The Great California ShakeOut – Teaching Risk & Resilience

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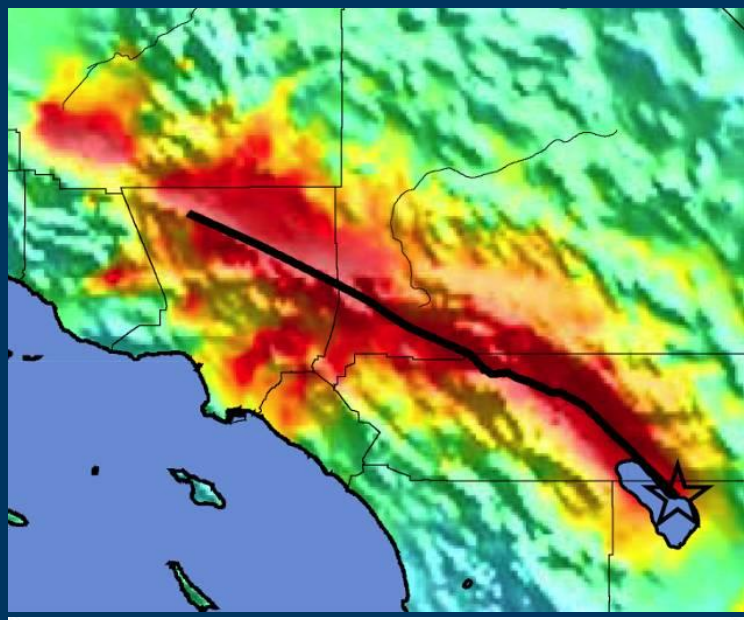
Earthquake Country **Alliance**
We're all in this together.

What is a ShakeOut?

- A 2008 USGS-led disaster scenario involving 300+ people
- Created at stakeholder request
- Severe, not-worst-case
- Science-based, societal scope
- A worldwide exercise
- To answer the question:



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

What could happen in the big one & how can one prepare?

ShakeOut

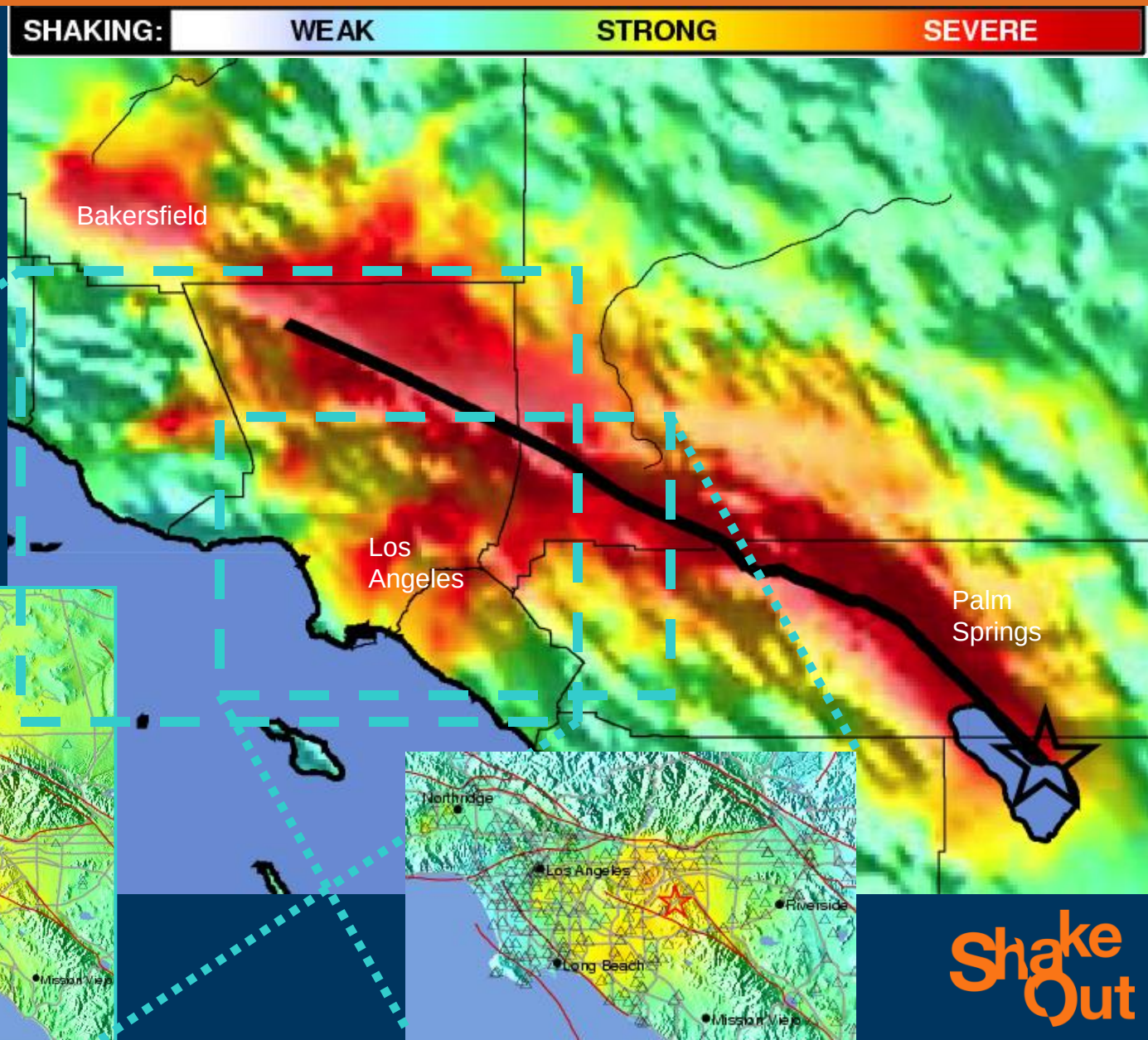
150 yr return period; 300 yr since last rupture

