
Earthquake Country Alliance

Statewide Fall Workshop December 4, 2024



1

Welcome!

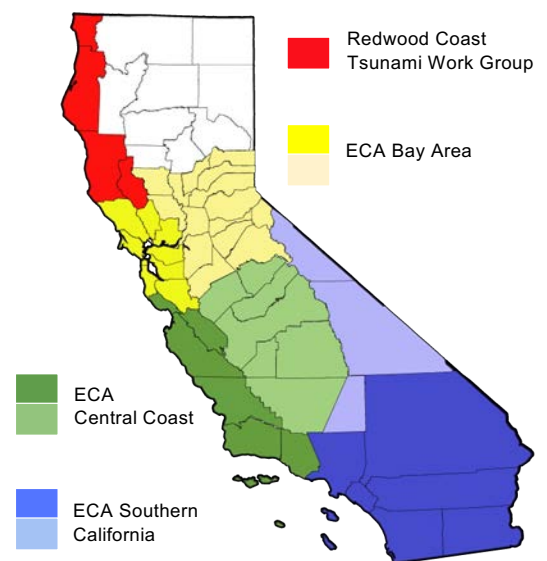
**Please introduce yourself in the chat:
Name & Organization
(ECA role if you have one)**

ECA 2024 Overview – brief overview of what we've accomplished this year

Mark Benthien
*ECA Executive Director,
Statewide California Earthquake Center*

Earthquake Country Alliance

- 4000+ *Public-Private-Grassroots* leaders
- Subject matter expert *Committees* develop resources and programs
- *Regional Alliances* organize meetings and outreach activities
- California's Office of Emergency Services provides FEMA NEHRP funding for ECA earthquake mitigation activities
- USC's Statewide California Earthquake Center (SCEC.org) administers ECA



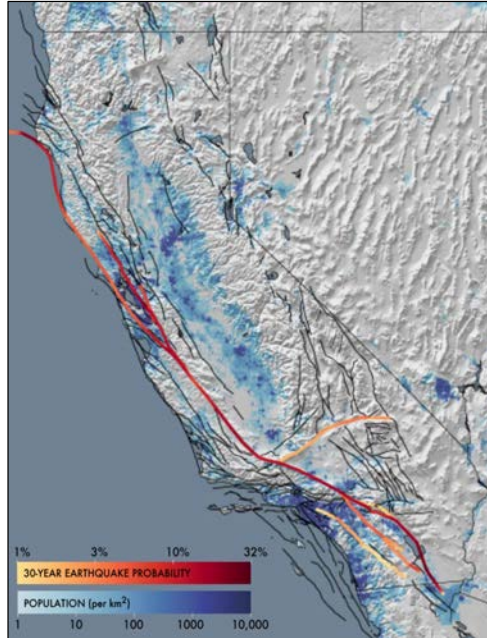
Join: EarthquakeCountry.org/join





Statewide California Earthquake Center

SCEC is a collaborative research and education hub headquartered at USC that brings together a global network of experts across geoscience and related fields to advance the understanding of earthquake processes and apply that knowledge to reduce their impacts on society in California and beyond.



Community

SCEC is a consortium of more than seventy institutions and over a thousand individuals. Leadership teams guide our programs and collaborations to fulfill the Center's mission.

Mission

SCEC develops and shares cutting-edge earthquake system science to enhance California's resilience and to educate and inspire future scientists.

Vision

SCEC provides comprehensive, validated models of earthquake processes that inform mitigation and educational approaches to greatly reduce earthquake losses.



ECA Statewide Activities

Develop Messaging and Resources:
EarthquakeCountry.org
EarthquakeCountry.org/resources
Terremotos.org



Support Tsunami Preparedness Week:
TsunamiZone.org/california



**March
22-30,
2025**

Created and Coordinate
The Great California ShakeOut:
ShakeOut.org/california



**Oct. 16,
2025**

Webinars & other events
EarthquakeCountry.org/calendar



ECA Regional Alliances

- Quarterly workshops (each with SCEC scientists) - online or in-person
- Speakers/event tabling
- Regional coordination among public, private, and grassroots organizations



View Past Workshops and more:
EarthquakeCountry.org/alliance



ECA SoCal Coordinating Committee

Coordinating Committee Chairs:

Heidi Rosofsky (Global Vision)
Margaret Vinci (Caltech)
Alan Hanson (Simpson Strong-Tie)

Media Bureau Coordinators:

Mimi Teller (LA Red Cross)

Participation Bureau Coordinator:
Management)

Pei Lee (Orange County Emergency
Also positions for each county

Events Bureau Coordinators:

John Hammett & Lance Webster (Volunteers)

ShakeOut Events Coordinator:

Pauline Louie (EPA)

Communications Coordinator:

Open position

Quarterly Workshops Coordinator:

Open position

Membership Coordinator:

Open position

SCEC Regional Liaison for ECA SoCal:

Vanessa Nava (USC/SCEC)

EarthquakeCountry.org/socal

socal@earthquakecountry.org

ECA SoCal Summer 2024 Workshop

Welcome from the ECA SoCal Chairs
Alan Hanson (Simpson Strong-Tie, retired)
Margaret Vinci (Caltech)

2019 Ridgecrest Earthquake Sequence: Scientific Response
Brian Olson (Senior Engineering Geologist, Seismic Hazards Program, California Geological Survey)

2019 Ridgecrest Earthquake Sequence: Engineering Response
Kenneth O'Dell, S.E. (MHP Structural Engineers)

2019 Ridgecrest Earthquake Sequence: Emergency Services Response in Trona
Klasha Ray (Emergency Services Officer, San Bernardino County Office of Emergency Services)

Quake Break
Margaret Vinci (Caltech/ShakeAlert)

Special Screening of Quake Heroes Film

ECA 2024 Activities & Opportunities:
Mini Awards Update; Materials Order Form; Quake Heroes Expos
Mark Benthien (SCEC/ECA)

Open Discussion, Sharing, and Networking

Co-Chairs, ECA Central Coast

Anthony Rodriguez

Operations and Disaster Services Specialist
Foodbank of Santa Barbara County

Stacy Silva

Emergency Manager
Santa Barbara County Office of Emergency Management

EarthquakeCountry.org/centralcoast

ECA Bay Area Coordinating Committee

- Coordinating Committee Chairs: **Jeff Airth**, SFO International Airport
Ray Bonilla, Elevance Health & City of Hayward City Council
Dena Gunning, Central County Fire Dept. (San Mateo County)
 - Communications Coordinator: **Susan Garcia**, USGS
 - Events Bureau Coordinators: **Chief David Cosgrave**, San Mateo County Dept. of Emgcy. Svs.
Kacey Treadway, Santa Clara County Ofc. of Emgcy. Mgmt.
 - Media Bureau Coordinator: **Open Position**
 - Membership Coordinator: **Wendi Ellis**, US Department of Health and Human Services
 - Participation Bureau Coordinator: **Theresa Langdon**, Alameda County Office of Emergency Services
 - Regional Workshops Coordinator: **Jeff Airth**, SFO International Airport
- SCEC Liaison for ECA Bay Area: **Mark Benthien (ECA/SCEC)**
bayarea@earthquakecountry.org

EarthquakeCountry.org/bayarea

L1

ECA Bay Area Summer 2024 Workshop

Welcome & Self-Introductions

Overview of the Science of the 2014 South Napa Earthquake and the Faults of the Napa Valley
Prof. Mike Oskin (UC Davis)

Improvements to Tracking Damage Assessments for Recovery after the 2014 South Napa Earthquake

Matt Lamborn (Napa County GIS Departmental Coordinator) and
Jim Reeves (Napa County Field Inspection Supervisor)

Wine Barrel Storage Losses and Lessons Learned from the 2014 South Napa Earthquake
Mike Blom (Wine Consultant)

Break

Quake Heroes- Film & Opportunities for Events

ECA 2024 Activities & Opportunities, Loma Prieta 35th, ShakeOut, etc.
Mark Benthien (ECA Exec. Director / Statewide California Earthquake Center)

Announcements by Participants & Open Discussion
Activities/events, new resources, recommended trainings, etc.

L2

Redwood Coast Tsunami Work Group ECA Reps.

Ryan Aylward

National Weather Service

Amanda Admire

Cal Poly Humboldt

rctwg.humboldt.edu

L3

ECA Sector-Based Outreach Committees

- | | |
|---|-------------------------|
| • Accessibility | Sue Fisher |
| • Businesses | Ines Pearce, PGP |
| • Healthcare | Mary Massey, CHA |
| • Higher Education | Steve Goldfarb, USC |
| • Non-Profit &
Faith-Based Organizations | Cheryl Nagy, SoCal VOAD |
| • PreK-12 Education | Open |
| • Public Sector | Open |

[**EarthquakeCountry.org/committees**](http://EarthquakeCountry.org/committees)

L4

ECA Partners at L.A. Abilities Expo



15

Seven Steps To Earthquake Safety

BEFORE

1. Secure Your Space



2. Plan To Be Safe



3. Organize Supplies



4. Minimize Financial Hardship



5. Drop, Cover, and Hold On



6. Improve Safety



AFTER

7. Reconnect and Restore



EarthquakeCountry.org/sevensteps

Terremotos.org/sietepasos

16

ECA Event Outreach



19

Your Action Plan for the Seven Steps



EarthquakeCountry.org/languages

20

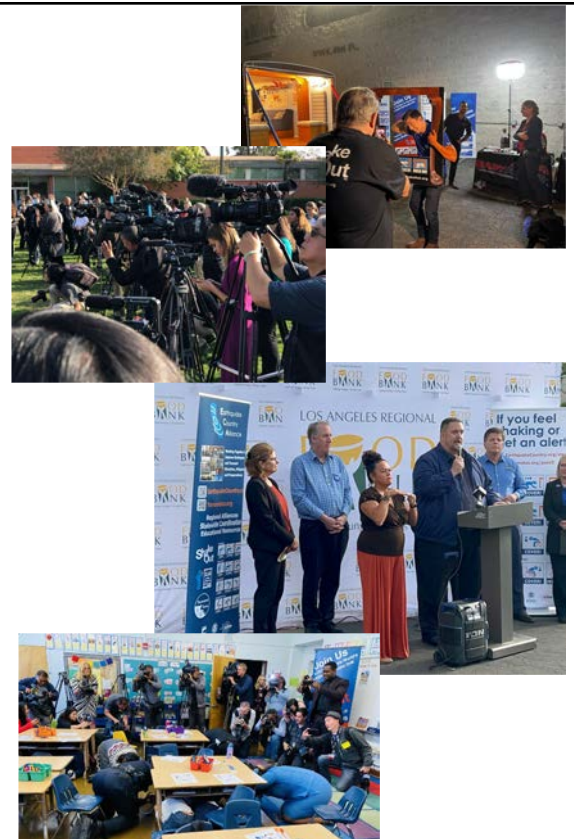
Great ShakeOut Earthquake Drills

- Annual opportunity for schools, organizations, and families to practice earthquake safety and other aspects of their emergency plans
- 2024 International ShakeOut Day: **October 17**
- Learn more and register: ShakeOut.org
- **10.6 million** registered in 2024!
- How to participate, guides, etc.: ShakeOut.org/howtoparticipate



ShakeOut Day Media Events

- Every year ECA organizes a primary major media event in the Southern California and the San Francisco Bay Area
- Each event highlights an organization's exercise/drill:
 - 2024 – SoCal Edison & UC Berkeley
 - 2023 – Los Angeles Region Food Bank
 - Previous: Natural History Museum, LA City Hall, Several elementary schools, a Target store, Biola University, California Science Center, USC,
- Ready America provides their "Big Shaker" earthquake simulator for news interviews which begin before 5am
- Partner agencies staff information booths for additional interviews
- Local, State, and Federal reps speak at press conference



Q&A

To be notified of future events and recordings, join ECA (free!):

EarthquakeCountry.org/join

Please take our survey:

SurveyMonkey.com/r/T2JXLDV

Questions?

info@earthquakecountry.org

23

Opportunities for free materials, trainings, and retrofit funding

24

Secure Your Space Online Training

- This online training workshop provides basic understanding and skills for how to reduce damage or injuries by *properly [securing your space](#)* (at home or work)
- December 12, 1-3pm
- Instructors: Glen Granholm (Earthquake Counseling) & Trevyn Reese, ReadyAmerica
- Learn more and register: EarthquakeCountry.org/sysdec24



27

Share the Gift of Earthquake Safety

Have you “secured your space” for earthquakes?
Have your family, friends, and colleagues?

It’s the season of giving, and helping those you care about be safer before, during and after earthquakes is a great way to show you care.

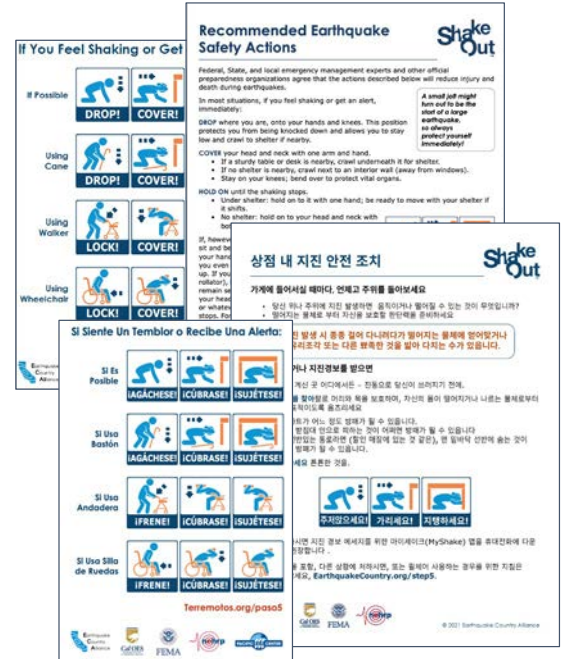
Visit EarthquakeCountry.org/giftofsafety to receive 25-30% discounts on earthquake safety fasteners for furniture, TVs, and other items, plus other emergency supplies!



