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GIS DATA FOR THE SEASIDE, OREGON, TSUNAMI PILOT STUDY TO MODERNIZE FEMA FLOOD HAZARD MAPS

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INTRODUCTION

A Tsunami Pilot Study was conducted for the area surrounding the coastal town of Seaside, Oregon, as part of the Federal Emergency Management's (FEMA) Flood Insurance Rate Map Modernization Program (Tsunami Pilot Study Working Group, 2006). The Cascadia subduction zone extends from Cape Mendocino, California, to Vancouver Island, Canada. The Seaside area was chosen because it is typical of many coastal communities subject to tsunamis generated by far- and near-field (Cascadia) earthquakes.

Two goals of the pilot study were to develop probabilistic 100-year and 500-year tsunami inundation maps using Probabilistic Tsunami Hazard Analysis (PTHA) and to provide recommendations for improving tsunami hazard assessment guidelines for FEMA and state and local agencies. The study was an interagency effort by the National Oceanic and Atmospheric Administration, U.S. Geological Survey, and FEMA, in collaboration with the University of Southern California, Middle East Technical University, Portland State University, Horning Geoscience, Northwest Hydraulics Consultants, and the Oregon Department of Geological and Mineral Industries. The pilot study model data and results are published separately as a geographic information systems (GIS) data report (Wong and others, 2006). The flood maps and GIS data are briefly described here.

100- AND 500-YEAR FLOOD MAPS

Probabilistic tsunami hazard analysis (PTHA) is based on techniques developed in the related field of probabilistic seismic hazard analysis (PSHA) and attempts to model the magnitude of tsunami flooding from multiple sources, each with an associated mean recurrence rate. The probabilities of interest for the Flood Insurance Rate Maps are 1 percent and 0.2 percent per year, better known as the 100-year and 500-year flood maps, respectively (Figure 1; Tsunami Pilot Study Working Group, 2006).

A common feature for both the 100- and 500-year maps is an increase in the offshore wave height as the water depth decreases toward the outer coast (Figure 1). This is a direct effect of shoaling of long tsunami waves. Far-field tsunamis that occur at a combined mean return time of 100 years or less are of small amplitude relative to local tsunamis that occur much less frequently. For the 100-year tsunami map, there is little inundation of the developed areas in the study region. This is primarily because the region of coastal dunes south of the river mouth are high enough in elevation to block most of the far-field tsunamis.

In contrast to the 100-year tsunami map, the 500-year tsunami map shows large regions of inundation with significant wave heights throughout the Seaside area. The 500-year tsunami map is dominated by tsunamis generated by local Cascadia subduction zone earthquakes. For reference, the region of inundation indicated by the 500-year tsunami map includes most of the localities where tsunami deposits from the 1700 Cascadia tsunami were found (Figure 2; Priest and others, 1997).

GIS DATA

The GIS data were developed with a combination of numerical models and GIS tools (Wong and others, 2006). In addition to 100- and 500-year probabilistic inundation products required by FEMA for Flood Insurance Rate Maps, other data layers include historic shorelines, historic tsunami deposits, probabilistic flow depth, and high velocity zones (V-zones). The analysis depended on far- and near-field earthquake source specification, field mapping and interpretation of paleotsunami deposits and recent tsunami events, development of a new digital elevation model, generation and refinement of a state-of-the-art tsunami inundation model, probabilistic computations, and extraction of the final 100- and 500-year maps by GIS analysis (Table 1).

We have acquired baseline conditions for geomorphic changes in the Seaside area in the form of historic shorelines and the new digital elevation model. The progressive erosion in north Seaside and accretion in Gearhart north of the river mouth indicated by historic shorelines in our data set continue in this dynamic coastal area. There is already a marked change in the coastline between 2000 (the year data were captured for the project) and 2004 satellite imagery of the Seaside area where the northwest end of the beach ridge in Seaside has been undercut by the meandering stream channel (Figure 3).

This newly compiled GIS data set paves the way for other coastal zone studies such as storm surge, sediment transfer, watershed management, or global sea-level rise. The GIS data are available on the world-wide web in standard GIS data formats and as files that may be viewed in Google Earth, a virtual globe application (Wong and others, 2006).