Compare with 1994 Northridge earthquake:

- 5000 smaller!
- Magnitude 6.7
- 33 deaths
- $40 billion damage

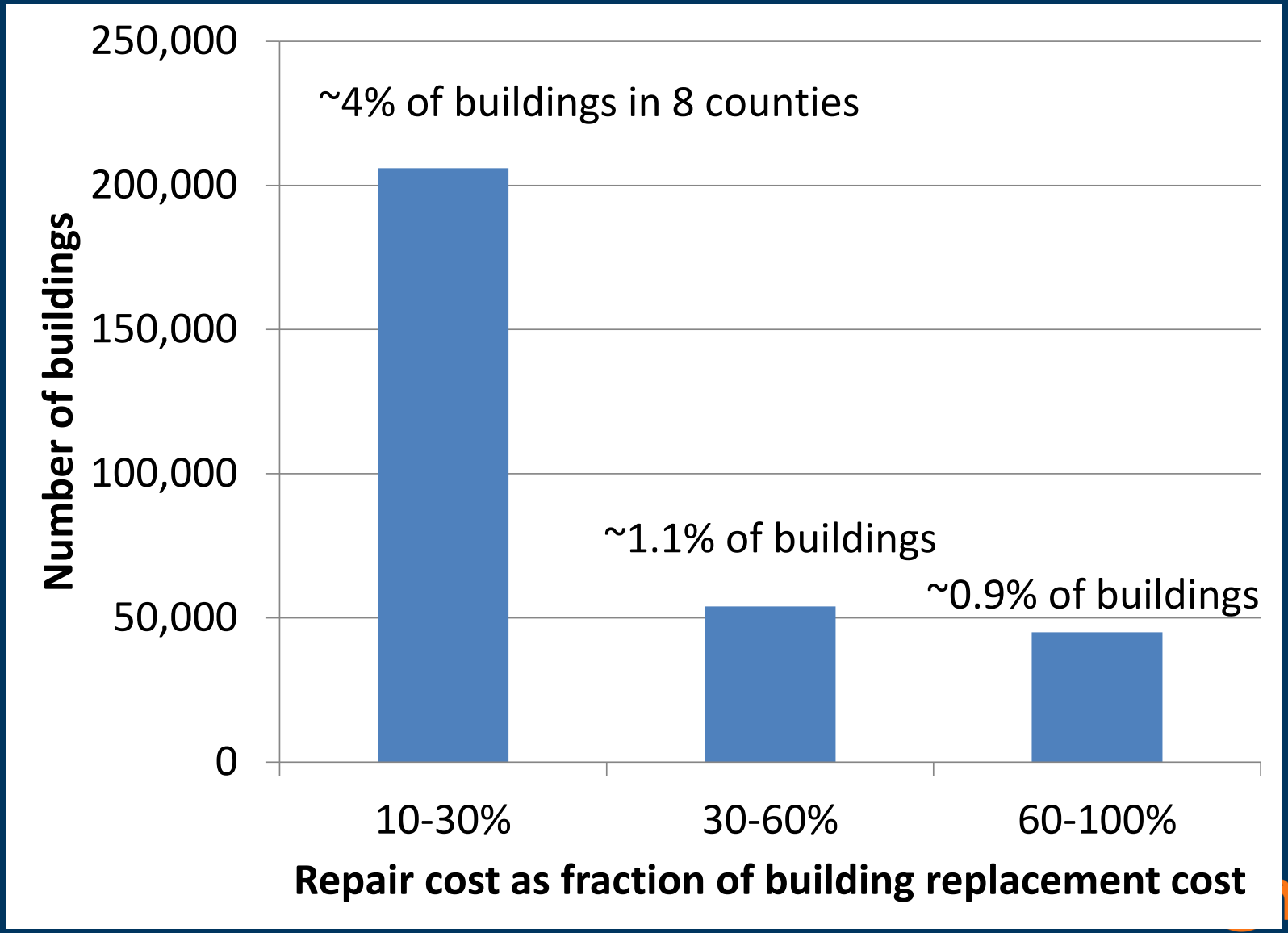
Compare with 2008 Chino Hills earthquake:

- 8 x smaller
- Magnitude 5.4
- 0 deaths
- $400 million damage



ShakeOut

Building damage



Focus study: steelframe buildings

- 600 buildings, 1,000+ occupants each
- Unexpected damage in 1994
- ShakeOut: 5 collapses, 30 more red or yellow tagged

Kobe, Japan 1995

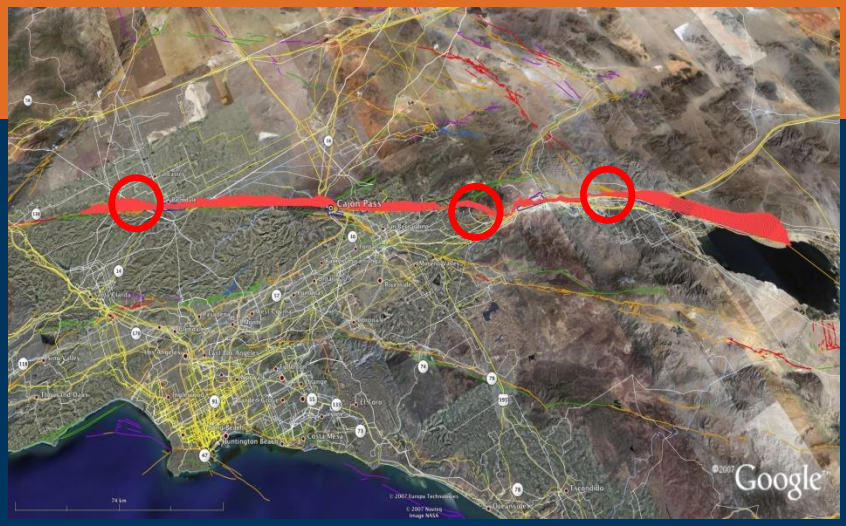
"The fact that there were no collapses in previous US earthquakes cannot be taken as evidence that there would not be collapses in this scenario. In fact, the possibility of some collapses is quite credible." – Review panel

