RESEARCH NOTES
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Corridor-Scale Landslide Hazard Maps Provide "Big Picture" for Planning and Mitigation

RESULTS: ***Under the direction of the GeoResearch Group, the California Geological Survey is piloting the development of "corridor-scale landslide hazard maps" to meet the needs of various Caltrans users. The maps provide a comprehensive inventory of landslide activity along a selection of highway corridors, and are presented at a scale and in a format that is meaningful to engineers, planners, and maintenance staff. This "big picture" perspective will benefit planning of route improvements and lead to more effective landslide risk mitigation measures.***

Why We Pursued This Research

Caltrans has responsibility for over 1200 miles of landslide-prone highway corridors throughout California. Routine landslide maintenance costs over $10 million annually, and particularly problematic slides have led to $100's of millions in capital expenditures. Impacts of landslides include not only road closures with the resulting traffic delays and economic effects, but also can produce adverse environmental impacts ranging from view degradation to water-quality issues.

Landslide hazards often go unrecognized until it is too late and costs have already been incurred. Seemingly inadvertent alterations to roadway or drainage systems associated with routine maintenance or minor alignment alterations can reduce stability and even initiate conditions that trigger a slide. Furthermore, the extent of landslide hazards is generally not recognized, and the focus tends toward recently active slides. Although Caltrans' geo-professionals can identify slide risks if alerted, the vast majority of routine corridor planning and maintenance activity does not involve their input. Therefore, a simple and direct means of communicating the broad context of landslide-hazards to all levels of staff was needed.

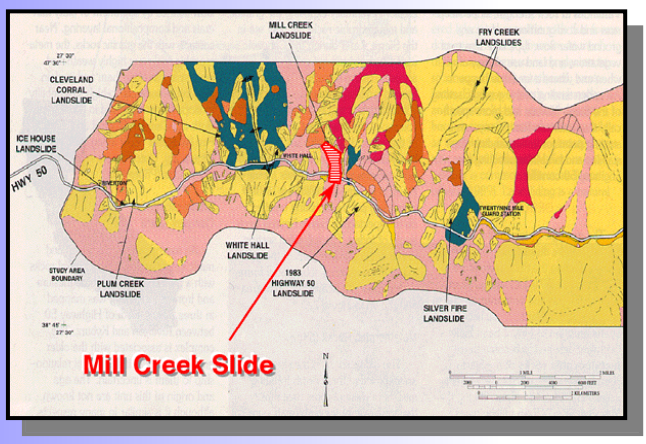

Figure 1 – CGS landslide hazard map for Route 50.

Figure 2 – 1997 Mill Creek Slide on Route 50.

Figures 1 and 2 illustrate the value of broader context regarding landslide hazards. Figure 1 highlights the extent of the 1997 Mill Creek Slide (Fig. 2) which closed Route 50 for approximately one month. Note that the yellow areas in Fig. 1 represent additional landslide features. This map was prepared by the California Geological Survey (CGS) as part of the emergency response and recovery from the 1997 incident, and now serves as a planning and maintenance document for developing long-term mitigation strategies. Recognizing the value of this product, Caltrans geotechnical engineers solicited assistance from the GeoResearch Group (GRG) to develop product standards using experience gained from slide mapping of selected highway corridors within a variety of climatological and geological settings.

What We Did

The GRG established a major inter-agency agreement with CGS to serve as the technical lead for this project so as to leverage their prior experience, extensive archives, geology expertise, and GIS capabilities. The CGS maintains geologic archives for the State of California, thus providing unique access to tremendous information resources, including relatively obscure reports, maps, aerial photography, remote sensing data, and records compiled by a variety of organizations. CGS staff have compiled information from these diverse sources and performed extensive field verification surveys to ensure the veracity of their synthesis.

To assure that the CGS work met Caltrans' user needs, the GRG established a "Project Advisory Panel" (PAP), consisting of Caltrans geo-professionals and various District representatives to help guide the project. Initially, the PAP helped assemble a list of over 1200 miles of slide-prone highway corridors based on Caltrans' project experience. The PAP also aided prioritization of 147 route miles along seven corridors in five Districts for mapping under this research-funded demonstration project. Selection criteria included route importance, diversity of Districts, and assuring that a representative variety of geologic and climatological environments were considered. Figure 3 shows slide-prone corridors in yellow, and the selected demonstration sites in blue.

