WAS THE 2016 GAP IN SAN JOAQUIN RIVER RUNOFF CAUSED BY LACK OF CLOUDSEEDING?

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ABSTRACT

The San Joaquin River basin in the southern Sierra has had cloud seeding programs for over 60 years, mostly funded by Southern California Edison. In 2016, no funds were available for the project, so seeding stopped. Water year runoff was near normal in the Central Sierra, but fell off progressively to the south to only about 50 percent on the Kern. However, there was an additional dip in San Joaquin River runoff of 8 or 9 percent. Could this dip be due to the lack of cloud seeding in WY 2016? (KEYWORDS: cloud seeding, runoff, San Joaquin, drought)

BACKGROUND

After 4 years of severe drought and large shortages in San Joaquin Valley water supply, near normal rains returned to Northern California in water year 2016. The April 1 snowpack in 2016 was 85 percent of average, a vast over the record-breaking 5 percent in 2015. The improvement was best in the northern part of the state, with the southern half lagging. (This year, 2017, saw a number of atmospheric rivers and is tracking near the wettest in over a century of runoff. The snowpack, too, at about 160 percent on April 1, is in the top 10 percent, but well under the enormous 1983 pack which was 237 percent of average.) During the 2012-2015 drought, there were large water shortages in the Central Valley. Both major water projects, the Central Valley Project and the State Water Project had severe cutbacks, worse in the San Joaquin Valley where some CVP users got no project water in 2014 and 2015 and SWP customers got only 5 percent in 2014 and a bit more at 20 percent in 2015.

Figure 1 shows a comparison of the notable droughts in the last 100 years for the Sacramento and San Joaquin River systems, color coded for the length of drought. For the Sacramento, the historic 1929-34 drought was worse. On the San Joaquin River system, the recent drought was worse than any 4-year period, including the lowest one, in the 1840s, from a 1000-year reconstruction from tree rings.

Figure 2 shows the magnitude of this year's (2017) Sacramento River seasonal runoff compared with the annual water year record since 1970.

