

## Research Notes

Program Steering Committee (PSC): Geotechnical/Structures

MONTH YEAR: JUNE 2014

Title: Corridor-Scale Landslide Hazard Mapping, Phase 2

Task Number: 1805

Start Date: 6/1/2011

Completion Date: 6/30/2015

Product Category: (7 & 6) Processed Data and New Decision Support Tool (Software)

Cliff Roblee

Senior Research Engineer

*cliff.roblee@dot.ca.gov*

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### TITLE:

Corridor-Scale Landslide Hazard Mapping, Phase 2

Extending Caltrans' Digital Landslide Inventory

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### WHAT IS THE NEED?

Each year, hundreds of landslides are mobilized near Caltrans highways with the vast majority located along an estimated 1600 miles of recognized slide-prone corridors. Landslide-related repair and reconstruction of California highways routinely costs \$40 million annually. Repair costs during wet years can well exceed \$100 million, and particularly problematic slides have led to \$100's of millions in capital expenditures. Beyond immediate safety implications, adverse impacts of landslides include road closures, traffic delays, economic losses, and environmental degradation.

The existence and extent of landslide hazards is often not recognized by those involved with highway corridor planning and operations, and readily-available knowledge is often focused only on historically active slides which tend to be minor elements within a much broader context of geologic instability. Seemingly inadvertent alterations to roadway or drainage systems associated with routine maintenance or minor alignment alterations can reduce the slope stability of dormant slides and even initiate conditions that trigger reactivation of these slides. There is a need for a comprehensive resource of landslide-hazard data along with a convenient means to discover and display these data so that both District corridor managers and geo-professionals alike can proactively manage landslide risk before slide costs are incurred.

### WHAT ARE WE DOING?

Project P204 is a long-term multi-phase effort initiated in 1999 that aims to produce corridor-scale landslide inventory map products (digital data, maps, and reports) that

conveniently communicate the broad context of landslide hazards for over 1600 miles of recognized slide-prone highway corridors in California.

Geologic interpretation work is being completed under interagency agreements with the California Geological Survey (CGS). CGS geologists review archives of topographic and remote-sensing data compiled by federal, state, local and private entities to map landslides based on their geomorphic expression. Landslides displace parts of the earth's surface in distinctive ways, and the resulting landforms can reveal the extent and characteristics of the landslide. Recognition of these landforms (scarps, troughs, benches and other subtle topographic features) allows the geologist to identify, map and classify most landslides. For each slide, the areal extent is mapped and attributed with the type and activity of slide, the direction of movement, the confidence of interpretation, and other factors.

The first phase (Task 0082), completed in 2006, piloted the original development of corridor-scale landslide hazard products (see report FHWA/CA/TL-2006/19) and created maps for approximately 191 miles of California highways. Corridors were selected to explore applicability and refine methods for diverse geologic and environmental conditions. Geologic settings ranged from coastal bluffs to heavily-forested mountain slopes to desert badlands. The phase-1 work involved extensive geologic field investigations, and piloted the use of LIDAR imaging to penetrate heavy forest cover. Among other applications, maps produced during phase-1 have been used in the development of the multi-agency Coast Highway Management Plan for the Route-1 Big Sur coastline as well as to support a route-selection decision process for a Route-101 bypass in the northern Coast Range.

The current second phase (Task 1830) was initiated in 2011 to both extend map coverage by approximately 273 miles and to refine digital products to improve accessibility and better serve a broader array of asset management applications. Corridor selection for phase-2 has focused on leveraging existing CGS data resources compiled for the Los Angeles and San Francisco areas under the Seismic Hazards Mapping Act of 1990 and for much of the northern Coast Ranges under their Forest and Watershed Geology Program. Beyond the extension in mapped mileage, phase-2 has also focused on improving the consistency and utility of digital products developed under both phases of the project. This focus on underlying data structures has enabled Caltrans' development of a prototype 'Landslide Viewer' desktop tool. The viewer conveniently displays the digital landslide inventory data within the standard Google Earth interface and allows users to customize products for their specific application. Viewer users control map scale and perspective, and can selectively display either individual landslides or groups of landslides based on their hazards to the traveler and/or facilities. This desktop tool will compliment enterprise-level GIS products to increase the utility and access to the digital landslide inventory data.

