Landslide Hazards: A Stealth Threat to the Nation

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Hazard, Risk, Reliability

- HAZARD is the
  Probability that an event of a certain magnitude occurs in a certain area within a certain time

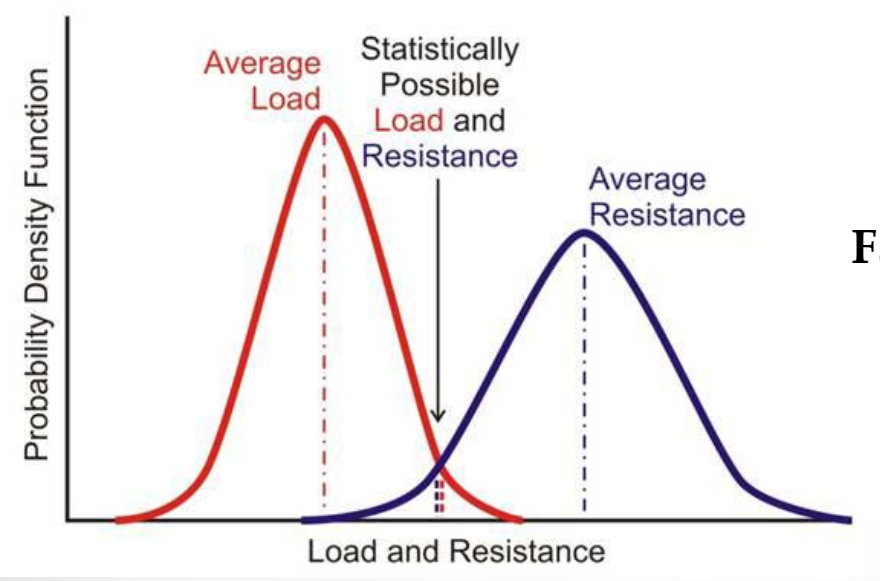
- RISK is the
  Product of HAZARD and consequence or vulnerability in terms of dollar value or human life

- How big/much? How likely? How extensive?

Hazard, Risk, Reliability

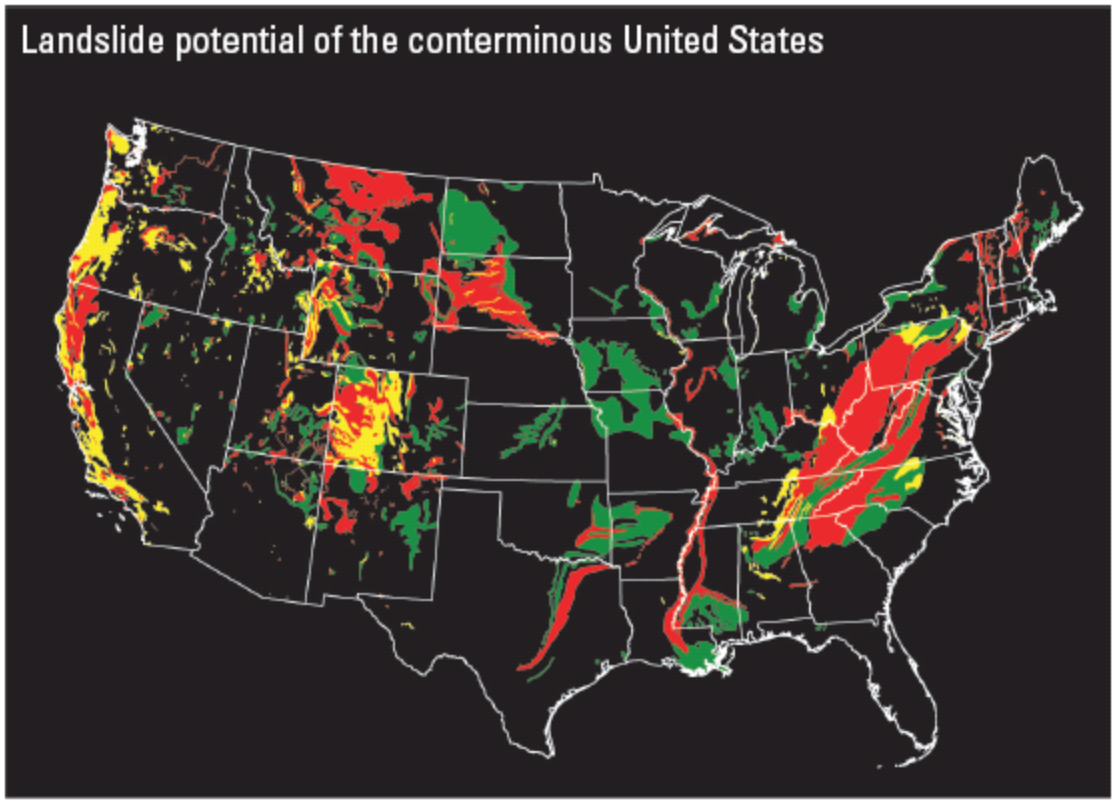
- **Reliability –** An approach which accounts for variability and uncertainty

