Maritime Mitigation and Recovery Planning

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Partners =

Historical tsunami impacts from notable distant-source events over the past 70 years. The USGS SAFRR and Cascadia scenario tsunamis are also summarized.

Significant Historical Distant Source Tsunamis (year-magnitude-source location)	Tsunami Amplitudes for Historical Events, from NGDC Database (in meters above normal tide conditions; information in parentheses from Cascadia modeling by state; "-" no data)					Effects in California (damage value is presented in constant dollars, representing that year and not adjusted for inflation)
	Crescent City	San Francisco	Half Moon Bay	Port of Los Angeles	San Diego Bay	
1946 M8.1 Eastern Aleutian Islands	0.9	0.3	2.6	0.4	0.2	One fatality; significant inundation in Half Moon Bay; damage approached several million dollars
1960 M9.5 Chile	2.0	0.5	2.2	0.5	1.2	Two fatalities; inundation in Crescent City; damage approached several million dollars
1964 M9.2 Alaska	4.8	1.1	2.0	0.5	2.0	Thirteen fatalities; significant inundation in Crescent City; damage approached $20M
2006 M8.3 Kuril Islands	0.9	0.2	-	0.1	0.1	Damage to docks in Crescent City approached $20M
2010 M8.8 Chile	0.6	0.3	0.6	0.4	0.6	Damage to 12 harbors approached $3M
2011 M9.0 Japan	2.5	0.6	0.7	0.5	0.9	One fatality; damage to 27 harbors approached $100M
Numerical Modeling of USGS SAFRR Western Alaska M9.1 Scenario	4.3	2.2	4.4	1.2	1.4	Projected: Inundation widespread; damage exceeds 10-Billion dollars
Catastrophic Cascadia M9 Scenario (FEMA and CalOES)	15+	(1.8)	(1.8)	(1.0)	(1.0)	Projected: Flooding extensive in Crescent City, low-lying coastal areas in northern state

California Tsunami Maritime Safety Planning

1. Create in-harbor hazard maps by modeling major harbors' tsunami hazards [damaging currents]

2. Create offshore safety zone maps for use by harbors that recommend if, when, and where vessels can be repositioned or sent to sea

3. Provide statewide guidance for response planning, harbor protection, and recovery/business continuity [based on above results]

Mitigation Planning Guidance and Implementation

General Mitigation Guidance in Maritime Response Playbooks, recommends:

MITIGATION PLANNING

In addition to using these Playbooks for tsunami response, the California Tsunami Program, FEMA, and its partners encourages maritime communities to utilize this information to help mitigate damages and loss of life from future tsunamis. These products and plans should be used by maritime communities to identify real-time response mitigation measures, determine where infrastructure enhancements should be initiated, and provide a mechanism for pre-disaster hazard mitigation funding through additions to their Local Hazard Mitigation Plans (see the list of potential mitigation measures below). Although these products, plans, and related mitigation efforts will not eliminate all casualties and damages from future tsunamis, they will provide a basis for greatly reducing future tsunami impacts on life-safety, infrastructure, and recovery in California maritime communities. Therefore, we recommend the following steps/actions:

1. **Review the maps within this Playbook guidance document to identify where strong currents could potentially damage docks, structures, and/or infrastructure, especially where aging or run-down facilities exist.**
2. **Review the Mitigation Measures below for both real-time response actions, or "soft" mitigation, or permanent measures, or "hard" mitigation.**
3. **Incorporate these measures/actions into the community Local Hazard Mitigation Plan, and work with the community, the state tsunami program, and/or FEMA to develop a strategy to request funding to implement these improvements.**