## **WHAT IS OUR GOAL?**

The long-term goal of Project P204 is to create and disseminate a comprehensive set of corridor-scale landslide inventory map products (digital data, maps, and reports) that conveniently communicate the broad context of landslide hazards for over 1600 miles of recognized slide-prone highway corridors in California. The specific goal of Task 1805 is to extend map coverage from the existing 191 miles to 464 miles and to improve the consistency, utility, dissemination and awareness of the digital products.

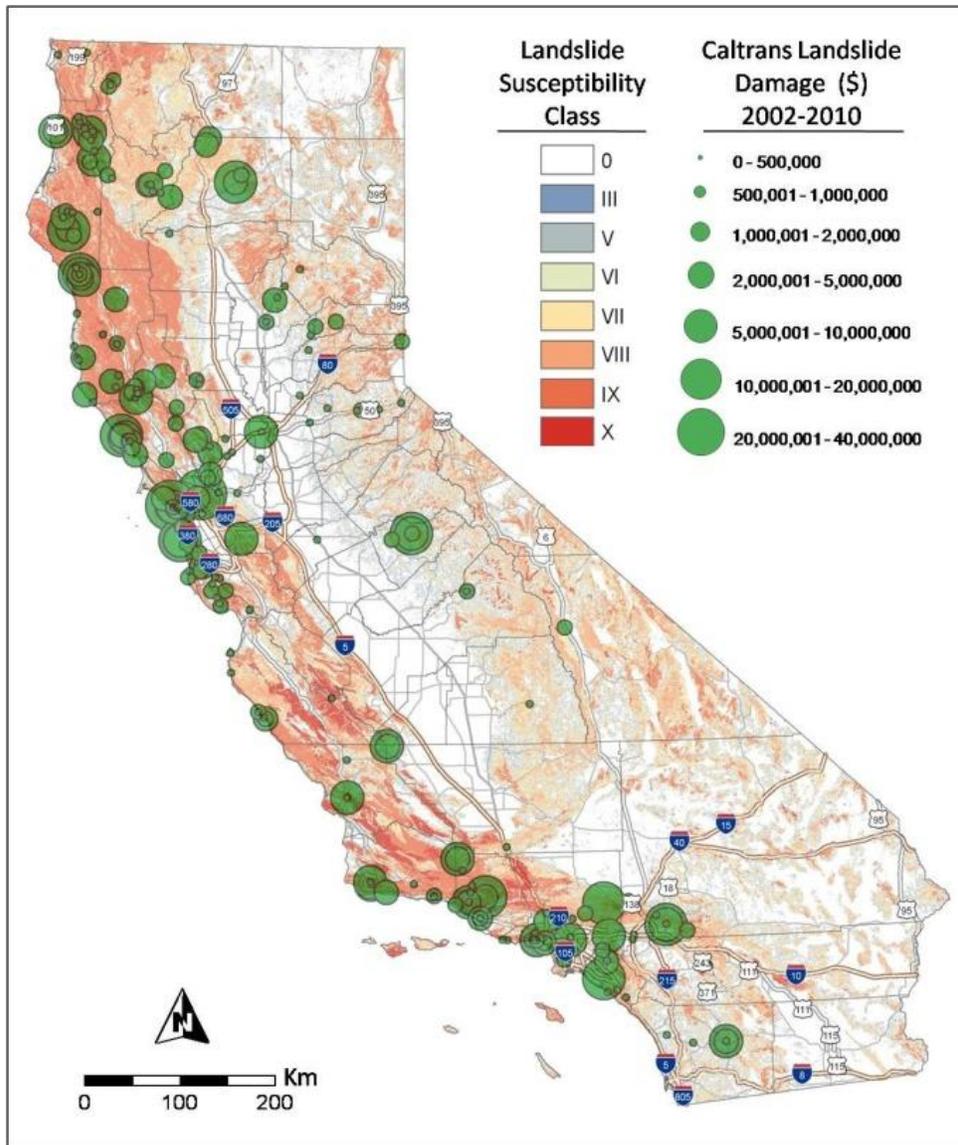
## **WHAT IS THE BENEFIT?**

Successful deployment of landslide inventory maps using both enterprise GIS and desktop viewer applications, complemented with District outreach, will facilitate broader awareness and fuller comprehension of corridor-specific landslide hazards. This will encourage more meaningful communications between design, maintenance, planning and management functions that will support improved planning and investment decisions to mitigate adverse impacts of landslide hazards before they occur. This, in turn, will benefit traveler safety, improve overall route reliability, and reduce both facility maintenance costs and adjacent environmental degradation.

