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Insights into Runoff Provided by Infiltration Measurements made during Different Types of Rainstorms

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Difference infiltrometers, specifically designed to measure infiltration during temporally variable rainfall, were deployed at six sites in a mountainous area burned by the 2010 Fourmile Canyon Fire near Boulder, Colorado, USA. The infiltrometer use a novel adaptation of two, tipping-bucket rain gages. One gage measures rainfall onto, and the other measures runoff from a small circular plot about 0.5-m in diameter. Infiltration rate is computed from the difference of the cumulative rainfall and cumulative runoff. During the summer of 2011, data were collected during 25 storm cells. Nine cells were part of cyclonic frontal storms (low intensity, long duration) and 16 cells were part of convective storms (high intensity, short duration). Soil-water content was measured by using the thermogravimetric method for surface samples (0-3 cm) collected near the difference infiltrometers 3-4 times per week. These thermogravimetric values were used in conjunction with a time series (1-minute interval) recorded by soil sensors at 5 cm below the surface to estimate, every minute, the soil-water content at the surface.

Half of the data sets from two sites were used to estimate parameters in models of infiltration into the unsaturated zone, and half were used for verification. The models were then used as tools to determine the salient relations between variables that determine (1) the runoff coefficient, (2) peak runoff, (3) the elapsed time from the beginning of rainfall to the start of runoff, and (4) for delineating the domains where the capillary process and gravity process are dominant. Initial results indicate that the time to the start of runoff had an inverse relation with the initial soil-water content at the beginning of rainfall for a storm cell, and that the peak runoff was related to peak rainfall intensity and to initial soil-water content. These results provide insights into the infiltration process, and thus, provide the foundation for physically based rainfall-runoff models and specifically, in this application, models for areas burned by wildfire.