Paper presented Western Snow Conference 2017
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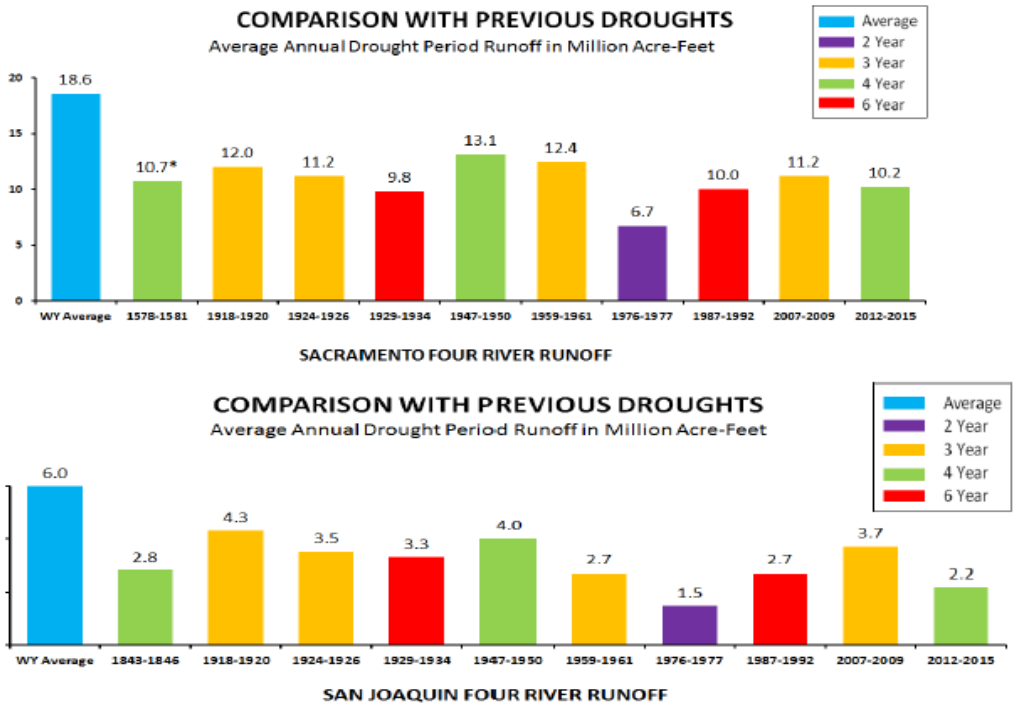
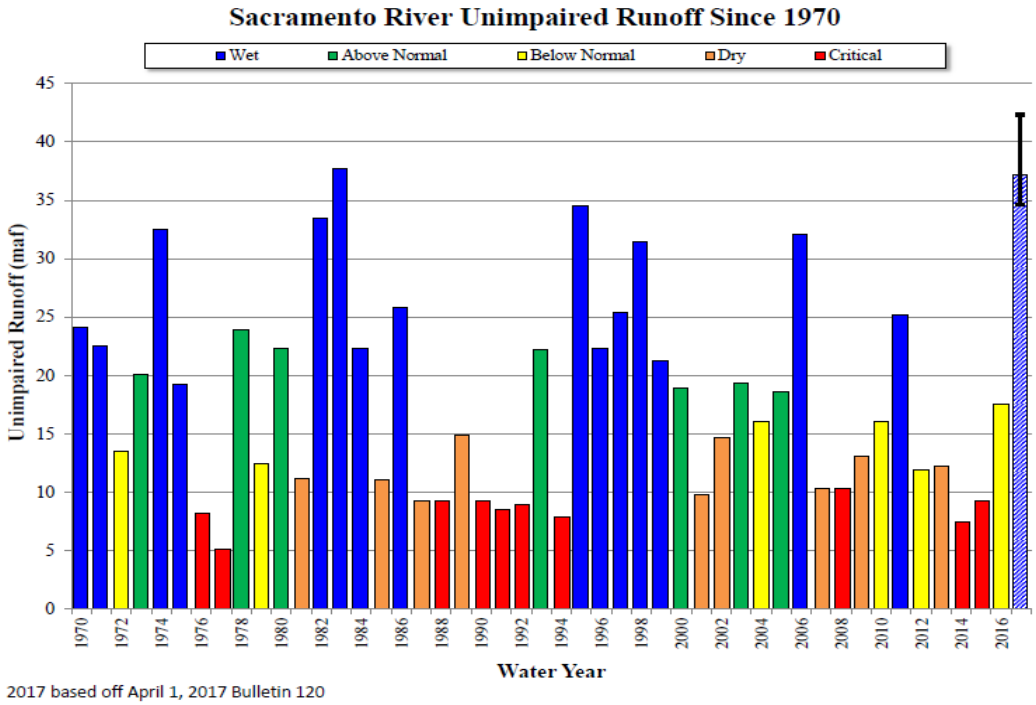


*from tree rings
(1 million acre-feet = 1.23 billion cubic meters)

Figure 1. Comparison of runoff patterns in the Sacramento and San Joaquin basins.



RUNOFF COMPARISONS

Figure 2. Unimpaired runoff for the Sacramento River from 1970 through 2017.

WEATHER MODIFICATION PROJECTS

Figure 3 shows the weather modification projects regarded as operational in California. The upper San Joaquin River project did not operate in WY 2016. It has been one of the oldest cloud seeding projects operating continuously since 1951 by Southern California Edison Company to increase hydroelectric power production. For the 2016 season, the Company wanted downstream Friant water users to contribute to the costs of the program. The Friant Water Authority is composed of a number of water user organizations served by the Friant Kern and Madera Canals. Some wanted the program, others did not want to pay because they doubted the effectiveness of seeding. As a result, no agreement was possible and the program did not operate in WY 2016.

