Hillslope Erosion Processes after High Severity Wildfires, Colorado Front Range

Joseph H. Pietraszek
Watershed Science Academic Program, Forest, Rangeland, and Watershed Stewardship Dept., Colorado State University, Fort Collins

Lee H. MacDonald
Watershed Science Academic Program, Forest, Rangeland, and Watershed Stewardship Dept., Colorado State University, Fort Collins

Abstract.
High-severity wildfires reduce the infiltration capacity of soil by altering its chemical and physical structure, and removing the surface of litter cover and vegetation. The resulting overland flow causes an extension of the channel network onto hillslopes, and rill erosion in topographically convergent areas. Previous research indicates that sheetwash is the dominant post-fire erosion process on the small (1m²) plot scale (Benavides-Solorio, 2001), while channel incision is the dominant process for drainages of 3.7 to 7.0 ha (Moody and Martin, 2001). The goal of this study was to document the dominant post-fire erosion process at the hillslope scale of 30-7000 m². The specific objectives were to compare erosion rates from planar and convergent hillslopes, quantify rill incision from individual storms, and compare the erosion from rill incision to sediment yields measured with sediment fences.

Sediment yields were measured on 37 sites that burned at high-severity in early summer 2002 in the central Colorado Front Range. Twenty-six sites are in topographically convergent swales and the other 11 sites are on planar hillslopes with contributing areas ranging from 30 to 150 m². Rill incision was measured at 117 cross-sections in the axes of 14 swales.

Unit area sediment yields from individual storms varied by an order of magnitude between sites separated by less than 0.5 km. This variability is largely due to the spatial variability in the amounts and intensity of summer rainstorms. In the swales the mean annual sediment yield for 2003 was 1.3 kg m⁻² yr⁻¹. After normalizing by contributing area and rainfall erosivity, the average sediment production in the swales was 6 times higher than from the planar hillslopes. The cross-sectional area of the rills in the swale axes generally increased with successive rain events in both the first and second summers after burning. Data from 10 storms show that rill erosion in the swale axes can account for approximately 80% of the measured sediment yields. The identification of rill incision as the dominant sediment source at the hillslope scale should improve our predictions of post-fire erosion rates and assist in the design of more effective rehabilitation treatments.

References

1 Watershed Science Academic Program, Forest, Rangeland, and Watershed Stewardship Dept., Colorado State University, Fort Collins, CO 80523-1372; Tel: (970) 491-2774; e-mail: jpietrzk@cnr.colostate.edu
2 Watershed Science Academic Program, Forest, Rangeland, and Watershed Stewardship Dept.; Colorado State University, Fort Collins, CO 80523-1372, Tel: (970) 491-6109, e-mail: leemac@cnr.colostate.edu