Landslide Hazards: A Stealth Threat to the Nation

Sponsored by the Geological Society of America
Association of Environmental & Engineering Geologists
American Society of Civil Engineers

In Cooperation with the Congressional Hazards Caucus
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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?

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.
### Stability Index Map of Watauga County, North Carolina

**For shallow translational slope movement susceptibility during a 5-inch (125 mm) recharge event**

#### How Big/Much?

- **Inset Map Scale:** 1:18,000

#### How Likely?

- **Conditional Probability**

#### How Extensive?

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<td>Unstable</td>
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<td>High</td>
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<td>Maximum FS &lt; 1</td>
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<td>Upper Threshold of Instability</td>
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<td>0 - 0.5</td>
<td>&gt;50% of FS &lt; 1</td>
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<td>Lower Threshold of Instability</td>
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<td>&gt;50% of FS &gt; 1</td>
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<td>Nominally Stable</td>
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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

How big?
How likely?
How extensive?

Post-NEHRP (2002 edition)

Peak Acceleration
(10% Exceedance Probability in 50 Years, %g)

- 3-4
- 2-3
- 1-2
- > 100
- 80-100
- 60-80
- 40-60
- 20-25
- 9-10
- 6-7
- 5-6
- 4-5
- 3-4
- 2-3
- 1-2

For basic site conditions. Site-specific information is still needed.
Conceptual Landslide Hazard Model

Zone 3: moderate & high landslide incidence & susceptibility, accelerations $\geq 15\%g$ & precipitation $\geq 400\text{mm}$

Zone 0: simple geology, low topographic relief & precipitation $< 400\text{mm}$

Zones 1 & 2: complex geology, some relief, & precipitation $< 400\text{mm}$

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
  o Damaging and devaluing property and the environment,
  o Injuring people,
  o Diminishing tax revenues, and
  o Wasting resources
Thank You

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