Susceptibility to Deep-Seated Landslides in California

2011

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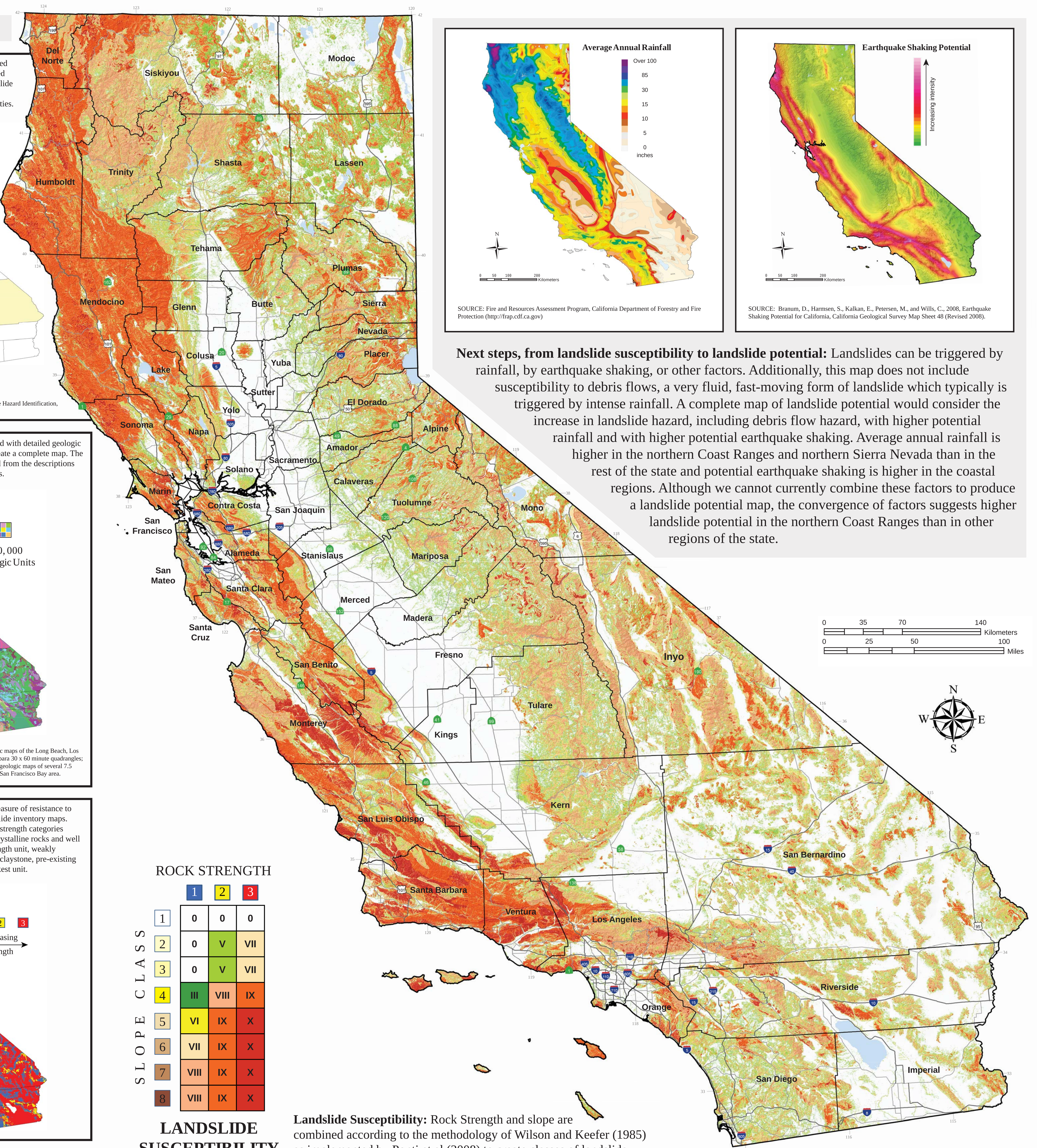
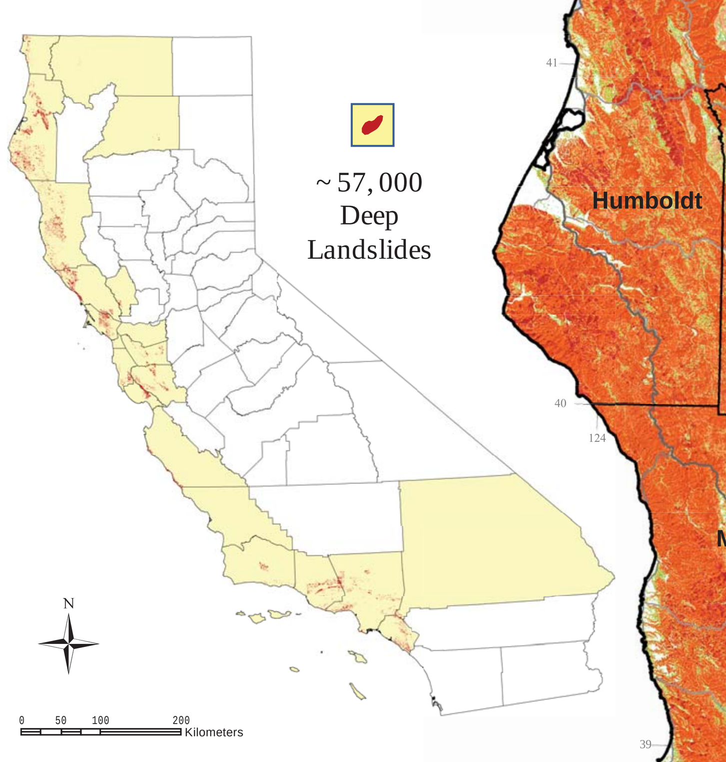
This map shows the relative likelihood of deep landsliding based on regional estimates of rock strength and steepness of slopes. On the most basic level, weak rocks and steep slopes are more likely to generate landslides. The map uses detailed information on the location of past landslides, the location and relative strength of rock units, and steepness of slope in a methodology developed by Wilson and Keefer (1985). The result shows the distribution of one very important component of landslide hazard. It is intended to provide infrastructure owners, emergency planners and the public with a general overview of where landslides are more likely. The map does not include information on landslide triggering events, such as rainstorms or earthquake shaking, nor does it address susceptibility to shallow landslides such as debris flows. This map is not appropriate for evaluation of landslide potential at any specific site.