Mexico City, 1985

Water supply

19 reps from 8 water agencies:

- Aqueducts & tunnels rupture at fault crossings
- ≤ 10 mi. of fault: supply impaired up to 6 months
- In 3 counties, 5% lose service for 1-8 weeks
- 1/2 customers lose service for up to 1 week
- LADWP now renovating aqueducts
- Water agency staff now have desk at EOC



1971 San Fernando Earthquake

1994 Northridge Earthquake

Deaths & injuries

1,800 killed, 50,000 injured (ER)

Northridge: 33 killed, 8,300 injured

Up to 2/3 of hospital beds unavailable in some counties

Evacuation of Sherra Cox, 1989 Loma Prieta earthquake

Olive View Medical Center
1971 San Fernando earthquake

Fire following earthquake

1,600 ignitions

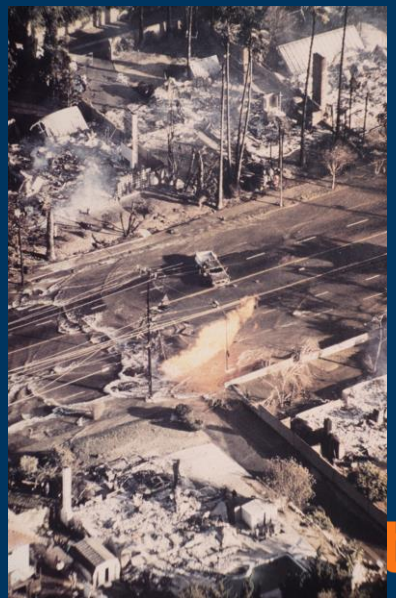
200M ft^2 burn ≈ 133,000 homes

Not worst case

Recommended new water supply system

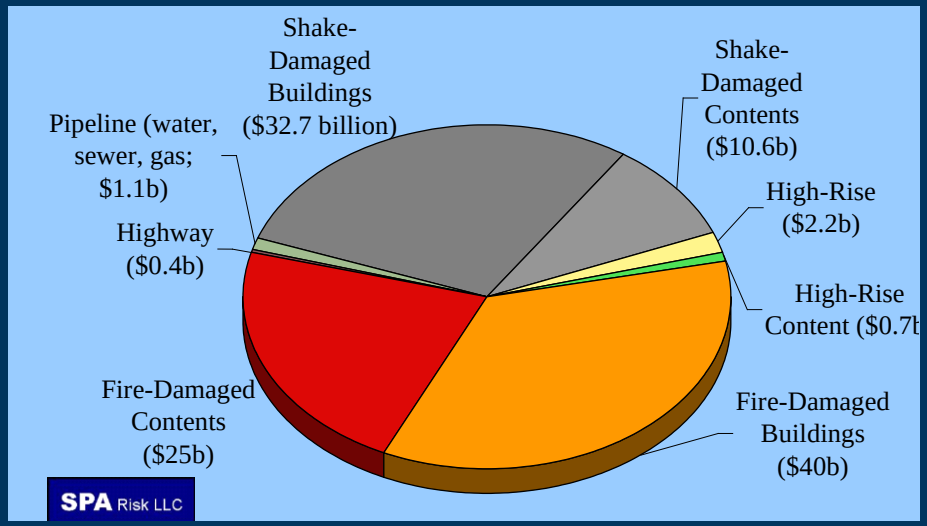
1989 Loma Prieta

2 fire chiefs, 2 other fire officials:
“Reasonable… if anything, a bit low.”



