, it is not difficult to imagine the creation of a legitimate process where most people are supportive because they had the opportunity for dialog, learned about the options, and were allowed to consider all the consequences of their decisions."

Last year, Ronald Kaiser of the Texas A&M University (TAMU) Recreation Parks and Tourism Sciences Department, Bruce Lesikar of the Agricultural Engineering Department, C. Scott Shafer of the Texas Cooperative Extension (TCE), and Jan Gerston of TWRI surveyed regional planning group members to obtain their impressions about which water demand and supply strategies were preferred and thought to be most feasible. Results were published in a TWRI fact sheet that aggregates the responses from each region.

Recently, Kaiser and Frank Skillern, a faculty member with the Texas Tech University (TTU) Law School, coauthored a paper about various policy options to manage aquifers in Texas. The paper discusses a variety of aquifer management strategies that are available that may be amenable to specific circumstances. The document was made available to several regional water planning groups and the Texas Legislature.

Economists from universities throughout Texas provided advice about the plans developed in specific regions, as well as the economic principles that should guide water planning efforts. In December 2000, TWRI brought together a team of economists and policy analysts including Ari Michelsen, Ron Lacewell, and Gene Nelson from the Texas A&M University System (TAMUS) Agricultural Program; David Willis and Don Ethridge from TTU; Ronald Kaiser and Thomas Saving from TAMU; David Eaton and Peter Wilcoxen of UT; Gary McBryde from Texas A&M University–Kingsville; and Barry Carr of Texas A&M University–Commerce. The meeting resulted in a TWRI report that provided recommendations to the TWDB about the importance of using proper economic guidelines in the statewide regional water planning process.

John Merrifield, a researcher with the University of Texas–San Antonio Economics Department, provided analyses of the costs and benefits of several regional water plans to Environmental Defense.

Higher Education Supports Regional Water Planning Groups

In several instances, university scientists consulted planning groups about issues related to water availability.

Texas A&M University–Corpus Christi (A&M–Corpus) researchers Rick Hay and Allan Berkebile studied many issues for the Coastal Bend Regional Planning Group, including the possibility that saltwater could migrate across the Calallen Dam. They examined possible relationships between oil and gas exploration and production and increases in total dissolved solids in the aquifers and the Nueces River, to determine how pollution may adversely impact water availability in the region.

In Region F, Jason Johnson of TCE and Phillip Johnson of the TTU Economics Department identified current water use for agricultural irrigation and livestock. They identified strategies for water conservation in various agricultural sectors. The intent was to identify areas where the greatest amount of water could be conserved.

The TTU Water Resources Center worked to set the framework to developing an Ogallala Regional Water Management Plan for the High Plains. Center Director Lloyd Urban, colleagues, and graduate students, provided assistance by identifying key water issues facing the region that should be considered in the planning process.

Faculty with the TAMU Agricultural Research and Extension Center in Amarillo teamed up with the U.S. Department of Agriculture Research Service (USDA/ARS) at Bushland and West Texas A&M University (WTAMU) to assist in planning efforts for the Panhandle Regional Planning group. This work was carried out for the Freese and Nichols, Inc., engineering firm. Project leaders include Stephen Amosson, Tom Marek, Leon New, John Sweeten, and Frances Bretz of the TAMUS Agricultural Program; Lal Almas and Bobby Stewart of WTAMU; and Terry Howell USDA/ARS.

The goal was to determine how increased efficiency of agricultural water use may help negate anticipated water shortages in the region during the next 50 years. The researchers modeled how the expanded use of the North Plains Potential Evapotranspiration (NP-ET) Network, more widespread use of low-energy precision application (LEPA) and surge irrigation, changes in crop varieties and types, the use of conservation tillage, weather modification, and the conversion of irrigated lands to dryland farming, may save water in each county in the region. They calculated the water savings, costs, and benefits of implementing several water-conserving measures, and identified site-specific circumstances in which irrigation may or may not be feasible. By using the NP-ET Network to project irrigation demands, they demonstrated that irrigation would use roughly 25% less water than estimated by TWDB studies. Their results team accounted for 97% of the declines in aquifer levels, as verified by observation wells.

The Panhandle Regional Planning Group established a goal that no more than 50% of existing groundwater reserves would be withdrawn during the 50-year planning horizon. The TAMUS research team produced data that illustrated how water management strategies could help counties with large levels of irrigation meet these guidelines. The team developed projections of livestock water use for the Panhandle and Llano Estacado regions that will allow confined animal feeding operations to grow.

