Texas Water Resources Institute

November/December 1985
Volume 11
No. 6

TWRI: 20 Years of Progress Through Research and Education

By Ric Jensen Staff Writer, TWRI One of the key natural resources of the State of Texas is water. Water for agriculture throughout the state. Water to fuel the growth of major cities such as Dallas, Houston, and San Antonio. Water for recreation and fishing, whether along the Gulf Coast's bays and estuaries or streams or inland reservoirs. Water to keep the wheels of industry turning.

Water supplies contained in surface reservoirs or underground aquifers are not the only resources available to the state to assure adequate supplies of high quality water for the future. Both the people of Texas and its institutions that are devoted to water conservation and the wise use of our total water supply may be viewed as important resources to meet our future water needs.

The Texas Water Resources Institute (TWRI), located on the campus of Texas A&M University in College Station, is one of those institutional resources. The Institute, supported by state and federal funds and part of the Texas Agricultural Experiment Station (TAES), is charged with a number of diverse goals„sponsoring water-related research that concerns Texans, training future researchers and scientists in water-related disciplines, and transferring the results of the research to other scientists and the general public.

In Novemb er of this year, the Institute entered its 21st year of operation. This article looks back at some of the Institute's accomplishments, paying particular attention to progress in the 1980s, and looks ahead to new opportunities and needs for research in the future to insure that water resources remain safe and plentiful for all.

History

Water had been of vital concern to Texas A&M University long before the Institute was founded. The need for an institutional response to the drought of the 1950s led to the establishment of "The Water Research and Information Center" in 1952. The Center served as a focal point through which water research activities and information transfer were coordinated within The Texas A&M University System. The Center also developed the first statement of research priorities to address water-related problems of the state. The first statewide "Water for Texas" plan formulated in the 1960s drew heavily from research results and research planning activities developed by the Center during the early years of its existence.

The Texas Water Resources Institute (TWRI) was established in its present form as a result of federal legislation known as "The Water Resources Research Act" of 1964. This act established federal funding to assist participating states in the conduct of research and training of scientists. Succeeding acts in 1978 and 1984 continued the program of national investment in water research and technology transfer at the state level.

The first director of TWRI was Dr. Ernest Smerdon, who served from 1964 to 1968. Dr. Smerdon is now director of the Center for Research in Water Resources at the University of Texas in Austin. Dr. Jack R. Runkles succeeded Smerdon and directed the Institute from 1968 to 1982. Dr. Runkles is now retired and lives on a ranch near San Angelo. The Institute's current director is Dr. Wayne R. Jordan, who is also a professor of plant physiology at Texas A&M University's Department of Soil and Crop Sciences.

A unique feature of the federally assisted program of the Institute is that it is open to all colleges and universities in Texas that have the capability to conduct research. Thus, in this program, the Institute strives to focus the extensive talents of the entire university community on gaining solutions to important state water problems.

Programs Of the Institute

The programs of the Institute address research, technology transfer, and the training of future scientists. Each of these program components plays an important role in meeting Texas' needs for sound technical information and trained professionals.

In 1985, the Institute updated its five-year program plan, covering the period 1985-1990. The list of priority research areas, ranked in order of importance, is as follows:

1. Improvement of the Efficiency of Water Use in Agriculture
2. Improvement of Urban Water Management and Conservation
3. Development of Strategies for Groundwater Management
4. Protection and Enhancement of Water Quality
5. Development of Reclamation and Reuse of Wastewater
6. Formulation of Water Policy Alternatives
7. Improvement of Management of Multi-Use Reservoirs
8. Determination of Freshwater Inflow Needs of Bays and Estuaries
9. Development of Strategies for Effective Management of Flood Plains
10. Strategies for Surface Water Development and Use
11. Reduction of the Impact of High Energy Costs on Water Use
12. Development of Strategies for Instream Water Management
13. Prevention of Land Subsidence from Excessive Groundwater Pumpage

Priorities for research and technology transfer are established with the guidance of a 14-member Advisory Committee. The Committee is composed of representatives of state and federal water agencies and private organizations in an attempt to assure that the Institute programs reflect state and national priorities as well as local needs. Current members include:

- Charles W. Boning, District Chief, Water Resources Division, U.S. Geological Survey, Austin
- Colonel A.J. Genetti, U.S. Corps of Engineers, Ft. Worth
- Emmett L. Gloyna, Texas Representative, U.S. Bureau of Reclamation, Fort Worth
- Leroy Goodson, General Manager, Texas Water Conservation Association, Austin
- Billy C. Griffin, State Conservationist, Soil Conservation Service, Temple
- Glen Jones, Director of Research and Education, Texas Farm Bureau, Waco
- Mervin L. Klug, President, William F. Guyton Associates, Inc., Consulting Groundwater Hydrologists, Austin
- Ron Neighbors, General Manager, Harris-Galveston Coastal Subsidence District, Friendswood
- Charles Nemir, Executive Administrator, Texas Water Development Board, Austin
- Catherine Perrine, Water Director, League of Women Voters, Dallas
- Fred Pfeiffer, General Manager, San Antonio River Authority, San Antonio
- Leland Roberts, Chief, Resource Protection Branch, Texas Parks and Wildlife Department, Austin
- Thomas E. Taylor, Director, Dallas Water Utilities, Dallas
- A. Wayne Wyatt, Manager, High Plains Underground Water Conservation District No. 1, Lubbock

Funding

Financial support for the Institute's programs comes from funds provided by both public and private sectors. Federal allotment funds, distributed equally among all 50 states, have been a stable source of support since their original appropriation as part of the Water Resources Research Act of 1964. The allotment funds are used by the Institute to conduct a competitive grant program open to faculty at all colleges and universities in Texas. For example, in fiscal years 1984 and 1985, research was conducted at Texas Tech University (one project), Southwest Texas State University (one project), the University of Texas at Austin (three projects), Texas A&M University (three projects), and the Texas Agricultural Experiment Station at Temple (one project). Since 1964, research projects have been completed at 12 different colleges and universities and at 5 different TAES locations.

Other federal funds were awarded to the Institute on a competitive basis in response to requests for proposals issued at the national level. This federally sponsored research reached a peak in 1982 after which research funding program through the matching grant program of the U.S. Department of the Interior was discontinued. The Water Resources

Research Act of 1984 reestablished this program, but at greatly reduced levels. The Institute no longer serves as the state clearing house for proposals submitted to the new matching grant program.

State appropriations were made to the Institute for the first time in fiscal year 1976, and have increased to the present level of about $200,000 per year. The steady growth in state appropriations during the past six years reflects a greater concern by the state legislature for the need for research and education in the wise use of our water resources. Coupled with the general decline in federal funds, the current balance between state and federal support reflects a policy shift from federal to state responsibility to solve state water problems.

Support from the private sector continues to be an important source of funds, especially for training of future scientists. The Institute administers the W.G. Mills Fellowship program that annually honors the most outstanding graduate students conducting research in hydrology. The trust fund, established in 1968 by Mr. O. Mills Cox in honor of W.G. Mills, currently yields in excess of $20,000 per year. A total of 241 graduate students have been honored and supported through this fellowship program. Many of the program's graduates have gone on to professional positions with private firms, state agencies, and educational institutions working to solve water problems at both state and national levels.

The Shell Companies Foundation program was established in 1976 to broadly support activities in water resources research and education. This program supports research and provides for visits to the Texas A&M University campus by outstanding researchers and scholars to broaden the awareness of both faculty and students on important current water issues.

In total, the Institute has provided funds for research in which 1,011 students have participated, including 346 undergraduates, 386 master's degree candidates, and 279 doctoral students. This training has been conducted across the state in a wide array of disciplines ranging from agricultural engineering to political science. The Institute programs continue to be an important resource for the training of professionals for the future.

Recent Program Emphasis

The era of rapid water development in Texas has passed. Of the 250 or so potential sites for major reservoirs, 189 have either been built or are currently under construction. While some surface water development will continue, the major research emphasis is shifting toward management and protection of existing ground and surface water supplies. Constitutional amendments, approved by voters as Propositions 1 and 2 in the November 1985 election, clearly establish water conservation as a statewide policy. These amendments also provide the initial legal framework for protection of water quality, assure supplies of freshwater inflow to bays and estuaries, and encourage efficient Groundwater management. These issues are also reflected in the most recent update of

"Water for Texas: A Comprehensive Plan for the Future," published in November 1984 by the Texas Department of Water Resources.