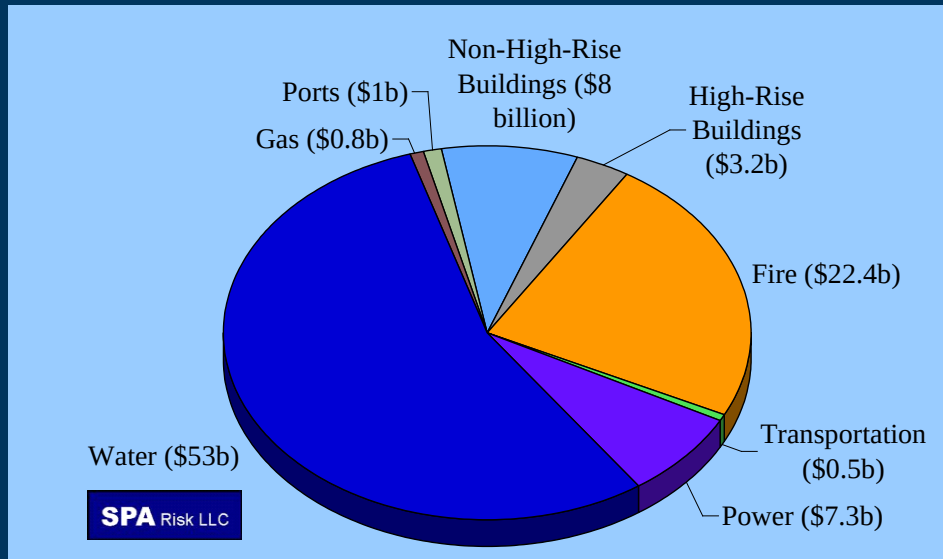
1994 Northridge

Monetary bottom line



Property damage: $113 billion
60% from fire

Business interruption: $96B
55% from water



10 Teaching Lessons

1. Risk measures matter

Public & officials

Not-very-rare earthquake

1,800 deaths

53,000 injuries

$213 billion damages

255,000 displaced people – 1 in 60

1,600 fires requiring response

300,000 buildings significantly damaged – 1 in 16

Engineers

2500-year shaking

~0.2% collapse rate

10 deaths per 100,000

ShakeOut

2. Relate to experience

1989 Loma Prieta

1989 San Francisco

1971 San Fernando

5/2/83 M6.5 Coalinga

1994 Northridge CA

1933 Long Beach

ShakeOut

3. Avoid sensationalism

- Five highrise steelframe buildings collapse
- *Steel frame is safer than other types*

