ODF: Landslides and debris flows

The public and news media may ask ODF stewardship foresters and staff to respond to questions on landslides generally and the Highway 30 slide in particular. The discussion points below are provided as a refresher of what we know about landslides and debris flows, and as a way to have a consistent message. A major source of information used in this document is the "Storm Impacts and Landslides of 1996" report which is available on the Department's website (executive summary at http://www.oregon.gov/ODF/PRIVATE_FORESTS/docs/fp/StormExecSum.pdf)

A PowerPoint presentation about the Highway 30 landslide can be found at DOGAMI's website at: http://www.oregongeology.com/sub/default.htm

Landslides and Debris Flows

A landslide is a mass movement of rock, soil, and debris down a slope under the influence of gravity. There are various types of landslides, including rock falls, creep, earthflows, slumps, block slides, debris avalanches and debris flows. The size and rate of movement can vary tremendously, and as a result so can the risks to life and property.

In steep terrain, landslides may transform into dangerous, rapidly moving events often referred to as debris flows, mudslides, mudflows, or debris torrents. In western Oregon, debris flows often originate as small shallow rapidly moving landslides.

Typically, debris flows consist of mud, boulders, and logs traveling down steep slopes, narrow stream channels, or v-shaped canyons. Debris flows often move rapidly and may exceed 30 mph, traveling several hundred feet or several miles. They often have major impacts on streams and can damage or destroy homes, roads, or other structures that are in their path.

Landslides are a natural, geologic process

Landslides are the dominant erosion process on steep forested slopes in western Oregon and throughout the Pacific Northwest. Slope saturation by water is the primary cause of many landslides. This normally occurs during intense rainfall, snowmelt, or "rain on snow" events. Flooding can influence landslides and landslides can influence flooding. For example, erosion caused by flooding can steepen or undercut slopes making a landslide more likely. Likewise, landslides can dam streams and cause flooding.

As natural geologic processes, landslides and debris flows have a range of environmental effects. In the short-term, material from landslides may bury or suffocate fish eggs and emerging young fry. However, long-term, the logs, sediment and boulders that landslides deliver provide nutrients, and create habitat where fish and wildlife can rear and hide.

The wet climate and rugged terrain found throughout western Oregon means that many areas are prone to landslides. Landslides occur on both managed and un-managed forests. Landslides do not just occur on forestlands. It is neither possible nor even desirable to prevent the majority of landslides in Oregon. Unfortunately, many people are unaware of their exposure to these landslide risks. Many people live in the path of potential landslides or debris flows. In addition, many people assume that most landslides are "caused" by human activity rather than part of the natural geologic process.

Landslide Risk is a Function of Location

Because of their unique geological conditions, some areas of Oregon are more susceptible to landslides. The "Storm Impacts and Landslides of 1996" study examined areas in western Oregon determined to have the highest disturbance due to landslides.

The "Tyee Core Area" denotes a geographic area in the central Coast Range of relatively homogeneous geology and topography that are very susceptible to shallow, rapidly moving landslides due to a combination of factors. These factors include long, steep slopes, higher drainage density, shallow coarse-grained low cohesion soil, with an abrupt transition to an impermeable layer or rock, and interbedded siltstone/sandstone beds, which can route water to slope faces. These geologic and geomorphic characteristics thus warrant lower slope thresholds in applying forest practice rules related to landslides.

Other portions of the Coast Range such as in Columbia and Clatsop Counties were found by the 1996 study to have a lower landslide incidence than the Tyee area. These areas may be relatively more prone to deep-seated landslides since they have more diverse geologic conditions including sandstone, intrusive igneous, mudstone, basaltic conglomerate, basaltic andesite. Steep geologic conditions dominated by basalts like in Tillamook County did not have an incidence as high as the Tyee area, but they are also prone to shallow rapid landslides. The Cascade Mountains also have steep areas prone to landslides. Glacial conditions on some of the high peaks in the Cascades can result in unique large-scale mudflow events due to large volumes of unconsolidated glacial sediments and the formation of glacial debris jams. The Columbia River gorge also has a unique set of conditions that lead to very larger debris flows.

Forest Practices and Landslide Risks

The activities of people, including forest practices, may be directly or indirectly influenced landslides. Forest practices may alter the physical landscape and its vegetation, which can affect the stability of steep slopes. They may also affect the timing of landslides and the nature of landslide deposits in streams. Physical alterations can include slope steepening, slope-water effects, and changes in soil strength. Most physical alterations are the result of roads and skid roads.

