Abstract

Landscape and Management Response to Wildfires in California

by

Frederick Andrew Booker

Master of Science in Geology

University of California, Berkeley

Professor William E. Dietrich, Chair

Studies of fire areas throughout the western United States and Australia provided information about the potential for the timing, magnitude, and sources of increased runoff and erosion from burned watersheds, and the effectiveness of post-fire mitigation.

A combination of field monitoring and sprinkler experiments revealed the link between soil strength and texture on the position of hydrophobic horizons and their relationship in the generation of rill networks in fire areas. Use of a Torvane shear tester to measure the resistance of a soil surface to shear, revealed a threshold of 0.1 kg cm^{-2} between rilled and unrilled soils. Thin, fine textured soils along crest slopes, typically had shear values higher than the threshold and hydrophobic horizons close to the surface. These soils tended to generate Horton overland flow. Soils with shear strengths below the threshold typically had hydrophobic horizons at some depth within a layer of coarse non-cohesive sediments which supported perched throughflow leading to saturated overland flow. When Horton overland flow encountered these downslope soils of lower cohesion, rilling occurred by a process of ploughing, entrainment and deposition in a repeating sequence dictated by local perturbations in slope and heterogeneity of infiltration. Once established, rill networks increased flows to the channel resulting in the flushing of

accumulated sediment and ravel.

A review of nearly seventy years of debris basin data for the San Gabriel Mountains revealed that the greater the proportion of watershed area with slopes greater than 35 degrees, the higher the sediment yield. Additionally, sediment yields from the San Gabriel Mountains were not dominated by fire events, but rather by major storm events.

Erosion control following wildfires was generally ineffective. Applied grass seeds germinated after first rainfalls had already caused most of the erosion, and generally failed to reach sufficient cover to be beneficial. Furthermore, landslides appeared to be less common on bare, hydrophobic soils, than on soils with successful grass seed germination or on unburned grassy areas. The use of temporary channel structures to trap and store sediment proved to be ineffective because their design typically could not handle the high flows generated from burned watersheds.

Keywords: wildfire; erosion; runoff; debris flow; debris torrent; landslide; ravel; rill; shear strength; erosion control