

Drought History

for the Edwards Plateau of Texas



Prepared by the South Central Climate Science Center in
Norman, Oklahoma

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Why be prepared for drought?

Since 2000, the National Oceanic and Atmospheric Administration has identified nine droughts nationwide as *billion-dollar* weather disasters based on both damages and costs, such as from crop loss. The 2012 drought, which at its height affected over 80% of the contiguous U.S., resulted in estimated damages and costs of over \$50 billion from both direct and indirect impacts. Drought can result in crop, pasture, and forest damage; increased livestock and wildlife mortality; increased fire hazard; threats to aquatic and wildlife habitats; increased water demand; and reduced water supplies.

Proper management of water resources is necessary to protect supplies for drinking water, sanitation, and fire protection as well as to maintain economic activity and environmental sustainability. ***Because disasters affect families, neighbors, and businesses locally, community-level planning is necessary to reduce the vulnerability to drought in the Edwards Plateau of Texas.***

How to be prepared for drought?

Local officials and other key stakeholders in the Edwards Plateau of Texas will be better prepared for drought when they complete the following: (1) have assessed their vulnerability to drought, (2) understand past droughts and the local climate, (3) monitor drought, (4) prepare a thorough set of actions to be taken before, during, and after a drought, and (5) educate citizens on this plan.

Having a plan in place will enable these individuals to understand key factors to monitor so they may respond proactively to drought conditions early. Following this plan helps reduce the risk such that, when drought conditions occur, water resources do not run out. This report will help governmental officials and resource managers by overviewing the climate and drought history in the Edwards Plateau of Texas since record-keeping began in the late 19th century.

What is drought?

Drought is difficult to define. This is problematic because the impacts associated with drought are often far-reaching and devastating. A *meteorological drought* is a prolonged period when precipitation is below “normal” for the location (Heim 2002). An *agricultural drought* occurs when soils are too dry to grow healthy vegetation, particularly crops or forests. As water becomes scarce in rivers, lakes, and other water bodies, a *hydrological drought* develops. If, at any time, the water demands of society (e.g., water for drinking, maintaining lawns and gardens, washing clothes) exceed the availability of good-quality water, then a *socioeconomic drought* has occurred. A socioeconomic drought may arise even during times of normal precipitation because of increased water demand from a growing population, increased temperatures and wind speeds, new businesses, or other societal changes.

Has the Edwards Plateau of Texas experienced drought?

Drought is a recurring condition in the Edwards Plateau of Texas, and is part of our climate. Our climate history can provide us insight into what we may see in the future. Being “drought ready” means, in part, that we recognize how our climate has changed over time. Let’s examine our past.

The Climate of the Edwards Plateau of Texas

Temperature and precipitation are the two main elements of our climate. Because the Edwards Plateau of Texas is located in the middle latitudes, and northwest of the Gulf of Mexico, its citizens experience a wide range of weather conditions. Hence, our climate is highly variable, from year to year, season to season, and month to month.

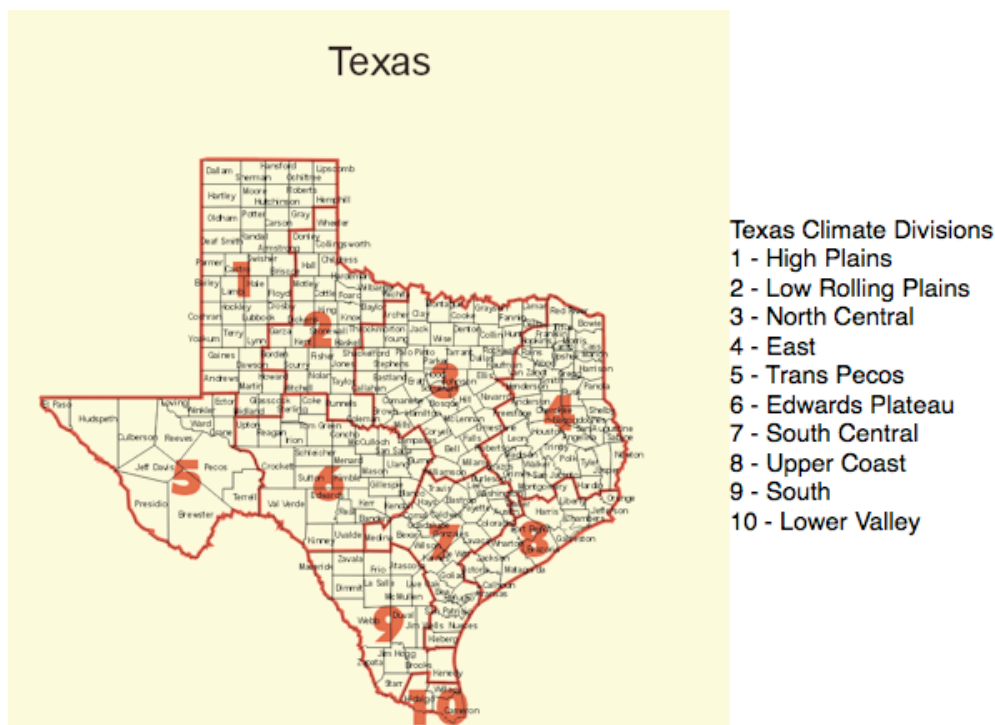


Figure 1. Map of the climate divisions of Texas. For this report, we will focus on Climate Division 6 in the Edwards Plateau of Texas.

