



UNESCO/IOC – NOAA ITIC Training Program in Hawaii (ITP-TEWS Hawaii)
TSUNAMI EARLY WARNING SYSTEMS
AND THE PACIFIC TSUNAMI WARNING CENTER (PTWC) ENHANCED PRODUCTS
TSUNAMI EVACUATION PLANNING AND UNESCO IOC TSUNAMI READY PROGRAMME
15-26 September 2025, Honolulu, Hawaii

Preparedness for Maritime Community

Tsunami Planning for Ports and Harbours

USA Examples

Dr. Laura Kong
Director, ITIC



Best Practices – Compilations - International



- ❑ PTWS and TOWS actions
- ❑ Request Member States to share guidance, building codes, examples

- ❑ **Vertical Evacuation**
117 refs from Pacific, IO, NEAMTWS

https://www.weather.gov/itic-car/vertical_evacuation_guidance

- ❑ **Marine Preparedness – Ports and Harbors**
100 refs from Pacific, IO

https://www.weather.gov/itic-car/marine_ports_guidance

Vertical Evacuation Guidance

In some locations, high ground may not exist, or tsunamis triggered by local events may not allow sufficient warning time to evacuate to high ground. A potential solution is vertical evacuation above rising waters into buildings and other structures that have the strength and resilience necessary to resist the effects of tsunami waves. A vertical evacuation refuge is a structure or earthen mound designated as a place of refuge in the event of a tsunami. The refuge is designed for short-term protection (12-24 hours), has sufficient height to elevate evacuees above the tsunami inundation level, and has been designed and constructed to withstand an earthquake and resist tsunami load effects. An evacuation shelter is designed for longer-term use; it provides a safe, sanitary, and secure environment and life-sustaining services to disaster survivors displaced from their primary residences due to natural or man-made disasters.

Tsunami design was incorporated by reference into the 2018 International Building Code for structures in risk category III and IV (large occupancy, such as for shelters, and essential facilities). The reference is Chapter 6, "Tsunami Loads and Effects," of the ASCE/SEI 7-16 standard, *Minimum Design Loads and Associated Criteria For Building and Other Structure*.

During the 2011 Japan tsunami, vertical evacuation structures saved many lives. Based on lessons learned, *Guidelines on Structural Requirements for Tsunami Evacuation Buildings Considering the Great East Japan Earthquake* were issued by the Ministry of Land, Infrastructure, Transportation and Tourism (MLIT).

Vertical evacuation should not be chosen over safe, solid, nearby high ground that is out above the tsunami hazard zone. However, if you cannot evacuate inland and there are no multi-story, reinforced concrete or steel refuge structures nearby, then you should find the tallest, sturdy structure and climb up and cling to it until the wave passes. In some cases, this might only be a strong tree or utility pole. If you are swept up by a tsunami, look for something to help you stay afloat, and to protect you from dangerous floating debris such as houses, cars, and trees.

RESOURCE MATERIALS ON VERTICAL EVACUATION STRUCTURES
KEYWORDS: Engineering Assessment, Building Code, Mitigation, Response

For a complete list of all available resources on tsunami vertical evacuation, click [here](#) to download. Currently, this list contains 117 references.

COUNTRIES (Click a link below to go to a highlights)
GENERAL (9 references): BUILDING CODE (6), COUNTRIES (3)
PACIFIC OCEAN (79 references): AUSTRALIA (1), CANADA (3), CHILE (6), CHINA (4),

Marine Ports Guidance

Tsunami waves can easily turn towns into debris fields of crushed homes, buildings, automobiles. In addition, as water recedes and returns, strong water currents can splinter docks and break large vessels from their moorings where they can ram into docks and float onto building or other structures. The 2004 Indian Ocean, 2009 Samoa, 2010 Chile and 2011 Japan tsunamis, and the many images and videos showing the destructive nature of the waves not only locally but across ocean basins, have provided a wealth of science information to help improve marine preparedness.



Ships left aground during the 2011 Great East Japan Tsunami in Kamaishi (left, credit A. Yalciner) and Otsuchi (right, credit M. Ando).

During a tsunami warning, the marine community must also know what to do. Ports and harbours must have response plans for the evacuation and safe return of recreational and commercial vessels, and each boat and ship owner must be prepared - they must know how they will receive a warning, whether they will evacuate their vessels to sea or not, and to where, and be prepared with fuel and provisions should they evacuate.

RESOURCE MATERIALS ON MARINE PORT GUIDANCE

KEYWORDS: Hazard Assessment, Tsunami Modeling, Response, Mitigation

For a complete list of all available resources on Marine Port Guidance and Best Practices, click [here](#) to download. Currently, this list contains 99 references.

COUNTRIES (Click a link below to go to a highlights)

GENERAL (4 references): COUNTRIES (4)

PACIFIC OCEAN (92 references): CHILE (2), JAPAN (37), NEW ZEALAND (3), USA (50)

INDIAN OCEAN (3 references): INDIAN OCEAN REGION (3)



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Best Practices – Compilations - USA



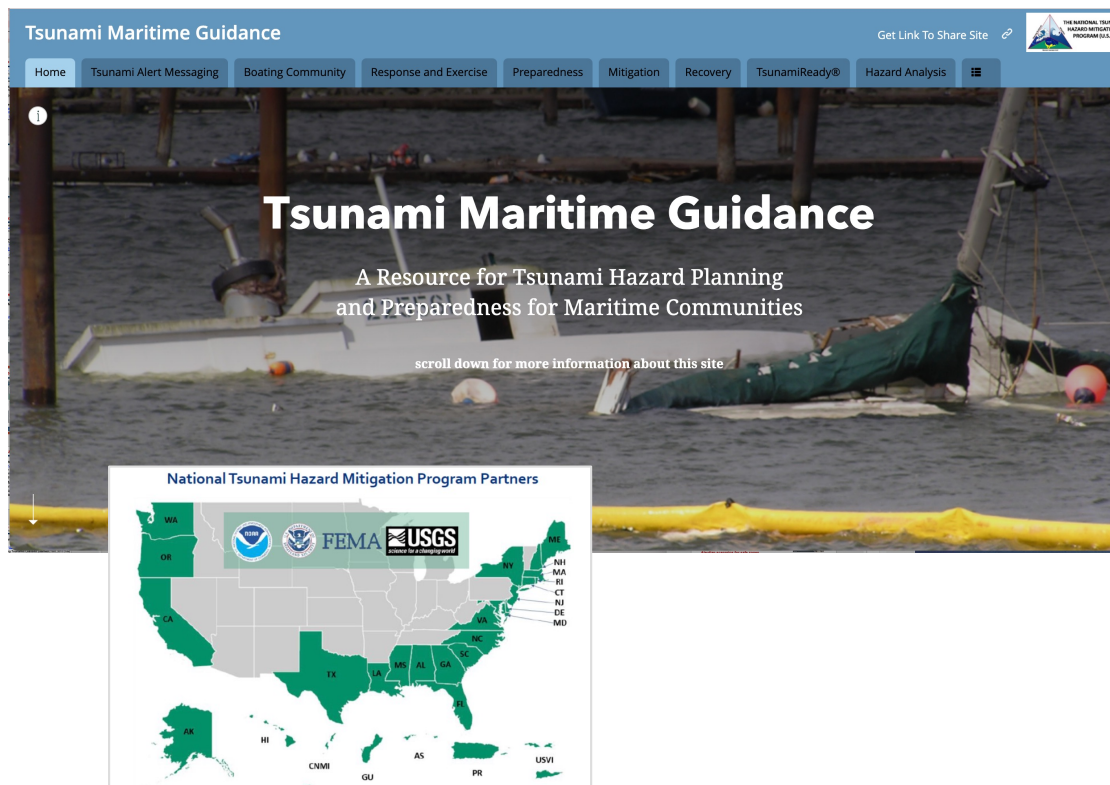
❑ Tsunami Maritime Guidance

<https://arcg.is/0DeHrG>

❑ US National Tsunami Hazard Mitigation Program

❑ Resources for life-safety and damage-reduction mitigation measures - implement before, during, and after tsunami to reduce risk, improve resilience, and facilitate recovery

