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Hydrologic Drought of Water Year 2006
A Historical Context

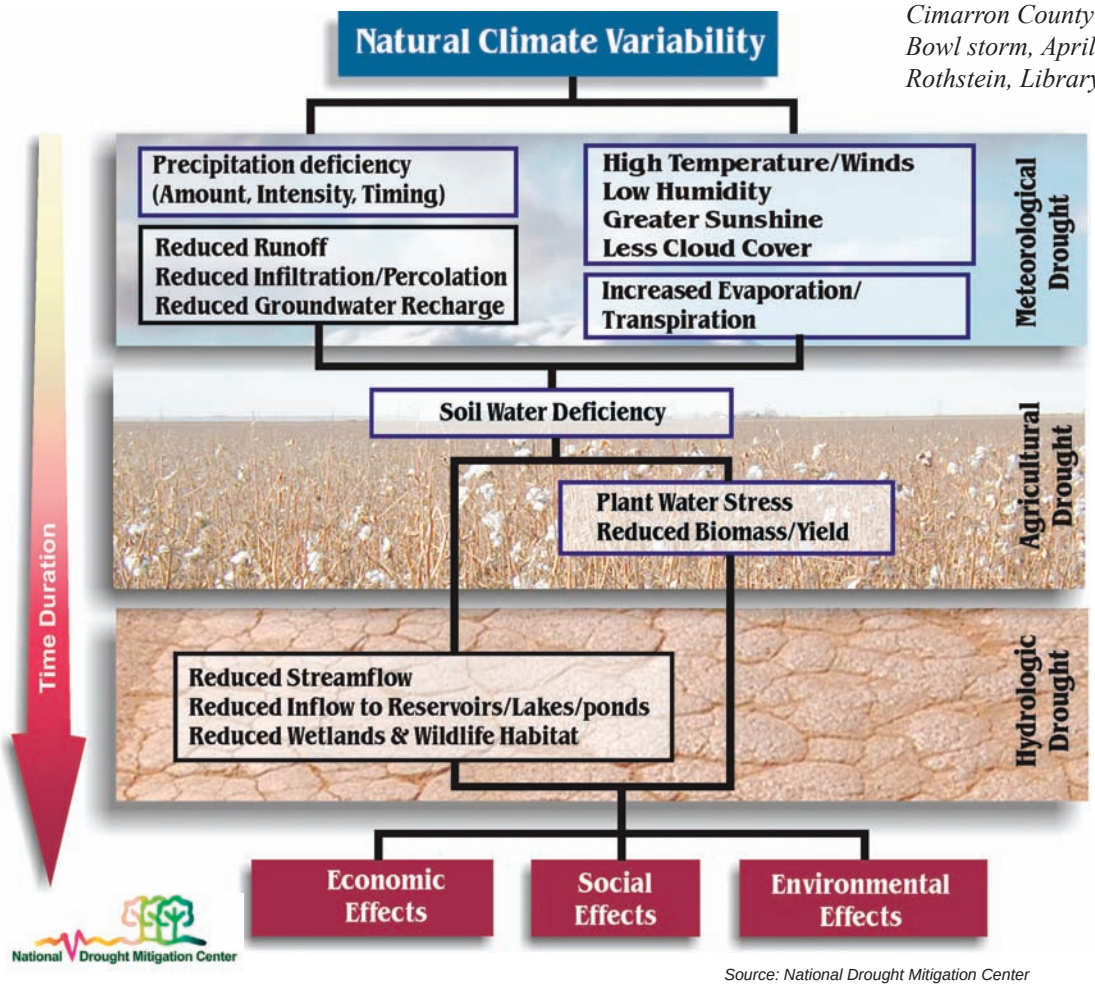
Published by the Oklahoma Water Resources Board in cooperation with the U.S. Geological Survey and the Oklahoma Climatological Survey

Drought is Normal

Drought is a normal, recurrent aspect of climate variability. Still, this hazard causes extraordinary economic and social distress that can affect hundreds of thousands of people or more. Unlike floods, earthquakes, and other natural events, drought "creeps" up on us, often masking its beginning and end.

As demonstrated 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.

