Post-fire Channel Change in Small Mountainous Catchments

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Abstract. Increased runoff after high severity wildfire accelerates hillslope erosion and incises gullies into previously unchanneled hillslope swales. Elevated peak flows transport this sediment to downstream reaches where it can adversely affect public water supplies and aquatic ecosystems. Gullies that incised since the fire may rapidly stabilize and fill in as runoff rates decline to pre-fire levels. The pre-fire drainage network ("downstream channels") can either incise or aggrade following wildfire, and we hypothesize that these downstream channels may stabilize more slowly due to the accumulated sediment and decline in peak flows. The objectives of this study were to: (1) compare the slope-area threshold for channel initiation between burned and unburned watersheds; (2) determine if the product of local slope and contributing area can predict the transition from an incising gully to a downstream channel; (3) determine the relative cross-sectional change from summer thunderstorms versus spring snowmelt; and (4) determine whether the magnitude and direction of cross-sectional change varies systematically in the downstream direction or over time. Field measurements focused on two small (3.4 and 6.1 km^2) catchments in the Colorado Front Range that burned in summer 2002. Drainage areas and local slopes were determined for 14 channel heads in the burned watersheds, 4 channel heads in unburned watersheds, and 32 locations where incising gullies transitioned to downstream channels. Seventy cross-sections in 6 gully and 15 downstream reaches were re-surveyed 2-5 times following major storms in summer 2004, after snowmelt in May 2005, and at the end of the study in November 2005.

The slope-area product for unburned channel heads was approximately three orders of magnitude higher than for channel heads in the burned catchments. Slope times contributing area did not reliably predict the transition from an incising gully to a downstream channel. Summer thunderstorms generally caused much more cross-sectional change than spring snowmelt. The mean absolute change in channel cross-sections dropped from 6.7 cm in the wet first summer to 2.2 cm in the dry second summer. There was less incision in the gullies than in most of the downstream channels in both summer 2004 and during snowmelt 2005, while in summer 2005 the gullies aggraded much more than the downstream channels. Longer-term monitoring is needed to determine if the decrease in cross-sectional change and the shift from net incision to aggradation is the first indication of recovery, or a consequence of fewer large storm events in the second summer.

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