- A probabilistic expression of those forces that promote stability and those that promote instability



$$\text{Factor of Safety} = \frac{\text{Resistance}}{\text{Load}}$$

Landslide Hazards—A National Threat



Landslide potential of the conterminous United States: Red areas have very high potential, yellow areas have high potential, and green areas have moderate potential. Landslides can and do occur in the black areas, but the potential is low. Map not to scale. Sources: the National Atlas and the USGS

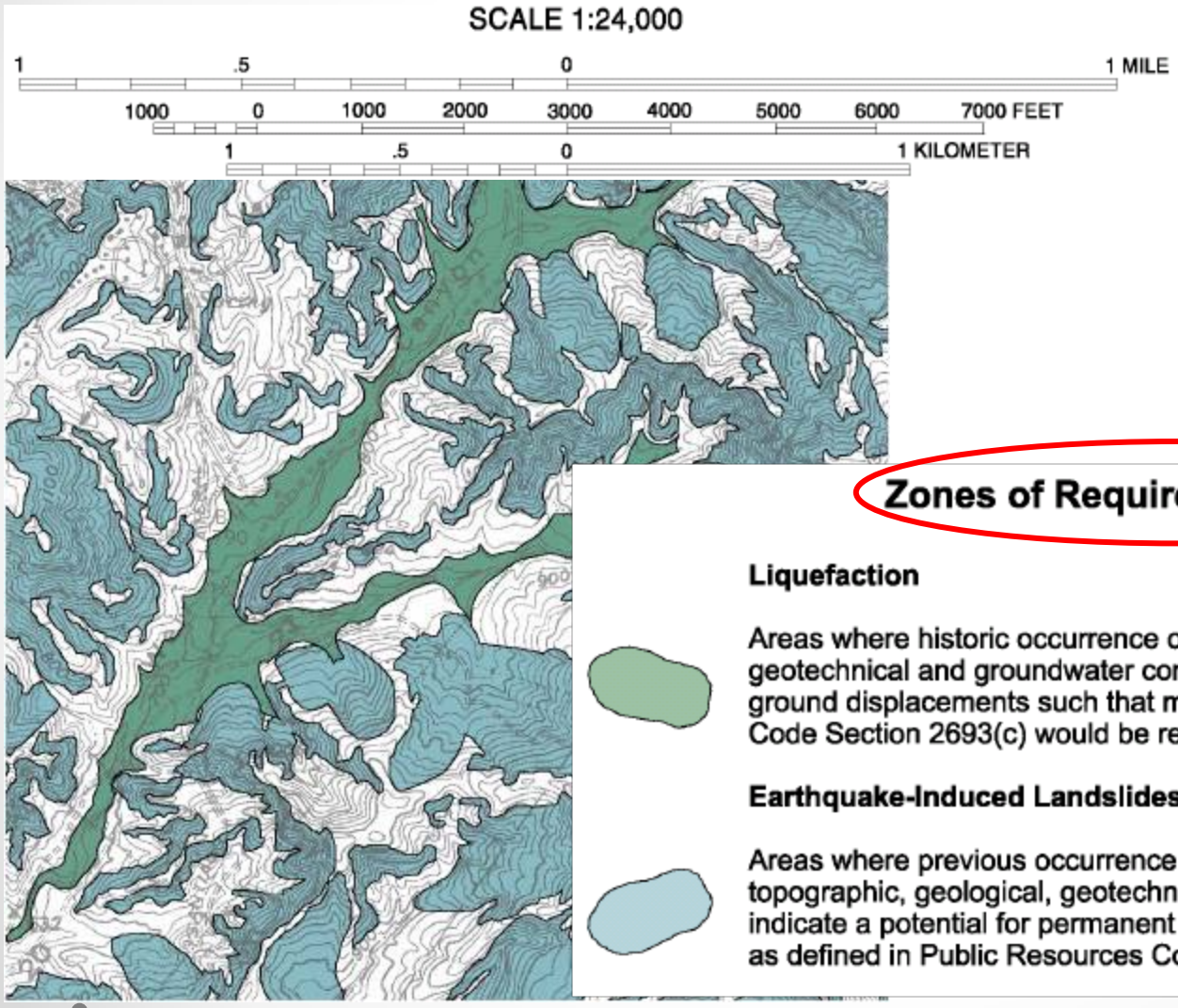
How big/much?

