



Science Application for Risk Reduction

# THE SAFRR TSUNAMI SCENARIO

NORTHCOM Joint Interagency Coordination Group

Keith Porter, Research Professor, University of Colorado at Boulder

25 Feb 2014

# Science Application for Risk Reduction

Mission: innovate and apply hazard science for the safety, security, and economic well-being of the nation

# Scenarios

# Codes, PSRAs

Systems, interaction & time

Human behavior

Societal interests, societal 3D's

Info for planning, mitigation, response, recovery

Isolated facility, context-blind, time-blind

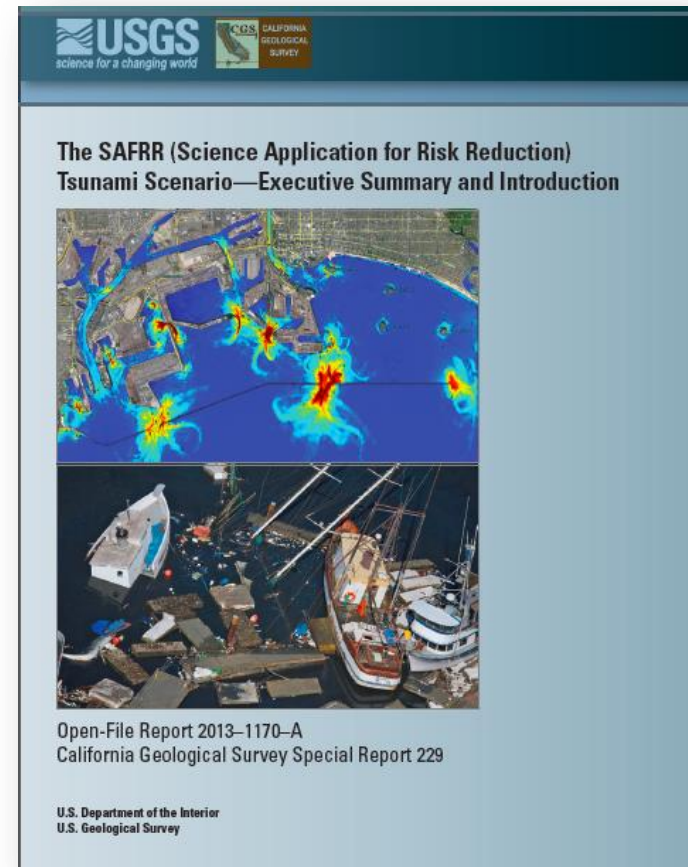
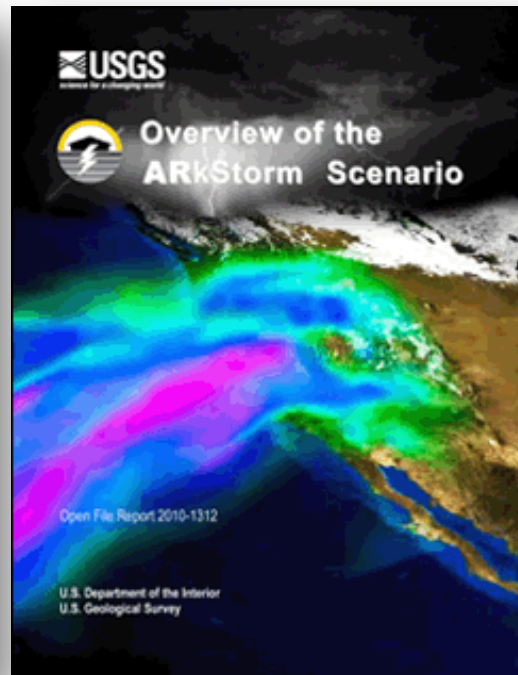
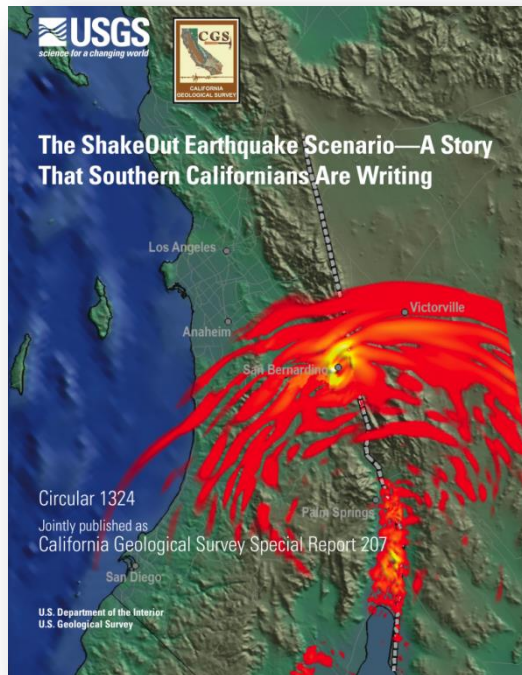
Deep math, shallow model

Codewriter interests

Pass/no pass or benefit-cost ratio

# SAFRR scenarios

Large, not-very-rare events worth planning for  
Science & engineering consensus  
For planning & mitigation  
Crafted with stakeholders





[http://www.usgs.gov/natural\\_hazards/safrr/](http://www.usgs.gov/natural_hazards/safrr/)

U.S. Geological Survey: SA x

www.usgs.gov/natural\_hazards/safrr/

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science for a changing world

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**Start with Science**

- Climate and Land Use Change
- Core Science Systems
- Ecosystems
- Energy and Minerals
- Environmental Health
- Natural Hazards
- Science Quality and Integrity



## SAFRR - Science Application for Risk Reduction

Modern Americans are more at risk from natural hazards today than at any other time in our nation's history, due especially to our increasing reliance on technology and communications and the strong interdependencies of both. Expected losses from Natural Hazards in the US exceed \$3 billion per year. These losses are most effectively reduced through informed decisions guided by the most current and thoroughly-researched understanding of the hazards, risks, and cost of mitigation.

The Science Application for Risk Reduction (SAFRR)

**SAFRR News**

Flooding in Reno, NV in 2005

[SAFRR Newsletter - Fall/Winter 2013 \(PDF\)](#)

ARLShawet also updates the SAFRR newsletter. Scenario to the future basin, with downstream impacts to Reno, Sparks, and Carson City.

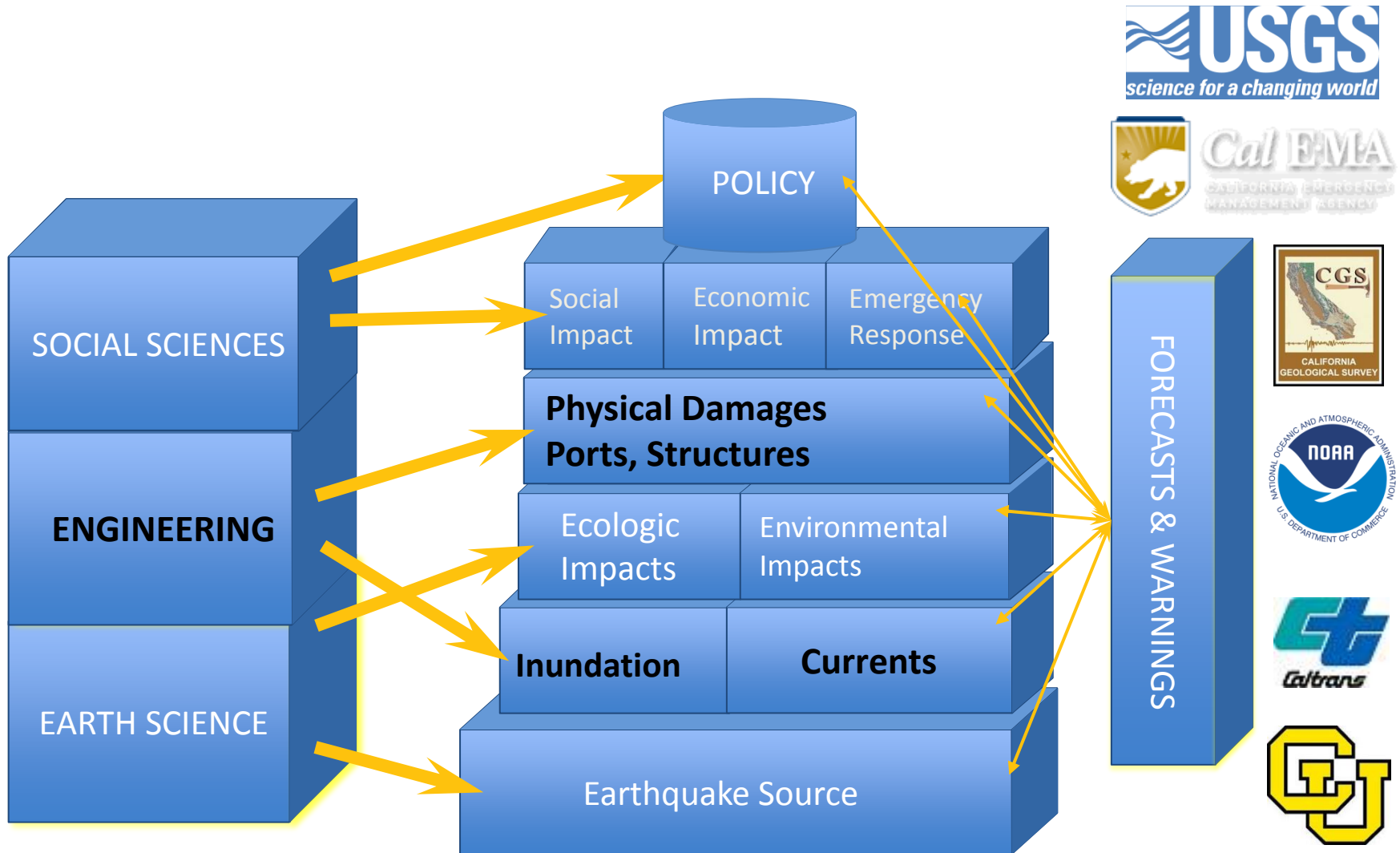
# Some SAFRR partners



Washington Military Department

Emergency Management Division

# Elements of the tsunami scenario



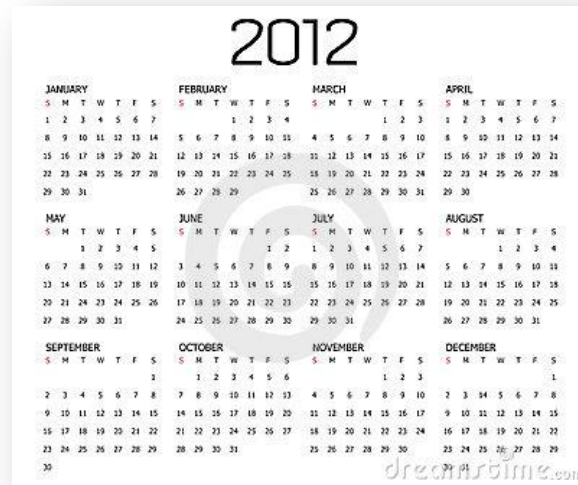


# SAFRR scientists, scholars, practitioners



61 authors, 198 other contributors  
50 peer reviewers, 300 workshop participants

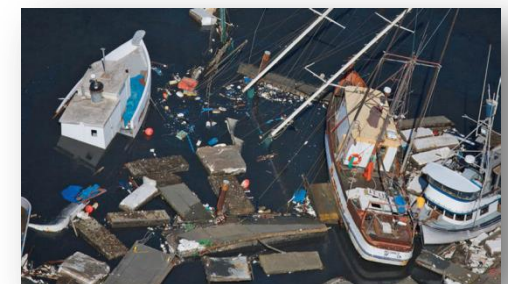
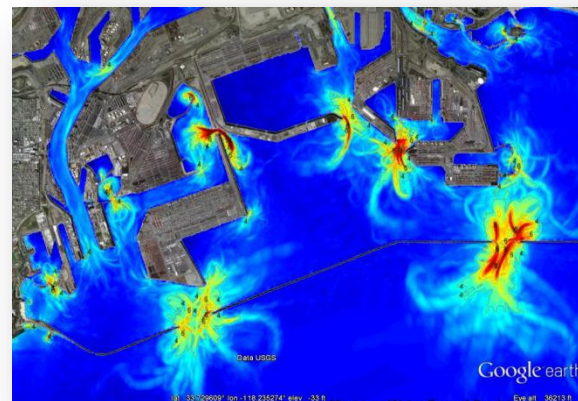
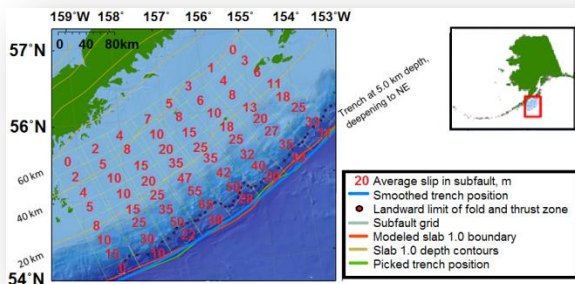
# Develop & deploy