Cimarron County farmer and family fleeing a Dust Bowl storm, April 1936. (Photographer Arthur Rothstein, Library of Congress)



Source: National Drought Mitigation Center

Figure 1: Sequence of drought development.

Oklahoma Historical Precipitation Trends

Figure 2 shows precipitation observed each year throughout Oklahoma from 1895 through 2005. Two features are clearly evident over the past century: 1) Oklahoma's rainfall history is dominated by a decadal-scale cycle of precipitation that includes relatively consistent alternating periods of wetness and dryness lasting approximately 5 to 10 years; and 2) from the early 1980s to around 2000, the state has experienced an extensive and unprecedented wet period.

Certain periods in Oklahoma history are substantially drier than others, most notably the 1910s, 1930s, 1950s, and late 1960s. Between these episodes, however, conditions have been

typically wetter than average. The prolonged wetness of the 1980s and 1990s is unmatched by any period in the record (wet or dry) in terms of duration. This wet period is unique in the low variability, as almost all of the associated yearly totals fall within a fairly narrow window. The graph suggests, although does not prove, that the state may be experiencing the beginnings of yet another dry cycle. The most recent years also demonstrate variability of the same magnitude seen earlier in the state's precipitation record.

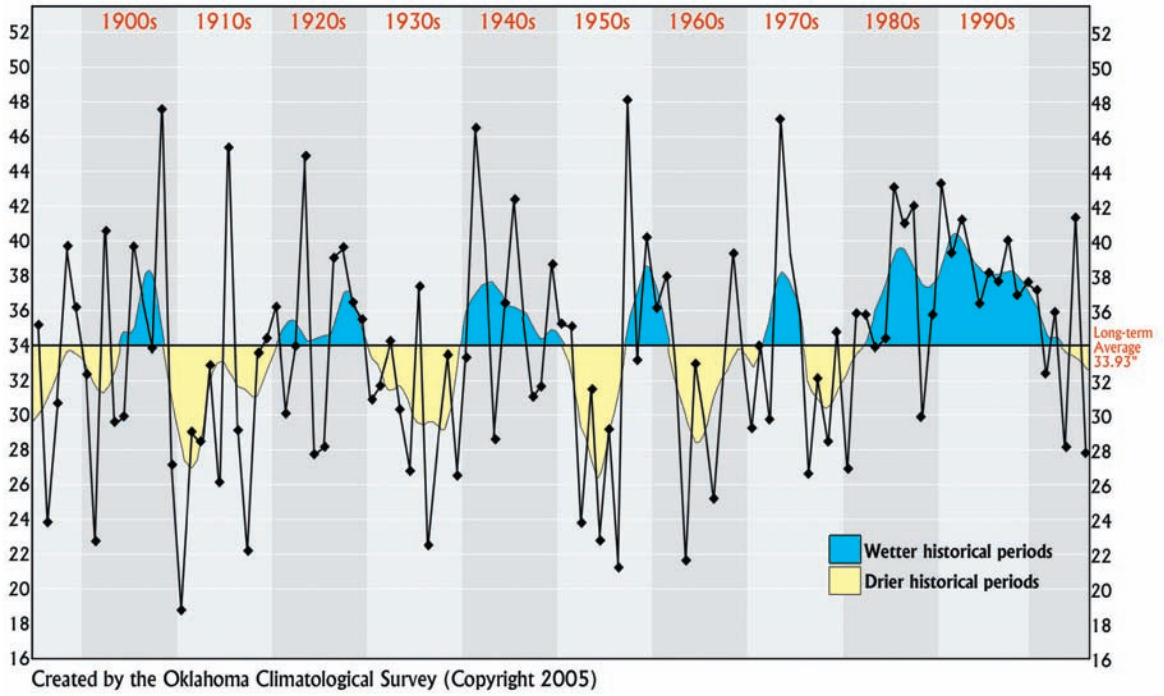


Figure 2: Each of the 111 individual years in Oklahoma's precipitation history is represented with a black diamond, and the average of all years (33.93") is shown as a horizontal line. Five-year weighted trends within the record are shown in color. Blue indicates periods with greater-than-average precipitation, and yellow indicates below-average precipitation.

