

Effects of High Park Fire on road surface erosion and road-stream connectivity

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Abstract. Theory would suggest that high- and moderate-severity wildfires should increase sediment production and delivery from unpaved roads due to the increased surface runoff from upslope, but we know of no studies documenting such effects. In this study we conducted a detailed survey of an unpaved road 14 months after the surrounding area burned in the High Park Fire west of Fort Collins, Colorado. The specific objectives were to evaluate how fire severity and road segment characteristics, such as slope and area, affect: 1) the frequency and size of road surface erosion features; and 2) the connectedness of the road drainage features to the stream. The study was conducted on seven kilometers of the Old Flowers Road in the Arapaho-Roosevelt National Forest, Colorado that had burned at low, moderate, and high severity. The survey identified 141 hydrologically distinct road segments with an average length of 49 m (s.d.=18 m) and a mean slope of 8% (s.d.=5%). Increasing burn severity led to increasing rill lengths and widths, but did not significantly affect the mean rill depth of 0.14 m (s.d.=0.08m). Rill surface area was strongly related to road segment slope in areas burned at high severity ($R^2=0.59$), while segment slope explained only 36% and 9% of the variability in rill surface area in areas burned at moderate and low severity, respectively. Segment slope was inversely related ($R^2=0.31$) with the percent of the road surface with sediment deposits. Segments with slopes of less than 5% tended to act as barriers that accumulated sediment, regardless of burn severity. Seventy-one percent of the road segments had a planar design where the surface runoff and sediment from upslope was collected and discharged at a single point or drainage feature. Mean drainage feature width was nearly 1.5 m for the road segments in areas burned at high severity as compared to just 0.85 m for the segments in areas burned at low severity. All of the road segments in areas burned at high and moderate severity had drainage features that connected to a stream, and 87% of the segments in areas burned at low severity also were connected. These exceptionally high rates of road-stream connectivity are due to the increased runoff from upslope, the concentration of runoff to a single drainage feature, and the reduced infiltration and trapping capacity of the burned area below the road. These results indicate that land managers need to greatly increase the frequency of road drainage features after wildfires, and one can expect a sharp increase in road-stream connectivity and road sediment delivery after wildfires.