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# Runoff, Erosion, and Channel Changes from Fires and Floods: Comparisons Over Time and Across Spatial Scales

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Both fires and floods are major drivers of geomorphic change, and in this study we compare the relative effects of a 2012 wildfire and a subsequent extreme flood on hillslope erosion and downstream channel change in northcentral Colorado. We also assess whether channel change in the two watersheds was affected by differences in post-fire sediment deposition and the residual effect of an extreme flood nearly forty years earlier. Our primary focus was two 15 km2 watersheds with four years of intensive monitoring, including five tipping bucket rain gages, 29 sediment fences, 10-11 cross-sections and longitudinal profiles in each watershed, and spatially explicit volume changes calculated by differencing DEMs from five sequential lidar datasets. In the Skin Gulch watershed there was much more downstream deposition as a result of an extreme convective storm that occurred just one week after burning, while in Hill Gulch there was much less hillslope erosion, downstream deposition, and subsequent snowmelt incision.

Fifteen months after burning both watersheds were subjected to an extreme long-duration flood that had lower peak rainfall intensities and less hillslope erosion than in the summer convective storms, but the sustained high flows incised up to 1.6 m and scoured out much of the pre-and post-fire deposited sediment, leaving much larger and coarser channels and floodplains. In Skin Gulch, which had been subjected to the large convective storm, the mean increase in cross-sectional area was 7.7 m2 and the mean thalweg incision was 0.67 m, and both of these values were more than five times the corresponding mean values in Hill Gulch. We attribute the much larger change in Skin Gulch to the large convective storm, as this effectively “loaded the gun” by depositing so much post-fire sediment. The relative effect of this fire-flood sequence was compared to historic photos showing that the 1976 Big Thompson flood had a very similar effect in Hill Gulch as the fire-flood sequence in Skin Gulch, even though Hill Gulch was unburned.

These results indicate that: 1) fires can cause tremendous localized erosion and deposition, but the driving summer thunderstorms are much more limited in spatial and temporal scale than the sustained large storms that caused the 1976 and 2013 floods; 2) the longer duration and larger spatial extent of the 1976 and 2013 rainstorms caused much greater channel changes and downstream sedimentation than fires, especially in watersheds larger than Skin and Hill Gulch; and 3) the geomorphic effect of a given disturbance can vary greatly according to the previous disturbance history.