Modeling and Mapping of Tsunami Hazards for Maritime Communities in US Pacific Islands

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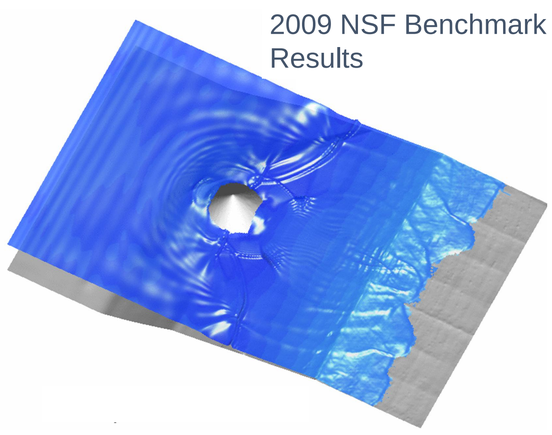
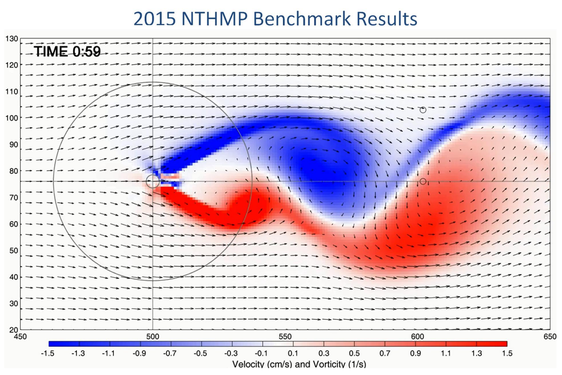
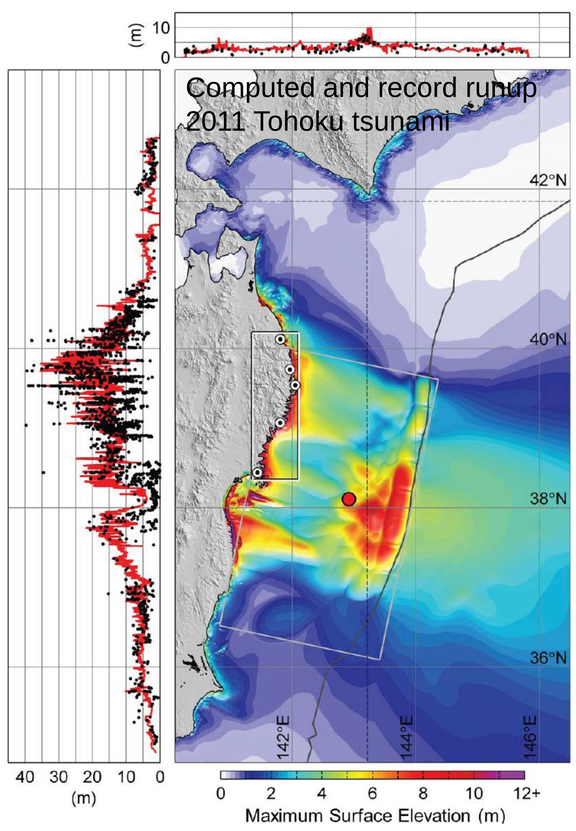
Ports and harbors are lifelines for island communities that are vulnerable to disruption by tsunamis. With support from the US National Tsunami Hazard Mitigation Program (NTHMP) and in collaboration with local emergency management agencies, we are developing maritime hazard maps for Hawaii, American Samoa, and Guam. Successful execution of these projects requires a tsunami model suitable for tropical insular environments, high-resolution digital elevation models, local community participation, and integration of data products into port operation plans.

Tsunami Model NEOWAVE

The non-hydrostatic shock-capturing model can describe tsunami generation from seafloor displacement, dispersion during trans-oceanic propagation, vertical acceleration over steep insular slopes, and bore formation at near-shore reefs and lagoon. NEOWAVE, which is being used by researchers around the world, has been validated at the 2009 NSF and the 2011 and 2015 NTHMP benchmarking workshops with top performance. Additional validation includes measurements of waveforms, currents, and runup from all major tsunamis since 2009.