Rupture model

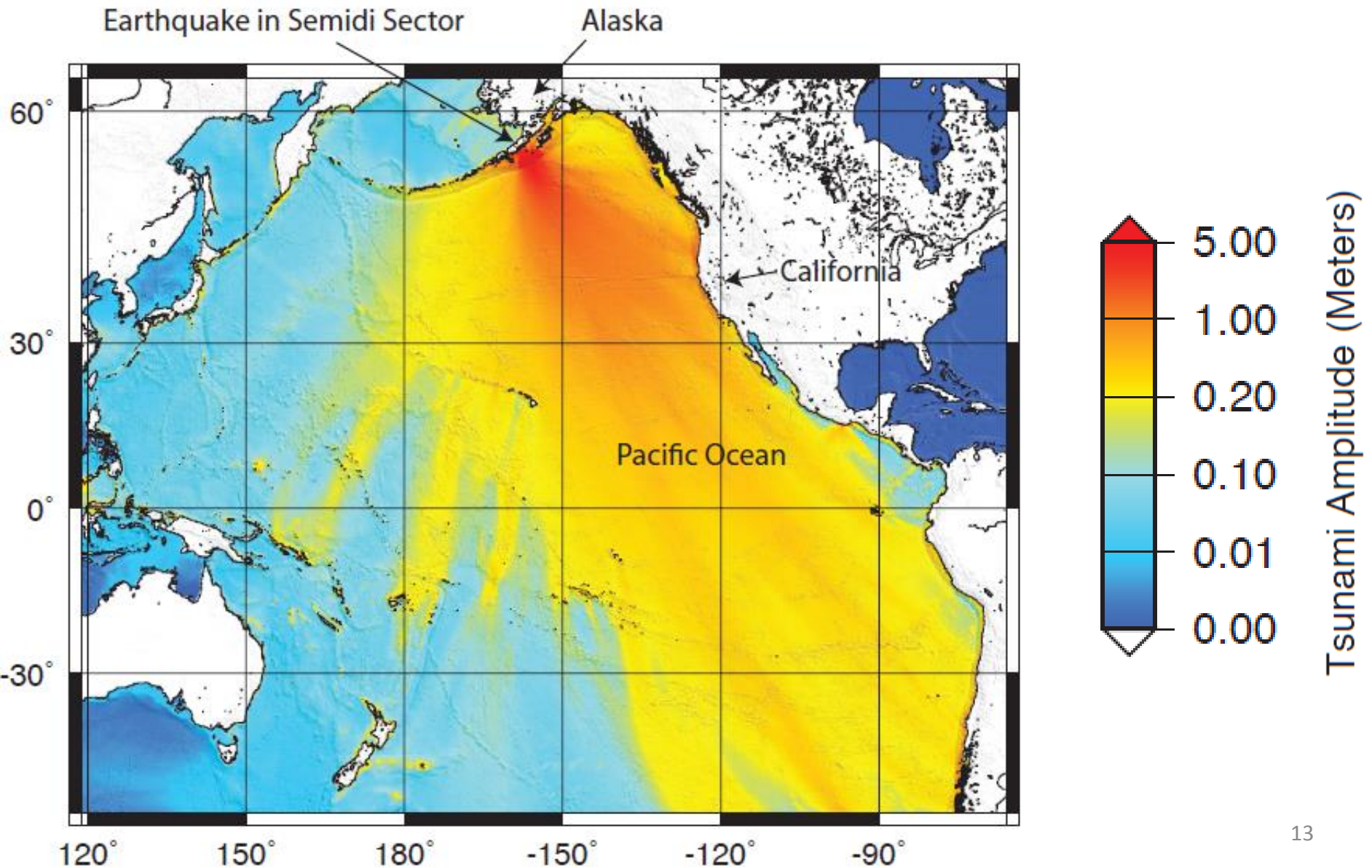
H&H

Impacts, rollout

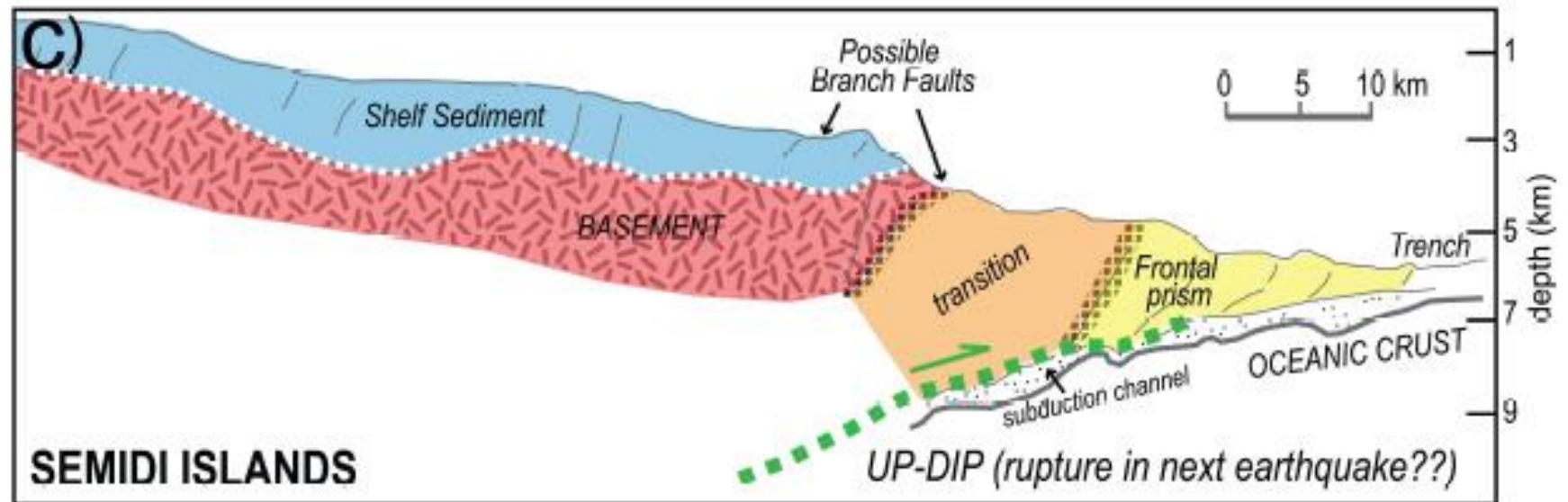
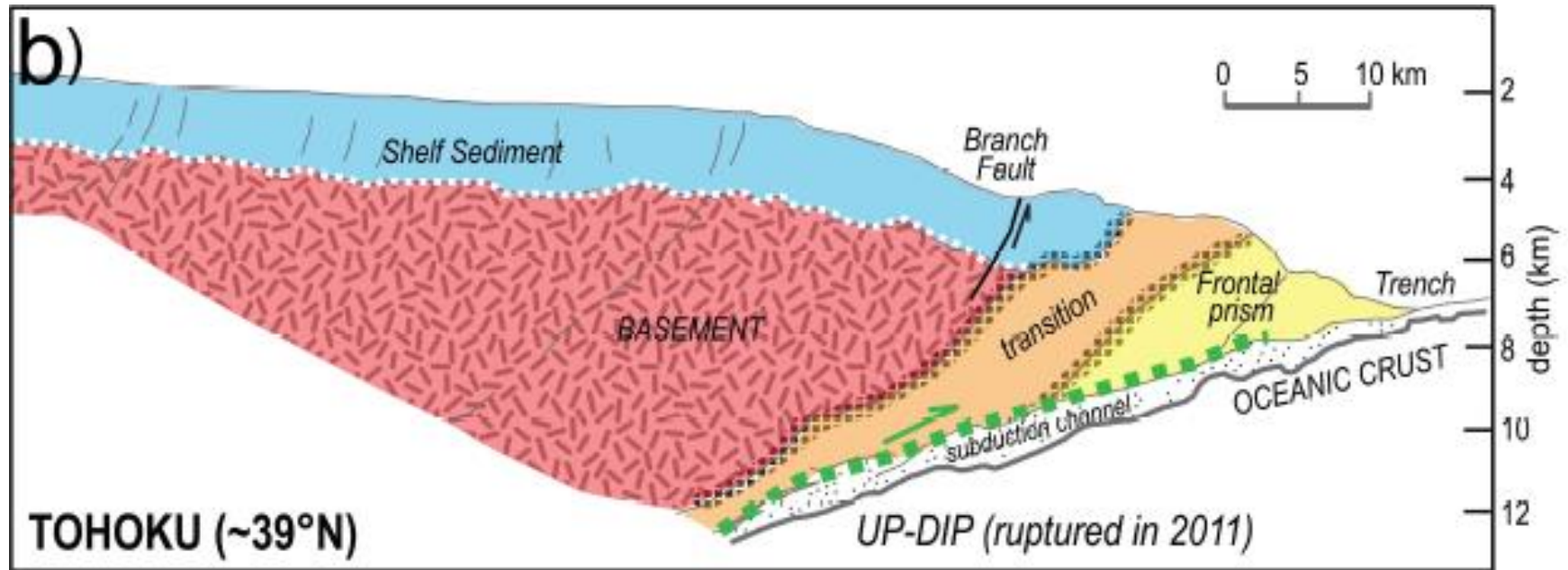




