Workshop Report: "Developing Hydroclimatic Reconstructions for Decision Support in the Colorado River Basin"

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Western Water Assessment and NOAA scientists have been exploring ways to expand paleoclimatic research activities to address larger regional concerns in the southwest and Colorado River Basin. Paleoclimatic reconstructions, such as those based on tree rings (Figure 1a), provide a record of climate variability in the past. In May 2005, they worked with researchers at the University of Arizona to conduct a workshop to broaden the use of paleoclimatic data and to expand its applications to management and decision-making.

The Colorado River is a critical water resource for a wide array of economic, political, and environmental concerns in seven western U.S. states and Mexico. Water management within the basin must balance the competing demands and changing needs of an expanding population, agricultural and natural ecosystems, interstate and international compacts, and the uncertain impacts of global climate variability and change. Many operational water management procedures and decision processes consider only hydroclimatic variability based on the range of hydroclimatic extremes experienced in the 20th century. This approach presumes that the range of streamflows in the 20th century adequately represents the full range of variability. To supplement the 20th century record of hydroclimatic variability, policy makers and water resource managers are starting to use dendrochronological reconstructions of streamflow as a decision support resource (For example see Figure 1b). These partnerships between scientists and water managers are occurring in the Colorado Front Range and the Salt River valley of Arizona.

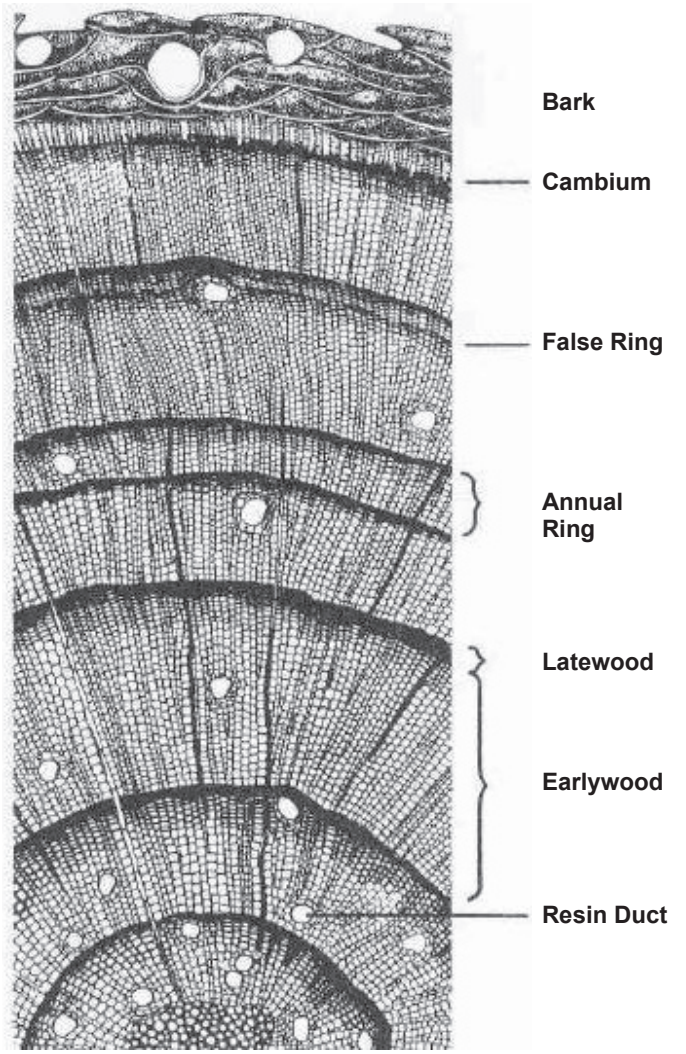

Figure 1a. A cross section of a tree showing the growth rings. The size of a tree ring can tell scientists about the amount of water the tree received that year.

The Workshop

The goals of the workshop were to learn about resource management and decision-making needs, to explore ways in which decision support systems can integrate tree-ring reconstructions, and to develop plans for collaborative work between paleoscientists and resource managers. The workshop participants listened to presentations and participated in multiple discussion groups.

The workshop brought together a diverse set of over 50 participants, almost evenly split between scientists from academic institutes and government agencies, and water resource managers from both national and local entities, including governmental agencies and private water providers. All seven upper and lower basin states were represented. It took place in Tucson, AZ on May 5, 2005 and was hosted by the University of Arizona Institute for the Study of Planet Earth (ISPE) and Climate Assessment for the Southwest (CLIMAS), with funding by NOAA's Office of Global Programs.