Runoff/Streamflow and Groundwater Level Trends

Monitoring runoff/streamflow and groundwater levels, bolstered by the use of historical data, provides extremely valuable information on 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 1929-41, 1952-56, 1961-72, and 1976-81. Extreme hydrologic drought also was experienced during Water Year 2006 (October 1, 2005, through September 30, 2006), which represents the driest year during the current 2002-2006 drought. The severity of drought during Water Year 2006 becomes especially evident when compared to the four previous major hydrologic droughts during the past century. As expected, the state's annual runoff for Water Years 1925-2006 (Figure 3) mirrors Oklahoma's historical rainfall patterns. Statewide, Water Year 2006 ranks as the 6th driest year in 82 years of streamflow records (since 1925, Table 1).

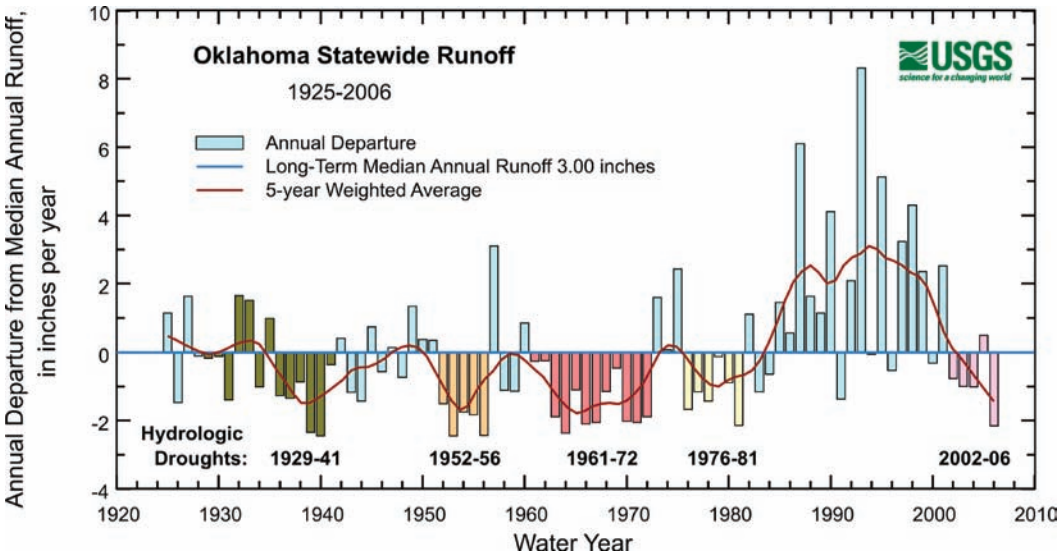


Figure 3: A plot of statewide runoff showing the annual departure of runoff from the statewide median of 3 inches (blue line) and a 5-year weighted average line for Water Years 1925-2006 (red line). Wetter years plot above the median line and drier years plot below the median line.

Source: http://water.usgs.gov/waterwatch/.

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Drought Period	Statewide Driest WY	Statewide Rank [1]	Canadian River at Calvin, Oklahoma Driest WY	Canadian River at Calvin, Oklahoma Rank [2]	Canadian River at Calvin, Oklahoma Percent of Normal [2]
2002-06	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

[WY, water year; U.S. Geological Survey WY 2006 data are provisional and subject to revision; Rank is based on the worst year during the drought period]

Table 1. How Water Year 2006 ranks with four major droughts of 20th century.

Photo 1: Canadian River downstream from State Highway 99 near Ada, Oklahoma, August 11, 2006.