How likely?

How extensive?

USGS Fact Sheet
2005-3156

STATE OF CALIFORNIA
SEISMIC HAZARD ZONES



How big/much?

How likely?

How extensive?

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

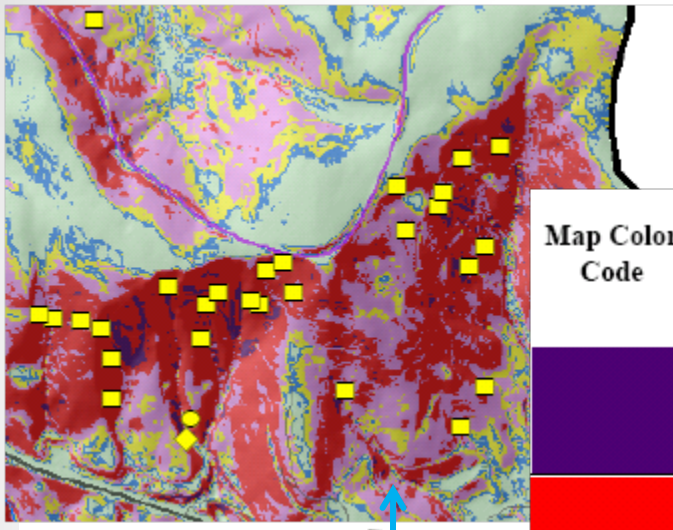
Earthquake-Induced Landslides

Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

GEOLOGIC HAZARDS MAP SERIES 3
SLOPE MOVEMENT HAZARD MAPS OF WATAUGA COUNTY, NC
SHEET 2 OF 4, VERSION: MARCH 18, 2008

STABILITY INDEX MAP OF WATAUGA COUNTY, NORTH CAROLINA

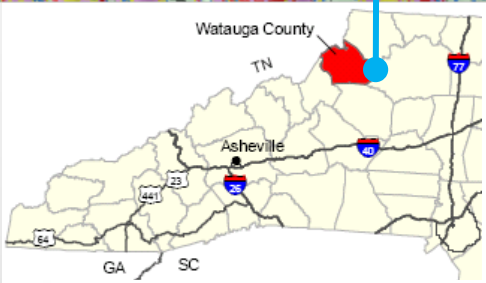
FOR SHALLOW TRANSLATIONAL SLOPE MOVEMENT SUSCEPTIBILITY DURING A 5-INCH (125 MM) RECHARGE EVENT

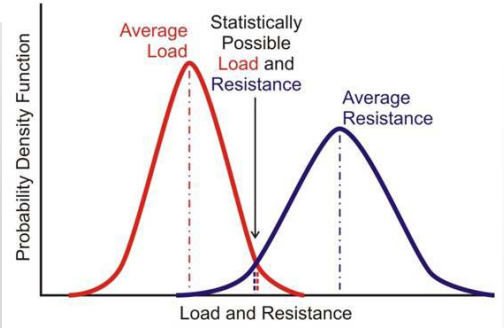


Inset Map Scale:
1:18,000
FEET
0 1,000

How big/much?
How likely?
How extensive?

Conditional Probability





Map Color Code	Predicted Stability Zone	Relative Debris/Earth Flow/Slide Hazard Ranking [1]	Stability Index Range [2]	Factor of Safety (FS) [3]	Probability of Instability [4]
	Unstable	High	0	Maximum FS <1	100%
	Upper Threshold of Instability		0 - 0.5	>50% of FS <1	>50%
	Lower Threshold of Instability	Moderate	0.5 - 1	>50% of FS >1	<50%
	Nominally Stable	Low	1 - 1.25	Minimum FS = 1	___
	Moderately Stable		1.25 - 1.5	Minimum FS = 1.25	___
	Stable		>1.5	Minimum FS = 1.5	___

