

SCAG Earthquake Preparedness Initiative

Regional Seminars

October 25 – November 9, 2016

Dr. Lucy Jones

Founder, Dr. Lucy Jones Center for
Science and Society



What is your earthquake risk?

Your Risk =

Probable Loss in lives & dollars =

What the Earth does X what you do

What is your earthquake risk?

$$\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Fragility} \div \text{Response} \div \text{Recovery}$$

Faulting, shaking,
landsliding,
liquefaction



Extent & density
of built
environment



Structural
weaknesses



Will to recover

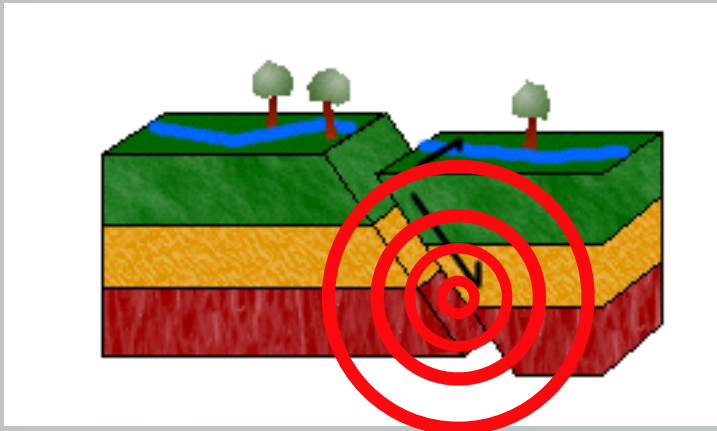
Ability to
respond



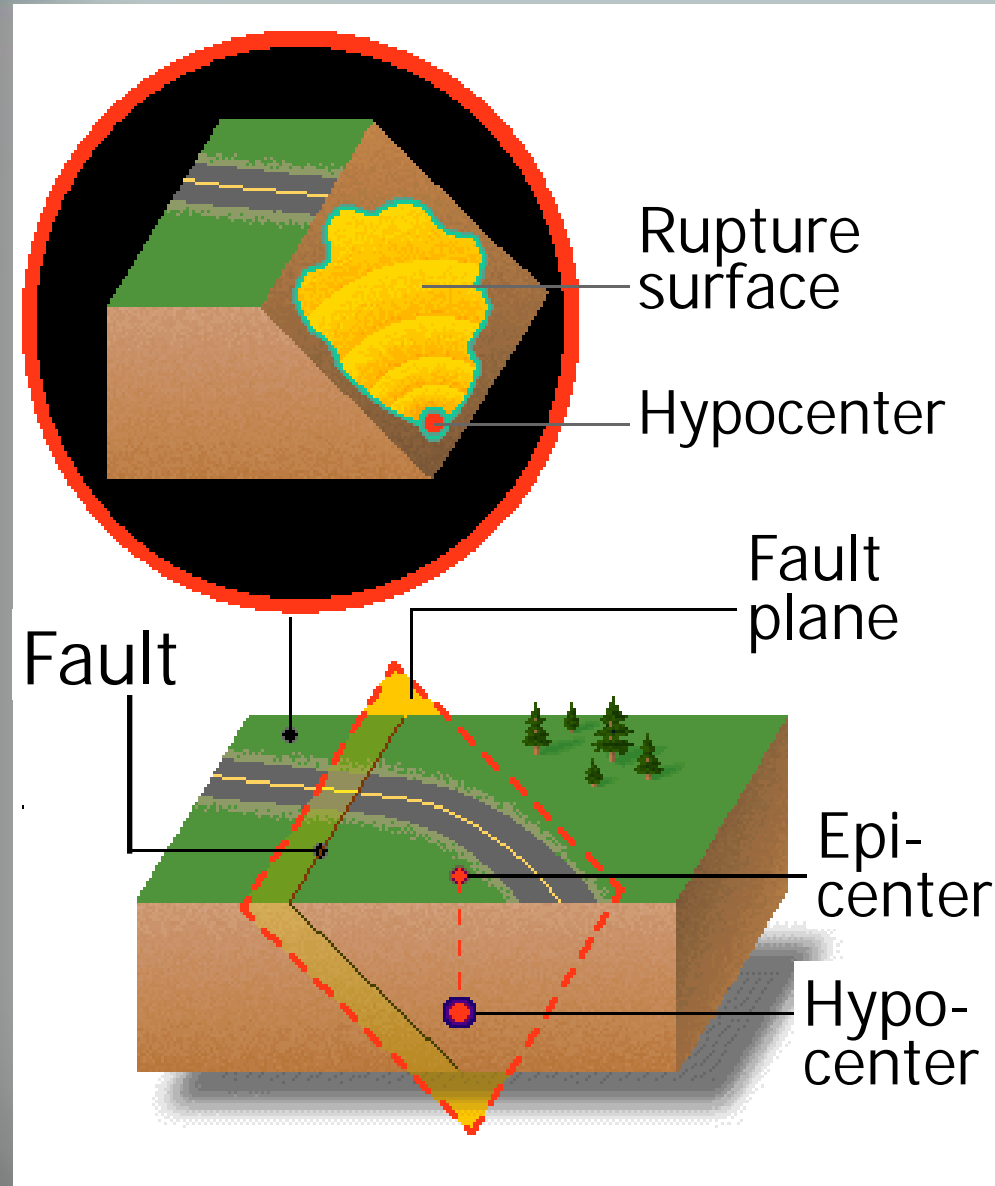
Preparedness Now

- Available on YouTube
- From SCEC - Southern California Earthquake Center

What is an earthquake?