The current concern for conservation and management stems from the realization that Texas' water resources are being stretched to the limit. Shortfalls in water supplies are expected in many Texas communities within the next 20 to 30 years, suggesting that increased pressure will be exerted to change current water allocations. Agriculture has long been the major consumer of water. Rapid population growth and economic development in other sectors of the state's economy will almost surely result in reallocation of scarce water supplies among competing users.

Since 1980, the Institute programs have emphasized the growing needs for water conservation and efficient management in agriculture. Between 1980 and 1985, the Institute has funded 49 projects representing an investment of $2.70 million. Summaries of several of these projects are presented in the "Accomplishments" section of this report. Recent expansion of the water research and education programs of TAES and the Texas Agricultural Extension Service has allowed the Institute to initiate new programs dealing with efficient reservoir operation, urban water management, and surface water quality. Since several of the Institute's highest research priorities address problems associated with the needs and activities of a growing population, future Institute programs will continue to emphasize the needs of urban areas.

Technoloy Transfer

The transformation of research results into information and technologies that can be applied at the user level is an exceptionally challenging part of the Institute's responsibilities to the citizens of Texas. A general awareness of water issues and efforts to solve important problems is brought to the public through this publication, Texas Water Resources. In its 11th year of publication, Texas Water Resources is delivered six times each year to over 10,000 individuals in homes, businesses, schools, and state water agencies and organizations. The actual impact of this publication is much greater since many organizations use individual issues to support their own educational programs.

Specific water research programs of TAES were featured in a series of 12 issues of Water Currents, a magazine published by the Institute between 1982 and 1984. Issues of Water Currents still serve as important resource documents on topics such as design of plants for efficient water use, innovations in water management technology for farm use, preparation for drought, protection of surface water quality, shrimp mariculture, and others.

Texas Water Resources and Water Currents are targeted to the general public or groups having interest in water issues. However, detailed information must be available to support adoption of new technologies by individual users. The Institute has neither the staff nor the budget to deliver research information directly to each individual user. Responsibilities for individual contact are met by those agencies having long-standing delivery systems in place. The Texas Agricultural Extension Service is one such agency. Through contacts with state extension specialists, important research results are evaluated and incorporated into education and demonstration programs at the county, farm, and residential levels. The Institute is currently supporting efforts to develop water management guidelines for the Texas High Plains. Specific information about new irrigation technologies and water management techniques will be delivered through mass media presentations as well as through more traditional methods.

Accomplishments

Throughout the 1980s, Institute-funded research has contributed to significant advances in the water-related fields of agriculture, urban hydrology, secondary groundwater recovery, water quality, efficient reservoir operation, and economics. Many of the research results have been published as part of the Institute's Technical Report (TR) series, available from the Institute free of charge. Some of the major findings are highlighted in the following research summaries.

New Irrigation Technology

In agriculture, TWRI-funded researchers are investigating water-efficient irrigation systems and technologies. One example of an extremely water-efficient irrigation system is the Low Energy Precision Application (LEPA) technology (TR-105). LEPA is a low-pressure sprinkler irrigation system that uses drop tubes to apply water very near to the soil surface. LEPA avoids the problems of high energy demand, evaporation, and runoff, which are common in many sprinkler irrigation systems. When LEPA is used in combination with furrow diking, water can be applied at 99% efficiency, saving up to 25% on water and energy.

Furrow Diking and Water Harvesting

TWRI researchers aren't just looking at equipment and technology that conserve irrigation water on the farm. They're also investigating agricultural management techniques such as furrow diking that capture rainfall, thereby reducing the farmer's need to irrigate. Furrow diking involves forming mounds of soil across furrows to retain rainwater. Small basins created by these dikes hold the precipitation until it can infiltrate the soil. During one 24-hour period at Bushland, diked furrows held six inches of rain without runoff. Furrow diking is also economical--the equipment needed to form dikes can pay for itself in just one season with increased yields from only 75 acres of cotton. In comparing fields with and without furrow diking, researchers at Vernon have found that diking can increase cotton yields by 25% and sorghum yields by as much as 30%. Research at Vernon has shown that just one inch of moisture stored in a field increases cotton lint yield by 30 pounds, while scientists near Amarillo have learned that one inch of water stored in the soil may increase grain sorghum yields by 350 pounds per acre and wheat yields by 2.5 bushels per acre. It's estimated that more than 3 million acres are now furrow diked at some time during the year.

