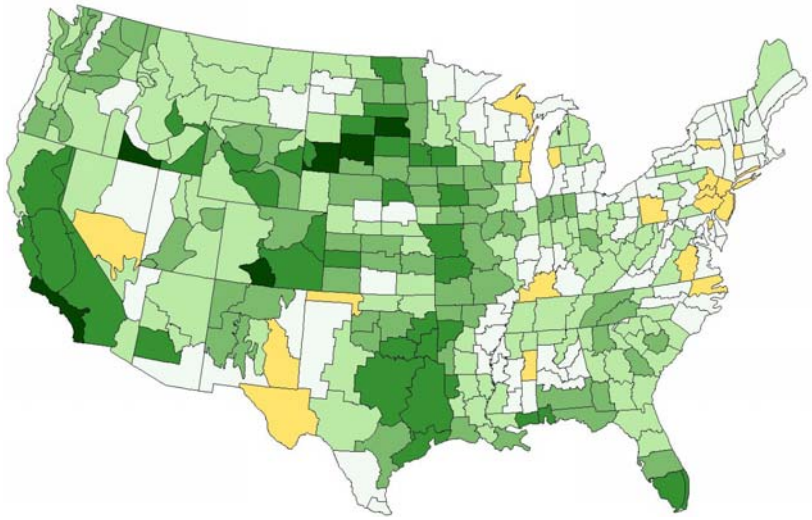
United States Department of Agriculture
Agricultural Research Service

Climate and Watershed Science Fact Sheet

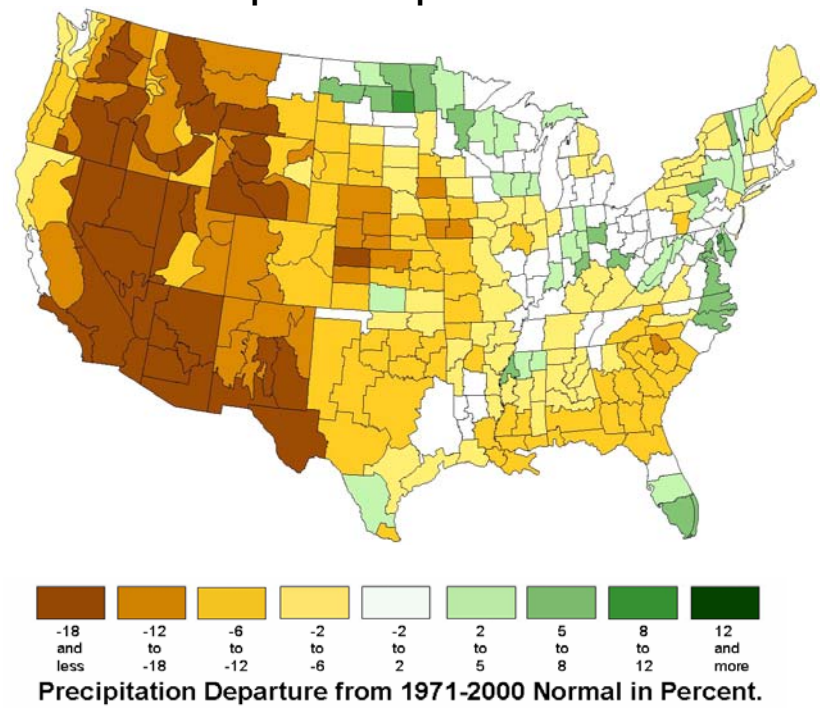
Grazinglands Research Laboratory, El Reno, Oklahoma November 2006

Determining Hydrologic Drought Probabilities Due to Decade-Long Precipitation Variations

1990–1998 Precipitation Departure from Normal



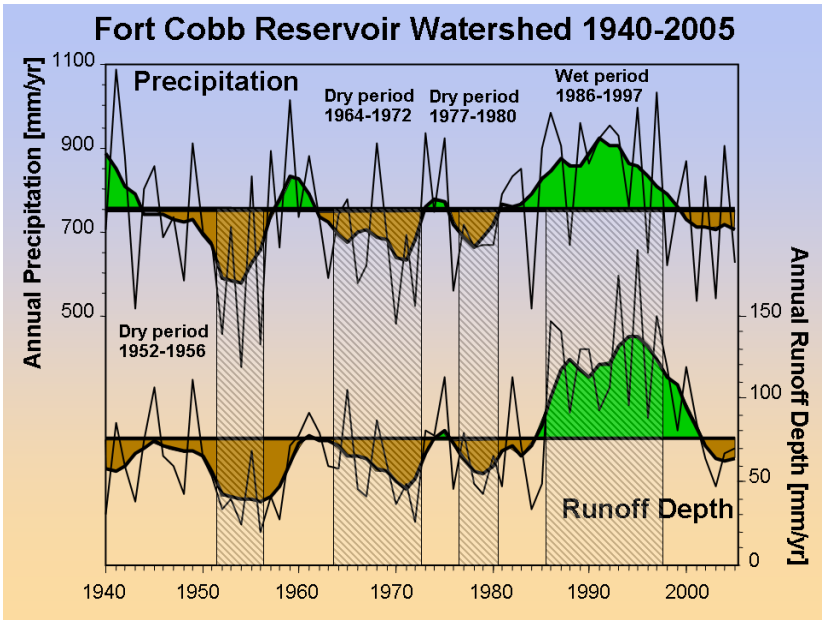
1999–2003 Precipitation Departure from Normal