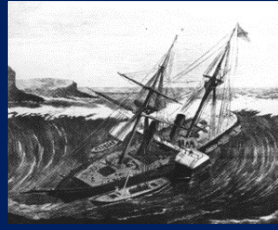
❑ Living document



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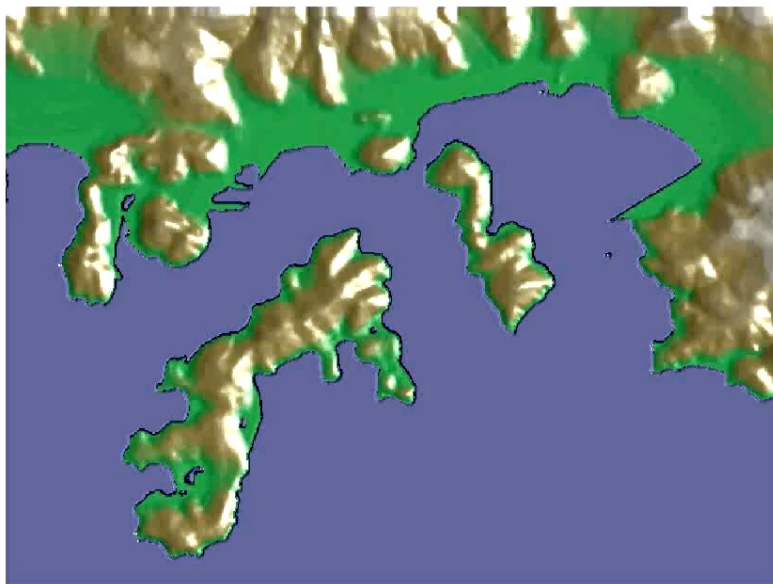
Marine Preparedness - Tourism and Cruise Ships

18 Nov 1867
M7.5
24 deaths
USVI:
4.9-15.2m

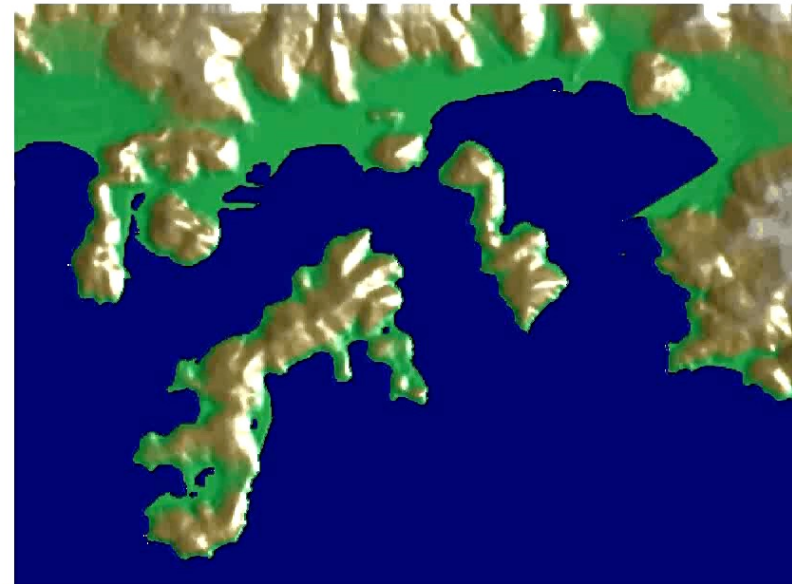


M9, Northern Puerto Rico Trench

Ocean Surface Elevation (meters), Time Post-EQ (hrs) = 0



Tsunami Currents (knots), Time Post-EQ (hrs) = 0



P. Lynett, USC

Tsunami Safety Products for Hawaii and Guam



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Maritime Hazard Modeling & Mapping - Hawaii

Maritime and Scientific Community Input

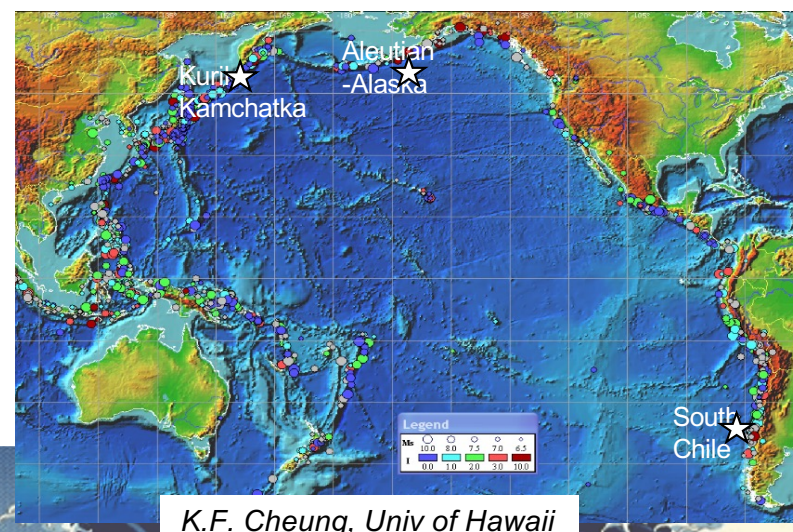
- USCG, PTWC, HDOT, Matson, Sause, Foss (Young Brothers), Kirby, and Pilots Association
- Hawaii Earthquake and Tsunami Advisory Committee
- National Tsunami Hazard Mitigation Program

Data Products

- **Offshore currents - Mw 9.3 / 9.6 Aleutian scenarios for safe zones**
- **In-harbor hazard maps of current, surge & drawdown for advisory-level tsunamis**