Figure 2 shows the annual temperature (top) and annual precipitation (bottom) in the Edwards Plateau of Texas since 1895.¹ The annual temperature for the Edwards Plateau of Texas averages 66.0 degrees Fahrenheit, while precipitation averages 25.24 inches. Warmer-than-average periods have spanned the late 1900s through the mid-1910s, the 1920s through the 1930s, the mid-1950s, the mid-1990s through the early 2000s, and the early 2010s. Significant periods of drier-than-average conditions include the early 1910s, the late 1910s, the 1950s, the 1960s, and the early 2010s.

¹ Data from the National Climatic Data Center and obtained from the Oklahoma Climatological Survey (<http://climate.ok.gov>).

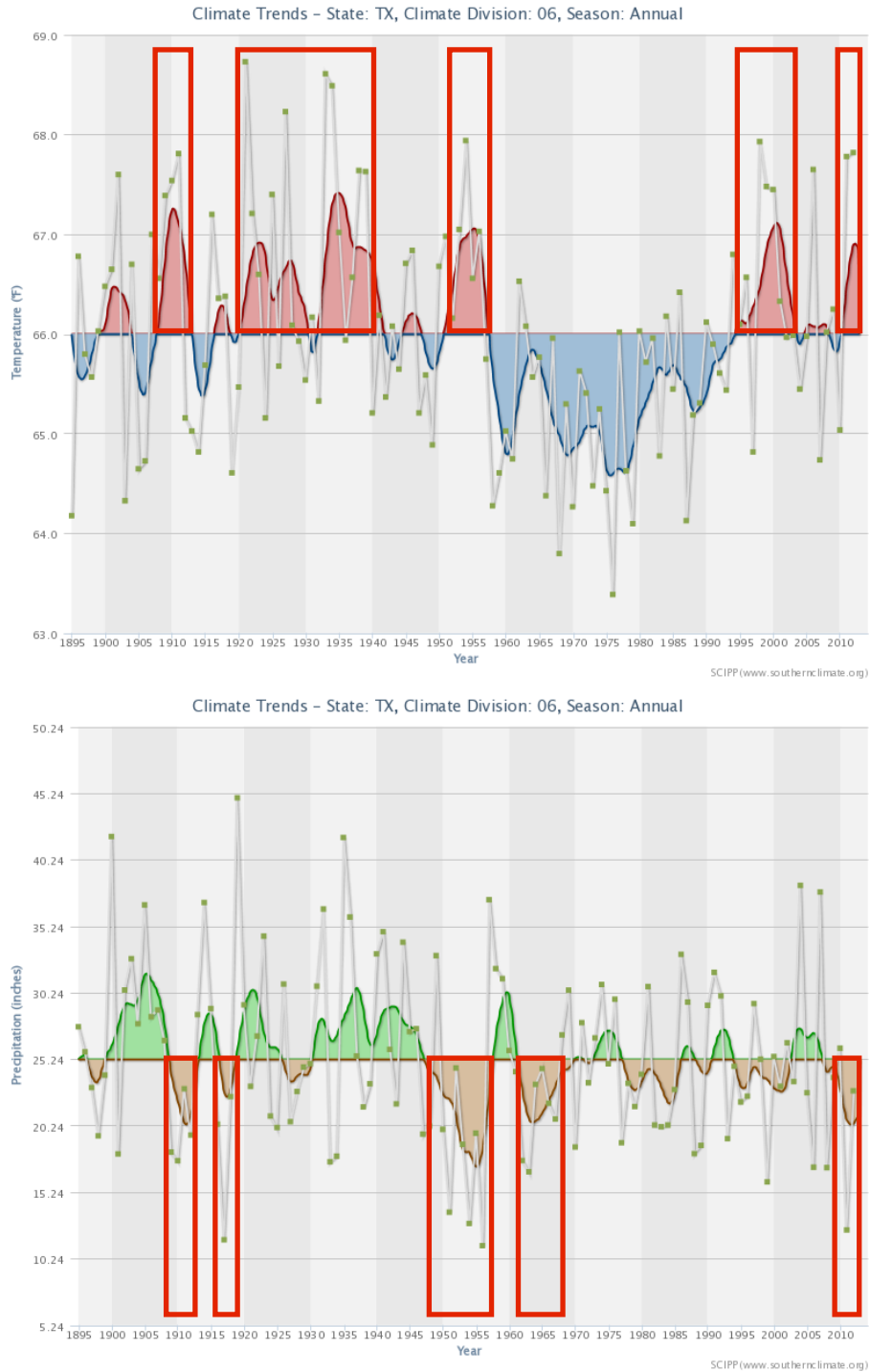


Figure 2. The average annual temperature (top graph) and total annual precipitation (bottom graph) in the Edwards Plateau of Texas from 1895 to 2012. To highlight warmer, cooler, wetter, or drier periods, 5-year moving averages are shaded. On the top graph, red shading (above the horizontal line) indicates warmer periods and blue shading (below the line) notes cooler periods than average. Similarly, on the bottom graph, green shading (above the horizontal line) highlights wetter periods and brown shading (below the line) highlights drier periods than average. Extended periods of relatively warm temperatures or low precipitation are outlined in red boxes.

To understand when there is the greatest stress on water availability for the Edwards Plateau of Texas, the average monthly temperature and precipitation, as well as their average highest and lowest monthly values, are shown in Figure 3. Warmer temperatures result in greater water loss by evaporation and transpiration. The warmest temperatures typically occur during July and August (top of Figure 3).

