INSURANCE FOR LANDSLIDE DAMAGE: THINKING OUTSIDE THE SHEAR BOX

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ABSTRACT:

Landslides can be induced by seismic activity, among other causes. The science of landslides is now mature enough that, in many locations, the probability of landslides can be predicated and mitigated.

Comprehensive models of the effects of natural hazards, combined with inventories of at-risk properties and populations, are needed to quantify natural hazard damage risks. Reasonable probabilistic models require collaboration of geo-technical specialists, insurance actuaries, urban planners, and geographers. Government agencies involved at a regulatory level should produce quantitative hazard-distribution maps of use to insurers.

Climate change, responsible for more frequent natural processes at potentially damaging intensities, can initiate landslides or intensify their immediate or future damage potential. The contribution of climate change to landslide damage and evolution of insurance as an alternative mitigation response deserve consideration by landslide geologists and engineers. Damage statistics, typically disregarded by geo-technical specialists, are vitally important in these considerations.

KEYWORDS: Landslide, insurance, modelling, climate change.

1. INTRODUCTION

The potential usefulness for a paper such as this one became evident during discussions with the organizers of the First North American Landslide Conference in Vail, Colorado, in 2007, when the second author suggested that conference attendees should be challenged to 'think outside the shear box' regarding mitigation of the impact of landslides on society. Traditionally, landslide conferences are attended by engineers and geologists who are interested in the mechanics of slope movements, what triggers them, how they behave, and what can be done to stabilize moving slopes. This paper seeks to present a brief overview of some aspects of insurance in the context of landslide damage.

2. ADDRESSING THE PROBLEM

Schuster (1996) notes that landslides are responsible for considerably greater socioeconomic losses than is generally recognized, because they often occur as one element of multiple-hazard disasters and are reported in combination with the triggering process (e.g., earthquake, flood, hurricane, volcanic eruption, and brush fires that expose the soil). Most of the losses caused by the 1964 Alaska earthquake resulted from shaking-induced landslides and liquefaction rather than from shaking of buildings and bridges.

These questions leap over a fundamental issue about landslides and landslide damage: Are high monetary losses from this hazard being recorded in the United States or abroad? Is the need for landslide mitigation and insurance local or broad-based? The U.S. Geological Survey (Figure 1) compiled landslide incidence and susceptibility information in the United States to begin the process of assessing the extent of landslide hazards.