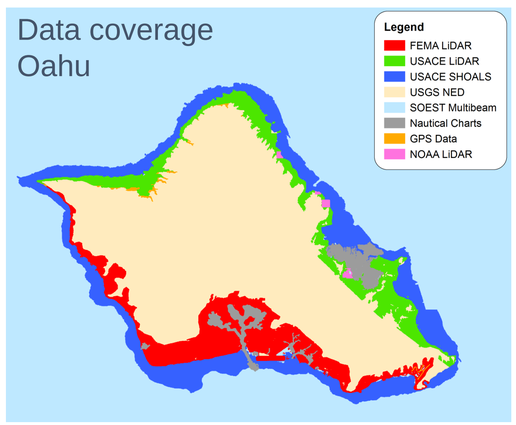


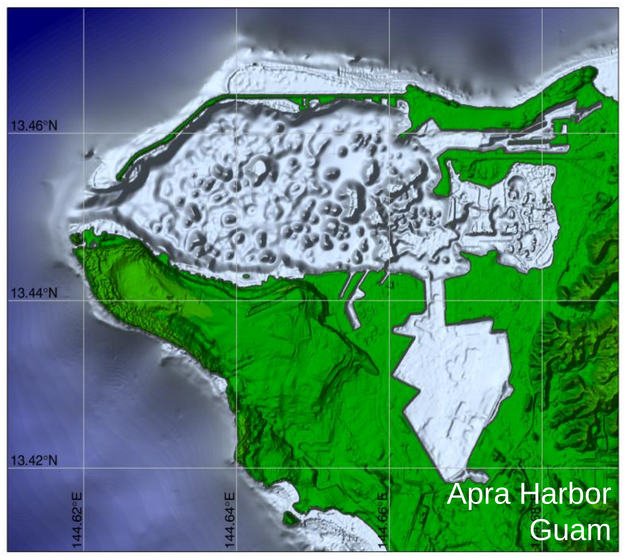


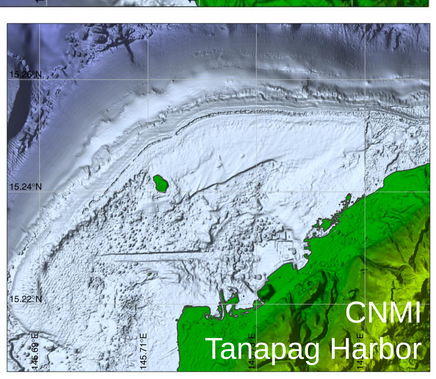
Digital Elevation Model

High-resolution bathymetry and topography are need to describe the steep insular slopes and shallow shelf and reef systems in tropical insular environments. The source data includes

- LiDAR topography of 0.5 to 3 m resolution from USACE, FEMA, and NOAA
- LiDAR bathymetry of 3 to 4 m resolution from USACE and FEMA
- Multibeam bathymetry of 1 to 60 m resolution from US Navy, NOAA, and University of Hawaii SOEST
- USACE hydrographic survey data of federal harbors and waterways
- Nautical charts and port facility plans





