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Landslide Inventory Map of the Coastal Portion of Douglas County, Oregon

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Landslide Inventory Map of the Coastal Portion of Douglas County, Oregon

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INTRODUCTION

The Oregon Department of Geology and Mineral Industries (DOGAMI) partnered with Oregon Emergency Management (OEM) to better understand the landslide hazards in the coastal portions of Douglas County, Oregon. The goal of the partnership was to create detailed landslide inventories. The text below explains how this was done.

EXPLANATION

This map is an inventory of existing landslides in the study area. The landslide inventory is one of the essential data layers used to delineate regional landslide susceptibility. This landslide inventory is not regulatory, and revisions can happen when new information regarding landslides is found or when new landslides occur. Therefore, it is possible that landslides within the mapped area were not identified or occurred after the map was prepared.

This inventory map was prepared by following the Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (lidar) Imagery developed by Burns and Madin (2009). The three primary tasks included compilation of previously mapped landslides (including review of the Statewide Landslide Information Database for Oregon [SLIDO] Release 4 [Franczyk and others, 2019]), lidar-based morphologic mapping of landslide features, and review of aerial photographs. Landslides identified by these methods were digitally compiled into a GIS database at varying scales. While the protocol recommends data use at a map scale of 1:8,000, and the geodatabase contains data at 1:8,000 or better, for representation purposes the data have been visualized on the map plate at 1:32,000. Each landslide was also attributed with classifications for activity, depth of failure, movement type, and confidence of interpretation. The landslide data are displayed on top of a base map that consists of an aerial photograph (orthorectified) overlaid on the lidar-derived hillshade image.

This landslide inventory map is intended to provide users with basic information regarding landslides within the study area. The geologic, terrain, and climatic conditions that led to landslides in the past may provide clues to the locations and conditions of future landslides. It is intended that this map will provide useful information to develop regional landslide susceptibility maps, to guide site-specific investigations for future developments, and to assist in regional planning and mitigation of existing landslides.

LANDSLIDE CLASSIFICATION

Each landslide shown on this map has been classified according to a number of specific characteristics identified at the time the data were recorded in the GIS database. The classification scheme was developed by Burns and Madin (2009). Several significant landslide characteristics recorded in the database are portrayed with symbology on this map. The specific characteristics shown for each landslide are the landslide activity, landslide features, deep or shallow failure, confidence of landslide interpretation, and type of landslide movement. These landslide characteristics are determined primarily on the basis of geomorphic features, or landforms, observed for each landslide. The symbology used to display these characteristics is explained below.

LANDSLIDE ACTIVITY: Each landslide has been classified according to the relative age of most recent movement. This map display uses color to show the relative age of activity.

HISTORIC LANDSLIDE POINTS: These are the locations of known landslides that were recorded and included in previous version of SLIDO Release 4.

HISTORIC and/or ACTIVE (movement less than 150 years ago): The landslide appears to have moved within historic time or is currently moving (active).

PRE-HISTORIC or ANCIENT (movement greater than 150 years ago): Landslide features are slightly eroded and there is no evidence of historic movement. In some cases, the observed landslide features have been greatly eroded and/or covered with deposits, which resulted in smoothed and subdued morphology.

LANDSLIDE FEATURES: Because of the high resolution of the lidar-derived topographic data, some additional landslide features were identified. These include:

HEAD SCARP ZONE and FLANK ZONE: The head scarp or uppermost scarp, which in many cases exposes the primary failure plane (surface of rupture), and flanks or shear zones.

HEAD SCARP LINE and INTERNAL SCARP LINES: Uppermost extent of the head scarp and internal scarps within the body of the landslide. Hatching is in the down-dropped direction.

DEPTH OF FAILURE: The depth of landslide failure was estimated from scarp height. Failures less than 4.5 m (15 ft) deep are classified as shallow, and failures greater than 4.5 m (15 ft) deep are classified as deep.

SHALLOW LANDSLIDE: Estimated failure plane depth is less than 4.5 m (15 ft).

DEEP LANDSLIDE: Estimated failure plane depth is greater than 4.5 m (15 ft).