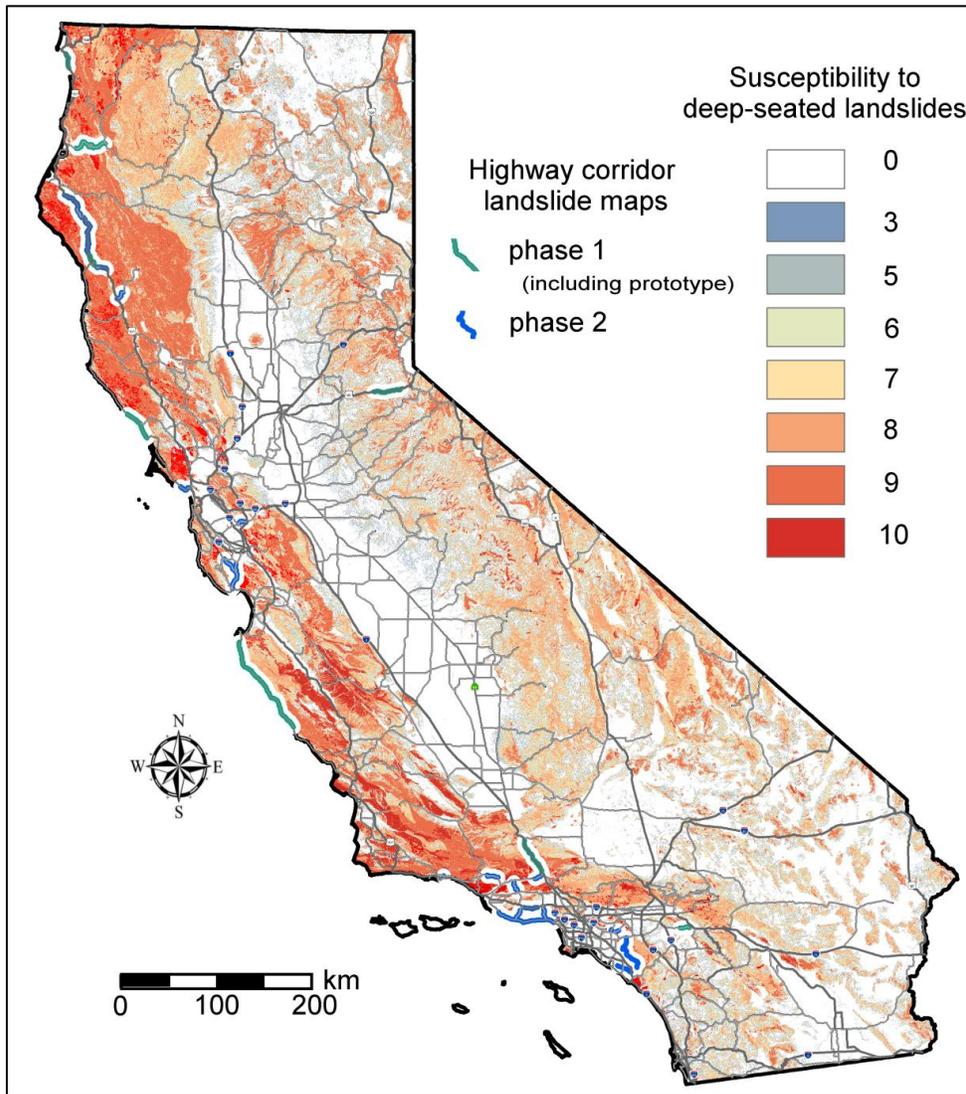
## **WHAT IS THE PROGRESS TO DATE?**

Task 1805 is entering the final year of a four-year contract. CGS has completed draft maps for over half of the corridor mileage, and has begun geologic interpretation and mapping of all remaining corridors to be addressed under this phase. Considerable CGS and Caltrans effort has also been dedicated to establishing a uniform standard for all digital landslide data and converting both phase-1 and phase-2 data to that standard. Caltrans has prototyped a 'Landslide Viewer' desktop tool for customizable display the digital landslide data using the standard Google Earth interface.