The workshop began with presentations made by water resource engineers from Denver Water, the Salt River Project, and Hydrosphere Resource Consultants. In all three talks, the presenters focused on the collaboration of decision makers and scientists to apply tree-ring reconstruction of streamflow to water management issues. Denver Water, Colorado's largest water provider, is using the full range of streamflow reconstructions for the South Platte and upper Colorado River developed by several NOAA scientists in Boulder, CO in their water supply model to determine the level of demand that the current system could

accommodate. Likewise, the Salt River Project (SRP), which provides water to the Phoenix metropolitan region, is working with University of Arizona scientists at the Laboratory of Tree-Ring Research to explore the utility of tree-ring reconstructions of streamflows for the Salt, Gila, and Colorado Rivers in long-term planning for drought. Finally, Hydrosphere Resource Consultants, based in Boulder, CO, which serves clients from many Colorado Front Range municipalities, remarked on some of the benefits, limitations, and challenges of using tree-ring reconstructions of streamflows in water resource management planning decisions. All three speakers recognized that while tree-ring data helps explain past climate variability, the reconstructions are not suitable for predicting future flows, particularly due to the uncertainty of future regional impacts of global climate change.

Following this session, six panelists from federal and state water management agencies, presented a diverse set of perspectives on long-term planning and the role for paleoclimatic reconstructions. They discussed topics ranging from the levels and types of uncertainty confronted in water management to the politics related to water management and growth. This panel included representatives from the U.S. Bureau of Reclamation reservoir operations, drought planning in New Mexico, and water resource management for the California Department of Water Resources. Although few had experience using tree-ring data in their policy decisions, all acknowledged the potential utility of long-term streamflow records provided by the tree-ring reconstructions.

The next segment of the workshop included presentations on the science behind tree-ring based reconstructions of streamflow to help the water managers and policy makers understand how scientists generate hydroclimatic reconstructions. The audience learned about the entire process from field collections to the calibration of tree-ring data with streamflow data to generate reconstructions. One intriguing presentation reported the results of an updated reconstruction of streamflow for Lees Ferry, which is the point of measurement for the Upper Colorado River basin annual flows. This reconstruction, which updates the well-known work of Stockton and Jacoby in 1976, utilizes a larger network of tree-ring data and an extended calibration period for the reconstruction. Like the 1976 reconstruction, this new version found that while droughts of the 20th and 21st centuries are not unusual in the context of the past five centuries, the early decades of the 20th century, the period of record upon which the Colorado River Compact was based, does appear to be one of the wettest periods in the full reconstructed history.

Finally, audience members were asked to participate in breakout discussion groups that allowed water managers and policy makers to provide input to climate scientist about their future streamflow reconstruction needs, and it allowed climate scientists to provide clarification for these decision makers. The workshop organizers divided the discussion topics into two broad topics: strategic issues (e.g., planning and decision-making issues that could benefit from long-term records, or possible limitations in the tree-ring data for optimal use by resource managers) and tactical issues (needs for updated or