CONFIDENCE OF INTERPRETATION: Each landslide was classified according to our "confidence" that the landslide actually exists. We mapped landslides on the basis of characteristic morphology, and the confidence of the interpretation was based on how clearly visible that morphology is. As a landslide ages, after its most recent movement, weathering (primarily through erosion) degrades the morphology produced by landsliding. With time, landslide morphologies may become so subtle that they resemble morphologies produced by geologic processes and conditions unrelated to landsliding.

Landslides may have several different types of associated morphologies, and we define confidence through a simple point system (see table below). The point system is based on a 0 to 10 point ranking of each of four primary landslide features. For example, if the head scarp and toe of a landslide were identifiable and clearly visible during mapping, the mapper would apply 10 points for the head scarp and 10 points for the toe, equaling 20 points, which would be associated with a moderate confidence of identification.

The visual display of this landslide characteristic is through the use of different line styles as shown below.

HIGH CONFIDENCE (≥30 points)

MODERATE CONFIDENCE (11-29 points)

LOW CONFIDENCE (≤10 points)

Landslide Feature	Points
Head scarp	0-10
Flanks	0-10
Toe	0-10
Internal scarps, sag ponds, compression ridges, etc.	0-10*

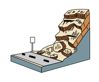
* Applied only once so that total points do not exceed 40.

CLASSIFICATION OF MOVEMENT: Each landslide was classified with the type of landslide movement. There are five types of landslide movement: slide, flow, fall, topple, and spread (Varnes, 1978). These movement types are combined with material type to form the landslide classification. Not all combinations are common in nature, and not all are present in this study area.

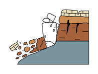
EFL EFL - Earth Flow - Abbreviation for type of slope movement. The table below displays movement types (Varnes, 1978). Generalized diagrams (some modeled from Highland, 2004) showing types of movement are included on this plate.

Type of Movement	Type of Material		
	Rock	Debris	Soil
Fall	**RF** rock fall	**DF** debris fall	**EF** earth fall
Topple	**RT** rock topple	**DT** debris topple	**ET** earth topple
Slide-rotational	**RS-R** rock slide-rotational	**DS-R** debris slide-rotational	**ES-R** earth slide-rotational
Slide-translational	**RS-T** rock slide-translational	**DS-T** debris slide-translational	**ES-T** earth slide-translational
Lateral spread	**RSP** rock spread	**DSP** debris spread	**ESP** earth spread
Flow	**RFL** rock flow	**DFL** debris flow	**EFL** earth flow
Complex	**C** complex or combinations of two or more types (for example, ES-R + EFL)		

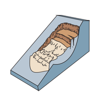
The abbreviation of classification of movement is not included on this map plate because of the scale. It is included in the GIS database and can be viewed on the online SLIDO web map available at www.oregongeology.org.



Falls are near-vertical rapid movements of masses of materials, such as rocks or boulders. The rock debris sometimes accumulates as talus at the base of a cliff.

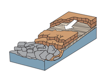


Topples are distinguished by forward rotation about some pivotal point, below or low in the mass.



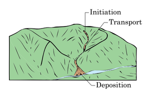
Slides are downslope movements of soil or rock on a surface of rupture (failure plane or shear zone).

- Rotational slides move along a surface of rupture that is curved and concave.

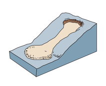


- Translational slides displace along a planar or undulating surface of rupture, sliding out over the original ground surface.

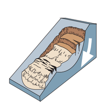
Spreads are commonly triggered by earthquakes, which can cause liquefaction of an underlying layer and extension and subsidence of otherwise cohesive materials overlying liquefied layers.



Channelized Debris Flows commonly start on steep, concave slopes as small slides or earth flows into channels. As this mixture of landslide debris and water flows down the channel, the mixture picks up more debris, water, and speed, and deposits in a fan at the outlet of the channel.



Earth Flows commonly have a characteristic "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head.



Complex Landslides are combinations of two or more types. An example of a common complex landslide is a rotational slide + earth flow, which usually exhibits rotational slide features in the upper region and earth flow features near the toe.

