Assessing Hillslope Inputs and Channel Change in Forested Watersheds

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Cumulative watershed effects (CWEs) result from multiple activities over time and space. The assessment of CWEs in the Sierra Nevada is severely limited by the lack of field data on the effects of a given action, the lack of models to predict the effects of multiple actions at the watershed scale, and the limited data relating stream channel conditions to measured or predicted changes in runoff and sediment yields. Since 1999 we have been measuring hillslope-scale sediment production rates from roads, timber harvest, wild and prescribed fires, and minimally-disturbed areas. From these and other data we are developing catchment-scale, spatially-explicit models to predict changes in discharge and sediment production from roads, fires, and timber harvest. The more difficult step in developing a reliable CWE model is to compare predicted changes in runoff and sediment production to stream channel conditions.

Channel conditions were measured in 28 pool-riffle reaches in the American and Cosumnes river basins. Contributing areas ranged from 2.9 to 70 km^2, and reach elevations ranged from 1200 to 1800 m. The basins were selected to encompass a wide range in the amount of natural and anthropogenic disturbance. The data collected for each reach included: gradient; drainage area; channel dimensions; number, depth, and size of pools; grain-size distributions in both pools and riffles; pool sediment infill; and amount of large wood. The variables used to characterize the amount of management within the contributing areas included road density, number of road crossings, modeled road sediment production, percent forest harvest by decade, and percent burned by wildfire by decade.

Drainage area, slope, and geology explained up to 50% of the variability in channel dimensions, bed-material particle size, and the amount of fine sediment in pools. After removing the effect of these variables, there were only a few significant correlations between channel characteristics and any of the management variables. There was a significant increase in the volume of fine sediment in pools and a significant decrease in the median particle size in pools with estimated road sediment production and the proportion of the basin with granitic soils. Predicted increases in the size of peak flows were not significantly correlated with any of the channel characteristics. The results indicate that: (1) management-induced increases in fine sediment are of greater concern than increases in the size of peak flows; and (2) other than large fires, unpaved roads are the most important source of fine sediment.

The limited number of significant correlations between channel characteristics and the different management indices can be attributed to a number of factors including: the lack of undisturbed basins to determine reference conditions; the complexity of factors that determine channel response; the difficulty of quantifying the magnitude of "disturbance" within a basin; the relatively low levels of recent human disturbance at the planning watershed scale; and the record

flood event in early 1997. The 1997 flood may have effectively "reset" the stream channels, which makes it more difficult to detect cumulative watershed effects. The data from our work in the Sierra are compared to the results of similar studies on the Routt National Forest in Colorado and the Kootenai National Forest in northwestern Montana. Taken together, these studies indicate that it will be a continuing challenge to establish rigorous criteria for stream channel characteristics in forested areas, and to validate predictive models for cumulative watershed effects.

Relevant Publications

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