

# Application of Probabilistic Tsunami Products

## California Tsunami Program

Disaster Planning Cycle

Hazard  
Assessment

Preparedness

Mitigation

Response

Recovery



Crescent City



Los Angeles

### 2013 USGS SAFRR Tsunami

#### Scenario finding:

Improving planning can reduce casualties and losses by as much as **80-90%**

Kevin Miller and Yvette LaDuke, California Governor's Office of Emergency Services

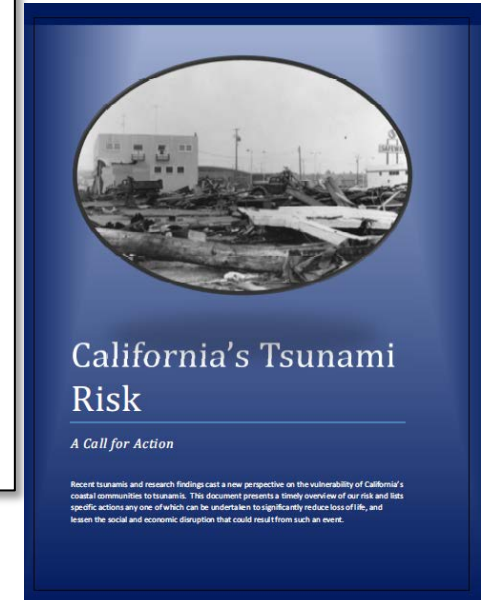
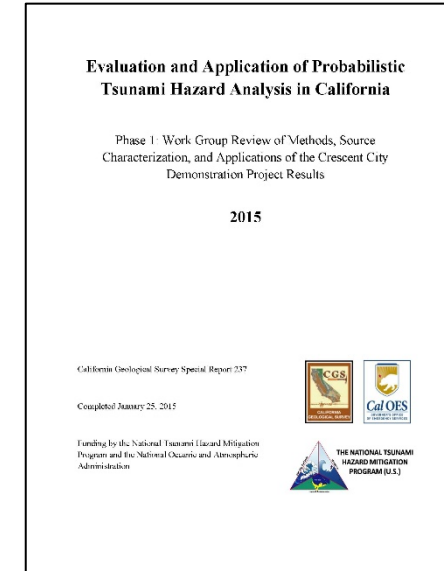
Rick Wilson and Cindy Pridmore, California Geological Survey

California Tsunami Hazard Preparedness and Mitigation Program coordinates with the partners below, 20 coastal counties, 100 coastal cities, and with other states through the National Tsunami Hazard Mitigation Program



# Brief History of Probabilistic Tsunami Hazard Maps in California

- **Pre-2013** - Initial PTHA work started by Caltrans and PGE with Hong Kie Thio (AECOM; URS)
- **2013** - CGS initiated work through collaboration with Thio
- **2014** - Intended use for Seismic Hazard Mapping Act implementation
- **2015 CGS Report – Phase 1 – First workgroup report on CA PTHA**
  - Sources (Cascadia) consistent with National Seismic Hazard Program Maps
  - Improvements to numerical model and model resolution (10m)
- **2015-present** - PTHA modeling and preliminary maps
  - Model results = wave elevation; flow depth; velocity; momentum flux (force)
  - Field check of model results made improvements where levees and other man-made and topographic features indicated reduction or expansion of flood area
  - Production of PTHA inundation maps
- **2019 Tsunami Technical Advisory Panel**
  - Panel of technical experts from CGS, USGS, and USC reviewed process and make recommendations





