Precipitation Trends and Changes in Drought

Kansas Climate Basics

A better understanding of precipitation and drought changes for the state of Kansas can help agricultural producers understand historical variations documented in crop production across all crop-reporting districts.

Precipitation trends

From year to year, precipitation in Kansas is inconsistent, with the statewide annual average varying from a low of 17.3 inches in the drought of 1956 to a high of 43.7 inches with the floods in 1951 (Figure 1). From the western third to the eastern third of Kansas, long-term mean annual precipitation totals (over the last 121 years) were 20.2 inches, 26.0 inches, and 37.2 inches (Figure 1). Over the last two decades, annual amounts of precipitation have increased, especially in central and eastern Kansas. Due to larger year-to-year variability, however, the long-term annual precipitation does not have any statistically significant increase or decrease.

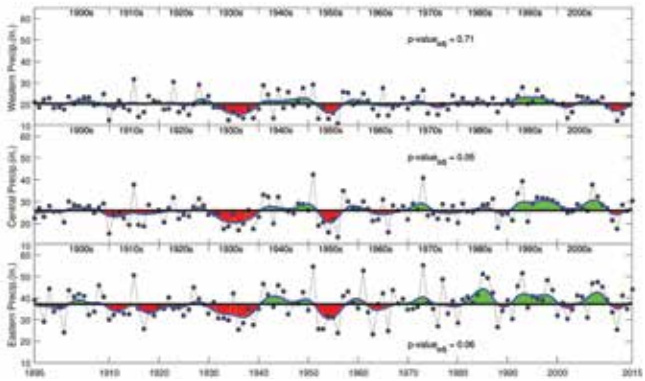

Figure 1. *Kansas precipitation 1895 to 2015: Western Kansas (top panel); central Kansas (middle); and eastern Kansas (bottom). The black lines are period-of-record mean over 1895 through 2015. A nine-point moving average provides an indication of multi-year trends (blue lines).*

The continental climate of Kansas has strong precipitation seasonality, with approximately 70 percent falling in warmer months. For the state as a whole, the seasonal averages of precipitation are nearly 20 inches during spring (March-April-May) and summer (June-July-August) seasons combined. The fall (September-October-November) and winter (December-January-February) seasons only contribute about 9.5 inches (Figure 2). The mean precipitation for the winter season is less than 2.8 inches, with small year-to-year variations.

There are no statistically significant trends in any seasons at a 95 percent confidence level (i.e., a 95% chance); however, precipitation amounts show a statistically significant increase in eastern and central Kansas at the 90 percent confidence level. Seasonally, only spring precipitations showed a statistically significant increase rate at the 90 percent confidence level (Figure 2).

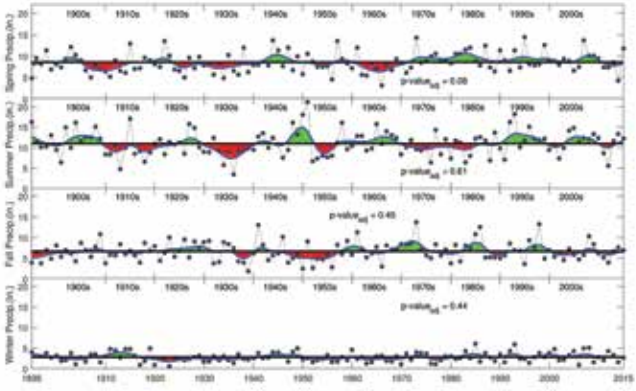

Figure 2. *Kansas seasonal precipitation 1895 to 2015, from top to bottom panels: Spring, summer, fall, and winter precipitation variations. The black lines are period-of-record means from 1895 through 2015 (inclusive). A nine-point moving average was used to provide an indication of multi-year trends (blue lines).*

Drought and drought changes

Droughts are one of the most devastating natural hazards. Kansas is one of the states most prone to droughts, which can have considerable effects on its water resources and its agricultural economy. The 1930s drought is often considered the worst drought on record in Kansas. This was the driest series of years since instrumental observations began starting in late 1800s. Sporadic and widely spaced weather observations in the mid-1800s have helped document droughts during that settlement period.

Tree-ring analysis helped climatologists reconstruct long-term drought patterns over the past 1,000 years for western Kansas (Figure 3). By going this far back, it becomes noticeable that the droughts in 1930s were not the worst in history in terms of either drought duration (consecutive years of drought) or drought intensity (the magnitude of drought index). Since 1000, many multiple-year droughts have occurred, ranging from 5 years to 40 years.