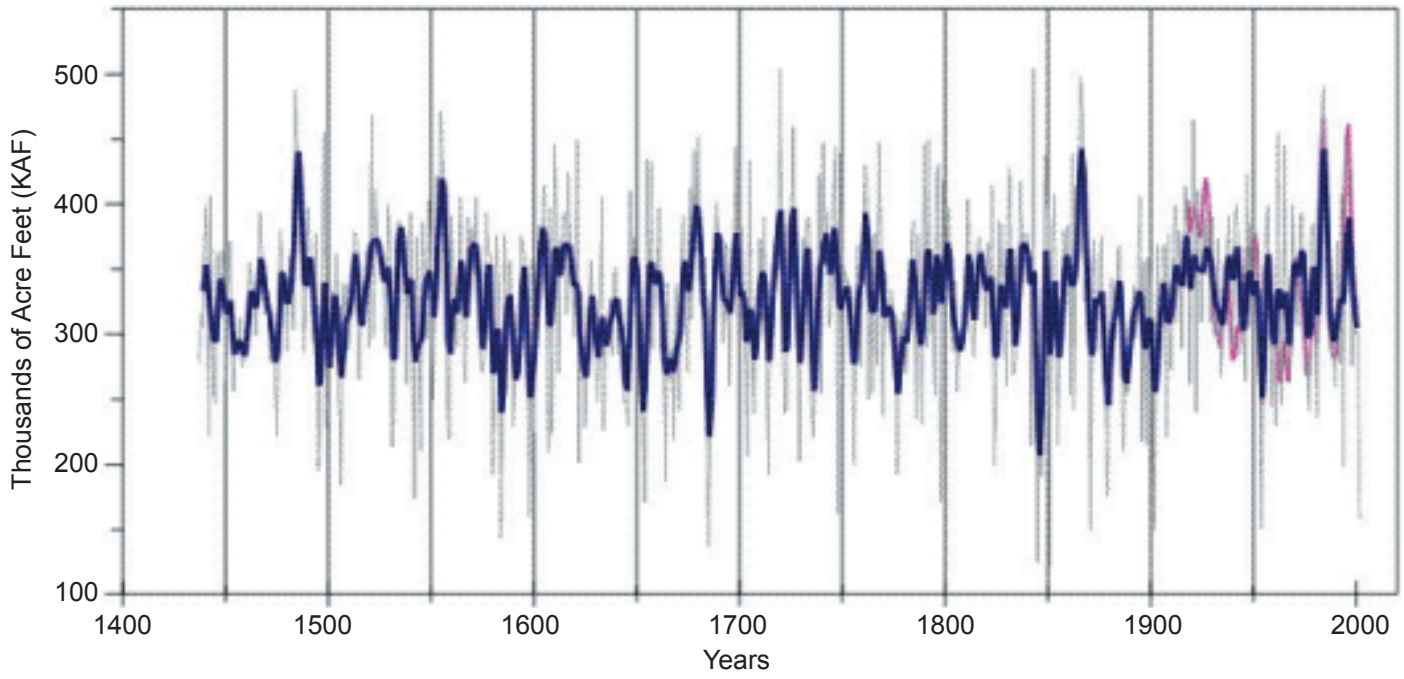

Figure 1b. Three gages on tributaries of the upper Colorado River (Blue, Fraser, and Williams Fork Rivers) were reconstructed by Connie Woodhouse and summed for this annual streamflow reconstruction. The graph shows the full reconstruction, 1427-2002, with annual values in gray and smoothed values in dark blue. Also shown are the gage values, smoothed, in pink. The reconstructions can be found at the NOAA Tree Flow site: http://www.ncdc.noaa.gov/paleo/streamflow/reconstructions.html

additional tree-ring data). The outcomes of these discussion groups will help climate scientists focus their research on the practical needs of the decision makers.

Workshop Outcomes

The water managers expressed concerns about the skill of the reconstructions and the methods used to develop reconstructions. One participant suggested developing a common method for all paleoclimatic scientists to use in creating "skill scores" to assess and compare reconstructions. While the concept of uncertainty and the use of probabilistic information are familiar to water managers, tree-ring scientists need to better characterize the uncertainty in the reconstructions. To make tree-ring data usable in water management, it was recommended that the research community work towards providing a single time series accompanied with a range of probabilities for streamflow estimates. New techniques, such as ensemble reconstructions, offer a promising way to accomplish this.

Water resources managers also voiced a desire to manipulate the paleohydrologic data themselves. To achieve a true partnership, the research community must first provide better documentation of the reconstruction methods and verification measures, as well as enhanced characterization of uncertainty associated with the data. These steps would make the information "transparent," which would help scientists feel more comfortable providing raw data to the water managers and policy makers.

Scientists also need to understand the language and vocabulary of water managers. Water managers recommended that scientists could better promote their work to non-scientific audiences through newsletters, journals, and meetings of water and engineering professional societies.

Overall, workshop participants identified the tree ring reconstructions as valuable to put the instrumental record within a broader context of hydroclimatic variability. Furthermore, participants agreed that reconstructions are potentially useful decision support resources for developing scenarios to evaluate system reliability. It is clear that collaborative partnerships are key to developing and providing useful information for decision support. Managers attending the workshop expressed interest in future collaborations and requested follow up technical training meetings and additional workshops.

Figure 1c. Workshop attendees: 26 water managers, policy makers, and planners, 24 scientists, and 5 graduate students.