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Quantifying Post-fire Sediment Transport Processes with USACE Numerical Models

Ian Floyd, Nawa Pradhan, and Charles Downer

U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, United States (ian.e.floyd@usace.army.mil)

The 2011 Las Conchas Wildfire burned more than 600 km^2 of forested land in the Jemez Mountains. Burn severity was greatest in the mountainous headwaters of some 15 streams that drain directly to the Rio Grande and into U.S. Army Corps of Engineers (USACE) Cochiti Reservoir, a multipurpose reservoir. The affected basins have shed sediment at rates far above their historic quantities. Recovery of these watersheds is decades away, creating an ongoing sediment management problem at Cochiti Reservoir. Observational and limited modeling data indicate dramatic changes in watershed hydrology, geomorphology, and ecology have occurred within the burn area. Watershed hydrologic studies at Santa Clara Creek found that post-fire peak flow conditions increased by 400% (e.g., 1% chance event increased from 140 to 560 m3/s). Other tributaries where data have been collected, such as Frijoles Canyon in Bandelier National Monument, show similar ongoing changes in flood hydrology. In this effort we incorporated shallow-water non-Newtonian closer approaches into the USACE Gridded Surface Subsurface Hydrologic Analysis (GSSHA) and Adaptive Hydraulics numerical models, while accounting for non-Newtonian sediment transport processes with the SEDLIB Sediment Transport Library. The GSSHA and AdH numerical models linked with SEDLIB provides a modeling framework that addresses complex post-fire spatial variability, physical changes to the subsurface by representing the soil layers as multiple discrete layers each with varying properties. The models where validated against debris-flow flume data and in situ empirical data collected following the Las Conchas fire. The initial results show improvements in replicating post-fire floods and non-Newtonian sedimentation events, especially predicting dynamic bed interaction and sediment entrainment.