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Targeting Forest Management through Fire and Erosion Modeling

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Forests deliver a number of ecosystem services, including clean water. When forests are disturbed by wildfire, the timing and quantity of runoff can be altered, and the quality can be severely degraded. A modeling study for about 1500 km2 in the Upper Mokelumne River Watershed in California was conducted to determine the risk of wildfire and the associated potential sediment delivery should a wildfire occur, and to calculate the potential reduction in sediment delivery that might result from fuel reduction treatments.

The first step was to predict wildfire severity and probability of occurrence under current vegetation conditions with FlamMap fire prediction tool. FlamMap uses current vegetation, topography, and wind characteristics to predict the speed, flame length, and direction of a simulated flame front for each 30-m pixel. As the first step in the erosion modeling, a geospatial interface for the WEPP model (GeoWEPP) was used to delineate approximately 6-ha hillslope polygons for the study area. The flame length values from FlamMap were then aggregated for each hillslope polygon to yield a predicted fire intensity. Fire intensity and pre-fire vegetation conditions were used to estimate fire severity (either unburned, low, moderate or high). The fire severity was combined with soil properties from the STATSGO database to build the vegetation and soil files needed to run WEPP for each polygon. Eight different stochastic climates were generated to account for the weather variability within the basin. A modified batching version of GeoWEPP was used to predict the first-year post-fire sediment yield from each hillslope and subwatershed.

Estimated sediment yields ranged from 0 to more than 100 Mg/ha, and were typical of observed values. The polygons that generated the greatest amount of sediment or that were critical for reducing fire spread were identified, and these were “treated” by reducing the amount of fuel available for a wildfire. The erosion associated with these fuel treatments was estimated using WEPP. FlamMap and WEPP were run a second time to determine the extent to which the imposed treatments reduced fire intensity, fire severity, and the predicted sediment yields. The results allowed managers to quantify the net reduction in sediment delivery due to the prescribed treatments. The modeling also identified those polygons with the greatest net decline in sediment delivery, with the expectation that these polygons would have the highest priority for fuel reduction treatments. An economic value can be assigned to the predicted net change in sediment delivered to a reservoir or a specified decline in water quality. The estimated avoided costs due to the reduction in sediment delivery can help justify the optimized fuel treatments.