Introduction

The objective of this report is to present a preliminary emergency assessment of the potential for debris-flow generation from basins burned by the Poomacha Fire in San Diego County, southern California in 2007. Debris flows are among the most hazardous geologic phenomena (Turner and Schoene, 1996). Debris flows that followed wildfires in southern California in 2007 killed 18 people and caused tens of millions of dollars of property damage (NOAA-USGS Debris Flow Task Force, 2008). A short period of even moderate rainfall on a burned watershed can lead to debris flows (Canan and others, 2008). Rainfall that is normally absorbed into hillslopes will run off almost instantly after vegetation has been removed by wildfire. This causes much more and more rapid runoff than is normal from creeks and drainage areas. Highly soluble sediments in a burned area allow fixed sediments to erode large amounts of ash, sand, silt, and unburned vegetation. Within the burned area and downstream, the force of melting water, soil, and rock can destroy culverts, bridges, roadways, and buildings, potentially causing injury or death.

This emergency debris-flow hazard assessment is presented as a relative ranking of predicted medium volumes of debris flows that can issue from basin outlet in response to 2.25 inches (57.15 mm) of rainfall over a 3-hour period. Such a storm has a 10-year return period (Hendriks, 1995). The calculation of debris-flow volume is based on a multiple-regression statistical model that describes the median volume of material that can be expected from a recently burned basin as a function of the area burned at high and moderate severity, the basin outlet slope steepness, and the areal rainfall from the storm. These data are from the U.S. Geological Survey’s (USGS) National Water Information System and the U.S. National Weather Service (http://www.wrh.noaa.gov/sgx/hydro/debris_flow.php). The goal of this assessment is to provide useful information for decision makers, particularly in support of emergency management activities.

Use and Limitations of the Map

This map shows potential locations possibly hazardous debris flows as estimates of median volumes of material that may issue from the outlets of basins burned by the Poomacha Fire of 2007 in southern California in response to a 10-year occurrence. These are not actual measurements. The map identifies the range of potential debris-flow volumes that can issue from individual basin outlets. This information can be used to issue warnings for specific locations, to prioritize mitigation efforts, to aid in the design of mitigation structures, and to guide decisions for evacuation, shelter, and escape routes in the event that storms of similar magnitude to that evaluated here are forecast for the area.

In addition to the potential dangers within the basins, areas downstream from the basin outlets are also at risk. In some of these areas homes were destroyed by the fire, and workers and residents may be faced with clearing and debris removal. The potential for debris flows during rainfall events places these people at high risk. In addition, if obstacles are plugged or overtopped by debris flows, or if roads wash out, motorists may be stranded for long periods of time. In some cases, channels cross roads or blind curves where motorists could attempt to encounter debris-flow deposits on the road.

In addition to the colored drainage basins, small debris flows can be generated from non-colored areas within the basin perimeter. These areas were not included in the analysis because they are occupied by other planar hillslopes or basins that are smaller than those used in the model development (Canan and others, 2008).

We expect that the map presented here may be applicable for approximately three years after the fires for the storm conditions considered. The potential for debris-flow activity decreases with time following fire and the occurrence frequencies and magnitudes of debris flows. A compilation of information on past debris events from throughout the western U.S. indicates that under normal rainfall conditions most debris-flow activity occurs within about two years following a fire. If dry conditions do not slow vegetation growth, this recovery period will be longer. Our assessment is specific to the debris flows, significant flash flooding can remain for many years after a fire.

This assessment is based on the assumption that all basins are equally prone to debris flows. Recent work has indicated that, in addition to the volume, the probability of debris flow will vary with basin severity, basin gradient, material properties and storm rainfall. Unfortunately, a determination of debris-flow probability cannot yet be incorporated into this hazard assessment.

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Suggested Actions

People-occupying businesses, homes, and recreational facilities downstream of the basins identified as the most hazardous must be informed of the potential dangers from debris flows and flooding. Warning must be given even for those basins with engineered mitigation structures at their mouths in the event that the structures are not adequate to contain potential debris flows. Site-specific debris-flow hazard assessments ought to be performed upstream from structures and facilities in areas identified as being at risk.

Because this assessment is specific to post-fire debris flows, further assessment of potential hazards posed by flash floods is needed. Continued operation of the early-warning system for both flash floods and debris flows established by NOAA’s National Weather Service and the U.S. Geological Survey (http://www.wrh.noaa.gov/sgx/hydro/debris_flow.php) NOAA-USGS Debris Flow Task Force, 2008) would help local officials make decisions to prevent or mitigate potential dangers of debris flows in advance of rainfall events. The system consists of an extensive reporting rain-gage and stream-gage network coupled with National Weather Service weather forecasts and radar rainfall measurements. Any early warning system should be coordinated with existing county and flood districts facilities.

An evaluation of the effectiveness of hillside and channel mitigation approaches focused on the ability of different treatment methods to decrease the potential volume of debris flows (deWolfe, 2006, 2008) and others, 2008). This work found that extensive applications of treatments that promote rainfall infiltration into hillside blocks with engineered works that control incision in low-gradient channel reaches can effectively mitigate debris-flows impacts in basins less than about 2 km2 in area that are expected to produce debris-flow volumes of less than 10,000 m3. Large engineered check dams or collection basins are necessary to effectively mitigate hazards posed by streams from basins larger than about two km2 that are expected to produce debris-flow volumes greater than about 10,000 m3 (Hungr and others, 1987; Fiebiger, 1997; Okubo and others, 1997; Horsman, 2000; deWolfe, 2006).

References Cited


U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN FILE REPORT 2007–1411
Version 1.0