OVERCOMMITTED WATER SUPPLY IN A WARMER AND DRIER CLIMATE

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Accelerated depletion of groundwater in the Prescott Active Management Area (PrAMA) as well as above the headwaters of the upper Verde River began in the mid-1990s. Climate analysis for Yavapai County and the southwestern states gives evidence of a transition at the same time to a warmer and drier climate. Citizens and government officials should be concerned that our warming and drying climate is now contributing to an increasingly diminished water supply.

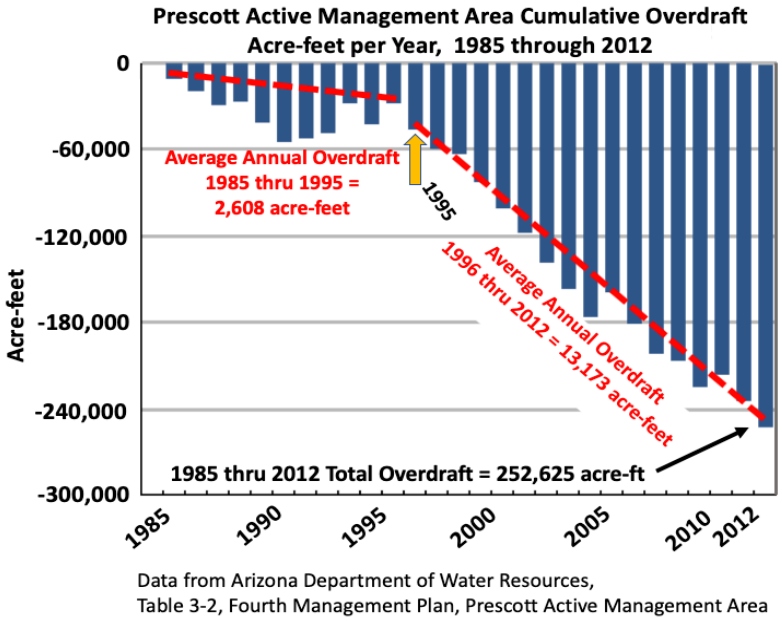

Figure 1. Cumulative annual change in groundwater overdraft, 1985 through 2012, PrAMA. An acre-foot equals approximately 326,000 gallons, enough to supply 3 Prescott homes for a year.

GROUNDWATER DEPLETION

Groundwater depletion, or overdraft, occurs when the quantity of water leaving an aquifer exceeds the amount of water delivered to the aquifer. Water exits an aquifer via either groundwater pumping or natural discharge to springs, streams, and evapotranspiration. Recharge (replenishment) of the aquifer occurs largely from downward seepage of water through streambeds. Data from the AZ Dept. of Water Resources (ADWR) show the progressive year-by-year total of PrAMA groundwater overdraft through 2012 (Figure 1). Recharge from larger than normal winter storms in 1988, 1991-1993, 1995, 2005, and 2010, added sufficient water to the aquifer to temporarily reduce the cumulative overdraft.

The growth rate of the PrAMA groundwater overdraft increased dramatically in 1996. Average overdraft thereafter was five times the average overdraft from 1985 through 1995. Total overdraft, 1985 through 2012, is estimated at 252,625 acre-feet by ADWR. It may represent depletion of as much as 5 to 8 percent of the groundwater stored in the aquifer. This large overdraft reflects in part the ever-increasing pumping of groundwater to supply thousands of new homes. Reduction of groundwater-supported irrigation has kept the overdraft from being even greater. However, the overdraft also reflects a substantial reduction of natural recharge that began in the mid-1990s.

The U.S. Geological Survey (USGS) Paulden streamgage, on the upper Verde River is about 10 miles east of Paulden. The gage recorded a protracted decrease in 7-day lowest annual flow (Figure 2) that essentially coincided in onset with the accelerated depletion of groundwater in the PrAMA (Figure 1). Seven-day low flow is a

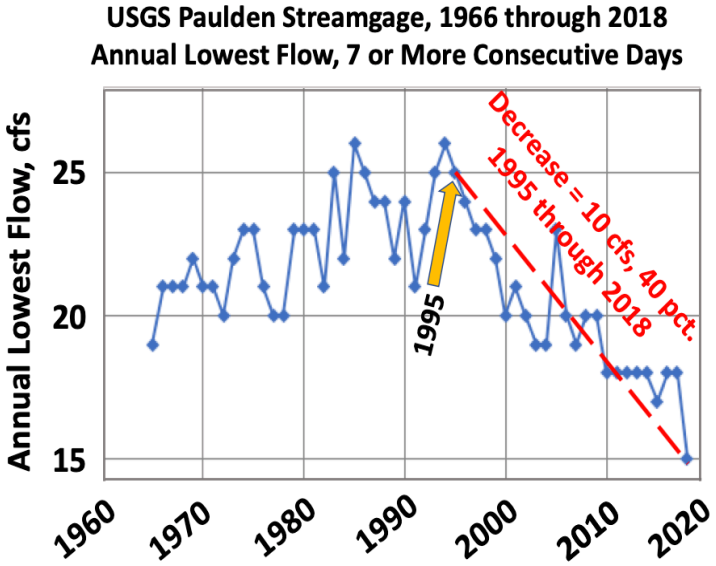

Figure 2. Magnitude of 7-day lowest annual flows recorded at the USGS Paulden streamgage, 1965 through 2018.