“This project allowed us to use the technical expertise of our faculty to enhance the efforts of the planning group and to help shape public policy, and that was rewarding,” Sweeten said. “Our participation gave us more visibility in the region, and showed how faculty at research and extension centers, and universities, can step up and contribute to pressing concerns. It may open the door to opportunities in research, extension, and technology transfer related to water resources.”

Researchers with the TAMU Agricultural Research and Extension Center at Beaumont conducted studies of rice growing areas for the planning regions studying watersheds near Beaumont, Houston, and Lower Colorado River. The studies were led by researchers James Stansel, Fred Turner, Garry McCauley, and Anna McClung. These studies evaluated the effect of various water management plans on rice acreage. They identified improvements in water conservation that can be achieved by developing new rice varieties, and increasing the water use efficiency of irrigation strategies.

Joe McFarland, who was recently the Director of the TAMU Agricultural Research and Extension Center in Stephenville, did several studies for the Brazos Planning Group (Region G). He described current trends in agricultural water use within the region, as well as opportunities for conservation. Researchers Bill Dugas and John Corbett of the TAES Blackland Research and Extension Center (BREC) assisted Region G, developing geographic information systems (GIS) that display irrigated acreage and can be used to analyze water use trends.

A team of researchers from TTU, TAES, and TAEX assisted the efforts of the Region F Regional Water Planning Group. The project was led by Jason Johnson of TCE, Phillip Johnson of the TTU Applied Economics Department, David Willis and Don Ethridge of the TTU Applied Economics Department, Eduardo Segarra and Steve Amosson of TAES, and Ron Lacewell and John Ellis of the TAMU Agricultural Economics Department.

The research team developed water supply and demand projections for the region, including the potential impact of implementing several water-efficient irrigation technologies. They examined the cost of making irrigation more efficient, and identified portions of the region that are most vulnerable to water shortages. They described cropping changes that may occur if parts of the region convert to dryland farming. For example, irrigated corn and peanuts may be replaced by dryland cotton and grain sorghum at some sites.

TAMU researchers assisted in the development of the water plan for Region M in the Lower Rio Grande Valley. Guy Fipps of the Agricultural Engineering Department worked with Lower Rio Grande Valley irrigation district managers. They identified how preventing water losses in mains and canals that deliver water from the Rio Grande to farmers' fields may reduce water losses. Work included creating of a GIS that features data on soils, slopes, mains and canals. The project also evaluated how much water could be saved by the use of such on-farm water management practices as water monitoring and metering, replacing field ditches with poly pipe, and adopting improved water management practices and irrigation technologies. Information about this project is available on a WWW Fipps created site, http://dms.tamu.edu

"The results were astounding," Fipps said. "Our work suggests that nearly 211,000 acre-feet (AF) could be saved during years with normal rainfall, just by improving how irrigation water is conveyed. If irrigation districts help us improve on-farm water

management, an extra 226,000 AF could be conserved during years with normal rainfall." Fipps added that significant water savings could be accomplished, even in drought years.

TAMU agricultural economists helped create the Region M water plan. Researchers John Ellis and Ron Lacewell helped the planning group evaluate the economic and policy considerations associated with a variety of measures to boost agricultural and municipal water supplies. They investigated how changes in reservoir operations, acquiring additional supplies through water markets, developing new water supplies, and reducing demands through conservation, may increase available water. The economic merits of each strategy were then assessed.

A strategy to augment water supplies that was considered by several regions was the idea of removing nuisance brush species to increase runoff. To explore the site-specific costs and benefits of brush control on water yields, a team of TAMUS Agricultural Program scientists recently carried out evaluations of eight Texas watersheds. The research was led by J. Richard Conner of the TAMU Agricultural Economics Department; Joel Bach of the TAMU Rangeland Ecology and Management Department; Bill Dugas, Ranjan Muttiah, and Wesley Rosenthal of the TAES BREC, and Steven Bednarz and Timothy Dybala of the U.S. Department of Agriculture Natural Resource Conservation Service (USDA/ NRCS). Results were published in a TWRI technical report that provides guidance to policy makers about the feasibility of brush control in specific regions of Texas.

Modeling Surface Waters

Researchers and graduate students in the TAMU Civil Engineering Department are developing and refining computer simulation models to better estimate how much water may be available at specific sites for water rights holders under different flow regimes.

Researcher Ralph Wurbs created and updated water availability models that are part of the Water Rights Analysis Package (WRAP). The goal is to provide the capability to assess water availability and reliability within the framework of Texas' water rights system. Wurbs also hopes to develop a flexible generalized model which can be adapted to a broad range of applications to simulate the complexities of surface water management.

