3

Drought and drought response in Texas

Quick facts

Texas experienced the second-worst statewide drought on record from August 2010 to October 2014.

In response to the 2011 statewide drought, the most severe one-year drought on record, the 2016 regional water plans included additional region-specific information regarding drought preparation and response.

Texas is no stranger to drought and has experienced periods of drought in every decade of the 20th century. Although droughts typically develop slowly compared to other natural hazards, they often have far-reaching effects such as depleting water supplies, creating conditions that lead to wildfires, and decreasing agricultural production. Texas uses the 1950s drought of record as a benchmark for water planning, with the intention that preparing for severe drought conditions that have already occurred will help the state better respond to future droughts.

3.1 Measuring drought status and severity

Although drought conditions and impacts may vary locally, there are some common tools, with varying geographic scales, used to assess the status and severity of drought.

The U.S. Drought Monitor is commonly used in Texas to determine drought status. This weekly map of drought conditions is jointly produced by the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, and the National Drought Mitigation Center. The U.S. Drought Monitor is a composite index and includes many indicators such as measurements of climatic, hydrological, and soil conditions, as well as reported impacts and observations from contributors throughout the country.

Multiple drought indices, each based on different parameters, are available to assess the severity of drought. Drought indices used by the Texas Drought Preparedness Council to assess the severity of drought in Texas include the Crop Moisture Index, Keetch-Byram Drought Index, Palmer Drought Severity Index, Reservoir Storage Index, Streamflow Index, and Standardized Precipitation Index (TDEM, 2014). The Standardized Precipitation Index is now the accepted index for characterizing drought. The Drought Annex, a component of the state emergency management plan, shows how each severity index corresponds to stages of the U.S. Drought Monitor. The most recent U.S. Drought Monitor and drought indices are available online at waterdatafortexas.org/drought.

3.2 Types of drought

While the term drought has many definitions, there are several common types of drought, which include meteorological, agricultural, hydrological, and socioeconomic.

Meteorological drought begins with a period of abnormally dry weather resulting in less than the long-term average rainfall for that period. It does not necessarily impact water supply.

Agricultural drought often follows or coincides with meteorological drought and can appear suddenly and cause rapid impacts to agriculture. It reduces soil moisture, which decreases crop or range production, and increases irrigation demands. It often leads to drought disaster declarations and in many cases is an indicator of an impending hydrological drought.

Hydrological drought is a period of below-average streamflows and water volume in aquifers and reservoirs, resulting in reduced water supplies. It is the focus of regional water planning since it impacts water supplies.

Socioeconomic drought occurs when physical water needs affect the health, safety, and quality of life of the general public or when the drought affects the supply and demand of an economic product.

3.3 Precipitation influences

A key phenomenon influencing seasonal rainfall in Texas' fall and winter seasons is the El Niño Southern Oscillation. This phenomenon is a cyclical fluctuation of sea surface temperatures in, and associated air pressure patterns over, the tropical Pacific Ocean. It is infamous for the aberrations it induces in seasonal rainfall over many regions of the globe. Rainfall in Texas is enhanced in the fall and winter during positive phases of the El Niño Southern Oscillation and suppressed during negative phases. Thus, the onset of drought over Texas is often associated with a negative phase of the El Niño Southern Oscillation, known as La Niña. In addition to La Niña, sea surface temperature patterns in the North Pacific—particularly related to the Pacific Decadal Oscillation (Mantua and Hare, 2002)—and the North Atlantic Ocean—especially related to the Atlantic Multidecadal Oscillation (McCabe and others, 2004)—influence rainfall over Texas.

3.4 Drought of record and the 2010–2014 drought

The drought of the 1950s—the most significant drought recorded in Texas' history (dating back to 1895) in terms of both duration and intensity—is widely considered the statewide drought of record, the basis for state water planning in Texas. As measured by the Palmer Drought Severity Index, the drought of record lasted 77 months, from October 1950 to February 1957. By the same measure, the 2010–2014 drought lasted 51 months, from August 2010 to October 2014 (NOAA, 2015b).

The 2010–2014 drought ranks as the second-worst and second-longest statewide drought on record, based on the Palmer Drought Severity Index. During this period, extreme drought conditions (Palmer Drought Severity Index of less than or equal to -4) persisted 45 percent of the time and a record low statewide measurement of -8.05 was recorded after only 14 months (September 2011). By comparison, extreme drought conditions existed 62 percent of the time during the drought of record and its lowest statewide measurement of -7.7 was recorded after 72 months (Figure 3.1).