Table 1. GIS data sets, Seaside tsunami pilot study.

Category	Data set
Digital Elevation Model	Coastal Tide Stations Modeling Grid Limits Historic Shorelines Vertical Control Data Digital Elevation Model
Historical Tsunami Events	Alaska 1964 Event Deposits, Observations, and Inundation Cascadia 1700 Event Deposits and Inundation Photographs of Field Sites
Tsunami Propagation and Inundation Models	Far- and Near-Field Earthquake Sources Maximum Tsunami Velocity Zones Based on Far- and Near-Field Sources Coseismic Vertical Displacement Fields for Near-Field Sources Maximum Wave Heights Based on Far- and Near-Field Sources
Probabilistic Tsunami Hazard Analysis Model	Probability Surfaces for Maximum Wave Heights of 0.5 to 10.5 m Maximum Tsunami Wave Heights for 100- and 500-year Floods

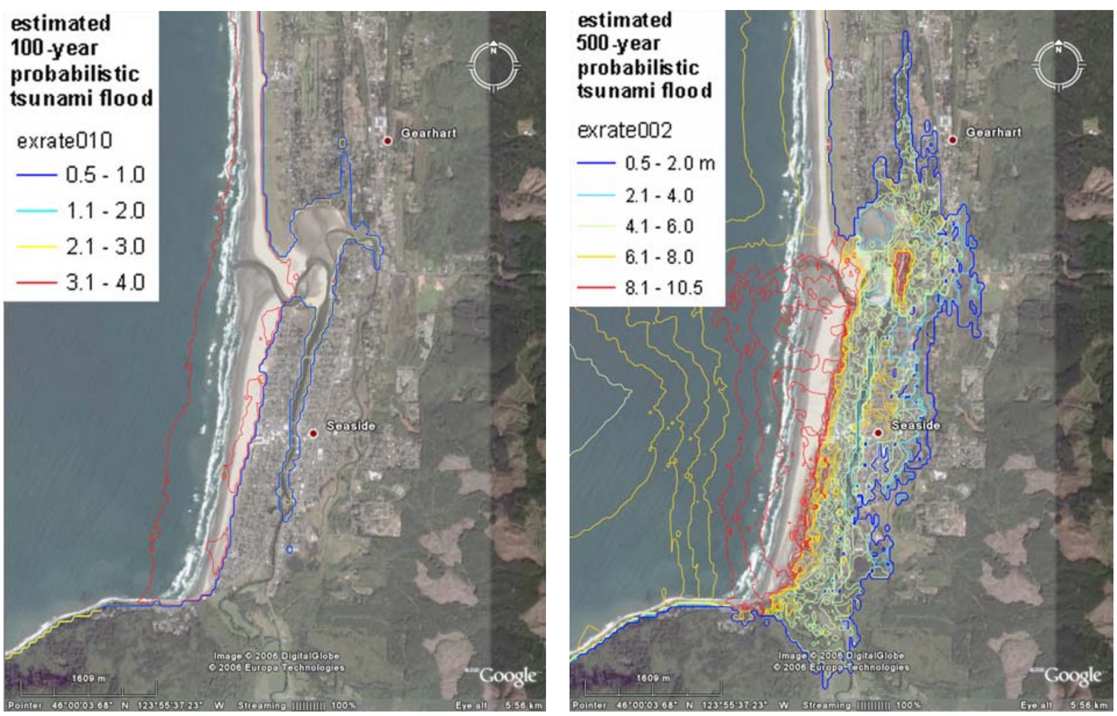


Figure 1. 100- and 500-year tsunami floods modeled by Probabilistic Tsunami Hazard Analysis. Tsunami wave heights (m) with (left) a 1 percent and (right) a 0.2 percent annual probability of exceedance.

