

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.

The CSZ is the tectonic plate boundary between the North American Plate and the Juan de Fuca Plate (Figure 1). These plates are converging at a rate of about 1.5 inches per year, but the movement is not smooth and continuous. Rather, the plates lock in place, and unreleased energy builds over time. At intervals, this accumulated energy is violently released in the form of a megathrust earthquake rupture, where the North American Plate suddenly slips westward over the Juan de Fuca Plate. This rupture causes a vertical displacement of water that creates a tsunami (Figure 2). Similar rupture processes and tsunamis have occurred elsewhere on the planet where subduction zones exist: for example, offshore Chile in 1960 and 2010, offshore Alaska in 1964, near Sumatra in 2004, and offshore Japan in March 2011.

Oregon, DOGAMI has also incorporated physical evidence that suggests that portions of the coast may drop 4 to 10 feet during the earthquake; this effect is known as subsidence. 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 Papers 41 (Priest and others, 2009) and 43 (Witter and others, 2011).

This tsunami inundation map displays the output of computer models representing five selected tsunami scenarios, all of which include the earthquake-produced subsidence and the tsunami-amplifying effects of the play fault. Each scenario assumes that a tsunami occurs at 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 Yaquina Bay (Central Coast Model) tide gauge. To make it easier to understand this scientific material and to enhance the educational aspects of hazard mitigation and response, the five scenarios are labelled as "T-shirt sizes" ranging from Small, Medium, Large, Extra Large, to Extra Extra Large (S, M, L, XL, XXL). The map legend depicts the respective amounts of sea, the frequency of occurrence, and the earthquake magnitude for these five scenarios. Figure 4 shows the cumulative number of buildings inundated within the map area.

The computer simulation model output is provided to DCGAMI 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 XXL 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 DCGAMI 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).

CS2 Model Specifications: The sizes of the earthquake and its resultant tsunami are primarily driven by the amount and geometry of the slip that takes place during the North American plate slips westward over the Juan de Fuca plate during the CS2 event. DOKAMI has modeled a wide range of slip geometries that are consistent with the available geologic fault geometries that could amplify the amount of seafloor displacement and increase tsunami inundation. Seismic profilers show that there may be a steep slope slip fault running nearly parallel to the CS2 but closer to the Oregon coastline (Figure 1). The amount of slip on this fault is not known, but it is possible that an increase in the amount of vertical displacement of the Pacific Ocean, resulting in an increase of the tsunami inundation onshore in

A cross-sectional diagram of the Juan de Fuca Plate subducting beneath the North American Plate. The Pacific Plate is shown to the west, with the Juan de Fuca Plate extending from it. The Juan de Fuca Plate is shown dipping into the mantle beneath the North American Plate. The subducting plate is labeled 'Juan de Fuca Plate' and the overriding plate is labeled 'NORTH AMERICAN PLATE'. The boundary between them is labeled 'JUAN DE FUCA RIFT ZONE'. The subducting plate is shown melting, with a 'Magma' label and an arrow pointing to the magma. The 'Litho Zone' is also labeled. The diagram shows the plate moving towards the right, indicated by an arrow. The subducting plate is shown dipping into the mantle, with a 'Magma' label and an arrow pointing to the magma. The 'Litho Zone' is also labeled. The diagram shows the plate moving towards the right, indicated by an arrow.

Figure 1: This block diagram depicts the tectonic setting of the region. See Figure 2 for the sequence of events that occur during a Cascadia Subduction Zone megathrust earthquake and tsunami.

A

B

C

D

E

Figure 2: The North American Plate rises over the descending Pacific Plate at a rate of approximately 1.5 inches per year.

Because the two plates are stuck in place at the "locked zone," strain builds up over time and the North American Plate begins to slip.

Eventually the locked zone ruptures and causes a great earthquake. The sudden slip of the two plates displaces Pacific Ocean water upward and creates a tsunami.

Displaced and uplifted Pacific Ocean water rushes in all directions.

Along the Oregon coast, tsunami waves run up onto the land for several hours.

