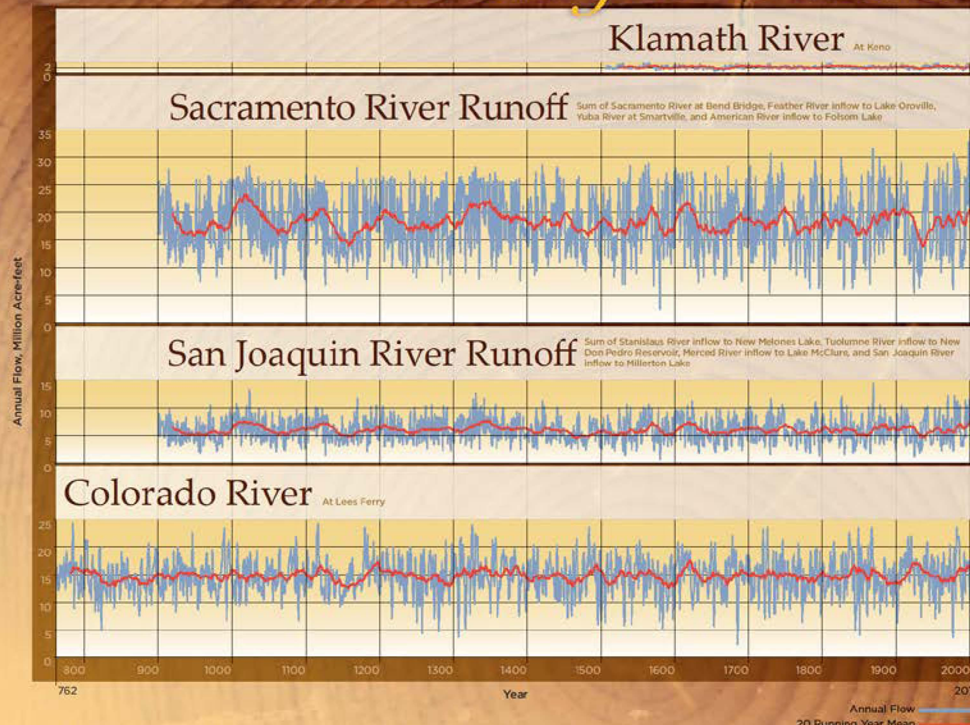
Drought Impacts

Jeanine Jones, California Department of Water Resources

Reconstructed Streamflows & Drought Periods



USING TREE-RINGS TO RECONSTRUCT STREAMFLOW

A tree-ring reconstruction is a set of tree-ring width data that have been calibrated with an instrumental or gaged record of a hydrologic or climatic variable such as annual streamflow or precipitation. The reconstruction, based on a statistical model that describes the relationship between tree growth and the gage record, extends that record back hundreds of years into the past.

Tree growth in dry climates is limited by water availability. Trees that provide the best information about hydroclimatic variability are those particularly sensitive to variations in moisture. These include species such as blue oak, ponderosa pine, Douglas fir, and western juniper, usually growing at lower elevations in sparse stands on dry and rocky sites where soil moisture storage is minimal.

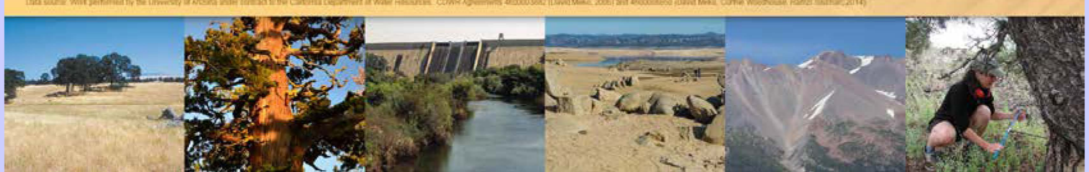
Tree-ring reconstructions of hydroclimatic variables are developed from tree-ring chronologies. A tree-ring chronology is a time-series of annual values derived from the ring-width measurements of 10 or more trees of the same species at a single site. To create a tree-ring chronology, cores from the sampled trees at each site are cross-dated (i.e., patterns of narrow and wide rings are matched from tree to tree) to account for missing or false rings, so that every annual ring is absolutely dated to the correct year. Then all rings are measured to the nearest thousandth of a millimeter using a computer-assisted measuring device. After growth-related trends unrelated to climate are statistically removed, the ring width values from all sampled trees for each year are averaged to create a time series of annual ring width indices. The complete series of ring width indices from a site is called a tree-ring chronology.