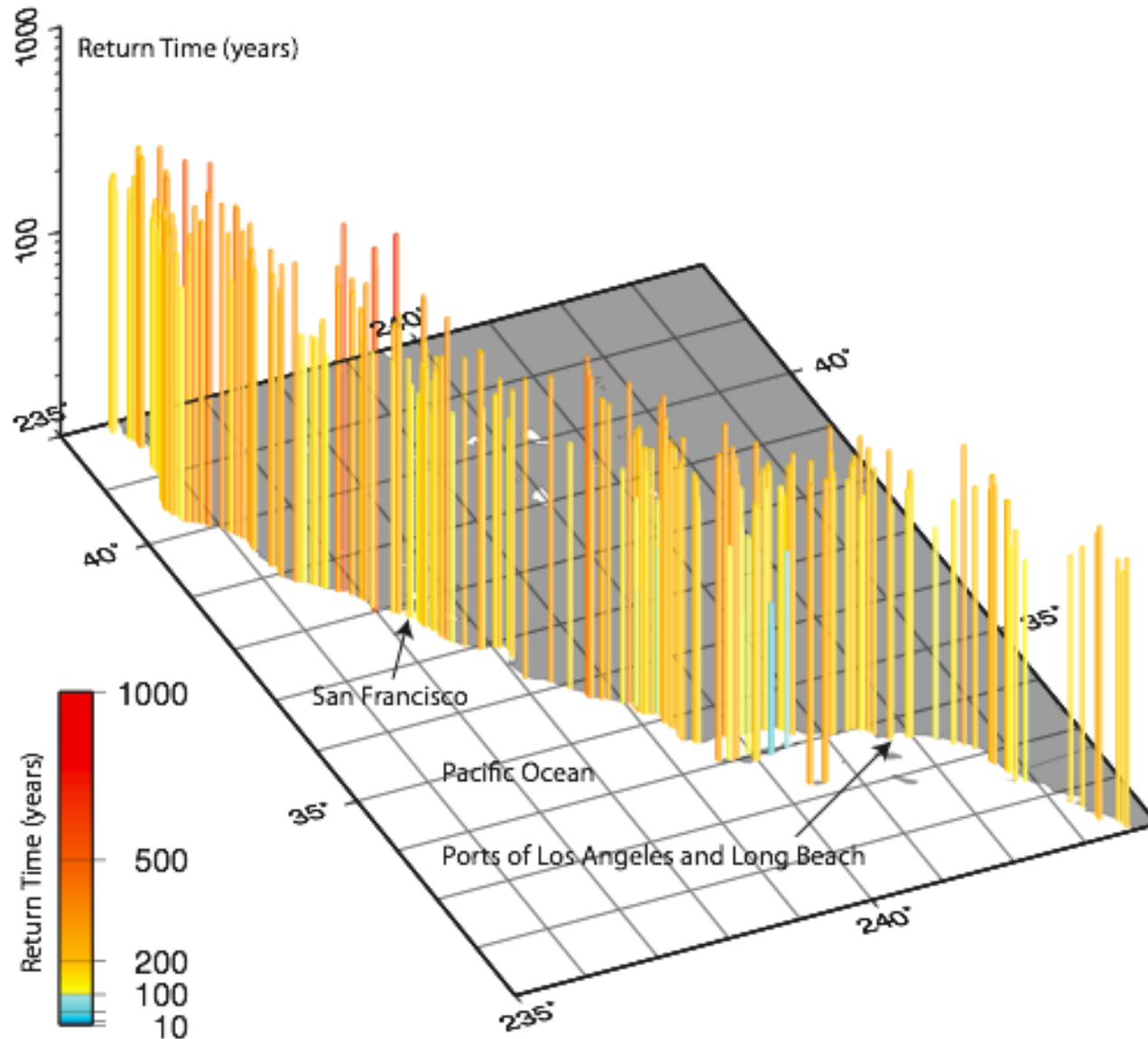
# Mw 9.1 Earthquake



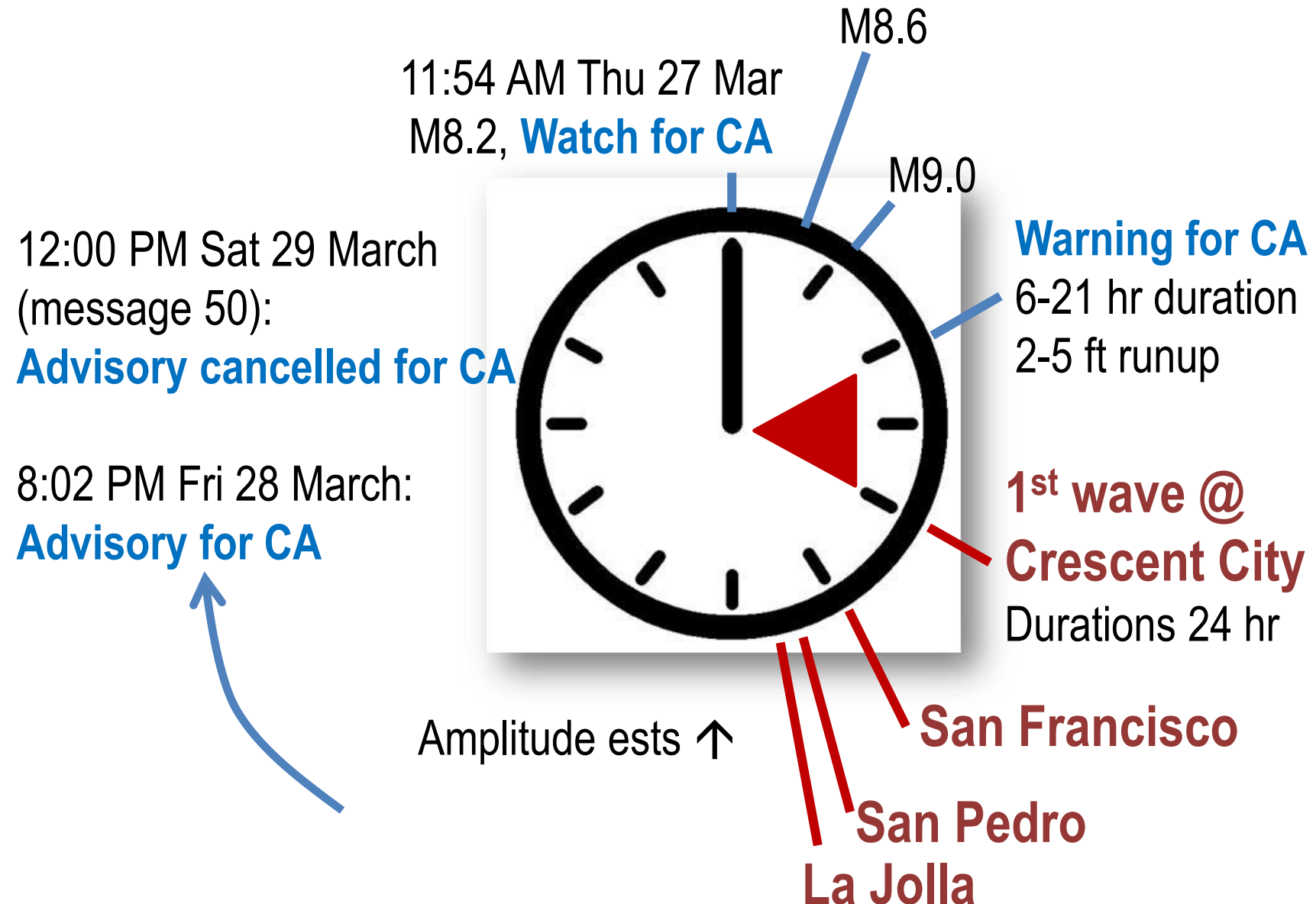
# Geology like Tohoku



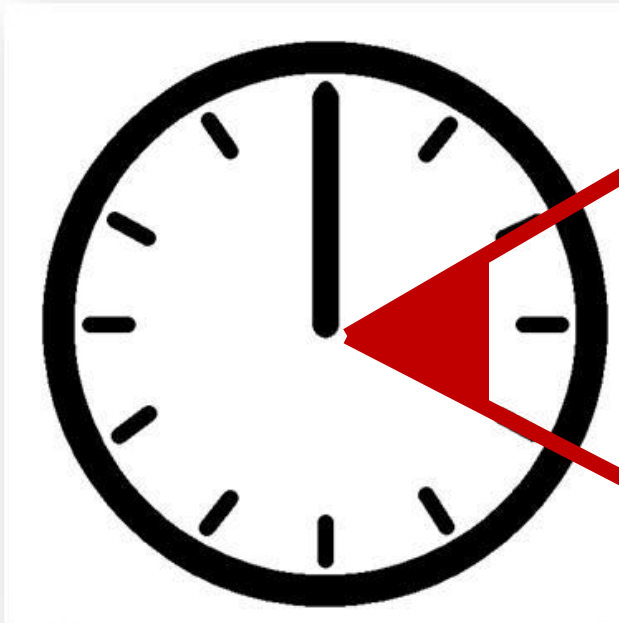
# Not very rare



# NOAA tsunami messages



# Decision-making



Receive

Understand

Consult

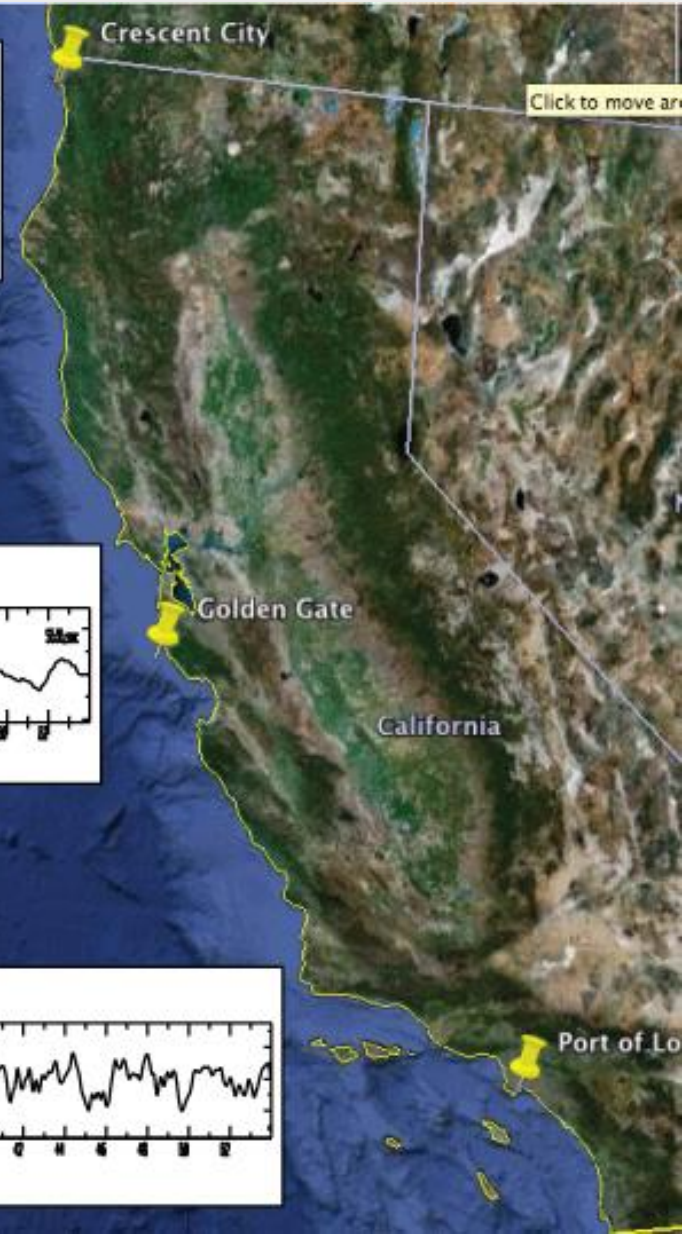
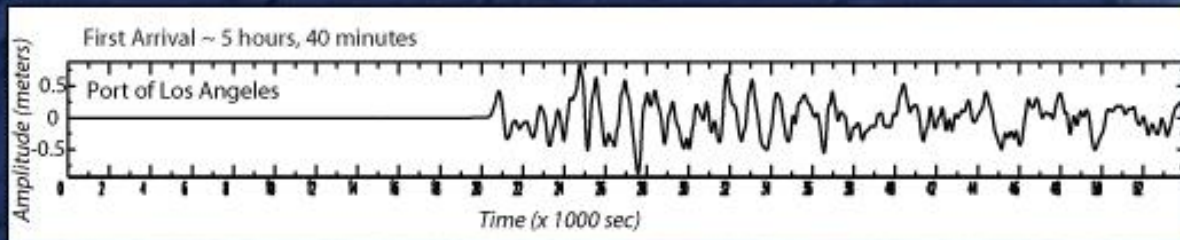
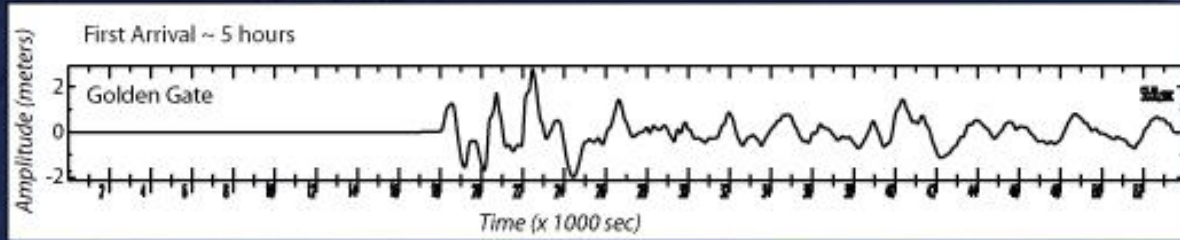
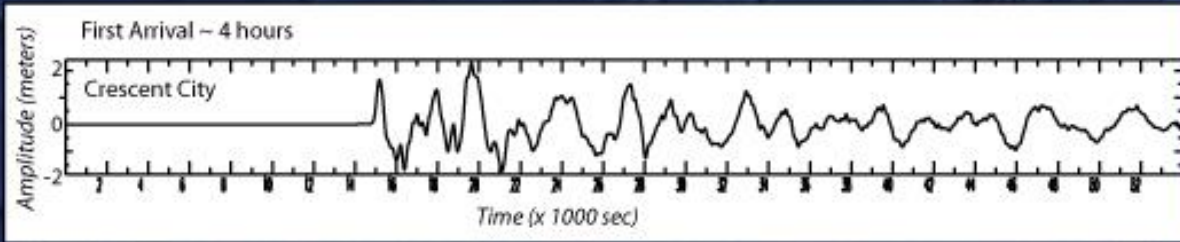
Decide

Communicate

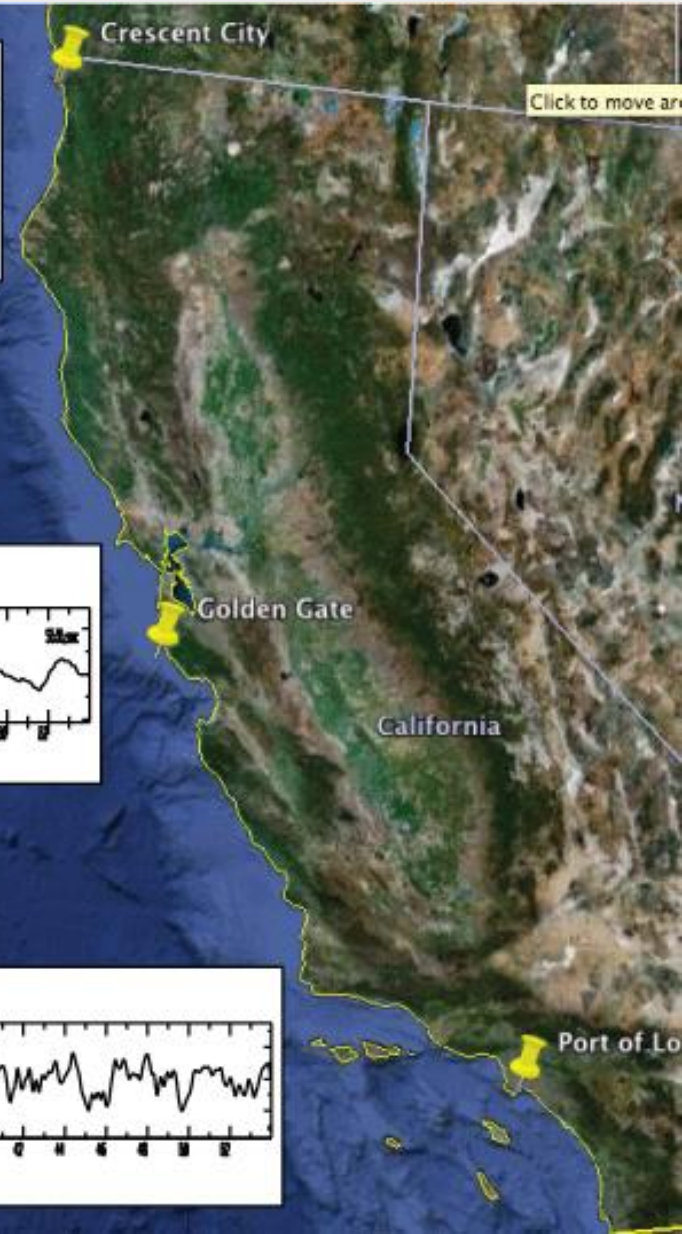
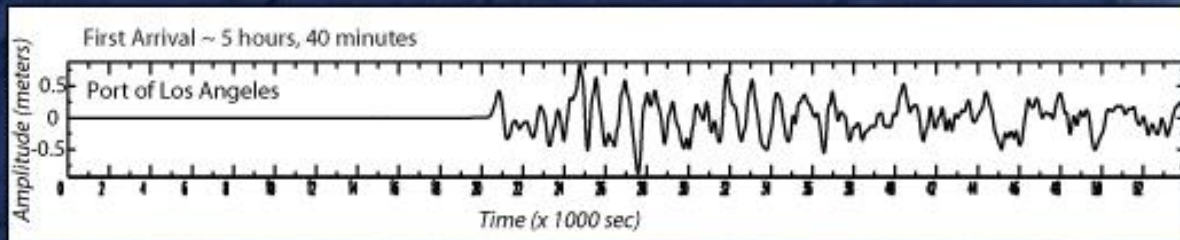
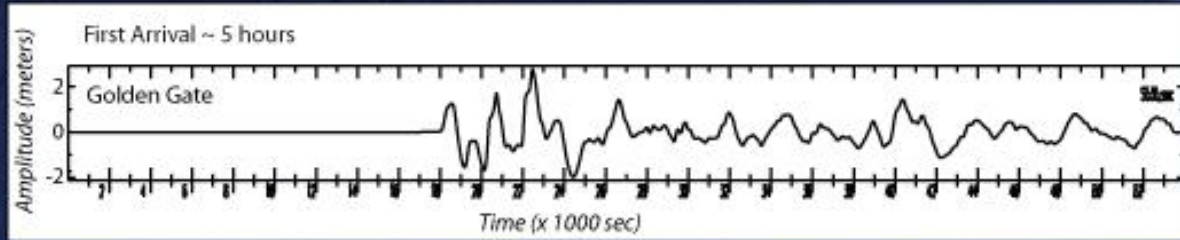
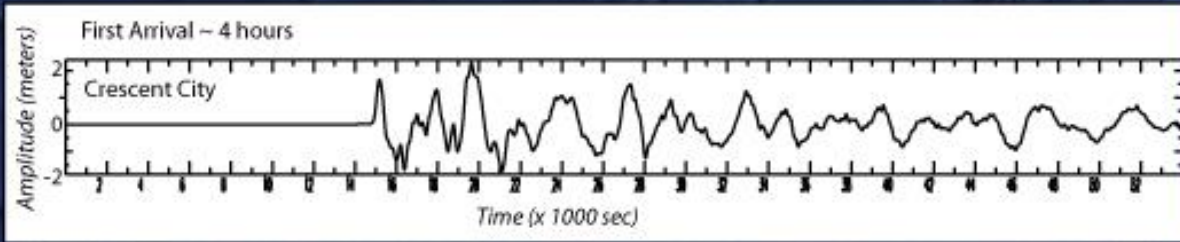
Take action