Of all forest management activities, roads have the greatest effects on slope stability. However, the 1996 study found that the majority of landslides were not associated with roads. While the road-associated landslides were typically about four times larger in volume than nonroad-

associated landslides, these road-associated landslides were smaller and fewer in number compared to previous studies. This research suggests that changing road construction and maintenance practices are reducing the effects of roads on landslides.

Changes in vegetation can have both hydrological and mechanical effects on the stability of slopes. Timber harvesting can affect when landslides occur in areas with a moderate to high landslide risk. The 1996 study found that, in three out of four study areas in very steep terrain, landslide densities and erosion volumes were greater in stands that had been clearcut in the previous nine years. On the other hand, stands between 10 and 100 years in age typically had lower landslide densities and erosion volumes as compared to forest stands older than 100 years. Landslides in clearcuts were not different in size from landslides in older forests.

The Oregon Forest Practices Act and Landslides

The Oregon Department of Forestry regulates forest practices to ensure the growing and harvesting of trees while protecting resources and public safety. The Board of Forestry adopted rules following the 1996 storms to manage landslide risk to protect natural resources and the public's safety.

These rules include appropriate practices designed to reduce the occurrence, timing, and effects of landslides when warranted by public exposure to safety risks. Harvesting is prohibited on steep slopes where there is a substantial risk to public safety from shallow rapid landslides. Where there are low or moderate risks to public safety, practices are designed to reduce the effect that harvesting has on landslides. The rules are designed to prevent harvesting from contributing to landslides that affect public safety; however, the risk of landslides exists with or without harvesting.

The Forest Practices Act rules for timber harvesting, road construction and maintenance, and reforestation are designed to minimize surface erosion, prevent steepening of slopes, limit changes in water flow and promote re-vegetation. These rules address factors that can influence the potential for landslides. Stewardship foresters and the department's geotechnical specialists assist foresters and landowners by providing guidance and administration of these rules to maintain soil productivity, water quality, and resource protection.

The Eilertsen Creek Fill Failure

The massive rainstorm that soaked the Pacific Northwest in early December once again raised questions about the cause of the numerous, sometimes very destructive landslides which follow such events. The answer involves a region with unstable geology, and torrential rains.

A full report on the circumstances surrounding the fill failure and resulting debris flow that affected homes and closed Highway 30 is planned. This report will be a public document and available to all interested parties. Until that report is released, it should be emphasized that our knowledge of the circumstances is preliminary.

The Eilertsen Creek fill failure was so catastrophic because of the large size of the fill and the sheer volume of water and debris backed up behind it. The current road follows an old railroad grade that used to cross the Eilertsen Creek Canyon with a wooden trestle. At some point in the past, that trestle was buried with soil fill to form a large embankment across the canyon. The current road crossed the Eilertsen Creek Canyon on this fill. During the heavy rains on December 2 or 3, it is likely that one or two landslides roughly 1.5 miles up slope of Woodson and roughly 1/4 mile up slope of the fill failed into Eilertsen Creek and formed debris flows that traveled down to the site of the fill. Both initiation sites were deep, about 10+ feet, while a typical initiation site in the Tyee Core Area is about 1-3 feet, which indicates a fundamental difference in geomorphic characteristics, soil properties, and failure mechanics. These debris flows likely contributed to blocking the drainage structure for the fill.

After the drainage under the old fill was blocked, the fill acted as a dam and a temporary lake formed behind the fill. The lake eventually reached 40 feet deep at the base of the fill and extended 200 feet upstream. The landowner became aware of the problem early, made efforts to remedy it, notified downstream residents, and called ODF and other agencies. After study of the fill and impoundment of water and debris, ODF notified the residents in Woodson and the Oregon Department of Transportation that a fill failure and resulting debris flow was imminent. Residents in Woodson were evacuated and Highway 30 closed during the morning of December 11. Around noon, the fill failed and the lake drained catastrophically. The resulting debris flow engulfed the town of Woodson and Highway 30. There were no injuries.

While the slides occurred on previously harvested areas and it is possible that harvesting affected slope stability, there is not sufficient information to establish that the logging "caused" the landslides. The depth of the slides (below the rooting layer), other slide characteristics, does not at this time suggest such a cause and effect relationship. However, until the relevant site data are collected and analyzed, any conclusion is premature.