Estimating and comparing two extreme post-wildfire peak flows in the Colorado Front Range

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Abstract. In June 2012 the High Park Fire just west of Fort Collins, Colorado burned 353 km^2. After the fire the ungaged 15.5 km^2 Skin Gulch watershed experienced two very different large floods; the first was caused by a localized convective storm just after the fire was fully contained, and the second was a highly unusual long duration storm in September 2013, fifteen months after burning. The goal of our study was to characterize the rainfall and resulting peak flows for these two extreme floods, and use the results to help guide future efforts to quantify post-fire peak flows and channel response. Precipitation was estimated with rain gages and bias-corrected radar observations. Peak flows were estimated using at-a-station, 1D, and 2D hydraulic modeling, calibrated to surveyed high water marks. Total rainfall for the convective storm on 6-7 July 2012 was only 20-45 mm, but the estimated maximum 15-minute intensity of 50 mm/h was concentrated over an area that burned at high severity. This storm caused extensive deposition in the channel along with large deposits of woody debris and imbricated boulders. Peak flow estimates ranged up to 240 m^3/s, but our best estimate of the peak flow using a 2D hydraulic model was 70 m^3/s. In contrast, the large storm on 9-15 September 2013 produced 220-240 mm of rain in Skin Gulch with maximum 15-minute intensities of 25-32 mm/h. For this flood the peak flow estimates ranged from 5-65 m^3/s, but our best estimate using a 2D hydraulic model was about 13-35 m^3/s depending on whether one uses the pre- or post-flood channel topography. Although considerably lower than the peak flow for the July 2012 flood, there was widespread incision and channel widening due to its extended duration. The results emphasize the high uncertainty in forensic estimates of peak flows, but both events clearly rank among the largest rainfall-runoff floods ever recorded in the continental United States, and point to the dramatic effects of wildfire on peak flows and channel morphology.