ESTIMATING SOIL EROSION AFTER FIRE AND FUEL TREATMENTS IN COAST REDWOOD: A GIS-BASED APPROACH

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ABSTRACT

Question: What is the potential soil erosion under four scenarios, including no treatment, thinning, prescribed fire, and wildfire, based on an approach that utilizes GIS and established erosion and fire effects modeling procedures?

Background: Erosion following wildfire or fuel treatments is of major concern to land managers and is directly related to the amount of vegetative cover removed, soil properties, topography, and precipitation patterns. A major shortcoming of many erosion models is that plot-level data are regularly used to designate slope and vegetation across an entire landscape, which has the potential to grossly misrepresent the high degree of topographic and vegetative complexity across a given watershed. Geographic information systems (GIS), however, provides the capacity to better estimate how soil movement is affected by topography and changes to vegetation via fire or fuels treatments.

The objectives of this research were to

1) Develop a methodology for estimating landscape-level soil erosion, utilizing GIS and established erosion and fire effects modeling procedures.
2) Estimate potential soil erosion under four scenarios, including no treatment, thinning, prescribed fire, and wildfire.

Location: Swanton Pacific Ranch (UTM 37.069364, −122.209648) near Santa Cruz, California, USA, in a 100-year-old second-growth forest of coast redwood (*Sequoia sempervirens*).

Methods: Surface fuel loading, canopy coverage, and other vegetation characteristics were measured in 33 field plots. Changes to surface fuel loading and canopy coverage were simulated in FOFEM (v. 5.5) under three scenarios: 1) thinning 50% of the overstory basal area with no change in surface fuels, 2) prescribed fire, and 3) wildfire. Each treatment affected the cover management factor (C-Factor) in the Revised Universal Soil Loss Equation used to estimate potential erosion across the watershed.

Results: Compared with the untreated landscape, both thinning and the prescribed fire resulted in ~10% greater sediment loss in the first year following treatment. Thinning affected canopy coverage but had little effect on surface fuels, based on unpublished data at the site. Prescribed fire removed surface fuels but had little effect on canopy coverage. The wildfire treatment, however, increased erosion by 74% compared with the untreated stand, the result of removing both 66% of the canopy coverage and also 85% of surface fuels.

Conclusions: Vegetation cover, both in surface fuels and canopy coverage, acts to buffer soil erosion. The C-Factor is extremely important in the Universal Soil Loss Equation because it measures the combined effect of all interrelated cover and management variables. Unfortunately, it also is one of the most difficult to obtain because of the wide range of environmental variables affecting it. In conclusion, the GIS-based approach to estimate soil erosion following fire and fuel treatments is both extremely powerful and promising. However, managers must be aware of the need for multiple types of complex spatial data, which are potentially difficult to obtain and cost-prohibitive.

keywords: erosion, fire, FOFEM, fuel treatments, GIS, redwood, *Sequoia sempervirens*, Universal Soil Loss Equation.

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