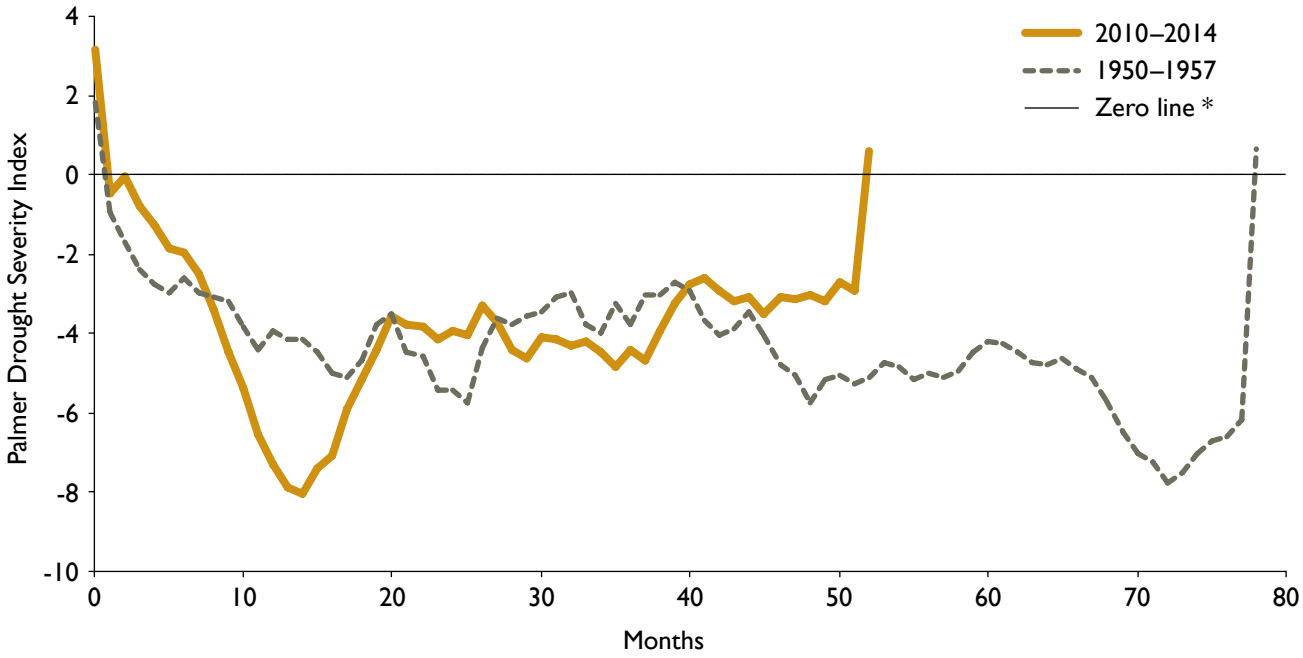
The 2011 drought is ranked as the worst one-year drought on record. The record low Palmer Drought Severity Index measurement in September 2011 followed the driest 12-month period of statewide precipitation on record. In that 12-month period from October 2010 to September 2011, the statewide average precipitation was only 10.86 inches, while the statewide average precipitation for the 12-month period between October and September using a 1981 to 2010 baseline is 27.02 inches (NOAA, 2015a). The spring intensification of the 2011 drought was likely due to interactions between dry soil moisture, elevated surface temperatures, and environmental conditions preventing heavy rainfall.

According to the U.S. Drought Monitor, July 2015 marked the first time since April 2010 that no drought conditions existed on the landscape of the state. However, this period of no drought lasted only two weeks.

3.5 The State's response to the 2010–2014 drought

During the 2011 drought, the Texas Department of Emergency Management and the Texas Commission on Environmental Quality were not always able to find relevant drought response information in the regional water plans. In response to their input, the TWDB revised a portion of the regional water planning rules to require additional

Figure 3.1 - Statewide average Palmer Drought Severity Index (NOAA, 2015b)



** An index value of zero indicates normal conditions, while negative numbers indicate drought and positive numbers indicate above normal moisture.*

and better organization of drought information in the plans. The planning rules, amended in 2012, now require each regional water plan to include a separate chapter dedicated to drought response information, activities, and recommendations. This chapter and the drought information contained in the regional water plans serve as the drought response component of the state water plan.