Database of scenarios

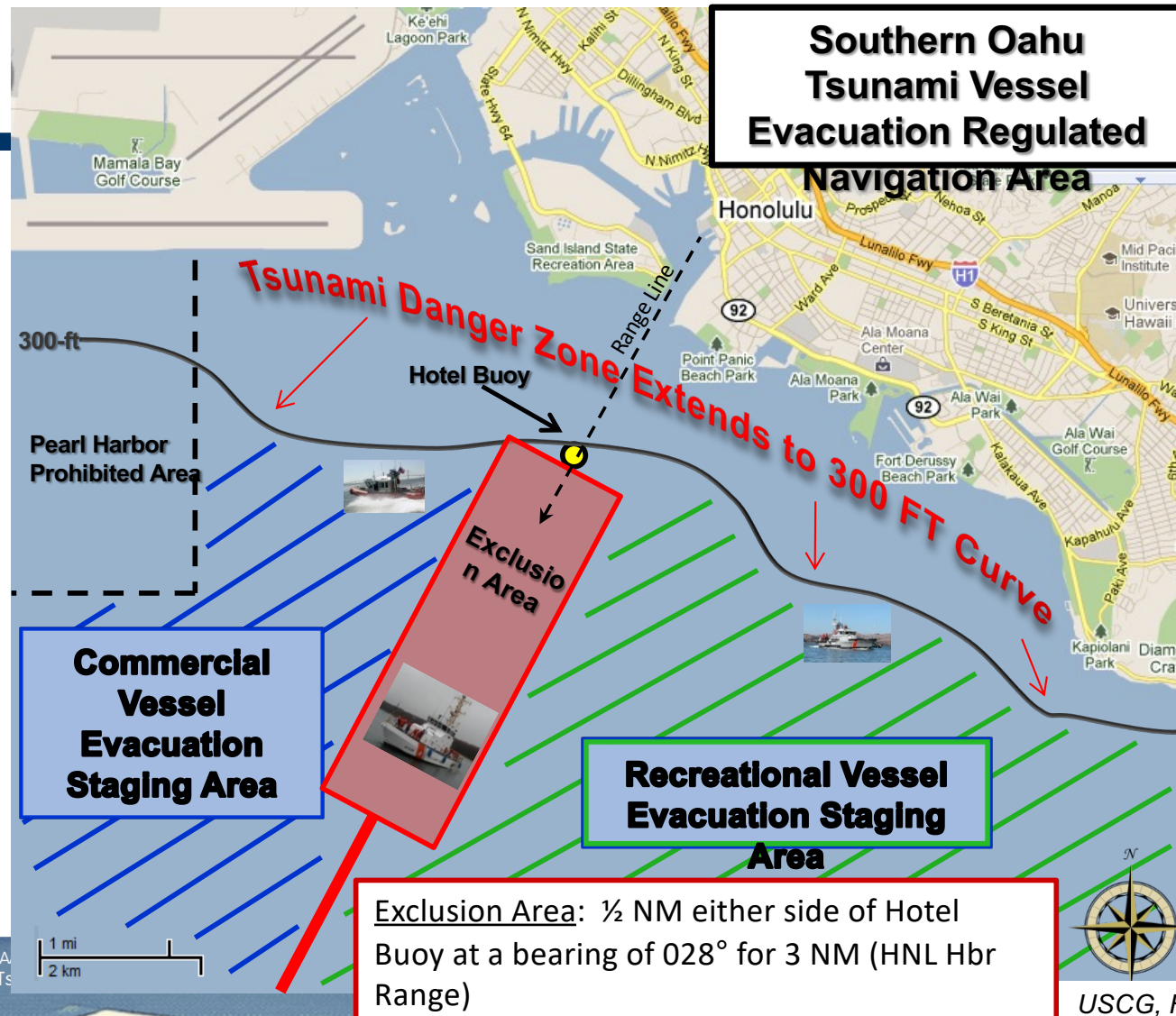
- Three major subduction zones
- Earthquake at 0.1 Mw increments up to ~2 m nearshore wave amplitude
- Modeling of all events at mean-sea level