Challenging Processes

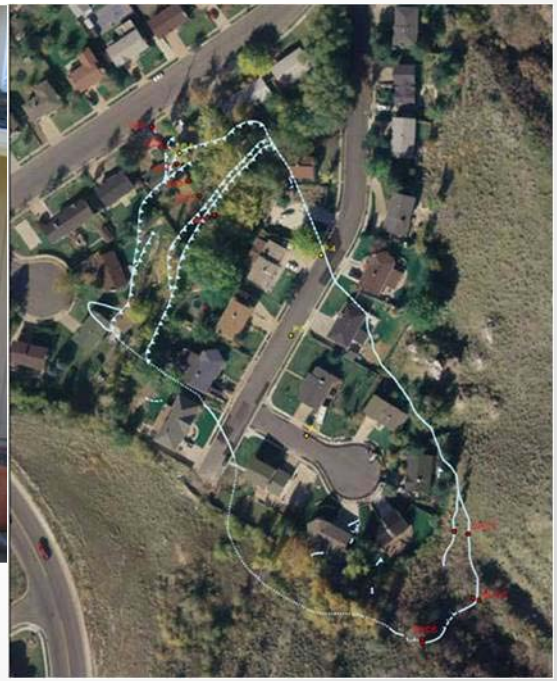
- Landslides are secondary features triggered by primary processes

- Landslide damage has not been well documented

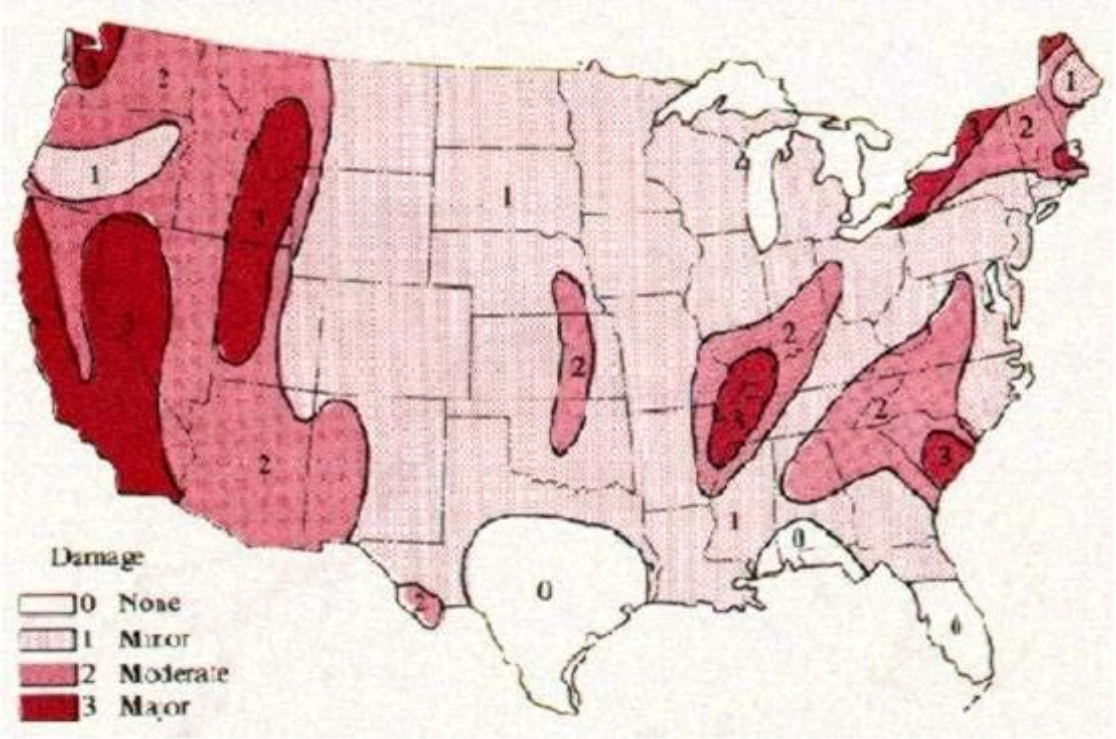
Challenging Processes

- Landslide damage tends to be limited
- Property can be “damaged” by “remote” landslides that block roads or break utilities



