



2013

Plate 2

The Oregon Department of Geology and Mineral Industries (DOGAMI) has been identifying and mapping the tsunami inundation hazard along the Oregon coast since 1994. In Oregon, DOGAMI manages the National Tsunami Hazard Mitigation Program, which has been administered by the National Oceanic and Atmospheric Administration (NOAA) since 1995. DOGAMI's work is designed to help cities, counties, and other sites in coastal areas reduce the potential for disastrous tsunami-related consequences by understanding and mitigating this geologic hazard. Using federal funding awarded by NOAA, DOGAMI has developed a new generation of tsunami inundation maps to help residents and visitors along the entire Oregon coast prepare for the next Cascadia Subduction Zone (CSZ) earthquake and tsunami, as well as for far-travelled, or "distant," tsunamis.

The "Ring of Fire," also called the Circum-Pacific belt, is the zone of earthquake activity surrounding the Pacific Ocean. It is an arc stretching from New Zealand, along the eastern edge of Asia, northward to the Aleutian Islands of Alaska, and south along the coast of North and South America (Figure 1). The Ring of Fire is located at the borders of the Pacific Plate and other major tectonic plates. The Pacific Plate is colliding with and sliding underneath other plates creating subduction zones that eventually release energy in the form of an earthquake rupture. This rupture causes a vertical displacement of water that creates a tsunami. When these events occur around the Ring of Fire but not directly off the Oregon coast, they take more time to travel the Pacific Ocean and arrive ashore in Oregon (Figure 2). Distant earthquake/tsunami events have affected the Oregon coast; for example, offshore Alaska in 1964 and offshore Japan in March 2011.

Historically, about 50 distant tsunamis have been documented by Oregon tide gauges since 1854. The most severe was generated by the 1964 M9.2 Prince William Sound earthquake in Alaska. Oregon was hit hard by the tsunami, which killed four people and caused an estimated 750,000 to 1 million dollars in damage to bridges, houses, cars, boats, and sea walls. The greatest tsunami damage in Oregon did not occur along the ocean front as one might expect, but in the estuary channels located further inland. Of the communities affected, Seaside was inundated by a 10 foot tsunami wave and was the hardest hit. Tsunami wave heights reached 10 to 11.5 feet in the Nehalem River, 10 to 11.5 feet at Depoe Bay, 11.5 feet at Newport, 10 to 11 feet at Florence, 11 feet at Reedsport, 11 feet at Brookings, and 14 feet at Coos Bay (Witter and others, 2011).

Alaska-Aleutian Model Specifications: DOGAMI model two distant earthquake and tsunami scenarios involving M9.2 earthquakes originating near the Gulf of Alaska. The first scenario attempts to replicate the 1964 Prince William Sound event, and the second scenario represents a hypothetical maximum event. This maximum event is the same model used by the U.S. Geological Survey (USGS) in their 2008 tsunami hazard assessment of Seaside (TPSW 2008). This model uses extreme fault model parameters that result in maximum seafloor uplift, primarily twice as large as in the 1964 earthquake. The selected source location for the Aleutian chain of islands also shows higher energy directed toward the Oregon coast than other Aleutian source locations. For these reasons the hypothetical "Alaska Maximum" scenario is selected as the worst case distant tsunami scenario for Oregon. Detailed information on fault geometries, subsidence, computer models, and the methodology used to create the tsunami scenarios presented on this map can be found in DOGAMI Special Paper 43 (Witter and others, 2011).

A world map illustrating the boundaries of tectonic plates. The map shows major plates such as North America, South America, Africa, Eurasia, Australia, Antarctic, Pacific, Indian, and others. Red lines indicate plate boundaries, with arrows showing the direction of movement. Some plates like the Nazca Plate and Caribbean Plate are also labeled.

Entire Map Area **Unincorporated Areas**

Total Buildings	133	133
Buildings within Tsunami Zones*	0	0
Alaska M0 2 (1964)	0	0
Alaska Maximum	8	8

Percent of Buildings within Tsunami Zones

Alaska M0 2 (1964)	0.0%	0.0%
Alaska Maximum	6.0%	6.0%

*Building counts shown are based on polygon centroids and are cumulative within the map area.

Category	Percent of Buildings within Tsunami Zones
Entire Map Area	0%
Unincorporated Areas	6%

Figure 3: The table and chart show the number of buildings inundated for the Alaska M9.2 (1964) and the Alaska Maximum tsunami scenarios for cities and unincorporated portions of the map.

Change in water level for two tsunami scenarios at the simulated gauge station shown on the map

Legend:

- Alaska M9.2 (1964)
- Alaska Maximum

Station B2 Tennille Creek Mouth (Station B2)

Y-axis: Elevation, feet (NAVD89)

X-axis: Time since Earthquake (hours)

Figure 4: This chart depicts the tsunami waves as they arrive at the selected reference point (simulated gauge station). It shows the change in wave heights for the two Alaska tsunami scenarios over an 8-hour period. Wave heights vary through time, and the first wave will not necessarily be the largest as waves interfere and reflect off local topography and bathymetry. Any absence of data indicates periods for which tsunami inundation has not yet reached or has receded from the station location and dry land is exposed.

A SEACROFT BEACH A'

Elevation (feet NAVD83)

Distance along Profile, miles

Seacroft Beach

Seacroft Creek

Seacroft Rd

B TENMILE CREEK B'

Elevation (feet NAVD83)

Distance along Profile, miles

Pacific Ocean

Tenmile Creek

Deer Rd

Legend:

- Study Area
- Seacroft Beach
- Seacroft Creek
- Seacroft Rd

Figure 5: These profiles depict the expected maximum tsunami wave elevation for the two Alaska tsunami scenarios along lines A-A' and B-B'. The tsunami scenarios are modeled to occur at a static (no flow) tide and equal to the Mean Higher High Water (MHHW) high tide.