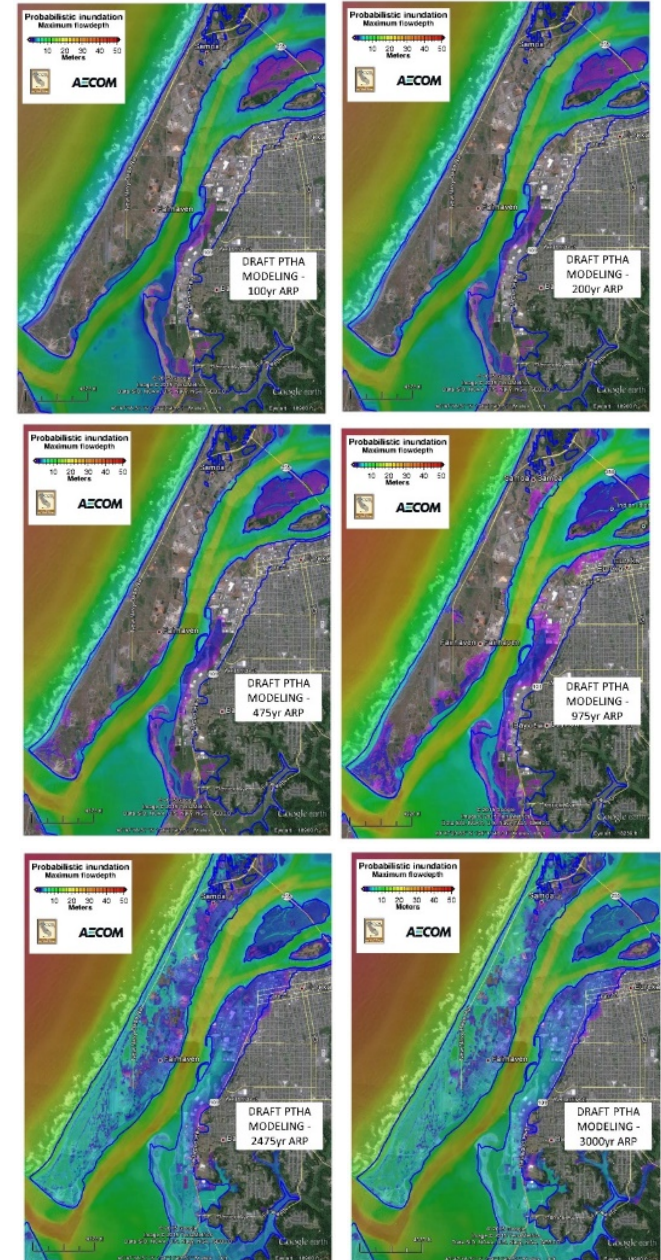
# Applications of New Probabilistic-based Tsunami Hazard Maps

Single-set of accurate Probabilistic Tsunami Hazard Analysis maps/products for multiple applications:

- California Geological Survey – “zones of required investigation” and resulting mitigation measures through the Seismic Hazard Mapping Act.
- CalOES – informs recurrence of tsunami hazard for inundation maps for evacuation planning, and assists communities with vertical evacuation structure planning and land-use planning.
- California Building Standards Commission – maps to replace Tsunami Design Zones in the California Building Code for essential (schools) and critical facilities (hospitals).
- Federal Emergency Management Agency – RiskMAP products as equivalent and comparison to existing Flood Insurance Rate Maps, and consistent hazard levels for HAZUS runs.
- ALL maps can help with other local community planning efforts, especially with Local Coastal Plans

PRELIMINARY  
Model Results  
AECOM for  
CGS (2015-16)

Probabilistic  
Tsunami  
Hazard  
Analysis in  
Humboldt  
Bay; blue line  
is 2009 state  
inundation  
map line





Ports of Los  
Angeles and  
Long Beach

CA-PTHA Prelim. Maps

- 475yr ARP
- 975yr ARP
- 2,475yr ARP
- 2009 inundation map

9259 ft

Google Earth



Santa Cruz

CA-PTHA Prelim. Maps

- 475yr ARP
- 975yr ARP
- 2,475yr ARP
- 2009 inundation map

6310 ft

Image © 2018 TerraMetrics  
Data CSUMB SFML, CA OPC

Google Earth



# Eureka and North Spit of Humboldt Bay

## CA-PTHA Prelim. Maps

- 475yr ARP
- 975yr ARP
- 2,475yr ARP
- 2009 inundation map

8078 ft

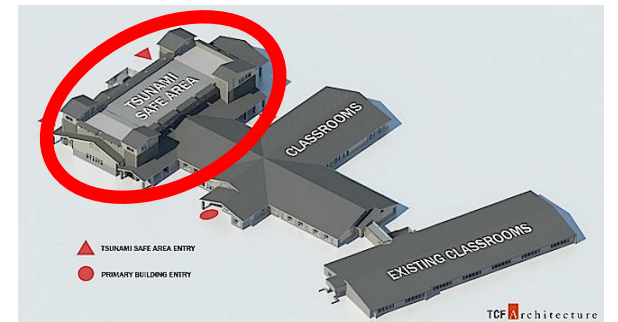
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2018 TerraMetrics