28

Printed Materials Ordering Process

- Cal OES NEHRP funding now supporting printing & shipping of ECA materials to local governments, non-profits, and others (on approval)
- A new ordering form will be available this week (at EarthquakeCountry.org/resources)
- Request from many ECA printed materials
- Items will be printed and shipped to you for free
- Limits will apply per person/organization
- Intended for use at upcoming events (not to build a stockpile for general use)
- For larger quantities, purchases will be possible at discounted prices



29

Q&A

To be notified of future events and recordings, join ECA (free!):
EarthquakeCountry.org/join

Please take our survey:
SurveyMonkey.com/r/T2JXLDV

Questions?
info@earthquakecountry.org



Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES



FEMA

RESILIENT WORKPLACE WEBINARS

DISASTER RESISTANT BUSINESS (DRB) TOOLKIT



31

WEBINAR TAKE-AWAYS

1. Step-by-step process to prioritize your operations

a. The Disaster Resistant Business (DRB) Toolkit

- Simple interactive design
- Easy step-by-step process with tools & videos
- No disaster experience needed

b. DRB Guide

- New mobile tool**
- Recovery Blueprint



❖ *All in English/Spanish/Chinese/Tagalog*

2. Connection to local partner resources & networks

- Can assist daily or in emergencies

32

Disaster Resistant Business | Toolkit

VIEW/PRINT EXPORT ACTION ITEMS CALENDAR HELP

Your Plan

- Home
- Introduction
- Progress
- 1 Getting Started
- 2 Identifying Your Business Environment
- 3 Identifying Your Risks & Assessing Your Vulnerabilities
- 4 Defining Your Goals, Objectives, Actions & Strategies
- 5 Defining Pre-Emergency Procedures
- 6 Defining During-Event Procedures
- 7 Defining Post-Event Procedures
- 8 Testing Your Plan
- 9 Moving Your Plan to a Program and Updating
- Glossary
- Acknowledgements

Disaster Resistant Business Toolkit

9% Complete

Estimated time to complete: 6.76 Hours (total plan)

Get Started

33

New Mobile Tool

nt.drtoolkit.org

DRB Toolkit English

Welcome to the Disaster Resistant Guide

Please join us on our walk through the steps and key tips to help you become a disaster resilient business. Answer a few questions and in less than 15 minutes you'll determine the value of preparing and your priorities to recover. When finished, print and share your own Workplace Recovery Blueprint & Resilient Workplace Declaration documents!

Estimated Time: 15 minutes

Get Started

Survive And Thrive
Make your workplace safer

Upgrade to the Full DRB Toolkit

Completed this Disaster Resistant Guide? Now create an account and upgrade to your full Toolkit. Get access to customize your preparedness solutions with easy business.

4 / 7

What Concerns you most?
Please select the disruption that concern you most?

- Earthquake
- Fire
- Flood

Back Continue

3 / 7

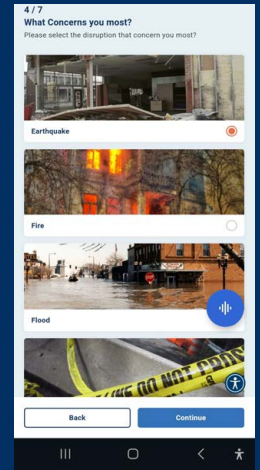
Confidence
How confident do you feel in the current practice you have in place to help make your workplace resilient to disaster?

- Not Confident
- Slightly Confident
- Not Sure
- Confident
- Very Confident

Back Continue

34

YOUR DRB TOOLKIT® & SUITE



www.DRBToolkit.org

35

Help Spread the words to your local
Businesses & Non-Profits:

www.DRBToolkit.org/2024webinars

bit.ly/DRBwebinars

36

PICK ONE:

Dec. 3
1– 2:30pm

Dec. 11
1– 2:30pm

Dec. 12
10– 11:30am

Dec. 17
10– 11:30am

Click Here to Register Today!

Or visit
bit.ly/DRBwebinars
More info?
stacey@DRBToolkit.org
877-563-5628

**Use our free tools to
SURVIVE & THRIVE
after any disaster.**

Join us for a **FREE** Resilient Workplace Webinar.

Learn how to

1. reduce your potential disaster losses (from earthquake to power outage)
2. **keep your doors open** when disasters strike
3. prioritize your operations to make better strategic decisions in a crisis

Become a Disaster Resistant Business (DRB) by following an easy, interactive, step-by-step Toolkit & **NEW MOBILE TOOL** to ensure you can survive and thrive without any interruptions. No experience necessary. Invite your team to plan your resilience together.

PRESENTED BY



Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES



FEMA

REGISTER TODAY!



HayWired Scenario
**EXERCISE
TOOLKIT**

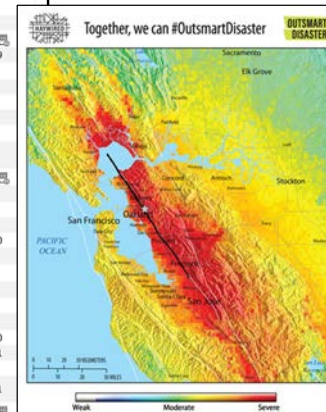
A **guide** for creating discussion-based exercises using the HayWired **Earthquake Scenario**



Exercise Themes & Ideas

- The Scenario is a comprehensive assessment of the impacts of a M7 earthquake on the Hayward fault
- The Toolkit identifies **30 Themes** addressed in the Scenario, spanning **45 ideas** for discussion-based exercises, organized within each emergency management phase.
- **17 Facilitator Tools** have been developed based on the suggested ideas (3 more soon)

	Planning and Preparedness	Response	Recovery	Mitigation
Access to Data & Information		29		39
Accounting for Employees		29		
Aftershocks & Fault Afterslips			35	
Alternate Locations	23		36	
Building Content				39
Clean-up				39
Communications & Internet	23 & 24	29 & 30		
Customer Base			36	
Economic Impact			36	
Elevators		31		
Employee Commutes and Residences	24			
Employee Retention & Staffing Shortage		31	37	
Fires After the Earthquake				40
Fuel (Gasoline and Diesel)	24	31		
Generators	25			
Insurance			37	
Lifeline Infrastructure in Fault Zones				40
Mail Package Delivery		32		
Mental Wellbeing			37	
Natural Gas	25	32		
Payroll	26			
Power (Electricity)	26	33	38	
ShakeAlert®	26			40
Shutting Off Utilities				41
Slow Return to Normal			38	
Structural & Non-Structural Building Damages				41
Supply Chain Movement of Goods	27			41
Water	27	33 & 34		
Wastewater Sewer	27	34		
Working Remotely	28			



39

Facilitator Tools

- Each set of *Facilitator Tools* includes:
 - *Discussion Guide*
 - Suggested exercise objectives
 - Recommended participants
 - Discussion questions to select from
 - Locations of relevant data in the Reports
 - *Imagery Slideset*
 - Relevant maps, charts, and tables
- Facilitators can follow closely, or use as inspiration for their exercises



40

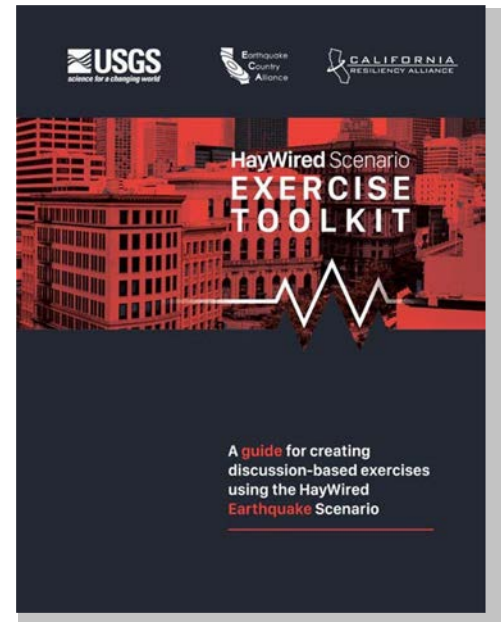
Download and Learn More

- All materials are available at EarthquakeCountry.org/haywired

- **2024-2025 Trainings and Outreach:**

We have support for several local workshops through June 2025. Email benthien@usc.edu if you can host a workshop or know someone who may be interested.

Ideal audiences: Businesses, business associations, non-profits, government agencies, and others looking to improve planning and resilience.



11

Q&A

To be notified of future events and recordings, join ECA (free!):
EarthquakeCountry.org/join

Please take our survey:
SurveyMonkey.com/r/T2JXLDV

Questions?
info@earthquakecountry.org

12

Mitigation: A Culture of Earthquake Resilience



Park Boulevard Historic District, San Diego, CA

JANIELE MAFFEI, S.E.
CHIEF MITIGATION OFFICER

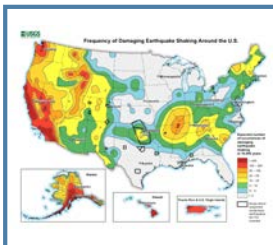
December 6, 2024



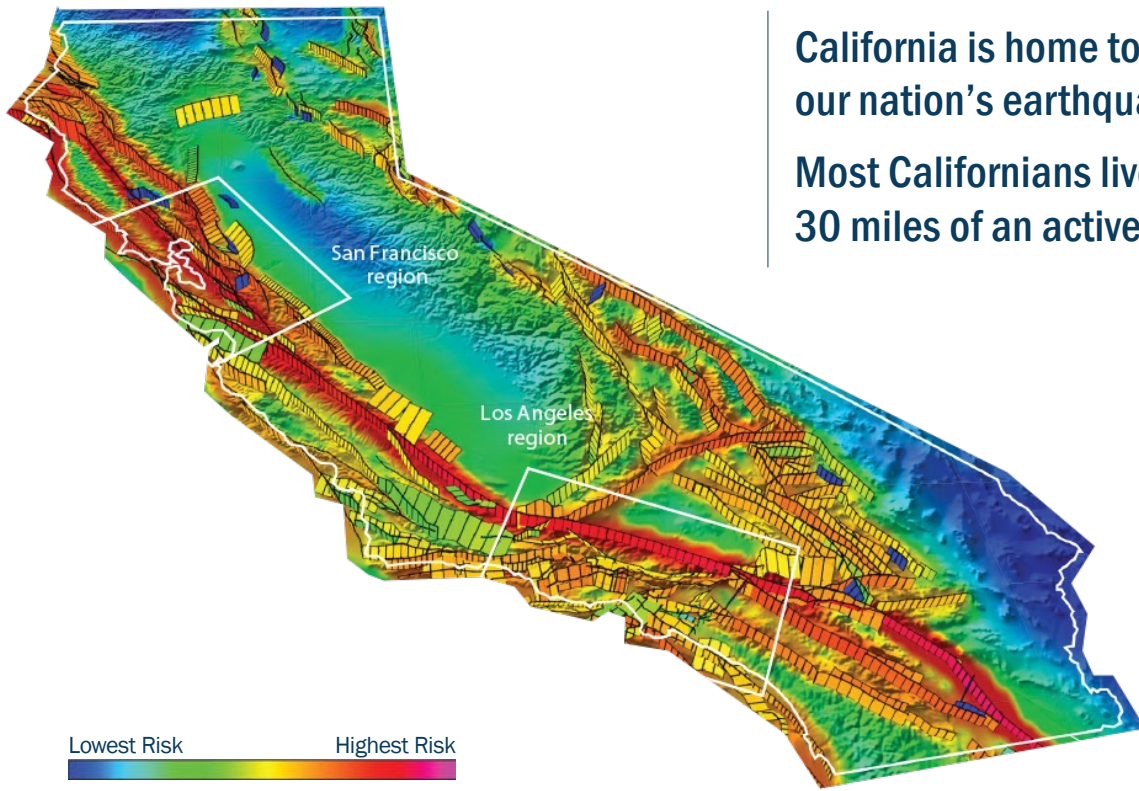
13

Things to Know About Earthquake Risk

RISK = HAZARD + VULNERABILITY + EXPOSURE



14



California is home to two-thirds of our nation's earthquake risk.
Most Californians live within 30 miles of an active fault.

ICC East Bay, November 12, 2024

45

15

California Earthquake Authority

CEA is a not-for-profit residential earthquake insurer.

ICC East Bay, November 12, 2024

46

16



CALIFORNIA: MANDATORY OFFER LAW

Earthquake coverage is excluded from homeowner's insurance policy.

However, insurance companies are required to offer a separate earthquake insurance policy at time of homeowner policy sale.

ICC East Bay, November 12, 2024

47

17



WHEN M6.7 NORTHRIDGE EARTHQUAKE STRUCK IN 1994:

- One of the costliest natural disasters in U.S. history.
- Caused **\$20 billion** in residential damage.
- Destroyed or severely damaged thousands of single-family homes.
- Left about 22,000 people homeless.
- Most insurance companies stopped writing Homeowners insurance; prompted creation of CEA.

