Connectivity of runoff and sediment from hillslope to watershed-scale in the High Park Fire

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Abstract. The 2012 High Park Fire (HPF) burned 330 km^2 of Colorado's Front Range forests. Downstream communities depend on forested watersheds for recreation and drinking water supplies. Prior research suggests wildfire can increase runoff and sediment yields up to several orders of magnitude, but research connecting hillslope runoff and sediment production to watershed-scale water quality is still needed. The objective of this research is to examine connectivity between hillslope and watershed-scale runoff (Q) and sediment (S) for a large rain event on August 16, 2015 in Hill Gulch of the HPF. Rainfall (P), Q and S were continuously monitored to assess connectivity of runoff and sediment at nested hillslopes (0.76 ha), headwater- (78 ha) and intermediate-catchments (366 ha), contributing to a common watershed outlet (1430 ha). During the August 16 storm, the maximum 5-minute P intensity (MI5) over 3 nested rain gages ranged from 116-122 mm hr^{-1}. At all monitoring locations, runoff responded 12 to 16 minutes after rain began. The time to peak Q after peak MI5 ranged from 10 to 46 minutes, with the shortest lag to peak at hillslope scale and the longest lag to peak at the watershed outlet. Runoff ratios (Q/P) ranged from 0.24 at the hillslope scale to 0.02 at the watershed outlet; with each increase in spatial scale, Q/P decreased by at least 50%. Each catchment experienced an initial rise in turbidity coincident with the rising hydrograph, but turbidity peaked during the hydrograph recession. Time to peak S after peak MI5 ranged from 39 to 135 minutes from the headwater catchment to the watershed outlet. In-stream surveys conducted before and after the event showed that channels both aggraded and incised in response to this storm. The headwater and intermediate catchments aggraded up to 40-45 cm, but aggradation nearly equaled incision at the watershed outlet (20-30 cm). Wolman pebble counts conducted before and after the event reveal fining at the headwater and intermediate catchments and no change in particle size distribution at the watershed outlet. These findings suggest that the event generated highest runoff and erosion in the hillslope headwaters, but much of this runoff and eroded sediment was stored on hillslopes and within the channel network before reaching the watershed outlet.