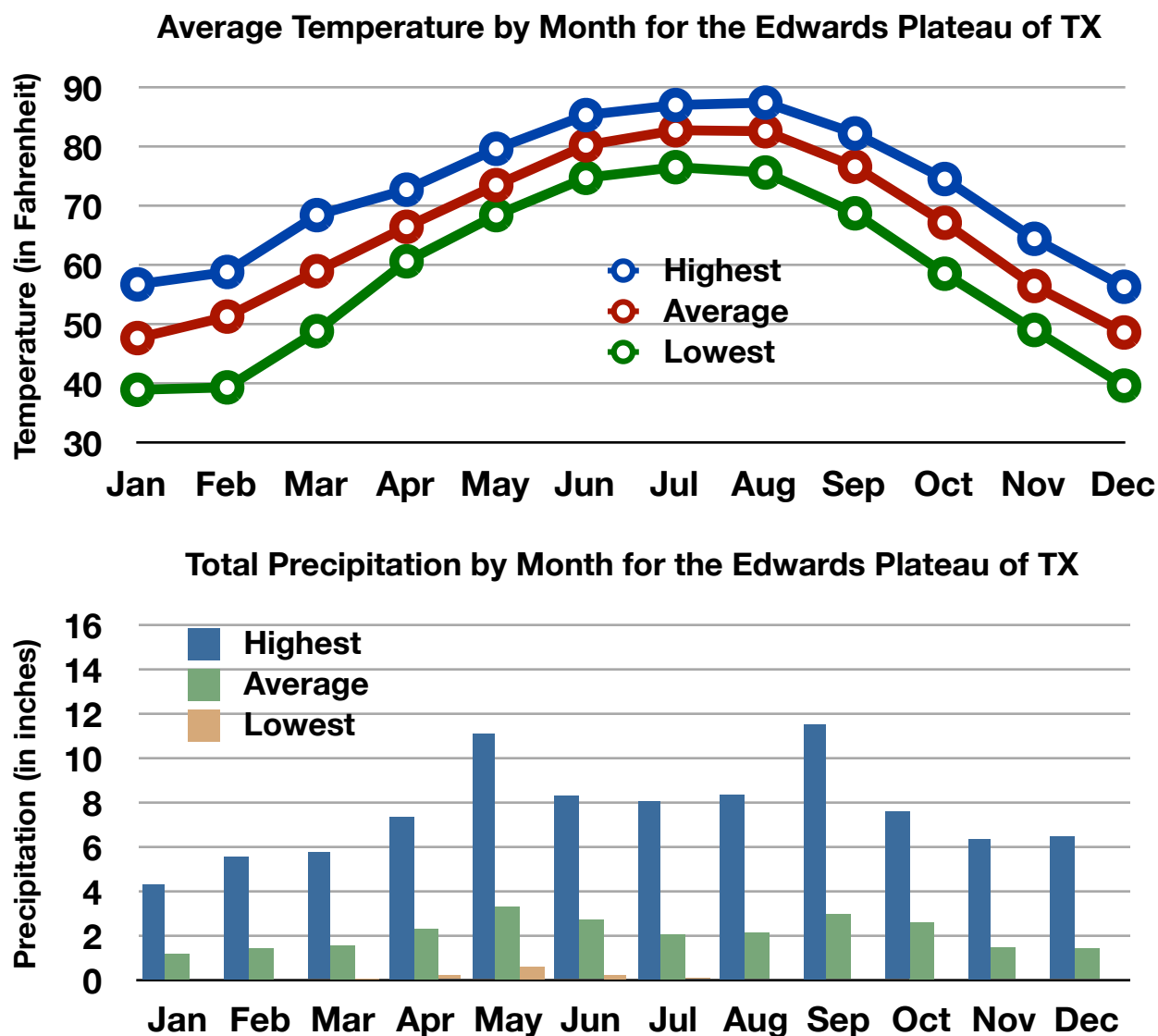


Figure 3. Top graph: The monthly average temperature (in degrees Fahrenheit) across the Edwards Plateau of Texas using data from 1895 to 2012. The red (middle) line is the average of all climate-division average temperatures for that time period. The blue (top) line is the highest monthly average and the green (bottom) line is the lowest. Bottom graph: The average total precipitation (in inches) by month across the Edwards Plateau of Texas using data from 1895 to 2012. The blue (leftmost of each monthly cluster) bar is the highest monthly precipitation; the green (middle of the cluster) is the average precipitation total recorded for that month; the gold (rightmost) is the lowest precipitation total recorded for that month. [Note that zero precipitation has occurred at least once during January, February, August, November, and December] The two peaks of precipitation, first in May, then in September, are clearly visible.

Drought in the Edwards Plateau of Texas

Because drought is hard to define, it also is hard to measure. Understanding the need to quantify drought severity, the scientific community has developed several methods to assess drought, including departure from normal precipitation, the Palmer Drought Severity Index, and the Standardized Precipitation Index (Figure 4). All three use weather observations to diagnose drought conditions. The simplest of these is the annual departure from normal precipitation, which is the actual precipitation total for the year subtracted from the annual normal. Large negative values indicate a precipitation deficit for that year.

