4-2018

Maximizing Whole Watershed Storage through Optimized Reservoir Reoperation and Managed Aquifer Recharge

Erfan Goharian
University of South Carolina - Columbia, goharian@cec.sc.edu

Robert Gailey

Stephen Maples

Samuel Sandoval-Solis

Graham Fogg

Publication Info
Published in *Geophysical Research Abstracts*, Volume 20, 2018.

Geophysical Research Abstracts
Vol. 20, EGU2018-867, 2018
EGU General Assembly 2018

Maximizing Whole Watershed Storage through Optimized Reservoir Reoperation and Managed Aquifer Recharge

Erfan Goharian, Robert Gailey, Stephen Maples, Samuel Sandoval-Solis, and Graham Fogg
University of California, Davis, United States

Growing water scarcity in many parts of the world has a profound effect on human, agricultural, and environmental water needs. During California's historic 2012-16 drought, dramatic depletion of surface water supplies together with the acceleration of groundwater overdraft highlighted the importance of both surface and subsurface water storage in the quest for greater water security. These challenges call for a careful evaluation of future water resources sustainability and security in the state. In arid and semi-arid regions, integrated short- and long-term management of flood and groundwater offer potential mutual benefits for flood protection, groundwater sustainability, water security, drought preparedness, and ecosystem restoration. This study presents an innovative hybrid optimization framework to integrate the flood, land use, and groundwater management strategies by maximizing total water stores in the combined surface water, groundwater, as well as snow reservoirs as the central objective. Major foci of the work include re-operation of Folsom Reservoir and Managed Aquifer Recharge (MAR) in American-Cosumnes River Basin (ACRB). The potential use of high peak flows for MAR on farmlands and working landscapes can be transferred and tested for other places with high variation in water availability intra- and inter-annually. The whole system reoperation includes securing the hydropower generation, carry-over storage in the reservoir, available water for replenishment, and downstream water requirements. The hybrid optimization structure and its application for the whole system reoperation are the key novelties in this study. The hybrid optimization core consists of a Non-dominated Sorting Genetic Algorithm II (NSGAII) that dynamically nests a linear programing (LP) module. The LP module tends to maximize the total groundwater recharge by distributing and spreading water over suitable farmlands and working landscapes in the basin. The hybrid optimization model is informed by detailed simulation of topography, geology and heterogeneity, and coupled land-surface processes to represent the complex behavior of an integrated water system. Preliminary results show additional releases from the reservoir for groundwater recharge during high flow seasons. The expected value of the amount of water available for MAR, during wet and above normal years, is about 388 million Cubic Meters per year for the five-month (Nov-Mar) recharge period, which is about one-third of the total storage of Folsom Reservoir. Tradeoffs between different objectives (hydropower generation vs. total water storage) show that the new operation policy performs satisfactorily to increase the storage in the basin, with nonsignificant violations from other objectives. Moreover, simulation of groundwater recharge in ACRB shows that 37% of recharged water appears as additional storage in the groundwater system, 22% benefits the natural streams, and the rest of recharged water flows to the adjacent aquifers. Finally, the integrated resources management concept of using flood flows for MAR (Flood-MAR) on farmlands can be simply tested for other regions around the world using the novel hybrid optimization framework presented in this study.