Figure 3. Weather modification project areas in 2016

Figure 4, taken from the DWR Snow Surveys April 1 bulletin, shows the location of southern Sierra river basins with the forecasts of 2017 natural runoff during April through July, as of April 1 of 2017, a super wet year with percentages approaching twice average. The main purpose of the chart is to show location of the southern Sierra river basins. Because of ample snow and ensuing flood threats, most cloud seeding operations were suspended early in the winter.

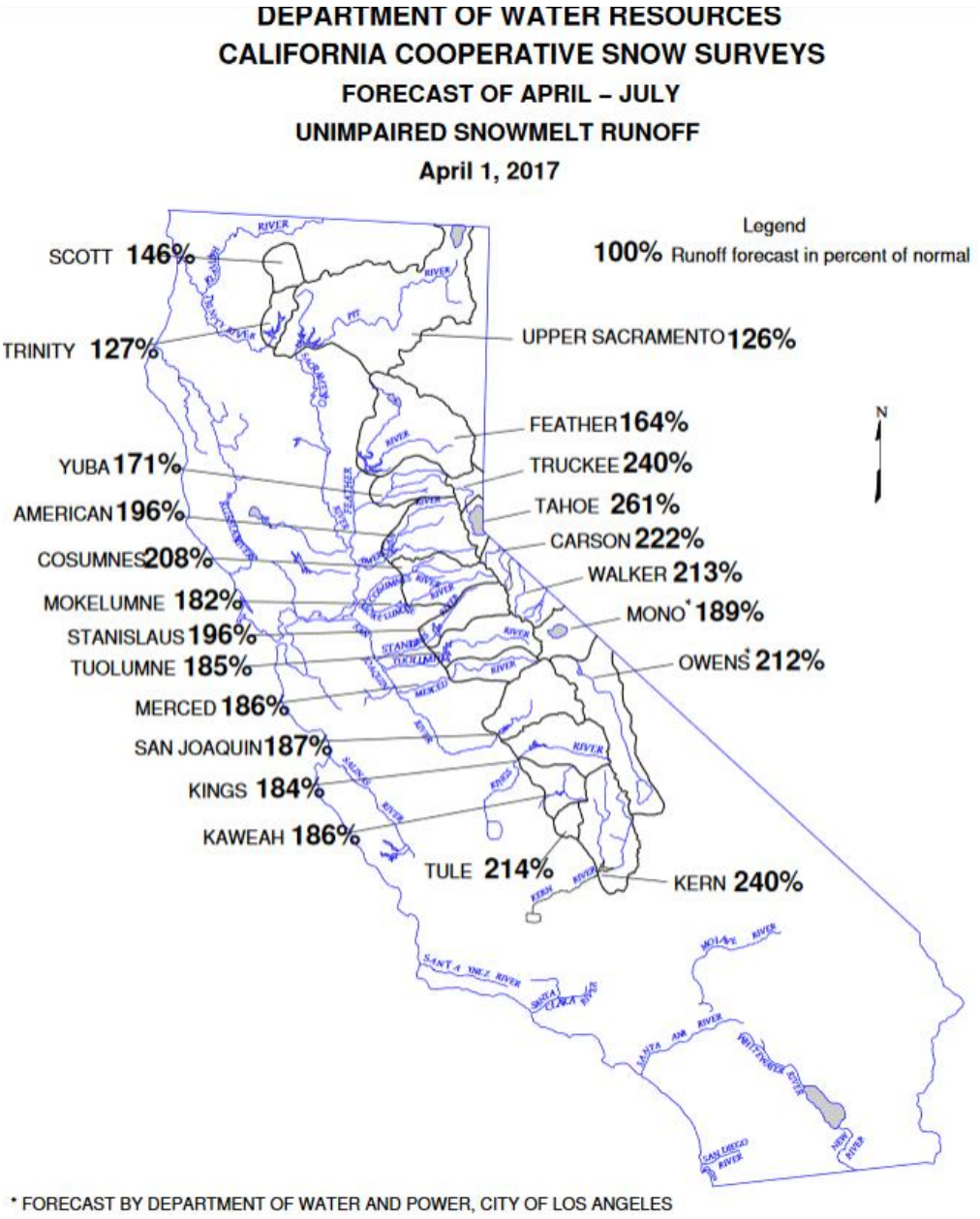


Figure 4. April through July forecasted unimpaired runoff, with a statewide average of 147%.

