

Hydrologic Drought of Water Year 2011: A Historical Context

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Lake Carl Etling, April 2009

Lake Carl Etling, January 2012

Drought is Normal

Drought is a normal, recurrent aspect of Oklahoma's climate. However, it causes extraordinary economic and social distress that can impact hundreds of thousands of people or more. Unlike floods, earthquakes, and other natural events, drought is a "creeping" phenomenon, which often lacks a well-defined beginning or end.

As shown in Figure 1, the onset of drought begins with a deficiency in rainfall, high temperatures and winds, and decreased humidity, collectively resulting in "meteorological" drought. As soil moisture is reduced, "agricultural" drought is experienced. If this scenario continues through several seasons, streamflow is reduced to critical levels and "hydrologic" drought results.

Oklahoma Historical Precipitation Trends

Measurement of statewide precipitation in Oklahoma from 1895 through 2011 indicates that 1) Oklahoma's rainfall history is dominated by a decadal-scale cycle of relatively consistent alternating wet and dry periods lasting approximately 5 to 10 years; and 2) from the early 1980s through the first decade of the 2000s, the state experienced an extensive and unprecedented wet period, with the exception of the severe 2006 drought.

Some periods in Oklahoma history have been substantially drier than others, most notably the 1910s, 1930s, 1950s, and late 1960s. Between those drought periods, however, conditions have been generally wetter than average. The prolonged wet period of the 1980s and 1990s is unmatched by any period in the record (wet or dry) in terms of duration. This period is unique in its low variability, as almost all of the associated yearly totals fall within a fairly narrow window. The graph also suggests that the state may be experiencing the beginnings of yet another dry cycle.

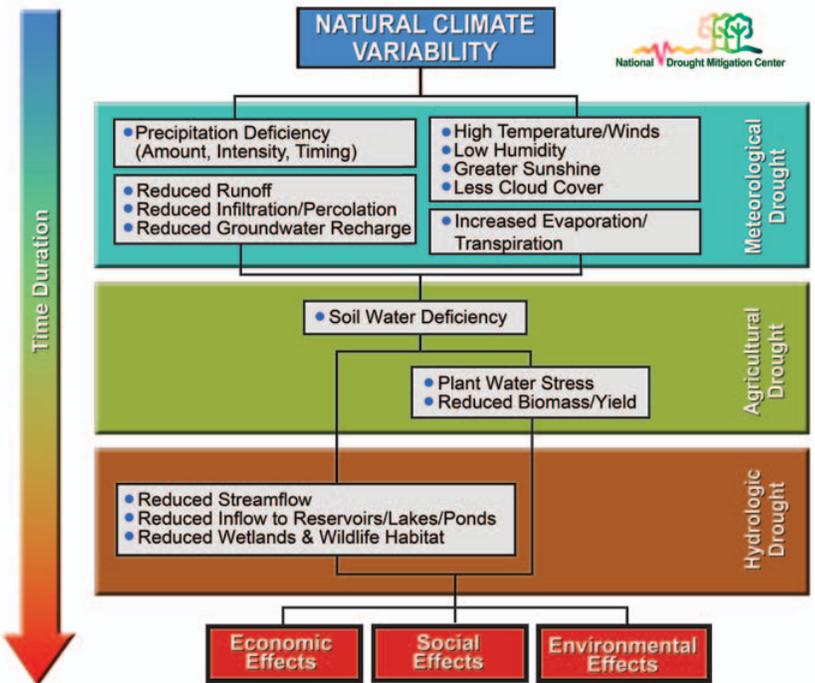
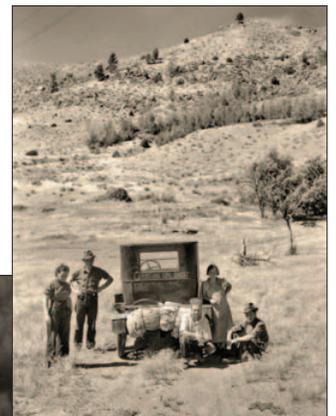


Figure 1. Sequence of drought development.