Photo 2: Canadian River upstream from Interstate Highway 44, near Moore, Oklahoma, August 11, 2006. (Photos courtesy Daniel Fenner, USFWS)

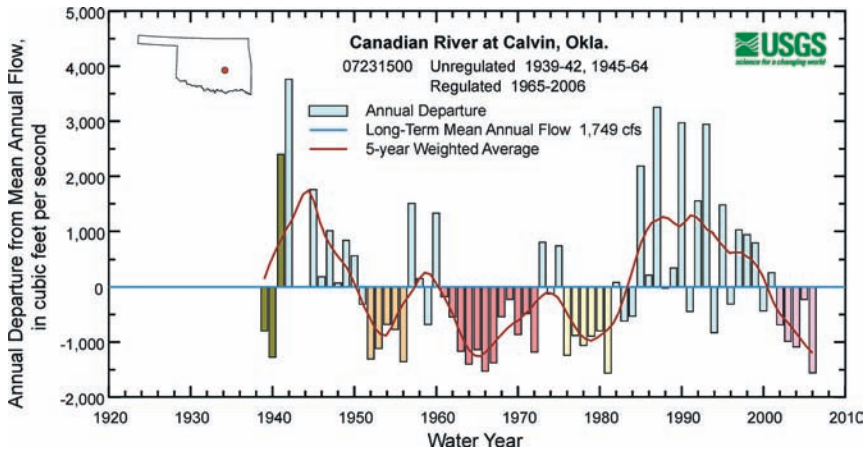

Figure 4: Canadian River at Calvin, Oklahoma, streamflow-gaging station, annual departure from long-term mean annual flow, 1939-2006.

Source: *http//waterdata.usga.gov/ok/nwis*

In particular, many streams in central Oklahoma experienced severe hydrologic drought during Water Year 2006, as demonstrated by a time series of streamflow for the gaging station on the Canadian River at Calvin in central Oklahoma (Figure 4). This record is consistent with both the statewide departures from normal streamflow and hydrologic drought events occurring during the 50s, 60s, and 70s. Water Year 2006 was second driest for that site on the Canadian River, with only 12 percent of the

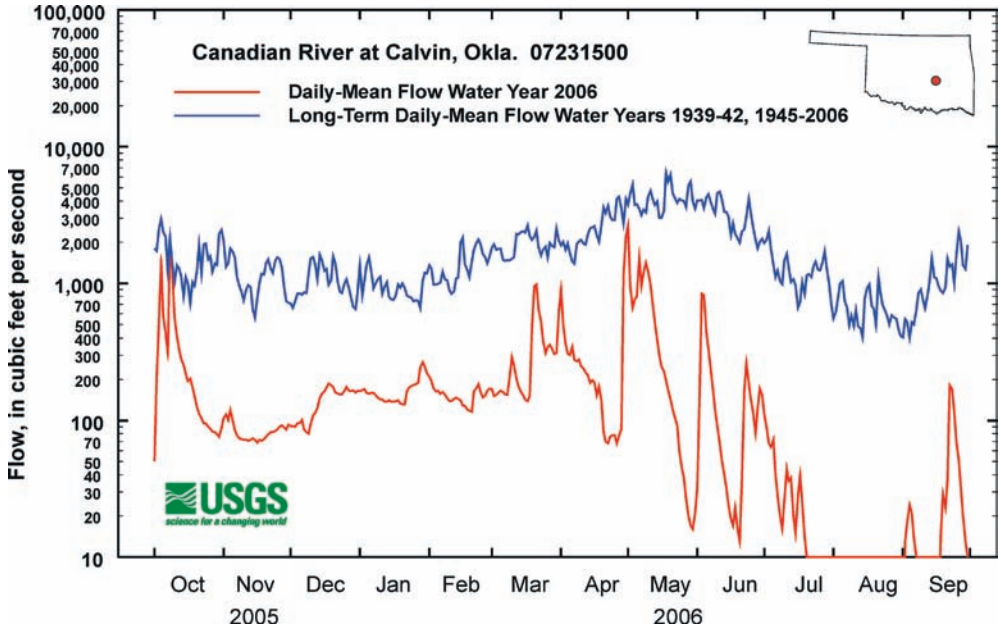

Figure 5: Canadian River at Calvin, Oklahoma, comparing daily-mean flow of Water Year 2006 and long-term daily mean flow, Water Years 1939-2006.

Source: *http//waterdata.usga.gov/ok/nwis*

long-term average annual flow (Table 1).

Photos 1 and 2 demonstrate the zero-flow conditions in much of the Canadian River during August 2006. The plot of the daily mean flow for Water Year 2006, shown by the red line in Figure 5, is far below the long-term daily mean flow for the entire year (blue line).

