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Reducing Losses from Landslides – A National Mitigation Strategy

Issue/Problem

US landslides losses amount to as much as $3 billion annually *(National Academy of Sciences, Transportation Research Board, Special Report 247, 1996)*. Losses occur in every state and involve federal, state and private lands. In 27 states and Puerto Rico the problem is substantial or severe. The Stafford Act (1974 Disaster Relief Act, 42 U.S.C. 5201 et seq.) assigns USGS responsibility to provide landslide warnings to emergency management authorities and the public in order to reduce losses. However, budgetary constraints and the lack of a national loss-reduction strategy have kept the Survey from effectively fulfilling this responsibility.

Over the past three years, State, university, and private-sector partners have worked with the USGS to formulate a national loss-reduction strategy. At the request of the U.S. Congress, a report describing the strategy was prepared (The National Landslide Hazard Mitigation Strategy – A Framework for Loss Reduction, USGS Open-File Report 000-450 available at: http://geology.cr.usgs.gov/pub/open-file-reports/ofr-00-0450/). ***It was concluded that only through a partnership program in which scientific understanding and common approaches are developed nationally, and loss-reduction actions are implemented locally, would landslide losses in the United States be reduced.***

Extent and growth of the hazard:

Landslides are triggered by heavy precipitation, by earthquakes, and by volcanic eruptions. Individual slides affect areas of one to thousands of acres, and debris flows can extend for more than 50 miles down stream. Landslides are most commonly triggered on steep slopes by heavy or sustained rainfall, such as produced during El Ninõ winters in the West or as a result of hurricanes and tropical storms in the East. ***Although individual events are local, storm-induced slides and debris flows occur by the thousands and affect vast multi-State, multi-jurisdictional areas.***

Risk to life and property is increasing on both public and private lands as steep slopes and areas susceptible to land failure are being utilized for recreation, transportation, energy distribution, housing, and for other commercial purposes. ***Although landslide losses are tragic, most are preventable.*** Advances in science and technology now make it feasible to forecast and mitigate landslide hazards, and thereby save lives and property.

USGS Landslide Hazards Program

With its responsibility under the Stafford Act, the USGS conducts landslide hazard research under the congressionally funded Landslide Hazards Program (FY 2001 appropriation ($2.628 M). This small federal program conducts research and assessment of landslides, focusing mainly on precipitation-induced landslides in urban areas and on public lands. The Program's National Landslide Information Center communicates information to the user-community through fact sheets, books, reports, databases, and press releases (***http://landslides.usgs.gov***).

Within available resources, the Program conducts studies only in high-risk areas of California, Washington State, the Blue Ridge Mountains of Virginia and Puerto Rico. USGS also assists FEMA and Project Impact partners and has participated in landslide disaster responses in Virginia, Ohio, Washington, and California. In addition to the landslide threat to urban and suburban areas, landslides are one of the most frequently occurring natural hazards in public parklands, forests, and tribal lands. The USGS is called on to directly assist federal land management agencies with expertise needed to mitigate landslide hazards. During the past five years, the USGS has conducted hazard assessments for seven National Park Service and Bureau of Land Management land units in five States (CA, AZ, NM, AR VA) and two National Forests (AZ and CA).

Building the Partnership: Annual funding estimates for implementation of

the National Landslide Hazard Mitigation Strategy, as outlined in USGS Open-File Report 000-450, are:

1. USGS Monitoring and Assessment **(+$8 M):** USGS would work with partners to: a) expand research on physical processes and develop new probabilistic landslide hazard maps and predictive models for populous and landslide-prone regions in the Pacific Northwest, California, the Appalachians, and Puerto Rico, b) conduct new hazard assessments in Alaska, in the Mid-Continent region, and in the East, c) conduct research on the relationship between submarine landslides and tsunamis; hazards that threaten both coasts, Hawaii, and the island Territories, d) design and implement a coordinated rapid response capability, e) expand assessments of the impacts of wildfires on landslide susceptibility and f) expand real-time monitoring. To better coordinate the activities of multiple partners, the USGS would expand the role of National Landslide Information Center in database management, and in development of standards and guidelines.

2. State and Territory Agency Grants **(+$8 M):** A matching-fund grants pro-

gram with State agencies would be put in place, similar to the STATEMAP component of the National Cooperative Geologic Mapping Act (US Public Law 106-148). Under such a program, States and Territories determine their own priorities, and a national review panel made up of representatives of participating State agencies and USGS sets sizes of grants.