Retail public utilities and entities from which the utilities obtain wholesale water service are required to report to the Texas Commission on Environmental Quality, co-chair of the Emergency Drinking Water Task Force, when they are reasonably certain that the water supply will be available for less than 180 days. This reporting was initially voluntary and later became a statutory requirement in September 2013. The entities themselves are solely responsible for identifying and reporting their projected outage dates. When entities self-report having less than 180 days of water supply remaining due to drought conditions, they will be added to the Texas Commission on Environmental Quality High Priority Water System List (called the 180-day list). As circumstances change, either through increased precipitation or the completion of a water supply project, entities may move off the list. The Emergency Drinking Water Task Force began tracking public water systems impacted by persistent drought conditions in October 2011. As of August 2015, there have been 110 public water systems on the 180-day list over the past four years. The highest number of public water systems on the 180-day list at one time was 58 (November 2014 and February 2015).

In 2012, the Texas Department of Agriculture revised an eligibility rule for disaster relief grants related to drought. To be eligible, communities must have declared that their water supplies have less than 180 days left, in addition to other program requirements. In September 2014, the TWDB began funding urgent need projects through the Drinking Water State Revolving Fund. Urgent need projects address unforeseen situations that require immediate attention to protect

public health and safety and may be eligible for loan forgiveness up to $500,000. Urgent need situations include prolonged drought-related water supply reductions resulting in a loss of supply within 180 days, catastrophic events resulting in a 20 percent loss in connections or water provided, or other situations as established by the TWDB.

3.6 Planning and response to drought

Drought planning and response in Texas occurs with drought contingency plans at the local level, regional water plans at the regional level, and the state water plan and state emergency management plan (which includes the state drought preparedness plan) at the state level.

Drought response at the state and local levels are intertwined in Texas. Before drought conditions even exist, entities implement water conservation plans and water management strategies on an ongoing basis. When drought conditions exist, entities then implement drought contingency plans and drought management strategies as necessary. They may also seek emergency funding from the TWDB or Texas Department of Agriculture. Entities implementing water restrictions as part of their drought contingency plans are required to notify the Texas Commission on Environmental Quality. This information is reported to the Drought Preparedness Council, which coordinates the state's response to drought through the state drought preparedness plan, now known as the Drought Annex. A disaster proclamation due to drought conditions may also be issued at the state or local level.

TWDB Chairman Bech Bruun in drought-stricken Lake Arrowhead, Wichita Falls, Texas

3.6.1 Statewide drought planning and response

Texas Water Code lays the foundation for the state drought response plan. It designates the Texas Department of Emergency Management as the state drought manager, responsible for managing and coordinating the drought response component of the state water plan, and as the chair of the Drought Preparedness Council, which is composed of at least 14 representatives from state entities as well as governor-appointed members.

Section 16.055 of the Texas Water Code assigns the Drought Preparedness Council the following responsibilities:

1. Assessing and reporting on drought monitoring and water supply conditions
2. Advising the governor on significant drought conditions
3. Recommending that specific provisions for state response to drought-related disasters be included in the state emergency management plan and state water plan
4. Advising regional water planning groups on drought-related information in the regional water plans
5. Ensuring effective coordination among state, local, and federal agencies in drought response planning
6. Reporting biennially to the Texas Legislature on drought conditions in the state

The Drought Preparedness Council develops the state drought preparedness plan (replaced in 2014 by the Drought Annex), which is a component of the state emergency management plan. The Drought Annex essentially lays out the state's response to drought and defines responsibilities for state agencies for drought monitoring and assessment and response and recovery. It provides triggers and potential actions that correspond to each drought stage of the U.S. Drought Monitor and includes information on drought impacts, indices and indicators, decision-making guidance, and drought coordination tools (TDEM, 2014). Coordination of the state's drought response is implemented through the Drought Preparedness Council's four committees and an Emergency Drinking Water Task Force, and there are 20 entities with specific, drought-related responsibilities listed in the Drought Annex. Annex A of the state drought preparedness plan contains the Emergency Drinking Water Contingency Annex, which develops procedures for public water systems to provide adequate water supplies and mitigate the impacts of prolonged drought.