The Palmer Drought Severity Index uses observations or estimates of precipitation, temperature, and soil water content. Values typically range from +4 representing extremely wet conditions to -4 representing extremely dry conditions. Values less than -1 indicate some level of drought, and the values become more negative with less rainfall and hotter temperatures. The lowest value on record for the Edwards Plateau of Texas was -6.13 in September 2011.

The Palmer Drought Severity Index helps to diagnose agricultural drought because it is sensitive to soil moisture conditions and works well at relatively long time scales. The index does not account for reservoir levels and streamflow, so it has drawbacks for diagnosing hydrological drought.

The Standardized Precipitation Index is based solely on precipitation but has the advantage of multiple time scales (e.g., 3 months, 6 months, 1 year) to better highlight short-term versus long-term droughts. Values typically range from +2 as extremely wet to -2 as extremely dry, with values less than -1 representing drought.

Figure 4 displays the departure from normal precipitation, Palmer Drought Severity Index, and two-year Standardized Precipitation Index for the Edwards Plateau of Texas from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 2. ***It is evident from these three drought indicators that the Edwards Plateau of Texas has experienced long and extreme droughts in its past.***

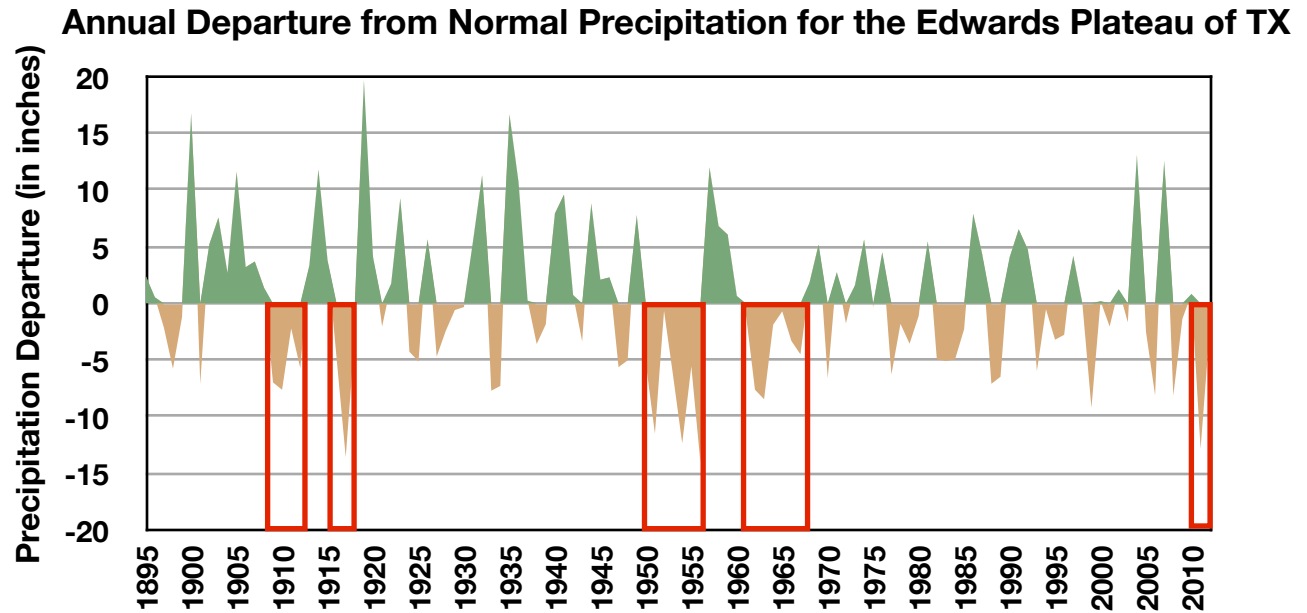


Figure 4a. Annual departure from normal precipitation (actual precipitation total for the year subtracted from the annual normal) for the Edwards Plateau of Texas from 1895 to 2012.