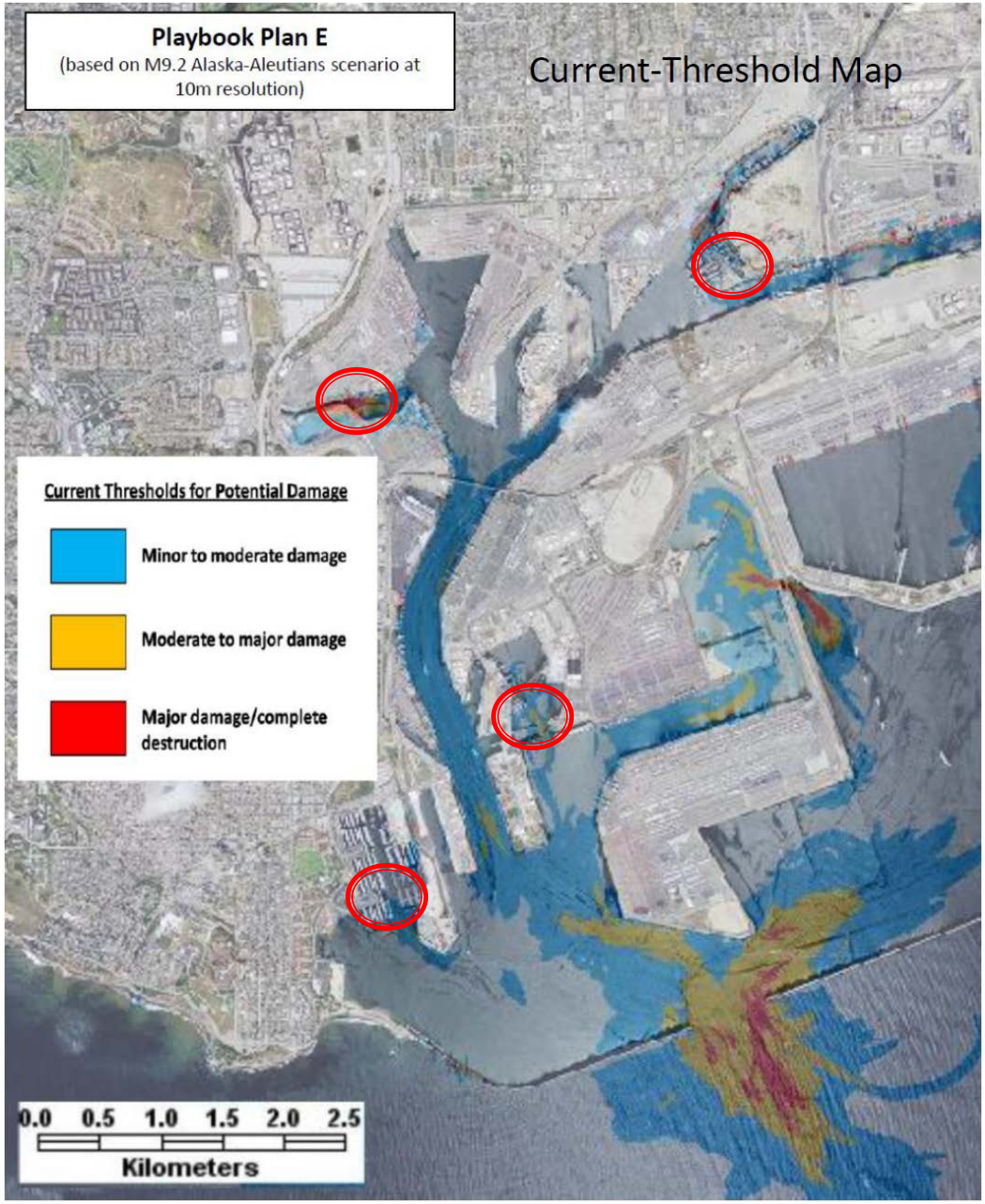
Mitigation Measures for Reducing Impacts in Maritime Communities

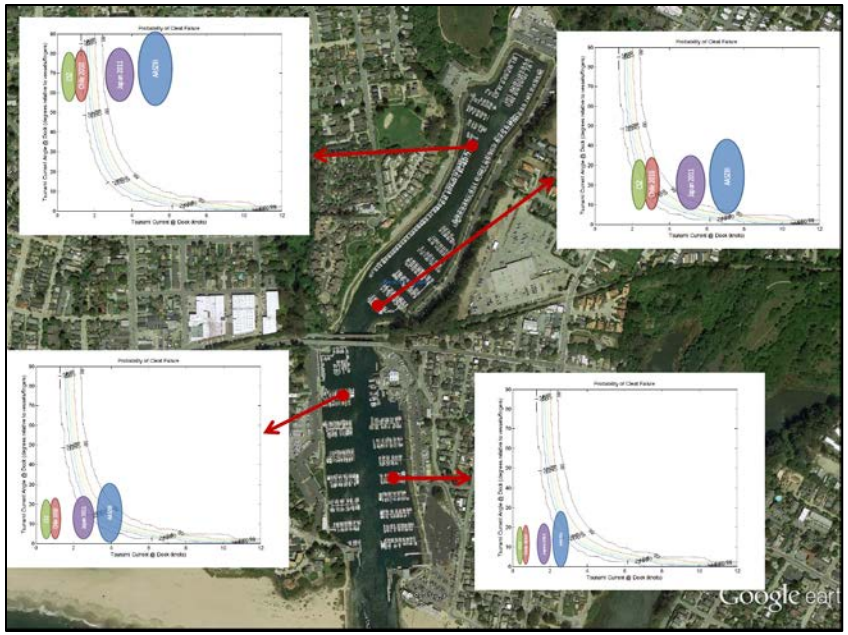
Real-time response mitigation measures	Permanent mitigation measures
Moving boats and ships out of harbors	Fortify and armor breakwaters
Repositioning ships within harbor	Increase size and stability of dock piles
Move large, deep keeled ships from harbor entrance	Strengthen cleats and single-point moorings
Remove small boats/assets from water	Improve floatation portions of docks
Shut down infrastructure before tsunami arrives	Increase flexibility of interconnected docks
Evacuate public/vehicles from water-front areas	Improve movement along dock/pile connections
Restrict boats from moving during tsunami	Increase height of piles to prevent overtopping
Prevent boats from entering harbor during event	Deepen/Dredge channels near high hazard zones
Secure boat/ship moorings	Move docks/assets away from high hazard zones
Personal flotation devices/vests for harbor staff	Widen size of harbor entrance to prevent jetting
Remove hazardous materials away from water	Reduce exposure of petroleum/chemical facilities
Remove buoyant assets away from water	Strengthen boat/ship moorings
Stage emergency equipment outside affected area	Construct flood gates
Activate Mutual Aid System as necessary	Prevent uplift of wharfs by stabilizing platform
Activate of Incident Command at evacuation sites	Debris deflection booms to protect docks
Alert key first responders at local level	Harbor control structures being tsunami resistant
Restrict traffic entering harbor; aid traffic evacuating	Construct breakwaters further away from harbor
Personnel to assist rescue, survey and salvage	Install Tsunami Warning Signs
Identify boat owners/live-aboards; establish phone tree, or other notification process	Equipment/assets (patrol/tug/fire boats, cranes, etc.) to assist response activities