ICC East Bay, November 12, 2024

48

18

Publicly Managed • Privately Financed

A not-for-profit provider of residential earthquake insurance

Governing Board:

Governor
Insurance Commissioner
State Treasurer



Governor
Gavin Newsom



Insurance
Commissioner
Ricardo Lara



State Treasurer
Fiona Ma

Non Voting:

Assembly Speaker
Senate Rules Chair



Assembly Speaker
Robert Rivas



Senate Rules
Chair
Mike McGuire

Privately Financed:

1,132,605 Policyholders

Mission:

Educate
Mitigate
Insure

ICC East Bay, November 12, 2024

49

19

CEA Participating Insurers

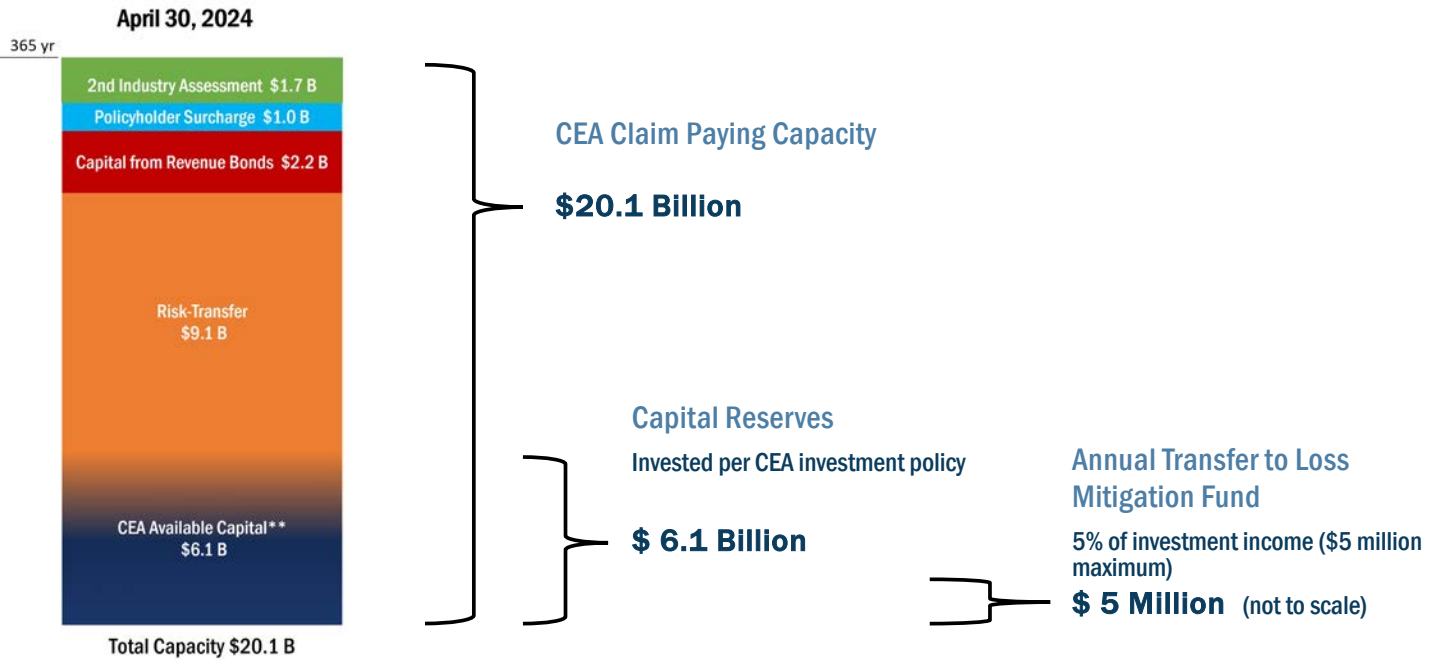


ICC East Bay, November 12, 2024

50

50

CEA Insurance Claim Paying Capacity and Mitigation Funding



ICC East Bay, November 12, 2024

51

CEA Mitigation

Standards • Research • Incentives

ICC East Bay, November 12, 2024

52

52

FEMA P-1100 Pre-Standard – Earthquake Vulnerabilities

CRMP Grant Programs Available



ICC East Bay, November 12, 2024

53

53

Crawlspace Walls and Unbraced Water Heater Vulnerability

2014 M6.0 South Napa Earthquake



ICC East Bay, November 12, 2024

54

54

Mitigation Research – Quantification of Savings for Retrofitted House

PEER Cripple Wall Damage Project (2020)

How Much Could I Save In “The Big One” If I Retrofit My House*?

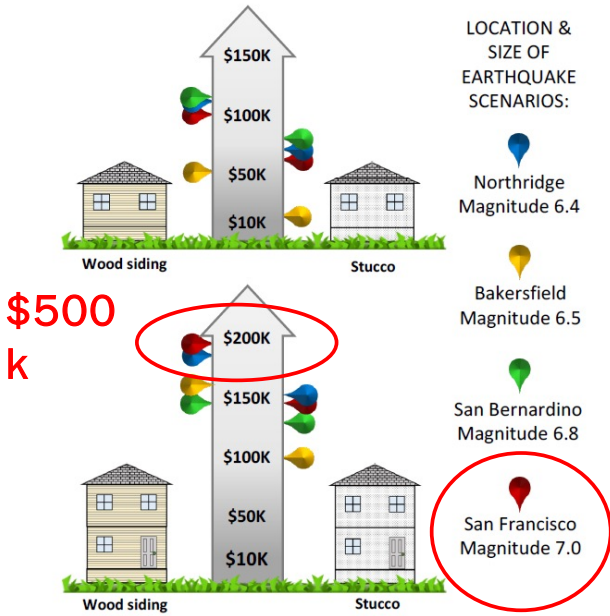


Figure 1. Estimated average savings for four generic house types in four scenario earthquakes.

*Note: Savings are average repair costs avoided in thousands of 2019 US dollars. Values assume a one-story 1,200 sq.ft. house (UPPER) and a two-story 2,400 sq.ft. house (LOWER), at a construction cost of \$200 per sq.ft. Potential savings depend on the actual size, age, location, and configuration of the house, the quality, and types of construction materials, the intensity of earthquake shaking, and regional construction market conditions.

M 7.0 Scenario Earthquake in SF: Retrofitted two-story house with wood siding would have \$200,000 less damage (based on \$200/SF replacement cost) X 2.5

ICC East Bay, November 12, 2024

55

55

Mitigation Incentive Programs

CEA jointly manages the California Residential Mitigation Program (CRMP) with Cal OES through a Joint Powers Agreement (JPA).

ICC East Bay, November 12, 2024

56

56

CRMP Single-Family Crawlspace Retrofit Grant Programs



Funded by \$84m FEMA HMGP grants
Open to owner-occupied houses in select ZIP Codes

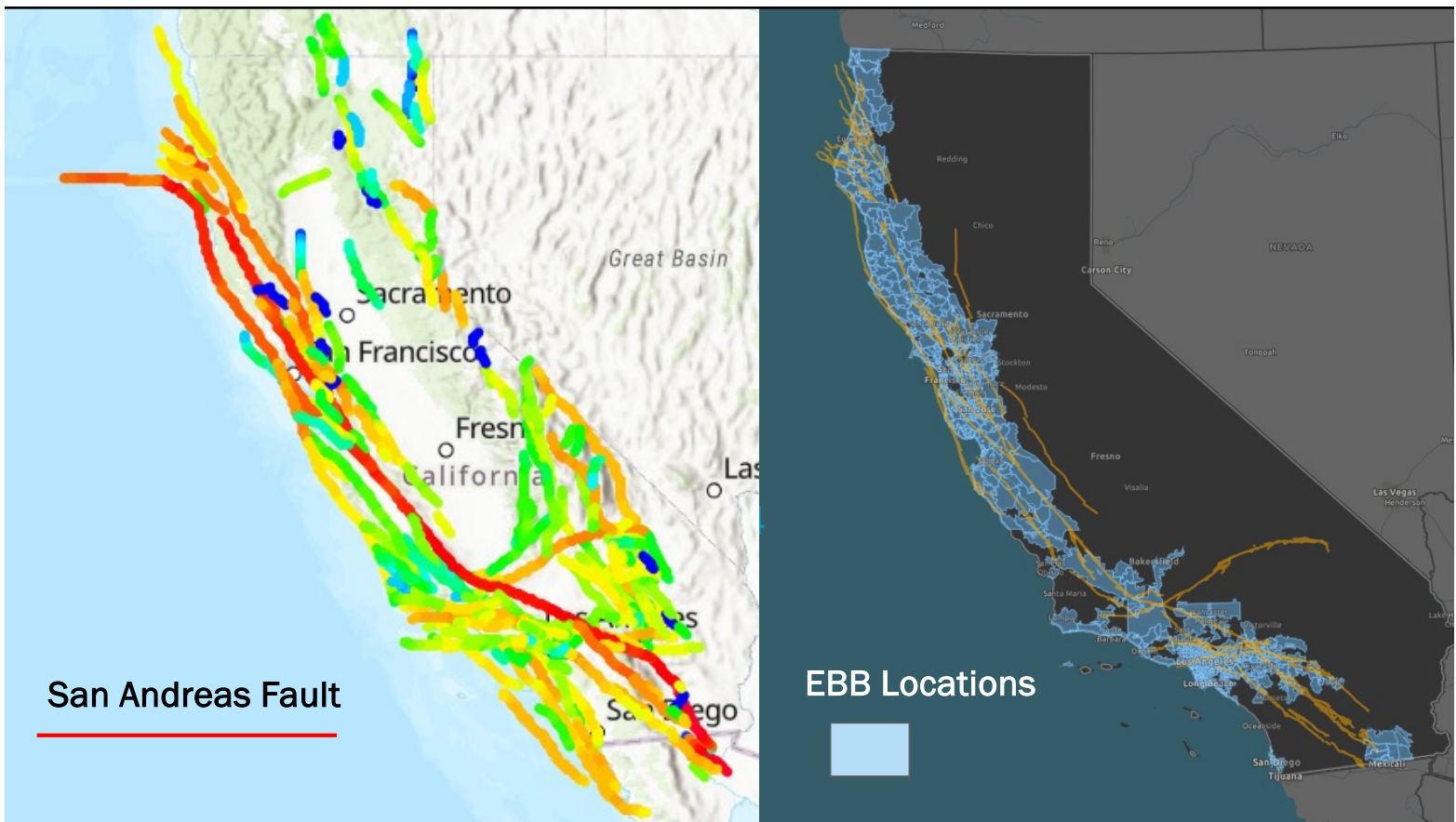


Funded by CEA
Open to policyholders in select ZIP Codes

ICC East Bay, November 12, 2024

57

57



58

Earthquake Brace + Bolt Retrofit - EBB

California Residential Mitigation Program Retrofit Grants - Earthquake Brace + Bolt



Earthquake Brace + Bolt Program:

- Retrofits crawlspace with plywood bracing and new bolting
- Provides up to \$3,000 grant
- Currently requires owner-occupied
- In select ZIP Codes with high seismic hazard
- Has collected **important data**:
 - Retrofit averages \$5,200 in CA
 - More expensive in Northern CA
 - Number of retrofitted houses in a City

REGISTRATION OPENS JANUARY 2025

ICC East Bay, November 12, 2024

59

59

EBB Program includes supplementary grants for income qualifying households.

The supplementary grant:

- Will provide, in most cases, 100% OF THE FUNDS needed
- Offered in all EBB ZIP Codes



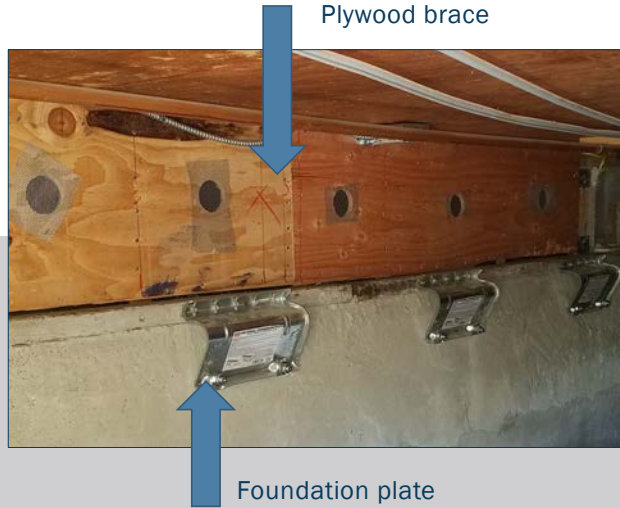
50

Earthquake Brace + Bolt

Short Cripple Wall Requires Framing Clips, Foundation Plates, and Plywood



Crawlspace Before Retrofit



Crawlspace After Retrofit

ICC East Bay, November 12, 2024

61

51

CRMP Single-Family Retrofit Grant Programs

EBB, CEA BB, and ESS



Funded by \$5m FEMA HMGP grants
Registration re-opens October 15, 2024

ICC East Bay, November 12, 2024

62

52

Earthquake Soft-Story (ESS)

Living-Space-Over-Garage (Soft-Story) Found in Pre-2000 Houses



1971 San Fernando EQ



1989 Loma Prieta EQ



1994 Northridge EQ



2014 Napa EQ

ICC East Bay, November 12, 2024

63

53

Earthquake Soft-Story (ESS)

Adding the earthquake protections found in new houses



Plywood or OSB on first-floor walls

New steel shear walls either side of garage door opening

ICC East Bay, November 12, 2024

64

54



Funded by \$40m FEMA BRIC grants

Multi-Family Soft-Story Retrofit Program



Photo credits: LA Times

Northridge Meadows Apartments – Northridge M6.7 Earthquake 1994

Multi-Family Soft-Story Retrofit Program



Photo credit: Janiele Marfei

Steel frame around garage door opening

ICC East Bay, November 12, 2024

67

57

2014 M 6.0 Napa Earthquake



Unretrofitted - Red Tagged

Retrofitted - Green Tagged

ICC East Bay, November 12, 2024

68

58

2022 M 6.4 and 2023 M 5.4 Ferndale Earthquakes



Unretrofitted - Red Tagged

Retrofitted - Green Tagged

ICC East Bay, November 12, 2024

59

Thank You.