(Block diagrams from Highland, 2004)

REFERENCES

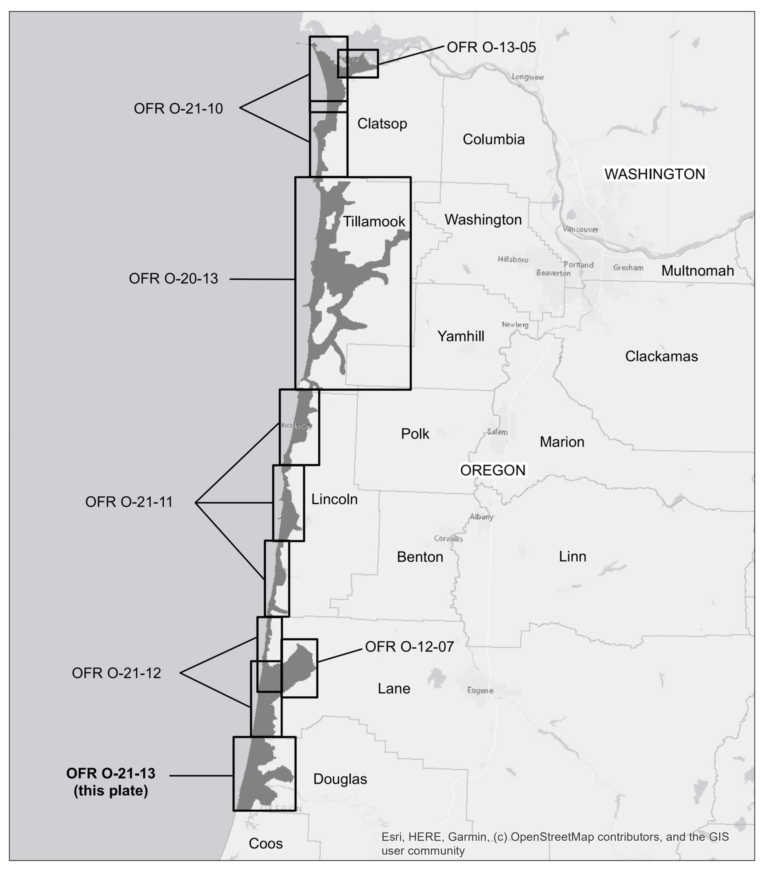
Franczyk, J.J., Burns, W.J., and Calhoun, N.C., 2019. Statewide Landslide Information Database for Oregon, Release 4 (SLIDO-4.0), Oregon Department of Geology and Mineral Industries, Digital Data Series, https://www.oregongeology.org/slido/index.htm

Burns, W.J., and Madin, I.P., 2009, Protocol for inventory mapping of landslide deposits from light detection and ranging (lidar) imagery: Oregon Department of Geology and Mineral Industries Special Paper 42, 30 p., geodatabase template.

Highland, L., compiler, 2004, Landslide types and processes: U.S. Geological Survey Fact Sheet 2004-3072 (ver. 1.1), 4 p.

Varnes, D.J., 1978, Slope movement types and processes, *in* Schuster, R.L., and Krizek, R.J., eds., Landslides—analysis and control: Washington, D.C., Transportation Research Board Special Report 176, p. 11–33.

LOCATION MAP



National Agriculture Imagery Program (NAIP) under contract for the United States Department of Agriculture (USDA) for the Farm Service Agency's (FSA). Oregon Imagery Framework Implementation Team.

Base Map:

Lidar data for this publication are from the DOGAMI Lidar Consortium.

Digital elevation model (DEM) consists of a 3-foot-square elevation grid that was converted into a hillshade image with sun angle at 315 degrees at a 60-degree angle from horizontal. The DEM was multiplied by 2 (vertical exaggeration) to enhance slope areas.

2009 orthophoto imagery is from Oregon Geospatial Enterprise Office and is draped over the hillshade image with transparency.

Projection: North American Datum 1983, UTM zone 10.
Software: Esri ArcMap 10.5.1, Adobe Illustrator CS2.
Source File: Project\DEM88f

SCALE 1:32,000

4,100 2,050 0 4,100 8,200 12,300 16,400 Feet

0.8 0.4 0 0.8 1.6 2.4 3.2 Miles

0.8 0.4 0 0.8 1.6 2.4 3.2 Kilometers

15½°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2009

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

This map benefited from review by Ian Madin, Oregon Department of Geology and Mineral Industries.