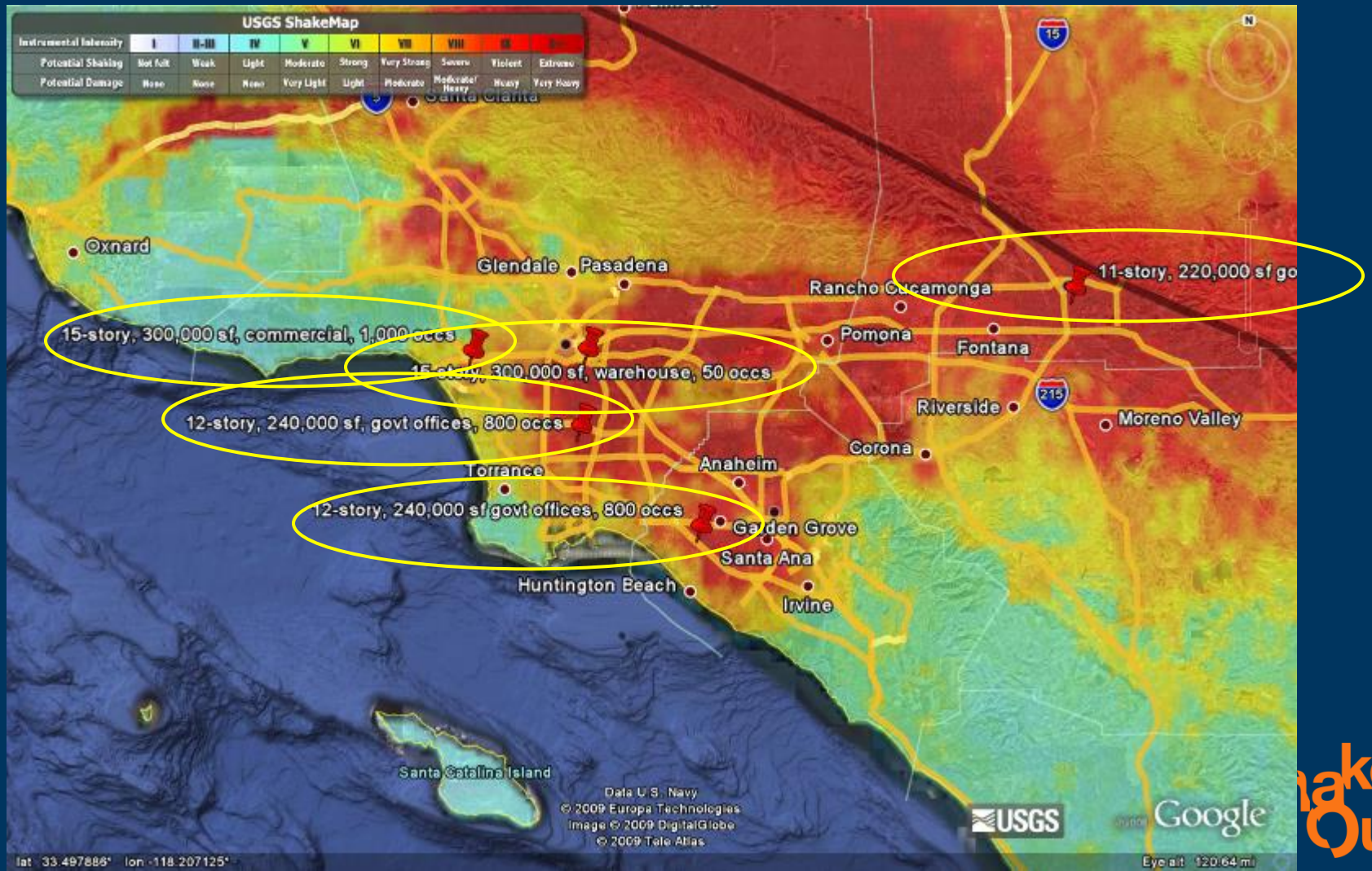
Crack in steel weld

Collapsed steel building

ShakeOut

4. Use probability sparingly

