STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
www.OregonGeology.org

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Landslide Susceptibility Overview Map of Oregon

2016

ABOUT THIS PUBLICATION

Climate, geology, and topography combine to make Oregon a landslide-prone state. Landslides are triggered by precipitation, earthquakes, and other factors. The growing Oregon population inevitably pushes development onto landslide-prone slopes, adding to the people and infrastructure at risk. Mitigating this risk starts with detailed (1:8,000 scale) landslide hazard maps. Because it is impossible to create detailed landslide hazard maps for the entire state due to lack of data and resources, we created this landslide susceptibility overview map as a way to help prioritize areas in Oregon for future detailed efforts.

The purpose of this project was to create a generalized (coarse grid,1:500,000-scale) landslide susceptibility overview data set of the entire state. The intended use this overview map is to help identify regions (cities, counties, communities, portions of lifelines, etc.) that may be regionally at risk for future landslides. This landslide susceptibility data can help the state and communities prioritize areas for more detailed mapping.

METHOD OVERVIEW

We produced the landslide susceptibility overview map of Oregon using these available statewide data sets (numbers correspond to numbers in the matrix and maps below):

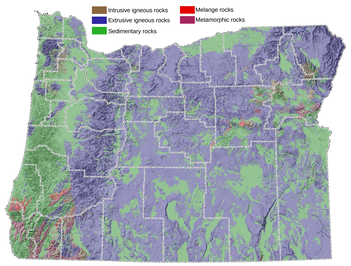
1. Generalized Geologic Map (148 generalized geologic units)
2. Landslide Inventory (54,758 landslide polygons)
3. Slope Map (lidar- and NED-derived 32.8 ft² grid in degrees)

We used this general procedure to create the map (see accompanying report for details): First, we combined the generalized geology (1) and landslide inventory (2) to determine landslide area per geologic unit area. We used the percentage of landslide area within each of the 148 generalized geologic units were used to establish classes of low, moderate, and high landslide density (landslide area/geologic unit area).

Next, we calculated spatial statistics between the combination of maps 1 and 2 and the slope map (3) to determine the mean and standard deviation of slope angles within the landslides per geologic unit. We used the mean and standard deviation to establish classes of low, moderate, and high slopes prone to landsliding within each geologic unit.

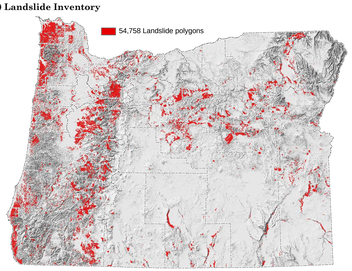
We then used Landslide Density and Slope Prone to Landsliding, along with the original landslide inventory in the landslide susceptibility hazard matrix to establish the final landslide susceptibility overview map zones.

1 Generalized Geologic Map

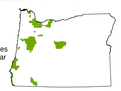


The Appendix B of the accompanying report contains details about the 148 generalized geologic units grouped into five basic rock types for display on this plate and in to create this map. Data source: Pre-release version of Oregon Geologic Data Compilation, release 6, provided by I.P. Madin, 2014.

2 Landslide Inventory

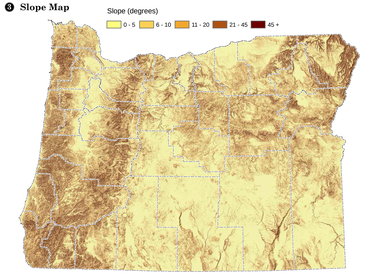


Data source: Statewide Landslide Information Database for Oregon, release 3.2 (Burns, 2014)

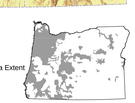


Note that the quality of detailed landslide mapping varies across the state and impacts the quality of the final overview map.

3 Slope Map



Data sources: National Elevation Dataset (10-m DEM)
Gesch and others, 2007) and lidar-derived data sets
(DOGAMI, 2005-2014, published and unpublished data;
http://www.oregongeology.org/sub/lidardataviewer/)



Note that the quality of lidar basemap sources varies across the state and impacts the quality of the final overview map.

