Ecohydrology

RESEARCH ARTICLE

Estimating evapotranspiration change due to forest treatment and fire at the basin scale in the Sierra Nevada, California

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First published: 06 April 2018 | https://doi.org/10.1002/eco.1978 | Cited by: 3

Abstract

We investigated the potential magnitude and duration of forest evapotranspiration (ET) decreases resulting from forest-thinning treatments and wildfire in west-slope watersheds of the Sierra Nevada range in California, USA, using a robust empirical relation between Landsat-derived mean-annual normalized difference vegetation index (NDVI) and ET measured at flux towers. Among forest treatments, the minimum observed NDVI change required to produce a significant departure from control plots with NDVI of about 0.70 was −0.09 units, corresponding to a basal-area reduction of 29.1 m^2/ha (45% reduction) and equivalent to an estimated ET reduction of 153 mm/year (21% change; approximate mean annual precipitation = 1,000 mm). Intensive thinning in highly productive forests that approached prefire-exclusion densities reduced basal area by 40–50%, generating estimated ET reductions of 153–218 mm/year (21–27% change) over 5 years following treatment. Low-intensity underburn treatments resulted in no significant change in ET. Examining the cumulative impact of wildfires on ET between 1990 and 2008, we found that the lower and wetter American River basin (5,310 km^2) generated more than twice the ET reduction per unit area than those in the higher and drier Kings River basin (4,790 km^2), corresponding to greater water and energy limitations in the latter and greater fire severity in the former. A rough extrapolation of these results to the entire American River watershed suggests that ET reductions due to forest thinning by wildfire could approach 10% of full natural flows for dry years and 5% over all years.