Sprinkler Irrigation in Rice Fields

TWRI-supported research may even reach into South Texas rice fields (TR-134). Substantial water savings may be achieved statewide if farmers would switch from the traditional method of growing rice in standing water to sprinkler irrigation. Currently, roughly 400,000 acres of rice are grown in Texas annually. These crops consume 1.8 million acre-feet of water per year„roughly 13% of Texas' renewable water resources. Flood irrigation requires 76 to 135 centimeters (cm) of water per acre per year in addition to rainfall. Sprinkler irrigation required only 18 to 52 cm per acre per year, a considerable water savings. However, a small yield reduction was observed with sprinkler irrigation using the new higher yield varieties. It is unclear if rice producers will be willing to accept slightly lower yields, however, to obtain the water savings that would result from a conversion to sprinkler irrigation. Additional research is continuing to seek ways to reduce the amount of water required in flood irrigation. Laser leveling, lower grades, and multiple inlets into fields appear promising.

The economic impacts of new water-efficient irrigation technologies and management systems on the High Plains region, as well as on the individual farmer, were evaluated (TR-128). More than 6 million acres of the Texas High Plains, half the regional cropland, are currently irrigated. Results projected that over a 40-year period water availability and use would drop throughout the region, reducing irrigated acreage, gross returns, and net revenues. Adoption of advanced irrigation technology could reduce the amount of idle land in the region to less than 20%. Technologies that improve dryland crop production„limited tillage and crop rotation„are also important, but they are not a substitute for irrigation, the researchers found. In another report (TR-133), researchers examined farm level benefits of improved irrigation water distribution efficiency. On-farm irrigation efficiency statewide is estimated at only between 60% to 70%, while the implementation of advanced irrigation application techniques could potentially increase that figure to as much as 98%. Surge flow, furrow biking, and LEPA were all examined. The results predict that low crop prices will be a major constraint to farmers who might otherwise want to purchase water-efficient irrigation tion equipment. In a majority of cases evaluated, the benefits of improving irrigation efficiency by 20% to 30% are positive. However, it was more economical to improve the efficiency of an existing system than to change irrigation systems. For example, a producer in the Northern High Plains who improved the efficiency of furrow irrigation on his 160-acre farm from 50% to 80% could expect a net benefit of $78,000 during the next 20 years, the report suggests. Conversion from furrow to LEPA, however, requires such a large capital investment that costs are not recovered in 20 years under the same conditions.

Water Quality Studies

Maintaining and assuring water quality are major concerns to both Texas and the nation, and TWRI is answering those questions with intensive water quality research. Research efforts have included studying trihalomethanes (THMs)„synthetic organics that are found in treated drinking water and can combine to form deadly chemicals such as chloroform. That research (TR-109) centered on sampling water from Texas lakes and rivers to determine the levels of THMs in those ecosystems, and also investigated methods for water supply systems to reduce the amounts of THMs in treated water. Samples from Lake Somerville, Lake Livingston, and the Neches and Sabine Rivers indicated high levels of organic precursors„contaminants that have the potential to form THMs. Research results suggest the best way to reduce THMs is to reduce the amount of natural organics before adding chlorine by improving conventional coagulation processes. This could be done by adding aluminum sulfate to water to form tiny, sticky particles called floe, which then gathers together solids in the water and hastens the settling process. Other water treatment options include disinfecting with something other than chlorine, adjusting the pH of water, and allowing THMs to form during treatment and removing them before distribution.