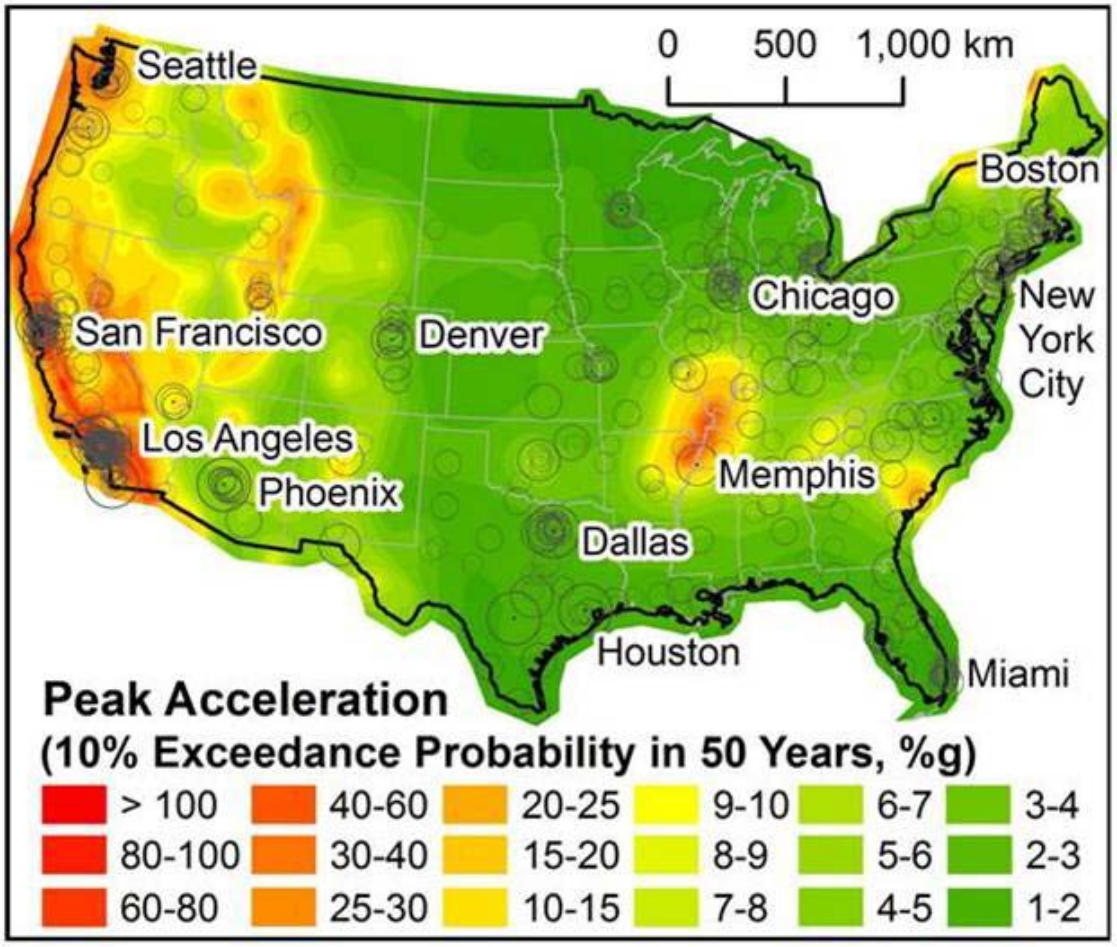



Lessons from Earthquake Hazards



- Early earthquake damage map
- Pre-NEHRP (1977) National Earthquake Hazards Reduction Program

Modern Earthquake Hazard Map



Post-NEHRP
(2002 edition)

How big?

