Crescent City PTHA Project

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NTHMP MES & MMS Subcommittee Meetings
20-22 August 2013
Pacific Marine Environmental Laboratory
Seattle, WA
Probabilistic Post-processing \(<==== GeoClaw Simulations\)

González, et al., JGR, 2009

(a) \( \hat{N}_i(x,y) \)
(b) \( H_0(x,y) \)
(c) \( \hat{N}_i(x,y) \)
(d) Hazard Curve

Time postquake: 1:00
CPU time: 0:01
(1 core of MacBook)
Level 1: \( \Delta x = 2^\circ \)
Level 6: \( \Delta x = 1/3^\circ \)
Ratios: 3,4,5,8,45.

11 March 2011 Tohoku event

Time postquake: 8:00
CPU time: 4:49
(1 core of MacBook)
Level 1: \( \Delta x = 2^\circ \)
Level 6: \( \Delta x = 1/3^\circ \)
Ratios: 3,4,5,8,45.

R. J. LeVeque, University of Washington
NTHMP workshop, PMEL, July, 2012
Phase I: Flooding Depth Annual Probabilities of Exceedance

- **Sponsor**
  - BakerAECOM, as part of FEMA RiskMAP program.

- **Final Report completed on 31 January 2013**
  - [https://digital.lib.washington.edu/researchworks/handle/1773/22366](https://digital.lib.washington.edu/researchworks/handle/1773/22366)

- **Primary Products:**
  - 0.01 and 0.002 Annual Probability of Flood Depth Exceedance

- **Sources:**
  - 15 Sources viewed as stochastic realizations with conditional probabilities

- **Improvements to PTHA Tidal Methodology:**
Effect of tides on inundation at Crescent City

Source: One of 12 CSZ $M_w$ 9.1 realizations (worst case)

Maximum inundation at MLW: at MHW:
Physics of Improved Tidal Uncertainty Methodology

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<td><strong>Tide Effect on Inundation</strong></td>
<td>No nonlinear inundation effects. Estimated by Gaussian approximation to PDF for tide + tsunami, using station tide gage constants.</td>
<td>Direct nonlinear modeling at multiple levels: MLW, MSL, MHHW</td>
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| **Tsunami Time Series** | Synthetic (based on Van Dorn, 1984):  
  • T=20 minutes  
  • 2-day decay time  
  • multiple amplitudes | GeoClaw output at each cell. |

For small amplitude tsunamis, the maximum heights grow in amplitude as the tsunami amplitude increases. For large amplitude tsunamis, the inundation effects on the maximum of the wave heights tend to cluster in elevation.

The wave period of 20 min is within the middle range (10-20 min) of major transpacific tsunamis striking the U.S. West Coast. The theoretical predictions are based on 37 harmonic constants, where those for 18.6-yr nodal cycle of the tides, the insensitivity to using different methods for fitting the coefficients for 29 U.S. Pacific tide stations plus the Seaside tide station.

The discussion addresses the influence of the tides on the maximum of the tsunami PDFs and present values of these coefficients for 29 U.S. Pacific tide stations plus the Seaside tide station. The PDFs depend on the initial tsunami amplitude relative to the method used by Houston and Garcia (1978) in their statistical study of tsunamis along the U.S. West Coast; this is also the site for a probabilistic tsunami pilot study recently carried out by the Federal Emergency Management Agency (FEMA), the United States Coast Guard, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS). Depending on the amplitude of the tsunami, there are different inundation effects. For small amplitude tsunamis, the maximum heights are estimated by a simple Gaussian model. For large amplitude tsunamis, the inundation effects are more complex and depend on the initial tsunami amplitude.
Phase II: Current Speed and Momentum Flux Annual Probabilities of Exceedance

- **Primary Products:**
  - 0.01 and 0.002 Annual Probability of Exceedance for Flood Depth, Current Speed and Momentum Flux
  - Use sources consistent with USGS NSHM Program

- **GeoClaw Currents Compared to Field Data:**
  - Amanda R. Admire, 2013: Observed and modeled tsunami current velocities on California's north coast. Humboldt State University. (Available at [http://humboldt-dspace.calstate.edu/handle/2148/1458](http://humboldt-dspace.calstate.edu/handle/2148/1458).)

Figures are warped to ease comparison. Note that in the eddy of the small boat harbor, the GeoClaw estimates of maximum current speed are consistent with the field estimates of ~1 – 5 m/s.
Menlo Park Workshop (3-4 June 2013): “Sources should be consistent with USGS NSHM Program.”

**Bandon sources**

- **Splay**
- **Shallow**
- **Deep**

**Basis for sources consistent with NSHM**

1. **Candidate Goldfinger et al. (2004-2012) Sources**
   - Frankel scenario1.in: Mw 9, T = 513
   - Frankel scenario2.in: Mw 8.8, T = 10000
   - Frankel scenario3.in: Mw 8.6, T = 5000
   - Frankel scenario4.in: Mw 8.4, T = 2500
   - Frankel scenario5.in: Mw 8.6, T = 10000
   - Frankel scenario6.in: Mw 8.2, T = 5000

**Candidate USGS NSHM Sources**

- M9.1, T=520y
- M8.8, T=10000y
- M8.6, T=5000y
- M8.4, T=2500y
- M8.6, T=10,000y
- M8.2, T=5000y

Frank I. Gonzalez, University of Washington 20-22 August 2013 NTHMP MMS & MES Workshop
Summary

• Phase I
  - PTHA of Flood Depth
  - 0.01 and 0.002 annual probabilities of exceedance (100- and 500-yr events)
  - Developed improved tidal uncertainty methodology
  - But ... used Bandon Sources, which are not entirely consistent with USGS National Seismic Hazard Mapping Program

• Phase II
  - PTHA of Flood Depth, Currents and Momentum Flux
  - 0.01, 0.002 and 0.0004 annual probabilities of exceedance (100-, 500- and 2500-yr events)
  - URS developing sources consistent with USGS National Seismic Hazard Mapping Program
  - Completion by 3 December 2013