The TWDB, a member of the Drought Preparedness Council and the Emergency Drinking Water Task Force, provides a variety of resources to assist Texans with drought response and preparedness. The TWDB maintains drought data and information on waterdatafortexas.org/drought, prepares monthly "Texas Water Conditions" reports documenting storage in the state's reservoirs and groundwater levels in aquifers, issues a weekly water report summarizing reservoir and drought conditions in the state, and provides statewide outreach on drought through educational materials and literature.

3.6.2 Regional drought planning and response

After the 2011 drought, planning groups incorporated new requirements into the 2016 regional water plans. All drought-related content is now consolidated into a single chapter in each plan to make it easy to find. An overview of current preparations and planned responses, including current triggers and how water suppliers respond to drought, is included.

New planning requirements of this fourth regional water planning cycle included

- identifying potential alternative sources for loss of municipal supply for small entities with a single source of supply,
- developing region-specific model drought contingency plans, and
- providing recommendations to the Drought Preparedness Council.

Recommendations provided in regional water plans are not mandatory or enforceable.

Regional droughts of record

While the statewide drought of the 1950s is considered the benchmark drought for state water planning, regional droughts of record may vary by sub-basin or water source. The drought of record for reservoirs for planning purposes is determined with water availability models developed by the Texas Commission on Environmental Quality and is based on historical naturalized inflows—flows without human influence. The Texas Commission on Environmental Quality models use naturalized flow at predetermined control points along river basins for all major river basins in Texas from the 1930s and 1940s to the 1980s and 1990s. Recent drought years such as 2006, 2009, and 2011 are not included in the hydrology of the water availability models.

The region A, B, C, F, G, and K planning groups reported potential new drought of record periods for some reservoirs or sub-basins that occurred after the historical period covered by the current water availability models.

Until the water availability models are updated to reflect recent hydrological conditions, it is not possible, however, to definitively confirm whether the potential new droughts of record for reservoirs or sub-basins identified by the planning groups are actually the new droughts of record. A number of regional water plans included recommendations that the Texas Commission on Environmental Quality update its water availability models to capture the more recent hydrological record.

The 2011 drought was also identified as a drought of record for run of river supplies in Regions A and F (with the exception of the Llano River), based on minimum annual streamflow data.

Some planning groups reported drought of record information for groundwater resources. A new drought of record for groundwater resources beginning in 2011 was identified in Region A based on an assessment of annual precipitation and Palmer Drought Severity Index data.

Response to potential loss of supply for small entities

Planning groups evaluated potential emergency responses to local drought conditions or loss of existing supply for entities with a population of 7,500 or less that rely on a sole source of water supply (for example, a single reservoir or aquifer) and all county-other (rural municipal) water user groups. The high-level evaluation was based on the assumption that an entity would find itself with only 180 days or less of supply left and had to identify alternative sources. This high-level screening was intended to serve as a guidepost for potential emergency response options and to identify water user groups who may be particularly vulnerable to a loss of supply.

The most common response options deemed feasible among the planning groups for providing emergency supply to these small entitles included

- trucked in water,
- local groundwater wells,
- existing or potential water system interconnects,
- brackish groundwater development (limited treatment or desalination),
- releases from upstream reservoirs, and
- curtailment of water rights.

Less frequently cited options included voluntary transfers from irrigation, supply from nearby entities, purchase of land with existing wells, and purchase of surface water.

Existing and potential emergency interconnects

Planning groups assessed water infrastructure facilities within the region to identify existing emergency interconnects between water systems and potential new emergency water supply connections. Detailed information on these facilities was submitted confidentially to the TWDB, as required by statute. The planning groups reported approximately 570 existing emergency connections and 430 potential new emergency connections.

Drought management recommendations by planning groups

Drought management reduces water use during times of drought by restricting certain economic and domestic activities such as car washing and lawn watering. Although the planning groups recommended many conservation strategies that don't restrict normal economic and domestic activities, they generally deferred to local water providers regarding the decision of whether to rely on drought management measures. In areas with projected high growth, temporary drought management strategies cannot be used to address overall increases to water demands that will occur even during non-drought periods. While planning groups recommended that individual water providers follow their local drought contingency plans, most planning groups chose not to incorporate drought management as recommended strategies in their plan.