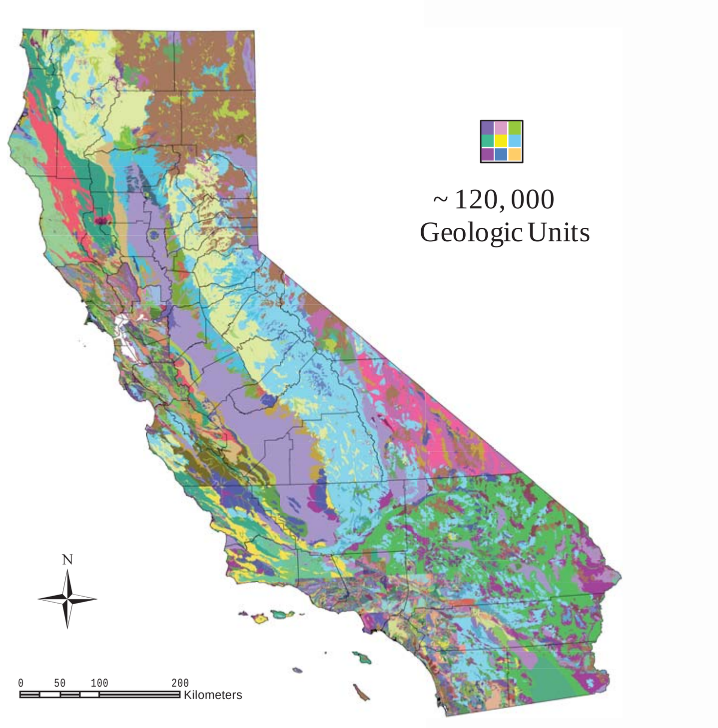
How this map was prepared

Landslide inventory: All previously mapped deep-seated landslides that are available in digital format are assigned the lowest value of rock strength. Note that digital landslide inventory maps are only available for specific counties, shown in yellow, and may cover only part of those counties.



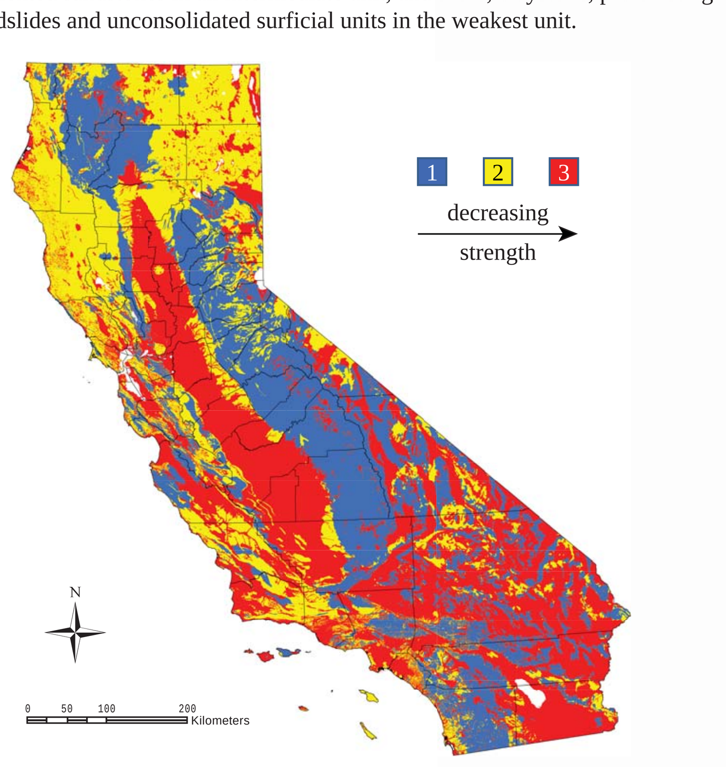
SOURCE: Digital maps compiled from USGS, and from CGS's Landslide Hazard Identification, Seismic Hazard Zoning and Forest and Watershed Geology Programs.

