Oregon Department of Geology and Mineral Industries, USGS Landslide Hazard Program FY24 Grant Final Technical Report

Award Number: G24AP00424

Title: Landslide inventory of northeast Clackamas County, Oregon and Special Paper 42 video short course

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Abstract

Landslides are common throughout Oregon usually due to the combination of high precipitation, steep slopes, landslide-prone geologic units, and frequent earthquakes. In 2024, the Oregon Department of Geology and Mineral Industries (DOGAMI) applied for and was awarded a grant through the U.S. Geological Survey Cooperative Landslide Hazard Mapping and Assessment Program Funding Opportunity Number (FON) G24AS00345 to perform regional landslide inventory mapping of the northeastern portion of Clackamas County, Oregon, and to create a video short course taught by Burns on how to perform Special Paper 42 (SP-42), Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (Lidar) Imagery (Burns and Madin, 2009). Recording SP-42 to video will make it available to many more scientists. The recordings are published as part of this project, making them publicly available. The purpose of this project was to provide detailed information about existing landslide hazards in this region of Oregon and create the SP-42 video short course. The main tasks included:

- Creating a detailed lidar-based landslide inventory following DOGAMI Special Paper 42 (Burns and Madin, 2009)
- Limited field checking landslides
- Creating the SP-42 video short course
- Writing this report and publication

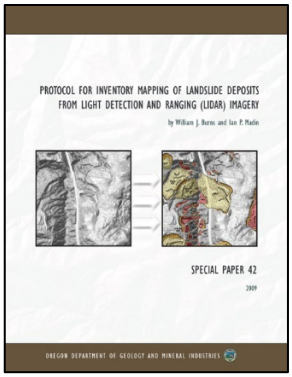
We mapped 2,438 landslide deposits in the project area (Plates 1-3). Of the deposits, 809 are slides or flows with estimated depths of failure, with 651 classified as deep and 158 classified as shallow. Most of the types of landslides were debris flows, which is not

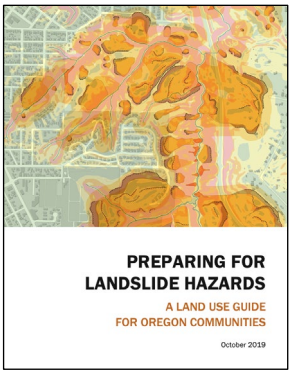
surprising as it is one of the primary hillslope processes on stratovolcanoes like Mount Hood. Risk reduction strategies recommended include increasing public awareness, planning and zoning approaches, and emergency response considerations.

Goals and Objectives

To reduce losses from landslides, areas of landslide hazard must first be identified. The initial step in landslide hazard identification is to create an inventory of past (historic and prehistoric) landslides. The inventory can be used directly to identify areas of risk, perform outreach and education, short and long-term planning, regulations for future development, emergency response and warnings, create susceptibility or probabilistic maps that display areas likely to have landslides in the future, and identify areas with mitigation needs or projects. Areas without modern landslide inventories (Burns and Madin, 2009) that also have relatively high development rates, infrastructure such as highway corridors and electric transmission, and a history of damaging landslides are the highest priority for future landslide inventory projects (Figure 1). We proposed an area which has all these high priority attributes: the Oregon State Highway 26 corridor. This corridor connects the Portland Region to Mt Hood and onto eastern Oregon. It includes the Villages of Mount Hood (Welches, Zigzag, Brightwood), a portion of the expanding Portland region, the highway corridor, electric transmission infrastructure (The Dalles Dam, USACOE), and has recently experienced damage and losses from landslides and debris flows. Some of the proposed areas are part of the Mt Hood National Forest. Partnering with Federal Agencies to complete landslide hazard mapping on federal land is another priority in Oregon. We plan to share the new landslide inventory mapping data with Clackamas County and the Villages of Mount Hood, Oregon Department of Transportation, U.S. Army Corps of Engineers, and the Mt Hood National Forest and assist them in ways to use the new data to perform landslide risk reduction, for example implementation of planning measures guided by (Sears and others, 2019) Preparing for Landslide Hazards, A Land Use Guide for Oregon Communities (Figure 1), https://www.oregongeology.org/Landslide/Landslide-Hazards-Land-Use-Guide_FINAL.pdf