# 5m waves above MHHW at shore



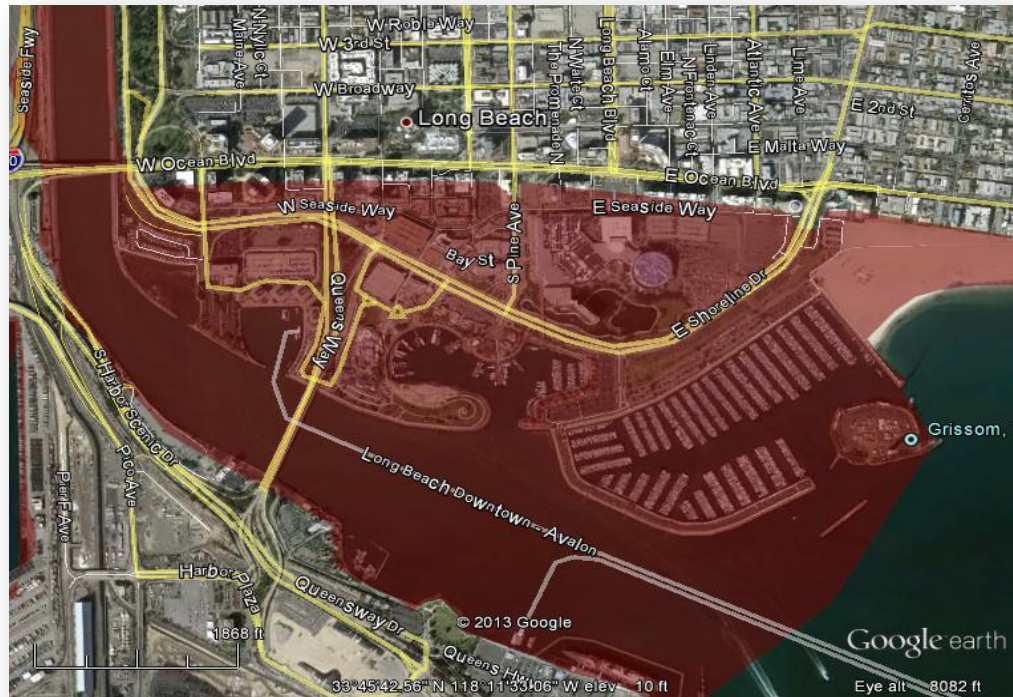
# 1<sup>st</sup> wave generally not the largest





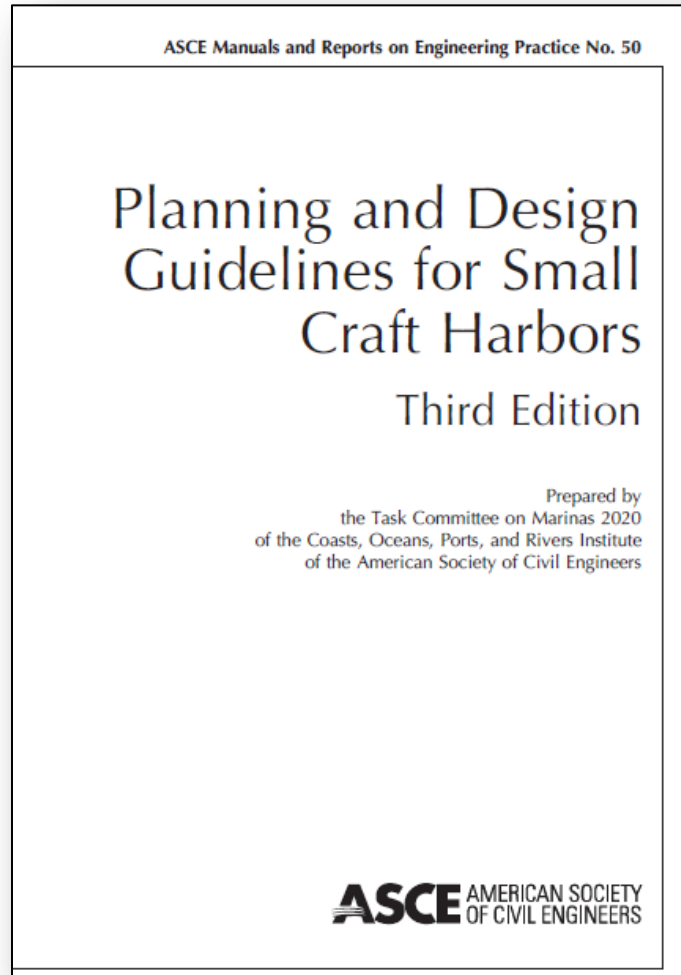
# Inundation

## Long Beach



## Huntington Beach

# Marinas and harbors



“We don't THINK that a large tsunami would cause docks to float off the top of pilings, we KNOW that it will happen.” -- Morro Bay Harbor Director



# 15% of boats sink, 20% damaged, \$700M



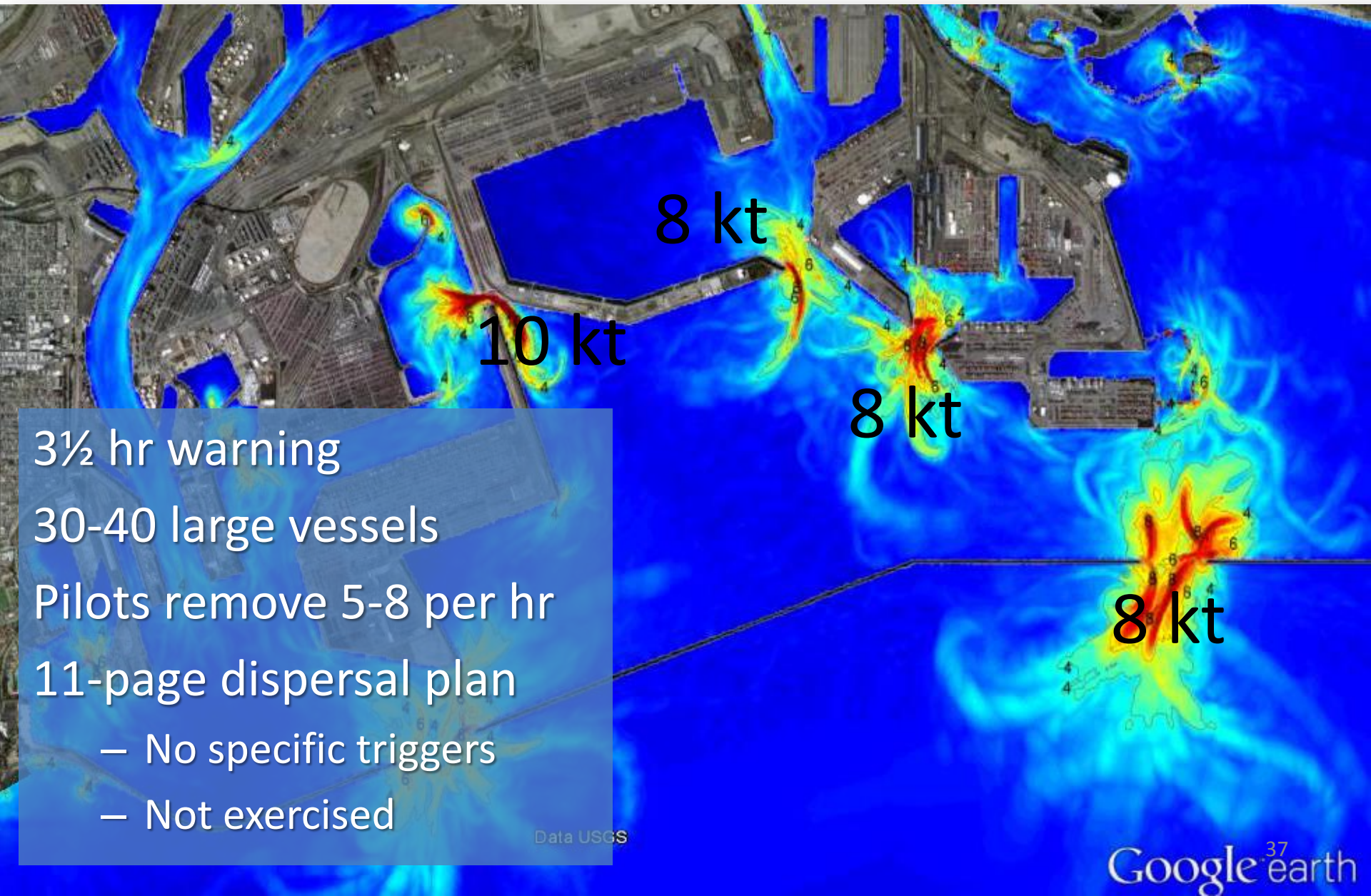
+ sediment  
transport,  
hazmat,  
nav hazards