Resting along the way, a family flees the dust bowl region in the 1930s hoping for a new beginning in the west.
(Photographer, Arthur Rothstein, Library of Congress)



A dust storm approaches a ranch near Boise City, Oklahoma, in 1935.
(AP Photo)

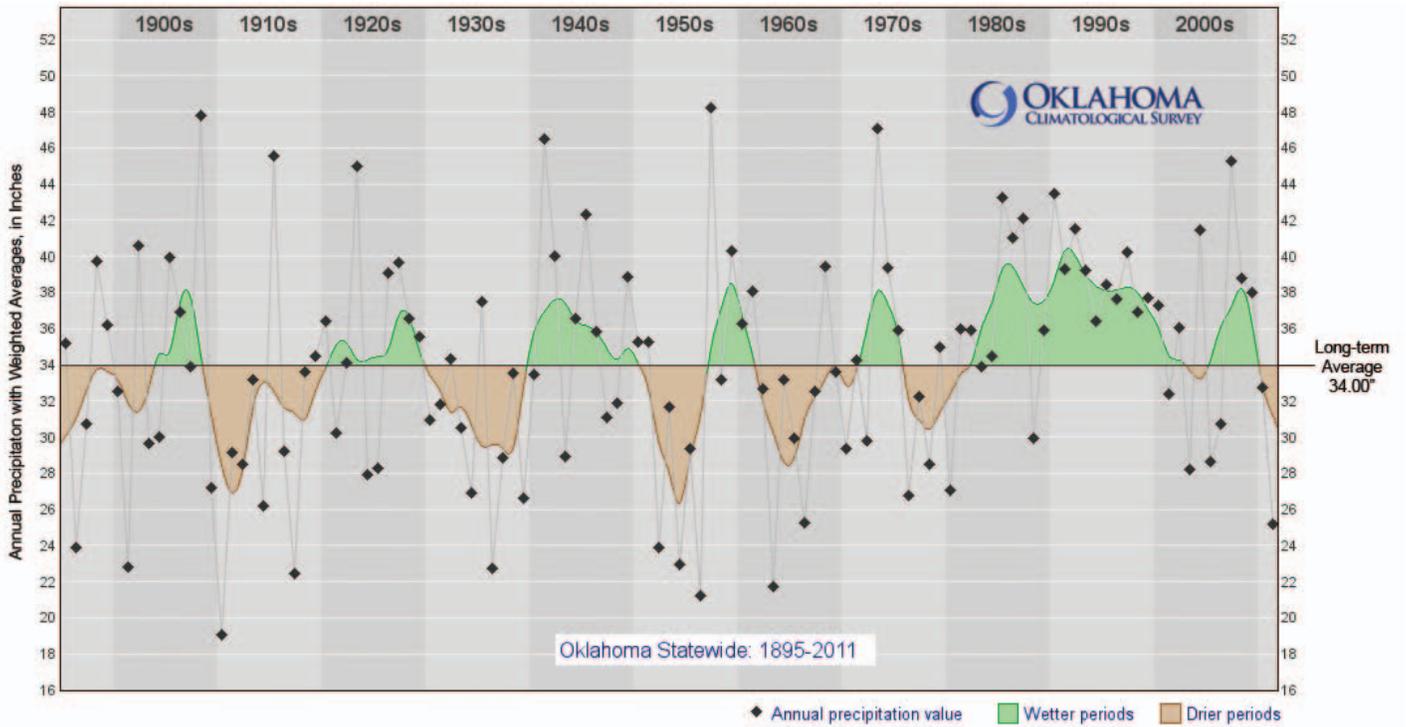


Figure 2. Each of the 116 individual years in Oklahoma’s precipitation history is represented with a black diamond, and the average of all years (34 inches) is shown as a horizontal line. Five-year weighted trends within the record are shown in color. Green indicates periods with greater than average precipitation; brown indicates below average precipitation.

Runoff/Streamflow and Groundwater Level Trends

Monitoring runoff/streamflow and groundwater levels provides valuable information about Oklahoma’s water resources and the status of ongoing drought episodes. Recent and historical data indicate that hydrologic droughts in Oklahoma have occurred in Water Years (WY) 1929-41, 1952-56, 1961-72, and 1976-81 (Figure 3). Extreme hydrologic drought was also experienced during WY 2006 (October 1, 2005, through September 30, 2006). The severity of drought during WY 2006 and 2011 becomes especially evident when compared to the four previous major hydrologic droughts of the 20th century. Statewide, WY 2011 ranks as the 16th driest year in 87 years of streamflow records (since 1925, Table 1).