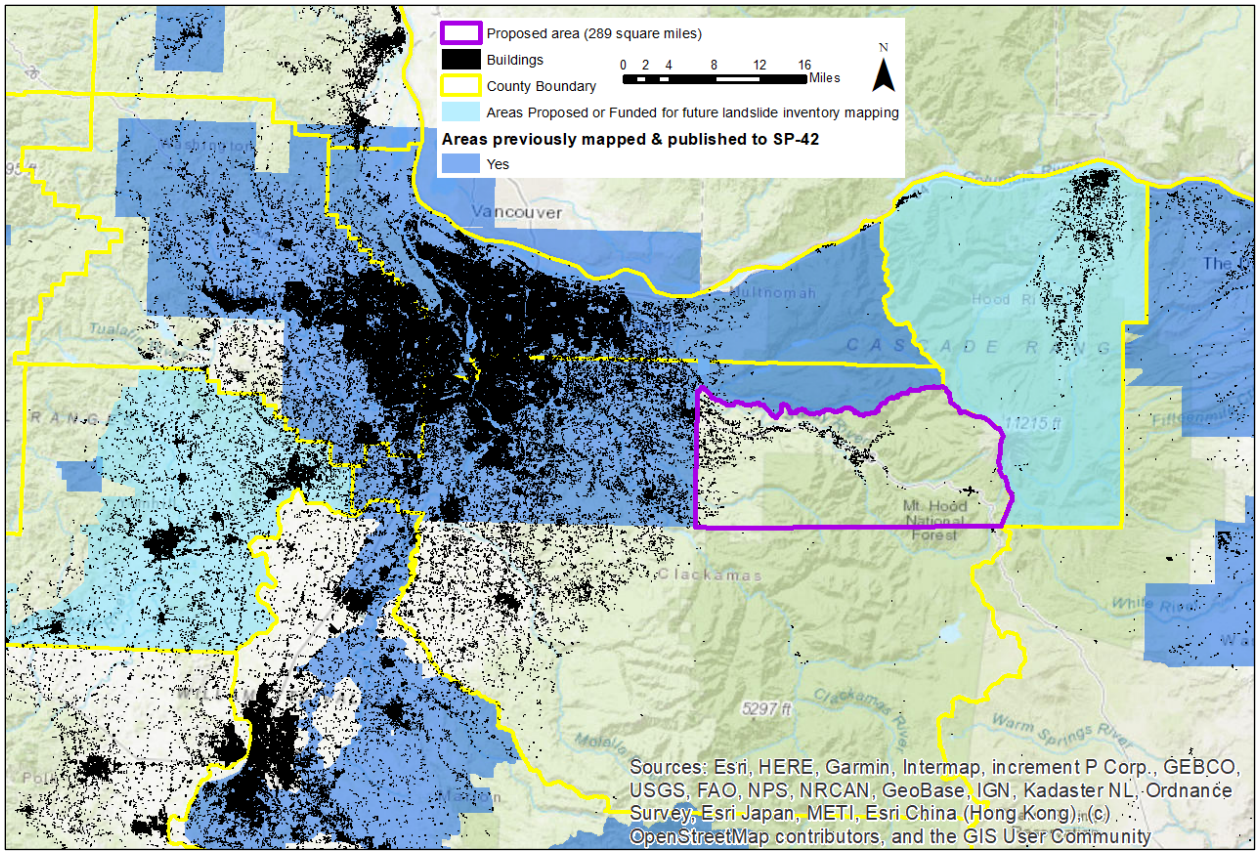
Figure 1. Burns and Madin (2009), Protocol for inventory mapping of landslide deposits from light detection and ranging (lidar) imagery, Special Paper 42 cover (left) and Preparing for Landslide Hazards, A Land Us Guide for Oregon Communities cover (right)(Sears and others, 2019).





We proposed to continue landslide inventory mapping in regions of high population density in Oregon. Specifically in the southeastern portion of the Portland region (Figure 2). Portions of the proposed project area have landslide information. We proposed to build on this information by completing a modern lidar-based landslide inventory following Burns and Madin (2009), Protocol for inventory mapping of landslide deposits from light detection and ranging (lidar) imagery, Special Paper 42 (herein referred to as SP-42).

Figure 2. Proposed landslide inventory project area (purple). The project area includes portions of the Portland region and areas along Oregon State Highway 26 and the Villages of Mount Hood (Welches, Zigzag, Brightwood).