Google Earth



# Types of tsunami planning activities underway (Final Recommendations TBD by Advisory Panel)

- **Probabilistic Mapping/Modeling**
  - 500 Year (buildings only)
    - Property (construction triggers/zones of req'd investigation)
  - 1000 Year (people only)
    - Evacuation, Life Safety, Human Lives
    - Response Planning
  - 2500 Year (people + buildings)
    - Essential Facility siting/approval (e.g. Hospitals, Police, Fire)
    - Vertical Evacuation Structures (need to be at this height because once you're there, there is no "Plan B." Meaning you can't go elsewhere. Need to be sure you are high enough.)



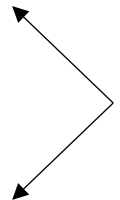
# Risk Categories of Buildings for Building Code and Other Construction (modified from Gary Chock slide)

|                          |   |
|--------------------------|---|
| <b>Risk Category I</b>   | <b>Up to 2 persons affected</b><br>(e.g., agricultural and minor storage facilities, etc.)  |
| <b>Risk Category II</b>  | <b>Approximately 3 to 300 persons affected</b><br>(e.g., single/multi-family structures, office buildings, condominiums, hotels, etc.)  |
| <b>Risk Category III</b> | <b>Approximately 300 to 5,000+ affected</b><br><br>(e.g., Public assembly halls, arenas, high occupancy educational facilities, some public utility facilities, etc.)                           |
| <b>Risk Category IV</b>  | <b>Over 5,000 persons affected</b><br><br>(e.g., hospitals and emergency shelters, emergency operations centers, first responder facilities, air traffic control, toxic material storage, etc.) |

