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Why Droughts Plague Texas

Dry Spells Have Always Been Part of Texas and Will Likely Continue

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An old anecdote about the drought of the 1880s may be the best way of introducing how Texans feel about droughts. A new settler moving into Texas, unaware of past dry periods, looked at a piece of farmland and commented, "This would be a fine country if it just had water." Replied a grizzled farmer who had been bankrupted by past droughts and was moving eastward, "So would Hell."

Most weather events strike forcefully and dramatically. Images come to mind of tornadoes tossing houses in the air, sending Dorothy and Toto to run for cover. Violent hurricanes, like the storm that wrought havoc on Galveston Island in the early 1900s, sweep floodwaters across low-lying coastal areas Droughts are a much different type of phenomenon for many reasons. First, droughts are poorly understood: there's no clear scientific definition of exactly what constitutes a drought. We hardly know that a drought is in progress until we observe its effects -- withering crops, plummeting water levels, parched fields, and the imposition of water conservation measures. Second, droughts don't have a definite starting or ending point. A 1987 Texas Water Commission report described droughts as "enigmatic," "difficult to define," and "not easily characterized." We know droughts will recur, but we don't know where, when,

This photo shows the impact of the 1950s drought on Lake Waco.

with what ferocity and for how long. Historian Walter Prescott Webb wrote that "drought creeps insidiously into the lives of its victims."

A good way to understand droughts and their impact on people is by reading popular literature. The fierce and numbing drought of 1886-87 near Sweetwater, TX, inspired Dorothy Scarborough's novel, *The Wind*, in which a "delicate Easterner" is tormented by severe wind and drought. In John Steinbeck's novel, *The Grapes of Wrath*, droughts and dust storms forced Oklahoma tenant farmers to leave their lands and homes. Elmer Kelton's novel, *The Time It Never Rained*, describes how the 1950s drought affected rangelands of West Texas. Charlie Flagg, a longtime rancher and the hero of the novel, saw how the drought killed his livestock, caused his heart attack, and drove his best friend to commit suicide, but it could not force him from his land.

Background Information

Dictionaries describe drought as a "protracted lack of rain." The *Glossary of Meteorology* defines droughts as "periods of abnormally dry weather sufficiently prolonged for the lack of water to cause a serious hydrologic imbalance in the affected area." Droughts can take on a regional context. Residents of arid West Texas may cope for two or three years with little rain before acknowledging that a drought exists. In East Texas, where rainfall is plentiful, a few months of below average precipitation can heighten concerns that a drought may be coming.

In a broad sense, drought occurs whenever water supplies are inadequate for human needs. Most often, these water shortages stem from a severe shortage of rainfall but they can be exacerbated by high water demands and inadequate distribution systems. Rainfall does not need to be below average for droughts to take hold. Evaporation, transpiration, and runoff all drain the amount of moisture provided by rainfall.

One of the most maddening aspects of droughts is the fact that it's nearly impossible to predict when they will hit in the future and how long they will last. A few drops or inches of rain may perk up Texas attitudes, but an end of a drought really has to be measured in terms of reservoir levels, soil moisture content, and groundwater storage. Long-term forecasts by the National Weather Service (NWS) suggest the current drought may last until the Spring of 1997 or beyond.

In 1987, Robert Riggio and George Bomar of the Texas Water Commission conducted a comprehensive analysis of droughts. They collected monthly NWS rainfall data at many sites from 1931 to 1980. Droughts were defined by the quantity and duration of rainfall events. Precipitation data were normalized to account for differences in rainfall between arid West Texas and humid East Texas. Droughts covering three, six, and 12 months were identified and classified by their severity, duration, and location. The results are revealing. They show that it is more likely that a 6-month or year-long drought will occur somewhere in Texas than a near-normal or wet-weather spell for the same period. Droughts that last at least six-months can be expected once every 16 months, while droughts covering more than a year will likely visit Texas once every three years.

Droughts lasting six months occur more frequently in West Texas, while longer droughts are found most often in the Northern part of Texas.

