United States Department of the Interior
GEOLOGICAL SURVEY
Geologic Hazards Team
MS 966, Box 25046
Denver, Colorado 80225-0046
16 October, 2008

Rob Clyburn
Monterey County Office of Emergency Services

Dear Mr. Clyburn:

At the request of the State Office of Emergency Services, we performed an emergency assessment of debris-flow hazards from the area burned by the Basin Fire and Indian Fires of 2008. This approach uses tools developed specifically for post-fire debris flow processes, and addresses two of the fundamental questions in debris-flow hazard assessments: where might debris flows occur and how big might they be?

A statistical-empirical model was used to calculate the probability of debris-flow production from individual drainage basins in response to a given storm event. This model was developed using logistic regression analyses of a database from 337 basins located in 13 recent burned areas in southern California. The model describes debris-flow probability as a combined function of areal burned extent, soil properties, basin characteristics and rainfall. A similar statistical model was used to estimate the volume of material that may issue from a basin mouth in response to the same storm. This model was developed using multiple linear regression analysis of a database from 56 basins burned by eight fires throughout the intermountain west and southern California (Gartner and others, 2008), and describes debris-flow volume as a function of the basin gradient, aerial burned extent and storm rainfall. In this assessment, the probability and volume relative rankings are combined to calculate a 'Relative Hazard Ranking'. The 'Combined Relative Hazard Ranking' identifies a possible spectrum of responses that range from basins that are most prone to the largest debris-flow events to basins with the lowest probabilities of producing small events.

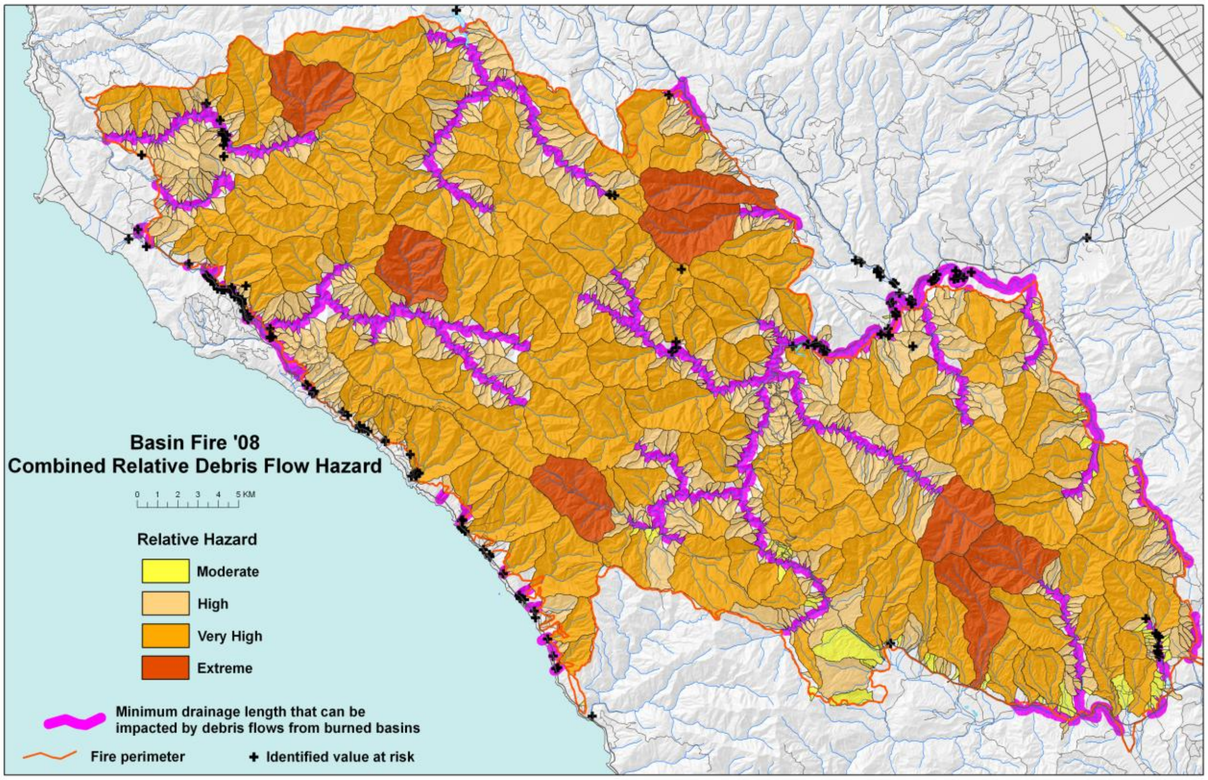
The models were implemented using the mapped burn severity distribution of the Basin and Indian Fires provided by USDA Forest Service and a 10-year recurrence, 3-hour duration storm of 1.9 inches (NOAA Technical Paper No. 40) to calculate the probability that a given basin will produce debris flows, to calculate an estimated volume of the possible debris-flow response at the basin outlet, and to determine a 'Combined Relative Hazard Ranking'. The 'Combined Relative Hazard Ranking' is shown as a map in Figure 1.

