Updated Streamflow Reconstructions for the Upper Colorado River Basin

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Web Sites:

1. http://www.ncdc.noaa.gov/paleo/pubs/woodhouse2006/woodhouse2006.html
   Updated reconstructions for Colorado River at Lees Ferry
2. http://fp.arizona.edu/khirschboeck/srp.htm
   Study of joint drought in UCRB and Arizona for Salt River Project
3. http://www.ncdc.noaa.gov/paleo/streamflow/index.html
   Tutorial on streamflow reconstrucion, with applications to Colorado watersheds

Workshop on Water Supply Reliability and Climate in the Lower Colorado River Basin, Phoenix, Arizona, September 6, 2006

Topics

1. Background
2. Main findings
3. Future work

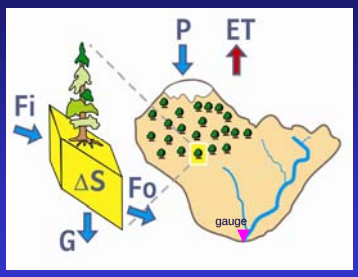
Historical Background

Edmund Schulman
1908-1958

1945: "Tree-Ring hydrology of the Colorado River basin", Univ. Arizona Bull., 18(3) (Lab. of Tree-Ring Res Bull. 4), 36 pp,

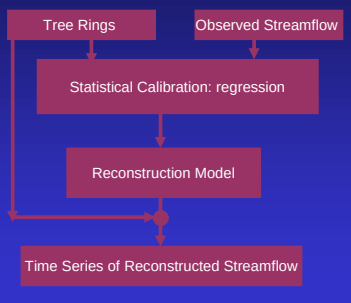
"…perhaps the greatest drought since A.D. 1300 began in 1573; it seems to have been essentially unbroken until 1593, the ring index averaging about 26 per cent below the mean during that interval. The most critical interval was that of 1579-85, with an average growth deficiency of 45 per cent."

Background: Physical Basis

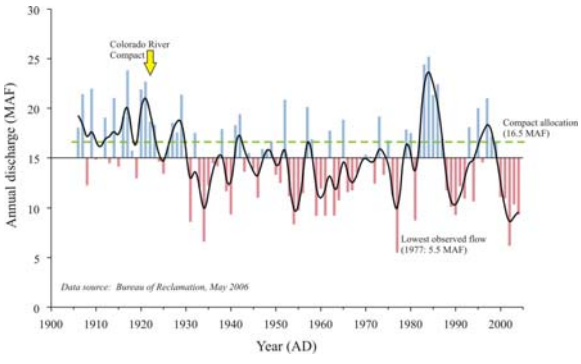


- The basic variable is ring width of drought-sensitive conifers
- Sampled trees are typically in runoff-producing mountains, not usually along the river
- Trees at the lower forest border are usually most sensitive to moisture variations
- Tree growth responds to soil moisture and atmospheric variations that are also correlated with runoff

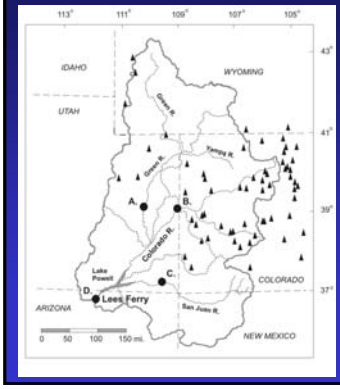
Background: Reconstruction Model



The "Observed" Lees Ferry Flows

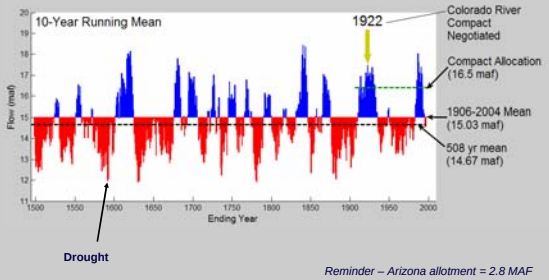


Developing New Colorado River Reconstructions



- Four gauges and 59 tree-ring sites with tree-ring coverage 1490-1997
- A subset of tree-ring sites used in model for each gauge
- Focus on the Lees Ferry record
- Some sensitivity analysis to data reduction, modeling decisions