This tsunami inundation map displays the output of computer models representing the two selected tsunami scenarios: Alaska M9.2 (1954) and the Alaska Maximum. All tsunami simulations were run assuming that prevailing tide was static (no flow) and equal to Mean Higher High Water (MHHW) tide; MHHW is defined as the average height of the higher high tides observed over an 18-year period at the Yakquina Bay (Central Coast) model tide gauge. The map legend depicts the respective amounts of deformation and the earthquake magnitude for these two scenarios. Figure 3 shows the cumulative number of buildings inundated within the map area.

The computer simulation model output is provided to DOGAMI as millions of points with values that indicate whether the location of each point is wet or dry. These points are converted to wet and dry contour lines that form the extent of inundation. The transition area between the wet and dry contour lines is termed the Wet/Dry Zone, which equates to the amount of error in the model when determining the maximum inundation for each scenario. Only the Alaska Maximum Wet/Dry Zone is shown on this map.

This map also shows the regulatory tsunami inundation line (Oregon Revised Statutes 455.446 and 455.447), commonly known as the Senate Bill 379 line. Senate Bill 379 (1995) instructed DOGAMI to establish the area of expected tsunami inundation based on scientific evidence and tsunami modeling in order to prohibit the construction of new essential and special occupancy structures in this tsunami inundation zone (Priest, 1995).

Time Series Graphs and Wave Elevation Profiles: In addition to the scenario scenarios, the computer model produces time series data for "gauge" locations in the area. These points are simulated gauge stations that record the time, in seconds, of the tsunami wave arrival and the wave height observed. It is especially noteworthy that the greatest wave height and velocity observed are not necessarily associated with the first tsunami wave to arrive onshore. Therefore evacuees should not assume that the tsunami event is over until the proper authorities have sounded the all-clear at the end of the evacuation. Figure 4 depicts the tsunami waves as they arrive at a simulated gauge station. Figure 5 depicts the overall wave height and inundation extent for the two scenarios at the profile locations shown on this map.

Pacific Ocean

Neptune State Scenic Viewpoint

Neptune State Scenic Viewpoint

Neptune State Scenic Viewpoint

Neptune State Scenic Viewpoint

Searose Beach

NO LIDAR

Tokaree Kūiaohimā State Natural Site

Tokaree Kūiaohimā State Natural Site

Earthquake Size	Slip / Deformation	Earthquake Magnitude
	Alaska M9.2 (1964)	Vertical seafloor deformation estimate
	Alaska Maximum	Uniform slip on 12 subfaults with each assigned values ranging from 48 to 98 feet
	Alaska Maximum Wet/Dry Zone	
	Urban Growth Boundary	Fire Station
	Building Footprint	Police Station
	Simulated Gauge Station	School
	Profile Location	Hospital / Urgent Care Clinic
	Senate Bill 379 Line	U.S. Highway
	State Park	State Highway
	Elevation Contour (25 ft intervals up to 200 ft)	Improved Road

Map of the Willamette Valley showing numbered locations 01 through 08. An inset map shows the location of the study area within the state of Oregon. The locations are: 01 Neptune, 02 Heceta Head, 03 Mirror Lake, 04 Florence, 05 Cushman - Wendson, 06 Terman - Mapleton, 07 Dunes City, and 08 Siltcoos Lake. The map also shows Lincoln Lane, Benton Lane, and Lane Douglas.

Source Data: This map is based on hydrodynamic tsunami modeling by Joseph Zhang and Hailong Zhang (University Portland, Oregon). Model data and input were created by John T. Engdahl and George R. P. S. Department of Geology and Mineral Industries Inc (DOGAMI), Portland, Oregon. Hydrology data, conduct, critical facilities, and building footprints were from the National Hydrologic Information System (NHIS) (USGS, 2012). Smith and Sean G. Pender, DOGAMI in 2011 (USGS site, see Rachel L. Urban) (2012). Organized boundaries (2011) were developed by the Department of Environment and Land Conservation and Development (DOL) Oregon. Transportation data (2010 and 2007) provided by Lane and Lincoln Counties were edited by DOGAMI to improve the spatial accuracy of the features or to add newly constructed features not present in the original datasets.

Legend: DOGAMI L1d4r Data Quadrangles L011: 441224-184-HS-Hohto-Hend L011: 441224-1 L4-HS-Hohto-Hend

Coordinate System: Oregon State Plane Lambert Conformal Conic, United States Foot, Horizontal Datum, NAD 1983 HARN, Vertical Datum, NAD 1983, GRS80. Data are shown with geographic coordinates (latitude/longitude).

References:
National Geophysical Data Center / World Data Center (NGDC/WDC)
Global Historical Tsunami Database, Boulder, CO, USA
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Witter, R. L., Zhang, Y., Wang, K., Priest, G. R., Goldfinger, C., Stimpert, L. J., English, T., and Fero, P.A., 2011. Simulating a tsunami inundation at Grindstone Point, Oregon, using hypothetical Cascadia and Aleutian earthquake scenarios. Oregon Department of Geology and Mineral Industries Special Paper 43, 57 p.

Software: ArcGIS® 10.1, Microsoft® Excel®, and Adobe® Illustrator®

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