In some cases, drought management was recommended only as a near-term, stop-gap strategy to be displaced in later planning decades by projects that provide additional water supplies. Planning groups did not, in general, consider it prudent, sustainable, reliable, and/or economically feasible to adopt a regional plan that would intentionally require restrictions on normal economic and domestic activities, especially when there were feasible alternatives. The effectiveness and sustainability of drought measures varies between utilities and were sometimes not considered to be predictable or reliable enough to quantify for inclusion as a recommended water management strategy. Most planning groups chose instead to leave potential water savings from drought management measures as a back-up or last-resort response to address uncertainty, such as the event of a drought worse than the benchmark drought of record (BBC Research & Consulting, 2009).

The Pedernales River more than 20 feet below normal levels, leaving the boat docks unusable

However, planning groups J, K, L, and P did recommend specific, quantified municipal drought management strategies:

- Region J recommended demand reductions of 20 percent for specific wells within the Bandera County-Other water user group.
- Region K recommended demand reductions, ranging from 5 to 30 percent, for most municipal water user groups, regardless of needs. The reductions depended on the water user group's gallons per capita per day, drought contingency plan triggers, and whether they were under severe water restrictions during 2011.
- Region L recommended all municipal water user groups with a water need in 2020 reduce their 2020 demands by 5 percent during drought. The San Antonio Water System requested a demand reduction strategy with varying demand reductions from 2020 to 2070.
- Region P recommended varying demand reductions for all municipalities with a drought contingency plan, regardless of needs. The reductions were based on drought contingency plan triggers and responses, and how often the trigger might actually be reached.

Planning groups also made general recommendations regarding implementing drought contingency plans, coordination among local providers during drought, protection of supply for municipal users, and recommendations regarding the Drought Preparedness Council.

3.6.3 Local drought planning and response

Drought contingency plans are implemented at the local level and often focus on potential issues related to the retail distribution system capacity rather than the total supply volume to which the entity has access. These plans may consist of one or more strategies for temporary supply and/or demand management and response to temporary water supply shortages and other water supply emergencies. The plans contain triggers, which are typically based on supply or demand, and responses associated with the triggers. Local entities now have the option to use the model drought contingency plans that the planning groups developed, which were intended to assist water users seeking guidance in developing plans with meaningful and applicable triggers and responses for water sources within the region.

Wholesale public water suppliers, retail public water suppliers with 3,300 or more connections, and irrigation districts must develop drought contingency plans and submit them to the Texas Commission on Environmental Quality. Retail public water suppliers with less than 3,300 connections must develop plans and make them available upon request. Investor-owned utilities are also required to develop drought contingency plans. Wholesale and retail public water suppliers must also notify the Texas Commission on Environmental Quality within five days after implementing any mandatory drought contingency plan measures.

Failed corn crop due to drought in the Lower Rio Grande Valley

At the local level, if a state of disaster proclamation is issued due to drought conditions, counties included in the disaster proclamation must provide notice of the declaration in a newspaper of general circulation in the county, to the chair of each planning group in which the county is located, and to each entity in the county required to develop a water conservation plan or drought contingency plan. After receiving such notice, the entities are required to implement the water conservation and drought contingency plans.

During the 2010–2014 drought, Wichita Falls exemplified how a large city successfully endured a drought that appears to have been worse than the benchmark planning drought largely because they did not base the plan on initiating drought management measures—restriction on water use—in the event of the lesser benchmark planning drought. Instead, they retained drought restrictions as a strategy for managing a worse-than-planned drought, which provided much-needed flexibility to the city.

3.7 Uncertainty of drought

While Texas has recently emerged from its second-worst statewide drought, we do not know when the next drought will occur. Tree ring records indicate that Texas has experienced droughts longer than the drought of record extending back to 1500 (Cleaveland and others, 2011). Had the recent drought persisted for two more years, it would very likely have become the new drought of record. A combination of warmer temperatures and decreased precipitation, as experienced during the 2011 drought, enhances the risk of Texas experiencing extreme droughts.

The tree ring records, recent drought, and very wet episodes indicate that the climate of Texas is highly variable and droughts with durations and intensities exceeding the drought of record could occur in the future. Given that historical record, climate variability will always affect the availability of the state's water resources; it is therefore prudent to continue water conservation efforts, even in non-drought conditions.

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