CaliforniaResidentialMitigationProgram.com

Earthquakebraceandbolt.com

EarthquakeSoftStory.com



70

Q&A

To be notified of future events and recordings, join ECA (free!):
EarthquakeCountry.org/join

Please take our survey:
SurveyMonkey.com/r/T2JXLDV

Questions?
info@earthquakecountry.org

71



California Earthquake Country Alliance
December 4, 2024

2004 Indian Ocean Tsunami 20th Anniversary: Lessons learned and implications for California

Dr. Laura Kong

Director
International Tsunami Information Centre (ITIC)

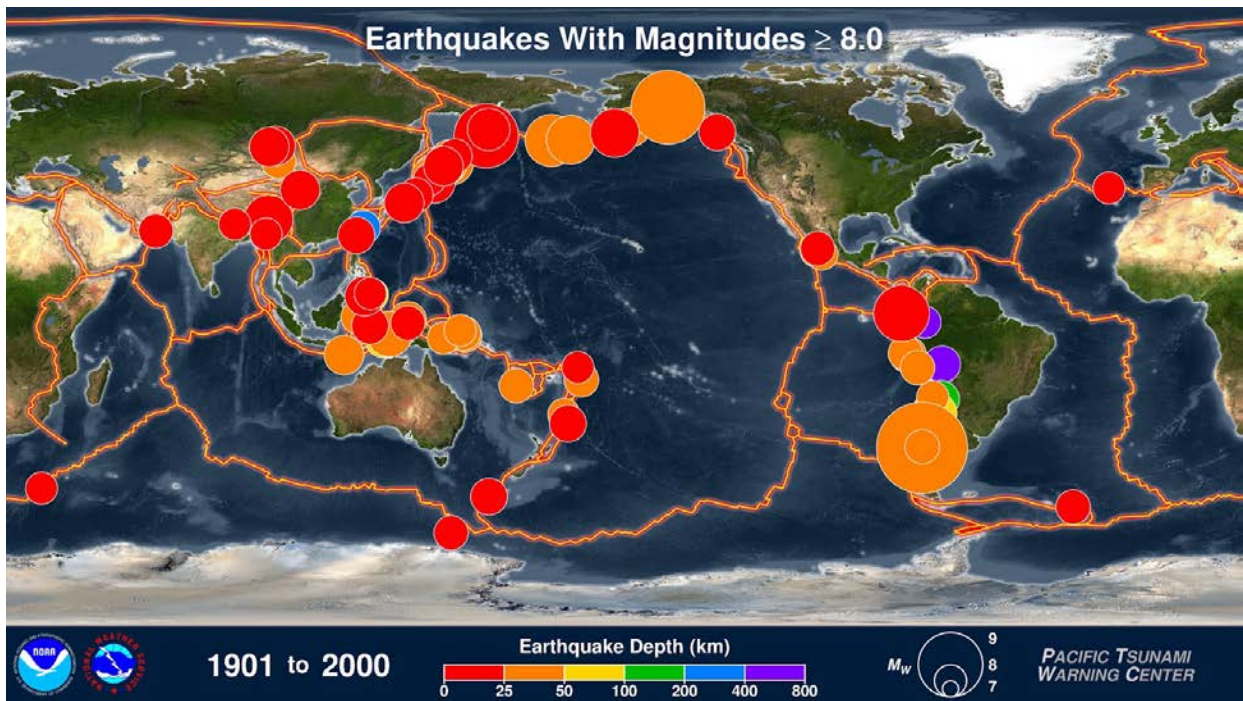


UNESCO/IOC-NOAA SHOA
International Tsunami Information Center



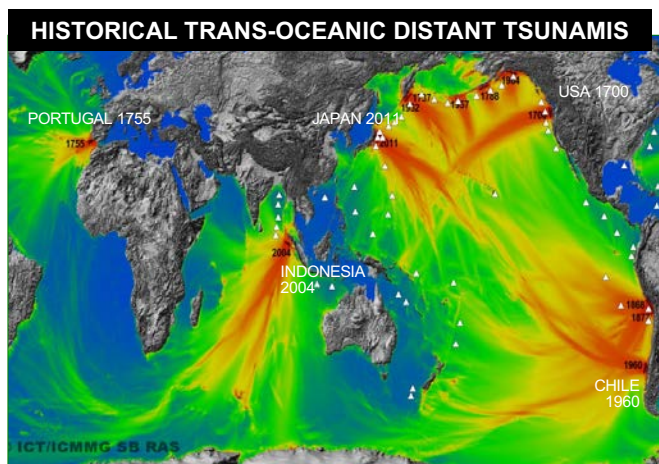
72

FACT 1: Dangerous Earthquakes & Tsunamis



73

FACT 2: Deadly Tsunamis – Distant to Local



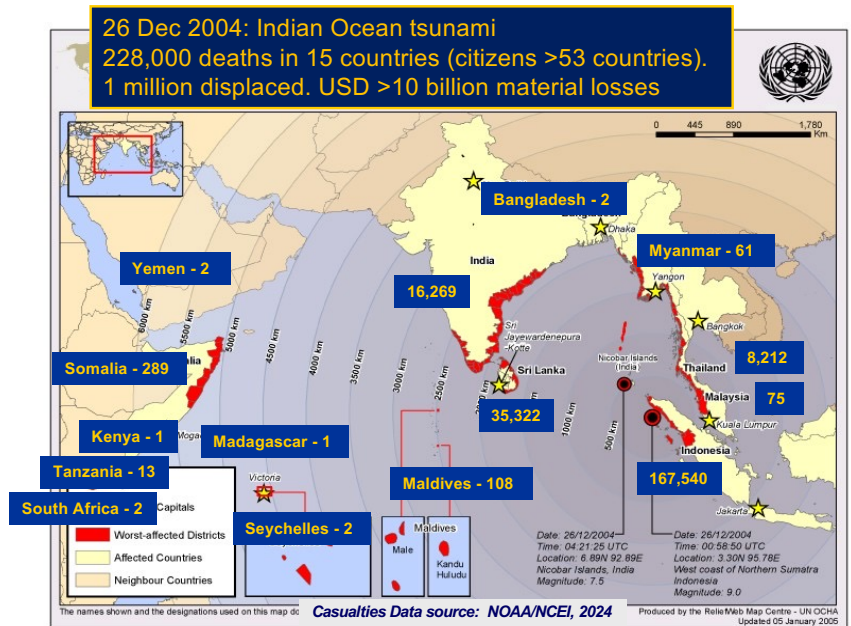
- ❑ 80% caused by earthquakes
- ❑ Most local (< 1 hr) or regional (1-3 hrs). Globally cause 90% of deaths
- ❑ But great earthquakes destroy everywhere – across basins



74

Fact 3: Tsunamis are apolitical

- ❑ **DANGER CONTINUES FOR MANY HOURS**
- ❑ **HIGH FATALITY HAZARD**
- ❑ **GLOBAL IMPACT – blind to political boundaries**
 - *Locally, arrives in minutes*
 - *Distant, travels hours across ocean basin*



hard copy: email itic.tsunami@noaa.gov, digital at <https://www.ncei.noaa.gov/products/natural-hazards/tsunamis-earthquakes-volcanoes/tsunamis/posters>

Historical Effects from 2004 Indian Ocean Tsunami

- ❑ **Up to 50.9 m runup in Banda Aceh, 1-2 m sea-level gauges** (Sri Lanka, India, Seychelles, Oman, South Africa, Indonesia, Thailand, Maldives, but none available in real-time for tsunami warning)
- ❑ **Measured in Atlantic and Pacific**
- ❑ **Rupture length 1200+ km, Avg fault displacement 10–15 m (up to 20 m).**

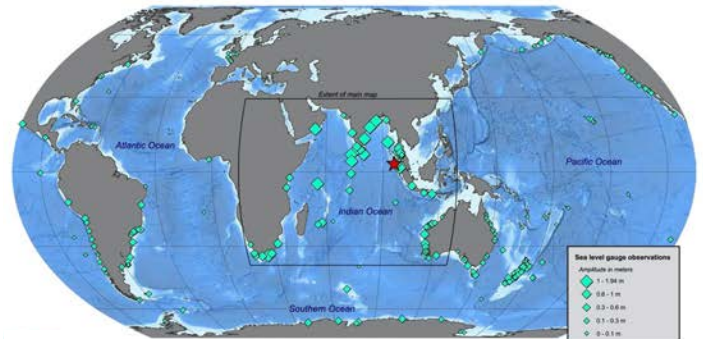
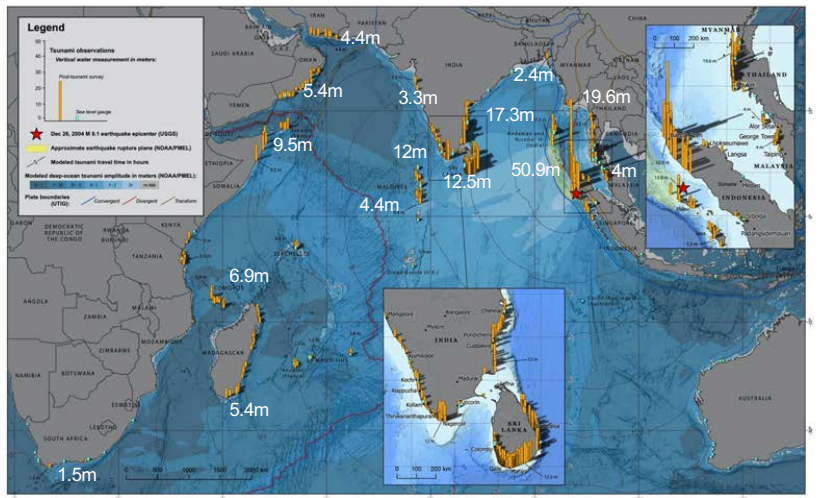


Table 2. Tsunami Height Observations

	Local*		Distant**	
	Number of Observations	Maximum Height (Location)	Number of Observations	Maximum Height (Location)
Sea Level Gauge*	220	1.9 m (Colombo, Sri Lanka)	210	1.9 m (Colombo, Sri Lanka)
Post-tsunami survey*	1,939	50.9 m (Banda, Indonesia)	784	12.5 m (Vello, Sri Lanka)

*Observation >100 km from the rupture epicenter
 **Observation >1000 km from the rupture epicenter
 *Half of the maximum height (minus the normal tide of a tsunami was recorded at the coast by a sea level gauge. Also called the surge.
 **Runup

2004 Sumatra earthquake

Energy Release imaged by Japan HINET Array

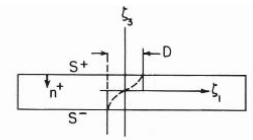
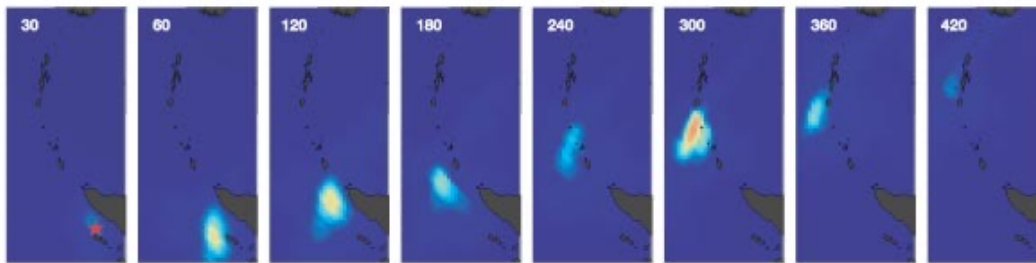
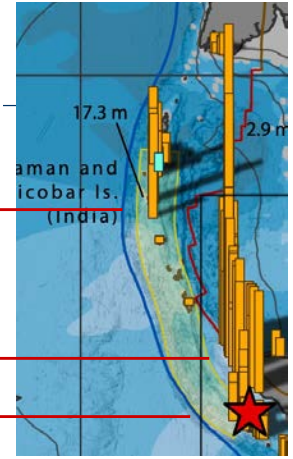
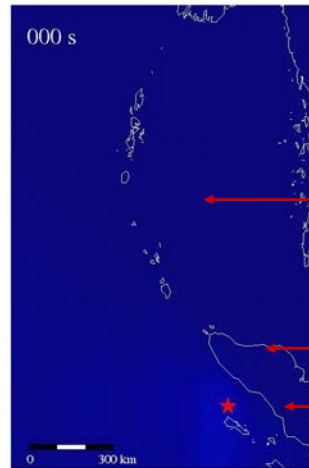
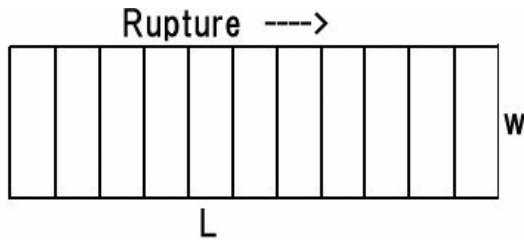


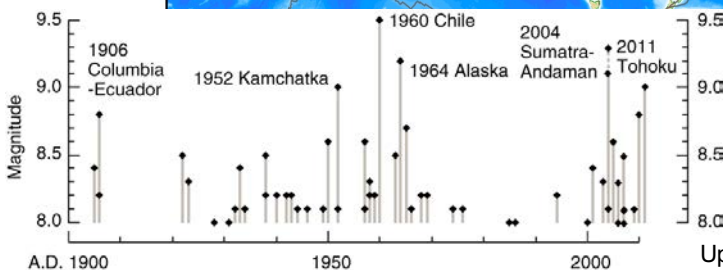
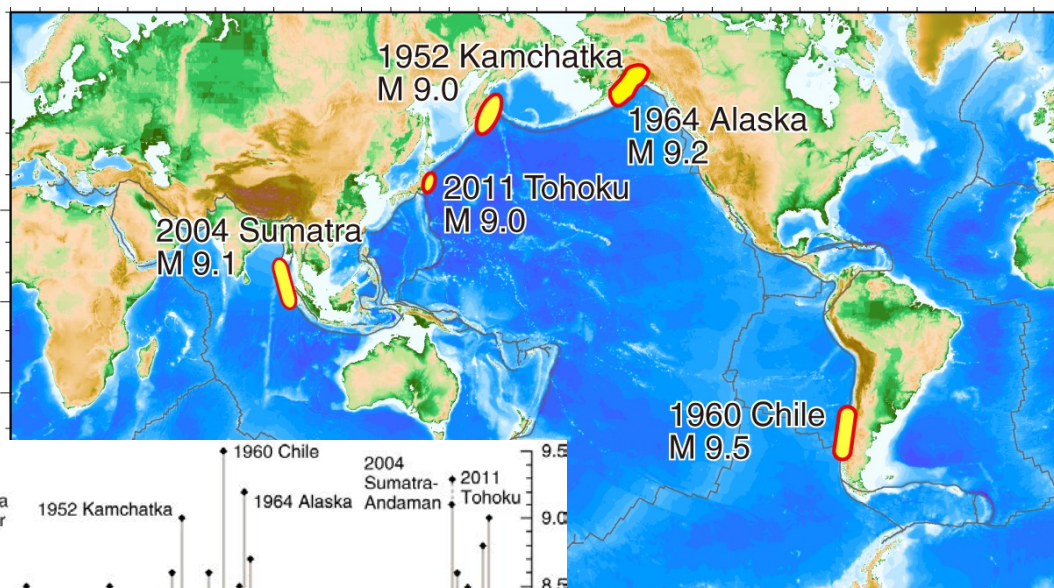
FIG. 1. Cross section of source region.