California  
Seismic  
Hazard  
Mapping  
Act



ASCE/  
Building  
Code

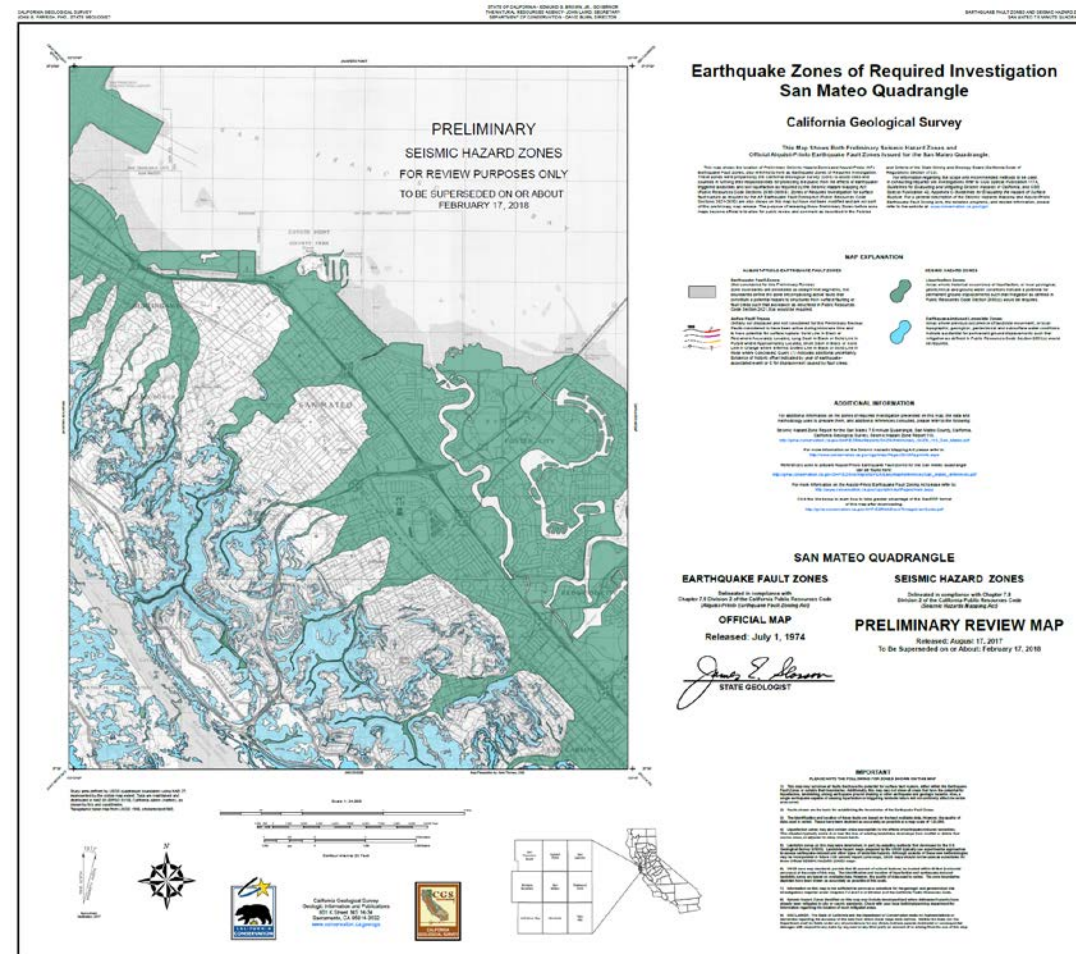




# New Probabilistic Tsunami Hazard Maps

## Application to Seismic Hazard Mapping

- The initial language of the 1990 SHM Act included hazards from soil liquefaction, earthquake-triggered landslides and amplified ground shaking.
- Following the April 25, 1992 Cape Mendocino Magnitude 7.2 earthquake, which caused a minor tsunami along the north coast, language was added to the SHM Act to address hazards related to tsunamis and seiches.
- **SECTION 2692.1: The State Geologist may include tsunami maps/zones/planning when “information becomes available” and that “information is appropriate for use by local government.”**
- Tsunami maps/products for land-use planning and construction, and property disclosures through the SHM Act.



New preliminary Seismic Zone Maps for San Mateo County. Tsunami Hazard Zones may be added to these maps in the future.



# Project Types, Applicable Land-Use, & Construction Mandates, With Potential Related Tsunami Hazard Maps

| Project/Land-Use Type                | Applicable Construction or Land-Use Mandate | Likely Construction Risk Category (RC) in CBC | Available and Applicable Probabilistic Maps (Based On Average Return Periods) |       |       |       |                  |        |        |       |
|--------------------------------------|---|---|---|-------|-------|-------|------------------|--------|--------|-------|
|                                      |   |   | 100yr   | 200yr | 475yr | 975yr | 2475yr minus 3ft | 2475yr | 3000yr | other |
| hospitals-in-patient                 | CBC   | RC 4  |   |       |       |       |                  | X      |        |       |
| hospitals-out-patient                | CBC   | RC 3  |   |       |       |       | X                |        |        |       |
| school-high capacity structure       | CBC   | RC 3  |   |       |       |       | X                |        |        |       |
| school-individual classrooms         | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| private school                       | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| daycare                              | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| police station                       | CBC   | RC 4  |   |       |       |       |                  | X      |        |       |
| fire station                         | CBC   | RC 4  |   |       |       |       |                  | X      |        |       |
| government-response use              | CBC   | RC 4  |   |       |       |       |                  | X      |        |       |
| government-non-response use          | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| jail/detention center                | CBC   | RC 3  |   |       |       |       | X                |        |        |       |
| tanks-hazardous materials            | CBC   | RC 4  |   |       |       |       |                  | X      |        |       |
| tanks-water (post-event use)         | CBC   | RC 3  |   |       |       |       | X                |        |        |       |
| waste water treatment plants         | CBC   | RC 4  |   |       |       |       |                  | X      |        |       |
| desalination plant                   | CBC   | RC 3  |   |       |       |       | X                |        |        |       |
| power-emergency                      | CBC   | RC 4  |   |       |       |       |                  | X      |        |       |
| power-non-emergency                  | SHMA?                                       | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| public assembly hall/arena           | CBC   | RC 3  |   |       |       |       | X                |        |        |       |
| multi-story buildings-high capacity  | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| multi-story buildings-low capacity   | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| apartments-senior                    | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| apartments-non-senior                | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| hotels/motels-high capacity          | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| hotels/motels-low capacity           | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| duplex residential                   | Comm  | RC 2  |   |       |       |       |                  |        |        |       |
| single residential                   | Comm  | RC 2  |   |       |       |       |                  |        |        |       |
| multi-residential project (>4 units) | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| residential hazard disclosure        | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| retail-high capacity                 | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| retail-low capacity                  | Comm  | RC 2  |   |       |       |       |                  |        |        |       |
| storage-high capacity                | SHMA  | RC 2  |   |       | ?     | ?     |                  |        |        |       |
| storage-low capacity                 | Comm  | RC 1  |   |       |       |       |                  |        |        |       |