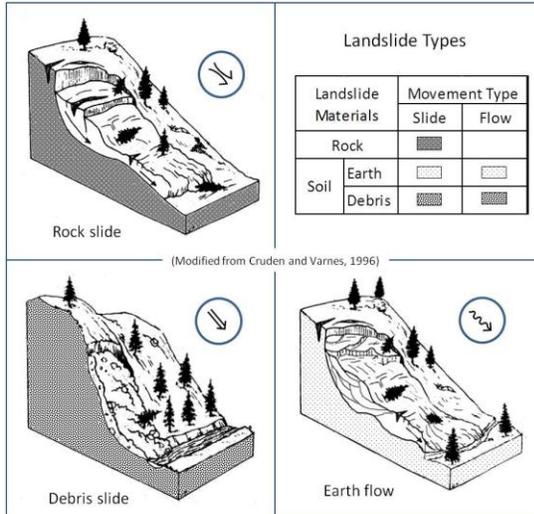
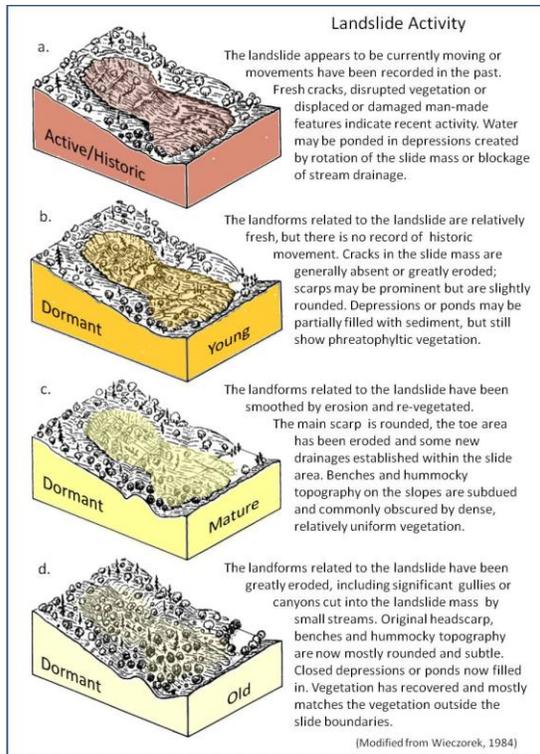
The final year of the project will focus on finalizing mapping products (data, maps, reports) for each selected corridor and disseminating this information through a combination of enterprise and desktop IT services coupled with outreach to affected Districts.



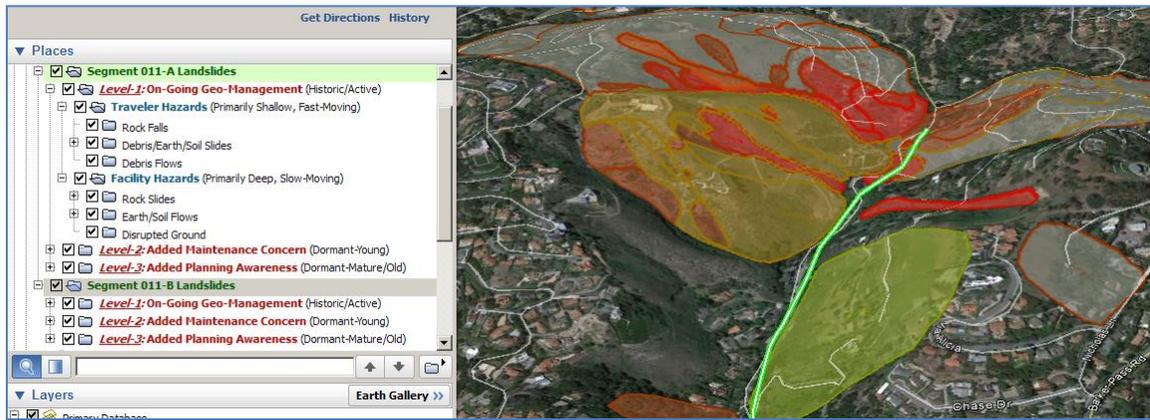
Landslide damage to highways occurs statewide with higher susceptibility associated with weak rock, steep slopes, and high rainfall. Landslide-related repair and reconstruction of California highways routinely costs \$40 million annually. Repair costs during wet years can exceed \$100 million, and particularly problematic slides have led to \$100's of millions in capital expenditures.



There are roughly 1600 landslide-prone highway corridors in California. Digital landslide inventories and related mapping products have been generated for approximately 191 miles in phase-1, and 273 miles in phase-2 of the project.



Each landslide in the inventory is mapped for location and areal extent and also assigned a slide type, activity level, and confidence of interpretation along with supplemental geologic and geomorphic attributes.



The prototype 'Landslide Viewer' desktop tool displays the digital landslide inventory data within the standard Google Earth interface to allow users to customize products for their specific application. Users control map scale and perspective, and can selectively display either individual landslides or groups of landslides based on hazards to the traveler and/or facilities.