Ishii et al., 2005

Haskell Line Source, Dislocation Source (Haskell, 1964)

77

M9+ earthquakes since 20th century



Updated Satake and Atwater (2007, Ann. Rev. Earth Planet. Sci.)

78

Giant earthquakes in the world

South America (Chile)

1960: M 9.2-9.5 avg interval (fr paleoseismology) ~ 300 yrs

North America (Cascadia)

1700: M ~9.2 avg interval (fr paleoseismology) ~ 500 yrs

Southern Kuril Trench

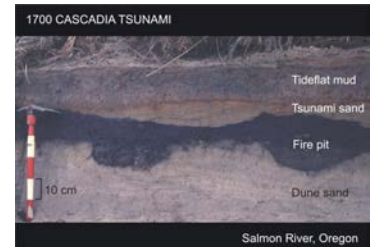
17th cent: Mw ~ 8.8 avg interval (fr paleoseismology) ~ 400 yrs

Japan Trench

2011: Mw 9.0. avg interval (fr hist seismology) ~ 500 yrs

Southeast Asia (Sumatra-Andaman)

2004: M 9.1-3 recurrence interval ~ a few 100 to 1000 yrs



Tsunami deposits - Thailand



Sheet A: 2004 tsunami deposit
Sheet B: 550- 700 years BP

UNESCO/IOC-NOAA SHOA
International Tsunami Information Center

79

“We cannot stop natural calamities, but we can and must better equip individuals and communities to withstand them.”

“Should disaster strike again, and it will in some part of the world, we must be able to say that we did everything humanly possible to build resilient societies.”



Kofi Annan, UN Secretary-General, 2005



Waves crushed structures, jammed boats into bridges, and flooded rivers with debris. Banda Aceh, Indonesia. Credit: Badan Anp Dasaah Aceh



Waves derailed and overturned 8-car train, killing ~1700. Peratiya, Sri Lanka. Credit: Sena Visanagema



Air Force building, Car Nicobar Island, India. Credit: Disaster Management, Andaman & Nicobar Islands



Khao Lak, Thailand. Credit: Khao Lak Ausflüge



Malé, Maldives. Credit: Sofwathulla Mohamed



Tsunami runup and inundation, Banda Aceh, Indonesia October 2004. Credit: Yuichi Nishimura

30

nature

6 January 2005 Volume 433 Issue no 7021

A divided world

The lack of preparation for last month's tsunami illustrates shocking disparities in how science is applied in different regions of the world. The global response to the disaster offers a glimmer of hope that these disparities will be addressed.

As the full horror of the Asian tsunami sinks in, the reactions of scientists echo those of the population as a whole. These range from a sense of hopelessness in the face of nature's power to concern for the victims and a determination that their suffering should be addressed.

The Indian Ocean tsunami of 26 December 2004 occurred at about 01:00 GMT, when the Indian tectonic plate moved underneath the neighbouring Burma microplate, raising it by about 10 metres along a length of more than 1,000 km and sending a wave propagating through the full depth of the overlying ocean at high speed. With wavelengths much larger than the depth of the ocean, such waves propagate across the great distances of the open sea without much surface perturbation and with very little energy loss, until shallower coastal shelves slow the wave and increase its amplitude — resulting, in this case, in a calamity of biblical proportions.

Such disasters have always been with us, but this particular event (see News, pages 3–5) had some characteristics that cry out for a

A master plan prepared in 1999 by ITSU, one of the international organizations that plans for the monitoring of tsunamis, stated: "Tsunami hazards exist on both sides of the Atlantic Ocean, in the eastern Indian Ocean, and in the Mediterranean, Caribbean, and Black Seas. Efforts to establish warning centers in those areas should be encouraged."

An important reason for the previous confinement of monitoring systems to the Pacific has been the occurrence of two tsunamis in the Pacific quite recently, in 1960 and 1964. The last tsunami produced by an earthquake in the Indian Ocean is thought to have occurred back in 1833.

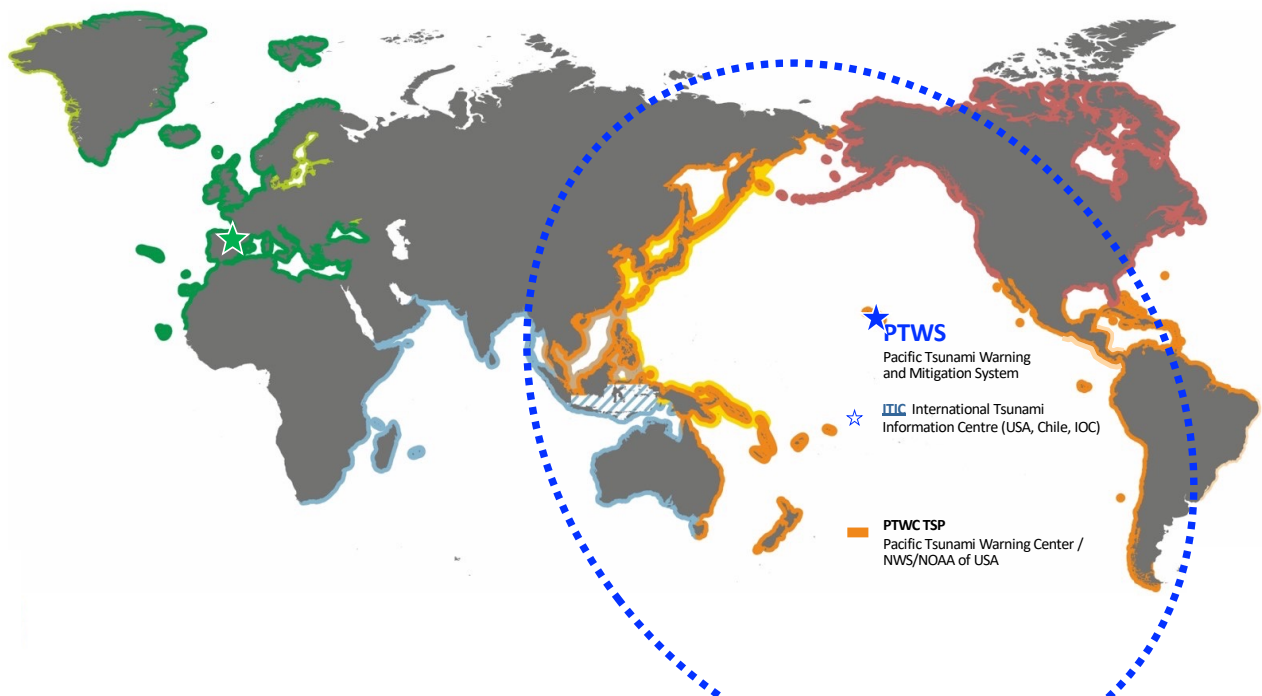
However, the most important differentiating factor has been the readiness of 'Pacific rim' nations such as Japan, Australia and the United States to support a cheap but potentially effective system for monitoring and for educating the public about an infrequent risk. India, Indonesia and the other nations on the Indian Ocean's rim are relatively poor countries with needs that seemed more pressing than

31

GLOBAL TSUNAMI WARNING AND MITIGATION SYSTEMS

Intergovernmental Oceanographic Commission of UNESCO
www.ioc-tsunami.org

1965-2004



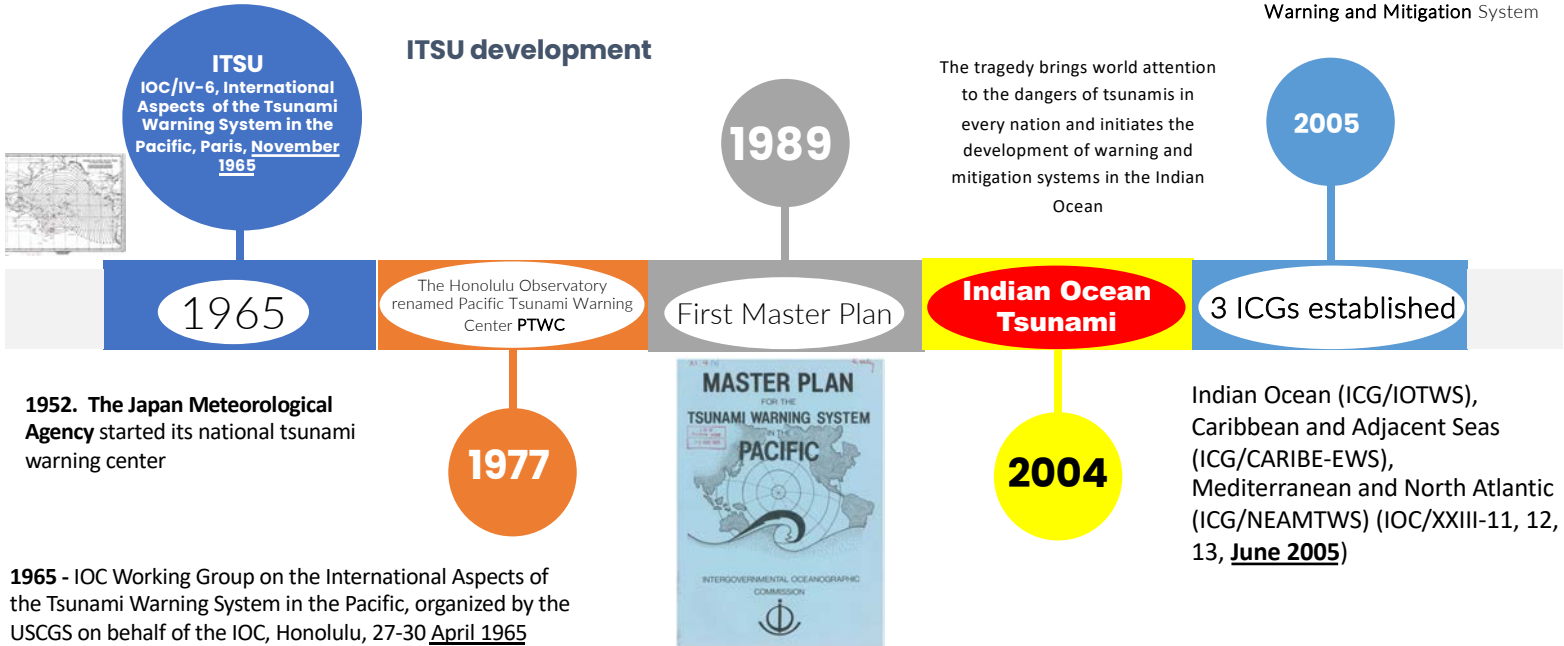
32

We have gone a long way...

ITSU renamed

September 2005, Vina del Mar, Chile
The 20th Session of the ICG/PTWS-XX decides to change its name to the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System

1948 the **Honolulu Magnetic Observatory**, under the US Coast and Geodetic Survey (USCGS) established

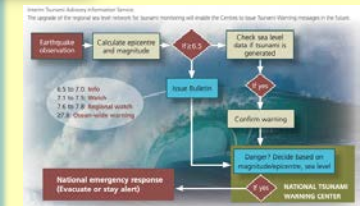
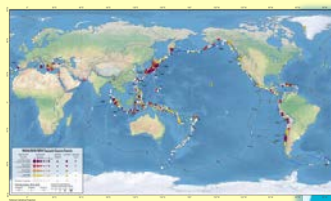


Taking Action – Building the IO TWS – 2005

UNESCO IOC - take immediate action
2005: 4 mtgs (WCDRR Jan, IOC Mar, May, Jun, Dec (IOTWS) Interim (Mar 2005, PTWC, JMA), Full (3 IO TSP, 2013)



From Commitments to Action:
Advancements in Developing an Indian Ocean Tsunami Warning and Mitigation System
Intergovernmental Oceanographic Commission of UNESCO





**EQ
Tsunami**

END-TO-END TSUNAMI WARNING

Science and data processing stage showing various data feeds: EQ, TSU, and FORECAST.

