Integrated Watershed Management and Whole-System Reoperation to Maximize Total Water Storage in American-Cosumnes River Basin

UC WATER Security and Sustainability Research Initiative

During California's historic 2012-16 drought the dramatic depletion of surface water supplies together with the rapid acceleration of groundwater overdraft highlighted the importance of both surface and subsurface water storage in the quest for greater water security. The need for greater water security, especially in a warming climate, calls for new water management strategies in which integrated management and maximization of the total water stores in combined surface water, groundwater, and snow reservoirs is a central objective. UC Water researchers are developing new approaches to manage all the major stores of water (headwater, surface reservoir, and lowland groundwater systems) to maximize the total water storage in the basin. The major focus of the work is re-operation of Folsom Reservoir and Managed Aquifer Recharge (MAR) in American-Cosumnes River Basin (ACRB) (Fig. 1).

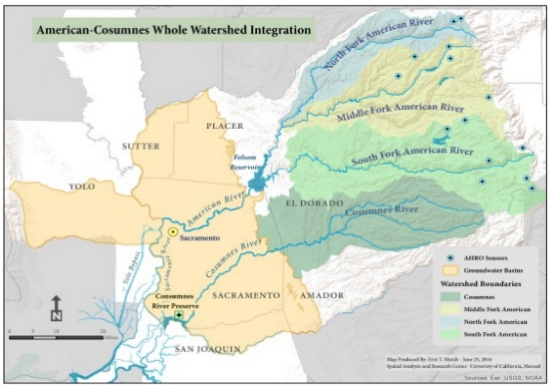

Figure 1. American-Cosumnes River Basin

The periodicity of wet and dry years in California (Fig. 2) means that much more aggressive subsurface storage must be accomplished during the wet years so that the total system (surface and subsurface) overdraft is stable and not decreasing on decadal time scales. Our team evaluates the coupled management of surface reservoir and MAR to capture peak flows from headwaters in Sierra Nevada and flood flows from Central Valley Rim Dams and use available water for recharge in Central Valley, especially during wet seasons/years. Therefore, water can be recovered during long droughts and better satisfy needs of humans and ecosystems.

As a proof of concept, to evaluate the feasibility of whole-system reoperation, we analyzed timing, amount, and frequency of water available for recharge in American and Cosumnes River Basin in California. We estimated the hydrological feasibility of implementing MAR by estimating the available water for recharge during flows in the American River using full natural flows (pre-development) and historical releases from Folsom Reservoir (post-development) during the five months of Nov-Mar.

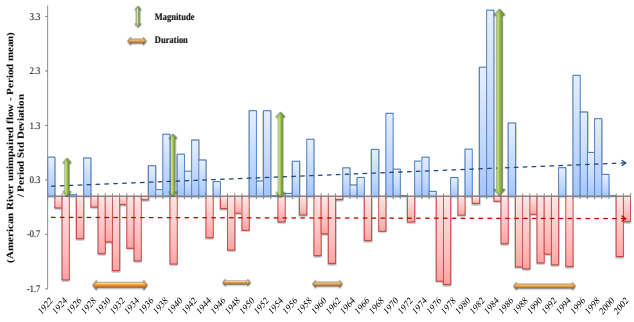

Figure 2. Magnitude and duration of wet and dry periods in ACRB

The expected values of water availability for MAR are about 325 taf/year and 350 taf/year during wet and above normal years for pre- and post-development scenarios. However, to improve the reliability of water supply, and reduce flood risk we needed to integrate operation of the whole system. For this purpose, we linked a new model for Folsom Reservoir, FolSim, with an upper watershed model, PRMS, and a groundwater model for Central Valley, C2VSIM. Then, a hybrid multi-objective optimization framework is used to operate the whole system and to maximize the water storage in the whole basin. The preliminary result of the coupled modeling shows that *the expected value of the amount of water available for MAR, for wet and above normal years, is about 315 taf/year for the five months (Nov-Mar) of recharge*.

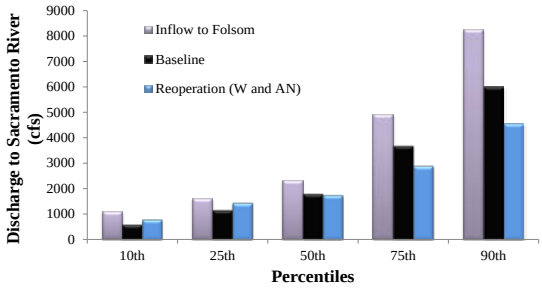

Figure 3. Inflow and outflow to the ACRB system for different scenarios

Simulation of groundwater recharge in ACRB, assuming the southern part of basin is available for recharge through Folsom South Canal, shows that 44% of recharged water appears as addition storage in the groundwater system and the rest of water flows to the adjacent aquifers and benefits the natural streams. UC Water team is studying the implementation of MAR in farmlands and working landscapes, and also intends to use the enhanced hydrological forecasts for the Forecast-Informed Reservoir Operation (FIRO) and use flood flows for MAR.

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