CBC = CA Building Code

SHMA = Seismic Hazard Mapping Act

Comm = Community level decision

capacity = no. of people per hour

similar projects are grouped by shading and non-shading of rows

? = maps TBD by TsuTAP for Seismic Hazard Zones

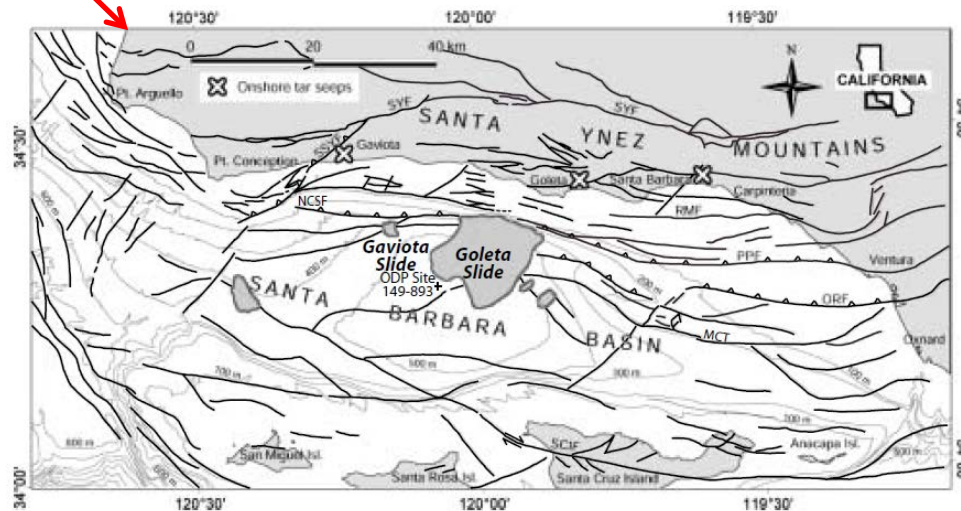


# Probabilistic Tsunami Hazard Maps – Moving Forward

## Tsunami Sources and Hazard Mapping

- Will generate Seismic Hazard Mapping Act tsunami zones: on-line maps and evaluation tools
- Product “needs” list is expanding and products require validation
- Local sources must be inventoried, more thoroughly evaluated, and updated (USGS Powell Center tsunami source improvement project)
- Distant source characterizations must be updated

Potential local tsunami source threats in Santa Barbara Channel (from Greene and others, 2006)



SCIF = Santa Cruz Island Fault  
SSYF = South Santa Ynez Fault  
NCSF = North Channel Slope Fault  
RMF = Red Mountain Fault

PPF = Pita Point Fault  
ORF = Oak Ridge Fault  
SYF = Santa Ynez Fault  
MCT = Mid channel Trend

2017 PTHA model results at Balboa Island, Newport Beach