The author thought that some useful comparisons on the impact of the San Joaquin weather modification program could be made by comparing 2016 water year runoff for southern Sierra rivers, as shown in Figure 5. Runoff in 2016 shows a decreasing trend with near 90 percent of the water year average in the northern end, Mokelumne to Stanislaus, decreasing to about 50 percent in the south end of the range on the Kern River. The Merced was 86 percent and the Kings was 72 percent. So, one would expect the San Joaquin to be around 79

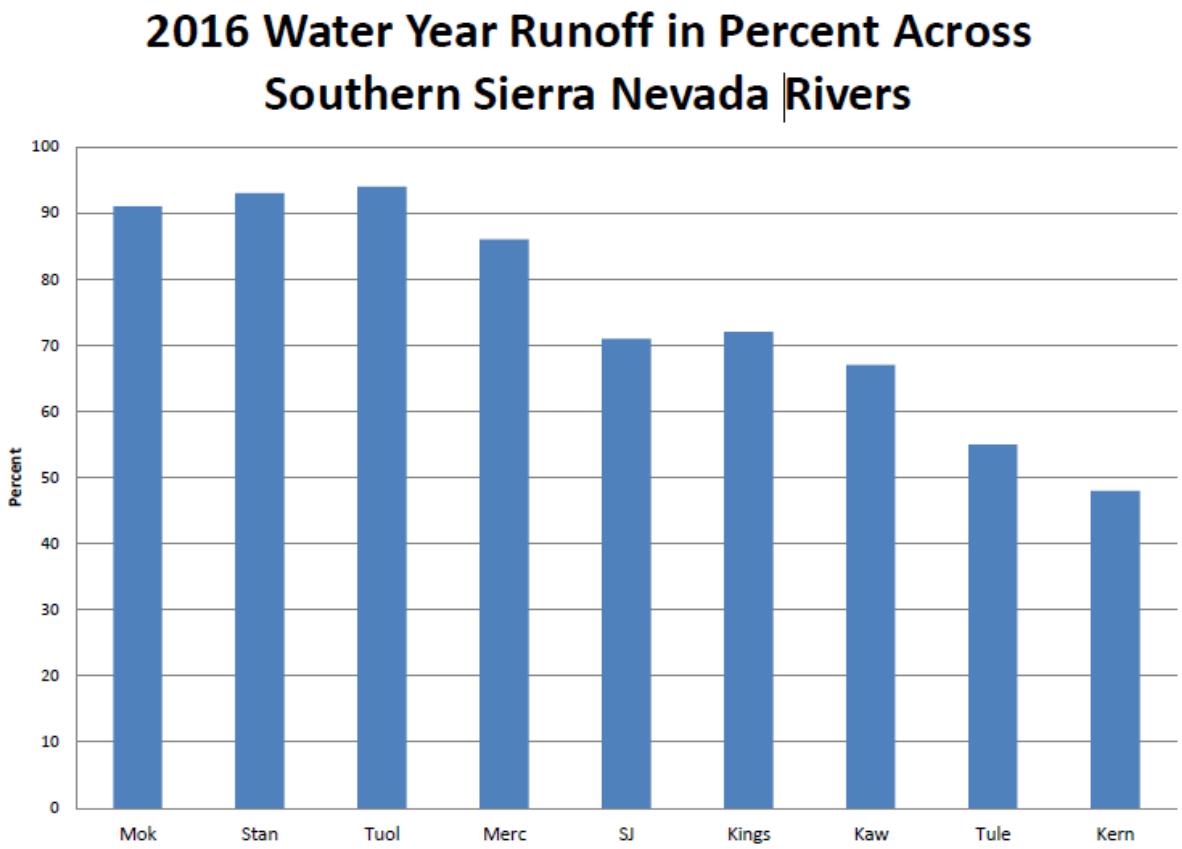


Figure 5. Basin runoff for WY2016, shown as a percentage of the normal basin runoff.

percent, which would be 7 or 8 percent higher than the actual 71 percent, which would be over 100,000 acre-feet. Could we attribute this gap to lack of cloud seeding?