Once a gaged record of interest is selected for reconstruction, a set of tree-ring chronologies from the region near the gage is calibrated with the gage record to form a reconstruction model. A statistical technique called multiple linear regression is commonly used. The reconstruction is evaluated by comparing the observed gage values with the reconstructed values by assessing the amount of variance in the gage record that is explained by the reconstruction.

DROUGHTS PRIOR TO THE HISTORICAL RECORD

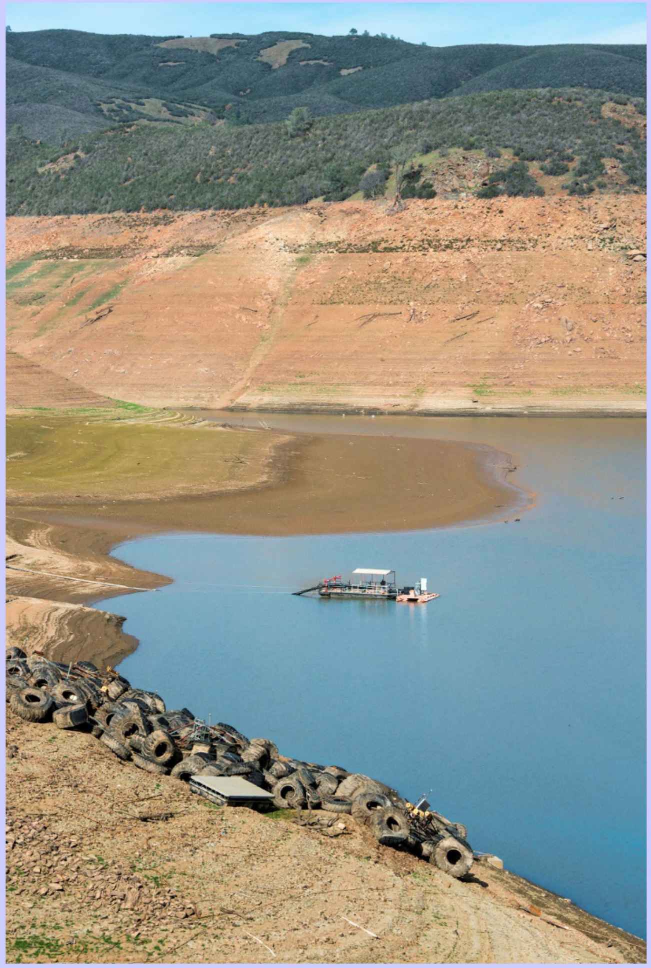
The period of reliably measured streamflows for rivers throughout the West seldom reaches beyond 100 years, which represents only a fraction of climatologically modern time. As these streamflow reconstructions show, there have been droughts prior to the historical period that were more severe – particularly in duration – than those in the measured record. The reconstructed record captures a broader range of hydrologic variability than does the historical record, making reconstructions useful for drought preparedness planning. Of particular interest from a scientific perspective is the Medieval Climate Anomaly, a time during which sustained severe drought gripped much of the western United States, as exemplified illustrated in the Sacramento, San Joaquin, and Colorado River reconstructions.

Data source: Work performed by the University of Arizona under contract to the California Department of Water Resources. CDWR Agreements 4600003682 (David Meko, 2005) and 4600008850 (David Meko, Connie Woodhouse, Ramzi Touchan, 2014)



California's 20th & 21st Century Statewide Droughts

- 1918-20
- 1922-24
- 1929-34
- 1947-50
- 1959-61
- 1976-77
- 1987-92
- 2007-09
- 2012-2016



Points to Keep in Mind About Drought

- Droughts/dry years are a normal part of the hydrologic cycle
- Drought conditions develop slowly; drought by itself is not an emergency – drought impacts drive action
- Drought impacts are site-specific and sector-specific
- The greatest drought impacts have ben related to unmanaged water uses (rangeland grazing, wildfire); greatest economic impacts historically associated with wildfire and forestry damages, not with urban & agricultural water uses

Lessons Learned From Past Droughts

- Impacts are highly site-specific, and vary depending on the ability of water users to invest in reliability
- Small water systems on fractured rock groundwater sources are most at risk of public health and safety impacts
- Larger urban water agencies can manage 3-4 years of drought with minimal impacts to their customers

Expected Impacts of Multi-Year Drought

- **Unmanaged systems**
  - Risk of catastrophic wildfire (health & safety, economic)
  - Non-irrigated agriculture (livestock grazing)
  - Fish & wildlife (e.g., salmonids)
- **Managed systems**
  - Small water systems (health & safety)
  - Irrigated agriculture
  - Green industry (urban water supplies)
  - Fish & wildlife (e.g., wildlife refuges, salmonids)
  - Other environmental (e.g., land subsidence)

