## Comparison – Three recent tsunamis
### Example: Santa Cruz Harbor

<table>
<thead>
<tr>
<th></th>
<th>Sept. 29, 2009</th>
<th>Feb. 27, 2010</th>
<th>March 11, 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Earthquake magnitude/location</strong></td>
<td>M8.1 Tonga/Samoa</td>
<td>M8.8 Maule, Chile</td>
<td>M9.0 Tohoku, Japan</td>
</tr>
<tr>
<td><strong>Warning Center Alert Level for California</strong></td>
<td>Advisory</td>
<td>Advisory</td>
<td>Warning, then Advisory</td>
</tr>
<tr>
<td><strong>Approximate travel time of tsunami to Santa Cruz Co.</strong></td>
<td>11 hours</td>
<td>13 hours</td>
<td>10 hours</td>
</tr>
<tr>
<td>Approximate peak wave amplitude in Santa Cruz Co. (Andy Ritchie, USGS)</td>
<td>1-2 feet</td>
<td>2-3 feet</td>
<td>+5-6 feet</td>
</tr>
<tr>
<td>Approximate duration of strong wave action in parts of California</td>
<td>~ 4 hours</td>
<td>~ 8 hours</td>
<td>+ 24 hours</td>
</tr>
<tr>
<td><strong>Effects/Damage in State</strong></td>
<td>Minor to moderate currents in harbors</td>
<td>Moderate currents in harbors</td>
<td>Strong currents in harbors</td>
</tr>
<tr>
<td>- $0 in damages</td>
<td>- $3M in damage</td>
<td>- ~$100M in damage</td>
<td></td>
</tr>
<tr>
<td><strong>Effects/Damage in Santa Cruz Co.</strong></td>
<td>Moderate currents</td>
<td>Mod to Strong currents</td>
<td>Strong to very strong currents</td>
</tr>
<tr>
<td>- $0 in damages</td>
<td>- Tens of thousands</td>
<td>- +$22M in damage</td>
<td></td>
</tr>
</tbody>
</table>

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**Fortunate:** Last two events occurred at [low tide](#).
Pre- and Post-Tsunami Field Team and Information Clearinghouse Plan

- **Before event**
  - Work with local entities
  - Establish project network
  - Determine field partners/locations

- **During event**
  - Collect real-time information
  - Information Clearinghouse to CalEMA, Counties, and WC/ATWC-WFOs

- **After event**
  - Collect perishable post-tsunami data
  - Report
Response to March 11, 2011 Event

- Early March, 2011 - Four regional CGS personnel selected... then March 11 occurred

- Before event
  - Six people in field at prime locations
  - Contacted and assisted local officials

- During event
  - Clearinghouse to CalEMA
  - Collect real-time information

- After event
  - Eight field teams and email surveys collect information at 160 coastal locations; Use of EQ Clearinghouse website
  - Damage reports to CalOES; Federal Disaster Declaration
  - Reported results in posters and peer-reviewed articles
  - Implementing new work based on results
Lessons Learned for CGS Field Team Plan

**Before event**
- Selection of primary field locations critical; work closely with locals
- Teams need guidance
  - Incorporate new IOC-UNESCO field guide
  - Regional field team workshops

**During event**
- Improved communication between field and CGS Clearinghouse

**After event**
- Set up of online data sharing point
- Request video from locals/harbors
- Seek additional funding source for post-tsunami field teams and data compiling

*South end Shelter Island, San Diego Bay*
Priority sites for real-time observations, based on:

• Population
• Harbors
• Higher potential run-ups based on modeling
• Historical run-up noted
• No tide gauges
Tsunami Response Project Data Collection

CGS Pre-Tsunami Field Teams

Information collected/provided during tsunami to clearinghouse and counties:

- Location
- Maximum amplitude/wave height
- Maximum/peak velocity
- Maximum peak-to-trough of wave
- Average time of wave cycle
- Damage
- Actions taken by/Issues for local community or harbor
- Photos/video
Update on Tsunami Field Team Project

- Developing tsunami observation teams
  - Integrating into State EM plan and the online CA Earthquake Clearinghouse
  - USGS Field Note App
  - Held several workshops and field trips
    - Identified key locations, many without tide gauges
    - Over 50 geologist/engineers state-wide
  - Guidance report on developing teams and team member tasks available Fall of 2013
- Preliminary call-down exercise has been completed
- Extended exercise in March 2014
Expand Tide Gauge and ADCP Currents Network

- Tide gauges assist Warning Center and EMs
  - Forecast updates
  - Changes to Alert level
  - Post-tsunami evaluation
- Developed NOAA and NTHMP priority locations
- Tide gauges through NOAA-NOS and Warning Centers
- Tide gauges = Ft Bragg, Santa Cruz, Ventura, Newport Beach
- ADCP = Acoustic Doppler Current Profiler; Crescent City (implemented soon) and Santa Cruz (proposed)
Develop Real-time Online Webcam Network

- Cameras either mobile (with field team members) or fixed locations

- Locations – primarily harbors where strong currents or damage expected

- Objectives:
  - Real-time “eyes on the water” for Ems
  - Data collection of tsunami evaluation
  - Multi-state proposal in 2014

Idealized multiple webcams statewide capturing tsunami in real time
Field Teams and Instrumentation Plan Summary

- Ready for implementation or still demonstration project?
  - Field teams and instruments can be implemented
  - Webcams still demo project under “research and development”
  - NEEDS: 1) guidance for field teams and webcams; and 2) state-level field team protocol plans

- Importance to NTHMP: MODERATE to HIGH, based on: 1) partial support in Strategic Plan; 2) importance in assisting NOAA Warning Centers and emergency response activities; and 3) assisting post-event disaster declarations (recovery funds)