1. **Review tsunami hazard maps**
2. **Review potential "real-time (soft)" and "permanent (hard)" mitigation measures**
3. **Identify where problem areas exist within the harbor and incorporate specific mitigation measures in Local Hazard Mitigation Plan, like:**
   - **Upgrade docks and floats**
   - **Strengthen piles and pile connectors**
   - **Strengthen cleats and mooring lines**
   - **Secure infrastructure, especially petroleum and sewage**

Mitigation Planning Using Maritime Response Playbooks

- Identify areas prone to tsunami hazards using historical information, tsunami current maps, and other products
- Determine where planning for pre-tsunami vessel movement and infrastructure controls/shut-down can reduce damage
- Develop strategy for updating or hardening docks, piers, piles, etc.
- Incorporate reasonable and doable mitigation measures into Local Hazard Mitigation Plans





Dock replacement in Santa Cruz Harbor in 2013, funded by FEMA and CalOES

Mitigation Guidance: Future Work Plan

- **FY14-15 Cooperative Technical Partnership with FEMA Region IX**
- **Continue work with Lynett (USC) and Eskijian (CA State Lands)**
- **Form Tsunami Mitigation Planning Work Group for guidance**
- **Develop "Tsunami Hazard Mitigation Plans" for each harbor**
  - General engineering analysis using failure probability curves for various hazards
  - Use tsunami current results from both scenario-based modeling and PTHA-based modeling
  - Consider mitigation measures that address multi-hazard (EQ, storm, etc.) impacts
  - Develop harbor specific plans that can be easily integrated into Local Hazard Mitigation Plans, Local Coastal Plans, General Plans, etc.
- **Assist harbors in obtaining funding for mitigation efforts from FEMA and CalOES**
- **Consult with NTHMP colleagues**

Recovery Planning Guidance and Implementation

Maritime Recovery Issues and Guidance

Crescent City – 3/18/11
Damage from tsunami

Direct Impacts (Damage):

- Vessels sunk or damaged
- Docks and infrastructure damage
- Permanent land change in large local source EQ
- Debris in water and on land
- Sedimentation and scour
- Contaminants in water and sediment
- Environmentally protected areas/species

Ichinomaki, Japan
3/11/13
2 year anniversary
Very little reconstruction

Indirect Impacts (Time):

- Commercial fishing and shipping disruption
- Harbor business disruption
- Regulatory redundancy and delays
- Limited funding for recovery
- Limited resources for recovery
- Loss of business and workforce over time

Recovery Planning and Guidance: Future Work Plan

Burning disposal of debris from 2011 Tohoku earthquake-generated tsunami, Japan
Bruce Jaffe photo

Port of Long Beach - large number of pier owners complicate planning

- **FY14-15 Cooperative Technical Partnership with FEMA Region IX**
- **Continue work with Laurie Johnson, recovery/land-use planning specialist, and colleagues in Japan**
- **Develop "Guidance for Tsunami Recovery" for harbors/communities**
  - Evaluate impacts on recovery from SAFRR scenario and Catastrophic Cascadia Plan scenario, as well as Japan and Chile
  - Test/Use/Integrate new HAZUS Tsunami Module
  - Align with Federal Disaster Recovery Framework
- **Assist harbors in developing local recovery plans**
- **Develop state-level recovery plan**
- **Consult with NTHMP colleagues**