Post-fire Erosion in the Colorado Front Range

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Over the past few years there has been a large increase in the number of acres burned by wildfires in the western U.S. In addition to the loss of life and property, there is considerable concern over the effects of these fires on runoff and erosion rates, and how these changes then affect downstream water resources and domestic water supplies. For the past four years we have been intensively studying the effects of wild and prescribed fires on runoff and erosion rates in the Colorado Front Range at different spatial scales, and our primary objectives have included: (1) assessing the strength and persistence of post-fire soil water repellency; (2) using a rainfall simulator to compare runoff and erosion rates between sites and over time; (3) measuring hillslope-scale sediment production rates and developing a series of predictive models; (4) evaluating the effectiveness of post-fire emergency rehabilitation techniques; and (5) measuring runoff and sediment production rates at the small watershed scale (2-5 km^2). A related project is evaluating the effects of forest thinning in the ponderosa pine zone on runoff, erosion, and water quality.

High-intensity convective storms from June through September trigger nearly all of the erosion after wildfires in mid-elevation forests in the Colorado Front Range. Overland flow and surface erosion are generated when rainfall intensities exceed 10 mm hr^{-1}. Burning at high severity increases runoff and erosion rates in forested areas by at least 1-2 orders of magnitude relative to unburned areas. The high runoff and erosion rates can be attributed to the development of a water repellent layer and the loss of surface cover. Both wild and prescribed fires generate a shallow, relatively strong water repellent layer in the soil, but this decays within 1-2 years. Rainfall simulations at the small plot scale indicate that soil water repellency explains only about 30% of the observed variability in runoff rates.

Erosion rates at the small plot and hillslope scale are 5-25 times greater for sites burned at high severity than sites burned at moderate or low severity. Post-fire erosion rates decline only slightly in the second year after burning despite the marked reduction in soil water repellency. Percent ground cover explains 50-80% of the variability in erosion rates at both the small plot and hillslope scale, and we are developing curves to predict ground cover as a function of fire severity and time since burning. The importance of percent cover explains why dry mulching and hydromulching are the most effective treatments for reducing post-fire erosion rates. Contour-felling is only effective for smaller storm events because of the limited sediment storage capacity. Post-fire seeding does not significantly increase percent cover or reduce erosion rates at the small plot or hillslope scale.