	Entire Map Area	Dunes City	Unincorporated Areas
Total Buildings	315	105	150
Buildings within Tsunami Zones*			
Small	1	0	1
Medium	47	6	41
Large	67	6	41
Extra Large	89	46	43
Extra Extra Large	99	55	44
Percent of Buildings within Tsunami Zones			
Small	0.3%	0.0%	0.7%
Medium	14.9%	3.6%	27.3%
Large	19.9%	3.6%	27.3%
Extra Large	28.3%	27.9%	28.7%
Extra Extra Large	31.4%	33.3%	29.3%

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

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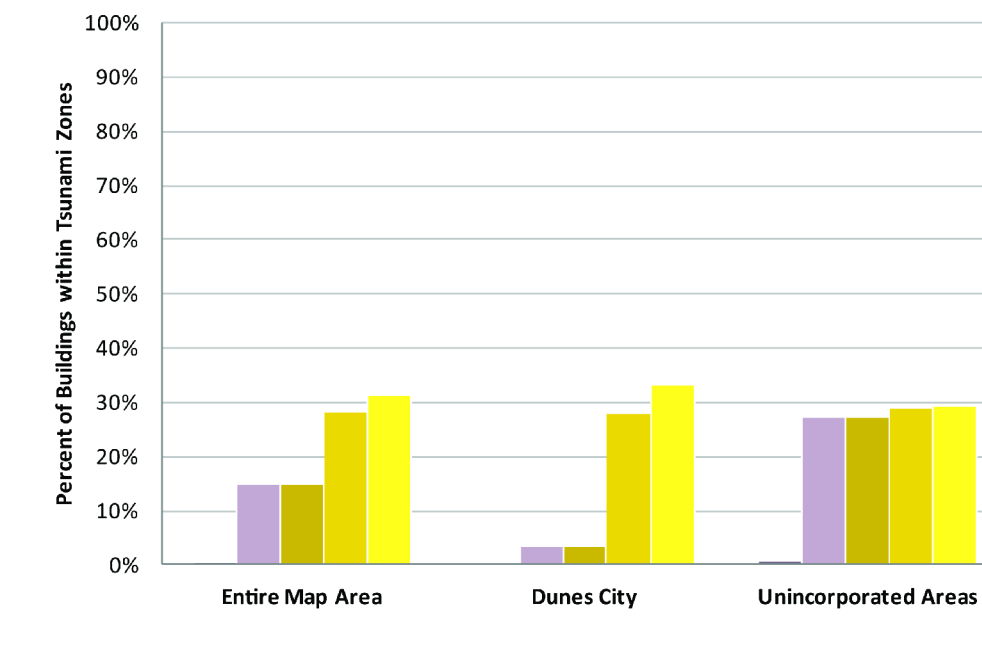


Figure 4: The table and chart show the number of buildings inundated for each "tsunami T-shirt scenario" for cities