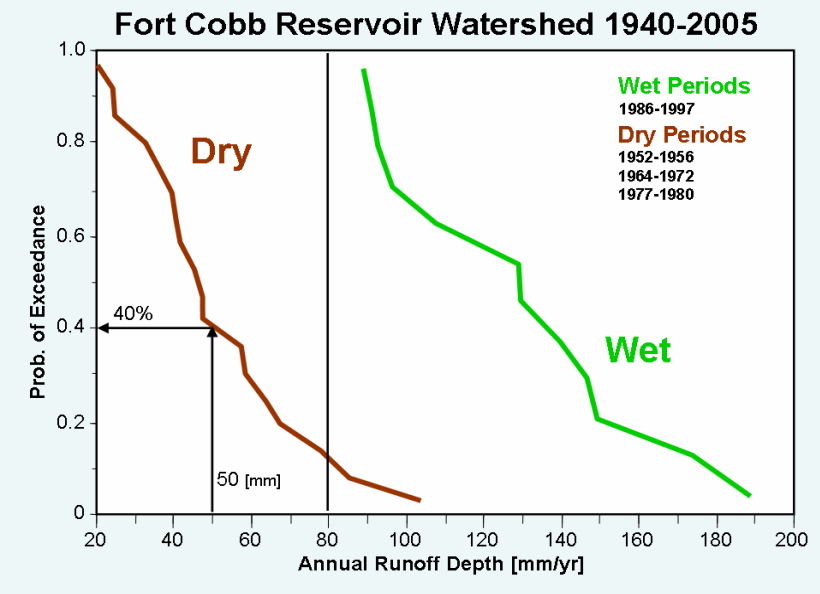
Seasonal and year-to-year variations in precipitation are readily recognized. However, variations in average annual precipitation lasting 5 to 50 years, decade-long precipitation variations, are more subtle, but may surpass impacts of short-term variations due to their cumulative effects. For example, the recent multi-year drought in the western United States had substantial impact on water resources. The figures to the left show that during 1990 through 1998 most central and western States experienced wetter than normal conditions, whereas during 1999 through 2003 drier than normal conditions prevailed. Similar multi-year precipitation variations can be found in the historical precipitation records of many regions of the United States.

Identification of meteorological and hydrologic drought probabilities during decade-long precipitation variations can help agricultural producers and water resources managers make informed, risk-based management decisions. Research on the identification of multi-year precipitation variations and development of related climate decision information is conducted at the Grazinglands Research Laboratory at Fort Reno, Oklahoma.

As an example, multi-year climate variations were identified on the Fort Cobb Reservoir Watershed in central Oklahoma and differences in probability distributions of precipitation and stream flow due to multi-year dry periods were determined. The Fort Cobb Reservoir Watershed drains an area of 720 km^2 (280 sq.mi.) in a landscape dominated by crops, range and pastures.



An analysis of annual precipitation from 1940 to 2005 identified three dry periods in the 1950s, 1960s, and late 1970s, and one extended wet period in the late 1980s and 1990s. The difference in average annual precipitation between dry and wet periods was 250 mm/yr (10 in/yr), or 33% of the 1940-2005 mean. These wet and dry periods led to corresponding variations in watershed runoff. The 33% change in average annual precipitation between dry and wet periods led to a corresponding 100% change in average annual watershed runoff.



The values of annual watershed runoff for wet and dry periods can be rearranged and plotted in terms of their probability of occurrence. For runoff in the Fort Cobb Reservoir Watershed, this plot shows that during a dry period there is a 60% probability that annual runoff is less than 50 mm/yr (2 in/yr), whereas during a wet period it is unlikely that the annual runoff will be less than 80 mm/yr (3 in/yr). The probability of occurrence for other runoff values can also be read from the plot as needed to support water management decisions.

Once decade-long precipitation variations in the historical record have been categorized into wet and dry periods, expectations for particular precipitation or flow outcomes can be derived for wet and dry periods. The resulting conditional expectations for precipitation and stream flow during dry periods can be used for drought planning and management. Research pertaining to the identification and interpretation of multi-year climate variations is ongoing at the Grazinglands Research Laboratory. Additional information pertaining to this research is available at: http://ars.usda.gov/Main/docs.htm?docid=11617