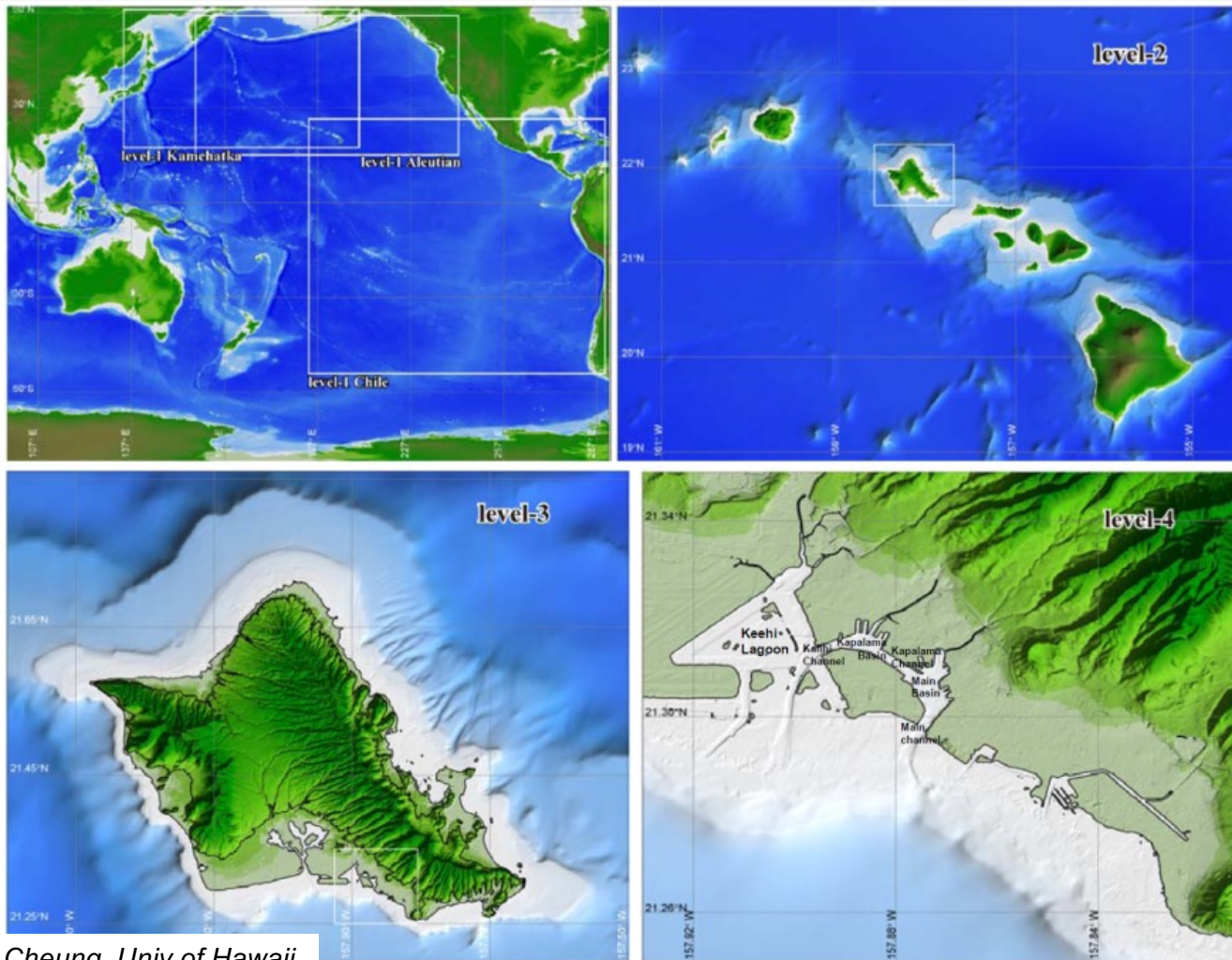
K.F. Cheung, Univ of Hawaii



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Computational Grids



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International

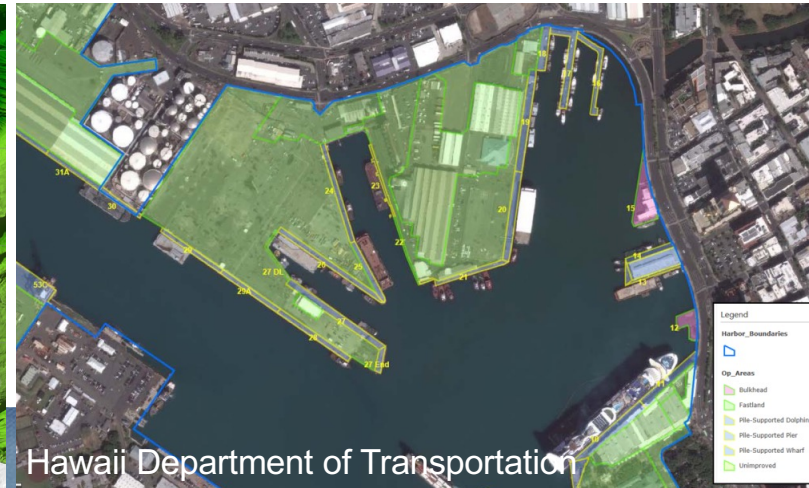
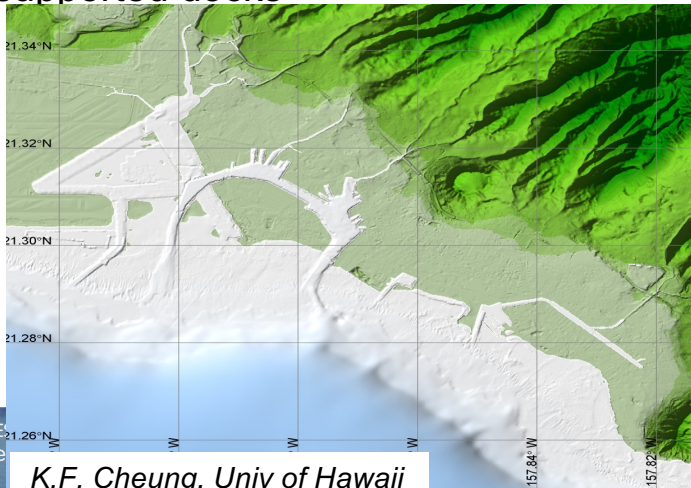
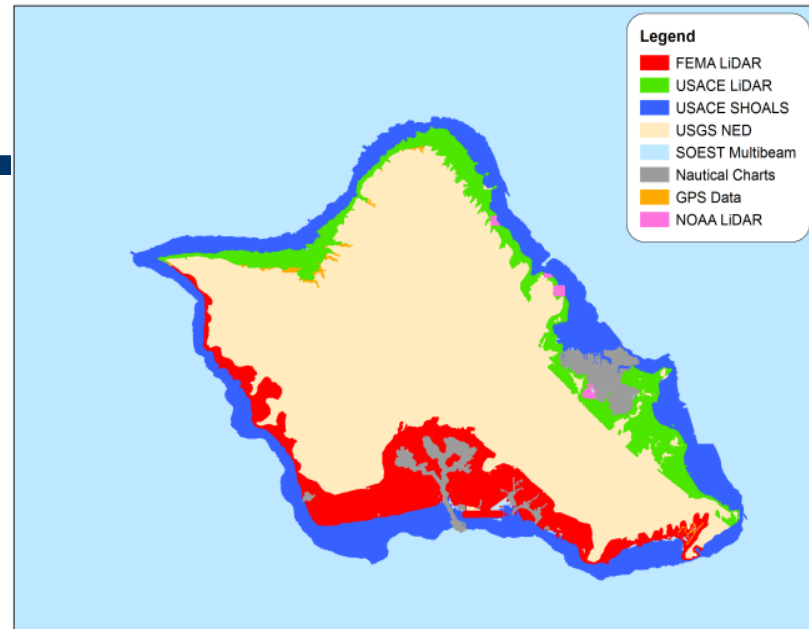
Digital Elevation Model

High Resolution Data

- FEMA, USACE, and DHS LiDAR topography (1 m resolution)
- NASA SRTM topography (30 m)
- USACE LiDAR bathymetry (3 m)
- SOEST multibeam data (50 m)