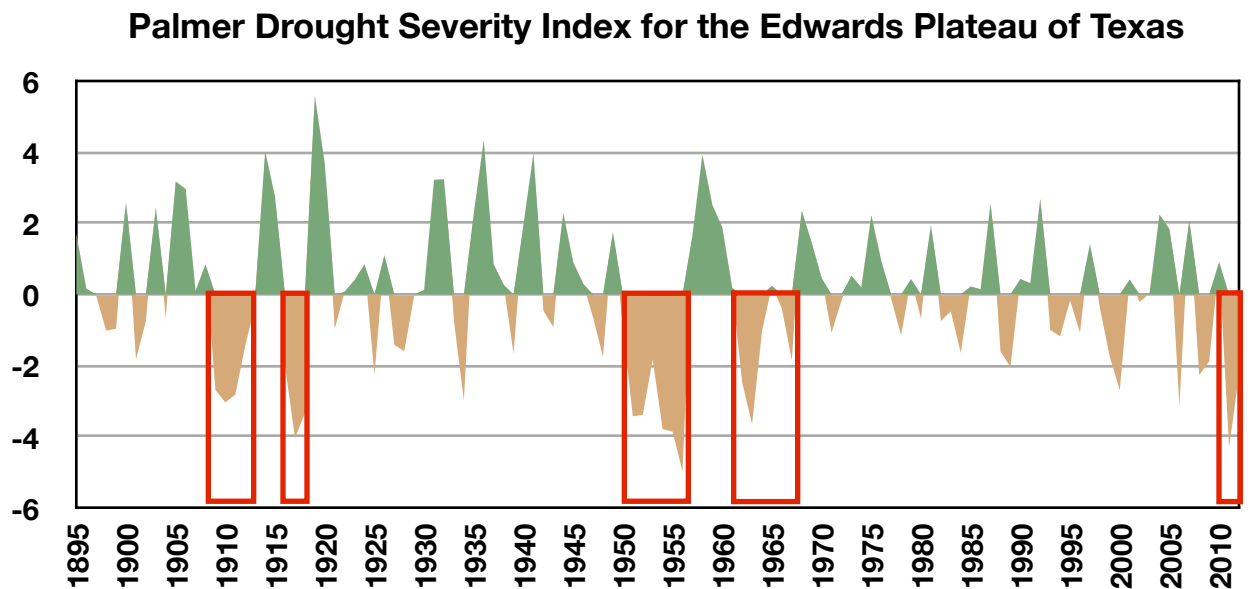


Figure 4b. Palmer Drought Severity Index for the Edwards Plateau of Texas from 1895 to 2012.

2-Year Standardized Precipitation Index for the Edwards Plateau of Texas

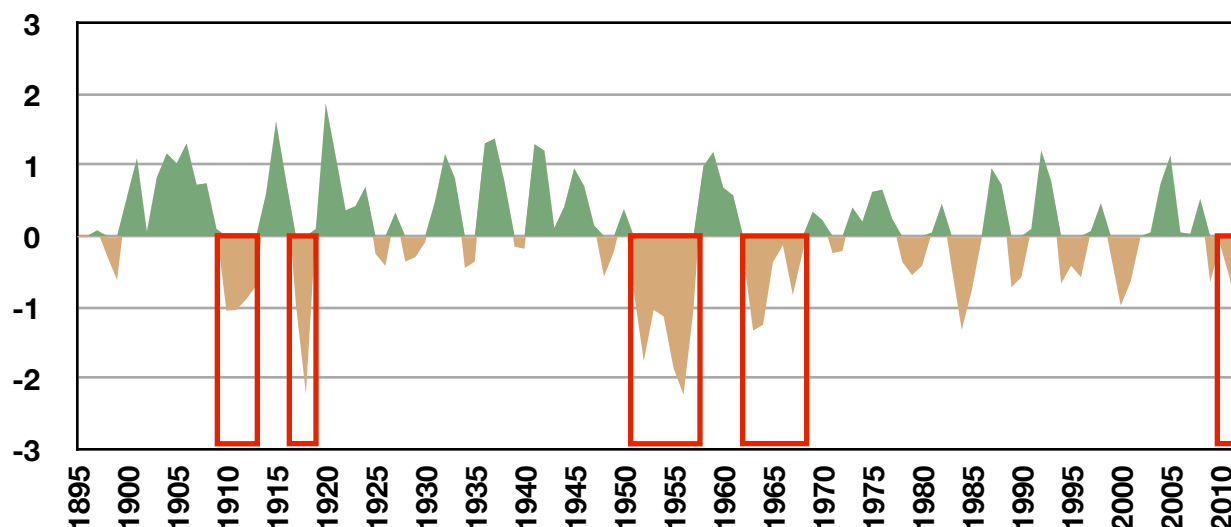


Figure 4c. The 2-year Standardized Precipitation Index for the Edwards Plateau of Texas from 1895 to 2012. Red boxes outline the same drier-than-average periods highlighted in Figure 2.

