Planning for Fire-Related Debris-Flow Hazards Using GIS

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Abstract

The Utah Geological Survey produces geologic hazard maps using Geographic Information Systems to assist with land-use planning. Local governments and agencies can use the GIS data and maps in their planning process to identify hazard areas and to aid in planning decisions.

Both wildfires and debris flows are prominent natural hazards along the wildland-urban interface in Utah. Wildfires greatly increase the debris-flow hazard due to the loss of vegetation and the formation of water-repellent soils on steep slopes. Brief intense thunderstorm rainfall of 0.5 inch or less can trigger debris flows in burn areas. Debris flows can occur with little warning and can cause damage to property and threaten lives. The debris-flow hazard is drastically increased following a fire and communities without protective structures are at substantial risk.

In August 2001, wildfires burned the mountain slopes on Dry Mountain above Santaquin. On the evening of September 12, 2002, intense thunderstorm rainfall on burned slopes of Dry Mountain triggered 10 debris flows that damaged houses and property. A small amount of intense thunderstorm rainfall, 0.27 in. over approximately 15 minutes, triggered the debris flows. The debris flows occurred with little warning and homeowners had little time to react as the flows traveled into subdivisions, damaging houses and property and depositing sediment. One flow traveled through a subdivision, moving and partially burying several vehicles, breaking through a house wall, and flowing into other houses through broken basement windows and doors. Thunderstorm rainfall triggered two additional debris flows on July 26, 2004, but no houses or residential properties were damaged.

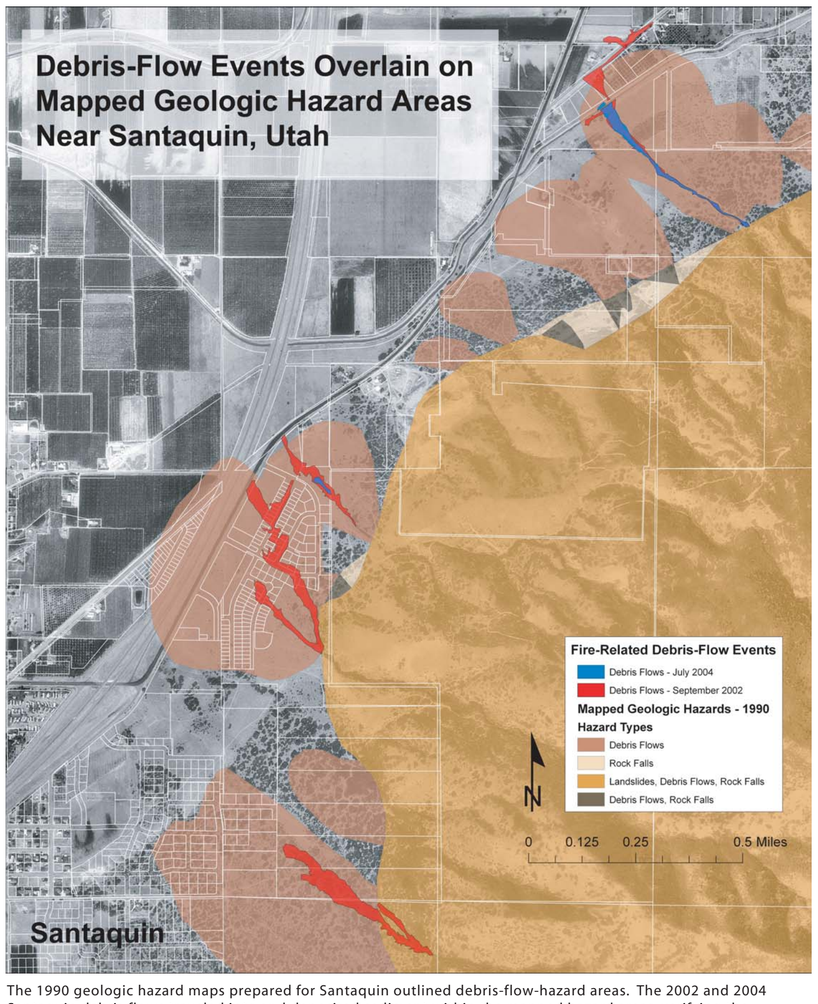
The GIS geologic hazard maps show areas prone to debris flows. The maps combine data from various sources including: geologic maps, digital elevation models, slope models, digital orthophoto quadrangles, and global positioning system data collected in the field. The 1990 geologic hazard maps prepared for Santaquin outlined debris-flow-hazard areas. The 2002 and 2004 Santaquin debris flows traveled into and deposited sediment within the mapped hazard areas, verifying the map boundaries and showing the map's usefulness for land-use planning. The GIS geologic hazard maps can be incorporated into city and county hazard ordinances to address debris-flow hazards prior to development.

