AN ASSESSMENT OF SNOW COVER IN 4 MAJOR RIVER BASINS OF SOUTHERN SIERRA NEVADA AND POTENTIAL APPROACHES FOR LONG-TERM MONITORING (3G)

Robert Rice and Roger C. Bales, University of California, Merced/Sierra Nevada Research Institute

Daily snow water equivalent (SWE) was reconstructed for 2000-2009 using canopy-corrected fractional snow covered area (fSCA) from MODIS and a temperature-index snowmelt calculation. The MODIS fractional SCA was based on the MODSCAG (MODIS Snow Covered Area and Grain size/albedo) model, and provides a daily estimate of SCA across complex terrain. The few ground-based index sites for snow measurement can in many years provide good statistical estimates of total seasonal runoff in the basin; but they do not form the basis for spatial estimates of snowpack and snowmelt distributed over the year. The latter are essential for a number of critical resource-management decisions, and are critical inputs to more physically based hydrologic forecasts. We analyzed the fraction of area that was snow covered, by 300-m elevation band, in the San Joaquin, Kings, Kaweah, and Kern River basins on the western slope of the Sierra Nevada. These basins range in size from 2846 to 6142 km2, with snow occurring mainly above 1500 m. Our analysis provided estimates of when the snow-covered area was at a maximum, when the snow started melting, how fast it melted and when melt was nearly complete. The fractional snow-covered area (SCA) derived from satellite data was highest above 3600 m, often over 90%. SCA decreased with elevation, with values in the 1800-2100 m elevation peaking well below 50%. In some years SCA at this elevation was barely detectable. Snowcover depletion occurred at average rates of 15-17 m of elevation per day, which is equivalent to each 300-m elevation band melting out 2-4 weeks later. In addition, SWE from snowmelt increased 0.4-0.8 m per 1000 m. Assuming that snowmelt is sensitive to temperature, and that on average temperature decreases 6oC per 1000 m elevation, each 2oC of climate warming would shift the observed snowmelt patterns upslope by 300 m, or shift the snow-depletion dates in a given elevation band earlier by approximately 3 weeks. Daily snowmelt volumes, estimated from the daily SCA and energy-balance calculations, show a similar shift and a significant reduction with a 2-6oC increase in average temperature across the 4 basins. Going forward, management of water dependent resources should consider an adaptive-management approach, involving a continual cycle of investigation and synthesis to inform decision-making, and developing more-definite scenarios for temperature, precipitation, snowpack, snowmelt and streamflow.

Key words: Snow, water quantity, climate, streamflow, precipitation