Geology: A general statewide geologic map is augmented with detailed geologic maps covering the most populous parts of the state to create a complete map. The physical properties of the geologic units were interpreted from the descriptions on the geologic maps to determine the rock strength units.

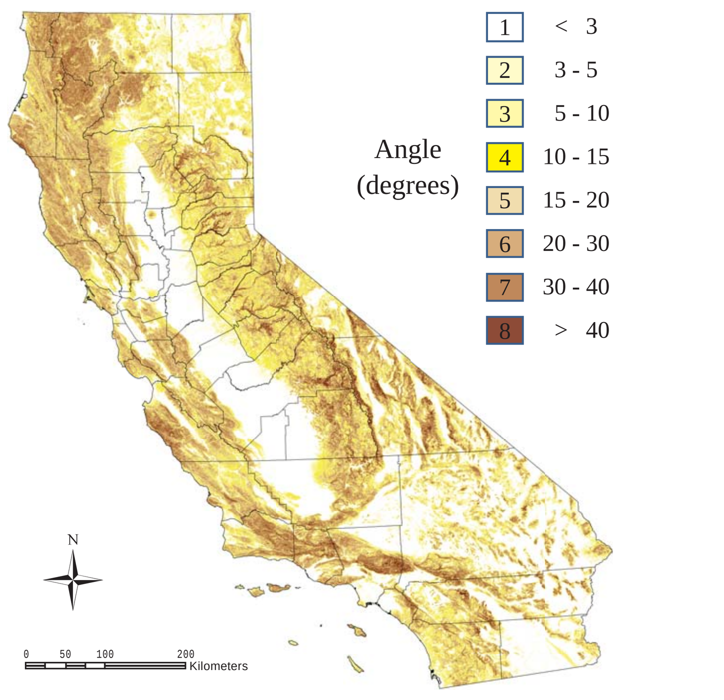


SOURCE: Digital geologic maps of various scales: 1:100,000 scale geologic maps of the Long Beach, Los Angeles, Oceanside, San Bernardino, San Diego, Santa Ana, and Santa Barbara 30 x 60 minute quadrangles; the regional simplified map of Wills and Clahan (2006); the 1:24,000 scale geologic maps of several 7.5 minute quadrangles; and the more detailed maps of Graymer (2008) of the San Francisco Bay area.

Rock strength: A relative rating of rock strength, a measure of resistance to landsliding, was developed from the geologic and landslide inventory maps. Each geologic unit was classified into one of three rock strength categories according to the methodology of Wieckzorek (1985). Crystalline rocks and well cemented sandstones are placed in the highest rock strength unit, weakly cemented sandstones in an intermediate unit, and shale, claystone, pre-existing landslides and unconsolidated surficial units in the weakest unit.



Slope: The slope gradient was computed from the 10-m grid of elevation values from the 2009 National Elevation Dataset (NED). Slope values were then grouped into eight slope classes ranging from nearly flat (less than three degrees) to very steep (greater than 40 degrees).



SOURCE: 2009 National Elevation Dataset (NED) produced and distributed by USGS (http://ned.usgs.gov) with the following data specifications:

Data Type:	Floating Point	Vertical units:	Meters
Projection:	Geographic	Spheroid:	GRS 1980
Datum:	NAD83	Tile size:	1 deg. by 1 deg.
Horizontal units:	Decimal Degree	Format:	ArcGRID and GRIDFLOAT

Average Annual Rainfall

SOURCE: Fire and Resources Assessment Program, California Department of Forestry and Fire Protection (http://frap.cdf.ca.gov)

Earthquake Shaking Potential

SOURCE: Branum, D., Harmsen, S., Kalkan, E., Petersen, M., and Wills, C., 2008, Earthquake Shaking Potential for California, California Geological Survey Map Sheet 48 (Revised 2008).