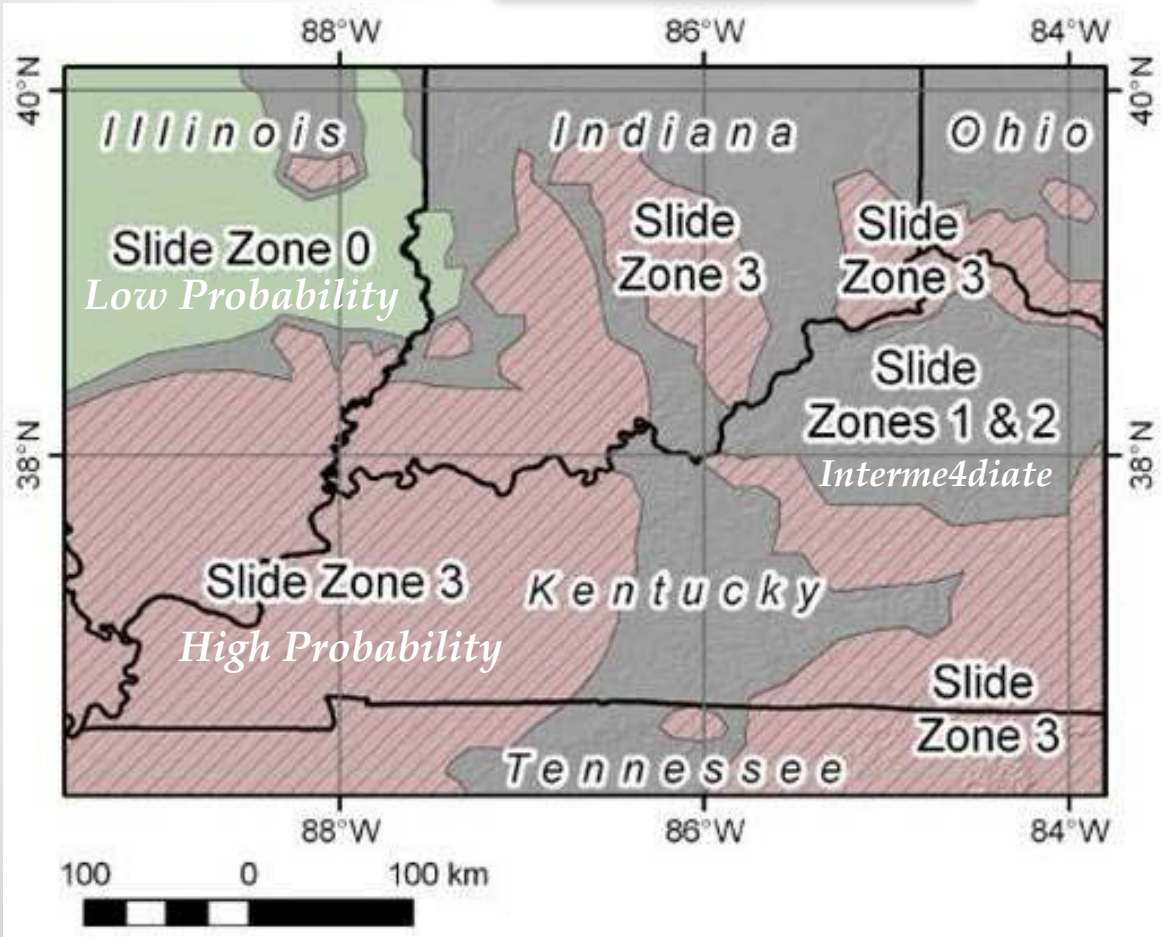
How likely?

How extensive?

Derived from USGS Seismic Hazard Data

For basic site conditions. Site-specific information is still needed.

Conceptual Landslide Hazard Model



Zone 3: moderate & high landslide incidence & susceptibility, accelerations ≥ 15%g & precipitation ≥ 400mm

Zone 0: simple geology, low topographic relief & precipitation < 400mm

Zones 1 & 2: complex geology, some relief, & precipitation < 400mm

Definition of basic site conditions is needed to develop amount of landslide deformation (how big/much)

Keaton & Roth, 2010

Current Status

- Earthquake hazard models are used by local and federal emergency management agencies
- Earthquake loss models are used by private insurance
- USGS national strategy (2000) called for mapping and assessing landslide hazards
- Landslide hazard and loss models still do not exist
- Therefore, Landslides are uninsurable

Conclusions

- Adaptation strategies and a suite of mitigation measures are needed
- Environmental change must be included in landslide hazard models
- Managing landslide risk is consistent with the philosophy of sustainability

What Can Be Done?

Develop and implement:

- Models for assessing hazard and risk
- Procedures for documenting damage and loss
- Strategies for adapting to and mitigating landslides

What Can Be Done?

- Encourage Public-Private Partnership approach
- Government Agencies and Professional Societies
  - Academic and private practice participation will come through professional societies
- Strengthen the USGS Landslides Hazards Program to build on the success of the Earthquake Hazards Program

Why Now?

- *The situation is urgent because landslide losses occurring year after year are unsustainable*
  - *Damaging and devaluing property and the environment,*
  - *Injuring people,*
  - *Diminishing tax revenues, and*
  - *Wasting resources*

Thank You

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