Landslide Susceptibility Matrix:

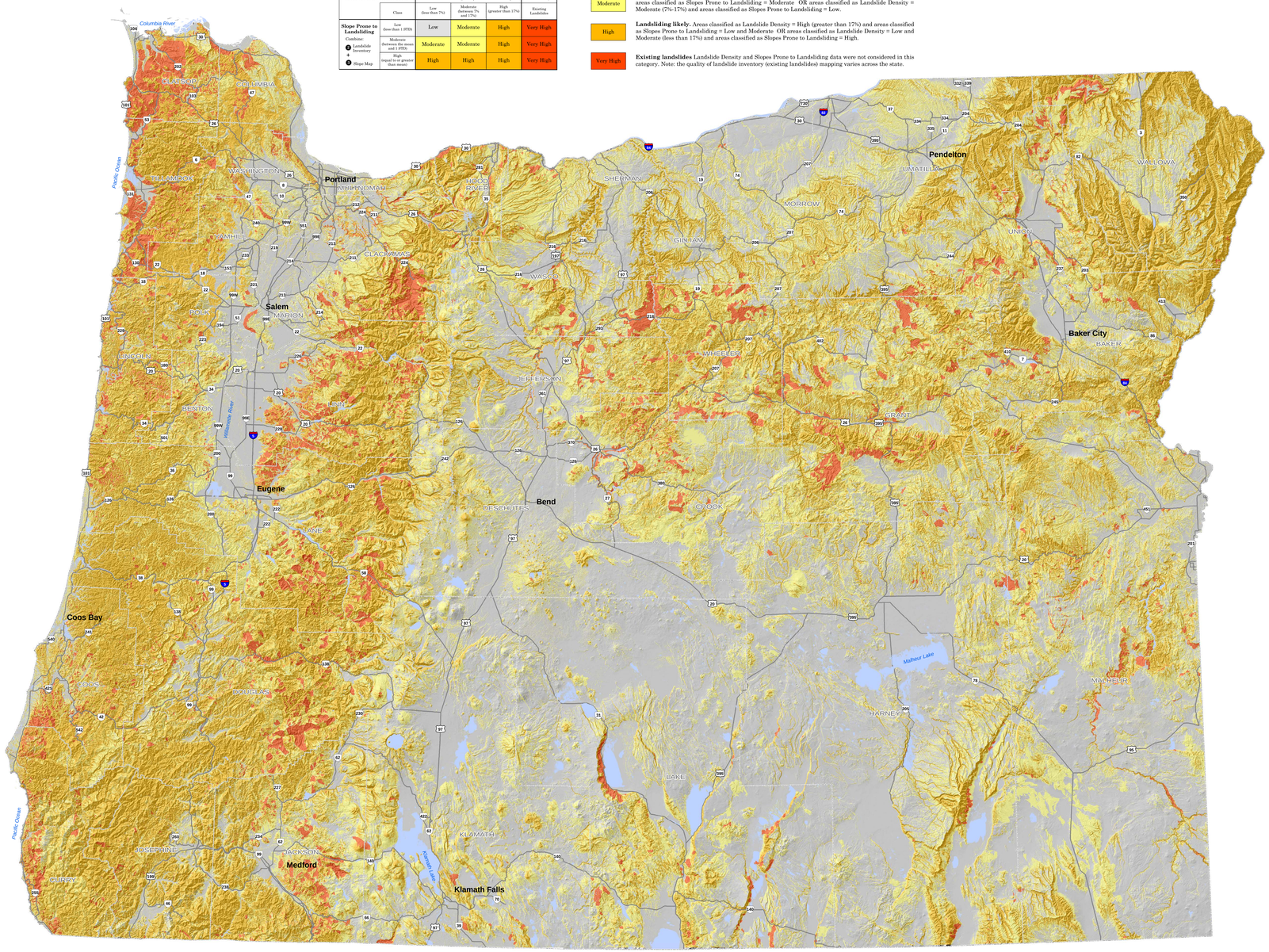
Graphic display of how data sets are combined to create the final landslide susceptibility zones.		Landslide Density: Combine: 1 Generalized Geologic Map + 2 Landslide Inventory			Landslides: 2 Landslide Inventory
	Class	Low (less than 7%)	Moderate (between 7% and 17%)	High (greater than 17%)	Existing Landslides
Slope Prone to Landsliding Combine: 2 Landslide Inventory + 3 Slope Map	Low (less than 1 STD)	Low	Moderate	High	Very High
	Moderate (between the mean and 1 STD)	Moderate	Moderate	High	Very High
	High (equal to or greater than mean)	High	High	High	Very High

Low — **Landsliding unlikely.** Areas classified as Landslide Density = Low (less than 7%) and areas classified as Slopes Prone to Landsliding = Low.

Moderate — **Landsliding possible.** Areas classified as Landslide Density = Low to Moderate (less than 17%) and areas classified as Slopes Prone to Landsliding = Moderate OR areas classified as Landslide Density = Moderate (7%-17%) and areas classified as Slopes Prone to Landsliding = Low.

High — **Landsliding likely.** Areas classified as Landslide Density = High (greater than 17%) and areas classified as Slopes Prone to Landsliding = Low and Moderate OR areas classified as Landslide Density = Low and Moderate (less than 17%) and areas classified as Slopes Prone to Landsliding = High.

Very High — **Existing landslides** Landslide Density and Slopes Prone to Landsliding data were not considered in this category. Note: the quality of landslide inventory (existing landslides) mapping varies across the state.