# Ports of Los Angeles and Long Beach

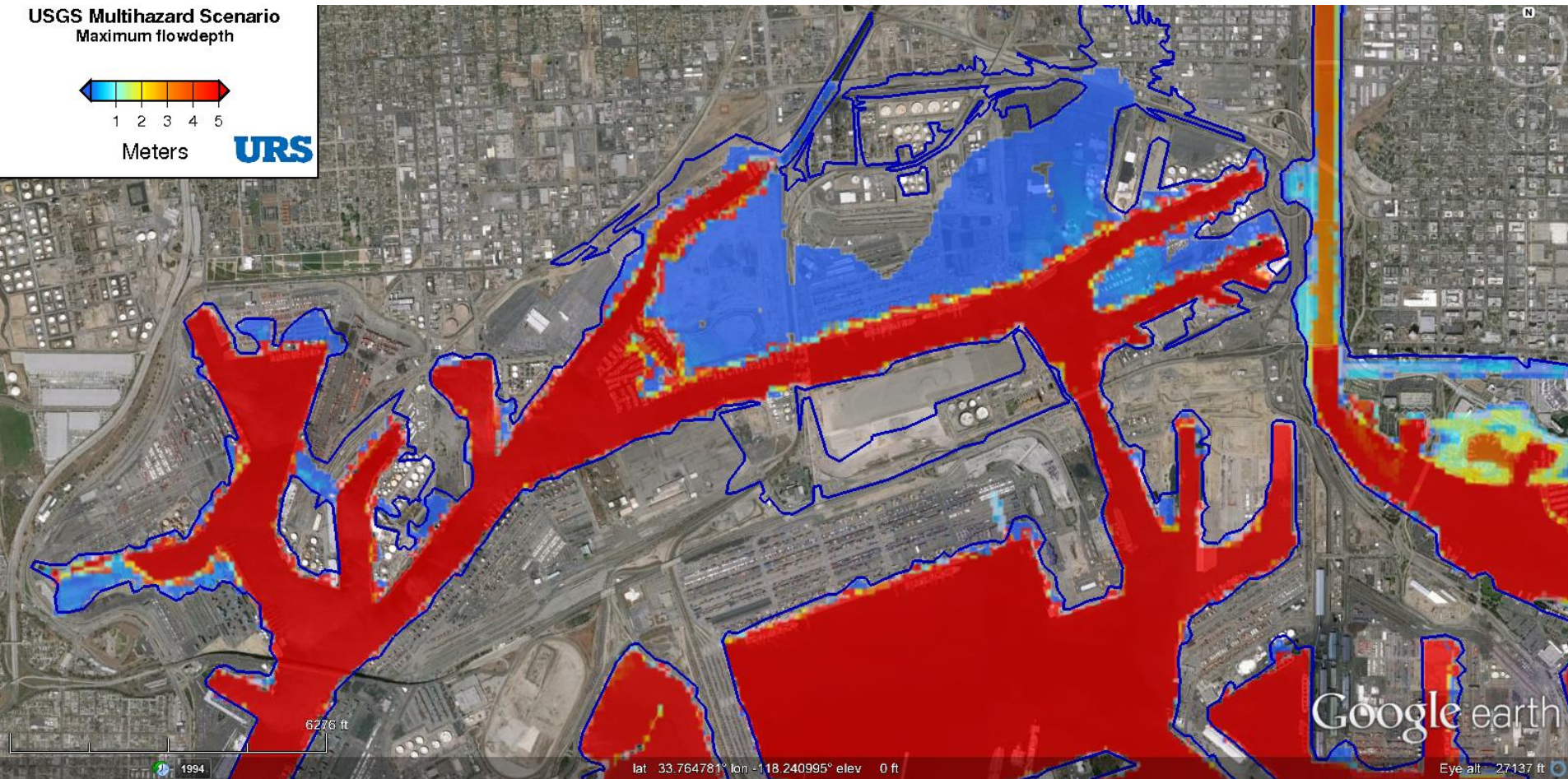


# Ports of Los Angeles and Long Beach





# Ports of LA & Long Beach





# Ports of LA & Long Beach: 2,650 cars

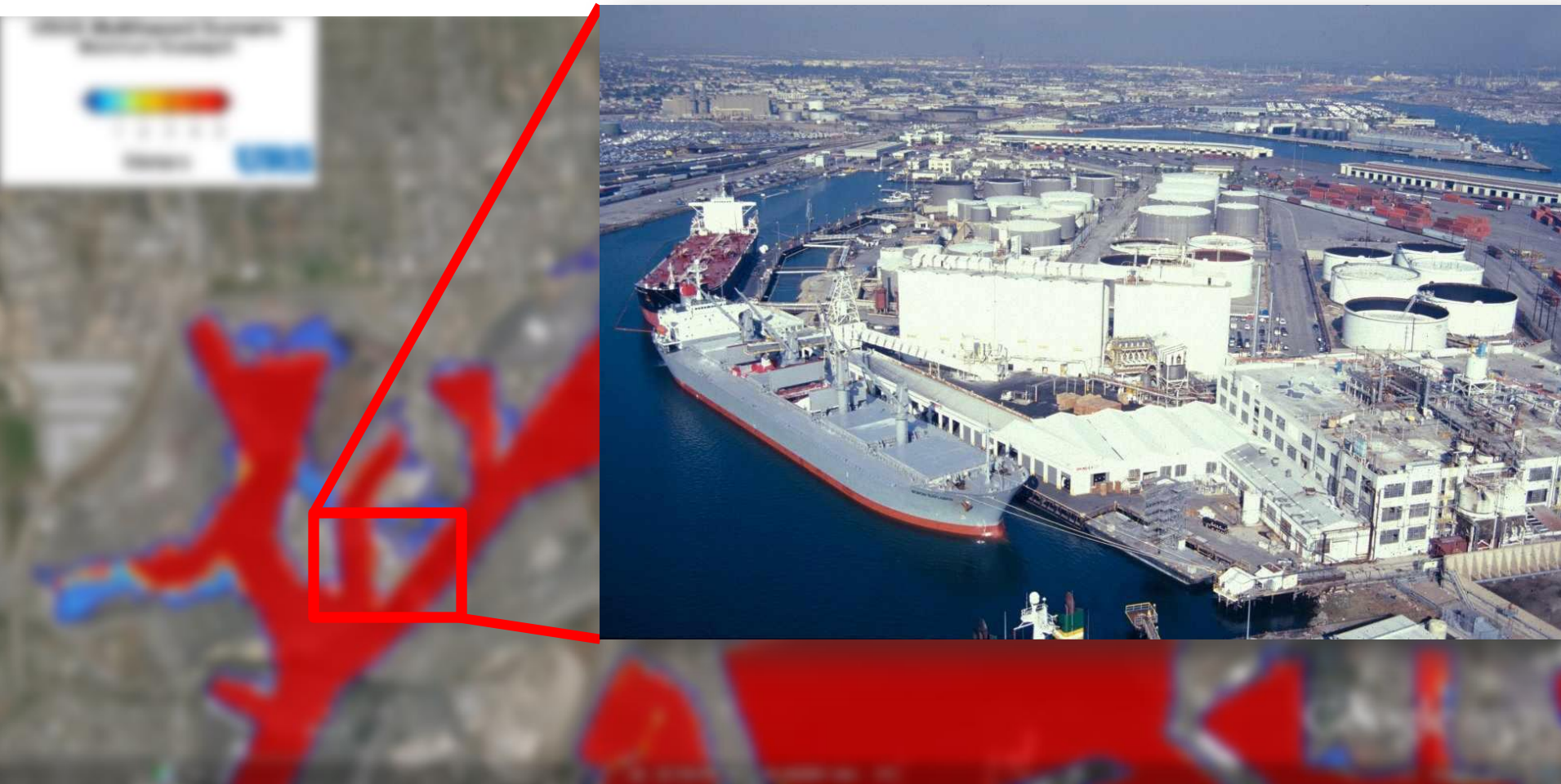


# Ports of LA & Long Beach: 1,040 TEUs



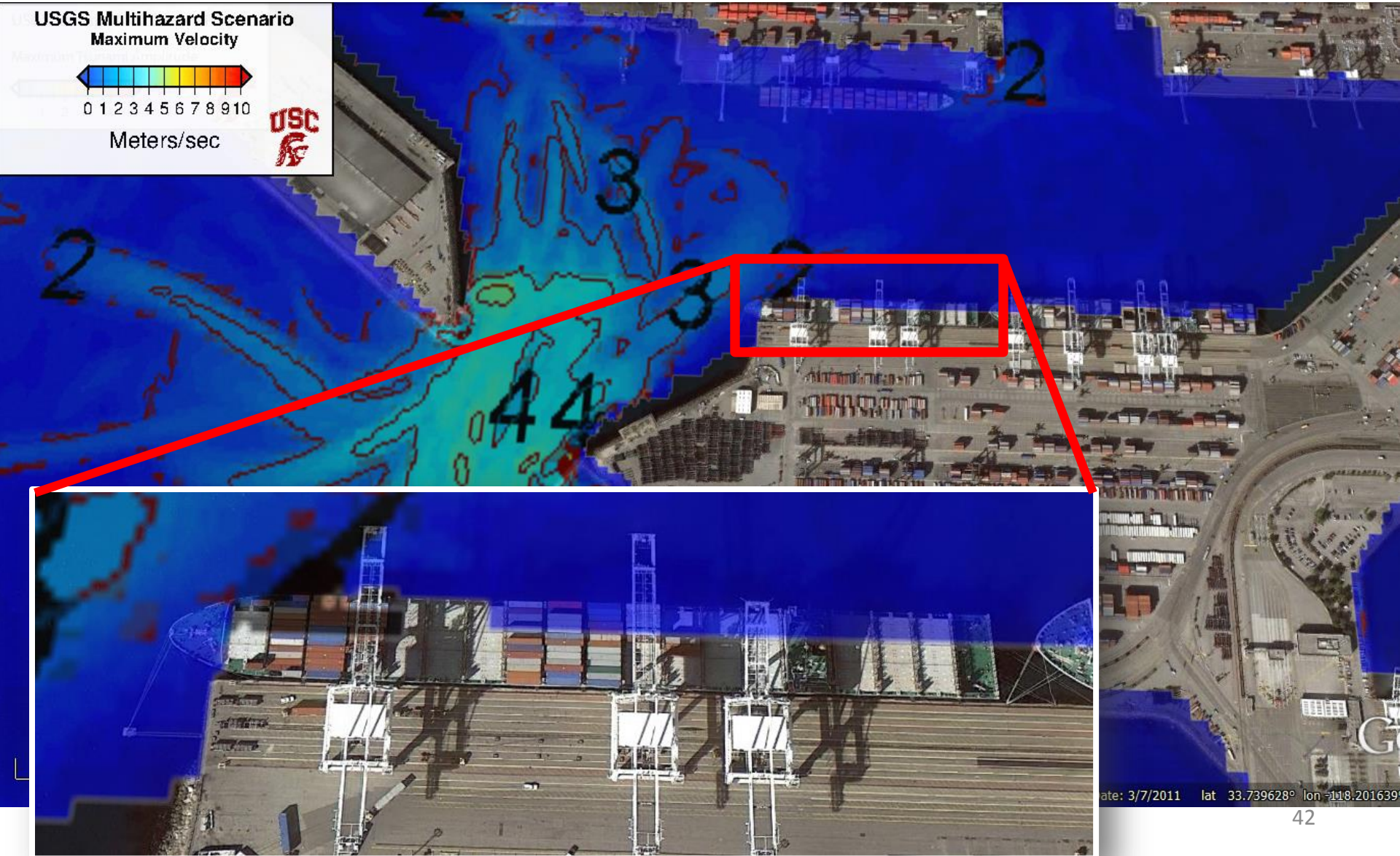


# POLA & LB: liquid & dry bulk





# POLA & LB: moorings, warehouses, equipment



# Ports of Los Angeles & Long Beach

\$100 million

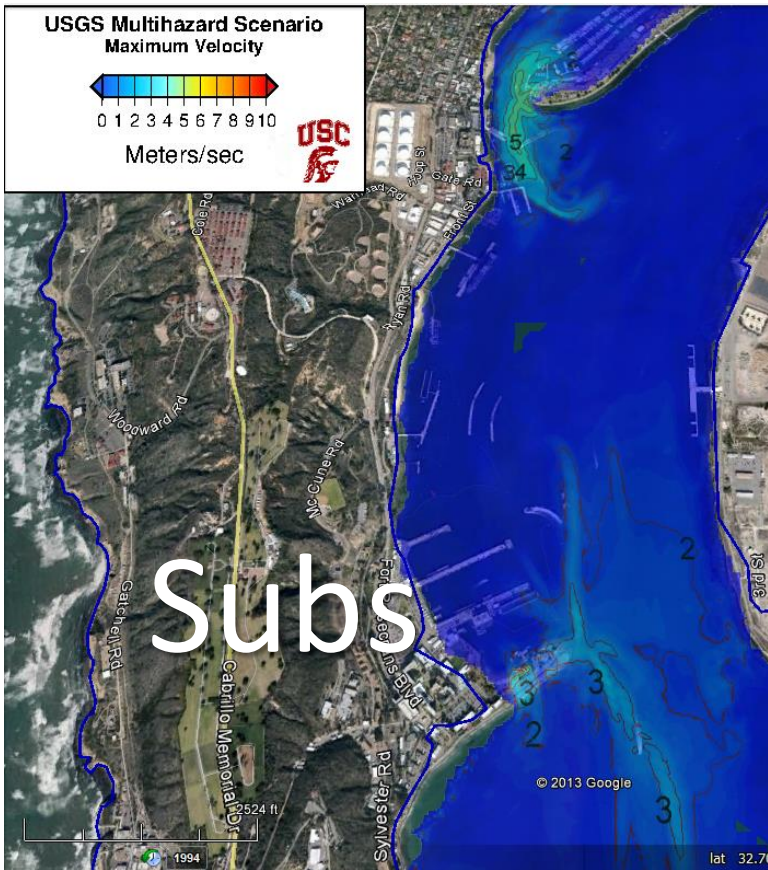
2-3 days of downtime

6 months repair





# Port of San Diego





# Highways and bridges: Bay Bridge toll plaza



# 13 highway bridges w/ embankment scour





Golden Gate Bridge

San Francisco-Oakland Bay Bridge

San Francisco-Oakland Bay Bridge





# Highways & bridges

\$100 million in repair costs  
2-3 days for some repairs  
3 months for others

# Coastal homes & businesses





# Coastal homes & businesses





# Coastal homes & businesses



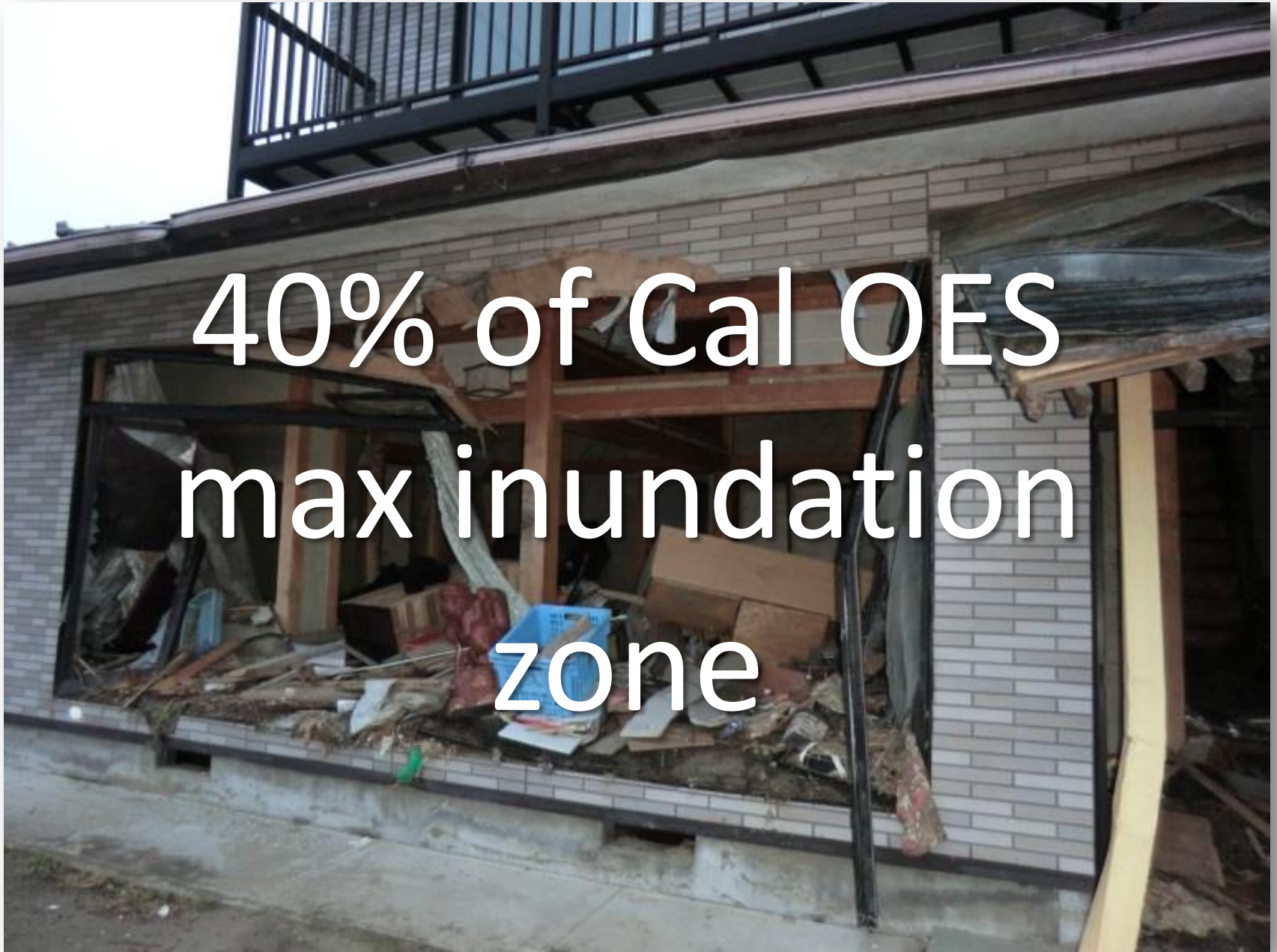
103 million sq ft  
≈ 70,000 dwellings

# Coastal homes & businesses





# Coastal homes & businesses



40% of Cal OES  
max inundation  
zone



# Coastal homes & businesses



\$2.6 billion in  
repairs, mostly  
contents



**Fuel + debris = fire**



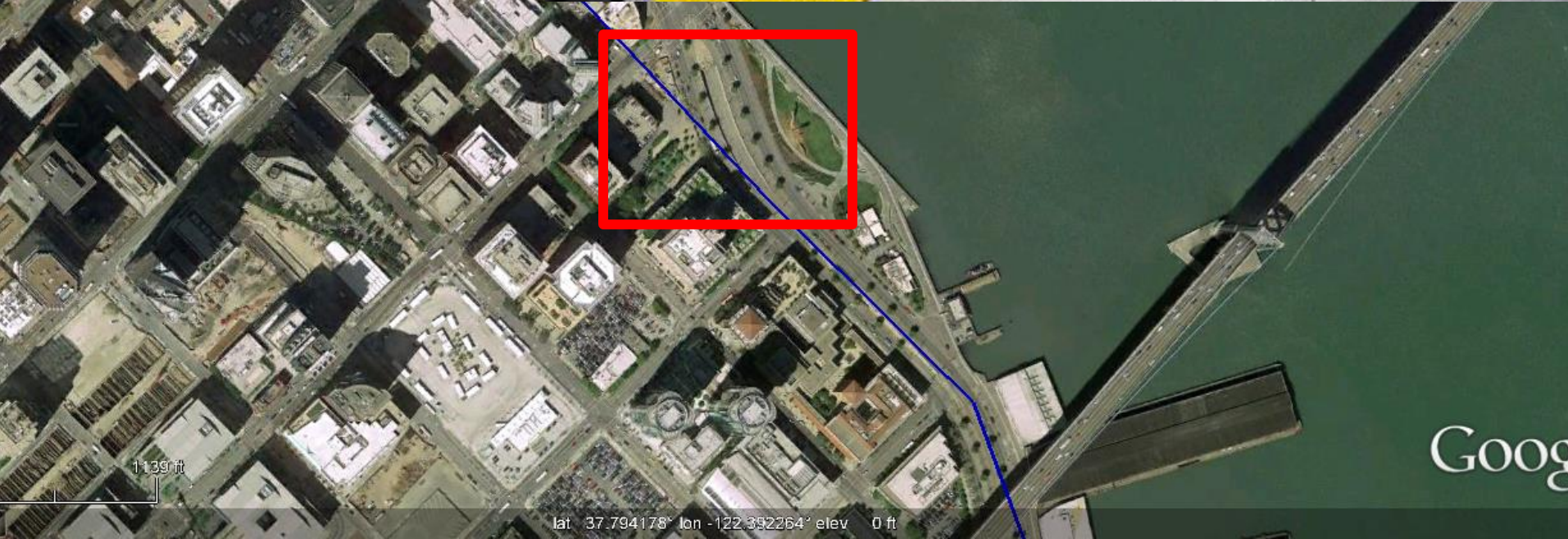
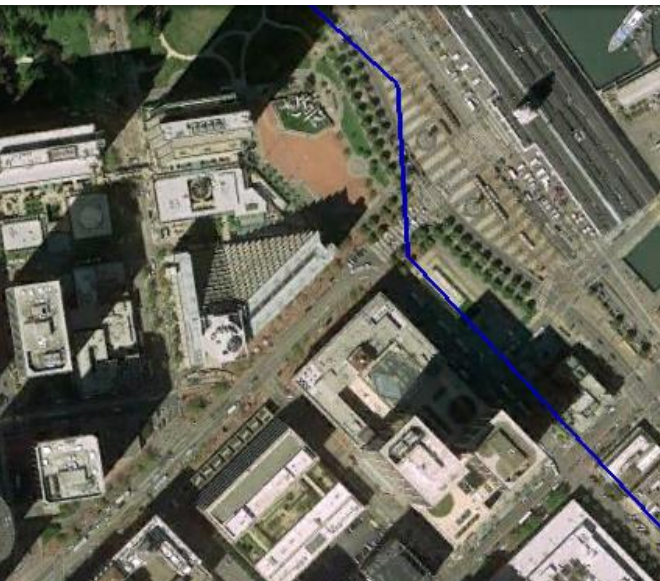


# 17 wetted tank farms





# Tunnels

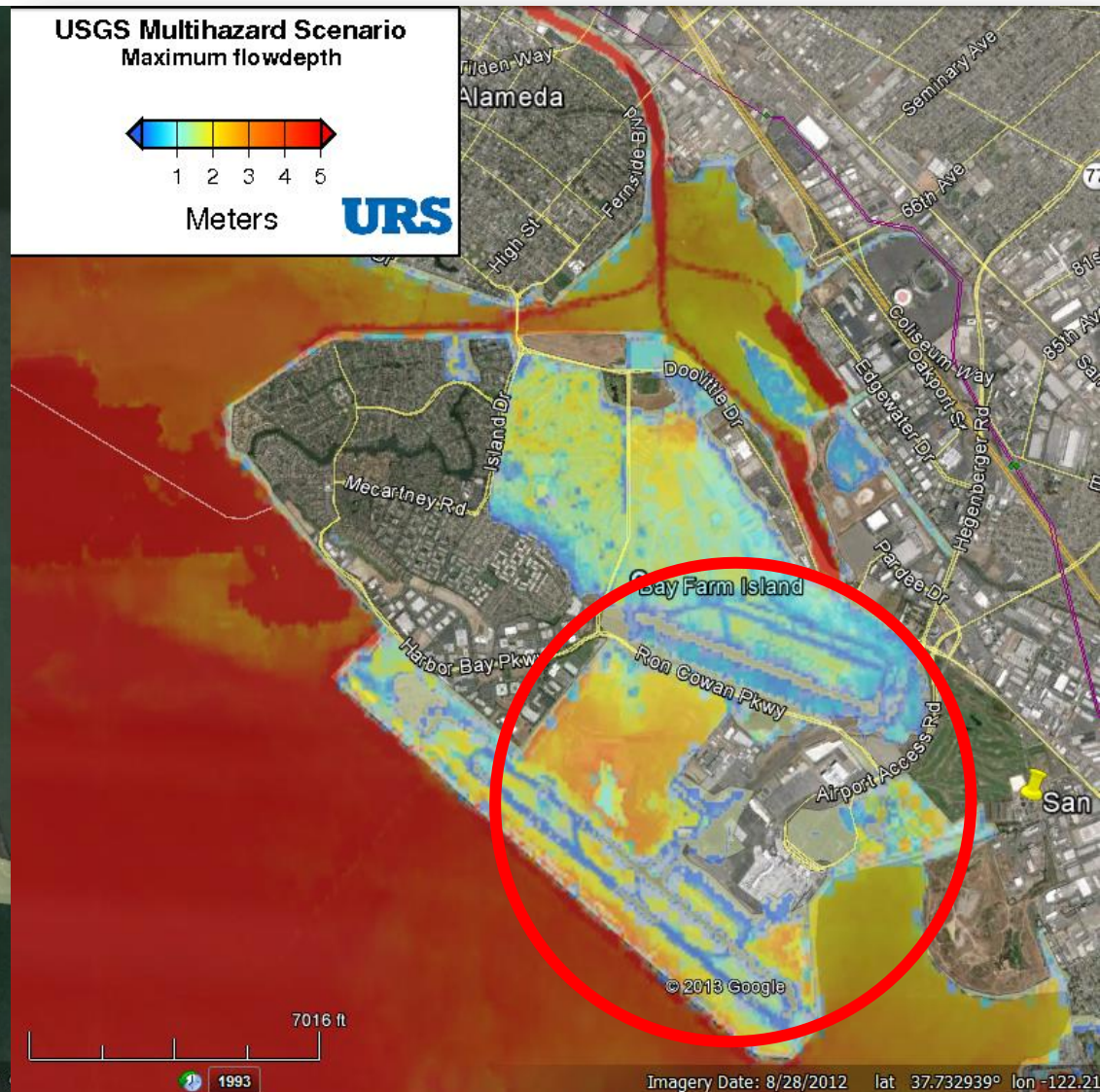


lat: 37.794178° lon: -122.392264° elev: 0 ft

Google



# Other infrastructure



# Repair cost across CA: \$4-5B

Assets	Repair cost M 2010 USD