Focusing on the more recent period of 1895 through 2015 (Figure 4), it is apparent the drought events in 1930s and 1950s were the longest and most pronounced. These and subsequent droughts caused significant

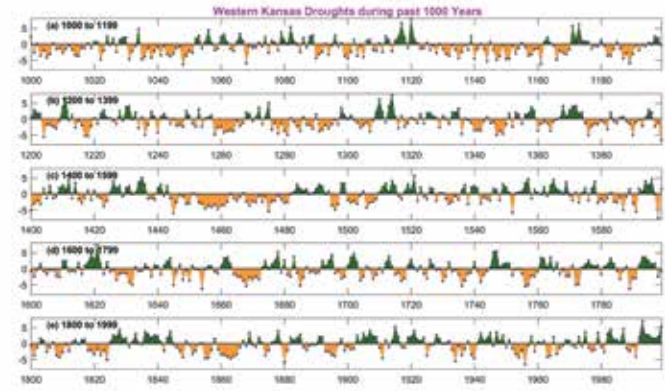

Figure 3. *Western Kansas drought during past 1,000 years. The vertical axis is the Palmer Drought Severity Index (PDSI). The more negative the PDSI, the drier (orange) the conditions. On the opposite side, the more positive the PDSI, the wetter (dark green) (Cook et al. 2004, Science 306 (5698):1015-1018).*

environmental effects and influenced Kansas settlement patterns and agricultural operations. Viewed in this historical context, the droughts in 2011 to 2014 in parts of Kansas, while serious, were not anything unusual.

Multiple-year droughts have often occurred in Kansas. The state as a whole has not experienced more frequent or more extreme droughts in recent years compared to either the last 1,000 years or the most recent 121-year period. The data can be subdivided by dividing the most recent 121-year period into two periods (1895 to 1955 and 1956 to 2015) for each of the three regions of Kansas. In doing so, only western Kansas was dryer on average during the most recent 60-year period when compared to data from 1895 to 1955 (Figure 5). Both central and eastern Kansas had showed wetter tendencies in the most recent 60-year period.

Recent wetter conditions are challenging crop establishment in summer row crops and final harvest. The drought change information, observable in Figure 5 is consistent with precipitation trends for Kansas.

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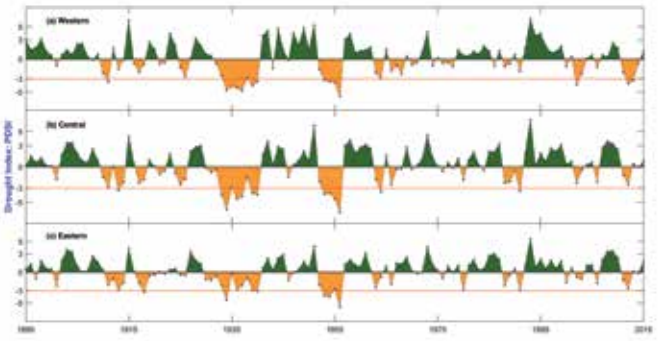

Figure 4. *Average PDSI for Kansas growing season (May to October) from 1895 through 2015: western (a), central (b), and eastern (c) thirds of Kansas. The more negative the PDSI, the drier (orange). On the opposite side, the more positive the PDSI, the wetter (dark green). The dotted red lines (PDSI = -3) are indicators of severe drought occurrence.*

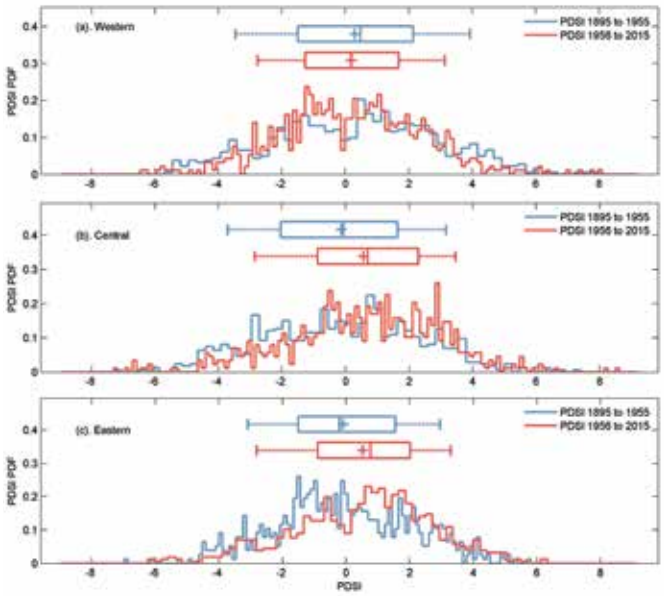

Figure 5. *Probability density function (PDF) of Palmer Drought Severity Index (PDSI) during 1895 through 1955 and 1956 through 2015 in western (a), central (b) and eastern (c) Kansas, respectively. The negative numbers to the left of "0" on the x axis represent drier-than-average conditions; the positive numbers to the right of "0" represent wetter-than-average conditions. Only in western Kansas is there a slightly drier-than-average pattern in the 1956 to 2015 period (red lines) compared to the 1895 to 1955 period (blue lines). In central and eastern Kansas, the most recent time period has been slightly wetter.*

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