Working closely with several state agencies — including the TNRCC, the TPWD — as well as federal and local agencies and consulting firms, Wurbs and his graduate students played a key role in using WRAP to model the Brazos and San Jacinto river basins. WRAP is now being used to simulate water availability in river basins throughout Texas. Several studies that led to the development of WRAP were funded in part by TWRI.

TWRI is now funding two of Wurbs' graduate students engaged in these studies. Richard Hoffpauir is working to expand the capabilities of WRAP to include the ability to assess how salinity constraints may limit the availability of surface water supplies. Andres Salazar is using WRAP to carry out case studies of the San Antonio, Nueces, and

Guadalupe River watersheds. His emphasis is to make WRAP better able to estimate the "conditional probability" or likelihood that waters will be available in real-time, based on reservoir levels and streamflows. Technical reports and users manuals that describe several of these projects are available from TWRI.

Assessing Groundwater Resources

In several instances, university scientists assisted regional planning groups in evaluating the availability of groundwater resources.

The UT Bureau of Economic Geology (BEG) participated in several groundwater studies to assist regional water planning groups. Alan Dutton led BEG work to use a MODFLOW model to simulate aquifers in the Panhandle. BEG staff are also developing a groundwater availability model (GAM) for the Llano Estacado Regional Water Planning Group. Recently, Dutton examined the amount of water in the Carrizo-Wilcox Aquifer to assess the extent that proposed or anticipated exports of groundwater may have an adverse impact on water availability in the region of origin. Bridget Scanlon of BEG carried out modeling exercises of the Barton Springs portion of the Edwards Aquifer to provide data for Region K in Central Texas, and is now working on a new simulation tool for the region.

"GAM models are good because they are a more sophisticated approach to studying issues related to groundwater resources and geology," Dutton said. "They use the best data and should generate more reliable predictions." Dutton said it was rewarding for BEG staff to be able to work hand-in-hand with planning regions on actual real-world problems. "It's satisfying to know that our work is going to be used by the public for water planning," he said. "We got to work with several groundwater conservation districts and learn about groundwater resources, and about the policies that will help shape aquifer use and management."

In many cases, users can already download the GAM models developed by BEG and other groups from the TWDB WWW site.

At TTU, researcher Ken Rainwater and Lloyd Urban and graduate students Jeff Stovall and Scott Frailey modeled the portion of the Ogallala Aquifer that underlies the Southern High Plains for the Llano Estacado Regional Water Planning Group. Their investigation calibrated existing models, developed baseline projections, examined how droughts could worsen water shortages, and projected the extent that precipitation enhancement and increased irrigation efficiency could prolong water supplies. In the future, the research team hopes to build more features into the models, including more details about individual wells, well log data, and the properties of aquifers.

"The purpose of the modeling study is to develop a tool that can be used to project changes in aquifer storage caused by pumping and recharge," Rainwater said. "We wanted to create a model that can compute the volume of water in storage for each

county, and sought to construct detailed maps of saturated thickness in each county throughout the region that is underlain by the Ogallala."

Urban said, "Working with the planning groups was definitely a positive experience for us. It provided opportunities for three graduate students to conduct complex groundwater modeling studies, and to see how the planning groups make policy choices."

Researchers at A&M–Corpus Christi carried out simulations of South Texas groundwater supplies. Rick Hay of Center for Water Supply Studies used groundwater flow models to simulate pumping from two well fields in Refugio County. The modeling exercises helped the Coastal Bend Regional Planning Group determine if each county would have sufficient groundwater resources available under various water use scenarios throughout the next 50 years.

Hay and A&M–Corpus Christi researcher Allan Berkebile mapped sites where concentrations of total dissolved solids in the Gulf Coast Aquifer may be so high they be only be useful for restricted water uses, and developed models to evaluate whether aquifer storage and recovery projects may be practical in the Robstown and Rockport areas.

Researchers at Sul Ross State University assessed groundwater resources in West Texas to assist in the regional water planning group studies. Researcher Kevin Urbanczyk of the Sul Ross Geology Department and his graduate students examined the igneous aquifers in Brewster, Jeff Davis, and Presidio counties to determine the volume of water they contain. The goal was to determine if these aquifers could be a viable source of groundwater.

Better Characterizing Watersheds

In order to conduct highly sophisticated simulations of streamflows, researchers at the BREC in Temple have been creating detailed maps that display the terrain and hydrologic characteristics of small watersheds. These maps can link these detailed watershed boundaries with hydrologic models to more accurately simulate flows in rural watersheds.