Why do droughts occur so often in Texas? It's really hard to tell, although the cause has been attributed to sunspot activity and water temperatures in the Pacific Ocean. Part of the answer may be that Texas lies on the fringe of "the Great American Desert" and straddles the 30° North latitude where many deserts in the world can be found. People, plants, and animals living in deserts become adapted to these environments. Those living in areas that border deserts face unexpected droughts and suffer most because they are the most unprepared. Because the High Plains and Trans-Pecos regions of Texas are near the Chihuahuan Desert, it is likely that these areas may be the most vulnerable to prolonged winter droughts. The Chihuahuan Desert continually expands and contracts in response to El Nino and La Nina events in the Pacific Ocean off the coast of Ecuador. El Nino events warm these waters, while La Nina events cool them. La Nina events can create ridges of high pressure that influence the flow of the jet stream and precipitation. As La Nina events occur, Texas often receives less than normal amounts of rainfall. According to Gerald North of the Texas A&M University (TAMU) Meteorology Department, Texas' climate has to be examined from a global perspective to be properly understood. North said that recent research at TAMU suggests that 70% of monthly variances in Texas weather may be caused by systems outside the region, which implies that La Nina events can have a significant impact on Texas climate trends.

A Historical Perspective

No one knows for sure how many droughts have smitten Texas throughout history, but what we do know suggests that droughts have visited often and come with a vengeance. Some of the earliest droughts include one in the 15th century along the Canadian River that decimated a native American tribe, an event in 1756 that dried up the San Gabriel River, and an 1822 drought that caused the first crops planted by Stephen F. Austin to wither and die. From 1822 through the 20th century, at least one drought has hit some part of Texas each decade.

In 1958, Robert Lowry of the Texas Board of Water Engineers published a report summarizing drought issues. The report contains detailed information about droughts that have visited Texas since 1891. The study ranked these droughts in terms of the extent to which rainfall was below normal levels. The report suggests that the worst droughts to impact in Texas were: 1) 1954-56; 2) 1916-18; 3) 1909-12; 4) 1901; 5) 1953; 6) 1933-34; and 7) 1950-52.

Quentin Martin of the Lower Colorado River Authority (LCRA) examined tree ring data and hydrologic records to assess drought conditions that have visited Central Texas during the past 200 years. His analysis suggests that the drought of the 1950s was likely the worst (in terms of intensity and magnitude) to afflict the region during the study period.

Early Texans realized the multitude of problems droughts can cause. In 1884, a *Texas Farm and Ranch* editorial commented that "with adequate rain, there is no country equal on Earth to Texas, but because drought is almost certain to prevail, there is no country on Earth less to be relied on and, consequently, less desirable."

Many Texans still vividly recall the "Dust Bowl" of the 1930s, which coincided with the Great Depression, and blighted Texas, Oklahoma, New Mexico, Kansas and Colorado. It struck in two periods (1933-34 and 1937-39) that were interrupted by normal rainfall. This drought was noted for vicious winds that blew away vast amounts of topsoil that was too dry to support growing crops. Many people who grew up during this time in West Texas recall lining up to buy water from the back of a wagon for $1 a barrel. Many families bathed in shifts without emptying the washtub and reused the water to irrigate gardens. As a result of the Dust Bowl, the federal government created the Soil Conservation Service and introduced other sweeping changes to help farmers prevent erosion and more efficiently use water resources.

The Drought of the 1950s

The drought of the 1950s became so bad that many West Texas ranchers ran out of grassland to graze their cattle on, and hay prices soared. As a result, some ranchers resorted to burning catcus, removing the spines, and using it for cattle feed. The photo at right shows a farmer pitching cactus out of a truck and tossing it to hungry cattle.

For many Americans, the 1950s are remembered fondly. In Texas it was a different story. Texans endured a 7-year uninterrupted drought (1950-56), which some say was the worst in 700 years. Experts believe this drought began in the Lower Rio Grande Valley and West Texas in 1949. From 1949-51, Texas rainfall dropped by 40% and West Texas experienced severe declines. By 1952, more than half the state received 20 to 30 inches less rainfall than normal. In 1952, Texas' monthly rainfall average fell to just 0.03 inches -- the lowest level since the Weather Bureau began collecting records in 1888. For the first time since 1914, Lubbock did not even record a trace of rain. Even hardy west Texas mesquite trees began to die. By 1953, 75% of Texas recorded below normal amounts of rainfall. Seven million parched acres scarred Texas and Oklahoma. That summer in the High Plains, bulldozers were used to remove drifts of blowing soil from highways.

