U.S. State-Level Tsunami Mitigation Activities and Planning for Resilient Communities

Hazard Assessment
Preparedness
Mitigation
Response
Recovery

Partners =

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Community

Tsunami Warning Centers and Regional National Weather Service Forecast Offices

State Emergency Management Agencies, State Geological Surveys, and Academic Partners

Federal

State

National Tsunami Hazard Mitigation Program

Coordinating Committee
Mapping and Modeling Subcommittee
Mitigation and Education Subcommittee
Warning Coordination Subcommittee
California has its faults!
Significant Historical Tsunamis in California


- Each of these events caused damage in California, with 1946, 1960, and 1964 causing inundation.

- Local tsunami events are less common but the most significant one was 1700 Cascadia (no written US record).
Historical tsunami impacts from notable distant-source events over the past 70 years. The USGS SAFRR and Cascadia scenario tsunamis are also summarized.

<table>
<thead>
<tr>
<th>Significant Historical Distant Source Tsunamis (year-magnitude-source location)</th>
<th>Tsunami Amplitudes for Historical Events, from NGDC Database (in meters above normal tide conditions; information in parentheses from Cascadia modeling by state; “-” no data)</th>
<th>Effects in California (damage value is presented in constant dollars, representing that year and not adjusted for inflation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946 M8.1 Eastern Aleutian Islands</td>
<td>Crescent City: 0.9</td>
<td>San Francisco: 0.3</td>
</tr>
<tr>
<td>1960 M9.5 Chile</td>
<td>2.0</td>
<td>0.5</td>
</tr>
<tr>
<td>1964 M9.2 Alaska</td>
<td>4.8</td>
<td>1.1</td>
</tr>
<tr>
<td>2006 M8.3 Kuril Islands</td>
<td>0.9</td>
<td>0.2</td>
</tr>
<tr>
<td>2010 M8.8 Chile</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>2011 M9.0 Japan</td>
<td>2.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Numerical Modeling of USGS SAFRR Western Alaska M9.1 Scenario</td>
<td>4.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Catastrophic Cascadia M9 Scenario (FEMA and CalOES)</td>
<td>15+</td>
<td>(1.8)</td>
</tr>
</tbody>
</table>
2011 Tohoku Tsunami in California

- Large tidal fluctuations = 16 feet in Crescent City (largest surges at low tide)

- Strong currents/debris in harbors

- Potential dangerous tsunami conditions lasted for more than 24 hours.

- Impacts: one fatality; two dozen harbors damaged; Official = $50M; Total ~$100M

March 11, 2011 Tohoku Tsunami in California; video at 11AM (about 3 hours after first arrival of tsunami) within Santa Cruz Harbor
Public Policy Issues

SAFRR Tsunami Scenario: http://pubs.usgs.gov/of/2013/1170/

California Ad Hoc Tsunami Policy Working Group: http://www.wsspc.org/

From Laurie Johnson, presentation at 10th National Conference on Earthquake Engineering in 2014
Some Recommended Courses of Action:

- Ensure Continued Funding and Support for the National Tsunami Hazard Mitigation Program, TsunamiReady and Affiliated State and Local Programs

- Develop a Coordinated and Sufficiently Robust Policy Framework for Tsunami Hazard Assessment and Mitigation Planning for California Coastal Communities and Ports and Harbors

- Explore Opportunities to Advance Multi-Hazard Mitigation Planning Along California’s Coast and Bays

- Encourage Responders and Government Managers to Conduct Self-Assessments, Devise Exercises, and More Carefully Consider the Geographic Scale of the SAFRR Scenario and Other Tsunami Scenarios

- Work to Address Recovery Challenges

From Laurie Johnson, presentation at 10th National Conference on Earthquake Engineering in 2014
Tsunami Hazard Preparedness Community Needs

- Evacuation/Emergency response planning
- Maritime planning
- Land-use/Mitigation planning
- Recovery planning