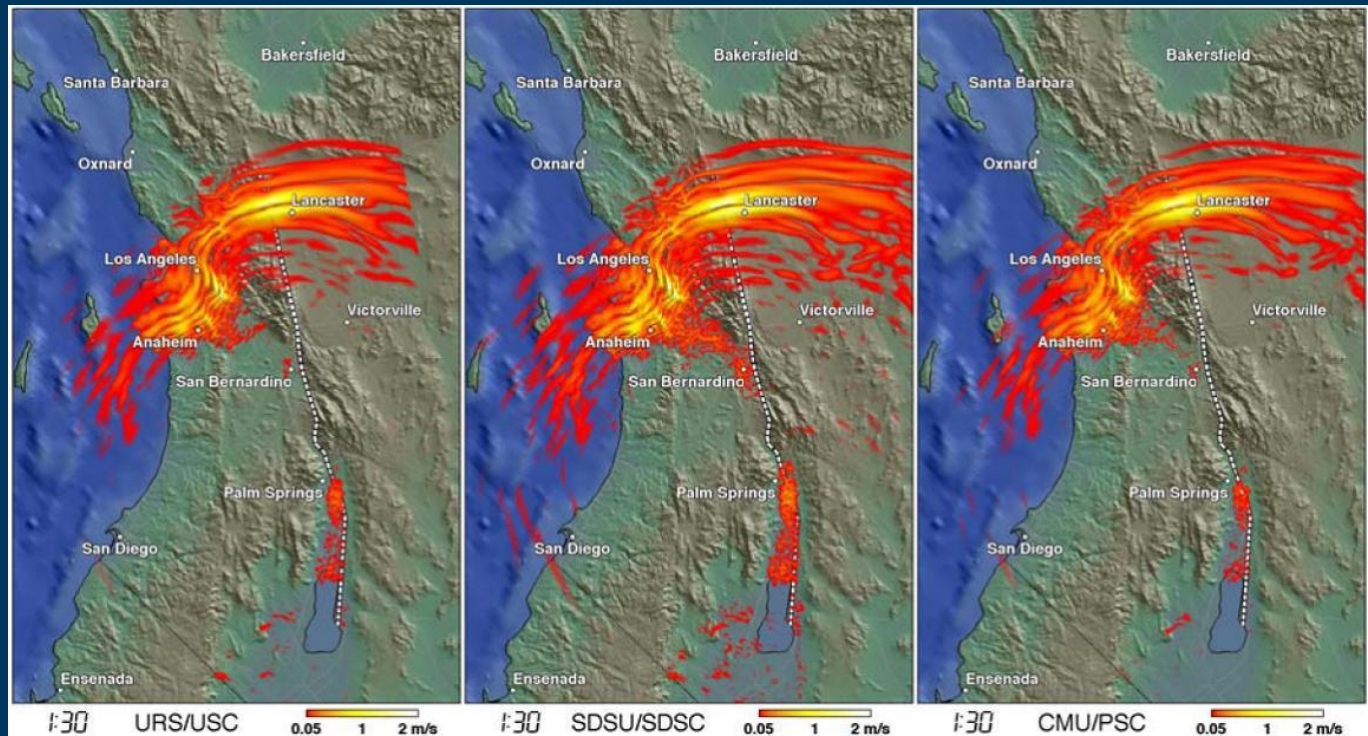
"Won't happen like this; will happen; could be tomorrow"