One effect of the 1950s drought was that it lowered lake levels dramatically. These two photos from the Waco area show lakefront homes that would normally be on the waterfront now rising above nothing but dirt, and a pier that extends out above a pile of mud.

The 1953 summer was blistering -- Dallas endured 52 days in excess of 100deg. F while Corsicana topped the century mark 82 times. The heat wave followed five years of below normal rains. Half the state received rains that were 30 inches less than normal amounts. Lake Dallas stood at only 11% of capacity. In 1954, yearly statewide rainfall averaged 18 inches, the least since 1917. In Dallas, water had to be rationed and a pump station was built to import water from the Red River. However, that water was so salty that it destroyed car radiators, fouled piping systems, and was unhealthy for people with heart and kidney problems. Dallas then opened stations where people could buy cartons of water from artesian wells for 50 cents a gallon, which was more than the cost of gasoline. More than 1,000 towns and cities had to enforce strict water conservation measures or import supplies. In the spring of 1955, rolling clouds of dust on the High Plains reduced visibility and motorists drove with their headlights on at midday. By 1956, Comal Springs, which normally flowed at the rate of 200 million gallons per day, dried up for the first time in recorded history. From 1954-56, flows in the Guadalupe River dropped from an average of 241,000 acre-feet (AF) to only 10,000 AF and were below normal for all but one month. As a result of the low flows, 11 power plants were crippled and sensitive aquatic species were threatened. Farmers saw grain yields drop by 20% and ranchers resorted to burning spines off prickly pear cactus and blending molasses as livestock feed supplements. Farmers began dramatically increasing the amount of groundwater pumped for irrigation. A Kinney County Extension Agent summed things up by saying, "We are fast finding out that water is about as valuable as oil, only we can drink water." By 1957, all but 10 of Texas' 254 counties were declared federal drought disaster areas. Finally, in the Spring of 1957, the drought ended. Dallas reported the second wettest May in its history, Kingsville received three inches in an hour, and there was street flooding in Bracketville. Cooke and Grayson counties had to apply for flood relief by June.

The impact of the drought can be shown by these stories. Texas schoolchildren were so used to the drought that many of them reached for brown crayons, not green ones, to color a picture of grass. A Junction family gave their 10-year-old daughter a raincoat as a birthday present in 1951. Because there were no rains, neither the 10-year-old nor her 5-year-old sister were ever able to use it. The coat died a natural death about the time it finally rained.

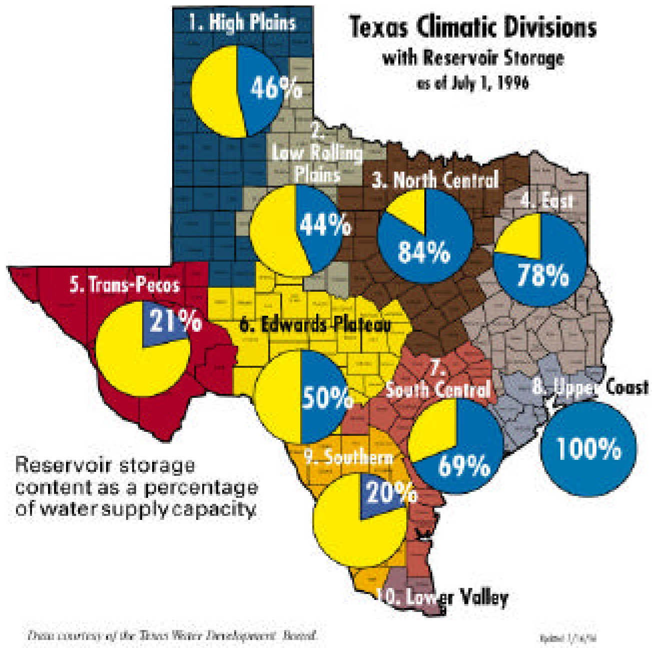
The Drought of 1996

Throughout much of Texas, drought conditions are cracking soils and ruining crops like this one.