Guidance Criteria Funded

The tasks accomplished prioritizations outlined in the National Landslide Preparedness Act including ways to reduce landslide hazards and risks to minimize loss of life and property. Our proposal aligns with the research priorities identified in the U.S. Geological Survey Cooperative Landslide Hazard Mapping and Assessment Program Announcement for Fiscal Year 2024 (G24AS00345). Task 1 accomplishes risk reduction priority area P1, Landslide hazard mapping and assessment and has some components of risk reduction priority area P2, planning and coordination. The proposed Task 1 will be completed by implementing SP-42 (Burns and Madin, 2009) and the updated procedure described in Franczyk and others (2023), A GIS-Based Toolbox for Improved Efficiency and Precision of Landslide Inventory Mapping, which are both established protocols and using a lidar DEM base map. Task 2 accomplishes risk reduction priority area P3, Landslide education, engagement, and outreach. Task 2, a recorded short course on implementation of DOGAMI SP-42 and Open-File Report O-23-07, will assist future mapping at DOGAMI and at other entities implementing SP-42, such as other U.S. State Surveys, university researchers, and federal employees. We plan to post the recording on the DOGAMI website and make it available to everyone.

Accomplishments

Guidance Criteria 1 (Landslide hazard mapping and assessment): We mapped 2,438 landslide deposits in the project area. Of the deposits, 809 are slides or flows with estimated depths of failure, with 651 classified as deep and 158 classified as shallow. Most of the types of landslides were debris flows, which is not surprising because it is one of the primary hillslope processes on stratovolcanoes like Mount Hood, which is partially inside the study area. We found most (~2,000) of the landslides to be associated with the Late Western Cascade Volcanics and specifically the Rhododendron Formation. Additional information about historic debris flow events can be found in Burns and others (2011), Multi-hazard and risk study for the Mount Hood region, Multnomah, Clackamas, and Hood River Counties, Oregon. The GIS database created during this project is included with the Open-File Report (OFR) publication. In addition, we created three large format PDF map plates (included with this publication) to display the data for users without GIS software (Plates 1-3). All of the data is being compiled into our Statewide Landslide Information Database of Oregon (SLIDO) and will be available for viewing on our SLIDO interactive web mapping services.

Guidance Criteria 3 (Landslide education, engagement, and outreach): The second project task was to create a video short course taught by Burns following Burns and Madin (2009). We created the short course which is included with this publication and is divided into the four modules below:

- Module 1: Background and Setup
- Module 2: Mapping

- Module 3: Attributes
- Module 4: Finalize

The videos are included with the DOGAMI OFR. The OFR is available for free download from our department website https://www.oregon.gov/dogami.

In addition to the video short course, we hired a geology graduate student from Portland State University named Natalie Culhane as an intern to work on the project. Natalie was trained in landslide mapping techniques following Burns and Madin (2009) SP-42. Natalie mapped much of the landslide inventory of northeast Clackamas County (published in the OFR), and she assisted in creation of the video short course. This opportunity provided Natalie with early career experience and a citable publication.

Unmet Results

None.

Summary

Although we cannot predict when and where the next landslide events will occur in NE Clackamas County, we are able to provide a detailed map of areas impacted by historic and prehistoric landslides. We conclude that the geology in NE Clackamas County is a fundamental factor in the location, type, and distribution of landslide deposits. We mapped 2,438 landslides deposits in the study area.

The primary purpose of this study is to help communities in the study area become more resilient to landslide hazards by providing new detailed landslide inventory maps which can be used during future risk reduction.

It is also important for the public to be notified during times of increased landslide potential. Oregon currently has a landslide warning system operated in partnership by the NOAA National Weather Service (NWS), DOGAMI, ODOT, and Oregon Emergency Management (Burns and Franczyk, 2021). NWS initiates the system by sending out landslide watches, and the state agencies help citizens become aware of the heightened potential for landslides. In the future, this information could be streamlined to the local municipalities via RSS feeds and live web pages. During these periods of increased landslide potential, the public could then access hazard maps to find locations where this potential is most likely.

Because awareness, planning, and emergency response of local landslide hazards are crucial to understanding, risk reduction, and response, we have added additional details in the OFR.

Attachments:

- DOGAMI OFR O-25-07, Landslide inventory of northeast Clackamas County, Oregon and Special Paper 42 video short course

- Three large format map plates (pdf)
- Four video short course modules (mp4)
- GIS dataset - NEClackamas_LSInventory.gdb

Bibliography

Burns, W.J., Culhane, N.K., Tsitsivas, A.N., Wilder, J.M., 2025. Landslide inventory of northeast Clackamas County, Oregon and Special Paper 42 video short course, Oregon Department of Geology and Mineral Industries, Open-File Report O-25-07. https://www.oregon.gov/dogami/pubs/Pages/ofr/p-OFR.aspx