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Advances in Predicting Soil Erosion After Fire Using the Rangeland Hydrology and Erosion Model

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The magnitude of erosion from a hillslope is governed by the availability of sediment and connectivity of overland flow and erosion processes. For undisturbed conditions, sediment is mainly detached and transported by rainsplash and sheetflow (splash-sheet) processes in bare batches, but sediment generally only travels a short distance before deposition. On recently disturbed sites (e.g., after fire), bare ground is more extensive and runoff and erosion rates are higher relative to undisturbed conditions. Increased erosion following disturbance occurs largely due to a shift from splash-sheet to concentrated-flow-dominated processes. On long-disturbed sites (e.g., after woody plant encroachment), years of soil loss can limit sediment availability and soil erosion. In contrast, recently burned landscapes typically have ample sediment available and generate high erosion rates. This presentation highlights recent advancements in hillslope erosion prediction by the Rangeland Hydrology and Erosion Model (RHEM) that accommodate recently burned conditions. The RHEM tool is a process-based model that was developed specifically for predicting hillslope runoff and erosion on rangeland ecosystems. The advancements presented here include development of empirical equations to predict erodibility parameters for conditions in which erosion by concentrated flow processes is limited (by runoff or sediment availability) and an erodibility parameter for conditions in which erosion by concentrated flow processes is the dominant erosion mechanism and sediment is amply available (burned conditions). The data used for developing and evaluating the erodibility parameter equations were obtained from rainfall simulation databases maintained by the USDA-Agricultural Research Service. The data span undisturbed, long-disturbed, and recently burned conditions. For undisturbed and long-disturbed conditions, a regression analysis was applied to derive the relationship between splash-sheet erodibility as dependent variable and ground and canopy cover attributes, slope, and soil texture as independent variables. Piecewise (segmented) regression analysis was applied where two continuous relationships between the log-transformed erodibility and the independent variables were fitted to improve the linear relationship. For burned, recently-disturbed conditions, empirical equations were developed by applying regression analysis to predict the differences of concentrated flow erodibility before and after fire as a function of vegetation cover and soil texture. This approach also uses an empirical function to predict temporal erodibility variation within a runoff event as a function of cumulative overland flow. These two erodibility estimation approaches were tested in the Rangeland Hydrology and Erosion Model (RHEM) and showed satisfactory results in predicting impact of various disturbances on erosion, including the immediate effects of burning.