In particular, many streams in central, southern and western Oklahoma were affected by severe hydrologic drought during WY 2011,

as demonstrated by streamflow data from the Canadian River at Calvin, in central Oklahoma (Figure 4). This data is consistent with both the statewide departures from normal streamflow and hydrologic drought events that occurred during the 50s, 60s, and 70s. WY 2011 was the fourth driest for that site on the Canadian River with only

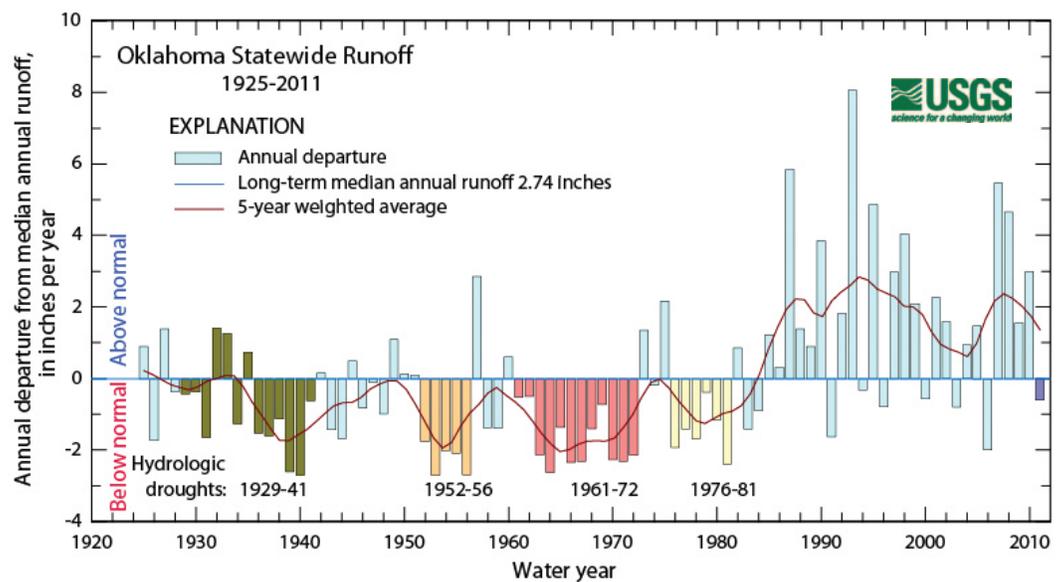


Figure 3. A plot of statewide runoff showing the annual departure of runoff from the statewide median of 2.74 inches (blue line) and a 5-year weighted average line for Water Years 1925-2011 (red line). Wetter years plot above the median line and drier years plot below the median line.

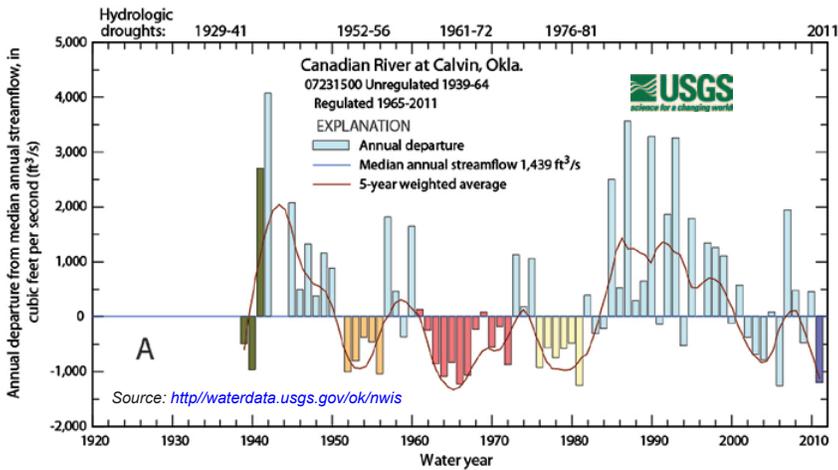


Figure 4. Canadian River at Calvin (A) annual departure from long-term median annual streamflow, Water Years 1939-2011.

16 percent of the long-term average annual flow (Table 1).