3. University Research and Private-Sector Grants (+$2 M): A university and private-sector research grant program would be needed to augment research capabilities in engineering geology, to increase understanding of landslide processes and to ensure local community participation in loss reduction. The university component would enhance landslide hazard research in academia and provide students with real-world experience in applying landslide science to societal problems. Cooperative agreements with private sector associations and consultants would provide incentives for community use of new technology and mitigation strategies, and important communication of local needs back to the program. Priorities for research would be selected using a proposal-based process similar to that of the National Earthquake Hazard Reduction Program (NEHRP), in which a multi-sector national review panel selects projects and establishes funding levels.

Partners

Federal

The National Weather Service forecasts the weather and maintains rainfall records, critical for landslide forecasting. The Federal Emergency Management Agency (FEMA) is responsible for emergency management and long-term mitigation of natural hazards, and facilitates multi-sector partnerships through programs such as Project Impact. The Federal Insurance Administration, a part of FEMA, provides insurance coverage for flood damages, including "mudslides" in some instances. In addition, a number of other Federal agencies depend on the USGS for landslide hazard information, including sister agencies in the Department of Interior, the U.S. Army Corps of Engineers, U.S. Forest Service and Department of Transportation (especially Federal Highway Administration).

State and local

The reduction of landslide losses is an important State and local responsibility. A number of State agencies have responsibility for addressing landslide hazards, including those with oversight of natural resources, transportation, geology, hazards, emergency services, and land-use issues. The reduction of landslide losses through land-use planning and application of building and grading codes is the function of local government. Local governments have responsibility to issue warning of imminent landslides and they manage emergency operations after a landslide.

Private Sector

Private-sector geologists, engineers, and building professionals identify and implement landslide reduction measures in building design, site evaluation, and planning. These firms provide advice to business and industry for loan, insurance, and investment decisions. Professional societies such as the American Society of Civil Engineers, the Association of Engineering Geology, the American Planning Association, as well as community-based organizations, such as the California Association of Geologic Hazard Assessment Districts, serve as conduits of information from researchers to practitioners and vice versa. Professional societies are a source of model codes, handbooks, and professional training for their membership. In addition, universities conduct research on landslide processes and development of mitigation technologies and methods.

Products:

Probabilistic landslide hazard maps – A key to long-term planning and insurance: Probabilistic maps combine information on the probability that a landslide-causing event will take place (e.g., heavy rainfall) with a map of susceptiblity to landsliding.

Dynamic landslide hazard models – A forecasting tool for emergency planning and response: Dynamic models combine probabilistic maps with rainfall forecasts and landsliding thresholds. The resulting models predict landslide hazard distribution for forecast conditions.

Landslide warning systems – A key to reduction of lives lost: Less detailed than the dynamic hazard model, warning systems combine rainfall data and regional landslide susceptibility to produce warnings of hazardous conditions at the regional scale.

Inventories of landslide occurrence and damage – A key to estimation of economic impact: Better inventories of economic impact of landslides will contribute to the prioritization of loss reduction strategies and to assessment of economic risk.

Enhanced landslide hazard data, education, and outreach – A key to better landslide preparedness: Databases and educational materials available via the Internet and through the National Landslides Information Center.

Coordinated mitigation strategies and emergency response plans – A key to effective loss reduction and emergency response: Formal mitigation strategies and response plans for hazardous areas.

US Landslide Disasters:

- 2001: Earthquake triggers landslides near Seattle: tens of millions damage
- 1999: Mother's Day rock fall at Sacred Falls State Park, HW – 8 dead
- 1998: Thousands of landslides in the West. $170 M damage, SF Bay area
- 1996: Thousands of landslides in OR & WA - costs exceed $300 M
- 1996: Yosemite NP – Rock Fall, 230 mph blast downs forest, kills one
- 1995: Hundreds of landslides in VA – 1 dead, $100 M damage
- 1994: Landslide buries 30 cars on I-70, two swept into Colorado River
- 1985: Mameyes landslide, Puerto Rico - 129 die (houses in hazard area)
- 1983: Town of Thistle, Utah destroyed - $500 million (2000 dollars) in losses
- 1982: Single storm triggers 18,000 landslides, kills 25 in Northern CA
- 1980: Mount St. Helens- largest landslide in history- triggers eruption and $500 M damage
- 1964: Alaska earthquake triggers most expensive landslide in US history - $1 B (2000 dollars). 23 lives lost to landslide generated tsunami

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