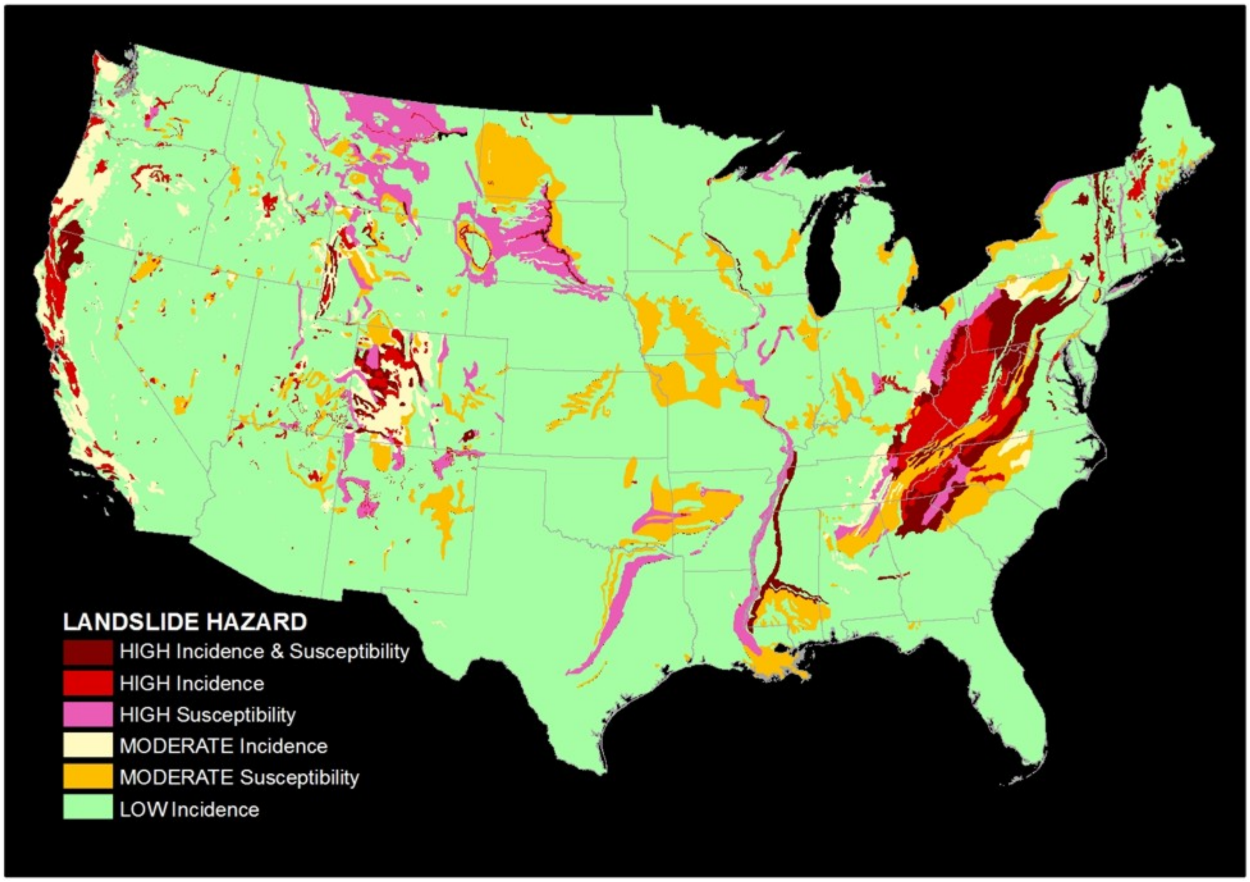

Figure 1. Overview of landslide hazards in the United States (plotted from GIS files available on the USGS website prepared by Godt, 1997).

Landslide costs include both direct and indirect costs that affect public and private properties. Direct costs consist of repair, replacement, or maintenance resulting from damage to the property situated within the boundaries of moving landslides or the paths or shorelines of resulting debris flows or lakes. Schuster (1996) reports direct costs of $200 million (1983 dollars) caused by the Thistle landslide in central Utah which buried a federal highway, a state highway, and a private railroad, as well as flooding a town. Municipalities bear significant costs to repair roads, as well as liability costs to property owners.

Indirect costs of landslides include:

1. Loss of industrial, agricultural, and forest productivity and tourist revenues as a result of damage to land or facilities or interruption of transportation systems.
2. Reduced real estate values in landslide threatened areas.
3. Loss of tax revenue on devalued properties.
4. Costs to prevent or mitigate future landslide damage.
5. Losses or costs to correct adverse effects on water quality in streams or irrigation facilities.
6. Loss of human or animal productivity because of injury, death, or psychological trauma, or
7. Secondary physical effects, such as landslide-caused flooding, with direct and indirect losses.

When an insurance policy covers the direct damage to a building, it may, under certain circumstances, cover some of the indirect damage to the insured as well. This is called “business interruption” coverage in commercial policies. The insurance policy can also cover the contents and inventory of the business insured.

On the positive side, a potentially unstable slope may have been stabilized or a road across a landslide may have been relocated. On the negative side, climate change may bring more frequent events of heavy precipitation. For example, consider the 2004 impacts on the southeast United States from Hurricanes Francis, Ivan, and Jeanne with extensive landslides caused by precipitation from subsequent storms falling on areas soaked by earlier storms.

Future landslide activity is increasing on a worldwide basis because of increased urbanization and development in landslide-prone areas, continued deforestation, and increased precipitation caused by changing climate patterns.

3. OVERVIEW OF INSURANCE

In the United States, insurance policies exclude any damage to land or buildings due to “earth movement.” The policies also exclude any damage to land or buildings caused by flooding. A separate earthquake insurance policy can be purchased that makes an exception to this exclusion by insuring damage if the earth movement was an earthquake. However, the insurance only pays for earthquake damage to the building, not to the ground under the building.

The situation is clear: insurance companies in the United States do not want to insure damage to land caused by earth movement or flooding. This clearly includes landslides. Interestingly, insurance is available for everything else imaginable, including: satellites, hurricanes, nuclear accidents, and acts of terrorism.

Many engineers and geologists may believe that private insurance is available to cover just about any condition, including unstable slopes. From a practical perspective, private insurers are in business to make a profit by offering a product that individuals and businesses will buy, while retaining an actuarially determinable risk. The cost of the product includes the same factors that any business considers: product development, marketing, servicing, administration, and profit. However, the cost of the insurance product includes the amount that they will have to pay in claims. The business of insurance is unique in that the costs of claims will not be known until after the insurance has been sold. The amount paid in claims depends on the frequency of claims and the size of the losses.

For ordinary homeowners and automobile insurance, the risk of loss is quantifiable based on the history of the past claims experience with similar types of homes and driving conditions. This is what actuaries do. The risk of loss is manageable based on the laws of statistics, because the claims are frequent.

