Linear-Regression Model for Estimating Runoff Volumes Using Paleoflood and Modern Streamflow Records from Snowmelt-Dominated Rivers

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Detailed long-term records of drought in the Western United States have been reconstructed from tree-ring data and provide the warning that similar events will likely be faced in the future. Tree rings are less useful at recording wet climatic periods, because although trees may respond to wet periods, they are less able to record the magnitude of such events.

Paleoflood and modern streamflow records from snowmelt-dominated rivers may provide the necessary information to estimate the magnitude of wet periods and help fill the gap in our understanding of normal climatic variation in the west. Knowing the total volume of water conveyed by a paleoflood would be useful to engineers considering design parameters for new reservoir construction and for planning the operations of existing reservoirs. We used the modern streamflow record as well as the paleorecord of high flows on the Colorado River at Lees Ferry as an example case.

The Colorado River at Lees Ferry is a snowmelt-dominated river with 43 years of streamflow data collected by the U.S. Geological Survey before the closure of Glen Canyon Dam. Using these data, the authors propose that least-squares regression between the annual peak instantaneous discharge and the associated 60-day event flow can be used to provide an estimate of paleoflood water volumes at Lees Ferry when the peak instantaneous discharge of the paleoflood is known. For the Colorado River at Lees Ferry, the fit based on least-squares regression between the peak flow and the associated 60-day event flow for each year has an r^2 value of 0.90. Recently the instantaneous discharge of a 1,000-year flood near Lees Ferry was estimated by the U.S. Geological Survey to be 300,000 cubic feet per second using a method that incorporated both modern flood and paleoflood records. Using the least-squares regression, this would result in an average 60-day event discharge estimate of 186,000 cubic feet per second and an estimated 60-day event volume of 22.1 million acre-feet. The most recent publicly available Bureau of Reclamation study to assess probable maximum flood magnitudes on the Colorado River at Glen Canyon Dam has a maximum 60-day event volume of 16.5 million acre-feet.

Substantial upstream diversions of water may adversely affect this method's ability to predict the volume of runoff near Lees Ferry (above Glen Canyon Dam) during future extreme wet climatic periods. However, the record of inflows to Lake Powell during the rare high-flow years after dam closure follows the curve established by the pre-dam closure data.