

Mitigating Landslide Hazards in Seattle: A Partnership

The Problem

Seattle, Washington, has suffered significant damage from landslides in recent years. Steep, hilly topography and susceptible geology have combined to cause landslides throughout the city during periods of above-normal precipitation. The resultant direct property loss, business losses, and recovery expenses exceed tens of millions of dollars. The human and financial costs related to landsliding have made residents and city officials aware of the need to review existing policies and programs designed to mitigate landslide damage.

One innovative approach to solving landslide problems is the recent formation of a collaborative partnership among the U.S. Geological Survey (USGS), the city of Seattle, the Federal Emergency Management Agency (FEMA), and Shannon and Wilson, Inc. (a geotechnical consulting firm, working for the city of Seattle). Facilitated by PROJECT IMPACT (FEMA's hazard reduction program for communities; <http://www.fema.gov/impact>), public and private entities have agreed to work together to more effectively solve the landslide problem in the Seattle, Washington, area. A set of digitally based maps that clearly portray the landslide hazards in Seattle are being developed through this partnership. These maps will serve as a basis for developing mitigation options to address the landslide hazards facing Seattle's residents and businesses.

Direction

To create this new set of landslide hazard maps, an inventory of landslides that occurred during 1997 has been combined with a 90-year historical record kept by the city. Shannon and Wilson, Inc., has been responsible for converting this record, kept in various forms, to a digital database. The USGS is developing probabilistic hazard maps from these newly compiled historical data, meteorological and climatological charac-



Landslide in northwest Seattle. The foundation of the house at far right and decks of neighboring houses were undermined. (Photo: Al Chleborad, USGS)

teristics, digital topography, and geotechnical information. Map development also includes spatially defining landslide susceptibility and determining precipitation and meteorological characteristics needed to initiate slope failure.

Additional studies are underway to understand the interaction between geology and ground water and their effects on landslide susceptibility and occurrence. Also, a partnership between Shannon and Wilson, Inc., the Burlington Northern Santa Fe Railway, and the USGS is proposing to install three monitoring sites on coastal bluffs between Seattle and Everett, Washington. The monitoring is designed to record rainfall, ground-water levels, and surface motions. These new data will provide the information needed to advance the understanding of the relation between rainfall, ground-water response, and landslide initiation.

The USGS, city officials, and Shannon and Wilson, Inc., are working to realize the objectives of Project Impact in Seattle. Their partnership has laid the foundation for understanding the natural and human causes of slope failure in Seattle. Planning and design alternatives that lower the landslide risk to public and private property and help ensure the safety of communities can be based upon this scientific understanding.

Landslide Hazards in the United States

Landslides occur in significant numbers in all 50 States. They threaten our communities and their transportation, energy, and communications infrastructure. Landslide-related fatalities average 25-50 per year nationally, and landslide-related economic losses cost between \$1 billion and \$2 billion per year. Rapid urban development, particularly in the Western United States, has created abundant new exposure to landslide conditions. This was demonstrated by widespread damage in Oregon, Washington, California, and Idaho associated with landsliding during the winter storm seasons of 1996, 1997, and 1998.

The U.S. Geological Survey Landslide Hazards Program

The U.S. Geological Survey (USGS) Landslide Hazards Program has operated since the mid-1970's as a congressionally authorized program dedicated to the reduction of damage and avoidance of hazards from the different forms of landslides. As the only Federal program dedicated to landslide



A house (overlooking Puget Sound in the Magnolia area of Seattle) destroyed by a landslide. (Photo: Ed Harp, USGS)

hazards, the USGS Landslide Hazards Program addresses the national landslide problem by (1) developing quantitative, regionally based probabilistic landslide hazard maps; (2) focusing process research and development of real-time monitoring systems on landslide types that produce the greatest hazards; (3) providing landslide-disaster emergency response; and (4) providing information through the National Landslide Information Center in Golden, Colorado, and on the Internet at <http://landslides.usgs.gov>.

USGS-developed probabilistic landslide hazard maps serve as prototypes that can be used by local and State governments, other Federal agencies, and private entities as models for developing their own hazard maps. These maps are developed digitally using landslide inventories, topographic models, information on geologic materials and properties, output from spatially distributed slope-stability models, and temporal information on the frequency of triggering events. Research on landslide processes and the development of real-time monitoring systems focus on landslides that are of the greatest potential hazard and on landslides that are associated with other natural hazards such as volcanic eruptions, earthquakes, meteorological events, and wildfires. Finally, the landslide emergency response and outreach efforts ensure that needed disaster assistance and landslide information are available to the Nation.

FOR MORE INFORMATION

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