However, the risk of loss associated with infrequent events, such as hurricanes and earthquakes, cannot be based on past experience. Instead, comprehensive models of the damaging effects of these natural events, combined with inventories of at-risk facilities and populations are needed to quantify the risk of damage. If model results are not accurate, then private insurers cannot quantify the risk. If model results are accurate, but the policy premiums are higher than what people will pay, then a viable insurance product cannot be offered.

The common natural hazards are floods, hurricanes, earthquakes, and landslides. Flood damage is mostly insured by the Federal Flood Insurance Program. Private insurance companies offer insurance against damage from hurricanes and earthquakes. Landslide insurance is the only insurance that is not offered by either the insurance industry or the government.

Floods and hurricanes are recurring events. To a lesser extent, earthquakes are recurring events. Recurring events have probability distributions associated with them, which are essential inputs for damage models. At least approximately, frequency and severity distributions can be assigned to geographical zones where floods, hurricanes and earthquakes occur.

Landslides present a more complicated risk situation. In order to model a geographical zone where landslides are likely to occur, a probability must be assigned to the occurrence and the magnitude of a landslide. A susceptible landslide zone usually has no history of landslides. Furthermore, landslides can be caused by rainfall, earthquakes, natural erosion, and human intervention (e.g., homes built on hillsides). In California, brush fires will remove the supporting vegetation from a hill side, causing landslides at the next major rain storm.

However, engineers have a very good understanding of the physics of soil conditions and of landslides. Potential landslide areas are to some extent predictable, and effective mitigation measures can be taken.

It is often said that the insurance industry is exposed to adverse selection, moral hazard, and correlated risk (Kunreuther, 1998). Adverse selection refers to policies being purchased only by owners of property that is likely to be damaged: People with property inside the 100-year floodplain boundary tend to buy flood insurance, but people outside the 500-year floodplain do not. Moral hazard refers to a relaxation in the level of care or concern on the part of an individual after insurance is purchased. Such relaxation can result in a greater amount of damage at a given event than might have occurred if the individual had maintained a proper level of care. Correlated risk refers to a concentrated exposure in a single-event. Since basically all property inundated by a 100-year flood will be damaged, and if people with property inside the floodplain have insurance, then a single flood will produce a large number of claims at once. Correlated risk is a major problem in earthquake-prone areas (Roth, 1998).

These issues are no longer as big a problem as they may have been in the past. If a person lives inside the 100-year flood plain boundary and the premium for the flood insurance is properly priced to reflect the risk of damage to the house, there is no adverse selection. The term “adverse selection” used to have in mind the situation in which the homeowner knew more about the risk of damage to the house than the insurance company did, and therefore was purchasing underpriced insurance. With the current modelling technology, the insurance companies now know more about the risk of damage than the homeowner does. Often, the true risk is far less than the homeowner realizes, which is especially true for earthquakes in the central part of California. Computer modelling is now used to control the correlated risk problem.

Relatively few people voluntarily purchase natural hazard insurance. This leads to the frequent comment that natural hazard insurance should be mandatory, in order to get enough participants to “spread the risk,” which is supposed to be the function of insurance. The reasoning is that mandatory basic natural hazard property insurance will result in a larger group of insureds and lower premiums for the same coverage. This is not necessarily an obviously good policy decision. It is not even necessarily true.

Automobile liability insurance is mandatory, in order to protect the other driver who was not at fault. You are not required to buy automobile insurance to protect yourself or your car. Natural hazard insurance pays for damage to your property, not someone else’s property (liability insurance is different and readily available). It is very unusual to be required to insure your own property (unless there is a lender; then it is for the lender’s benefit).

Furthermore, the number of policies that has to be sold in order to "spread the risk" is actuarially surprisingly small. This can be seen in political polling, where the outcome of elections can be predicted based on just a few hundred random responses.

The federal flood program is mandatory for property owners in certain flood zones with mortgages, in order to reduce the demand for federal disaster relief. Previously, flood damage losses were compensated as federal disaster assistance in the form of disaster loans and grants. There are requirements for flood plain management and flood hazard reduction, as well as issuing an extensive inventory of flood plain maps. A large number of insureds are necessary in order to cover the high fixed costs of maintaining the program. In reality, a mandatory program is a tax. Furthermore, a mandatory program often subsidizes the high risk property owner in order the make the insurance affordable.

The insurance industry needs accurate maps of hazard distribution in meaningful terms for actuarial calculations. Geologists and engineers are not yet thinking about slope processes in terms that are sufficiently meaningful to insurers.