For the 829 basins evaluated, the probability that a basin would produce a debris flow in response to the 10-year recurrence, 3-hour duration storm was calculated to be greater than 80% for all but 45 of the basins. In our experience, these are very high probabilities of occurrence, and reflect the relatively steep slopes and low clay content-soils in the area.

Calculated debris-flow volumes ranged between 114 m^3 and 126,000 m^3 in response to the same storm. Debris-flow volumes greater than 10,000 m^3 were calculated for 152 of the 829 basins. Debris flows within this range of volumes pose significant hazards to life and property.

The Combined Relative Hazard Rankings determined for each basin were either 'moderate', 'high', 'very high', or 'extreme' (Figure 1). None were classified with a 'low' relative ranking.

Figure 1. Map of 'Combined Relative Hazard Ranking' calculated for basins within the Basin Fire.



In addition to the potential dangers within the basins evaluated here, areas downstream from the defined basin outlets are at risk. Debris flows can travel long distances over fairly gentle slopes, and the minimum drainage lengths that can be impacted by debris are shown on the map of 'Combined Relative Hazard' (Figure 1). Neighborhoods, buildings, roads and bridges located along drainages within or below the burned basins can be impacted by debris flows. There is a great possibility of culverts and bridges plugging or being overwhelmed, and of roads washing out. Material transported in fast-moving debris flows presents a considerable hazard to residents, motorists, cyclists and pedestrians. Burned basins above identified 'values at risk' will require appropriate mitigation or warning efforts.

The potential for debris-flow activity decreases with time as revegetation stabilizes hillslopes and material is removed from canyons. A compilation of information on post-fire runoff events reported in the literature from throughout the western United States indicates that under normal rainfall conditions most debris-flow activity occurs within about 2 years following a fire (Gartner and others 2005). If dry conditions prevent sufficient re-growth of vegetation, this recovery period will be longer. We conservatively expect that the maps presented here may be applicable for approximately 3 years after the fires, given the magnitude and duration of precipitation considered in the models. Storms with greater rainfall accumulations, intensities or durations may present more severe hazards than those depicted here. Further, the assessments presented here are specific to post-fire debris flows; significant hazards from flash flooding can remain for many years after a fire.

The parameters included in the models are considered to be possible first-order effects on debris flow generation that can be rapidly evaluated immediately after a fire in southern California. Other conditions than those used in the models may also affect debris-flow production from recently burned basins in northern California. However, data necessary to evaluate these effects in this setting are not currently available.

And lastly, this work is preliminary, is subject to revision, and has not been fully reviewed and approved by the USGS Director. It is being provided due to the urgent need for timely "best science" information.

Sincerely,

Susan H. Cannon
Research Geologist