Country Alert System
Emergency Alert System & Mass Media

Public
Community

TSUNAMI WARNING! EVACUATE

TWC - Science

DMO / EMA - Safety

Intl / Natl

Natl / Prov / Local Govt

Community

**EQ
T=0**

Race against Time

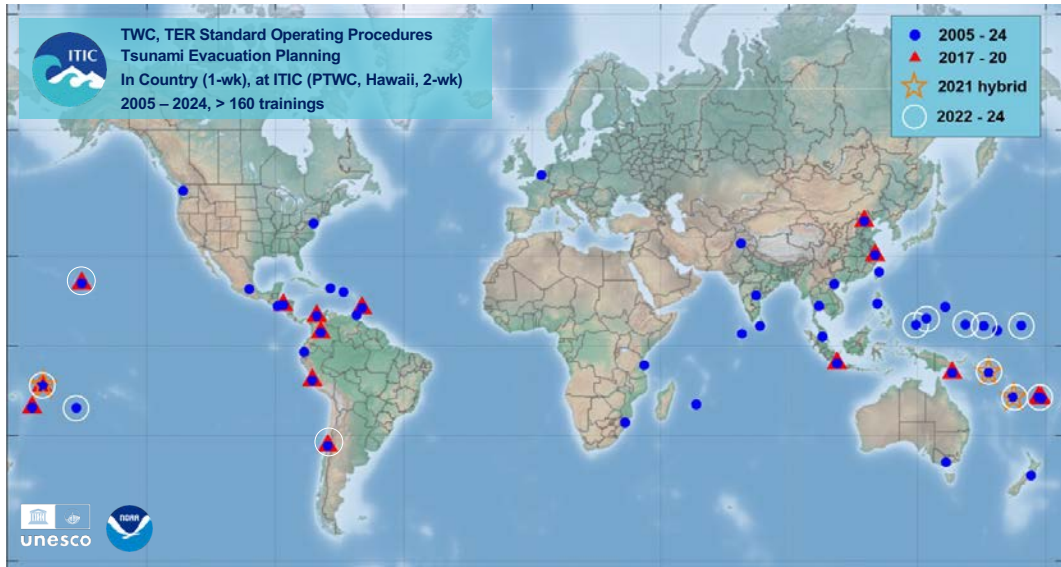
LIVES
SAVED

**TSUNAMI
T=20 min**

International Tsunami Information Center

ITIC, Seisichu, Japan, March 11, 2011

Building Resiliency: Capacity Building, Training



Importance of continual training to strengthen TWC decision-making skills:

>> Tonga did well for 2022 HTHH Volcano / Tsunami

- In-Country (5) - 2009, 2010, 2015, 2019
- ITP-Hawaii (14) - 2006, 2009, 2011, 2014, 2016, 2018, 2019

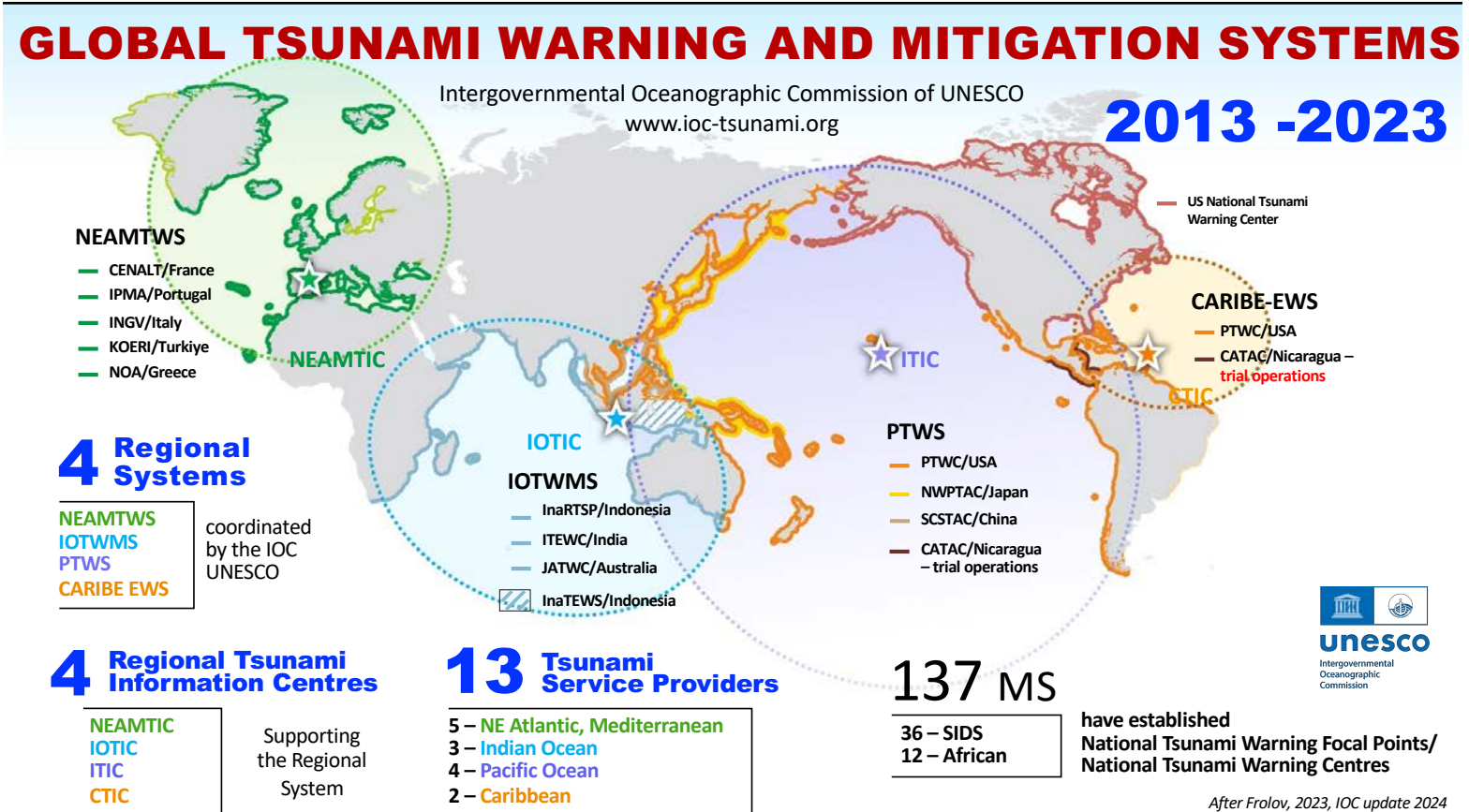


UNESCO/IOC-NOAA
International Tsunami Information Center

System Needs: Warning, Evacuation, Exercises



37



38

Photo 1. Damaged sea level station the day after the 27 February 2010 tsunami, Talcahuano, Chile
Photo by Rodrigo Núñez Gundlach



Minamisoma, Fukushima prefecture, Japan. 2011 March 11, Mw 9.0, Honshu, Japan earthquake and tsunami. (Credit: AFP/AFP/Getty Images.)



December 18, 2018 December 30, 2018



Volcano generated tsunami



2011 Tōhoku earthquake and tsunami

2018

2010 Chile

2011

Palu, Indonesia

Sunda strait, Indonesia

Tonga

Inter-ICG Task Team on Hazard Assessment Related to Highest Potential Tsunami Source Areas



2016 ->Recent case studies demonstrated complexity and variability, as well as importance of other types of tsunami sources and that earthquake generated Tsunamis can happen in any subduction zones.

Landslide generated tsunami



2018



2022

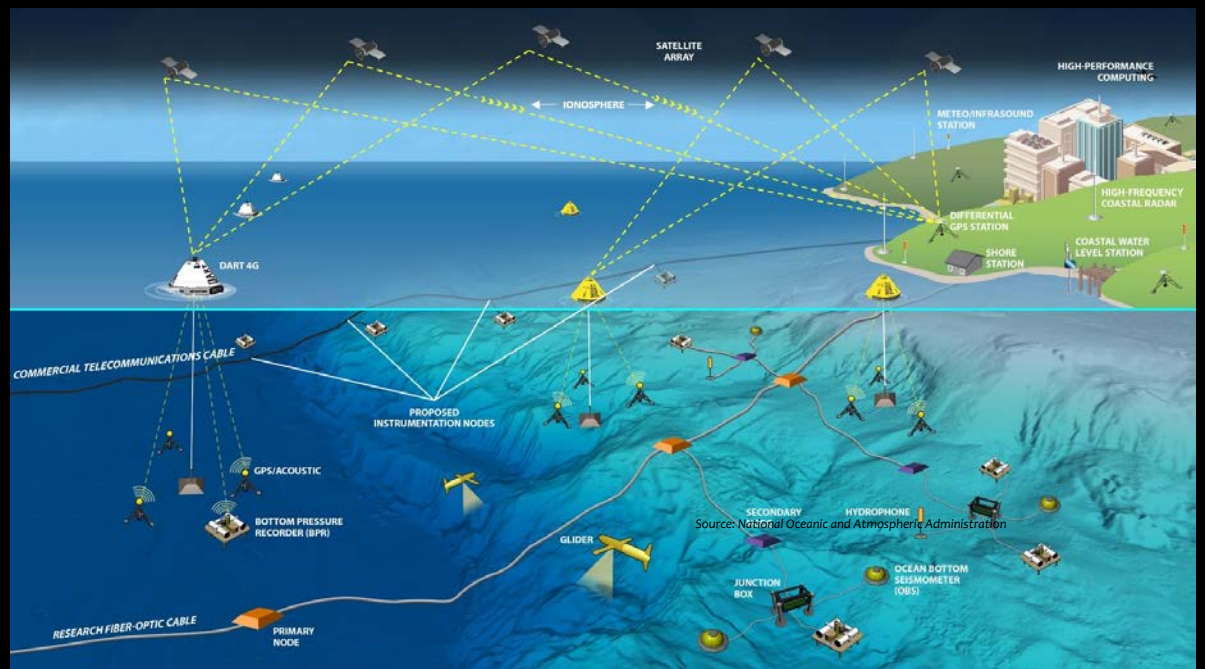
The Group decided to establish a specific Ad Hoc Team on **Meteo-tsunamis** & Ad Hoc Team on **Tsunamis Generated by Volcanoes**



OCEAN DECADE TSUNAMI PROGRAMME

A SAFE OCEAN – Tsunami Warning faster, accurate

- Fill in identified gaps
- **New technologies - SMART sensors on cable**
- **Expand access, availability, analysis of real-time sea level, seismic, GNSS data**
- **Map 100% of coastal waters for inundation forecasting**
- **Ensure all NTWCs have access to data, tools, communication, protocols & TRAINING**



THE MAIN SOCIETAL OUTCOME

TO MAKE
100%

OF COMMUNITIES AT RISK OF TSUNAMI PREPARED FOR AND RESILIENT TO TSUNAMIS

BY
2030



World Tsunami Awareness Day 2022

01

COMMUNITY PREPAREDNESS IS COLLABORATIVE

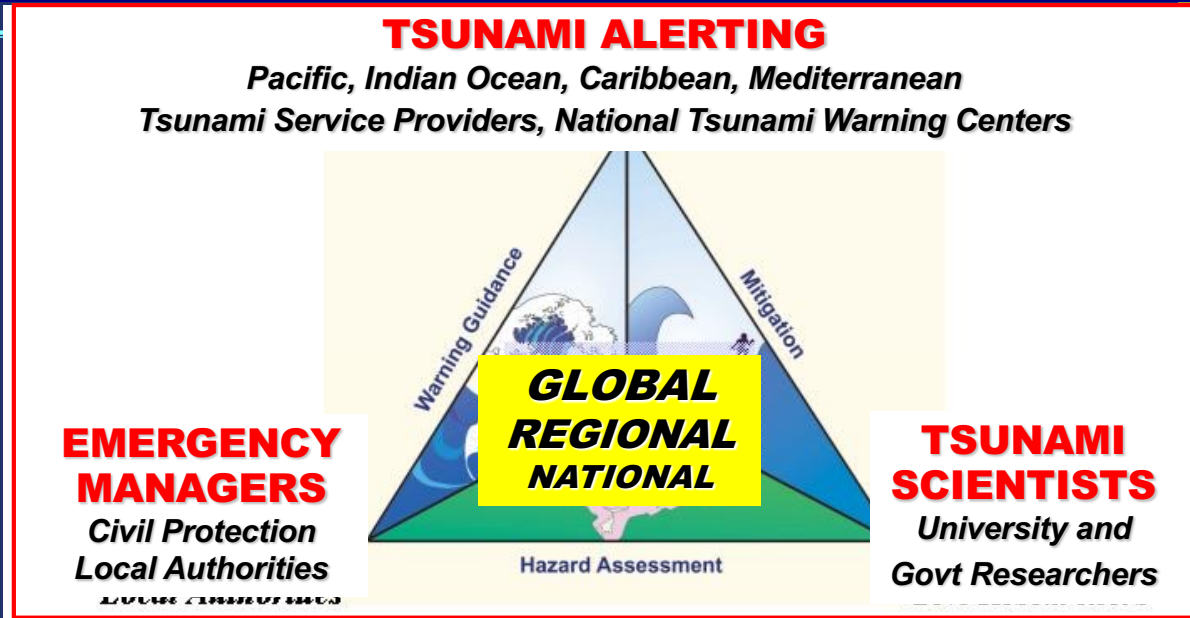


GOAL: Disaster-resilient community
TSUNAMI READY



02

Global Tsunami Hazard Mitigation



33



California Earthquake Country Alliance
December 4, 2024

Thank you

Dr. Laura Kong

Director

International Tsunami Information Centre (ITIC)



UNESCO/IOC-NOAA SHOA
International Tsunami Information Center

34

Q&A

To be notified of future events and recordings, join ECA (free!):
EarthquakeCountry.org/join