2013

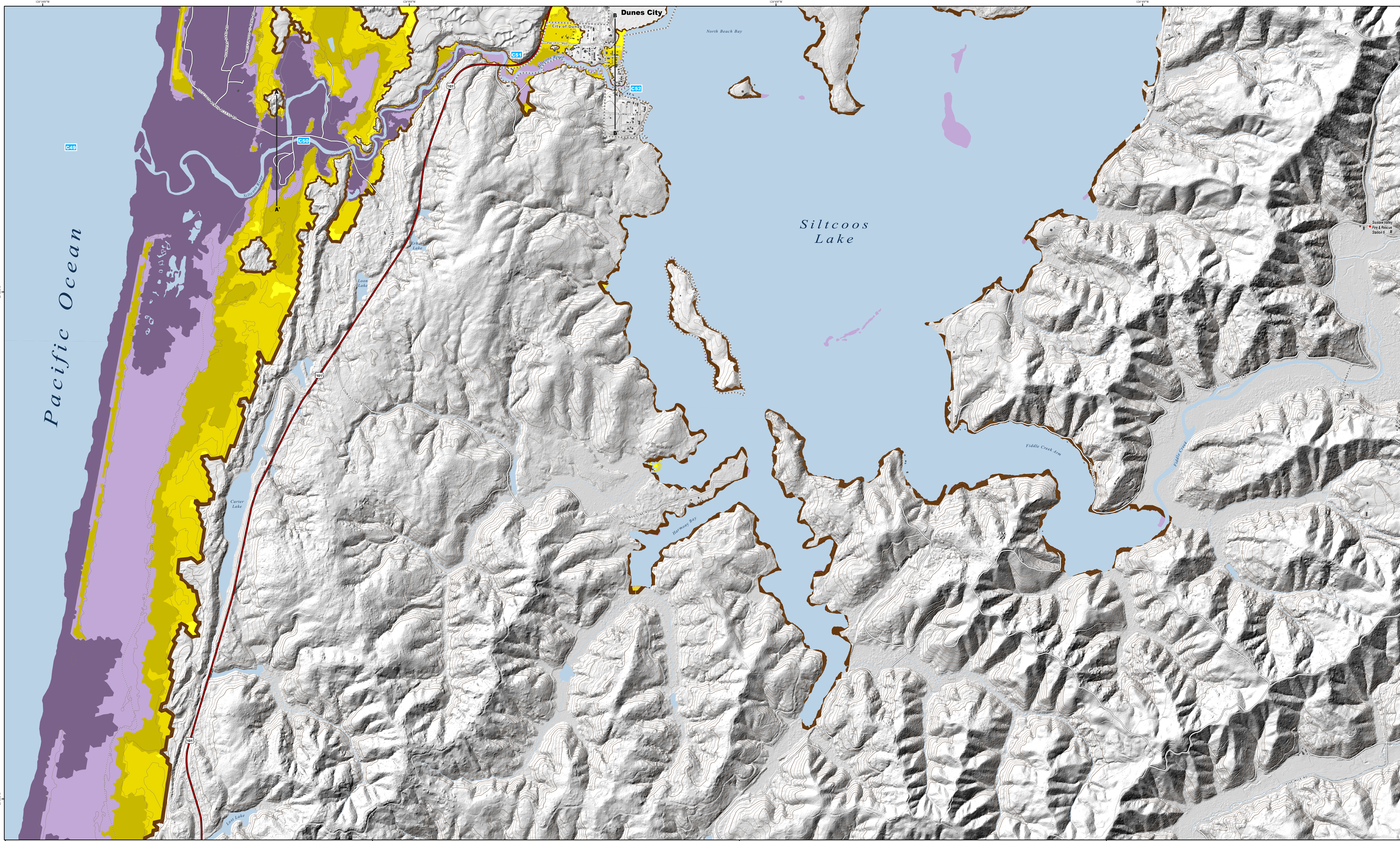


Figure 10 is a line graph titled "Change in water level for five tsunami scenarios at the simulated gauge station shown on the map". The y-axis is labeled "Elevation, feet (NAVD88)" and ranges from -40.0 to 70.0 in increments of 10.0. The x-axis is labeled "Time since Earthquake (hours)" and ranges from 0.0 to 8.0 in increments of 1.0. The graph displays five data series representing different tsunami scenarios: X1 (yellow), X2 (orange), L (blue), M (purple), and S (grey). A legend in the top right corner identifies these series and includes a red location pin icon for "Oregon Dunes (Station C49)". The X1 scenario shows the highest peak, reaching approximately 60 feet around 0.5 hours. The X2 scenario shows a significant drop in elevation, reaching approximately -30 feet around 1.8 hours. The L, M, and S scenarios show lower peaks, generally between 10 and 20 feet. The graph illustrates the varying impacts of different tsunami scenarios on the water level at the Oregon Dunes gauge station.

Figure 5: 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 all five tsunami scenarios over an 8-hour period. The starting wave elevation (0 h) takes into account the local land subsidence or uplift caused by the earthquake. 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.

Figure 6: These profiles depict the expected maximum tsunami wave elevation for the five "tsunami T-shirt scenarios" along lines A-A' and B-B'. The tsunami scenarios are modeled to occur at high tide and to account for local subsidence or uplift of the ground surface.

Earthquake Size	Average Slip Range (ft)	Maximum Slip Range (ft)	Time to Accumulate Slip (yrs)	Earthquake Magnitude
XXL	59 to 72	118 to 144	1,200	~9.1
XL	56 to 72	115 to 144	1,050 to 1,200	~9.1
L	36 to 49	72 to 98	650 to 800	~9.0
M	23 to 30	46 to 62	425 to 525	~8.9
S	13 to 16	30 to 36	300	~8.7
	XXL Wet/Dry Zone			

Doug-01 Silteous Lake
 Doug-02 Tahlequith Lake
 Doug-03 Gardiner
 Doug-04
 Doug-05 East Gardiner
 Doug-06 Umpqua River West
 Doug-07 Sulphur Springs
 Doug-08 Umpqua River East
 Doug-09 Clear Lake

Source Data:

This map is based on hydrodynamic tsunami model outputs from the Oregon Department of Geology and Mineral Industries (DOGAMI), Portland, Oregon. The 2009–2010 Model-data Input were created by Dr. T. English and George R. Priest, Department of Geological Engineering and Science, University of California at Berkeley.

Hydrology data, contours, critical facilities, and building footprints were created by DOGAMI. Senate Bill 379 in 2008 was redigited by Rachel L. Smith and Sean B. Peckner. DOGAMI, In 2011 [GIS file set, in press, 2012].

Urban growth boundaries (2011) were provided by the Oregon Department of Land Conservation and Development (DOLCD).

Transportation data (2012) provided by Douglas County were edited by DOGAMI to improve the spatial accuracy of the features or to add newly constructed roads not present in the original data layer.

Leaflet data are from DOGAMI Leaflet Lidar Data Quadrangles (LIDAR-2009-1312-04-H1-Firearm Creek; LIDAR-2009-1312-04-H1-Firearm Creek; LIDAR-2009-1312-04-H1-Jorencez; LIDAR-2009-1312-04-H1-Goose Pasture).

References:
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