Urban development near wildland areas introduces many natural hazards including fire-related debris flows. Fires in wildland areas greatly increase the debris-flow hazard . Brief intense thunderstorm rainfall of 0.5 inch or less can trigger debris flows in burn areas (U.S. Forest Service photo).

U.S. Forest Service employees assess burn conditions following the 2001 fire on Y Mountain, near Provo, Utah. Burn severity is one factor that contributes to fire-related debris flows (Utah Geological Survey photo).

Oblique air photo showing debris-flow deposits from the September 12, 2002 event. Three debris flows deposited sediment in subdivisions built on alluvial fans in Spring Lake and Santaquin, and others deposited sediment in undeveloped areas. The debris flow shown above partially buried several vehicles, broke through a house wall, and entered other houses by breaking basement windows and doors. Five homes and two businesses received major damage and 27 homes received minor damage (U.S. Forest Service photo).

The September 12, 2002 debris flow broke through the back wall of this house on Peach Street in Santaquin (Utah Geological Survey photo).



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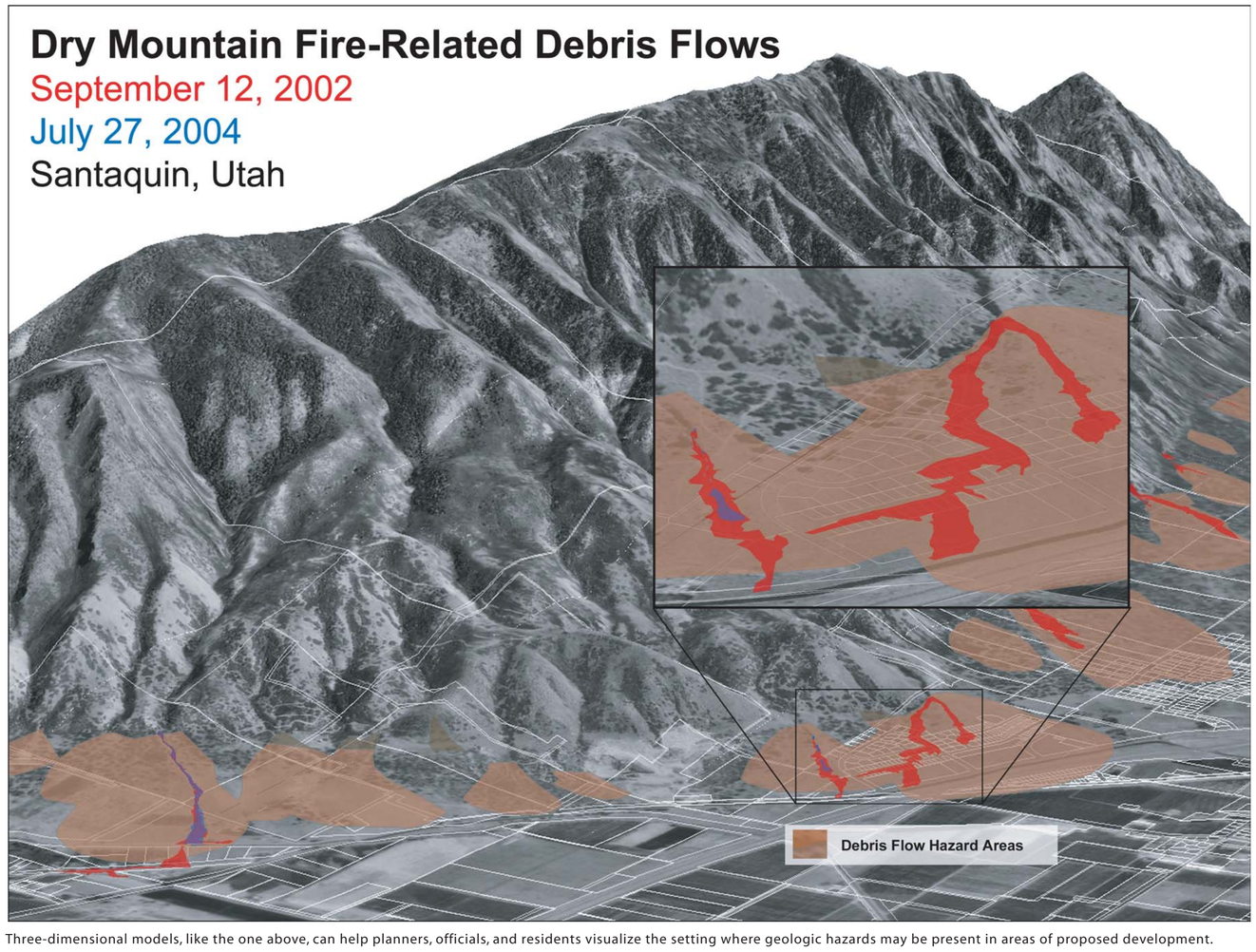

Three-dimensional models, like the one above, can help planners, officials, and residents visualize the setting where geologic hazards may be present in areas of proposed development.