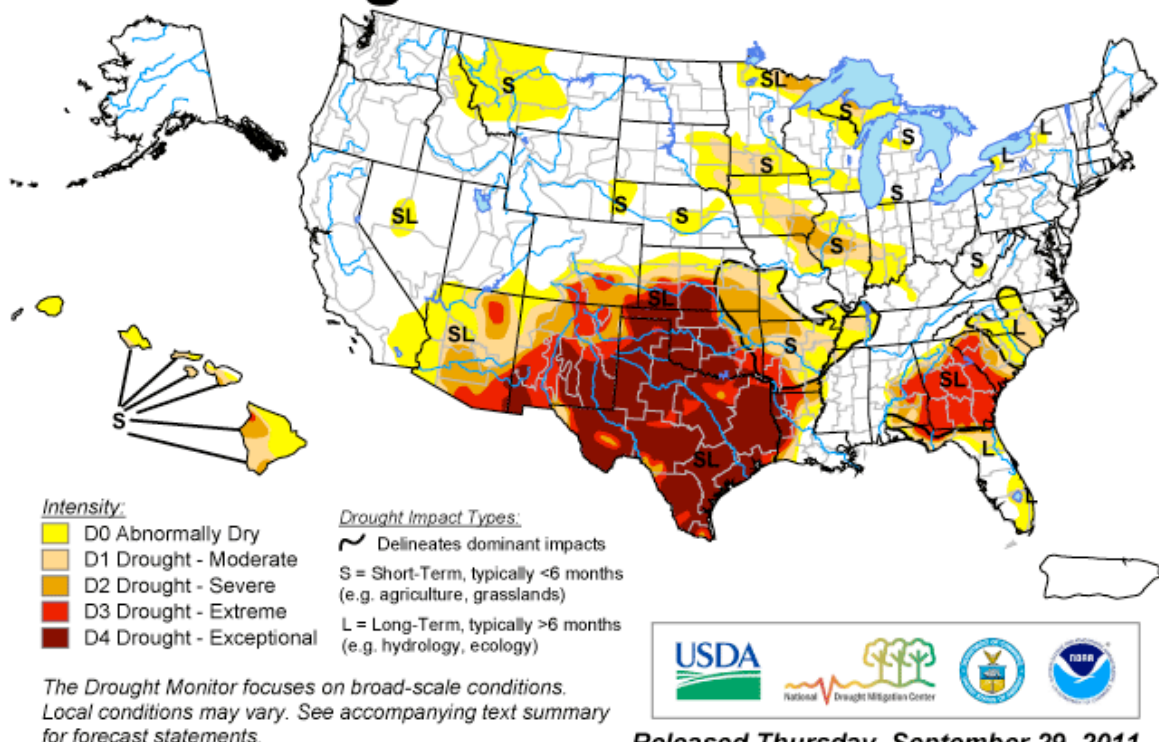
A more recent method to measure drought intensity is the U.S. Drought Monitor (Figure 5). This product depicts weekly drought conditions for the United States on a drought intensity scale of D0 to D4, with D0 representing areas that are abnormally dry and D4 representing areas of exceptional drought. Although the levels are subjectively determined, they are established through expert review of weather and water data, including local observations, as well as reports of drought impacts from local, tribal, state, and federal officials as well as the public and media. Figure 6 displays the weekly percentage of area in the Edwards Plateau of Texas affected by D0 through D4 drought since 2000². Short-term severe droughts in 2006, 2008 through 2009, and 2011 to present (data through March 2013) are evident for the region.

² Data provided by the National Drought Mitigation Center.

U.S. Drought Monitor

September 27, 2011

Valid 8 a.m. EDT



Released Thursday, September 29, 2011

Author: Michael Brewer/Liz Love-Brotak, NOAA/NESDIS/NCDC

<http://droughtmonitor.unl.edu/>

Figure 5. Example map of the U.S. Drought Monitor from the drought assessment issued for the week preceding September 27, 2011. The color scale (yellow to dark red) displays the level of drought from D0 (abnormally dry) to D4 (exceptional drought). Significant regional impacts on agriculture are designated with an “S” and regional impacts on water supply are designated with an “L”. The maps are released each Thursday at 8:30 a.m. Eastern Time. Courtesy of the National Drought Mitigation Center.

