

## Rainfall thresholds for post-fire runoff and erosion from plot to watershed scale

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**Abstract.** Colorado's Front Range watersheds provide municipal water supplies for downstream communities. Many of these watersheds have been affected by wildfire and subsequent runoff, erosion and sedimentation of waterways. Resource managers need information on the frequency and duration of post-fire runoff and erosion, so the objectives of this research were to: (1) identify rainfall thresholds for runoff and erosion within three recent Colorado Front Range wildfires, (2) examine whether thresholds changed with time since burn, spatial extent, and post-fire treatments, and (3) develop a tool for Colorado to estimate the frequency of runoff and erosion events in future fire areas. We identified 60-minute rainfall intensity ( $MI_{60}$ ) thresholds in the range of 0-17  $\text{mm hr}^{-1}$  at untreated plots (<0.06 ha), hillslopes (0.07-5.2 ha) and watersheds (100-1500 ha) during the first two years after fire. When all spatial scales and burned areas were merged, thresholds ranged from 7-8  $\text{mm h}^{-1}$ . Thresholds predicted 56-100% of post-fire runoff and erosion events (average 93% accuracy). For hillslopes, rainfall thresholds in the first two years post-fire were similar for the High Park, Hayman, and Bobcat Fires, with  $MI_{60}$  rainfall ranging from 7-12  $\text{mm h}^{-1}$  and prediction accuracy  $\geq 85\%$ . Thresholds increased substantially during the third year post-fire up to 8-22  $\text{mm hr}^{-1}$ . Mulch and other post-fire treatment effects were not detected at plots, but hillslope thresholds increased on average 1  $\text{mm hr}^{-1}$  with treatment relative to untreated areas. Effects of time since burn on thresholds were detected only in the Bobcat and High Park Fires. Results indicate that spatial scale can change thresholds for runoff, but the direction of change was not consistent from plot to watershed-scale. Many identified rainfall thresholds have less than a 1-year return interval, indicating that post-fire runoff and erosion are likely to occur several times per year during the first two years after fire. Frequency analyses indicate that  $MI_{60}$  rain storms of 4  $\text{mm h}^{-1}$  occur between 6 -  $\geq 10$  times per summer in Colorado, and events with intensities between 5-7  $\text{mm h}^{-1}$  occur between 2-6 times per summer. Understanding the likely frequency of rainfall events that will cause runoff and erosion after fire will help resource managers plan for post-fire runoff and erosion and prioritize treatments in areas with lower thresholds and higher frequencies of threshold exceedance.