The Palmer Drought Severity Index (PDSI) is a tool based on rainfall, evaporation and soil moisture that is widely used to gauge the severity of droughts. According the PDSI, the High Plains, Rolling Plains, the Edwards Plateau, and East, North Central, and South Central Texas are all in an extreme drought this Summer. This index predicts it is very likely that the drought will continue in North Central, East, and South Central Texas this Summer. Water levels in Falcon and Amistad reservoirs have dipped to 29% of capacity. Statewide, Texas' major reservoirs contain roughly 24 million AF, compared to more than 32 million AF in 1993. In every region of Texas, rainfall levels are only 20% of normal. Rainfall is especially low in South Texas, along the Edwards Plateau, and in the Lower Rio Grande Valley. Nearly 280 public water systems are limiting water use to avoid shortages, while seven systems reported drought-related water problems. In Northern Mexico, there has been a prolonged drought since 1992 and one reservoir is at 4% of capacity. Some areas of the state, particularly South Texas, are now in their third year of below normal rainfall, while Austin is experiencing its fourth driest year ever.

In May, the Texas Agricultural Extension Service (TAEX) and the Texas Department of Agriculture (TDA) summarized the economic impact of the 1996 drought on Texas agriculture. TDA Commissioner Rick Perry said the drought has the potential to be worst economic disaster to afflict Texas agriculture in the 20th century. To assist farmers, Perry recommended that drought-stricken farmers in Texas not be required to plant crops in dry fields to qualify for crop insurance benefits, and that grazing be allowed on lands in the Conservation Reserve Program. Roland Smith of the TAMU Agricultural Economics Department projects that direct economic losses to agricultural producers could total $2.4 billion, while there will likely be $4.1 billion in losses in associated industries (harvesting, transporting, processing, and marketing of agricultural products). Charles Gilliland of the TAMU Real Estate Research Center has been examining how rural land values may be affected this year's drought. Gilliland says that since this drought began, the value land along the Canadian River dipped 16% while property values in the San Antonio region dropped 13%. Forests are being hurt by the drought. The drought will likely cut the survival rate for newly planted commercial forest seedlings to only about 60% and has made conditions favorable for a beetle that destroys forest trees.

LCRA estimates that drought will drop Lake Travis to its lowest level in 12 years and asked users to adopt voluntary water conservation measures earlier this year. The Sabine River Authority reports that impacts of the drought include historical low levels at Lake Fork, Toledo Bend, and Lake Tawakoni, taste and odor problems, and fish kills. Flows from Toledo Bend have been reduced significantly and an emergency pipeline had to be built in Edgewood for water supplies. Many Texas cities have reported problems caused by the shrinking of soils during this heat wave, which results in breaks in water mains and sewer lines.



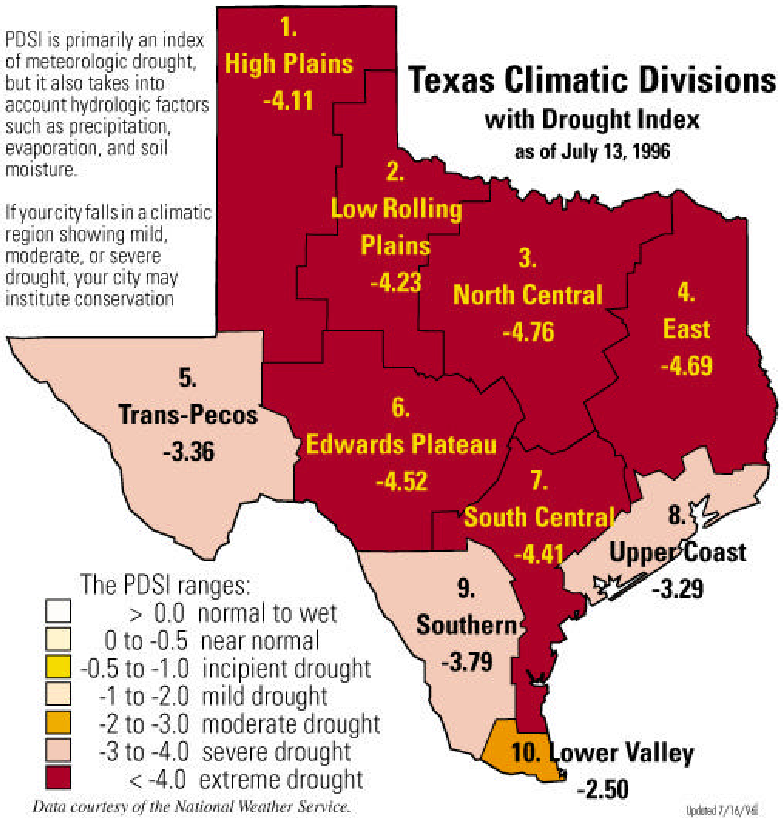
Texas climatic divisions with reservoir storage as of July 1, 1996.