However, there is an error band in the historical relationships of adjoining rivers. This is illustrated by Figures 6 and 7, where the years since 1950 are plotted, comparing water year amounts for San Joaquin River unimpaired inflow to Millerton reservoir with the Merced and the Kings Rivers. The Merced has never been seeded, although there might be a little spillover effect at times from San Joaquin operations. The Kings has been seeded most years, except a gap from 1981 through 1987 due to construction of Pine Flat power plant. Also, because of the huge Rough forest fire in 2015, Kings River seeding operations were quite limited in 2016, mainly to the North Fork, which contributes about 15 percent of total runoff. Looking at the relationships on Figure 6 for the Merced, the 2016 point (arrow) is near the upper fringe of the band of points. On the Kings River, 2016 seems to be fit within the historical relationship, probably because of the very limited seeding program in the Kings watershed in 2016.

CONCLUSION

To conclude, the 2015 data suggests, by absence, that cloud seeding, or in this case, lack of it, is effective. At 7 percent, the loss in potential San Joaquin runoff was about 90,000 acre-feet. The decision to cloud seed and spend the required funds to augment runoff for use by project operation is largely a matter of the cost per acre-foot.

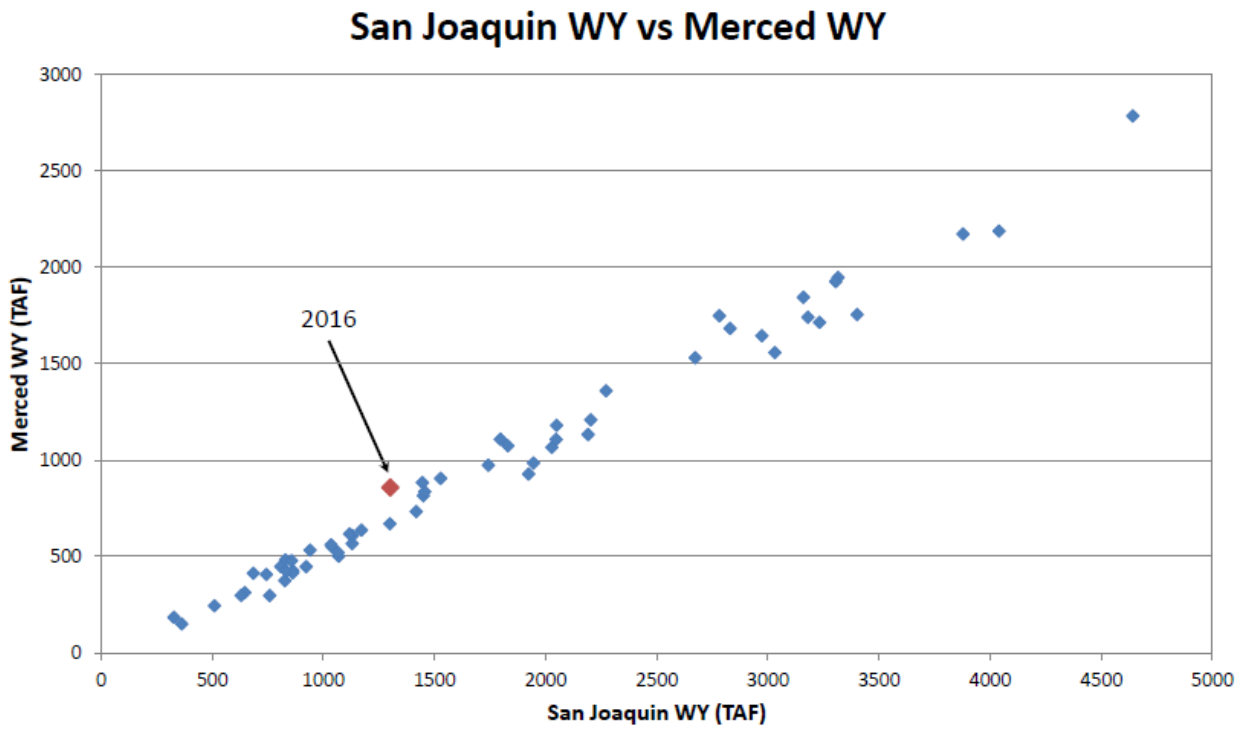


Figure 6. Scatter plot of runoff for San Joaquin basin versus runoff from Merced basin.

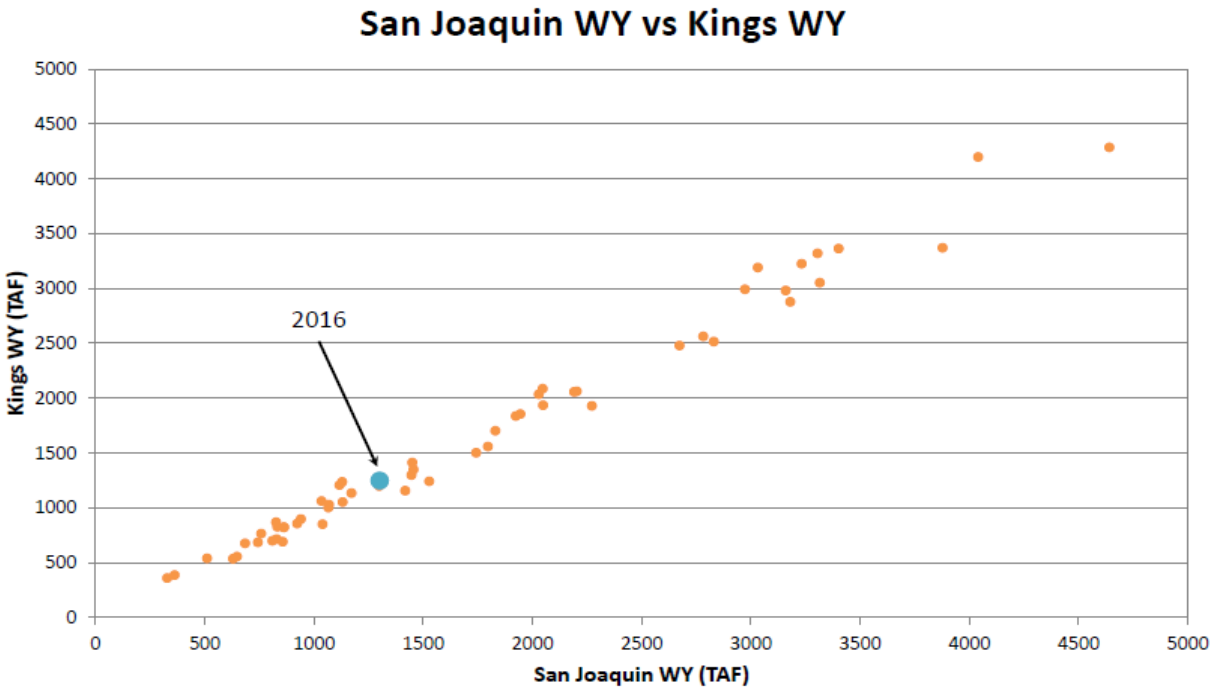


Figure 7.

Figure 7. Scatter plot of runoff for San Joaquin basin versus runoff from Kings basin.

Editor's Note: This paper was mistakenly omitted from the 2017 Proceedings, so it is included here.