Base Map:
National Elevation Dataset (NED) 10-m DEM hillshade with sun azimuth at 315 degrees and altitude at 45 degrees.

Projection: Oregon Statewide Lambert Projection, NAD 1983 HARN datum

Software: Esri ArcGIS 10.2

APPROXIMATE MEAN DECLINATION, 2012

SCALE 1:750,000

0 100,000 200,000 400,000 600,000 Feet
0 15 30 60 90 Miles
0 35 70 140 210 Kilometers

LOCATION MAP

Cartography by William J. Burns, Oregon Department of Geology and Mineral Industries.

This map benefited from review by George Priest, Oregon Department of Geology and Mineral Industries.

OPEN-FILE REPORT O-16-02

Landslide Susceptibility Overview Map of Oregon

by William J. Burns, Katherine A. Mickelson, and Ian P. Madin

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PLATE 1

LIMITATIONS

The new statewide overview map displays areas of low to very high landslide susceptibility throughout Oregon. The intended use of this overview map is to help identify the relative susceptibility to landsliding of each region of the state. This map is not intended for use at scales other than the published map data scale (1:500,000). The map is designed to provide a basis for regional planning and localities where more detailed landslide mapping is warranted.

Limitations of the input data and modeling methods we used to make the map are such that the map is not suitable to answer site-specific questions. The map should be used only for regional or community-scale purposes. The following is a list of specific limitations:

Every effort has been made to ensure the accuracy of the GIS database, but it is not feasible to completely verify all of the original input data.

The map is based on three primary sources: a) landslide inventory, b) generalized geology, and c) slope. Factors that can affect the level of detail and accuracy of the final susceptibility map include: 1) lack of detailed landslide inventory statewide, 2) too much or too little generalization of the geology, and 3) highly variable DEM resolution resulting in variable accuracy of the slope model.

Future geologic, topographic, and landslide mapping may render this map locally inaccurate.

The intent of landslide susceptibility overview map is to help identify regions (cities, counties, communities, portions of lifelines, etc.) that may be more or less at risk for future landslides. We did not consider runout areas from channelized debris flows or other types of landslides with runout deposits. We did not consider talus slopes from rock fall/topple areas and relatively small shallow landslides in this analysis.

Some landslides areas on the map may have been mitigated, reducing their level of susceptibility. Because it is not feasible to collect detailed site-specific information on every landslide, existing mitigation has been ignored.

REFERENCES

Burns, W.J., 2014, Statewide landslide information database for Oregon [SLIDO], release 3.2: Oregon Department of Geology and Mineral Industries, geodatabase. Web: http://www.oregongeology.org/sub/slido/

Gesch, D.B., 2007, Chapter 4—The national elevation dataset, in Maune, D., ed., Digital elevation model technologies and applications: The DEM users manual (2nd ed.): Bethesda, Md., American Society for Photogrammetry and Remote Sensing, p. 99–118.

Oregon State University, 2014, 30 year normal PRISM Climate Group, Web: http://prism.oregonstate.edu

Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H., 2014, Documentation for the 2014 update of the United States national seismic hazard maps: U.S. Geological Survey Open-File Report 2014–1091, 243 p.,Web: http://dx.doi.org/10.3133/ofr20141091.

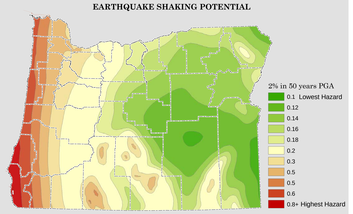
WHAT ARE SOME LANDSLIDE TRIGGERS IN OREGON?

Understanding likely locations for future landslides or landslide susceptibility is fundamental for understanding the hazard. What triggers the landslides at these likely locations is also important.

Landslides can be triggered by earthquake shaking, precipitation, and other factors including human effects. The following maps display areas in Oregon with lower and higher potential for earthquake shaking and precipitation. Earthquake shaking potential is generally higher along the coast and in the Klamath region. In general, there is more precipitation in western Oregon and in higher elevation areas, such as the Wallowa and Steen Mountains, of eastern Oregon.

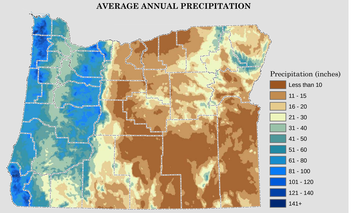
Combining the susceptibility map with either of these trigger maps produces a landslide potential map. One can infer by overlaying either trigger map on the susceptibility map that higher landslide potential exisits in western Oregon.

EARTHQUAKE SHAKING POTENTIAL



Data source: Petersen and others (2014)

AVERAGE ANNUAL PRECIPITATION



Data source: Oregon State University (2014)