HYDROSPHERE
Resource Consultants

Severe Sustained Drought Redux?

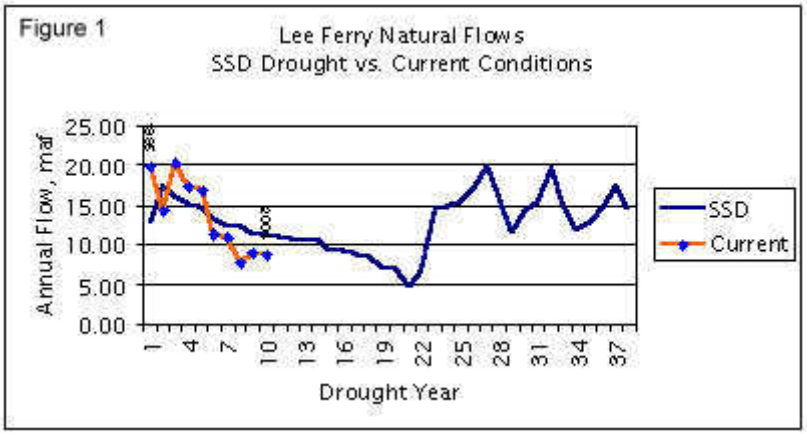
When the results of the Severe Sustained Drought study were published they raised only mild and fleeting interest among water resources professionals, and got virtually no notice by policymakers.

During 2002, the contents of Lake Powell on the Colorado River dropped by almost 5 million acre-feet (maf), the largest single-year decline since Glen Canyon Dam was closed in 1963. Further declines followed in 2003 and 2004. The end of September 2004 marked five straight years of declining water levels and saw Lake Powell standing at a little over 9 maf. These events provoked renewed interest in the Severe Sustained Drought study-what had once been an abstract, academic study now seemed more relevant. One obvious question is how the unfolding drought in the Colorado River basin compares with the circumstances we assumed as the basis for the Severe Sustained Drought study.

In some dimensions that question cannot be answered now-at this writing, in the late fall of 2004, the drought has not reached its dénouement. We do not know how long it will last, or how intense it will be. But, indications are that the onset of this drought is at least as intense as the SSD study drought. More significantly, it is clear that the system is entering this drought with lower reservoir contents and higher levels of water use than we had assumed would be the case in our work of 1995.

Streamflows in the Colorado River are substantially affected by human-caused depletions and reservoir operations. Valid comparisons of droughts must be done on "naturalized" flows that are derived by adjusting observed flows to back out human-caused depletions and the effect of reservoir operations. Recent comparisons by the USGS (Webb, et. al, 2004, revised, errata) and Scripps/UNLV (Piechota, et. al., 2004) have not made these adjustments.

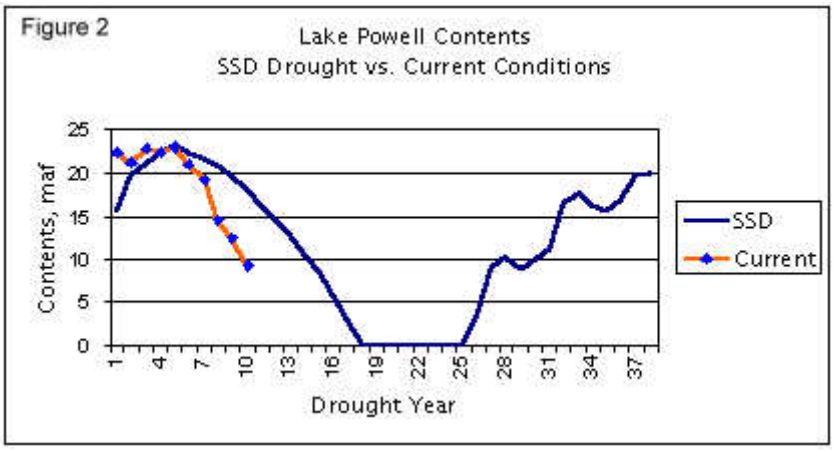
The study drought adopted for the SSD study was a 38-year drought period patterned after (but not identical to) the most severe long-duration dry period identified by the tree ring studies. The drought chosen for evaluation includes a period of unusually low flows lasting about two decades, followed by a period of high flows long enough for mean annual inflow to return to its long-term average. It is shown in Figure 1 below, as the trace of annual flows at Lees Ferry, Arizona (Tarbotton, 1995).



