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Influence of fire-induced water repellency on runoff and erosion

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Wildfire is a major ecological process and the recent increase in the number and severity of large wildfires has renewed interest in fire effects on soil properties such as infiltration and soil erodibility. In general, fire-induced soil heating and combustion of organic matter reduce infiltration by creating water repellent soil conditions. This effect is more pronounced when soils are exposed to prolong and/or extreme soil heating (high severity burn), causing a strong water-repellent layer to develop 1 to 3 centimeters below the soil surface. This sub-surface water repellent layer results in additional runoff and increased surface erosion. This increase in erosion is a major concern when valuable resources are located downstream.

Rainfall/rill simulation techniques and mini-disk infiltrometers have been used to measure the changes in infiltration due to fire. Runoff hydrographs were relatively constant with high hydraulic conductivity in unburned-undisturbed and low severity burn plots. Hydrographs from areas burned at high severity, although highly variable, indicate greater runoff and erosion rates than the plots in low-severity burn areas, especially during the initial stages of the rainfall event. These high runoff rates generally decreased to a constant rate over the last 10 to 15 minutes of the hour-long simulation event. These results indicate that water repellent soil conditions cause a temporary 10 to 40 percent reduction in hydraulic conductivity values as compared to non-burned soil. However, some volcanic ash-cap soils exhibit low infiltration rates and are naturally water repellent when they are very dry. Water repellency, whether wildfire induced and natural, makes the soil highly erodible—especially during high intensity rainfall.