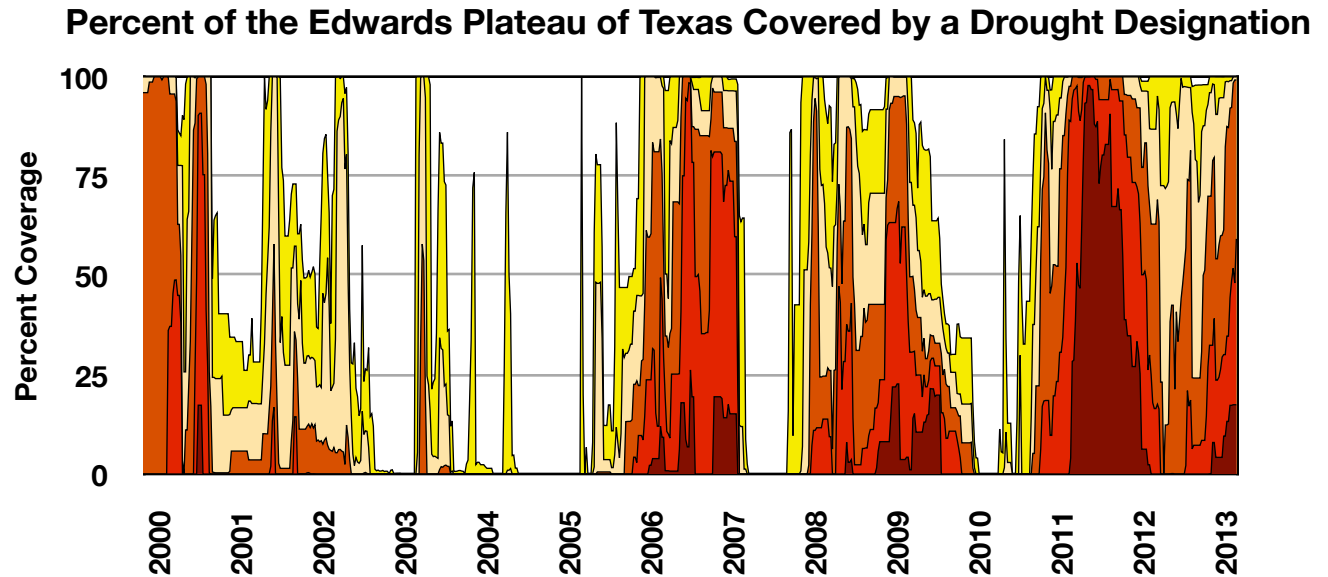


Figure 6. Drought history for the Edwards Plateau of Texas as designated by the U.S. Drought Monitor. The color scale is identical to that in Figure 5. Note that the Edwards Plateau of Texas was experiencing extreme (bright red) to exceptional drought (dark red) across most of the area during much of 2006, 2008 through 2009, and 2011 to present (data through March 2013). Data courtesy of the National Drought Mitigation Center.

The “Droughts-of-Record” for the Edwards Plateau of Texas

For purpose of planning, we consider the “drought-of-record” to be the drought with the worst environmental conditions rather than the drought with the worst recorded impacts on the Edwards Plateau of Texas. Hence, a shorter and less severe drought with high monetary losses in our recent past (e.g., during 2011) will not outweigh a long and severe drought in our early history, when fewer people lived in the region. We choose to prepare for the worst.

Options for the drought-of-record include the droughts in the mid-1910s and 1950s. The period with the longest duration is undoubtably the 1950s. Table 1 compares Palmer Drought Severity Indices for these droughts and others, as well as the most recent (hence, memorable) drought of 2011 to present (December 2012). Using these indices, the drought of the 1950s well exceeds intensity of all other droughts; hence, ***the period from October 1950 to February 1957 is the drought-of-record for the Edwards Plateau of Texas.***

Because of its non-stop dry conditions combined with a period of PDSI less than -4, ***January 1916 to October 1918 comes in second for the drought-of-record for the Edwards Plateau of Texas.***

Table 1: Comparison of Palmer Drought Severity Indices (PDSI) for Several Droughts Affecting the Edwards Plateau of Texas

Time Period	Months with PDSI less than –1	Months with PDSI less than –4	Lowest PDSI Value
January 1909 - August 1913	53 (of 56 months)	3 consecutive	–4.23
January 1916 - October 1918	33 (of 33 months)	14 consecutive plus 1 other	–5.25
October 1950 - February 1957	77 (of 77 months)	11 consecutive, 7 consecutive, plus 11 other	–6.08
January 1962 - July 1964	31 (of 31 months)	4 consecutive	–4.54
November 2010 - December 2012*	26 (of 26 months)	8 consecutive	–6.13

**Note: Data only available through December 2012; drought conditions may have continued past this date.*

So what can the Edwards Plateau of Texas do to prepare?

Key stakeholders (e.g., water managers), business leaders, and residents can contribute to ensuring that the Edwards Plateau of Texas is prepared for the next drought. Water management officials of the region must monitor and report drought conditions by Tuesday afternoons to be considered for the Thursday updates to the U.S. Drought Monitor.

