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Infiltration Process in Fire-affected Soils

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Post-wildfire infiltration is not well understood, which limits the ability to predict post-wildfire runoff. The time-to-start of runoff, soil-water content, rainfall intensity, and infiltration rates were measured on a hillslope burned by the 2010 Fourmile Canyon Fire west of Boulder, Colorado during rainstorms in 2011. A 1-D numerical model of infiltration was calibrated and evaluated using these data and measured soil physical properties to provide insight into the post-wildfire infiltration process.

Field saturated, vertical-hydraulic conductivity, Ks predicted by the model ranged from 0.1 to 10 mm/h, and only a shallow layer of soil of thickness, hw (the upper 10-20 mm) controlled runoff generation. Time-to-start of runoff, tp, was sensitive to the initial soil-water content at the start of rainfall, but tp did not correlate with initial soil-water content for all rainstorms. It was hypothesized that the shape of the rainfall profile affected tp. A simple analytical model was developed to predict tp by incorporating the soil saturation deficit (saturated soil-water content minus initial soil-water content) and a rainfall metric that estimates the initial rate of increase in the rainfall intensity. This model of tp explained about 92% of the variance of tp, and predicted values of tp that were nearly identical to observed values. These results strongly suggest that tp in burned soils, with low values of Ks, is probably controlled more by the rainstorm profile and the initial soil saturation deficit than by Ks.