Many of the hydrologic processes of the Colorado River basin go on unobserved and unmeasured. As such, reconstructing natural hydrology is time consuming and fraught with uncertainty.

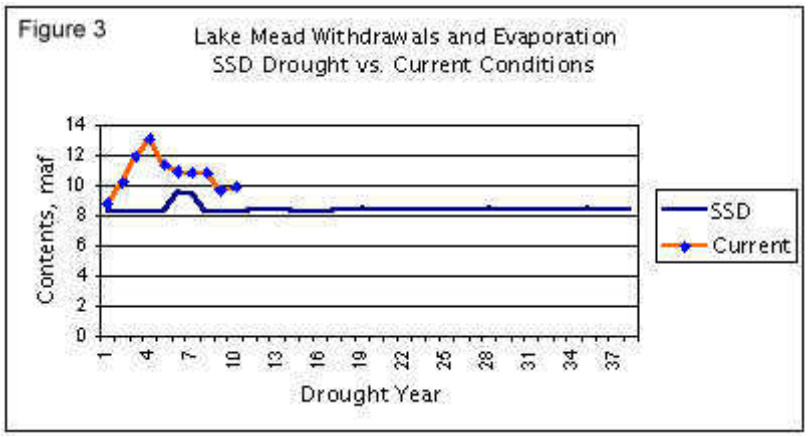
Reconstructed flows after 2002 are still provisional, so a clear picture of the hydrology of the current drought has yet to emerge. But, based on preliminary reconstructions, the onset of the current drought is intense, even compared to the SSD study drought, as can be seen in Figure 1.

The nature of the hydrological drought is of less practical interest than its impact on human and natural systems. In the case of the Colorado River these impacts can be known more precisely than the hydrologic characteristics. Figure 2 is a comparison of recent observed contents of Lake Powell with that reservoir's contents as they played out during the SSD study (Harding, et. al, 1995). These charts are synchronized on the last year (1999 and SSD year 5) before reservoir contents began their steady decline. Based on this assumption, the first year of the SSD drought corresponds to 1995. (This is the starting point for all of the comparisons in this article.)



What is apparent from Figure 2 is that the current decline in the contents of Lake Powell is substantially steeper than was the case during the onset of the SSD study drought.

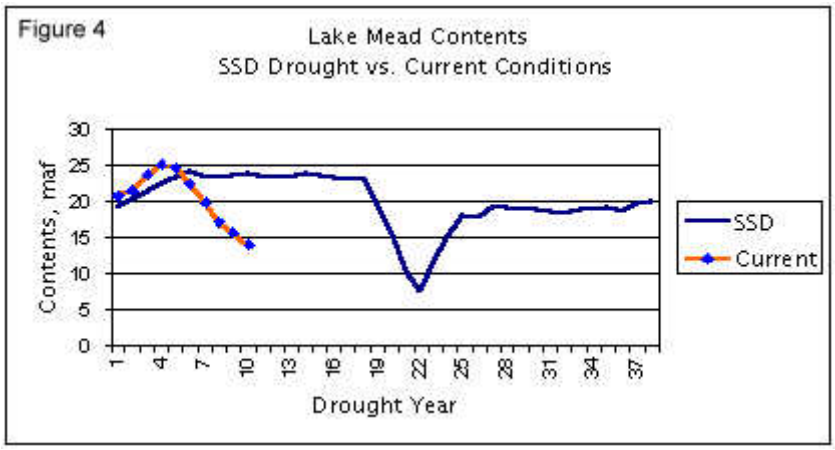
One of our fundamental assumptions in the SSD was that the study drought would be a very rare event, probably occurring many years in the future, and having been preceded by numerous less-severe droughts. Accordingly, we assumed that all water allocations would be fully implemented and strictly adhered to. We also assumed, quaintly in retrospect, that the high cost of pumping water through the Central Arizona Project would reduce the demand for and use of water through that project. The current drought, however, has caught water managers unprepared--while depletions in the Upper Basin are consistent with the assumptions in the SSD study, the depletions in the Lower Basin are substantially higher.