5. Involve everyone

- Stakeholders & scholars created the scenario
- Independent, parallel studies, cross-compared
- Considered interaction & limitations of mutual aid
- Validation by thought leaders for controversial results
- Multiple agencies, NGOs endorsed & promoted the scenario

Hudnut et al.,
Suess et al., Raleigh



6. Confront misinformation

E.g., “triangle of life”

Explain false assumptions

Cite rebutting authorities

7. Acknowledge limitations

Best earth science, but science evolves

Objective: reasonableness, not probabilistic risk

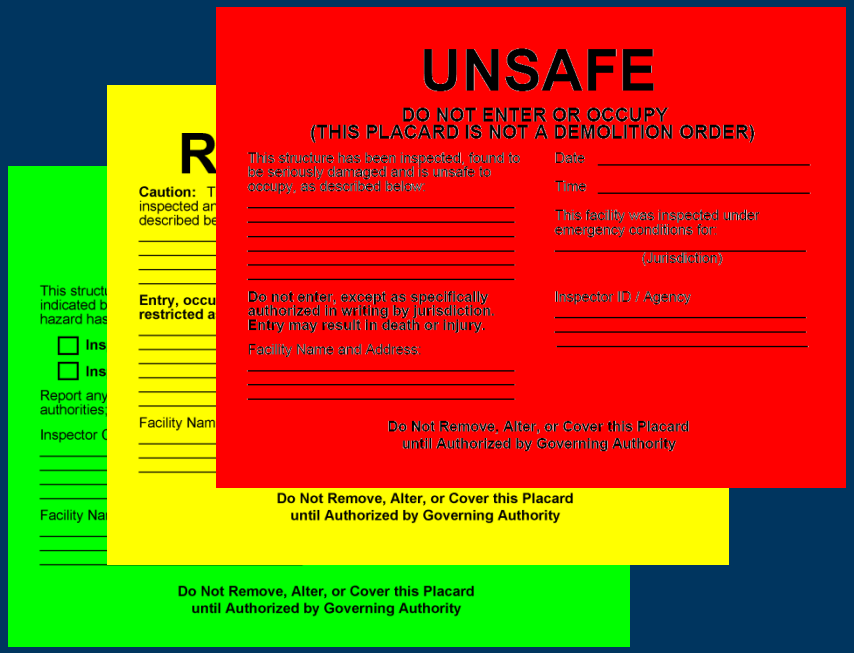
Some impacts purely from judgment

Computer models simplify & extrapolate, e.g., HAZUS not validated against a real Big One

