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Hydrologic monitoring in 1-km2 headwater catchments in Sierra Nevada forests for predictive modeling of hydrologic response to forest treatments across 140-km2 firesheds

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Abstract

As part of the Sierra Nevada Adaptive Management Project, an eight-year study designed to measure the impacts of forest treatments (thinning, mastication, controlled burns) on multiple forest attributes, four headwater catchments were established to provide data on hydrologic response to treatments. These 1-km2 study catchments are each sited within 40-100 km2 firesheds, which in this case largely follow watershed boundaries, and which are the larger study areas for informing adaptive management of approximately 3,000 km2 of mixed-conifer forest in California's central and southern Sierra Nevada. The aim of the hydrologic design was to put in place a ground-based monitoring network that would measure hydrologic attributes at representative locations, and when combined with remotely sensed data, provide a basis for predictive modeling of the larger study area. The selected locations employ instrument clusters, or groupings of instruments in a compact arrangement, to maximize the number of measurements possible and accessibility to the monitoring sites. The two study firesheds , located in the Tahoe and Sierra National Forests, cover a total of about 140-km2. Within each fireshed, two meteorological stations were placed near 1650-m and 2150-m, spanning the precipitation gradient from lower-elevation rain-dominated to higher-elevation snow-dominated systems. Two headwater streams draining approximately 1-km2 are monitored for stage, discharge, electrical conductivity, and sediment movement. Additionally, instrument nodes to monitor temperature, snow depth and soil moisture are installed within 0.5-1 km of the outlet and meterological stations. These nodes were placed to monitor end members of aspect, slope, elevation and canopy cover, which set the boundaries for the model outputs. High-resolution LiDAR provides the topographic and distributed vegetation characteristics, which are combined with field surveys and standard soils information to define the modeling environment. Results from embedded sensor networks, synoptic field surveys and satellite data indicate that the sampling design accurately captures the physiographic and hydrologic variability, and sufficiently constrains hydrologic model parameters and inputs to predict the impact of vegetation changes on hydrologic response to forest management.