Retrospective Analysis of the *Severe Sustained Drought Study*, Water Resources Bulletin in October, 1995.

Depletions can only be estimated, and only with much effort, and that work has not yet been completed for the most recent years. As a surrogate, we looked at the releases from Lake Mead and added to those releases estimates of evaporation from the reservoir. Figure 3 shows that the total withdrawals and depletions from Lake Mead for the last 10 years are greater than the values from the SSD study.

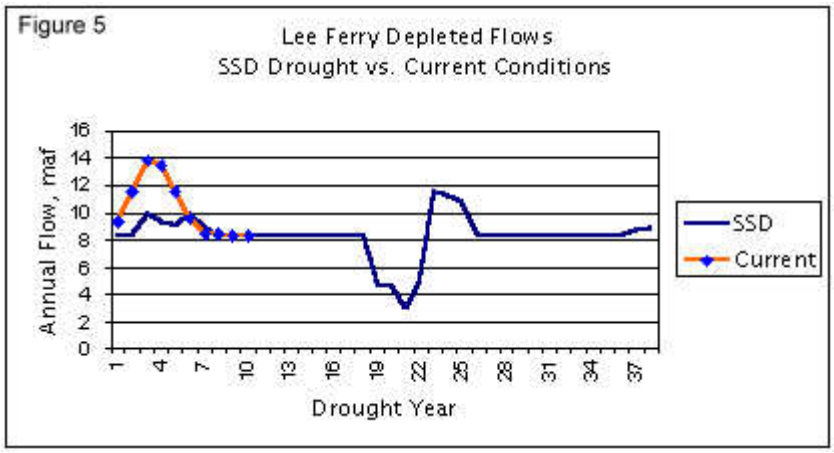
The net effect of increased withdrawals is lower reservoir levels. Lake Mead is substantially lower today than at an equivalent point in the SSD drought, as can be seen in Figure 4.



The rules by which the federal reservoirs on the Colorado River are operated force "equalization" releases from Lake Powell when the contents of that reservoir are greater than a prescribed volume and its contents are greater than those of Lake Mead. The SSD study showed some equalization releases at the initiation of the drought, but Figure 5 shows that those made over the last decade are greater as a consequence of lower levels in Lake Mead.

It is noteworthy that the observed contents of Lake Mead are lower than those shown in the SSD study even though substantially more water has been released from Lake Powell in the current situation.

There is no way to know how the current drought will develop. Tarbotten (1995) estimated that the SSD drought had a return period of between 2,000 and 10,000 years. On that basis, and assuming that the climate has not changed, it is very unlikely that the current drought will reach both the duration and severity of the SSD drought.



On the other hand, we find ourselves at this point in the current drought with almost 20 maf less water in the principal reservoirs than at a corresponding point in the SSD drought analysis. The system is now susceptible to shorter dry spells, which are considerably more frequent. This susceptibility will increase rapidly if withdrawals are not reduced.

This document can be found online at:
http://www.hydrosphere.com/publications/SSDRedux.htm

Hydrosphere Resource Consultants
1002 Walnut, Suite 200
Boulder, Colorado 80302
Phone: 303-443-7839
Fax: 303-442-0616
Email: hrcweb@hydrosphere.com