Water Conservation in Urban Landscapes

A task force has been established that is seeking ways to conserve water in urban landscapes. Studies to determine how much water is actually used by turf-grasses and landscape plants are in progress. Researchers are looking for genetic differences in water use that may be exploited, and cultural management options that may have an impact on water use. Specifically, Tifgreen bermudagrass, Common centipedegrass, and Common buffalograss were identified as three cultivars that fall in the category of "low water use." These grasses used 30% to 40% less water than "high water use" turfgrass cultivars such as St. Augustinegrass. One particularly promising cultivar is buffalograss, a native, warm-season, perennial, adapted to the 12- to 25-inch precipitation zone. It has a low water-use rate and may have potential usefulness as a waterconserving turfgrass in low maintenance areas. The scientists also investigated using native plants with built-up drought tolerance for urban landscapes. Cactus and creosote brush, for example, have finely branched and wide-spreading root systems so they can gather water from large areas, while cenizo and the Mexican Redbud have densely pubescent leaves. Other desirable characteristics for landscape plants with low water requirements include small leaves, gray or grayish-blue leaves, hard evergreen leaves, and leaves with a waxy or resinous coating.

Computer Modeling in Urban Hydrology

Urban hydrology, determining where water would flow through a city in the event of heavy rains or flooding, is being investigated by Institute-sponsored research using the latest in high technology. Researchers have developed a computer model that simulates discharge, water velocity, and water surface elevation in a river or stream during a flood. The model allows users to enter maps, weather radar information, and other data from a particular geographic area, making the model site specific. The program can provide information on the effect of flooding on water systems, subbasins, precipitation, routing, hydrologic soil groups, land treatment, and hydrology. The computer model is also useful in designing culverts and detention basins. The user provides information on drainage and designs hypothetical storms. The user develops an initial design, routes the water through the structure, and specifies the storage capacity of both downstream reservoirs and other catchment facilities. The model has already found its way into the general public, where it is being used in short courses on flood plain analysis sponsored by the

Texas A&M University Civil Engineering Department. Fifty professionals from across the state attended the initial four and a half day course in January of 1985, which consisted of lectures and microcomputer laboratory sessions. Response was positive, and the short courses will be offered again in January of 1986. The computer programs and operator's manual are available for a fee from Dr. Wes James of Texas A&M University's Civil Engineering Department.

Secondary Recovery of Groundwater

Secondary recovery of groundwater supplies, especially in the High Plains, can expand the amount of water that can be removed from aquifers and can actually extend the lifespan of an aquifer. More than 70,000 irrigation wells dot the High Plains, spreading water over more than 6 million acres of cropland. The Ogallala Aquifer, the major source in the region, at one time contained roughly 500 million acre-feet of recoverable water, but now that figure is down to an estimated 375 million acre-feet, and the water table continues to decline. Personnel of the High Plains Underground Water Conservation District at Lubbock borrowed a technique from the petroleum industry called "secondary recovery" where air is injected under pressure into an aquifer. The increased pressure forces water from the pores and pushes it to an area where it can be recovered by a conventional well. Field tests near Idalou and Slaton in 1982 involved injecting more than 10 million cubic feet of air into the ground for six days. Well levels began rising in the area and roughly 408 acre-feet of water were available to wells 160 days after the tests ended. Water levels continued to rise around the injection site for several months. An economic analysis of the recovery process indicated the cost of recovery was about $50 per acre-foot. Research sponsored by TWRI is continuing to develop a computer model that will predict flows of water caused by air injection. Such a model would serve as a basis to select optimum sites for secondary recovery and to predict the potential recovery from other aquifers.

Reservoir Management Studies

There are currently 187 reservoirs in the state for conservation, flood control, and recreation purposes with a capacity of more than 117 million acre-feet. Because of economic, political, and environmental factors, however, it has become much more difficult to construct additional reservoirs in recent years, creating a need for optimal management of existing reservoirs. One potential way of increasing the benefit from existing structures is to reallocate storage volume between conservation and flood control. In Texas, permanent allocations have been made at the time of reservoir construction. TWRI-sponsored research examined the feasibility of reallocating storage capacity between conservation and flood control in response to changing conditions. Based on a case study of Lake Waco, seasonal reallocations between conservation and flood control would be expected to increase the annual firm yield, but may reduce flood control benefits slightly (TR-135 and TR-136). A risk analysis was also performed to compare the potential benefits from increased water supplies with the potential costs associated with greater flood damage.