Ports of LA and LB	\$100
Marinas and small craft	\$700
Property damage	\$2,600
Roads and bridges	\$100
Railroads	\$2
Agriculture	\$4
Total (rounded)	\$3,500

- Other ports, sediment, soil remediation, fires, and evacuation could add \$1 B+
- Business interruption adds \$1-5 B



# What matters?

**Time:** short time for decisions; evacuate to state lines

**Tides:** previous tsunamis came at low tide

**People:** will trigger evacuation of 750,000 people

**Place:**

- So Cal has lower wave heights than the central and north coasts
- Some areas are completely submerged
- Cliffs can protect us

**Currents:** potentially more important than inundation

**Response:** you control the bottom line

# The Bottom Line

\$5-10 billion statewide loss

- \$4-5B marinas, ports, buildings, roads, bridges
- \$1-5B business interruption

Depends on actions and preparation

Recovery depends on planning

Planning matters...



# Looking Forward

- Policy implications - what can CA decision-makers do with this?
- 2014 Fiftieth anniversary of 1964 Good Friday earthquake and tsunami
  - Opportunity for exercises and public awareness
  - Communication products
- Working with the state tsunami program

Youtube PSA <http://goo.gl/ycxNtO>

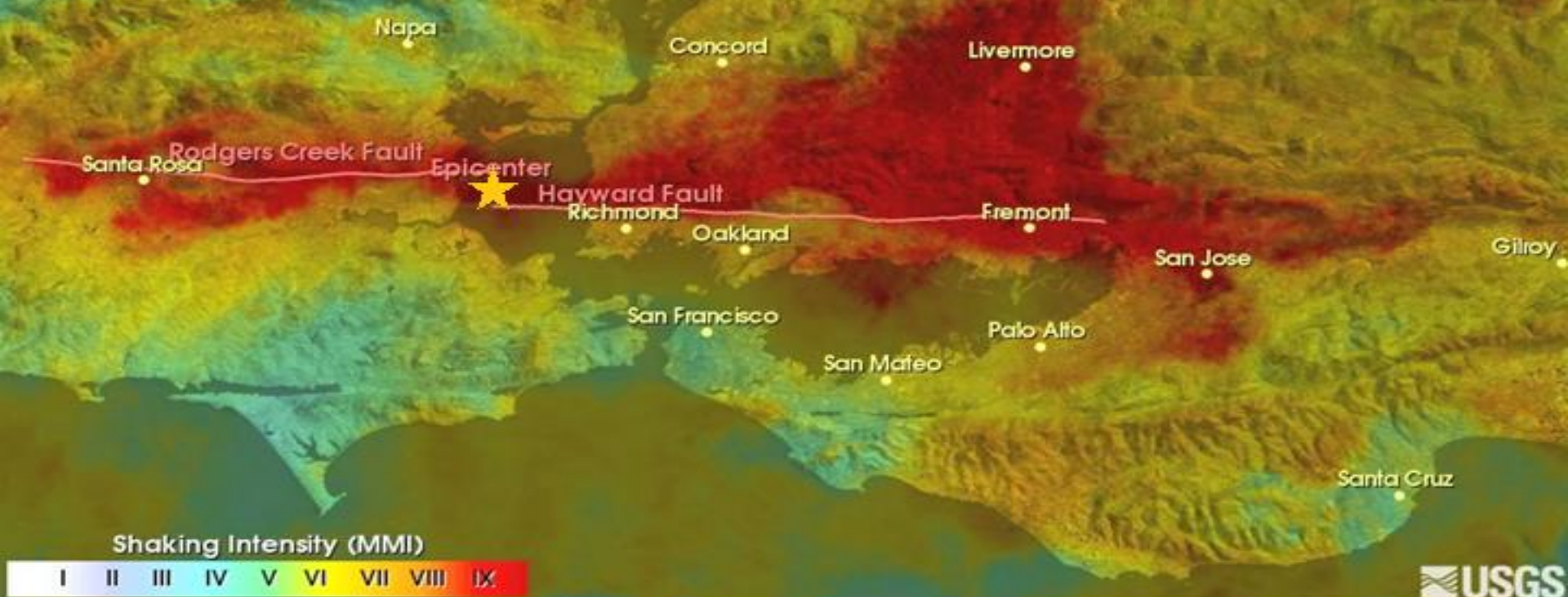




M7.2 Scenario Earthquake

Time = 75.0 s

# Coming soon: Haywired



# Additional material

More at: <http://goo.gl/KULg7r>

- Ports of Oakland, San Francisco & Richmond
- Potential environmental impact
- Rail
- Agriculture
- Tsunami walks



