

Landslides

General Information

The term landslide refers to the downslope movement of masses of rock and soil. Landslides are caused by one or a combination of the following factors: change in slope gradient, increasing the load the land must bear, shocks and vibrations, change in water content, ground water movement, frost action, weathering of rocks, and removal or changing the type of vegetation covering slopes.

"By geologic standards, Seattle's landscape is very, very young. Just 14,000 years ago, the land the city sits on was still under 3,000 feet of ice, part of the Ice Age's titanic Vashon Glacier, which extended from Canada to south of Olympia. When the ice melted, sea level rose 300 feet and filled the trough the ice had carved, creating Puget Sound. The region is still witnessing the erosion and settling that has followed that tumultuous episode."

Landslide hazard areas occur where the land has certain characteristics which contribute to the risk of the downhill movement of material. These characteristics include:

- A slope greater than 15 percent.
- Landslide activity or movement occurred during the last 10,000 years.
- Stream or wave activity which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable.
- The presence or potential for snow avalanches.
- The presence of an alluvial fan which indicates vulnerability to the flow of debris or sediments.
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Recently we have seen the power of landslides as a secondary hazard associated with the severe winter storm that hit the Puget Sound region in December 1996 and January 1997. Heavy snow storms were followed by a warming trend that caused quick melting, runoff and flooding. This period was then followed by rain. This led to over 100 slides in King County alone over the subsequent two month period.

Damages resulting from numerous landslides in 1972 totaled \$1.8 million. Seventy percent of the slides occurred over a two day period in which more than 1.75 inches of rain fell in 24 hours. To make matters worse, this period was preceded by a cold spell which lowered the absorption capabilities of the soil. The Seattle area was particularly hard hit due to urbanization and geologic conditions.

Vulnerability

Commonly, downslope movement is only considered a hazard when it threatens people and property. Therefore, this discussion focuses on landslides that occur in areas affecting human life or property; rather than landslides that occur in wilderness areas.

Although landslides can and do occur in almost any part of the state, the most vulnerable areas are the Puget Sound Basin and King County. Due to the high population density and the fact that many structures are built either on top of or below bluffs and slopes subject to landsliding, more lives are endangered and there is a greater potential for damage or destruction to private and public property. Many of the major valleys and shoreline bluffs of Puget Sound are bordered by steeply sloping unconsolidated glacial deposits that are highly susceptible to landslides. Other vulnerable areas include the Cascade Mountain passes leading to eastern Washington.

A study in the early 1970's showed that this area is most vulnerable to landsliding in the winter and spring. Generally significant landsliding follows periods of above average precipitation over an extended period, followed by several days of intense rainfall. It is on these days of intense rainfall that slides are most likely.

The Washington State Department of Transportation spends millions of dollars each year to repair damage caused by slope failures. These slope failures vary from a few rocks falling on to the highway, which work crews can remove in minutes, to a major landslide, that may require months of work and millions of dollars to correct. Some slopes fail year after year; others fail once in 50 years.

Effects

Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about \$1.5 billion. Damages to highways alone cost \$1 billion annually.

Typical effects include damage or destruction of portions of roads and railroads, sewer and water lines, homes and public buildings. Disruption of shipping and travel routes result in losses to commerce. Many of the losses due to landslides may go unrecorded because no claims are made to insurance companies, lack of coverage by the press, or the fact that transportation network slides may be listed in records simply as "maintenance." Even small scale landslides are expensive due to clean up costs that "may include debris clearance from streets, drains, streams and reservoirs; new or renewed support for road and rail embankments and slopes; minor vehicle and building damage; personal injury; livestock, timber, crop and fencing losses and damaged utility systems".

Conclusions

Landslides are often a secondary hazard related to other natural disasters. Landslide triggering rainstorms often produce damaging floods. Earthquakes often induce landslides that can cause additional damage. The identification of areas susceptible to landsliding is necessary to support grading, building, foundation design, housing density, and other land development regulations in reducing the risk of property damage and personal injury.

The most significant effect of landslides is the disruption of transportation and the destruction of private and public property. Some work has been done to prevent developments on top of or below slopes subject to sliding. Much more needs to be done to educate the public and to prevent development in vulnerable areas.