4. INFLUENCE OF CLIMATE CHANGE

Clearly excessive rain, droughts, and wildfires have direct impact on landslide potential, whether it is immediate or delayed. Rain often is considered to be a landslide triggering process. Drought stresses plants, possibly leading to excessive runoff and erosion. Wildfire destroys vegetation, can create hydrophobic soils, and promotes excessive runoff and erosion. Erosion, in turn, creates over-steepened conditions on slopes, which promotes larger-scale instability.

In the present paper, we make the point that climate change seems to allow natural processes to occur more frequently at damaging intensities, regardless of cause of the climate change. Little consensus exists on the degree to which humans may be responsible for climate change, but no doubt exists in the fact that humans choose to live and construct facilities in places where they can be injured and damaged because of landslides and other hazardous natural processes.

Well-documented geologic evidence of natural climate change exists for a number of areas. For example, an ice sheet moved across the Seattle area in Washington at a rate exceeding 100 m/yr and retreated abruptly at more than twice that rate (Porter and Swanson, 1998). The ice reached its southernmost limit approximately 85 km south of Seattle by 16,950 calibrated years before present (cal yr B.P.) and had melted to a point north of Seattle by 16,420 cal yr B.P. Meanwhile, glaciers in the Uinta Mountains in Utah were melting rapidly causing Lake Bonneville to rise rapidly to its maximum level approximately 14,500 cal yr B.P. and had evaporated to a small fraction of its former size by 13,000 cal yr B.P., dropping in level over 260 m (Link et al., 1999).

These are well-documented examples of climate-driven dramatic changes in temperature and evaporation that may have influenced geologists' impressions about giant ancient landslides which have been identified in a variety of locations. Ancient landslides that appeared to have been stable for thousands of years have been dismissed as relicts of the Ice Age and judged to have essentially no risk of movement in the future. A return to wetter conditions, perhaps similar in some respects to those of the Ice Age, may reactivate some of these ancient giant landslides which now have roads, reservoirs, and resorts built on them.

5. LANDSLIDE DAMAGE MITIGATION

Mitigation of landslide hazards involves stabilization of slopes. One of the significant challenges in slope stabilization is that the boundaries of many landslides extend beyond the limits of the properties owned by a group who would benefit from its stabilization. Even in situations in which a group has control over the entire unstable slope, mitigation measures may require long-term maintenance, possibly in perpetuity, as would be the case with dewatering wells. The cost of the mitigation often exceeds what any single property owner could manage, and long-term maintenance, which may be essential for the success of the mitigation, must go on regardless of property ownership succession. For these reasons, Geologic Hazard Abatement Districts may be created by legislative action to collect mitigation maintenance fees (taxes) from properties that benefit from the mitigation (Committee on the Review of the National Landslide Hazards Mitigation Strategy, 2004). Legal challenges regarding responsibility for initiation of slope movements can cause delays in defining the extent and character of the instability and optimum mitigation measures.

Landslides commonly damage public infrastructure, even when most of the unstable slope is under private ownership. Public infrastructure includes roadways and buried utilities. The contributions to instability arising from surface drainage intercepted by roadways and subsurface water leaking from sewer and water supply pipelines can be difficult issues in the legal and political aspects of evaluating causes of slope movement and selecting mitigation strategy.

6. DISCUSSION

Risk of loss associated with house fires and automobile accidents is quantified on the basis of past experiences with similar types of construction or driving conditions. Risk of loss associated with floods, earthquakes, and other natural processes cannot be based on past experiences. Instead, comprehensive models of the effects of natural processes, combined with inventories of at-risk facilities, populations, and functions, are needed to quantify natural-process damage risks. Collaboration of geo-technical specialists (engineers, geologists, meteorologists), insurance actuaries, urban planners, and geographers are needed to develop predictive models based on reasonable probabilistic parameters. Government agencies likely will be involved at a regulatory level and to produce maps of hazard distribution similar to flood and earthquake hazard maps.

Climate change seems to be responsible for more frequent natural processes at intensities that have the potential to cause damage. Notable examples are tropical storms and wildfires, both of which have direct impacts on initiating landslides or intensifying their immediate or future impacts. The contribution of climate change to landslide damage and evolution of insurance as an alternative mitigation response deserves consideration by landslide geologists and engineers.

A damaged building can be repaired or rebuilt on the same piece of property because the property's ability to support the building has not diminished. The effects of landslides are different in the sense that the damage arises out of a shift in the foundation of the building or the impact of debris sliding or flowing down a slope onto the property. The property may remain unstable or additional debris may remain on the slope in a position to again slide or flow onto the property causing future damage.

