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A small single-nozzle rainfall simulator to measure erosion response on different burn severities in southern British Columbia, Canada

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To study the effects of wildfire burn severity on runoff generation and soil erosion from high intensity rainfall, we constructed an effective yet simple rainfall simulator that was inexpensive, portable and easily operated by two people on steep, forested slopes in southern British Columbia, Canada. The entire apparatus, including simulator, pumps, hoses, collapsible water bladders and sample bottles, was designed to fit into a single full-sized pick-up truck. The three-legged simulator extended to approximately 3.3 metres above ground on steep slopes and used a single Spraying Systems 1/2HH-30WSQ nozzle which can easily be interchanged for other sized nozzles. Rainfall characteristics were measured using a digital camera which took images of the raindrops against a grid. Median drop size and velocity 5 cm above ground were measured and found to be 3/4 of the size of natural rain drops of that diameter class, and fell 7% faster than terminal velocity.

The simulator was used for experiments on runoff and erosion on sites burned in 2007 by two wildfires in southern British Columbia. Simulations were repeated one and two years after the fires. Rainfall was simulated at an average rate of 67 mm hr^{-1} over a 1 m^2 plot for 20 minutes. This rainfall rate is similar to the 100 year return period rainfall intensity for this duration at a nearby weather station. Simulations were conducted on five replicate 1 m^2 plots in each experimental unit including high burn severity, moderate burn severity, unburned, and unburned with forest floor removed. During the simulation a sample was collected for 30 seconds every minute, with two additional samples until runoff ceased, resulting in 22 samples per simulation. Runoff, overland flow coefficient, infiltration and sediment yield were compared between treatments. Additional simulations were conducted immediately after a 2009 wildfire to test different mulch treatments.

Typical results showed that runoff on plots with high burn severity and with forest floor removed was similar, reaching on average a steady rate of about 60% of rainfall rate after about 7 minutes. Runoff on unburned plots with intact forest floor was much lower, typically less than 20% of rainfall rate. Sediment yield was greatest on plots with forest floor removed, followed by severely burned plots. Sediment yield on unburned and moderately burned plots was very low to zero. These results are consistent with qualitative observations made following several extreme rainfall events on recent burns in the region.