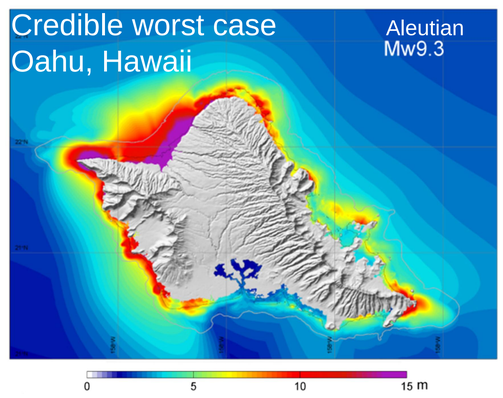


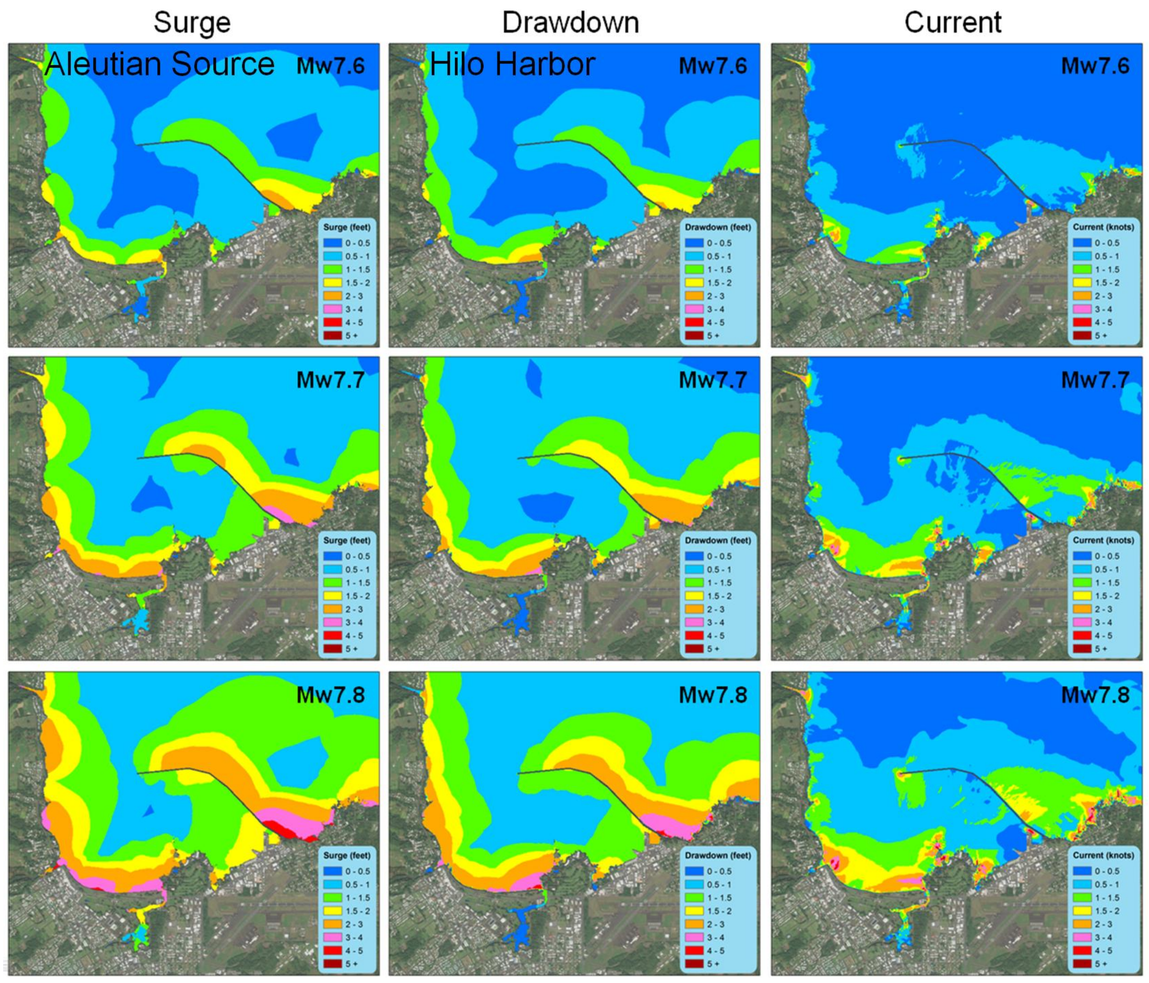
Community Input and Participation

Input from local maritime stakeholders, including port authorities, harbor pilots, shipping companies, and the US Coast Guard, has been instrumental in formulating the data products. The current emergency operation procedures call for evacuation of ships and shore-based personnel when a tsunami warning is issued. The use of credible worst-case scenarios facilitates delineation of offshore safe zones for vessels to evacuate to and assessment of potential impact to shore facilities. Of equal concern to the maritime communities is occurrence of more frequent advisory-level tsunamis, which have predicted near-shore amplitude of less than 1 m and do not require evacuation of shore-based personnel, but nevertheless can cause dangerous flow conditions posing navigational hazards and damaging ships and mooring systems.

Data Products and Implementation

The effort has produced GIS/KMZ map databases of credible worse-case tsunami scenarios for delineation of offshore safe zones as well as surge, drawdown, and current for possible tsunamis from subduction earthquakes around the Pacific for event-driven assessment of potential hazards.





The data products have enabled the US Coast Guard District 14 to determine additional under-keel clearance for safe passage in waterways, establish thresholds for channel closure and harbor evacuation, and incorporate a tsunami response component in its severe weather plan.

Aleutian Earthquake Magnitude	Hilo Harbor: Water Surface Rise/Fall			Water Current	
	Surge (feet)	Drawdown (feet)	Cycle Time Range (minutes)	Speed (knots)	Cycle Time Range (minutes)
7.5	2.3	2.0	8 - 13	2.7	13
7.6	2.6	2.6	8 - 13	3.5	13
7.7	3.6	3.9	8 - 13	4.5	13
7.8	4.6	4.3	8 - 13	5.2	13 - 20
7.9	6.2	5.2	8 - 13	6.0	13 - 20
8.0	8.2	6.6	8 - 13	7.4	13 - 20
8.1	9.2	8.2	8 - 13	9.3	13 - 20

UNESCO IOC Symposium: Advances in Tsunami Warning to Enhance Community Responses, Paris, France, 12-14 February 2018