As a result of the drought, many regions of Texas have begun cloud seeding programs, according to the Texas Natural Resource Conservation Commission (TNRCC). In West Texas, a Summer cloud seeding program is now being sponsored by the West Texas Weather Modification Association, while the Colorado River Municipal Water District is operating a cloud seeding program in the South Plains. The High Plains Underground Water Conservation District is considering the feasibility of seeding clouds using ground-based dispensers. Cloud seeding efforts are being considered in the Edwards Aquifer region, and in the Upper and Lower Rio Grande Valley. The Mexican border state of Coahuila will soon launch a cloud seeding effort.

University Research

Throughout the TAMU System, scientists are working to help agricultural producers cope with droughts. John Mullet of the TAMU Biochemistry and Biophysics Department is investigating how genes in crops are regulated during droughts. The study of genes induced by water deficit (water channels, genes that aid dehydration tolerance, and osmotic adjustment) and genes that regulate a "stay green" trait will eventually allow new drought tolerant sorghum genotypes to be developed. Ron Newton of the TAMU Forest Sciences Department and Ed Funkhouser of the TAMU Biochemistry and Biophysics Department are investigating how woody plants (loblolly pine and saltbush) respond to droughts. They are studying if some species have evolved morphological and physiological mechanisms to avoid and tolerate water stress.

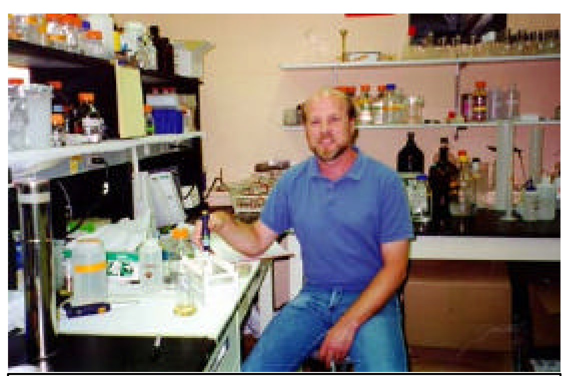
TAEX has assembled technical materials to help agricultural producers and rural residents cope with the drought. This includes information on how to manage livestock, dairies, and fish ponds, and how to farm range land, pastures, and field crops when water is limited.



Texas climatic divisions with drought index as of July 13, 1996.

In Dallas, the TAMU Research and Extension Center recently dedicated the Benny Simpson Native Plant Collection. Simpson long worked to locate and develop resource efficient native landscape plants that tolerate droughts and extreme heat. Milt Engelke of the TAMU Dallas Center has worked to develop and market drought-tolerant Buffalograsses with Richard White of the TAMU Horticulture Department and Rick Durham of the Texas Agricultural Experiment Station and Texas Tech University (TTU).

At Texas Tech University, agricultural scientists are investigating many drought-related issues. Randy Allen of the Plant and Soil Science Department is using molecular biology to insert specific genes into cotton that may protect it from drought stress. John Zak of the Biological Sciences Department and Bobby McMichael of the U.S. Department of Agriculture/ Agricultural Research Service (USDA/ ARS) are investigating if growing cotton and wheat plants in an integrated system may allow beneficial mycorrhizal fungi to become established on cotton roots. The fungi may increase water adsorption and lessen the impact of drought stress. Dan Krieg of the Plant and Soil Science Department is working on dryland farming systems that help farmers grow cotton when supplemental irrigation is not available.