The photos below contrast flooding and low-flow conditions at a site on the North Canadian River during flood conditions July 2007 and during drought conditions July 2011. The graph of the daily mean flow at this gage during WY 2011—indicated by the red line in Figure 5—is far below the long-term daily mean flow for the entire year (blue line).

An effect of the 2011 drought on groundwater resources in Oklahoma is illustrated by water level trends at the Fittstown groundwater well (Figure 6). The graph contrasts the dry year—including response to the brief precipitation event during late spring and early summer (red line)—with the historical mean depth to water (blue line).

Table 1. How Water Year 2011 ranks with five major droughts of 20th and 21st centuries.

Drought Period	Statewide		Canadian River at Calvin, Oklahoma		
	Driest WY	Rank ¹	Driest WY	Rank ²	Percent of Normal ²
2011	2011	16th	2011	4th	16
2006	2006	6th	2006	2nd	12
1929-41	1940	1st	1940	8th	27
1952-56	1953	2nd	1956	6th	22
1961-72	1964	4th	1966	3rd	12
1976-81	1981	7th	1981	1st	11

¹ Based on long-term median annual runoff 1925-2006

Data available at <http://water.usgs.gov/waterwatch/?m=statesum&r=ok>

² Based on long-term mean annual flow 1939-2006

Data available at <http://waterdata.usgs.gov/ok/nwis/sw>

U.S. Geological Survey Water Year (WY) 2006 data are provisional and subject to revision. Rank is based on the worst year during the drought period.

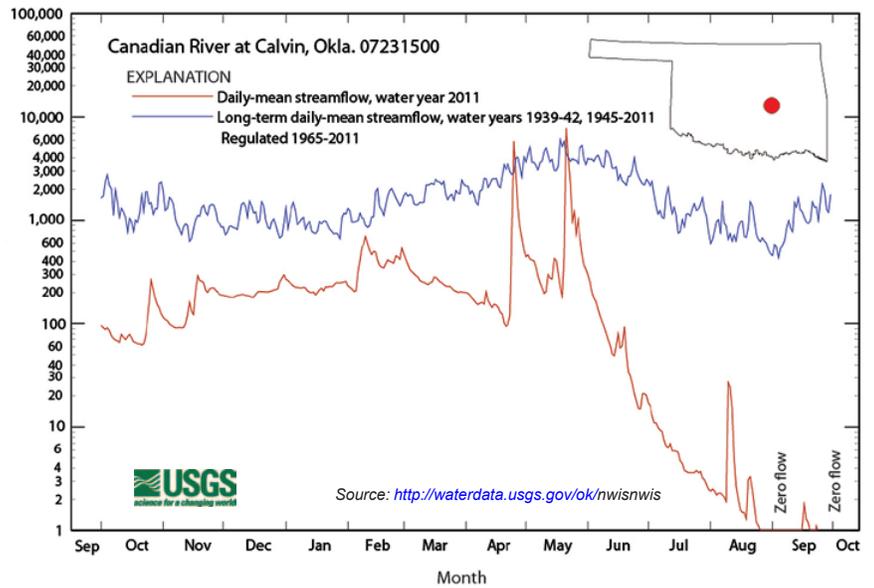


Figure 5. Comparing daily-mean streamflow of Water Year 2011 and long-term daily-mean streamflow, Water Years 1939-2011.



North Canadian River near Calumet, Oklahoma, during floods of July 2007. (Photo courtesy J. A. Savoia, USGS)



North Canadian River near Calumet, Oklahoma, during the drought conditions in July 2011. (Photo courtesy J. A. Savoia, USGS)