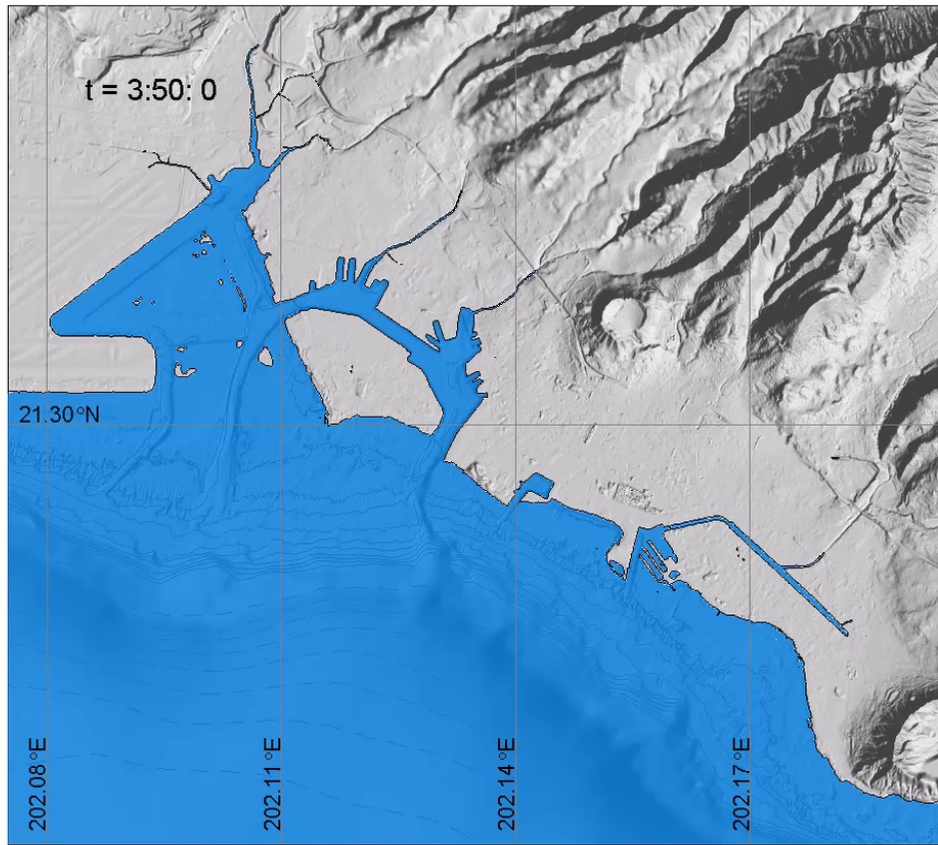
Modification of DEM

- US Army Corps survey data
- Pile supported docks



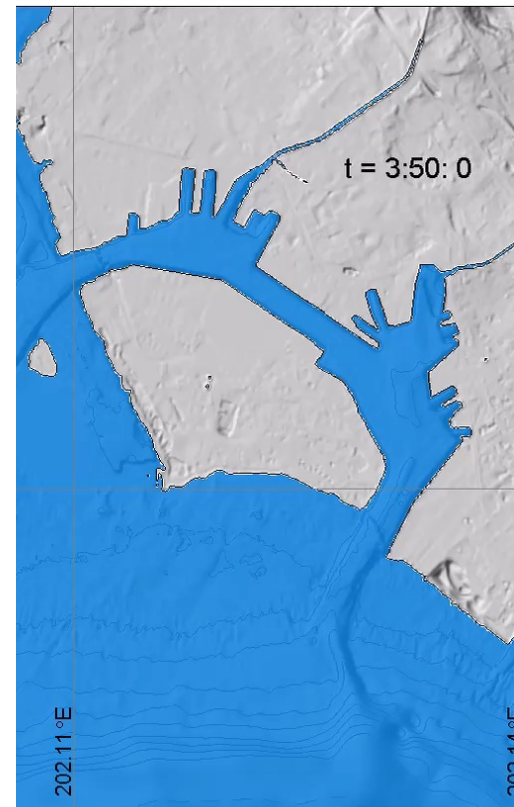
Mw 8.4 Aleutian Islands

SURFACE ELEVATION



-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1 m

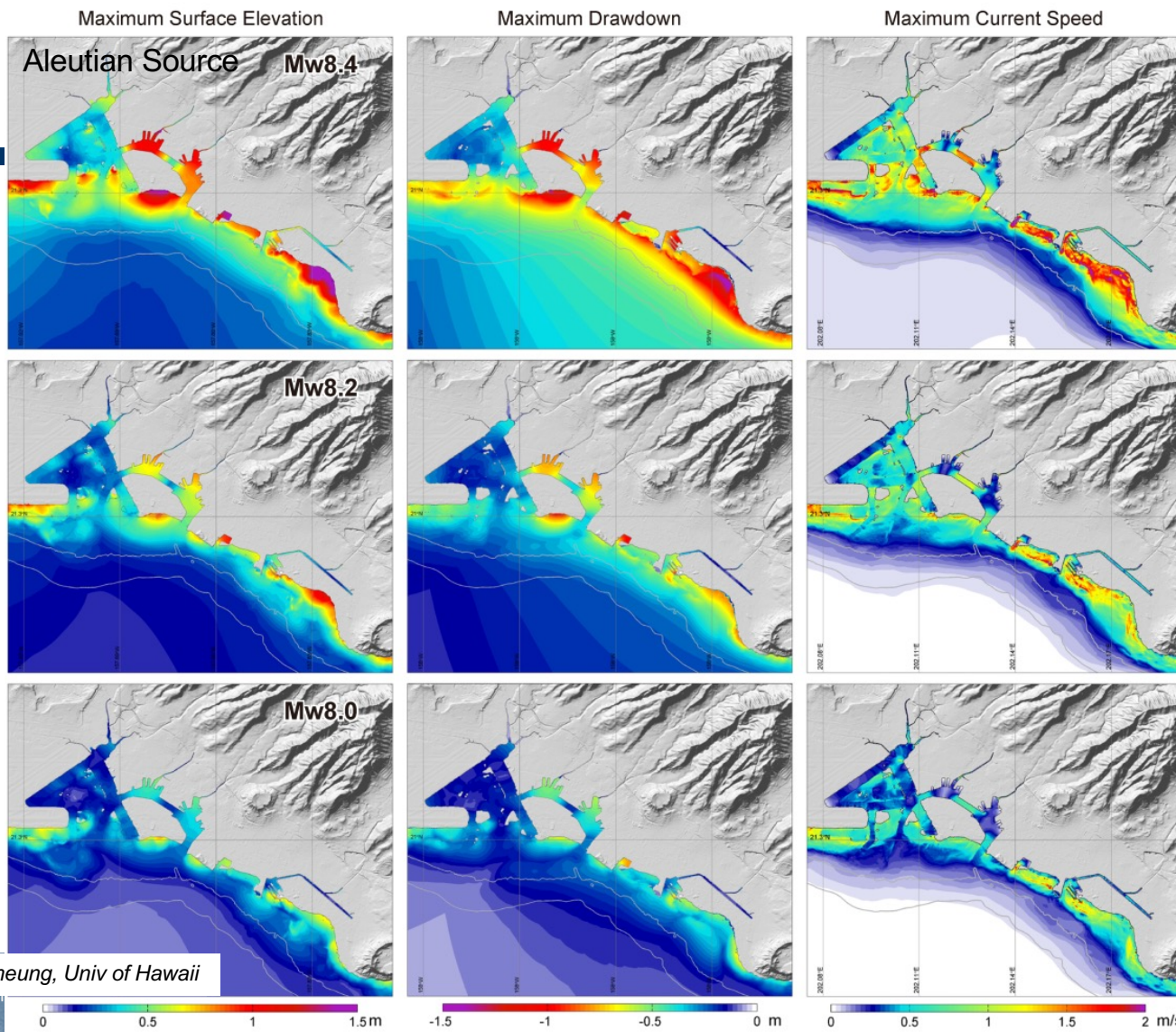
CURRENT SPEED

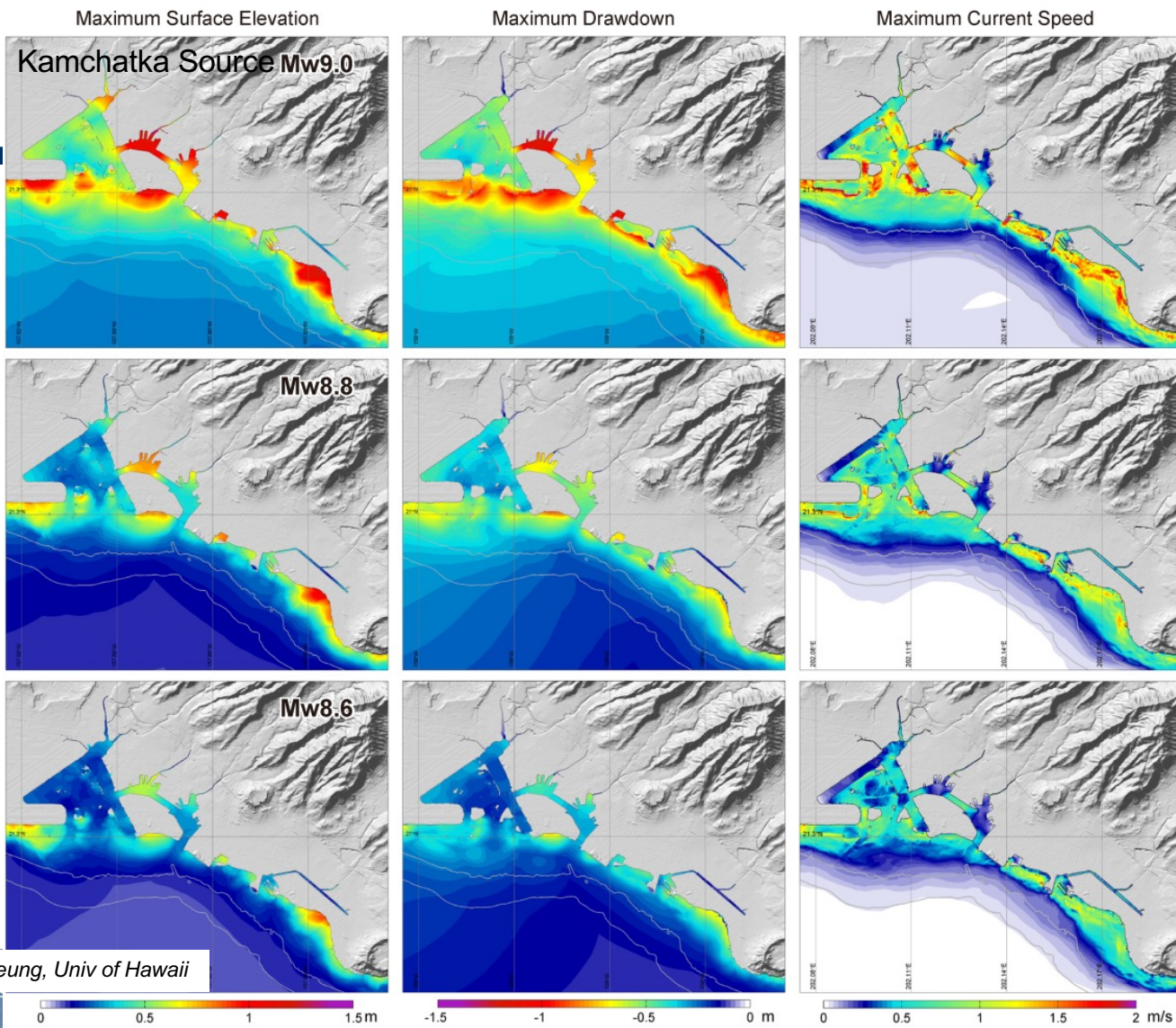


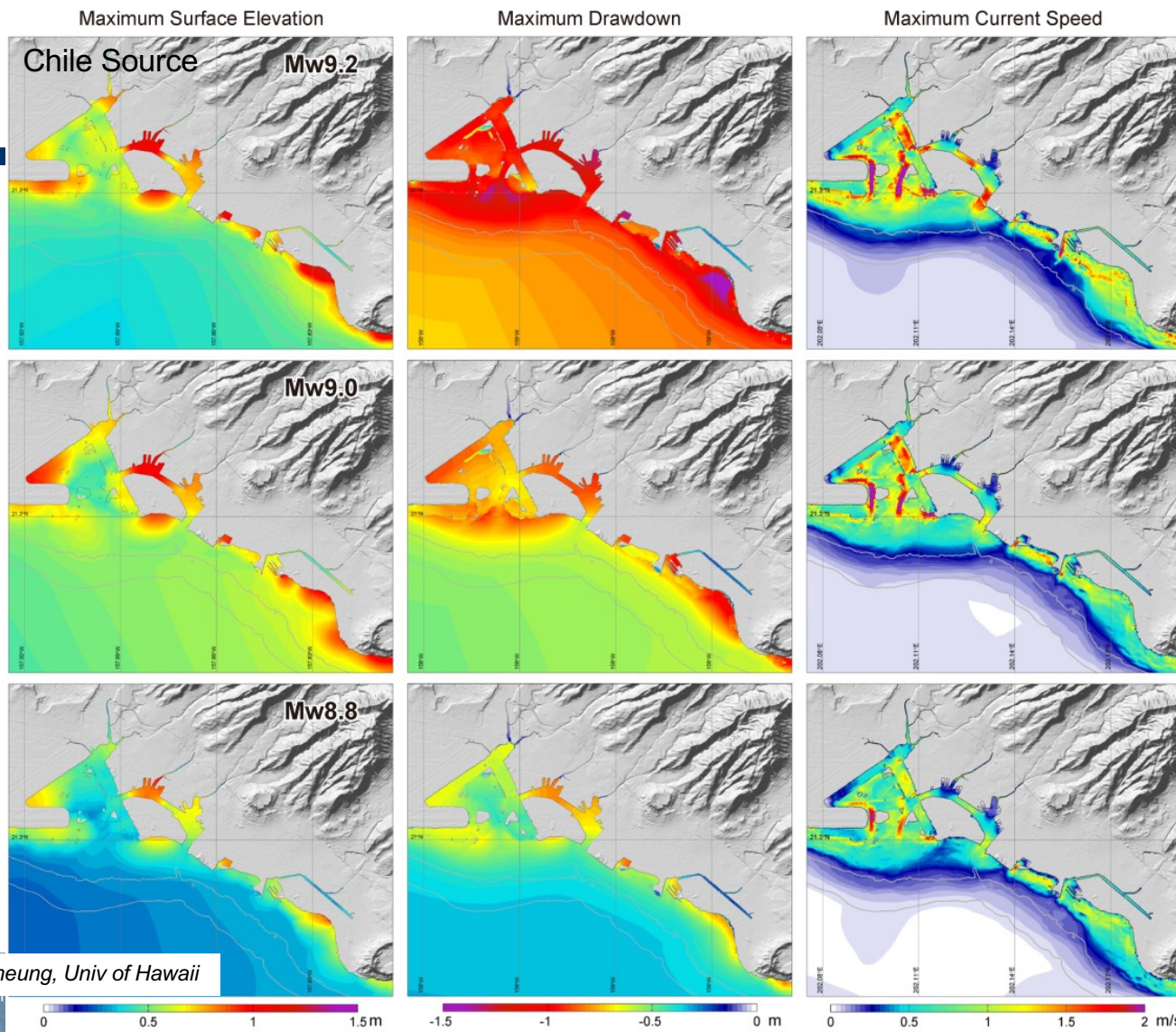
1 1.2 1.4 1.6 1.8 2m/s

K.F. Cheung, Univ of Hawaii

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US Coast Guard – Summary Table for Aleutian Tsunamis

| Earthquake Magnitude | Water Surface Rise/Fall | | | Water Current | |
|---------------------------------|--|--|---|--------------------------|---|
| | Surge from Mean High Water (feet) | Drawdown from Mean Low Water (feet) | Cycle Time Range (minutes) | Speed (knots) | Cycle Time Range (minutes) |
| 7.6 | 0.6 | -0.7 | 9 – 20 | 0.6 | 9 – 20 |
| 7.7 | 0.8 | -0.9 | 9 – 20 | 0.7 | 9 – 20 |
| 7.8 | 1.0 | -1.2 | 10 – 20 | 0.9 | 9 – 20 |
| 7.9 | 1.3 | -1.5 | 10 – 20 | 1.2 | 9 – 20 |
| 8.0 | 1.8 | -2.0 | 10 – 20 | 1.6 | 9 – 20 |
| 8.1 | 2.2 | -2.4 | 10 – 20 | 2.1 | 10 – 20 |
| 8.2 | 3.0 | -3.3 | 10 – 20 | 2.7 | 10 – 20 |
| 8.3 | 3.6 | -4.3 | 10 – 21 | 3.5 | 10 – 21 |
| 8.4 | 4.7 | -4.7 | 11 – 21 | 4.8 | 11 – 21 |