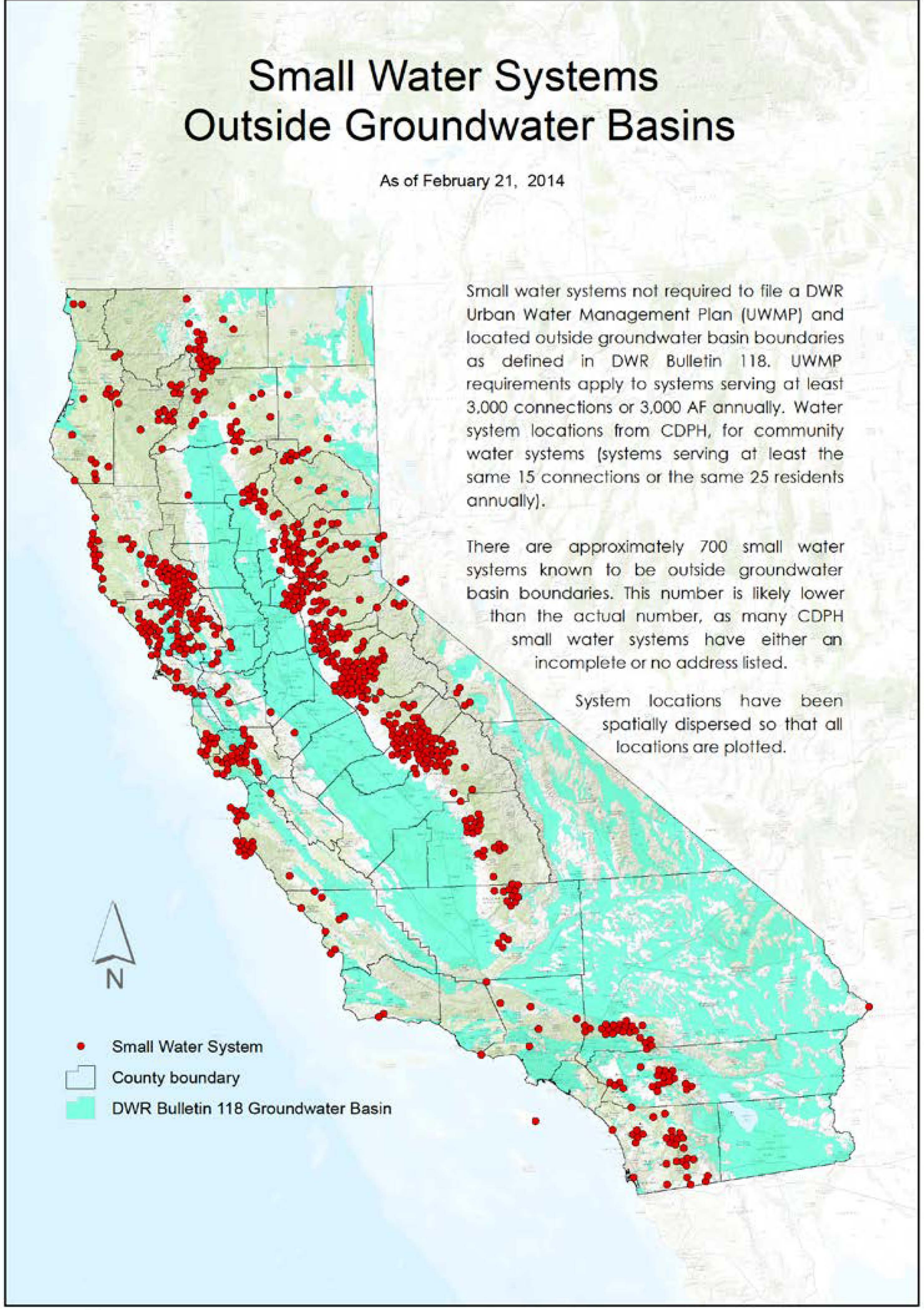
Historical Catastrophic Wildfire Risk

- 1991 Oakland Hills fire (25 lives lost)
- October – November 2003 Southern California wildfires (22 lives lost)
- October 2007 Southern California wildfires (~1 million people evacuated)

Catastrophic Risk Now Increasing, AND Wildfire Damage to Water Infrastructure

Drought & Small Water Systems

- Dramatic increase in small system problems during drought
- Often have less reliable groundwater (fractured rock groundwater, small coastal terrace groundwater basins)
- Typically only a single water source
- Often located in rural areas – few interconnection options, higher wildfire vulnerability
- Lack financial/technical resources
- Small ratepayer base



1:1,542,907

Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator

Produced by Division of Statewide Integrated Water Management, Data Management, Publication and Exchange Section