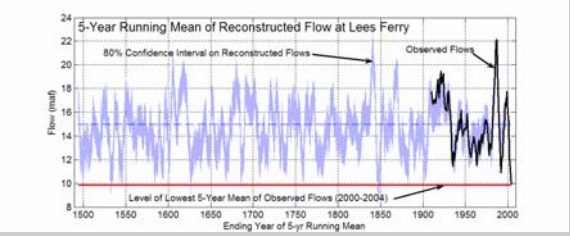
The Reconstruction: Broadly Smoothed Fluctuations



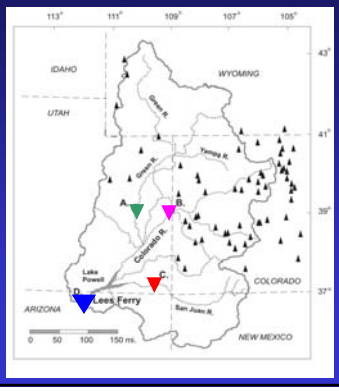
Reminder – Arizona allotment = 2.8 MAF

Woodhouse C. A., Gray S. T. and Meko D. M. (2006) Updated streamflow reconstructions for the Upper Colorado River Basin. Water Resources Research 42, W05415, doi:10.1029/2005WR004455.

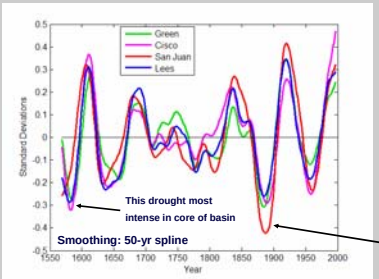
How Severe was the Recent Drought?



Covariation in Tributaries



Covariation of Flows in Tributaries



- **Coherence at multi-decadal periods across basin**
- **Amplified variation before 1700 and after 1850**
- **Individual Lees Ferry highs and lows have some spatial identity in anomalous tributary contributions**

Note: 50-yr spline roughly similar to 30-yr moving average in degree of smoothing; maximum positive flow departure for Lees in plot above ~110 percent of long-term mean

Future Work

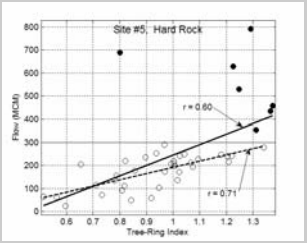
1. Linking the reconstructions to river management models
2. Reconstructing Lower-Basin inputs: Little Colorado River pilot study
3. Lengthening the Lees Ferry record

Application to River Management Models

- Interface with the CRSS model: target reconstructions to model input points
- Temporal disaggregation needed – model requires monthly inputs
- Modeling will be collaboration of Hydrologic and Paleoclimatic groups on project

Lower Basin Inputs

Pilot reconstruction study for Little Colorado River



- High flows present a challenge, especially in smaller basins
- Scatterplot of annual flow of Little Colorado near Cameron, AZ on tree-ring index for a site in the basin, 1926-67
- Linear relationship limited to flows below about 300 million cubic meters
- As part of ongoing work, we are exploring alternative reconstruction models to handle this situation

Lengthening the Record

- In collaboration with Connie Woodhouse (NOAA), we are applying remnant wood tree-ring records to lengthen Colorado River reconstruction **beyond A.D. 1490**.
- Field collections of remnant wood in summer 2005 yielded samples extending before A.D. 1000 at several sites in the Upper Colorado River Basin
- Example shown here is Douglas-fir from Harmon Canyon, Utah; sample dates to 300 BC