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At Texas A&M University-Kingsville, (TAMUK), geographer James Norwine of the Geosciences Department has studied how climate change may impact water resources in South Texas. His work suggests that climate change will likely increase evapotranspiration and reduce rainfall in the region. Recently, the TAMUK Wellhausen Water Resources Center implemented a solar powered weather station at a remote site in Webb County that transmits data to the TAMUK campus. The site is located in a drought-prone area that has not yet been monitored.

At Southwest Texas State University, efforts focus on examining how droughts impact the Edwards Aquifer and Comal and San Marcos springs. Glenn Longley of the Edwards Aquifer Research and Data Center has investigated how long-term climate records from tree rings can be used to assess the number and extent of droughts that have impacted Texas from 1698 to 1980. His work suggests that droughts often occur in the region and will visit again. Since 1900, 15 severe droughts plagued the Edwards Aquifer. Nisai Wanakule of the Center developed a computer model to simulate how droughts, pumping, and rainfall affect water levels and springflows in the aquifer.

Rick Durham, who is with both the Texas Agricultural Experiment Station in Lubbock and Texas Tech University, has worked with Milt Engelke of the TAMU Dallas Center to develop Buffalograss species for use in landscapes. Buffalograss can use less water than grasses traditionally used in landscapes and performs well in droughts.

At Texas A&M University International, Tom Vaughan of the Biology Department has been monitoring how the water quality in the Rio Grande is impacted by reduced flows that may be linked to droughts. At West Texas A&M University, Bobby Stewart directs the Dryland Farming Institute which develops and tests strategies farmers can use when rainfall is below normal.

At the University of North Texas, Kent McGregor of the Geography Department used the PDSI to compare the extent and severity of severe wet and dry periods in the Great Plains. His research suggests the 1950s drought spread over a larger area and was more intense and long lasting than the drought of the 1930s. Tom Orton of Concordia Lutheran University in Austin examined trends in agricultural production throughout the South. His studies show that major cotton growing centers shifted from the Deep South to the Ogallala Aquifer after World War II, because farmers desired plentiful groundwater supplies that would support farming during droughts.

Dealing with Droughts

Throughout this year's drought, innovative management strategies have been introduced to assist water supply managers. Researchers are investigating progressive approaches that may benefit Texas.

In June, Texas Governor George Bush implemented an interagency drought response committee to assist communities in mitigating the effects of the drought. The plan applies separate criteria to cases requiring immediate need and those where problems are likely to occur. The plan is coordinated by the Department of Public Safety and involves work by many agencies. It authorizes the use of convicts to build pipelines, calls for the Texas Department of Transportation to truck in water if needed, and requests that TNRCC be flexible in enforcing drinking water standards. The Federal Emergency Management Agency created a regional drought task force to assess the prospects for water conservation, review long term weather forecasts, and identify available drought relief resources. Some participating agencies include USDA, the Department of the Interior, and the U.S. Army Corps of Engineers.

The Texas Water Development Board (TWDB) and TNRCC have been working to help water managers cope with the 1996 drought. The TWDB Water Conservation Section has worked with TNRCC, the Texas Rural Water Association, and the Texas Water Utilities Association to conduct drought contingency workshops at sites throughout Texas. The workshops help water utilities assess their vulnerability to drought, develop and implement drought plans, establish trigger levels, and inform and educate the public. Examples are shown that illustrate how Texas cities have successfully coped with droughts.

TWDB and TNRCC have been developing innovative drought management strategies. Policy options that have been identified include temporary reallocation of surface water supplies, increased monitoring of surface water use (particularly in the Nueces, San Antonio and Guadalupe river basins), assessments of the socioeconomic and environmental impacts of droughts, and increased participation by local agencies in developing and adhering to local drought management plans.

Droughts, specifically the drought of the 1950s, drive water management policies in Texas. Immediately following the drought, many river authorities and local entities began constructing water supply reservoirs. Reservoirs are an important way to lessen the impact of droughts. Water can be stored in reservoirs when rains are plentiful and withdrawn later during dry periods. Rainfed and dryland agricultural producers are most vulnerable to adverse impacts caused by droughts, while the presence of reservoirs and groundwater wells provides insurance against bad weather. Water supplies in reservoirs are based on the amount of water that will be available during worst case conditions or the "drought of record." The volume of water that can be taken from a reservoir during droughts is the firm yield. The basic principle is that the worst drought that can be expected has already occurred. Planning for worst case scenarios will help utilities ensure that they can meet customer needs during droughts.

