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Concentrated flow erosion processes under planned fire

Christoph Langhans, Phil Noske, Rene Van Der Sant, Patrick Lane, and Gary Sheridan
University of Melbourne, Faculty of Science, School of Ecosystem and Forest Science, Parkville, Australia
(christoph.langhans@unimelb.edu.au)

The role of wildfire in accelerating erosion rates for a certain period after fire has been well documented. Much less information is available on the erosion rates and processes after planned fires that typically burn at much lower intensity. Observational evidence, and some studies in southern and southeastern Australia suggest that erosion after planned fire can be significant if rainfall intensities exceed critical intensities and durations. Understanding erosion processes and rates under these event conditions is of critical importance for planning of burn locations away from critical human assets such as water supplies and infrastructure. We conducted concentrated flow experiments with the purpose to understand what critical conditions are required for significant erosion to occur on planned burn hillslopes.
Concentrated flow runon was applied on pre-wetted, unbounded plots of 10 m at rates of 0.5, 1, 1.5 and 2 L/s, with three replicates for each rates applied at 1m distance of each other. The experiments were carried out at three sites within one burn perimeter with different burn severities ranging from low to high, with two replicates at each site. Runon was applied until an apparent steady state in runoff was reached at the lower plot boundary, which was typically between 0.7 and 2.5 minutes. The experiments were filmed and erosion depth was measured by survey methods at 1m intervals. Soil surface properties, including potential sediment trapping objects were measured and surveyed near the plots.
We found that fire severity increased plot scale average erosion depth significantly even as experiments were typically much shorter on the high severity plots. Unit stream power was a good predictor for average erosion depth. Uncontrolled for variations in soil surface properties explained process behaviour: finer, ash rich surface material was much less likely to be trapped by fallen, charred branches and litter than coarser, ash-depleted material. Furthermore, the erosion of coarser material was more threshold dependent as mobilized stones form granular lobes that can readily stop or re-mobilize depending on stream power. Low severity sites had much more trapping objects remaining on the soils surface than higher severity sites, which means that high fire severity increases the probability of sediment transport to the channels, especially for coarse material.