Runoff and sediment production from forest fires at two scales

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Abstract. Forest fires may produce large increases in runoff and sediment rates and several processes and factors control the rates. This work share the experience working two on two different scales: 1) runoff and erosion rates from small plots, and 2) sediment production rates at the hillslope scale. On the small plots 70-85 mm of mean rainfall was applied in 60 minutes, and runoff/rainfall ratios generally exceeded 45%. The high rainfall rate meant that runoff/rainfall ratios were only slightly higher from plots burned at high severity than from low severity/unburned plots. Post-fire soil water repellency was the main control on runoff/rainfall ratios. Mean sediment yields from rainfall simulations on high severity sites in the Bobcat wildfire were 1,280 g m^{-2} in 2000 and 1,230 g m^{-2} in 2001. Sediment yields from high severity sites in the Lower Flowers prescribed fire decreased from 850 g m^{-2} in 2000 to 350 g m^{-2} in 2001. High severity plots yielded 16-33 times more sediment than low severity and unburned plots. Regression analysis showed that percent bare soil was the dominant control on sediment yields, although percent silt and the runoff/rainfall ratio were significant factors for high severity sites. At the hillslope scale sediment production rates exceeded 10 Mg ha^{-1} yr^{-1} from sites burned at high severity in a recent wildfire, and only 0.1-4 Mg ha^{-1} yr^{-1} from high severity sites in recent prescribed fires. High severity sites in the Bobcat wildfire produced 75 times more sediment than moderate severity sites. Summer rainstorms generated at least 73% of the sediment at all sites. Sediment production rates from swales or small drainages were 2-3 times higher than planar hillslopes. Multivariate modeling showed that sediment production rates were a function of fire severity, percent bare soil, rainfall erosivity, soil water repellency, and soil particle size. The best model had a R^2 of 0.77. Areas burned at high severity are at particularly high risk for at least the first 2-3 years after burning. To be effective post-fire rehabilitation treatments must immediately provide ground cover and maintain this for at least two years.

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