Important 3 data products

- **Surge, drawdown, and current**

Tsunami scenarios – Honolulu, Oahu

- **Mw 9.3 & 9.6 Aleutian, Mw 7.7-8.4 Aleutian**
- **Mw 8.1-9.0 Kamchatka, Mw 8.3-9.2 Chile-Oahu**



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Guam - Community Input and Participation

Site visits and meetings with local communities to define data products (January 16 – 18, 2018)

USCG Sector Guam

- ❑ Integration of advisory-level tsunami scenarios into its severe weather plan
- ❑ Coordination with Port Authority of Guam and Naval Base Guam in plan development
- ❑ Consultation with USCG Sector Honolulu, which has already incorporated tsunami scenarios into its severe weather plan

Guam Power Authority

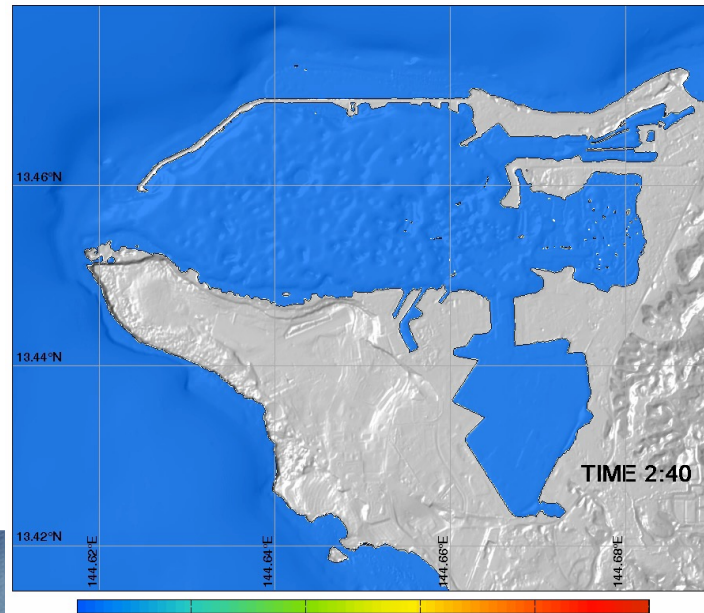
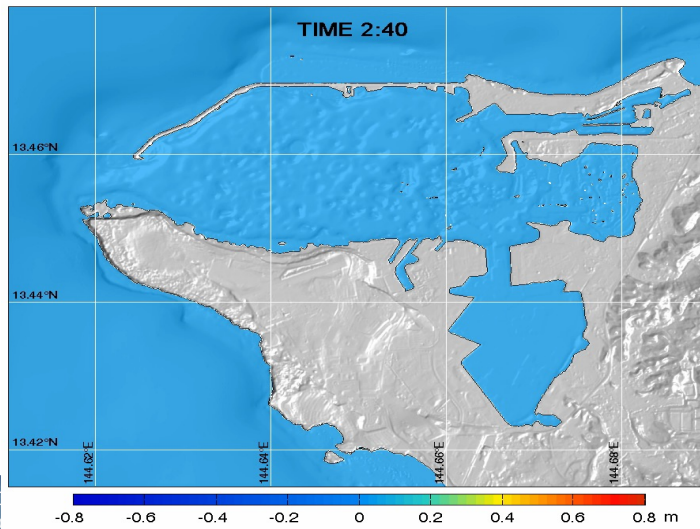
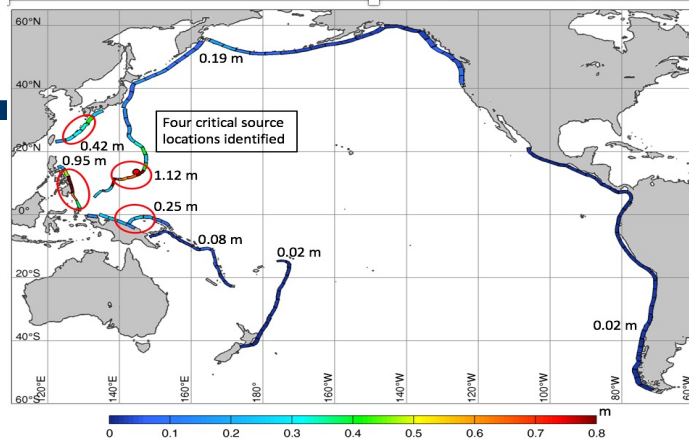
- ❑ Utilization of extreme tsunami scenarios in impact assessment of its power plant and fuel storage as well as siting of new facilities at Apra harbor

Guam Waterworks Authority

- ❑ Utilization of extreme tsunami scenarios in vulnerability assessment of wastewater treatment plant at Agana Bay



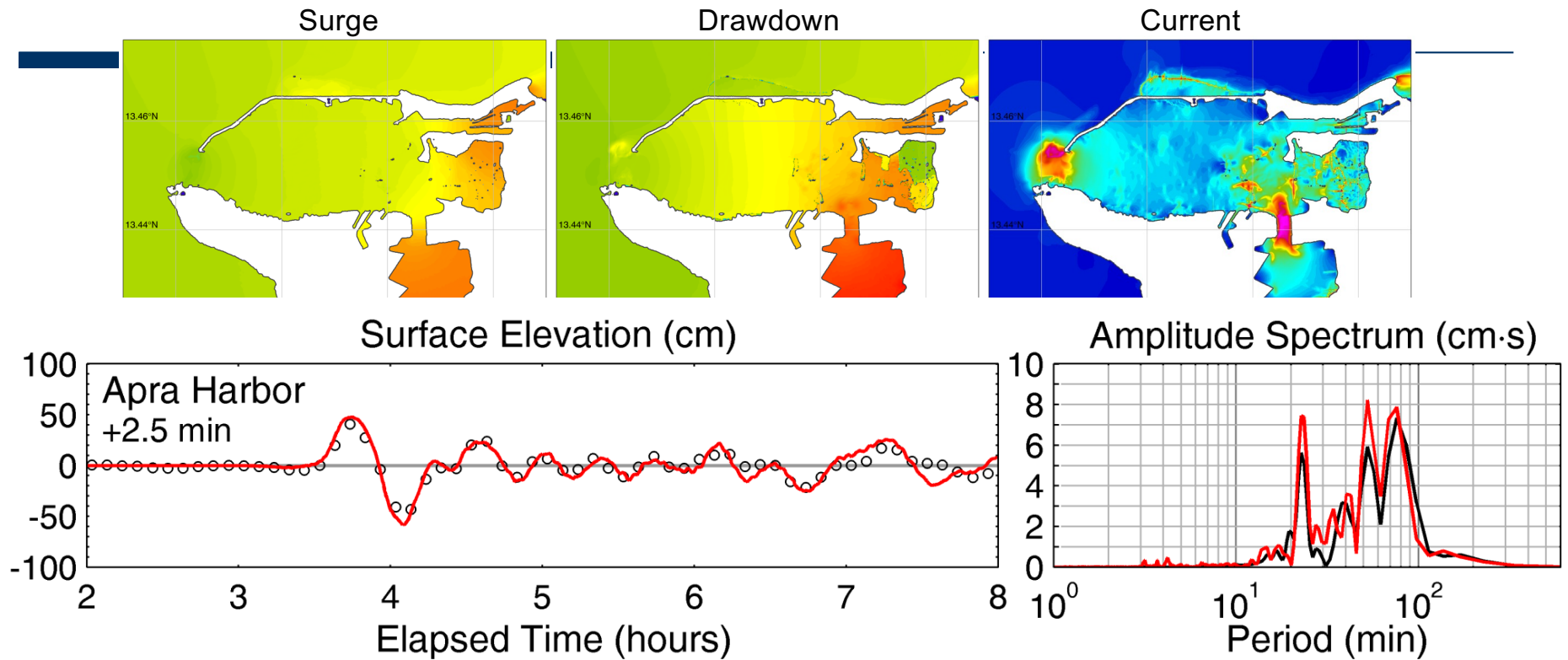
Maximum Sea-surface Elevation offshore of Apra Harbor, Guam
From Mw 8.5 earthquakes at Pacific Subduction Zones