Please take our survey:
SurveyMonkey.com/r/T2JXLDV

Questions?
info@earthquakecountry.org

95

California Tsunami Program



Governor's Office of Emergency Services
and
California Geological Survey



96



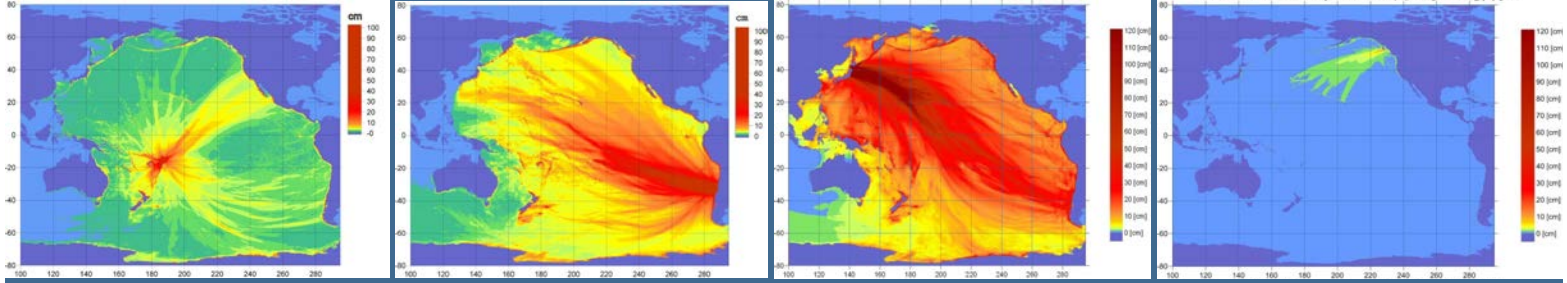
Notable Recent Tsunamis Impacting the U.S. West Coast

Samoa - Sept 2009

Chile - Feb 2010

Japan - March 2011

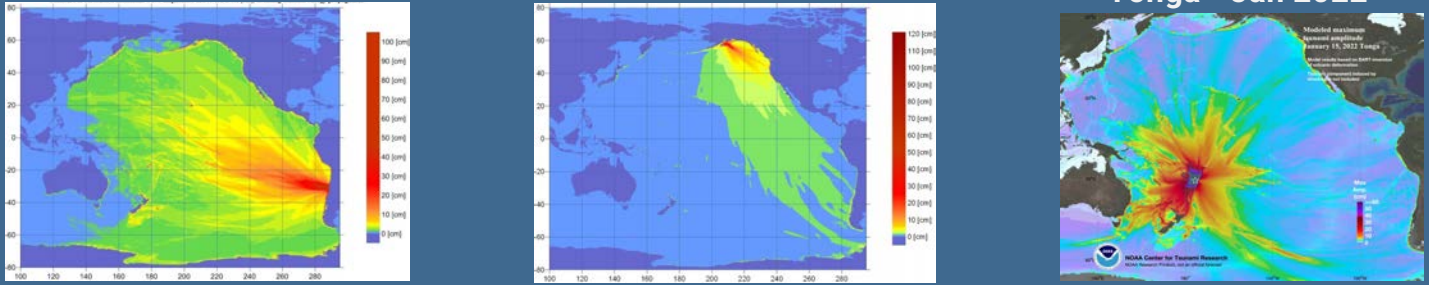
BC Canada - Oct 2012



Chile - Sept 2015

Alaska - Jan 2018

Tonga - Jan 2022



07



08

Why Do I Need to Know About Tsunamis?



99

Tsunami Hazard

Tsunami's Can Cause Damage On Land:

- ✓ Flooding/Water Surge
- ✓ Erosion
- ✓ Floating Debris
- ✓ Hazardous Materials/Hazardous Chemicals
- ✓ Utility Outages – Power, Water, Sewer



May 22, 1960, M9.5 Chile EQ
Damage in Hilo, Hawaii

How Do I Know if a Tsunami is Coming?

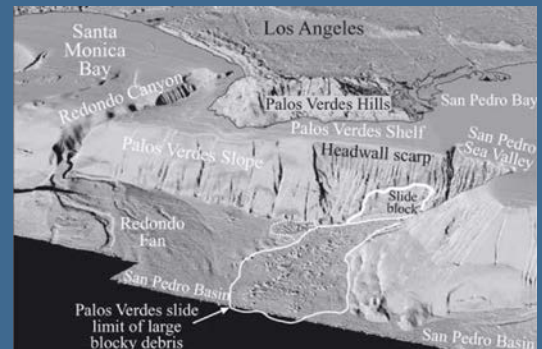


L01

Local Tsunami Threat

Natural Warning Signs

- **Feel** – Strong Earth Shaking
- **See** – Water Receding Exposing Sea Floor
- **Hear** – Loud Ocean Roar



EQ triggered Submarine Landslide

If one or more Natural Warning Sign Occurs – Go Immediately to High Ground or Inland and Stay There

You May Only Have **Minutes** before a Tsunami Arrives.

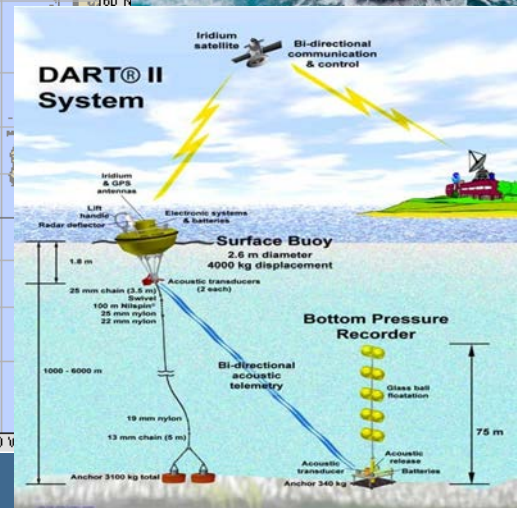
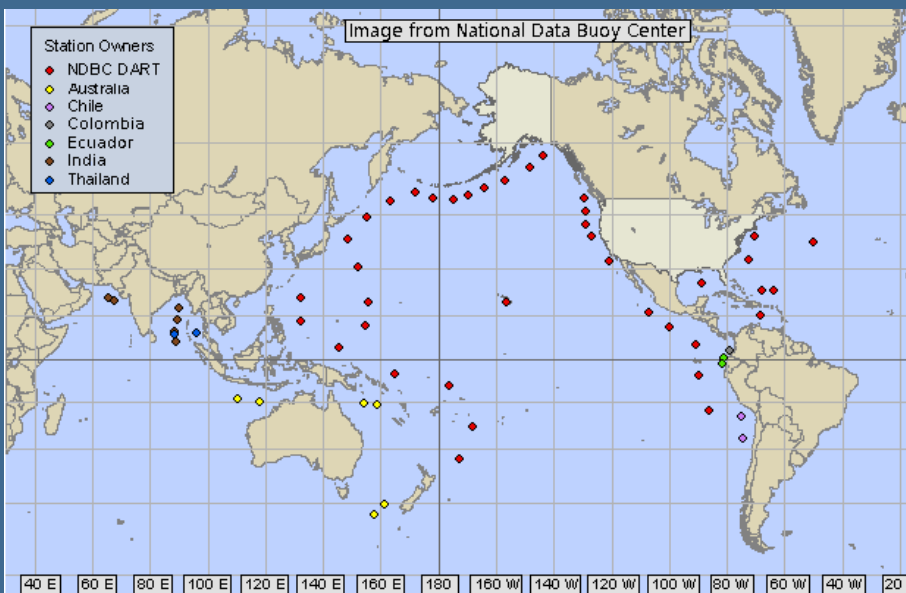
L02

Earthquakes Near the Ocean



L03





Tsunami Warning System



DART System

L04

Tsunami Alert Notifications

Alert Name	Actions	Potential Hazards
 WARNING	Get to high ground or inland IMMEDIATELY Follow tsunami evacuation signage	DANGER! TSUNAMI IMMINENT! Flooding/powerful currents Wave heights > 3 ft. or unknown
 ADVISORY	Stay out of the water and away from the shore	STRONG CURRENTS AND DANGEROUS WAVES in or very near coastal water Wave heights of 1 - 3 ft.
 WATCH	Be prepared to take action Stay tuned to local radio/TV/ NOAA "alert" weather radios	TSUNAMI IS POSSIBLE Alert level may change once more information is known
 INFORMATION STATEMENT	No action needed	NO TSUNAMI IMPACT EXPECTED Alert level may change once more information is known

THREAT Message: Intended to alert international partners only. Not applicable to U.S. coasts

**THE NATIONAL TSUNAMI WARNING CENTER ISSUES OFFICIAL TSUNAMI ALERTS.
CHECK TSUNAMI.GOV OR WEATHER.GOV WEBSITES FOR TSUNAMI ALERT DETAILS.**

L05

Tsunami Alert Tools

Tsunami Maritime Guidance

Receiving Tsunami Alerts


Twitter

Information regarding the National Tsunami Warning Center and Pacific Tsunami Warning Center Message Feeds is located here:

<https://www.tsunami.gov/?page=productRetrieval>

- Image shown at right: Screen image of National Tsunami Warning Center Twitter Feed.

https://twitter.com/NWS_NTWC



Twitter Notifications

Register to receive Alerts and
Emergency Information from Officials
in your County:

<https://calalerts.org/signup.html>

Tsunami Maritime Guidance

NOAA Weather Radio

NOAA Weather Radio All Hazards (NWR) is a nationwide network of radio stations broadcasting continuous weather information directly from the nearest National Weather Service office. NWR is an "All Hazards" radio network, making it your single source for comprehensive weather and emergency information. In conjunction with Federal, State, and Local Emergency Managers and other public officials, NWR also broadcasts warning and post-event information for all types of hazards – including tsunamis. To learn more about purchasing a NOAA Weather Radio receiver, check out the National Weather Service here.



NOAA Weather Radio

Tsunami Maritime Guidance

Additional Tsunami Alert Resources:

Additional resources for receiving tsunami alert messages can be found here: [NOAA/NWS U.S. Tsunami Warning System Website Message Subscriptions](#)

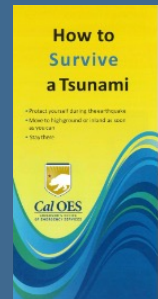


L06



What Should I Do?

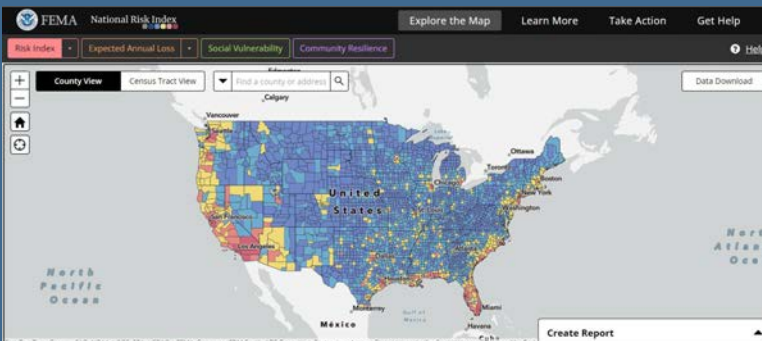
- Be Informed
- Be Prepared
- Get Involved



107



Are You in the Tsunami Zone?



<https://hazards.fema.gov/nri/map>

Announcing Updated and New Tsunami Products

MARCH 2021

New Tsunami Maps for California

In March we released a total of seven new tsunami maps covering the counties of Los Angeles, Monterey, San Mateo, Alameda, Mendocino, Humboldt, and Del Norte. We have maps for other counties, too (they're just not updated yet).

MARCH 11, 2021

California Tsunami Preparedness Guide

Appropriate for all ages, our updated multimedia guide is packed with videos, images, and maps.

MARCH 11, 2021

The 2011 Tōhoku-oki Earthquake and Tsunami

A scientific perspective of the event, including details of what happened in Japan and subsequently in California.

Tsunami.ca.gov

The **TsunamiZone**

Register Here | Know Your Zone | Who is Participating? | How to Participate? | Resources | News & Events | Partners & Sponsors

WELCOME TO THE TSUNAMIZONE IN CALIFORNIA!

Thank you to everyone who participated in California's 2023 Tsunami Preparedness Week (March 25 – 31)! If you missed it, we encourage you to plan and register #TsunamiPrep activities (at work, school, and home) on any other day of the year!

There are many ways to participate – you can organize or join a group tsunami walk, attend an in-person lecture or an online webinar, find out if you are in a tsunami hazard zone, update your "Go Bag," or many other options.

View or add to a list of events open to the public

406,292 Participants and counting!

Click the map for details about each area

Over 620,000 participants registered

TsunamiZone.org

108

Be Prepared



Evacuation Kit List

- Water
- Snacks
- Flashlight
- Portable Radio
- Emergency Blanket
- Cash
- ID Copy
- Insurance Info.
- Emergency Contacts
- Prescription Meds
- Contacts / glasses
- First Aid Kit
- Charging Cables
- Battery Pack
- Shirt
- Pants
- Underwear
- Socks
- Shoes
- Jacket
- Toothpaste
- Toothbrush
- Soap
- Pens
- Chalk
- Toilet Tissue
- Facial Tissue
- Pet Supplies
- Games / Toys
- Diapers / Formula
- Personal Items:

Are You in The Zone?

TsunamiZone.org



Get Involved Practice – Do a Drill



Move Inland or to higher ground

Follow Evacuation Route Signs

Listen to instructions from local officials

Be prepared to stay where you are for hours – possibly 2 days



Evacuation Communication

Look for signs and maps showing you which way to walk to exit the tsunami hazard area.



Tsunami Evacuation Routes
Familiarize yourself with evacuation routes, landmarks, and flood areas. Plan secondary routes as backup.

Official Tsunami Warning
Warnings are issued due to the imminent or expected threat of a tsunami typically called when forecasted tsunami amplitudes are equal to or greater than 1m (3ft). If you receive a tsunami warning:

1. MOVE to higher ground or inland beyond the Tsunami Hazard Zone.
2. SEEK further information from local radio, social media, or television stations.
3. FOLLOW directions from emergency personnel. DO NOT CALL 911.

Get connected
City of Hermosa Beach
www.hermosabeach.gov
Twitter: @HermosaBchCity
Facebook: CityofHermosaBeach
Register for South Bay Alerts (It's free!)
Text "ALERTSB" to 686777

For more information, visit tsunami.gov

L11



2025 California Tsunami Preparedness Week

March 22-30, 2025

Goal: 1,000,000 participants!