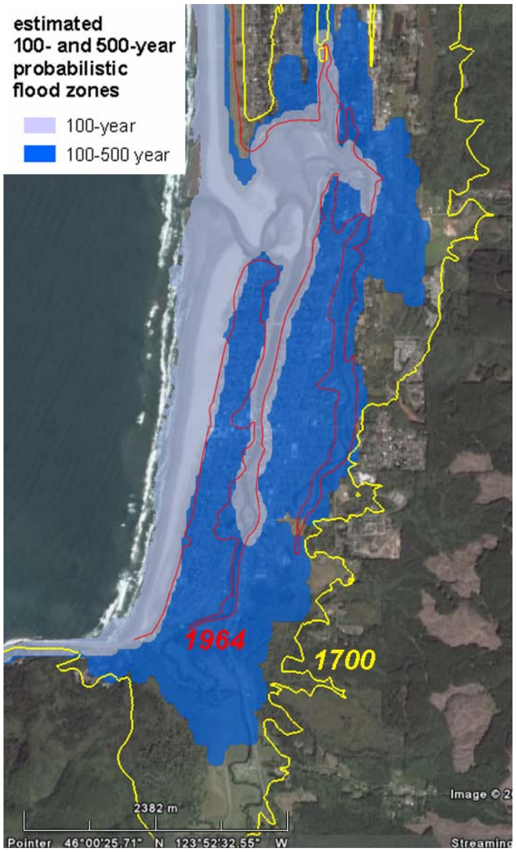
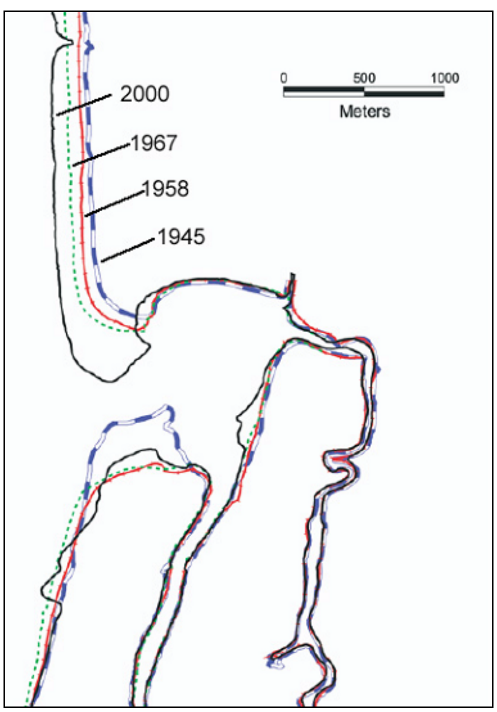


Figure 2. Comparison of newly modeled 100- and 500-year flood zones with tsunami inundation lines from 1964 Alaska (far-field) and 1700 Cascadia (near-field) earthquakes.



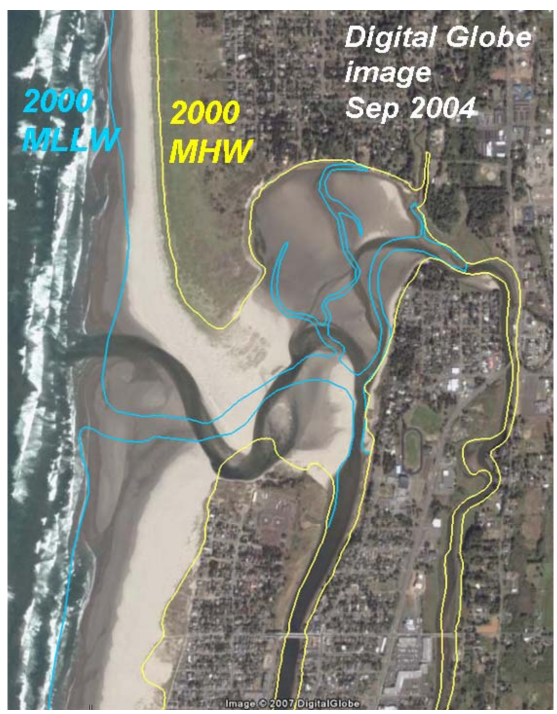


Figure 3. Evolution of shoreline of Seaside and Gearhart, Oregon. Historic shorelines developed for this project (left). Shorelines for 2000 overlaid on 2004 satellite image (right).

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