New Maximum Tsunami Inundation Maps for Use by Local Emergency Planners in the State of California, USA

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ABSTRACT: A consortium of tsunami modelers, geologic hazard mapping specialists, and emergency planning scientists is producing maximum tsunami inundation maps for California, covering most residentially and transitively populated areas along the state’s coastline. The new tsunami inundation maps will be an upgrade over the existing maps for the state, improving on the resolution, accuracy, and coverage of the state’s maximum anticipated tsunami inundation line. Thirty-three separate map areas covering nearly one-half of California’s coastline were selected for tsunami modeling using the MOST (Method of Separating Tsunami) model (FIGURE 1). Based on a preliminary evaluation of over fifty local and distant tsunami source scenarios, those with the maximum expected hazard for a particular area were input to MOST. The MOST model was run with a near-shore bathymetric grid resolution varying from three arc-seconds (90m) and one arc-seconds (30m), depending on availability. Maximum tsunami “flow depth” and inundation layers were created by combining all modeled scenarios for each area. A method was developed to better define the location of the maximum inundation line using higher resolution digital shoreline topographic data from intertidal, bathymetric, and radar sources. The final inundation line for each area was validated using field (FIGURE 5) and paleo-tsunami (FIGURE 11) data recorded at various locations throughout California. The maximum inundation line location was also calculated using an interferometric radar elevation model of the area.

MODELING AND MAXIMUM WAVE ELEVATION CREATION

- The Tsunami Research Center at USC ran each scenario through the MOST hydraulic model program (Titov and Synolakis, 1997), propagating the tsunami through next, lower- to higher-resolution bathymetric grids resulting in output grids of one arc-second (~30m) for three separate lines and one arc-seconds (~90m) resolution for rest of California. FIGURE 8 shows results from 10m maximum inundation lines near the immediately next potential source, the subaerial landslides north of the state’s largest submarine landslide, north of Santa Barbara. For each source scenario run for a particular area, three output grids are available for use: the initial bathymetric grid, a tsunami flow-depth grid, and a tsunami inundation grid.

- Through simple grid manipulation and processing, these three grids are used to create individual wave elevation, or runup, grids for each scenario scenario.

- As shown in the FIGURE 4, wave elevation grids for each source are combined into a single, maximum wave elevation grid.

- The maximum wave elevation grid represents the worst of all the scenarios for each individual grid cell.

FUTURE WORKING MAPS BY THE STATE TSUNAMI PROGRAM

- Existing paleotsunami deposit information (FIGURE 5) will be entered into a database, compatible with the National Geophysical Data Center’s Global Tsunami Deposits Database, and used to verify the results from the hydrodynamic tsunami models.

- A tsunami source scenario database and discussion forum will be created to allow geoscientists and hydrodynamic modelers to discuss and validate tsunami sources that could impact California.

- 3D tsunami escarpment maps (FIGURE 10) will be derived from the paleotsunami deposits. Local government agencies will use these new maximum tsunami inundation lines to assist in the development of their evacuation routes and emergency response plans.

LOCAL EMERGENCY RESPONSE PLANNING APPLICATIONS

- Draft inundation maps are submitted to the local lead agencies for review and comments and are collected and considered.

- Final inundation maps are submitted to the lead agencies and posted on the state tsunami program website (FIGURE 11).

- Workshops are held by state tsunami program representatives and local agency personnel to discuss how to best use the new inundation maps and what other needs local agencies might have.

- The state tsunami program may assist local lead agencies in development of new emergency and evacuation plans and placement of signage (FIGURE 11).

- Regional tsunamis “working groups” similar to the Redwood Coast Tsunami Working Group in the north part of the state may be organized at the state, local, and academic representatives to be initiated to maintain community-based tsunami hazard mitigation and outreach efforts.

MAXIMUM TSUNAMI INUNDATION-LINE PRODUCTION

- High resolution digital elevation models (DEMs) are used to enhance the location of the maximum inundation line.

- The maximum wave elevation grid is extended onshore and combined with the maximum inundation line from the USGS 10m DEMs (blue) to show how flooding from the tsunami might occur (FIGURE 5).

- A draft inundation line is digitized (also FIGURE 5). Because the topography used to create the USGS DEMs is out-of-date and the more up-to-date (2000) interferometric radar DEMs show structures or vegetation, careful consideration is given to these problems with both high-resolution DEMs.

- The inundation line is checked in the field and adjusted where appropriate.