# Thanks

[Keith.porter@colorado.edu](mailto:Keith.porter@colorado.edu)

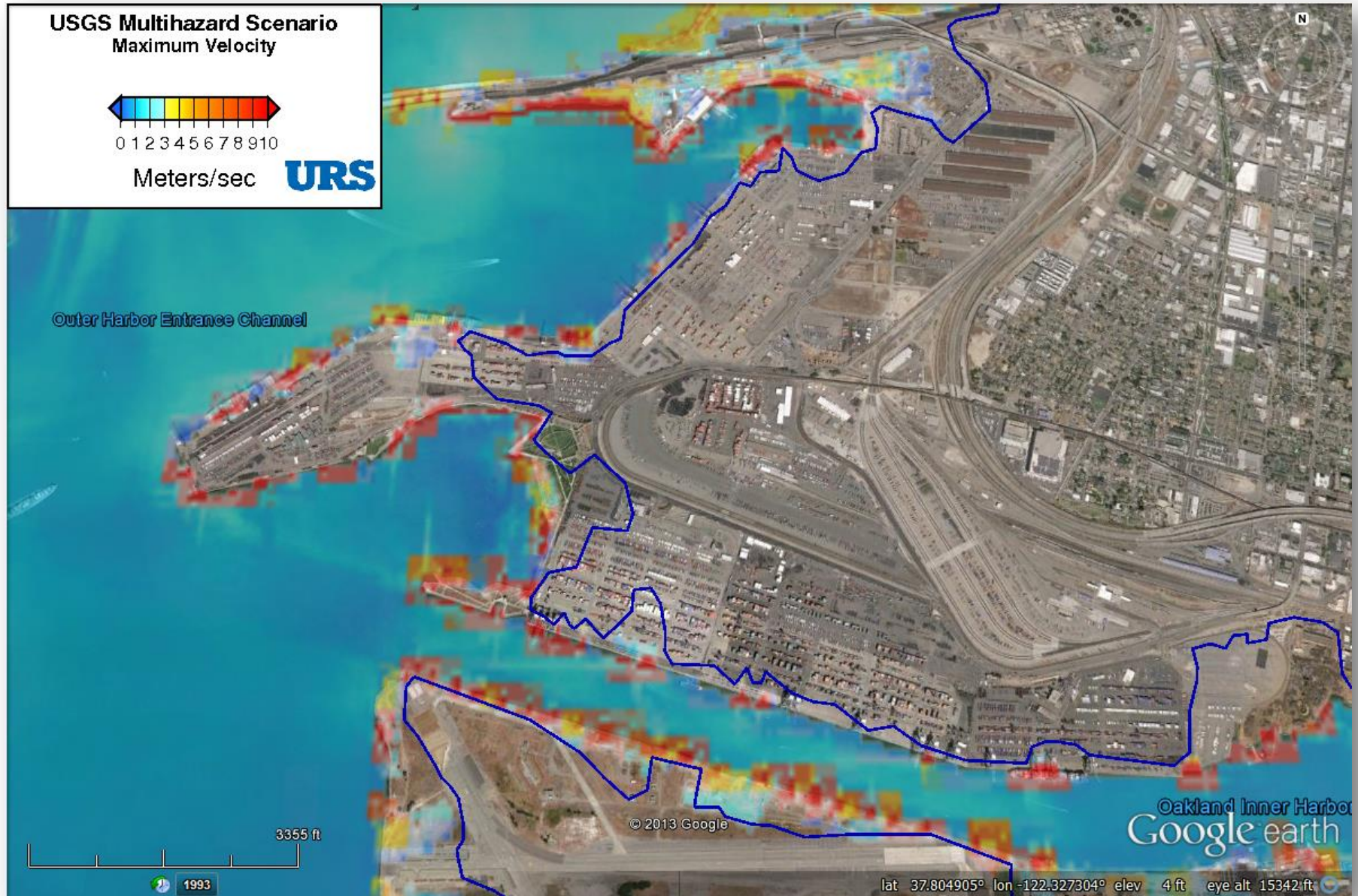
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# Port of San Francisco



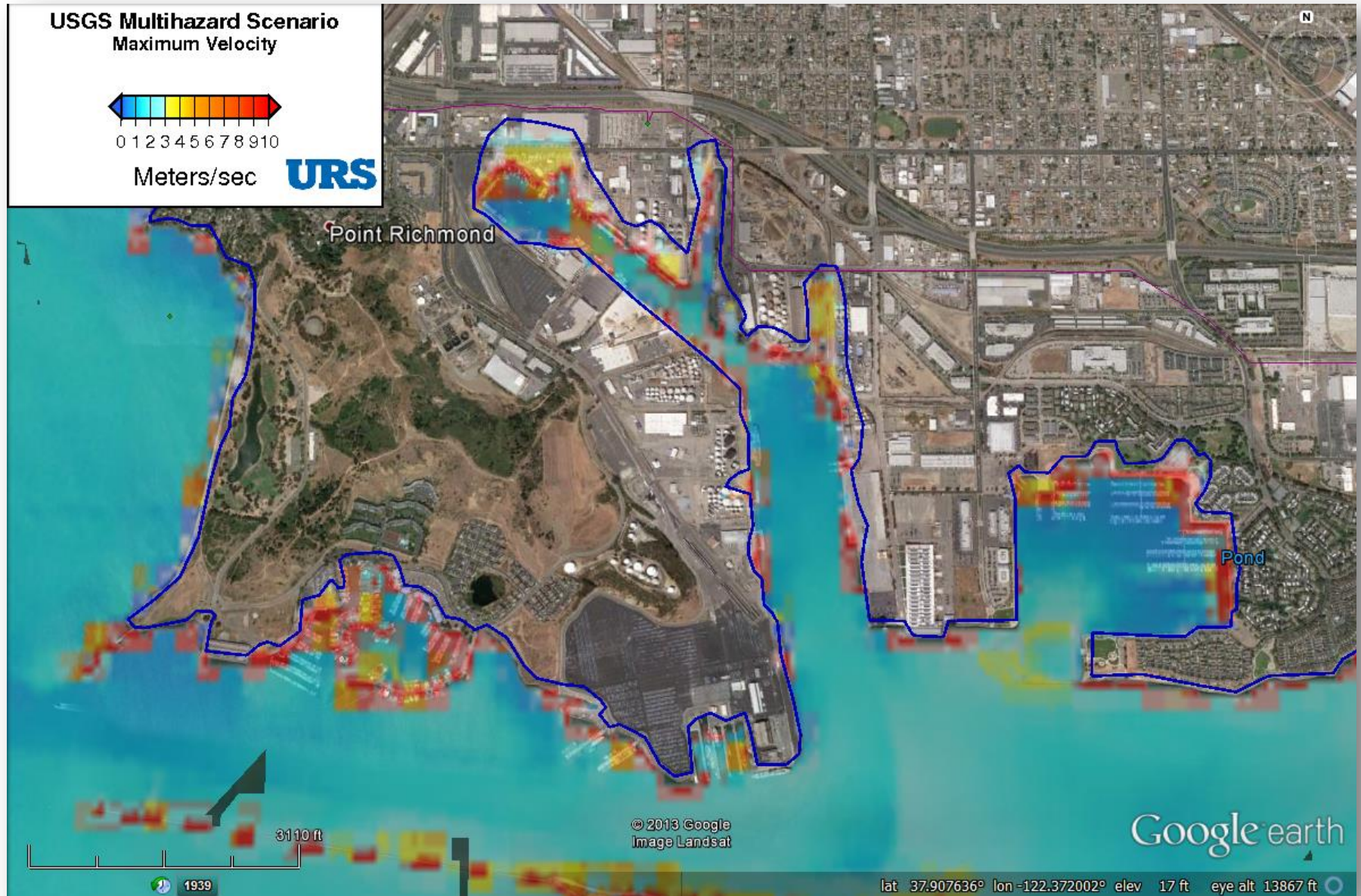


# Port of Oakland





# Port of Richmond



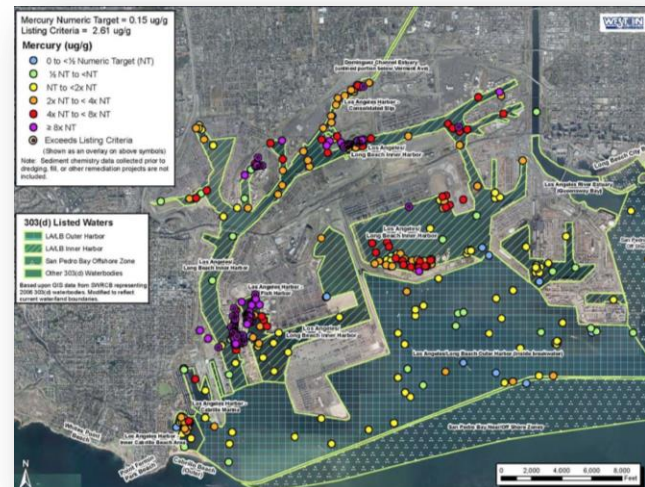


# Potential environmental impacts

- Toxicants in debris
- Petroleum from refineries, terminals, & vessels
- Dry bulk (industrial borates...)
- Smoke, ash, debris from fires
- Contaminated sediments



Port of Sendai March 2011 (EPA)



