Effects of thinning and a wildfire on sediment production rates, channel morphology, and water quality in the upper South Platte watershed

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Abstract. The Upper South Platter River watershed is the primary source of Denver's water supply. There has been increasing concern over the potential adverse effects of large wildfires. The initial goal of this study was to evaluate the effects of thinning on runoff and sediment at both the hillslope and small catchment scales. At the hillslope scale, the objectives were to: (i) measure sediment production from thinned and unthinned zero- or first-order catchments, (ii) measure road sediment production and connectivity to stream network, and (iii) relate sediment production and delivery to rainfall and site characteristics. At the small catchment scale, the objectives were to: (i) monitor runoff, and (ii) monitor water quality and channel morphology. Measurements of precipitation, sediment production rates, channel morphology, and water quality began in mid-2001. At the hillslope scale, crest gages and sediment fences were installed to assess runoff and erosion rates in 20 pairs of small zero- or first-order catchments in Spring Creek, Upper Saloon Gulch, and Trumbull. Area, slope, ground cover, water repellency, and particle-size distribution were measured for each zero- or first-order catchment. Given sediment fences were also installed on roads at drainage outlets such as waterbars or just downstream of culverts to assess erosion rates from forest roads. At the small catchment scale, channel characteristics were measured in four first- or second-order watersheds, and monthly grab samples were taken to characterize water quality. Flumes were installed in two watersheds of 6.2 and 3.4 km^2 in early summer 2002. In 2001, only 3 out of 40 swales produced sediment. The average sediment production rate from road segments was 2.0 and 0.7 kg m^{-2} in 2001 and 2002, respectively. Less than 20% of the roads in Upper Saloon Gulch and Spring Creek were connected to the streams, and approximately 70% in Trumbull. In June 2002, the Hayman fire burned many of the study sites. Mean percent ground cover decreased from 90% to 6% in sites burned at high severity and the soils were strongly water repellent from the surface to a depth of 6 or 9 cm. Although the total rainfall after the fire was only 62 mm, the first two storms of 11 and 17 mm, caused extensive rilling and channel incision. Erosion rates averaged 0.75 kg m^{-2} from a 45-minute storm event on 21 July 2002. At the small watershed scale, the observed high water marks were as much as 1.4 m above the estimated bankfull stage. The Saloon Gulch flume was buried under sediment, while the Brush Creek flume had to be cleaned after every small rain event. Potassium, magnesium, calcium, chloride and nitrate concentrations approximately doubled after the fire, while pH remained unchanged. Thinning operations in unburned swales in Trumbull in fall 2002 decreased the mean vegetative cover from 15% to 7% and increased the mean percent bare soil from 8% to 16%. However, litter and downed wood still covered 75% of the soil surface.

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