Join Us
Register your #TsunamiPrep Activities!
Register: TsunamiZone.org



Tsunami Walk

USGS logo and other icons

220,647 Participants and counting!
Click the map for details about each area

2024 California Tsunami Preparedness Webinar

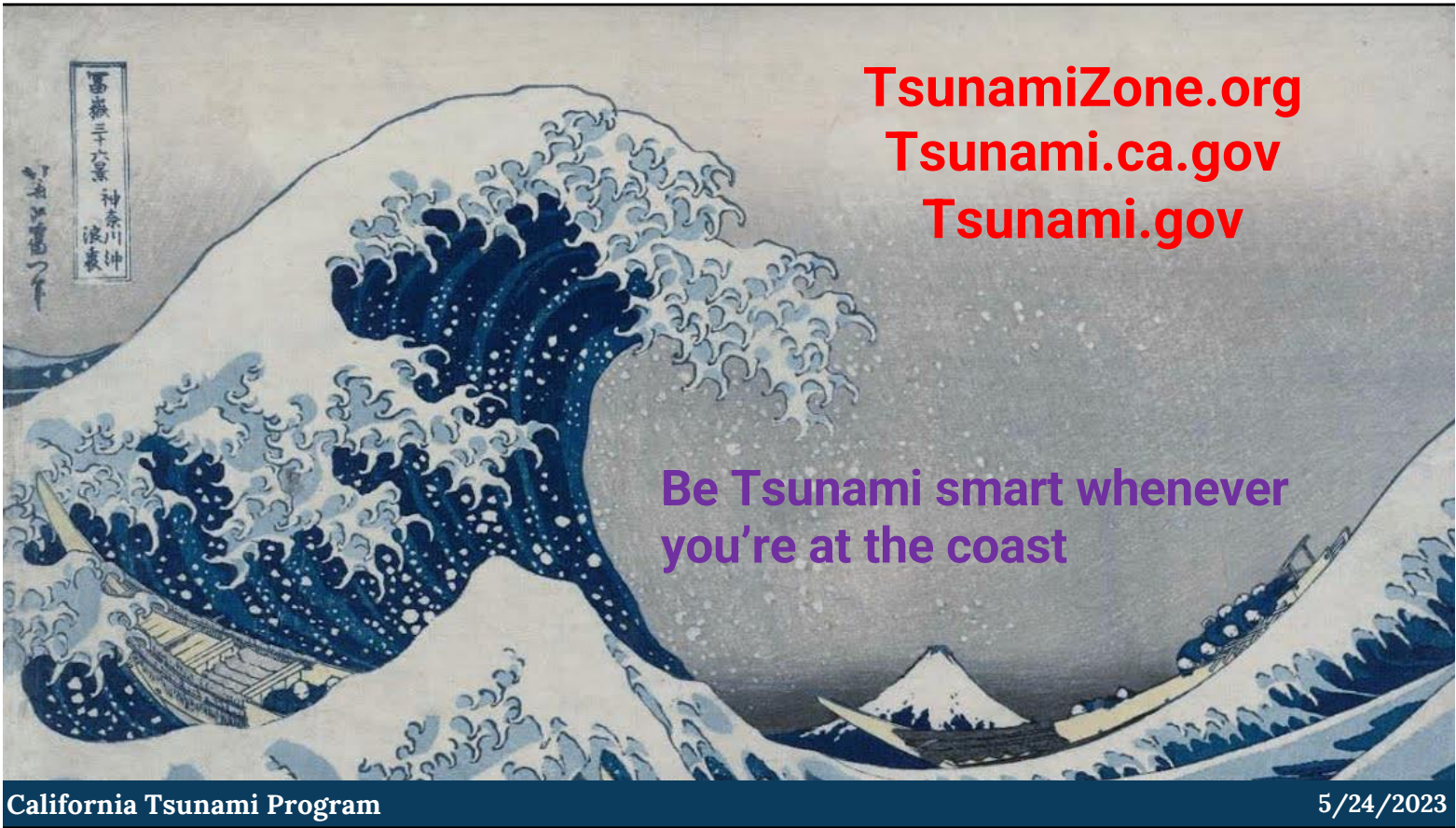
Earthquake Country Alliance

Tsunami Preparedness: Are You in the Zone?
Learn about tsunami hazards in California – what they are, tsunami maps and alerts, and what to do before, during, and after a tsunami occurs.

Recording Now Available

Watch Now
EarthquakeCountry.org/2024ctp

L12



TsunamiZone.org
Tsunami.ca.gov
Tsunami.gov

**Be Tsunami smart whenever
you're at the coast**

California Tsunami Program

5/24/2023

L13

Contacts

Yvette LaDuke
Earthquake and Tsunami Program Manager
California Governor's Office of Emergency Services

Yvette.laduke@caloes.ca.gov

or

Todd Becker
Tsunami Program Specialist
California Governor's Office of Emergency Services

Todd.Becker@caloes.ca.gov

L14

California Tsunami Preparedness Week

- March 22-30, 2025
- Activities coordinated locally across the state
- Register your activities, similar to ShakeOut participation.
- Hold a "Tsunami Walk"
- Become a TsunamiReady Community
- Many ways to participate!

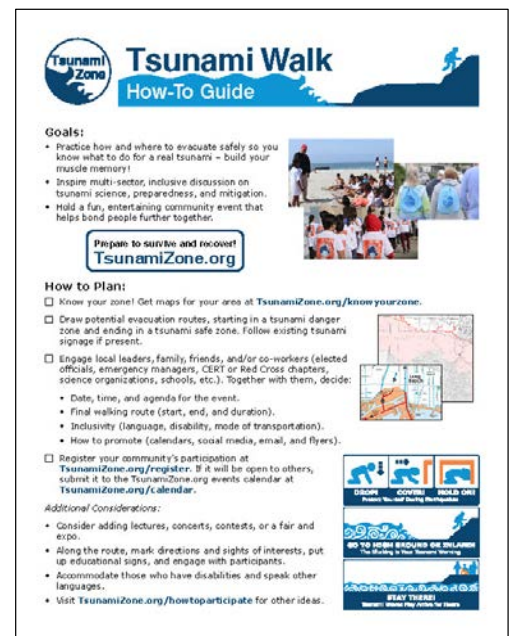


TsunamiZone.org/california

L15

California Tsunami Preparedness Week

- Attend a publicly organized tsunami walk drill
- **Organize your own tsunami walk drill**
- Participate in a boat evacuation drill
- Attend a Public Lecture
- Put together a preparedness kit
- Make a family plan
- Establish an out of town contact
- Participate in a work-related tsunami exercise
- Attend a commemorative event
- Re-tweet Tsunami Preparedness Info
- Participate in a school evacuation drill
- Watch a tsunami preparedness video
- Attend an open house at museum/government office
- Print out a map of your evacuation zone



TsunamiZone.org/california

L16

**Register your Tsunami Activities during
Tsunami Preparedness Week
(or any day of the year)**

[Tsunamizone.org/register](https://tsunamizone.org/register)

**If you are having an event open to the
public and/or news media, submit it
here:**

[Tsunamizone.org/calendar](https://tsunamizone.org/calendar)



TsunamiZone.org

L17

Connect with ECA & TsunamiZone

- EarthquakeCountry.org
Terremotos.org
info@earthquakecountry.org



- TsunamiZone.org
info@TsunamiZone.org



L18

Q&A

To be notified of future events and recordings, join ECA (free!):
EarthquakeCountry.org/join

Please take our survey:
SurveyMonkey.com/r/T2JXLDV

Questions?
info@earthquakecountry.org

L19

Northridge 30th Anniversary Campaign

- SCEC is leading a year-long educational campaign to commemorate the 30th anniversary of the Jan. 17, 1994, Northridge earthquake
- Purpose: increase awareness about earthquake hazards, encourage preparedness and mitigation, and inform about self-protective actions and response skills.
- Supporting Grants and sponsorships include:
 - Cal OES
 - California Seismic Safety Commission
 - Earthquake Program via FEMA NEHRP
 - California Earthquake Authority
 - Optimum Seismic
 - Other public/private partners
- **Primary activity: Quake Heroes Expos, screenings, and other events**
- Campaign website at EarthquakeCountry.org/northridge



L20



Quake Heroes



- 54-minute documentary featuring stories of people who experienced the 1994 Northridge earthquake in Los Angeles, and how they helped others
- Key moments tied to the *Seven Steps to Earthquake Safety*
- Scientists and engineers share how they informed the public about what happened, inspected damage, and learned lessons for reducing future losses.
- Encourages viewers to become trained (CERT, CPR, etc.) so they are prepared to help others
- Production sponsored by FEMA, NSF, USGS, Structural Engineers Association of Southern California, Simpson Strong-Tie, Hero in You Foundation, Safe-T-Proof, and others



RETROSPECTIVE INTERVIEWS

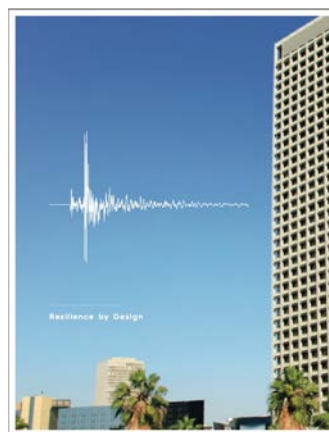


ARCHIVAL NEWS FOOTAGE



CINEMATIC RE-ENACTMENTS

Quake Heroes: Focus on Soft-Story Retrofitting



Quake Heroes Expos

- Organized to motivate preparedness actions by large community groups, businesses, faith-based organizations, local governments, and their members, employees, and constituents.
- After viewing the film, attendees take actions at a **Seven Steps to Earthquake Safety** resource and information fair where they can:
 - register for CERT and other trainings
 - receive free or low-cost disaster supplies & earthquake safety fasteners
 - learn about earthquake insurance & retrofitting
 - sign up for alerts
 - experience an earthquake simulator

California Seismic Safety Commission Grant to SCEC:

10 Expos in underserved communities across the state, through May 2025 (including at least one event fully in Spanish, possibly also one in Chinese) - now seeking partners / communities for these events.

Learn more at [QuakeHeroes.org](https://www.quakeheroes.org)

The poster for the Quake Heroes Expo at Cal State Northridge features a dark blue background with the title 'QUAKE HEROES' in white at the top. Below the title are five colorful triangles (red, green, blue, orange, purple) containing symbols for a first aid kit, a person, a plus sign, a house, and a lightning bolt. The event title 'EXPO @ CAL STATE NORTHRIDGE' is in white on a red banner. The main image shows a person in a helmet and a scene of a building being shaken. Text on the poster includes 'SATURDAY, FEBRUARY 3 10AM - 4PM', a QR code, and the text 'Learn More and Register Visit QuakeHeroes.org'. Logos for SCEC, John Lee (Los Angeles City Councilmember - District 12), and PS are also present. At the bottom, there are promotional phrases: 'Watch a film based on true stories!', 'Discounts on preparedness supplies!', 'Ride an earthquake simulator!', and 'Sign up for safety trainings!'.

L23

Learn More and Connect

Learn how to host a *Quake Heroes Screening or Expo*:
[QuakeHeroes.org](https://www.quakeheroes.org)

General Quake Heroes questions:
[info@QuakeHeroes.org](mailto:info@quakeheroes.org)

Other resources or requests:
[info@EarthquakeCountry.org](mailto:info@earthquakecountry.org)

L24

NORTHRIDGE **30** 1994 2024

The Northridge Earthquake - 30 Years Later *A Catalyst for Engineering Resilient Communities*

Webinar Series

EarthquakeCountry.org/northridge/events



L25

NORTHRIDGE **30** 1994 2024

The Northridge Earthquake - 30 Years Later *A Catalyst for Engineering Resilient Communities*

Episode 1: The January 17, 1994 Northridge Earthquake – Science & Engineering Aspects

Episode 2: Insurance Issues and Impacts Following the Northridge Earthquake

Episode 3: 30 Years of Progress in Quantification of Seismic Hazards

Episode 4: An Unexpected Milestone in Real-Time Loss Estimation

Episode 5: Legacies of the Northridge Earthquake in Disaster Recovery Planning & Policy

Episode 6: Northridge: The Catalyst for Resilience of Healthcare in California

Episode 7: Lessons learned about business losses and economic recovery –
The Northridge Earthquake as a catalyst for research and application

View all at EarthquakeCountry.org/northridge/events



L26

The Northridge Earthquake - 30 Years Later
A Catalyst for Engineering Resilient Communities
Webinar Series

Dec 18, 12-1pm: EarthquakeCountry.org/northridge30-webinar8

Episode 8: Rethinking Communication about Seismic Risk – Linking Knowledge to Action in Innovative Ways Since the 1994 Northridge Earthquake

Moderator: Louise K. Comfort, Visiting Researcher, University of California, Berkeley
Professor Emerita, Graduate School of Public & International Affairs, University of Pittsburgh

Speakers: Ronald T. Eguchi, President and CEO, ImageCat, Inc.
Lucy Jones, Founder and Director, Dr. Lucy Jones Center for Science and Society



L27

Q&A

To be notified of future events and recordings, join ECA (free!):
EarthquakeCountry.org/join

Please take our survey:
Surveymonkey.com/r/T2JXLDV

Questions?
info@earthquakecountry.org

L28

Short Announcements from Attendees

Please take our survey:
[Surveymonkey.com/r/T2JXLDV](https://www.surveymonkey.com/r/T2JXLDV)

L29

What is something that you:
learned
will do
will use
will tell others

L30

Connect with ECA

- EarthquakeCountry.org
EarthquakeCountry.org/socal
- Terremotos.org
- [Twitter.com/eca](https://twitter.com/eca)
- info@earthquakecountry.org



Please take our survey:

[Surveymonkey.com/r/T2JXLDV](https://www.surveymonkey.com/r/T2JXLDV)