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 Technical
 Commission



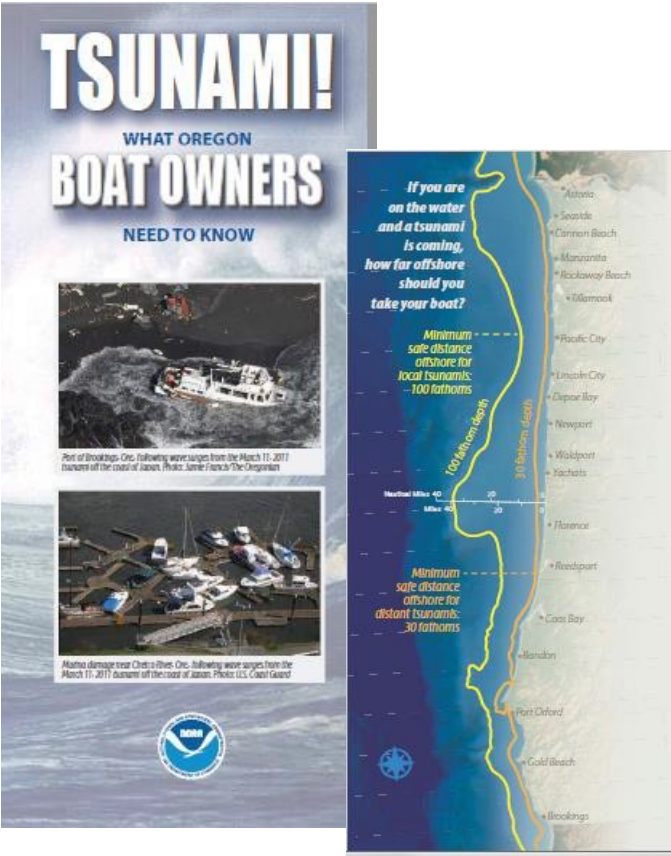
Model Calibration - Results based on the 2011 Tohoku Tsunami



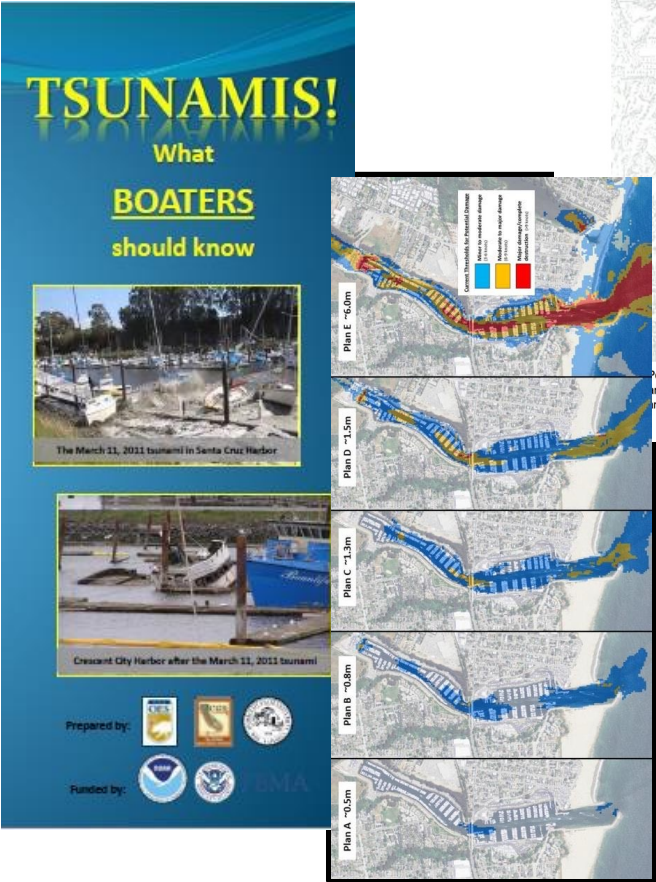
US NTHMP Outreach Products - Boaters

2-Level Response Guidance

Multiple-Level Response Guidance

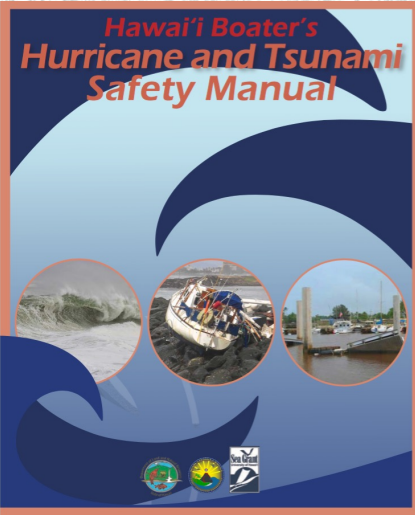
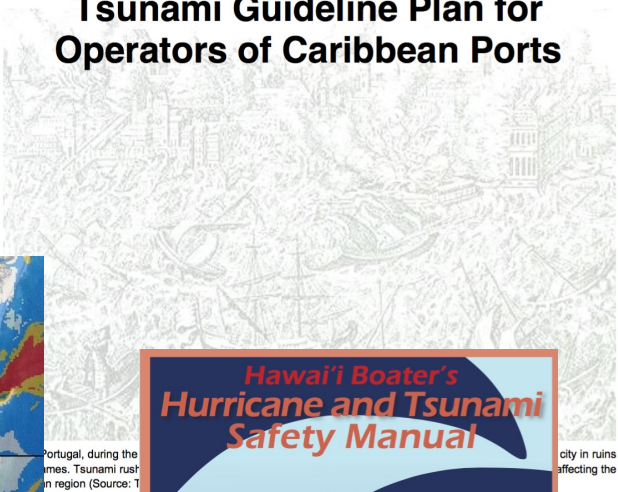


Warning /



Scenario-

Tsunami Guideline Plan for Operators of Caribbean Ports





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Thank You

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