Statewide tsunami inundation maps completed in 2009 for use community evacuation planning activities
Maritime Response and Mitigation Planning Guidance and Implementation
California Tsunami Maritime Safety Planning

1. Create in-harbor hazard maps and “playbooks”
2. Create offshore safety zone
3. Provide statewide guidance

Analysis and validation of modeled tsunami currents using video and observations from March 11, 2011 tsunami in Santa Cruz; from Wilson and others, 2012, and Lynett and others, 2014
Response and Mitigation Planning Using Maritime Tsunami Hazard Playbooks

- Identify areas prone to tsunami hazards using historical information, tsunami current maps, and other products

- REAL-TIME MITIGATION - Determine where planning for pre-tsunami vessel movement and infrastructure controls/shut-down can reduce damage

- LONG-TERM MITIGATION - Develop strategy for replacing or hardening docks, piers, piles, etc.

- Incorporate reasonable and achievable mitigation measures into Local Hazard Mitigation Plans
Land-Use Planning and Construction Products
Production and Uses for Maps based on Probabilistic Tsunami Hazard Analysis (CA Work Group)

Our concept: Produce single set of risk maps/products for multiple uses

- Project-level assessment and real-estate disclosure (CGS-Seismic Hazard Mapping Act)
- Land-use planning (communities, CA Coastal Commission)
- Standardized hazard analysis for evacuation planning (Cal-OES)
- Building design and construction, critical facilities (ASCE, Uniform/International Building Code, Nuclear Regulatory Commission)
- Flood protection and insurance (FEMA, Risk MAP, CA-Dept. of Water Resources)
- Input for consistent risk analysis and damage estimates (HAZUS)

URS Consultants, 2013 for Caltrans/PEER/CGS
Probabilistic Tsunami Hazard Analysis in Crescent City; blue line is 2009 state inundation map line
<table>
<thead>
<tr>
<th>Risk level (ARP)</th>
<th>Annual rate of exceedance</th>
<th>Liveable/Mitigated</th>
<th>Operational</th>
<th>Immediate Occupancy</th>
<th>Life Safety</th>
<th>Collapse Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>50% in 50yr</td>
<td>FEMA FIRM</td>
<td>Building Risk Cat. IV</td>
<td>Building Risk Cat. III</td>
<td>Building Risk Cat. II</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>25% in 50yr</td>
<td>DWR Flood Maps (for flood plains of Central Valley)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>10% in 50yr</td>
<td>Seismic Hazard Mapping Act and FEMA FIRM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>5% in 50yr</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2500</td>
<td>2% in 50yr</td>
<td>Vertical Evacuation Buildings</td>
<td>Building Risk Cat. IV</td>
<td>Building Risk Cat. III and II over 65'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td>1.67% in 50yr</td>
<td></td>
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</tbody>
</table>
Recovery Planning Guidance and Implementation
Tsunami Recovery Issues and Guidance

**Direct Impacts (Damage):**

- Residential structures and business damage
- Vessels, docks, and harbor infrastructure damage
- Permanent land change in large local source earthquake
- Debris in water and on land
- Sedimentation and scour
- Contaminants in water and sediment
- Environmentally protected areas/species

**Indirect Impacts (Time):**

- Residential reconstruction and/or relocation
- Commercial fishing and shipping disruption
- 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

• FY14-15 Cooperative Technical Partnership with FEMA

• Continue work with recovery/land-use planning specialist and colleagues in U.S. and 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 (when completed)
  • Align with U.S. Federal Disaster Recovery Framework

• Assist communities and harbors in developing local recovery plans

• Develop U.S. state-level recovery plan
Questions for 3ICUDR participants regarding tsunami mitigation and recovery efforts:

What guidance/references would you recommend in starting to develop a guide for community recovery planning?

What are the most important things for community/state/federal programs to focus on with regard to tsunami mitigation and recovery planning?

How does tsunami recovery planning fit into multi-hazard recovery planning approach?
Thank you!

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www.tsunami.ca.gov