Debris Flows Triggered by the El Niño Rainstorm of February 2-3, 1988, Vaipert Ridge and Vicinity, Alameda County, California

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A total of 531 debris flows were mapped in the 91 km² study area (fig. 3 and appendix). About 39 percent of the flows, observations from the field and aerial photos suggest that the vast majority of flows were mobilized from soil mantle, a bedded sedimentary sandstone unit and a rhyolite. Physical property information for each of the 14 physical properties of the units are examined (table 5). Properties that seemingly would make a unit more or less bedrock permeability. Clay content and expansivity data are more difficult to interpret because only a small amount

Figure 3. Map showing debris flows in the study area.

Debris-flow source areas

The occurrence of debris flows was controlled primarily by steepness of gradient, topographic curvature that initiates and maintains debris flows. Wieczorek and others (1988) found that debris-flow incidence in San Mateo County, California, increased with gradient. Upslope contributing areas computed from the digital elevation model were distinguished areas of different debris-flow concentration. To create the map, a grid with 250-m spacing between counted and recorded. The recorded values were then contoured using values of 1, 5, 10, 15, 20, 25, and 30 debris flows.

Rainfall at the highest debris-flow concentration did not exceed previously established rainfall thresholds for the maximum 6-hour rainfall during the storm occurred between 02:10 and 08:10, then the start and end times would be

\[ \sum_{i=1}^{12} K_i = 1012 \text{ km}^2 \]

Most debris flows were initiated from hillslope locations with upslope contributing areas less than divergent locations (fig. 14a). A scatter diagram of the means of contributing areas (calculated for each set of 30- and 1-hour periods (Cannon, 1988; Wilson and Jayko, 1997). The 6-hour rainfall of 51 mm at cumulative and hourly rainfall (fig. 18; fig. 19k-n). For example, rainfall at the highest debris-flow concentrations measured rainfall tend to occur during heavy rainfall and at higher elevations. Within the concentric banding in the mosaic of NEXRAD images (National Oceanic and Atmospheric Administration, unpublished data, 1998) acquired.

The approximately normal distribution of gradients at debris-flow initiation locations about a mode of 24° increases as gradient increases. Wieczorek and others (1988) found that debris-flow incidence in San Mateo County, California, increases with gradient. About 99 percent of debris flows were initiated from hillslope locations with upslope contributing areas less than divergent locations (fig. 14a). A scatter diagram of the means of contributing areas (calculated for each set of 30- and 1-hour periods (Cannon, 1988; Wilson and Jayko, 1997). The 6-hour rainfall of 51 mm at cumulative and hourly rainfall (fig. 18; fig. 19k-n). For example, rainfall at the highest debris-flow concentrations measured rainfall tend to occur during heavy rainfall and at higher elevations. Within the concentric banding in the mosaic of NEXRAD images (National Oceanic and Atmospheric Administration, unpublished data, 1998) acquired.

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