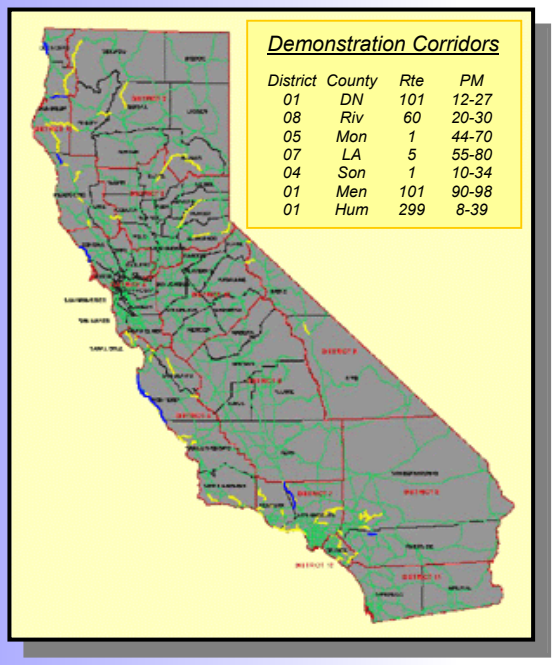

Figure 3 – Landslide-Prone Highway Corridors

The CGS, PAP, and GRG then developed general reporting and display standards. GIS-based maps prepared at 1:12,000 scale were selected as the optimal means for compiling and archiving available data and interpretations. GIS-based maps represent a major step forward from the hand-drawn generation of maps (e.g. Fig. 1), since each landslide can be represented spatially in a map display and also assigned informational attributes in separate data tables. Attributes selected by the PAP for map display include landslide type (i.e. rock slide, debris slide, debris flow, earth flow), activity (active or historic, dormant-young, dormant-mature, dormant-old), and confidence of interpretation (i.e., definite, probable, questionable). Additional attributes assigned to all slides include the interpreted depth of slide, azimuth of movement, geologic unit, lithology, and data sources. Significant landslides are assigned additional information including size, recency of movement, probable rate of movement, and possible consequences for the highway. A corridor-specific report is also generated for each route, summarizing geologic setting and key landslide features.

Draft summary reports and map plates are now available electronically from the GRG for 3 of the 7 demonstration corridors: the "Last Chance Grade" portion of Rte 101 Del Norte; the "San Timoteo Badlands" portion of Rte 60 Riverside; and the "Big Sur Coastline" portion of Rte 1 Monterrey. Figure 4 shows a representative portion of the Route 60 corridor where over 8500 slides were identified. The remaining routes are expected to be complete by June 2004. The GRG has also initiated efforts to provide web-based access to interactive GIS-based maps on the Caltrans intranet.

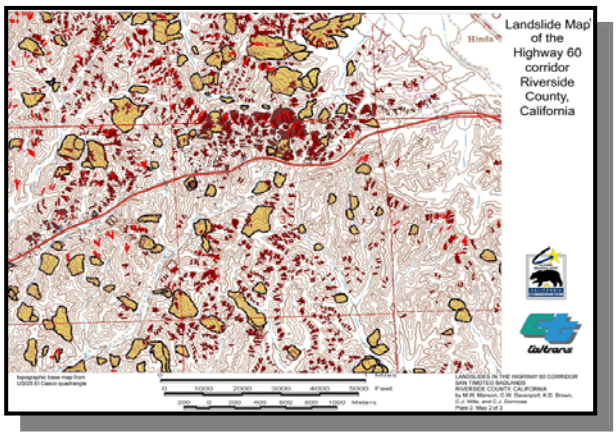

Figure 4 –Example Map for Rte 60 Corridor

The Researchers Recommend

This project developed a standard methodology for integrated archive and display of landslide hazards along a highway corridor to aid in risk assessment. Caltrans staff associated with the demonstration routes are encouraged to use and distribute these maps/reports (and web-based tools in the future) as resources to inform planning decisions, communicate with other agencies/public, and to guide maintenance practices for long-term proactive landslide hazard mitigation. Caltrans staff responsible for the other 1000-plus miles of slide-prone corridors are encouraged to examine these demonstration products, evaluate their utility, and decide whether similar mapping might warrant prioritization of future non-research budget resources.

For More Information on GeoResearch Projects

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