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Quantifying soil burn severity for hydrologic modeling to assess post-fire effects on sediment delivery

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Soil erosion is a secondary fire effect with great implications for many ecosystem resources. Depending on the burn severity, topography, and the weather immediately after the fire, soil erosion can impact municipal water supplies, degrade water quality, and reduce reservoirs' storage capacity. Scientists and managers use field and remotely sensed data to quickly assess post-fire burn severity in ecologically-sensitive areas. From these assessments, mitigation activities are implemented to minimize post-fire flood and soil erosion and to facilitate post-fire vegetation recovery. Alternatively, land managers can use fire behavior and spread models (e.g. FlamMap, FARSITE, FOFEM, or CONSUME) to identify sensitive areas a priori, and apply strategies such as fuel reduction treatments to proactively minimize the risk of wildfire spread and increased burn severity. There is a growing interest in linking fire behavior and spread models with hydrology-based soil erosion models to provide site-specific assessment of mitigation treatments on post-fire runoff and erosion. The challenge remains, however, that many burn severity mapping and modeling products quantify vegetation loss rather than measuring soil burn severity. Wildfire burn severity is spatially heterogeneous and depends on the pre-fire vegetation cover, fuel load, topography, and weather. Severities also differ depending on the variable of interest (e.g. soil, vegetation). In the United States, Burned Area Reflectance Classification (BARC) maps, derived from Landsat satellite images, are used as an initial burn severity assessment. BARC maps are classified from either a Normalized Burn Ratio (NBR) or differenced Normalized Burned Ratio (dNBR) scene into four classes (Unburned, Low, Moderate, and High severity). The development of soil burn severity maps requires further manual field validation efforts to transform the BARC maps into a product more applicable for post-fire soil rehabilitation activities. Alternative spectral indices and modeled output approaches may prove better predictors of soil burn severity and hydrologic effects, but these have not yet been assessed in a model framework. In this project we compare field-verified soil burn severity maps to satellite-derived and modeled burn severity maps. We quantify the extent to which there are systematic differences in these mapping products. We then use the Water Erosion Prediction Project (WEPP) hydrologic soil erosion model to assess sediment delivery from these fires using the predicted and observed soil burn severity maps. Finally, we discuss differences in observed and predicted soil burn severity maps and application to watersheds in the Pacific Northwest to estimate post-fire sediment delivery.