A hydrologic and geomorphic comparison of two extreme post-wildfire floods in the Colorado Front Range

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In 2012, the High Park Fire near Fort Collins, Colorado burned ~353 km^2 and destroyed 259 structures. After the fire, the ungaged 15.5 km^2 Skin Gulch watershed experienced two geomorphically effective floods. Here, we investigate connections among burn severity, storm characteristics, flood response, and geomorphic change by characterizing the hydrometeorology, peak flood discharge, and cross-sectional channel changes for these two extreme events. Bias-corrected radar observations and at-a-station, 1D, and 2D hydraulic modeling calculations are used to characterize the precipitation and peak discharge for each event. The first storm occurred on 6-7 July 2012, just days after the fire was extinguished, when a convective thunderstorm produced total rainfall of ~50 mm with a maximum 15-minute intensity of ~60 mm/h over a portion of Skin Gulch that was burned at high severity. Although this precipitation was relatively modest, the resulting flood caused considerable deposition in the channel and 2D hydraulic calculations suggest the peak discharge was 70-120 m^3/s. The following summer, from 9-15 September 2013, a very unusual multi-day storm produced 279 mm of rainfall, which represents a recurrence interval greater than 500 years, with peak 15-minute intensity of about 100 mm/h. Based on 2D flow analysis, the peak discharge for this event was <50 m^3/s. Although the peak discharge was lower than that of the 2012 event, this flood produced comparable channel change due to its extended duration. Both events rank among the largest rainfall-runoff floods per unit area ever recorded in the continental United States, and point to the dramatic effects wildfire can have on storm event hydrology and channel morphology.