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TITLE: Quantifying post-wildfire erosion patterns using terrestrial LiDAR

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ABSTRACT BODY: Wildfires are becoming increasingly frequent in the western United States. In burned landscapes, geomorphic change can take place rapidly during rainstorms following a wildfire. Rainfall over a burned area tends to mobilize more sediment than in unburned basins because the wildfire changes soil properties, creating more overland flow. A dearth of ground debris allows for deeper and faster flow that can entrain sediment. We apply terrestrial LiDAR to post-wildfire geomorphic change analysis to determine the pattern and magnitude of erosion following rain storms. By differencing digital elevation models created from terrestrial LiDAR surveys, we can measure post-wildfire geomorphic change. Topographic analysis with LiDAR allows us to monitor landscape recovery and evolution following a wildfire.

Traditional methods of post-wildfire erosion analysis have focused on measurements such as erosion pins and silt fences. These capture erosion or deposition at a point or cumulative deposition of the sediment from some unknown contributing area upstream of the silt fence. This requires researchers to integrate measurements over a large area to determine basin-wide erosion. By contrast, successive terrestrial LiDAR surveys allow us to map changes in topography over an entire basin or hillslope to determine the spatial distribution of erosion within a basin or on a hillslope and to correlate the erosion with the hydrologic processes between surveys.

Our study site is a high-severity burn hillslope, burned by the 2010 Fourmile Canyon fire about 15 km west of Boulder, CO. The wildfire was contained on 16 September 2010 and the first LiDAR survey was on 7 October 2010 prior to any significant rain storms. Following this baseline survey, we have used terrestrial LiDAR to capture the landscape state before and after unique hydrologic events such as: low-intensity rain storms, winter snowmelt, and summer convective thunderstorms. Comparing the landscape topography before and after these hydrologic events allows us to quantify the topographic change due to specific hydrologic processes.

The results of our LiDAR survey reveal that at the hillslope scale, erosion is not uniform across the burned hillslope. The maximum erosion on a hillslope area of 1900 m2 showed detectable change on only 4% of the total area, but 4 m3 of erosion. The centimeter scale

LiDAR topography reveals that most of the erosion is concentrated in concave portions of the hillslope where water concentrates, and relatively little inter-rill erosion was observed. Moreover, the majority of erosion occurs during high-intensity short duration summer convective thunderstorms. We saw a mean depth of erosion of 7 cm in a hillslope swale following storms with rainfall intensities greater than 30 mm/hr. However, in the same swale there was a mean erosion depth of 9 mm after a storm with only 10 mm/hr of precipitation. In general, low-intensity long duration rain storms and snowmelt events have had very little effect on our burned hillslope. The change in erosion with changing rainfall intensity is likely linked to switching between saturation-excess overland flow to infiltration-excess overland flow with increasing rainfall intensity.

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