These studies, which are funded by the U.S. EPA and the Texas State Soil and Water Conservation Board, are led by Ranjan Muttiah, Gary Coutu, and Mark Gaber of BREC and Raghavan Srinivasan of the TAMUS Spatial Sciences Laboratory. The emphasis is to develop accurate digital maps of smaller subwatersheds. "These new maps give you much better details than are available by using current methods," Muttiah says. "These new maps provide much more accurate data about the characteristics of these watersheds."

The project is being coordinated with the state agencies as well as the USDA/NRCS and the U.S. Geological Survey. Recently, the USDA/NRCS made the first of the maps developed through this project available to the public.

Developing improved methodologies to generate watershed parameters using GIS is the scope of ongoing studies by researcher David Maidment and graduate students at UT. Projects that have recently been carried out include efforts to better calculate drainage areas, curve numbers, and precipitation parameters, and work to create digital stream networks that can be used to distribute naturalized streamflows from sites with stream gages to ungaged sites. Recent projects have included case studies of the Sulphur, Nueces, Guadalupe, San Antonio, and San Jacinto river watersheds.

"This research is an integral part of the water availability modeling efforts now being undertaken by the TNRCC," Maidment said. "It should be a great assist to improve water supply planning throughout Texas."

How TWRI Is Making a Difference

TWRI is now building upon several of the efforts mentioned in this newsletter to assist in the development of regional water plans.

For example, TWRI recently began work on the Rio Grande Basin Initiative, which is a joint effort of the TAMUS Agricultural Program and New Mexico State University. This initiative, which is headed by TWRI Associate Director Bill Harris, is a regional effort that involves TAMUS Agricultural Program researchers and extension personnel throughout South Texas. The project will identify and implement a wide variety of water-conserving measures that could benefit the region, including training irrigation managers how to increase water efficiency, identifying institutional incentives to promote conservation, assessing the potential use of saline and reused waters, increasing the efficiency of the water conveyance system, and better modeling the hydrology of the region.

TWRI is also carrying out follow-up studies to determine how brush control projects may boost water yields. TAMU researchers Richard Conner, Bill Neill, and William Dugas are now working with colleagues from USDA/NRCS at Temple to examine the environmental and policy issues that need to be overcome to implement brush management projects. TWRI will administer this project.

TWRI programs to support graduate student research are supporting water resources planning studies.

Five projects funded under the TWRI competitive grants program will directly examine water planning issues. TAMU graduate students Richard Hoffpauir and Andres Salazar are working with Ralph Wurbs to enhance the capability of WRAP models. Two TTU graduate students are investigating economic issues associated with use of the Ogallala Aquifer: Jeff Johnson is working with Phillip Johnson and Biswaranjan Das is studying under David Wills. UT graduate student Daniel Stein is working with researcher David Eaton to investigate groundwater management strategies.

Summary

Certainly, great benefits have accrued from the opportunities for universities to participate in the SB 1 planning process. The bottom line seems readily apparent. First, universities can make a great contribution to pressing water resources issues if given the chance to participate. Secondly, involving universities in emerging water resources issues provides an excellent way to enhance the capability of university scientists to solve real world problems, and to train graduate students to pursue water resources careers.

Ideally, similar opportunities should be capitalized on in the future. University researchers should be encouraged to participate, and make a meaningful contribution, to other water resources challenges.

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News from TWRI

TWRI recently awarded 11 $1,000 grants to TAMU graduate students through the Mills Scholarship Program. Recipients and their majors include: Amanda Richmond and John Hay (Soil and Crop Sciences); Mary Bhuthimethee, Christine Burgess, and Raymond Li (Wildlife and Fisheries); Matt Wagner (Urban and Regional Planning); Vance Weynand (Agricultural Engineering); Graciela Lake and Melissa Roberts (Geology and Geophysics); and Richard Hoffpauir and Brooke Moore (Civil Engineering).

Two recent technical reports are available from TWRI.

Impacts of Recreational and Commercial Fishing and Coastal Resource-Based Tourism on Regional and State Economies (TR 183) was written by Lonnie L. Jones and Tanyeri-Abur Aysen of the TAMU Agricultural Economics Department.

Institutional Adjustments for Coping with Prolonged and Severe Drought in the Rio Grande Basin (TR 317), was written by Frank Ward, J. Philip King, and J. Thomas McGuckin of New Mexico State University; Robert Young of Colorado State University; Ron Lacewell and John Ellis of the TAMU Agricultural Economics Department; Marshall Frasier of Colorado State University; Charles DuMars of University of New Mexico; James Booker of University of Colorado; and Raghavan Srinivasan of the TAMUS Spatial Sciences Laboratory.