Tree Rings and the Colorado River: Lessons from the Past

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The longest gage records for the Colorado River are just over 100 years in length, and include a period of above average flow in the beginning of the 20th century as well as several notable droughts in the 1950s and in the early 2000s. Although water resource planning and management are generally based on this period of record, it is not possible to assess how representative these wet and dry events are over a longer time span. How unusual was early 20th century wet period, which was the basis for the allocation of Colorado River water to the upper and lower Colorado River basins, and with regard to the droughts in this record, are they typical or have even worse droughts occurred in the past?

Tree-ring data have been used to generate estimates of past flow and assess gage records in a long-term context in many parts of the western U.S., including the Colorado River basin. Coniferous tree species at low elevations throughout this region are primarily limited in growth by moisture. Thus, variations in their ring widths reflect variations in moisture and can be used to document hydroclimatic variability in the past. It is possible to reconstruct streamflow from tree rings because these conifers are sensitive to the same climatic conditions that contribute to water year flows, primarily winter snowpack, but also precipitation and evapotranspiration over the course of the water year streamflow (Meko et al. 1995).

In 1976, Charles Stockton and Gordon Jacoby developed a tree-ring based reconstruction of Colorado River flow, extending from 1520-1961. This reconstruction indicated no period as persistently wet as the early 20th century wet period in the 441-year record, but droughts more severe than any in the 20th century had occurred in the past. Since then, the results of Stockton and Jacoby (1976) have been replicated and updated (Michaelsen et al. 1990, Hidalgo et al. 2000, Woodhouse et al. 2006). Most recently, a Colorado River reconstruction has been generated that extends back to AD 762 and up to 2005 (Meko et al. 2007). The message that endures is that the Colorado River Compact was based on an anomously wet period, while the droughts more persistent and/or severe than those of the 20th century have occurred in the past. In addition, it is clear than the mean level of flow in the gage record is significantly higher than the long-term averages from the centuries-long reconstructions. These reconstructions also document a broader range of sequences of flow, including decades-long periods of near or below average flows.

While tree-ring reconstructions can provide information about past streamflow, they cannot be used to predict the future. Moreover, the climate of the past is unlikely to be an exact analogy for the future because of human influence on climate over the past century. However, natural climate variability, especially at multidecadal time scales, is likely to persist into the future, underlying anthropogenic climate change. Increases in temperature are assured, but projections of precipitation for the Colorado River basin are uncertain. In view of this uncertainty, tree-ring based reconstructions, with their natural interannual and multidecadal hydroclimatic variability,

may be a useful basis for planning, when combined with considerations about the impacts of increased temperatures.

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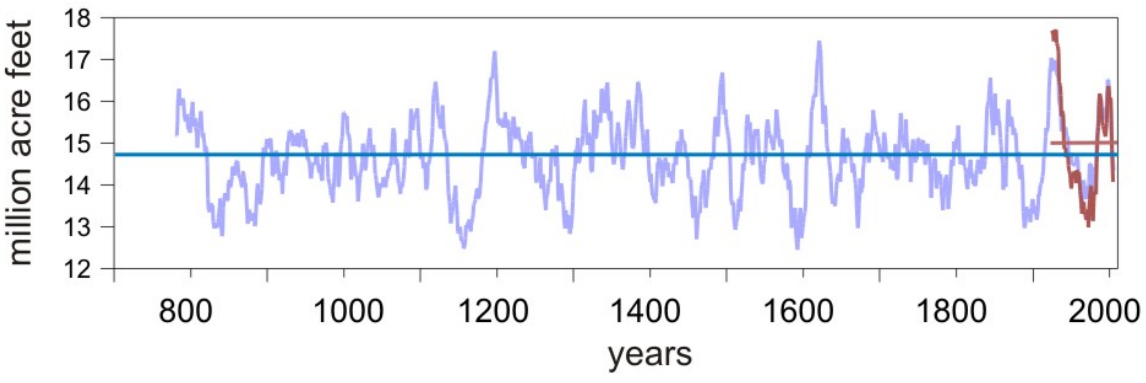

Reconstructed Colorado River flow, 762-2005, in blue, with gage record in red, shown as 20-year moving averages. Horizontal lines are means over the gage and reconstruction periods. From Meko et al. 2007