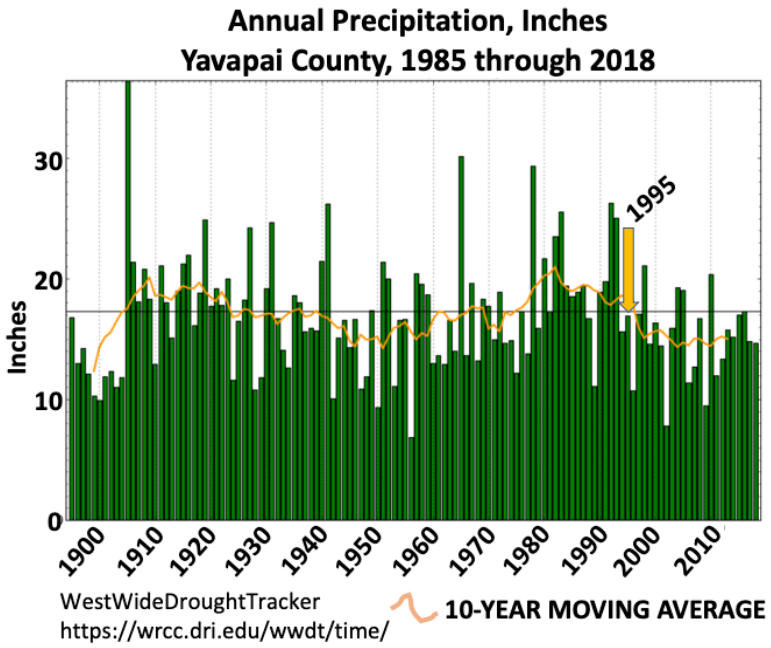

Figure 3. Annual precipitation in Yavapai County, 1895 through 2018. Gray horizontal line represents "normal period", 1981-2010, with average annual precipitation of 17.34 inches.

simple proxy for estimating base flow, which is the groundwater component of streamflow. Thus, the estimated base flow decreased 10 cfs (7,245 af/y), or 40 percent, over the past 24 years, reflecting depletion of groundwater within the Verde River watershed above the Paulden streamgage. Recharge from some exceptionally productive winter storms in the winters of 1992-1993 and 2004-2005 apparently contributed to the temporarily elevated base flows of the mid-1990s and 2005.

CLIMATE

The record of annual precipitation in Yavapai County (Figure 3, note ten-year moving average) shows drier periods from 1895 through 1904, from about 1940 through the mid-1960s, and again beginning in about 1995 and continuing through the present.

An episode of uniquely persistent elevated mean annual temperature in Yavapai County began in 1995 and continues through 2018 (Figure 4). It coincides with the dry period that began in the mid 1990s, as well as with the period of substantially increased rate of groundwater depletion recorded in the PrAMA and at the Paulden streamgage. Average annual temperature for this 24-year period is 1.8ºF warmer than the average annual temperature from 1895 through 1994, 59.6ºF. Unlike the 1895-1904 dry period, this current warm period occurs throughout the southwestern states.

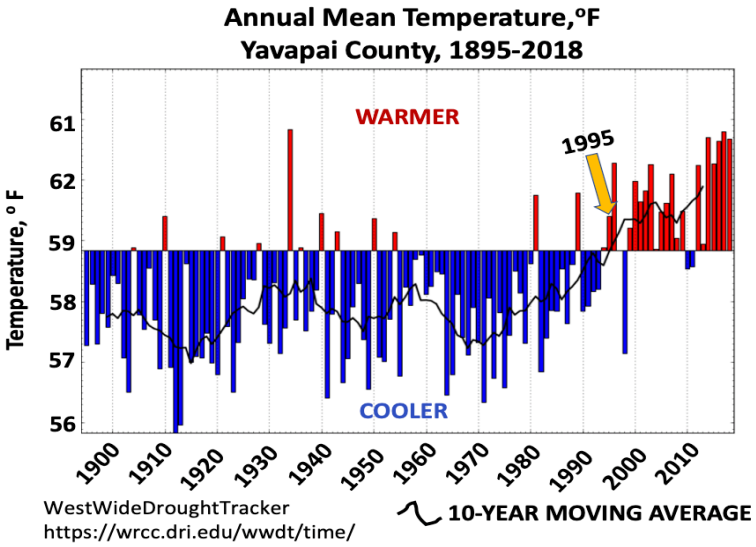

Figure 4. Annual mean temperature, ºF in Yavapai County, 1895 through 2018. Boundary between red and blue bars represents "normal period", 1981-2010, with average annual temperature = 58.83 ºF.

CONCLUSION

Distinctly elevated temperature, decreased precipitation, and decreasing groundwater in storage in our area have persisted for nearly a quarter century. Whether or not we call this climate change, it is imperative for citizens, community leaders and government officials to plan for a drier future and a less abundant water supply than that on which we now depend.