George Ward of the University of Texas Center for Research in Water Resources and Juan Valdes of the TAMU Civil Engineering Department investigated water resources issues associated with potential climate change. The research suggests that small droughts will strain water supplies in the near future because of increased population growth and water use. Specific simulations were developed for the Colorado, Rio Grande, and Trinity river watersheds. Valdes and graduate student Zhongjian Liu are now working to develop improved methods to correlate the occurrence of La Nina events with Texas droughts. Their work involves using complex spectral and wavelet analysis to identify statistical trends that may be useful in predicting how long droughts will last and how often they will occur. Preliminary results suggest that La Nina events are much more likely to produce droughts than El Nino cycles and that there may be a lag of one or two seasons between the beginning of a La Nina event and a change in Texas weather patterns. Future studies will use these methods for improved regional drought forecasting. Ralph Wurbs of the TAMU Civil Engineering Department has focused his studies on reservoir management strategies. His work shows that water managers can store more water to meet current demands if they accept a higher level of risk. He identified managing reservoirs in a system and establishing seasonal operating rules as strategies that could be helpful during droughts.

Bruce McCarl and Ron Lacewell of the Agricultural Economics Department are now investigating whether it is feasible to implement a "dry year option" in the Edwards Aquifer region. Under this plan, agricultural producers could be paid to stop irrigating during drought years. The research includes evaluating limited irrigation systems that farmers can use to maximize production in droughts, estimating whether on-farm conservation efforts will increase springflows, and quantifying third party economic impacts. Graduate student Keith Keplinger is refining and testing an Edwards Aquifer regional optimization model to define a schedule of reductions in water use and irrigated acres associated with various payments to farmers to stop irrigating. These reductions in pumping will then be used to estimate associated changes in springflow and aquifer elevation. Beginning of the year and mid-year cut-offs are being examined. McCarl is also evaluating the economic impact of precise long-term weather forecasts for agricultural producers. Ron Griffin and James Mjelde of the Agricultural Economics Department are now exploring how risk management can be incorporated into water supply planning and management. They want to quantify the economic trade-offs utilities face when evaluating the level of drought risk they are willing to accept. Ron Kaiser of the TAMU Recreation, Parks and Tourism Sciences (RPTS) Department has explored if water marketing could be a viable strategy to help manage water supplies during droughts by matching willing buyers and sellers. A recent study by Kaiser and graduate student Laura Phillips reveals that 33% of water users in the Edwards Aquifer region may be willing to sell or lease or water rights if a marketing scheme were implemented. Kaiser also investigated if the Texas Water Bank could be used to allocate water during droughts by reducing transaction costs and facilitating the trading of water contracts.

The Houston Advanced Research Center (HARC) was recently awarded a grant from the U.S. Environmental Protection Agency to examine water and sustainable development management strategies for the U.S. - Mexico border. The work is led by Jurgen Schmandt and Dan Sisbarro of HARC and scientists with Instituto Tecnologico y de Estudios Superiores in Monterrey, Mexico. It involves developing a binational database with water, ecological, population and economic information that can be used for watershed analyses. The project will help area leaders plan for droughts.

Summary

Perhaps the most amazing aspect of this year's drought is that people are surprised it's actually occurring. In the introduction to *The Time It Never Rained*, Elmer Kelton writes, "Each new generation tends to forget -- until it confronts the sobering reality -- that dryness has always been the normal condition in the western half of the state. Wet years have been the exceptions." Perhaps even more chilling is the idea that this drought is actually quite new. If it continues, the impacts will become more pronounced. It also needs to be remembered that drought is not only a condition of rainfall levels, but is influenced by water demands. A relatively minor drought (in terms of low rainfall) becomes a major headache as population and water use increase, and ecological needs are recognized. Keep in mind that we may not have yet experienced the worst drought that nature has in store. Worse events may have happened before and may occur again.

Excellent information about droughts is available through the Internet and the WWW. Some of these sites include TWDB and TNRCC.

For More Information

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