Monitoring and reporting drought conditions

There are several ways to monitor drought. For example, water managers can monitor drought by checking the water level of their main sources of water, such as lakes and streams. Larger-than-average decreases in the water level for a given month may indicate (1) more evaporation than normal, (2) reduced releases of water upstream, or (3) a greater water demand.

Another excellent monitoring tool is the U.S. Drought Monitor, hosted by the National Drought Mitigation Center at the University of Nebraska. Dozens of federal, state, and local agencies contribute to the Drought Monitor through local reports of drought conditions (such as reports from water managers and residents) as well as observations from weather and water instrumentation. As noted previously, drought categories range from D0 as

abnormally dry to D4 as exceptional drought. Many federal drought assistance programs activate at D2 drought.

The Southern Climate Impacts Planning Program provides a drought monitoring web site at <http://www.southernclimate.org/data.php>. The products on this site depict changes in precipitation and temperature across the Southern United States (including Texas). Tables summarize the current precipitation totals to past years across a variety of time scales (e.g., last 30 days, last 90 days), as shown in Figure 7.

30-Day Precip For TX - Apr 27, 2013 through May 26, 2013

Climate Division	Total Rainfall	DFN	% of Normal	Driest Rank	Driest on Record	Wettest on Record	SPI	Similar Season In Last 30 yrs (Score)
CD 1	0.62	-1.72	26.6	14/122	0.00(1893)	8.16(1941)	-1.42 D2	1987(9.26)
CD 10	3.08	0.6	124	98/134	0.00(1899)	9.11(1941)	0.59	1992(8.23)
CD 2	1.33	-1.72	43.6	15/118	0.70(1984)	10.05(1957)	-1.30 D2	2008(9.45)
CD 3	3.01	-1.49	66.9	37/132	0.38(1886)	12.71(1957)	-0.52 D0	2003(9.11)
CD 4	3.87	-0.98	79.8	56/121	0.60(1886)	11.55(1953)	-0.16	2003(8.70)
CD 5	0.51	-0.55	48.3	21/117	0.00(1896)	4.51(1914)	-0.84 D0	2009(9.43)
CD 6	3.66	0.49	115.5	83/121	0.48(1998)	8.91(1914)	0.40	2003(8.90)
CD 7	4.43	0.12	102.8	85/127	0.24(1998)	10.23(1972)	0.51	1997(8.38)
CD 8	4.27	-0.31	93.2	89/143	0.00(1874)	9.60(1972)	0.36	2005(8.99)
CD 9	4.99	2.12	173.7	107/116	0.08(1998)	8.04(1941)	1.22	2004(8.61)

Figure 7. Example of a drought monitoring product from the Southern Climate Impacts Planning Program (<http://www.southernclimate.org/>). This example provides an assessment of the past 30 days ending on May 26, 2013 and includes the following information: total rainfall for the period, departure (difference) from normal rainfall for the period, the percentage of normal precipitation for the period, how wet or dry the period has been compared to previous years, the precipitation amount for the driest similar period on record (and its year), and the precipitation amount for the wettest similar period on record (and its year).

Table 2 summarizes several excellent sources of information for drought monitoring and reporting, ranging from national to local.

Table 2: Sources of Drought Information & Tools

Source	Web Address	Uses
<i>Major Sources of Information</i>		
National Integrated Drought Information System	www.drought.gov	Consolidated source of drought information, monitoring & reporting tools, including many of the other sources listed below
National Drought Mitigation Center	drought.unl.edu	Consolidated source of drought information, including drought planning, monitoring reporting, risks, and impacts
State Climate Office - Texas	climatexas.tamu.edu	Consolidated source of Texas climate information
West Texas Mesonet	www.mesonet.ttu.edu/	Regional weather observing network specific to west Texas
<i>Specific Drought-Related Tools</i>		
U.S. Drought Monitor: <i>National Drought Mitigation Center</i>	droughtmonitor.unl.edu/	Current and past diagnoses of drought conditions, both nearby and across the United States
Texas Drought Monitoring Website: <i>Office of the State Climatologist</i>	climatexas.tamu.edu/index.php/drought	Current drought conditions and research on previous drought impacts within Texas
U.S. Seasonal Drought & Precipitation Outlooks: <i>Climate Prediction Center</i>	www.cpc.noaa.gov	Large-scale trends in drought across the U.S. for the next few months; Expert assessments (not forecasts) of possible changes in precipitation conditions over a range of times (6-10 days, 8-14 days, 1 month, & 3 months)

Acknowledgments

Weekly U.S. Drought Monitor data were provided by Brian Fuchs of the National Drought Mitigation Center, and climate division data were supplied by Monica Deming of the Oklahoma Climatological Survey. Texas drought photos courtesy of the San Angelo, TX National Weather Service Weather Forecast Office. (<http://www.srh.noaa.gov/sjt/?n=drought>).

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