8. Use activities

Shakeout.org: registration, local info, & drill scripts

Participants created their own activities



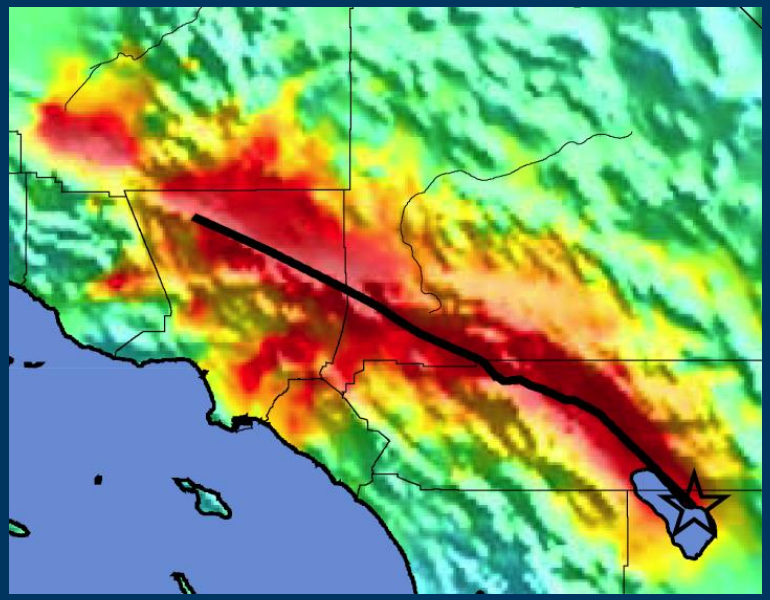
9. Defend in depth

ShakeMap

4 computer models largely agree
Vetted by 100 seismologists
Engineers tried to question it

Fire

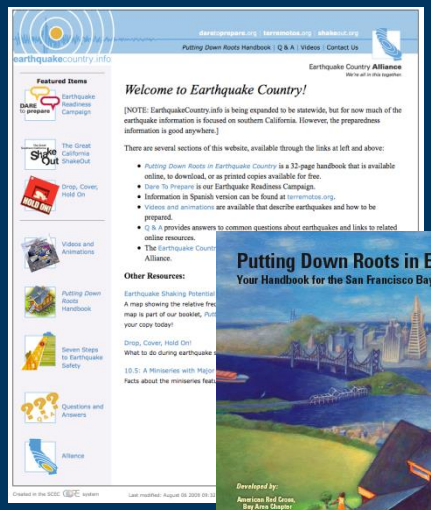
Frightening losses, costly mitigation
Reviewed by fire officials

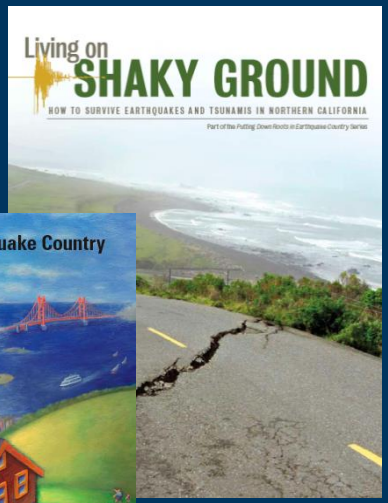


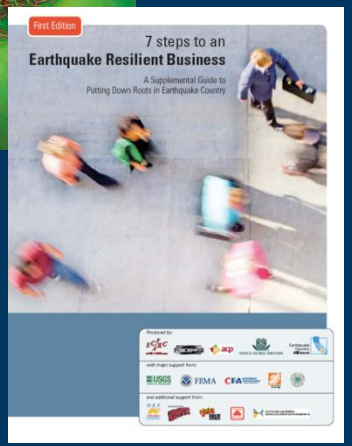
Highrises

Evoke 9/11
Vetted by leading practitioners

10. Offer engaging, useful resources







- Websites
- Multiple languages
- YouTube videos
- K-12 educational kits
- *Beat the Quake* online game
- Scholarly & lay publications
- Briefings & speakers' bureau
- Social media

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