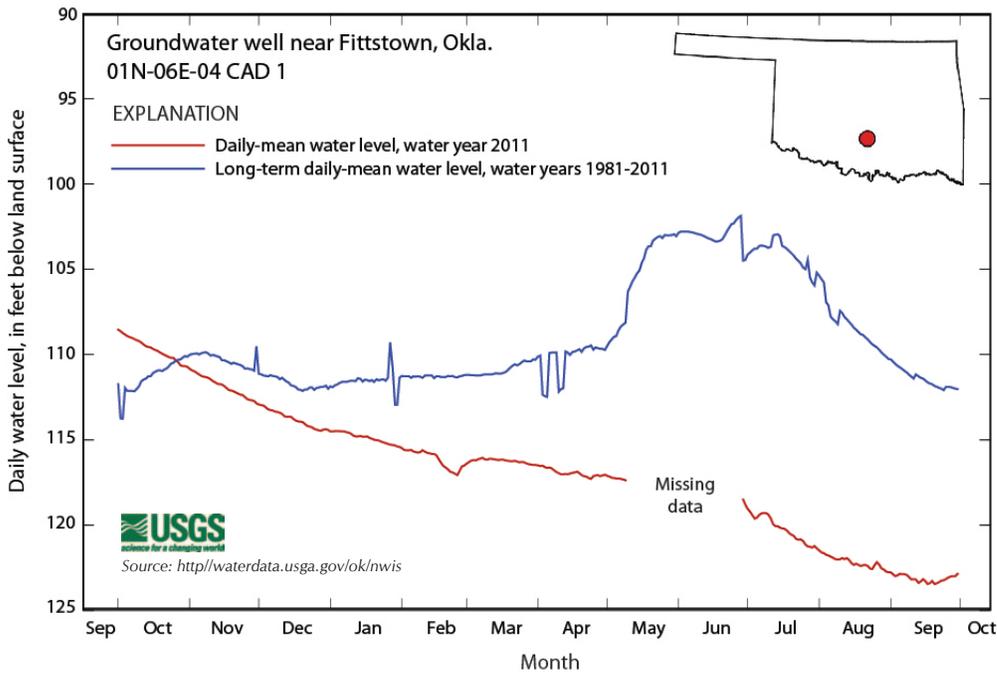


Figure 6. Fittstown groundwater well, comparing daily mean water levels for Water Year 2011 and long-term daily mean water levels.

Planning for Drought: A New Water Plan for Oklahoma

Considering Oklahoma's wet and dry trends over the past century, the recent unprecedented wet period, and even more recent recurring drought events, Oklahomans must be prepared for severe and extended future drought episodes. In addition to potentially drastic reductions in streamflow and lake and aquifer levels, which can severely impact domestic and municipal water supplies, drought can reduce significantly the amount of water available for hydropower generation, trigger deadly wildfires, and devastate the environment. The economic impacts can be staggering. The 2011 drought and heat wave in the southern plains and southwest states caused more than \$12 billion in damages and 95 deaths (not including wildfires).

During drought, many water systems fall apart under the strain of greatly increased customer demand for water. Older facilities are especially vulnerable. State and federal funding programs—such as the Oklahoma Water Resources Board's Financial Assistance Program, which has provided more than \$2.7 billion in water/sewer infrastructure projects—have done much to increase the drought resistance of Oklahoma's local water treatment and distribution systems. An analysis conducted for the *2012 Update of the Oklahoma Comprehensive Water Plan (OCWP)* estimates that Oklahoma faces an \$82 billion need in such financing over the next 50 years.

Through extensive statewide water supply and demand analyses, infrastructure assessments, and

grass-roots water policy development, the 2012 OCWP yielded multiple recommendations to help make Oklahoma a truly drought-resistant state. Subsequently, Oklahoma's Legislature and Governor Fallin embraced these directives to establish a long-term infrastructure financing strategy for Oklahoma, new statewide water monitoring network, enhancement of key water management and modeling tools, and sweeping water conservation policy for the state. The general result is empowerment of businesses, municipal and rural planners, and citizens to make informed decisions that enhance water reliability for Oklahomans through 2060 and beyond.

From a public water supply standpoint, water system managers can take the following steps to enhance and ensure reliability for their customers:

- Secure water rights.
- Establish system capacity according to future need.
- Maintain infrastructure, including treatment, storage and distribution facilities.
- Implement water conservation measures, including mandatory rationing, when necessary.
- Develop a long-range system water plan and implement it.
- Provide appropriate information and education to customers.

For more information on the *2012 Update of the Oklahoma Comprehensive Water Plan*, call the OWRB at 405-530-8800 or go to www.owrb.ok.gov.

All Water Year 2011 data are provisional and subject to change. Daily flows for the Oklahoma streamflow gaging stations can be accessed at the U.S. Geological Survey, Oklahoma Water Science Center, Web site: <http://waterdata.usgs.gov/ok/nwis>. Current streamflow conditions compared to historical streamflow can be found at the National Web site: <http://waterwatch.usgs.gov>