State of Oregon
Oregon Department of Geology and Mineral Industries
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**OPEN-FILE REPORT O-25-05**

# PATH DISTANCE TSUNAMI MODELING FOR OREGON TSUNAMI-HAZARD ZONES

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## DISCLAIMER



## WHAT'S IN THIS REPORT?

The Oregon Coast is threatened by tsunamis originating from megathrust earthquakes on the Cascadia Subduction Zone as well as from distant earthquake sources, the nearest being Alaska. This GIS data release includes path distance evacuation modeling for all five local Cascadia and two Alaska distant tsunami inundation scenarios. These data are the basis for undertaking tsunami evacuation modeling.

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# GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA

*See the digital publication folder for files.*
*Geodatabase is Esri® version 10.7 format. Metadata is embedded in the geodatabase and is also provided as a separate .xml format file.*

**Evacuation_Modeling_Compilation.gdb:**
*Feature class***:** *Beaches_and_Dunes* (raster)

# 1.0 INTRODUCTION

Between 2010 and 2013, the Oregon Department of Geology and Mineral Industries (DOGAMI) completed tsunami inundation modeling for the Oregon Coast (Priest and others, 2013; Witter and others, 2011). The simulations included five local Cascadia Subduction Zone (CSZ) earthquake scenarios (SM, M, L, XL, XXL) and two distant eastern Aleutian Island, Alaska scenarios (AK64, AKmax). With the completion of coastwide tsunami inundation mapping, Priest and others (2015) pioneered new techniques for tsunami evacuation modeling (*Beat the Wave* or BTW) in the cities of Seaside and Gearhart, Clatsop County. These techniques have subsequently been improved upon and evacuation modeling completed for all Oregon Coast communities:

- Warrenton & Clatsop Spit (Gabel and Allan, 2016)
- Rockaway Beach (Gabel and Allan, 2017)
- Pacific City (Gabel and others, 2018a)
- Florence and Reedsport (Gabel and others, 2018b)
- Newport (Gabel and others, 2019a)
- Coos Bay estuary (Gabel and others, 2019b)
- Lincoln City, Gleneden Beach, Waldport & Yachats (Gabel and others, 2019c)
- Cape Meares, Oceanside, Netarts, Neskowin & Cape Lookout State Park (Gabel and others, 2019d)
- Port Orford (Gabel and others, 2020a)
- Nehalem Bay (Gabel and others, 2020b)
- Gold Beach and Nesika Beach (Gabel and others, 2021)
- Cannon Beach, Arch Cape & Falcon Cove Beach (Gabel and others, 2022a)
- Astoria & Jeffers Garden (Gabel and others, 2022b)
- Bandon, Langlois, Floras Lake & Bullards Beach State Park (Gabel and others, 2023)
- Brookings-Harbor & Columbia River shoreline (Gabel and others, 2024)

These studies graphically demonstrate evacuation challenges and mitigation opportunities through path distance analyses of existing road and trail networks but do not quantify potential loss of life. More recently, Allan and O'Brien (2025) used the tsunami inundation data and BTW approach to perform updated path distance evacuation modeling for the entire Oregon Coast in order to document casualties associated with the M, L and XXL CSZ scenarios. This report expands on the work of Allan and O'Brien (2025), primarily by providing the underlying path distance modeling for all seven inundation scenarios developed for Oregon. These data were developed to assist federal partners (National Tsunami Hazard Mitigation Program (NTHMP), U. S. Geological Survey (USGS), and Federal Emergency Management Agency (FEMA)) compile national scale inventories of potential tsunami casualties from each state and territory for a range of scenarios.

Path distances are the product of least-cost distance (LCD) modeling, which can be run in Esri® ArcGIS® or ArcPro® software. The distance accumulation tool uses geospatial algorithms to calculate the most efficient route from each point on the road and trail network in the tsunami evacuation zone to a "safe" region outside of the hazard zone, with efficiency determined by the path surface and hilliness. The product of this tool is referred to as the least-cost path-distance surface, and it reflects an artificial distance to safety for every point in the evacuation zone that is governed by the difficulty of walking that route. LCD modeling is based on four inputs:

- The tsunami inundation zone limit,
- A digital elevation model (DEM),
- A land-surface cost raster that includes an assigned difficulty level, which is a function of the terrain (e.g., paved road, trail, muddy bog, beach, etc.), and
- A table relating slope to a cost factor derived from Tobler's (1993) hiking function.

The tsunami inundation limit serves as the destination for all evacuation routes. The DEM is used to determine actual distances and slope (hilliness). Slope data derived from the DEM, in conjunction with the slope table, are used to apply a cost reflecting evacuation difficulty due to terrain characteristics. The land cost raster contains a second set of cost values reflecting evacuation difficulty due to the type of terrain (e.g., walking on a paved surface versus across soft sand or a muddy bog). The road/trail network inside the tsunami zone was carefully reviewed and updated for accuracy; this network was then used to create the land-surface cost raster. Where applicable, bridge failure was incorporated – the input road trail network was cut at any location where a bridge was likely to fail in a CSZ earthquake. The LCD model outputs a path-distance surface showing the effective distance to safety from each pixel and a flow direction raster containing route information.

The LCD modeling was implemented using Esri® ArcPro® software and was undertaken using the five local CSZ and two distant Alaska scenarios. Coastwide path distance surfaces for all seven scenarios are included in the accompanying geodatabase.

## 2.0 ACKNOWLEDGMENTS

This data release was funded under award #NA23NWS4670018 by NOAA through the National Tsunami-Hazard Mitigation Program. We are grateful to Laura Gabel (DOGAMI) for her comments on the report and Jon Franczyk (DOGAMI) for his review of the metadata.

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