The effect of the current drought on groundwater resources in the state is illustrated by water level trends at the Fittstown, Oklahoma, recording groundwater well (Figure 6). The plot 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).

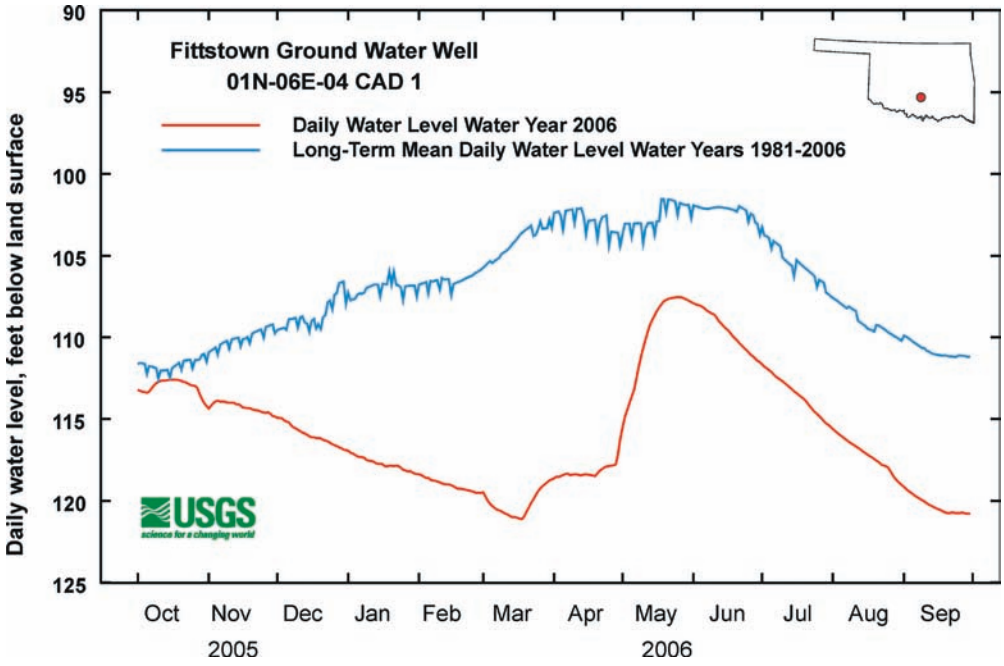

Figure 6: Fittstown groundwater well, comparing daily water levels for Water Year 2006 and long-term daily water levels .

Source: http//waterdata.usga.gov/ok/nwis

Planning for Drought: A New Water Plan for Oklahoma

Considering Oklahoma's wet/dry trends of the past 100-plus years, the recent unprecedented wet period, and the state's current drought, Oklahomans should be prepared for an extended drought episode. Already, the statewide drought has drastically reduced river flows and lake and aquifer levels, causing severe impacts to domestic and municipal water supplies and significantly reducing the amount of water available for other purposes.

While most Oklahoma citizens have become used to having water supply generally whenever and wherever they need it, other citizens, especially those in rural areas who lack access to a water system or other reliable source, experience extreme hardship during dry times. Intelligent water management and planning, while always important, now becomes imperative in providing both affordable and dependable water supply.

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 $1.6 billion in water/sewer infrastructure projects—have done much to increase the drought resistance of Oklahoma's local water treatment and distribution systems. Still, conservative estimates indicate that Oklahoma faces at least a $5.4 billion need in such financing over the next 20 years.

Making Oklahoma a truly drought-resistant state will require an all-encompassing water plan that contemplates both the implementation of efficient, long-term water management projects as well as a stable source of financing for maintaining and improving the state's 1,700 water systems. Through the ongoing update of the *Oklahoma Comprehensive Water Plan*, the OWRB is partnering with communities, rural systems, and state and federal agencies and organizations to conduct individual assessments of each system's infrastructure and future water needs. Throughout the planning process, the state's foremost water experts also will work with stakeholders to identify long-term solutions to the state's water supply problems.

For more on the update of the Oklahoma Comprehensive Water Plan, call the OWRB at 405-530-8800.

All Water Year 2006 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://water.usgs.gov/waterwatch/.

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