Mercury in harbor sediments



# Rail damage modes





# Rail debris deposition



14 locations, 42 km



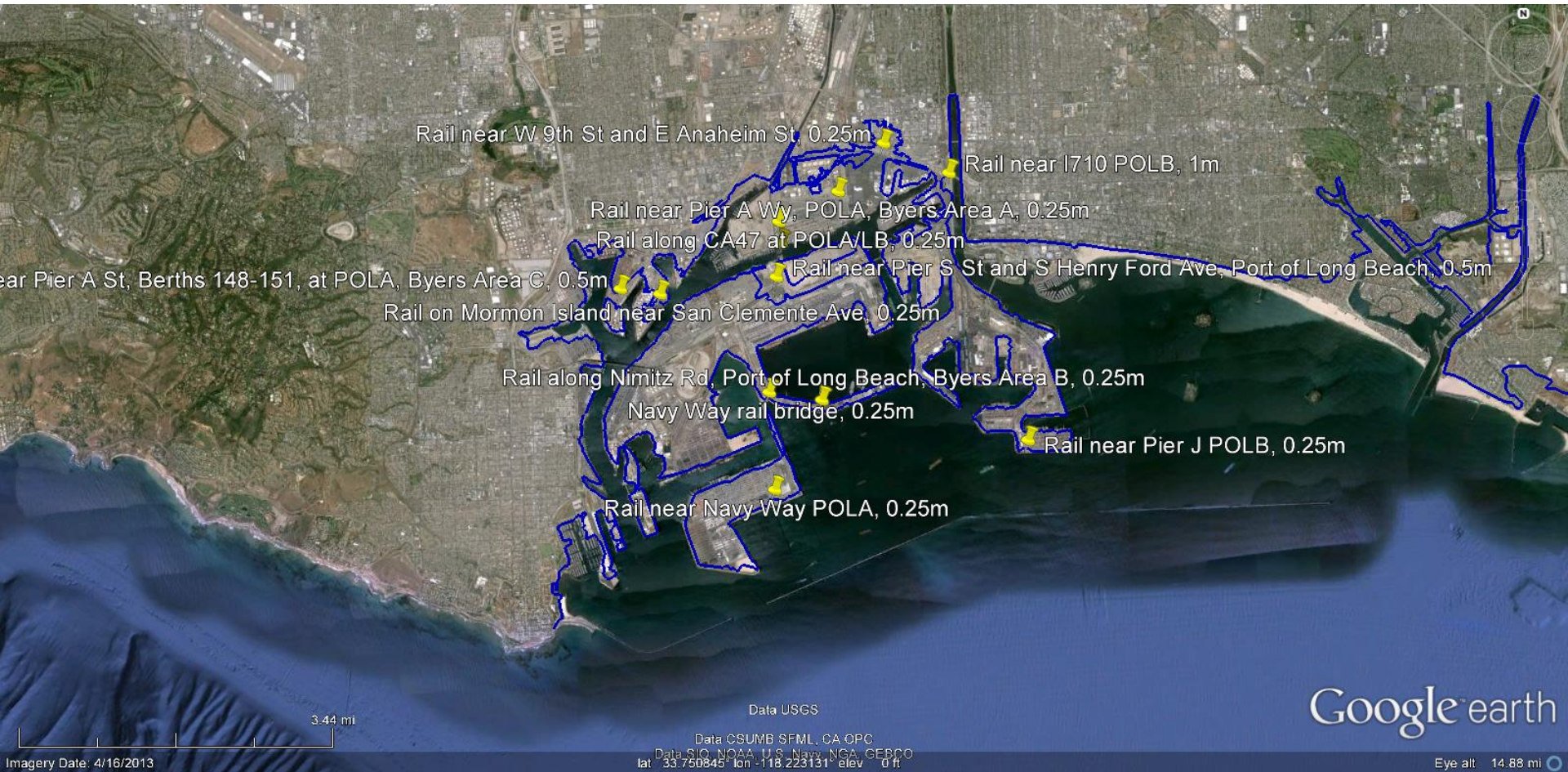
# Rail in Carpinteria



0.9 mi ballast,  
embankment and rail  
damage



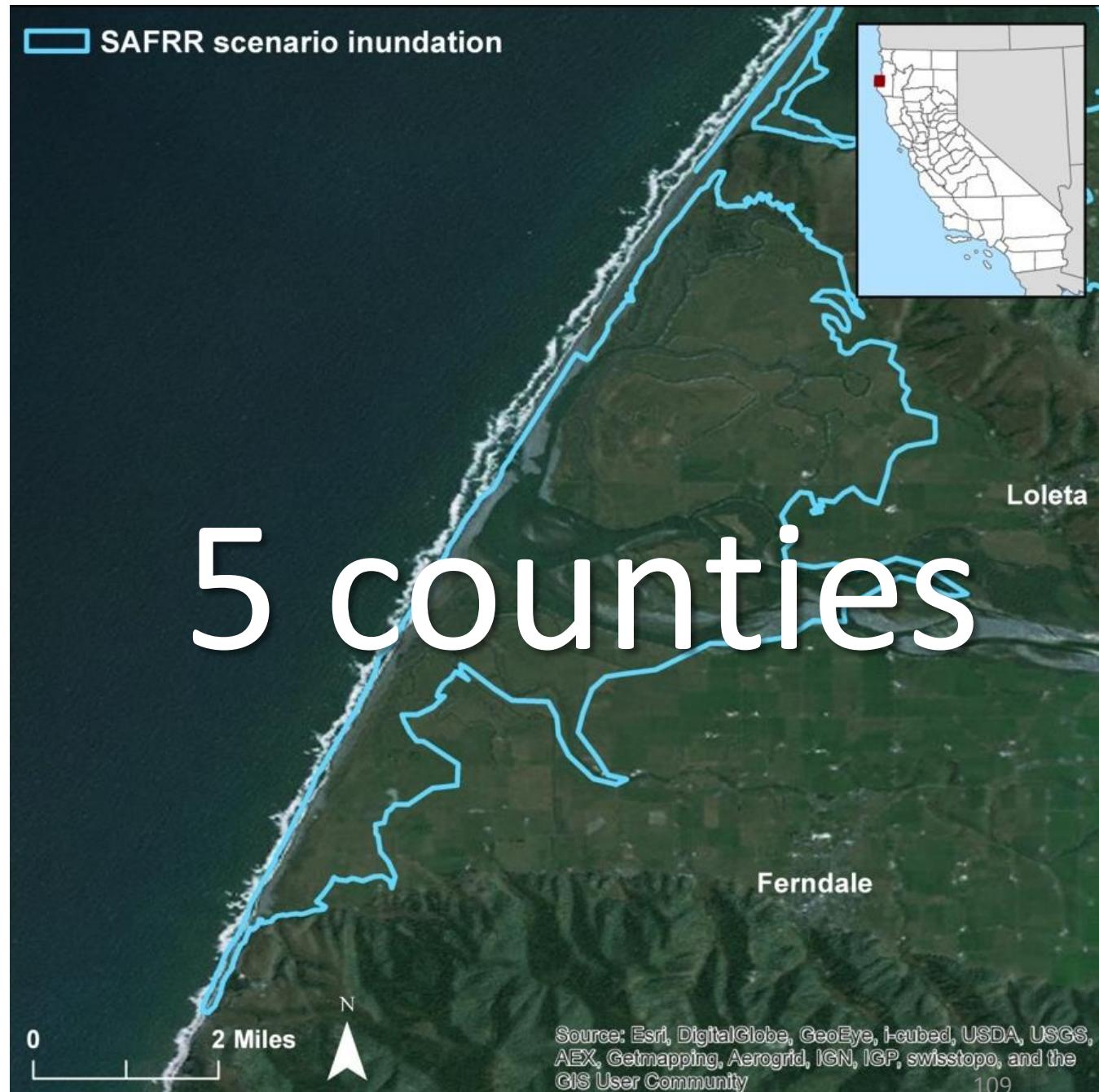
# Rail in Ports of LA & Long Beach



50 cars damaged, total \$2 million damage

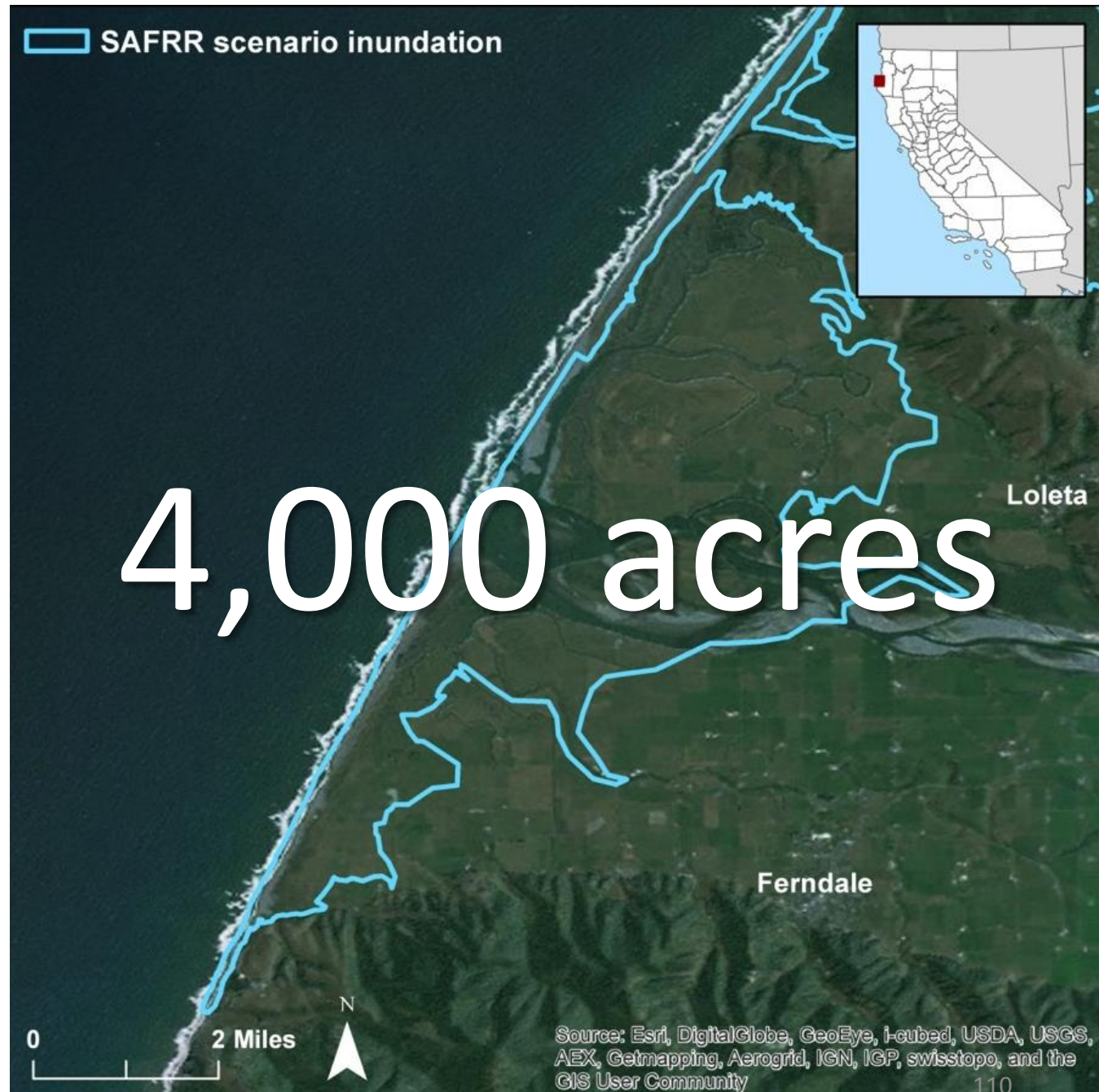


# Agriculture

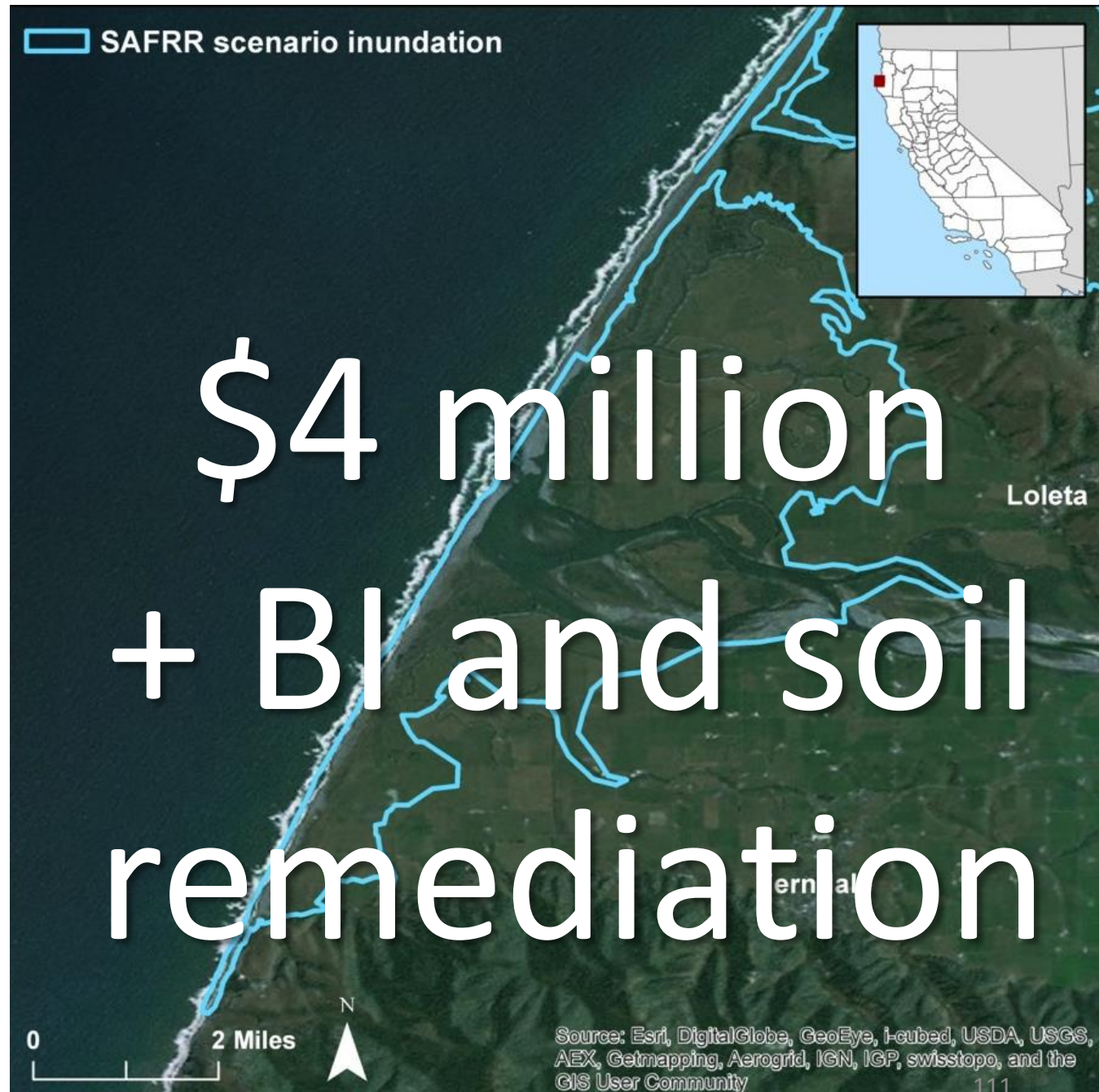




# Agriculture



# Agriculture





# Communication products



## Template for a Tsunami Walk

### What Is A Tsunami Walk?

A Tsunami Walk is a drill that stresses simplicity and fun, and is suitable for coastal residents or visitors. Walk participants will discover that there are tsunami danger zones and tsunami safe zones - and that they can walk from one to the other! They will learn how easy it can be to get safe.

The visual memory of making the walk provides a powerful, long-lasting boost to tsunami awareness. The lighthearted event helps many people reduce their fear and hear the underlying serious message.

### It's Your Event

In this document are ideas to help you stage a Tsunami Walk in your community. Feel free to change anything, including the name! Expect to adjust and embellish as you tailor the event to your situation. Let us know what you do, and how it goes!

For the most basic Walk, you will:

- select a route that starts in a tsunami danger zone and ends in a safe zone;
- set a date and time; and
- publicize your event.

Optionally, you might also:

- Invite local leaders and officials to lead the walk;
- Engage CERT or Red Cross to help organize your event;
- Coordinate with school drills;
- Come up with a slogan like "Walk Out, Don't Wipe Out";
- Color-code the walk with blue chalk or painter's tape, to emphasize which areas could get wet during a tsunami's inundation;
- Plan the walk to emphasize existing tsunami signs;
- Stage light-hearted contests for participants:
  - Give prizes for biggest group of participants or cleverest costume;
  - Hold a treasure hunt along the route;
- For those who conclude the walk:
  - provide handouts or goodies;
  - hold a concert or carnival.