Next steps, from landslide susceptibility to landslide potential: Landslides can be triggered by rainfall, by earthquake shaking, or other factors. Additionally, this map does not include susceptibility to debris flows, a very fluid, fast-moving form of landslide which typically is triggered by intense rainfall. A complete map of landslide potential would consider the increase in landslide hazard, including debris flow hazard, with higher potential rainfall and with higher potential earthquake shaking. Average annual rainfall is higher in the northern Coast Ranges and northern Sierra Nevada than in the rest of the state and potential earthquake shaking is higher in the coastal regions. Although we cannot currently combine these factors to produce a landslide potential map, the convergence of factors suggests higher landslide potential in the northern Coast Ranges than in other regions of the state.

ROCK STRENGTH

SLOPE CLASS	1	2	3
1	0	0	0
2	0	V	VII
3	0	V	VII
4	III	VIII	IX
5	VI	IX	X
6	VII	IX	X
7	VIII	IX	X
8	VIII	IX	X

LANDSLIDE SUSCEPTIBILITY CLASSES

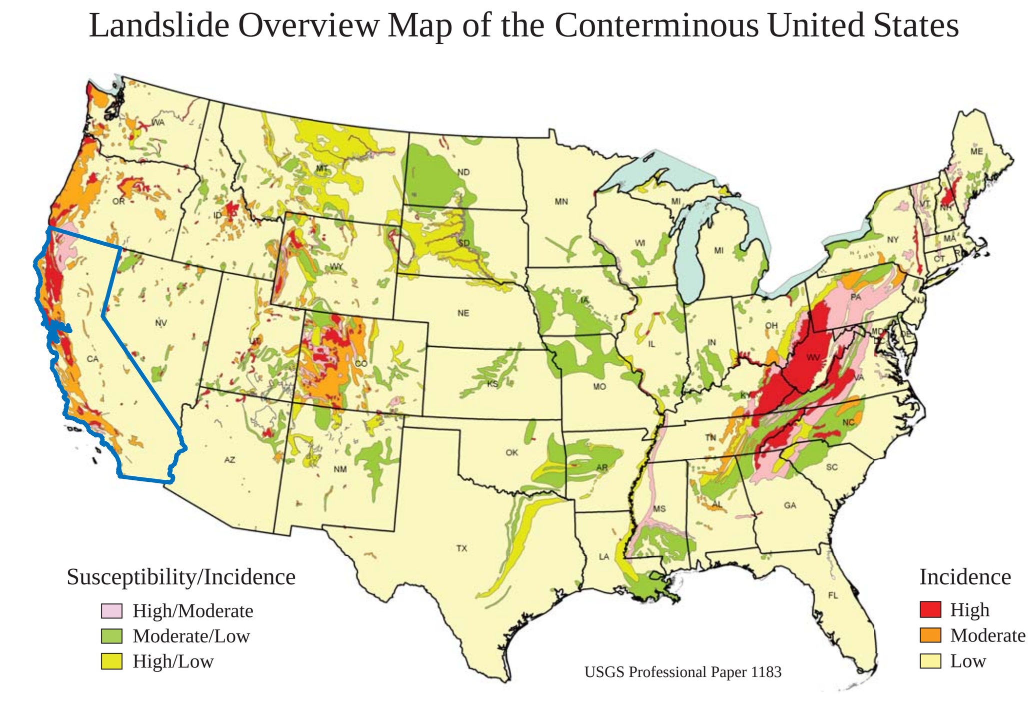
(0 III V VI VII VIII IX X)

increasing susceptibility

Landslide Susceptibility: Rock Strength and slope are combined according to the methodology of Wilson and Keefer (1985) as implemented by Ponti et al (2008) to create classes of landslide susceptibility. These classes express the generalization that on very low slopes, landslide susceptibility is low even in weak materials, and that landslide susceptibility increases with slope and in weaker rocks. Very high landslide susceptibility, classes VIII, IX, and X, includes very steep slopes in hard rocks and moderate to very steep slopes in weak rocks.

Landslide losses: California has a substantial share of the nation's landslide risk because of high population and concentration of infrastructure in areas with substantial landslide hazard. Landslides cause an estimated 25 to 50 deaths and over $2 billion damage per year in the United States (Spiker and Gori, 2003). This map of landslide susceptibility may be used to estimate where in California landslide losses are most likely to be concentrated.

Landslide Overview Map of the Conterminous United States



References:

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Acknowledgments: Special thanks to our colleagues at CGS: Dave Branum, Tim McCrink, Teri McGuire, Bob Moskovitz, Chuck Real, and Pete Roffers; and to Dino Bellugi of UC Berkeley and Dave Strong of USGS who processed and reprojected the original Geographic NED into UTM NED.

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