Part of the Bluebird Canyon area of the City of Laguna Beach in Orange County, California, experienced landslide damage in October 1978 and again in June 2005. Approximately $52.7 million were spent repairing a landslide that destroyed 60 houses in 1978, six months after unusually heavy rains. The 1978 slide area was repaired following detailed geotechnical investigations which recognized it to be a portion of a larger, ancient landslide. An early estimate of damage was $33 million for the 2005 landslide that destroyed 15 and damaged 25 houses. The 2005 landslide was adjacent to the repaired 1978 landslide and also occurred six months after unusually heavy rains. The ancient landslide that damaged the houses in 2005 was recognized in the 1978 investigation. Part of the 1:100,000-scale geologic map is presented on Figure 2, along with a portion of a specialized map showing soil-slip susceptibility. Maps of the detail and information content shown on Figure 2 are needed for land use planning and could be used for establishing premiums for landslide insurance policies. Maps such as these are available for a very small percentage of areas of the United States exposed to risk of landslide damage.

In December 2005, the citizens of Laguna Beach voted to increase sales taxes for six years to supplement approximately $7 million in federal funding to repair infrastructure and roads damaged by the June 2005 landslide. The Orange County Register reported that one resident said she voted for Measure A because she thought the city-managed disaster fund was “a prudent way to put something away for next time,” adding "It could happen to any of us here."

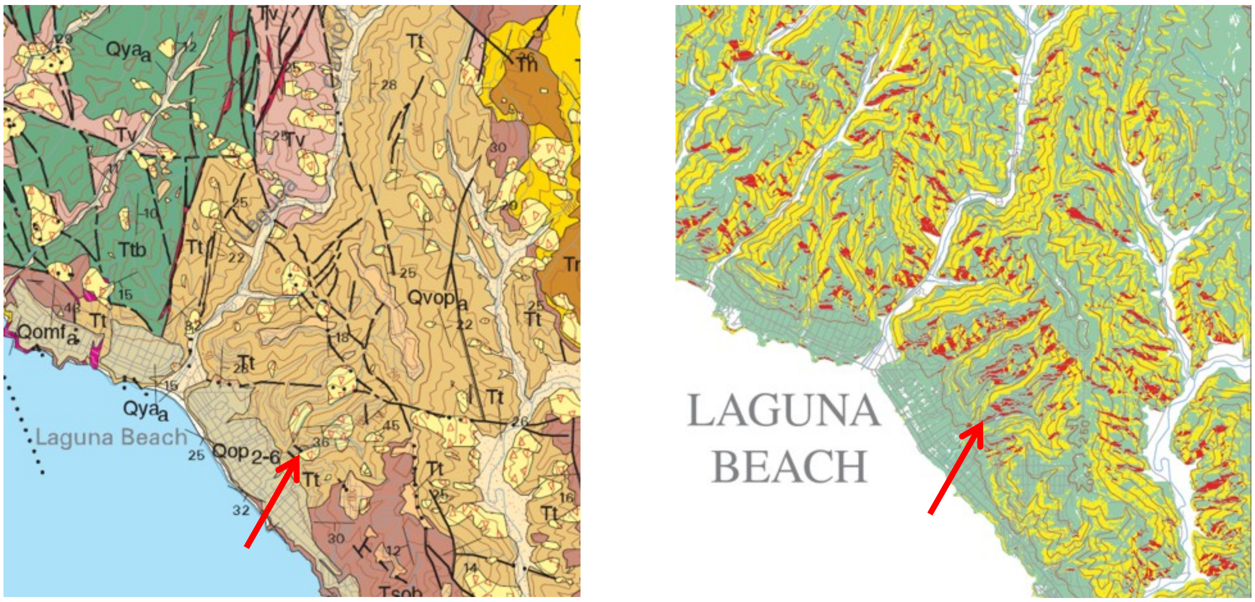

Figure 2. The Laguna Beach area of Orange County in Southern California showing geology (left) and soil-slip susceptibility (right) from Morton et al. (2004, 2003). Red arrow points to Bluebird Canyon area. Landslide deposits on the geologic map are shown in pale yellow with red triangles (left). Red denotes high soil-slip susceptibility, yellow denotes moderate susceptibility, green denotes low susceptibility, and uncoloured denotes no susceptibility (right).

7. CONCLUSION

We hope that this paper gives landslide geologists and engineers an opportunity to peek “outside the shear box” at social and economic impacts of landslides and issues of science-based public policy formulation and implementation. Perhaps we have been successful in providing a glimpse of the vital importance that professional geologists and engineers can make in mitigating landslide damage in an era of rapid development, changing climate, and increasing exposure of valuable infrastructure to potential damage.

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