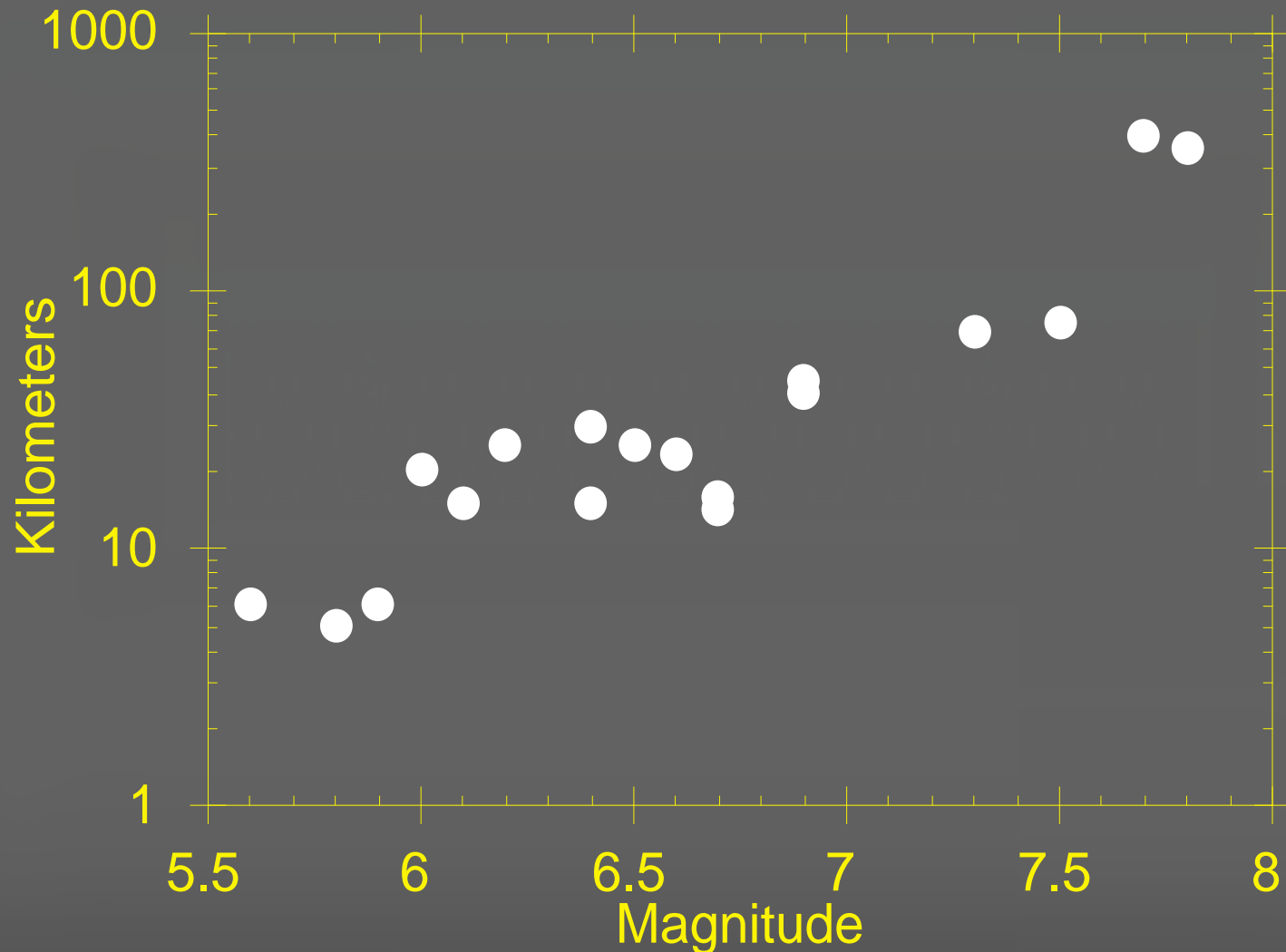


Earthquake Surface



A bigger fault means a bigger earthquake

Bigger Faults Make Bigger Earthquakes



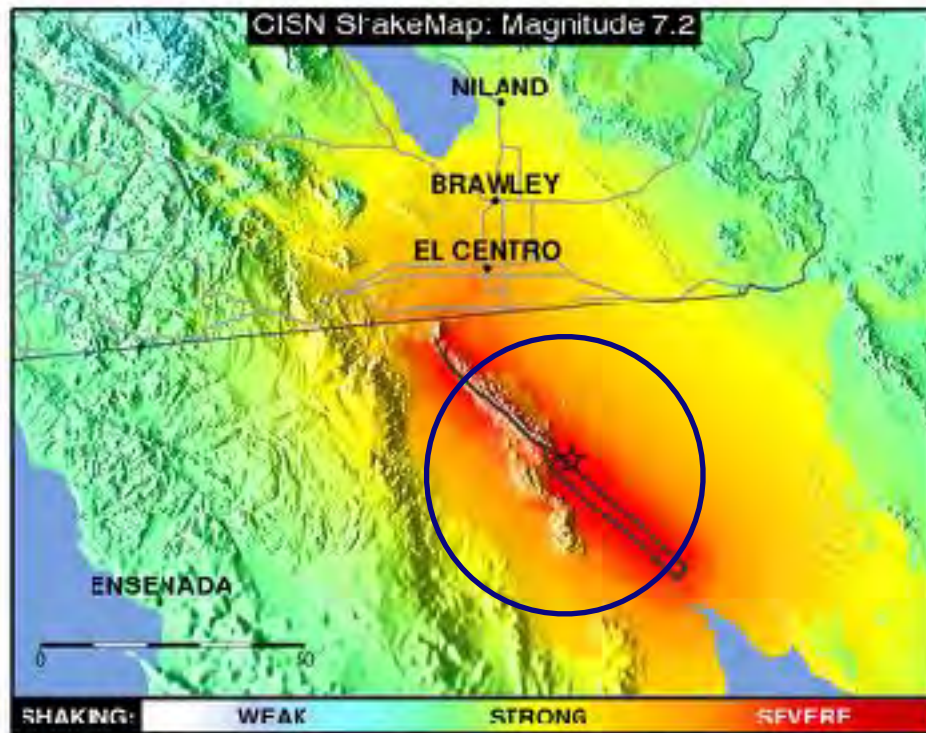
What Controls the Level of Shaking?

- Magnitude
 - More energy released
- Distance
 - Shaking decays with distance

Shaking with distance

Easter 2010
El Mayor Cucaipa

January 1994
Northridge

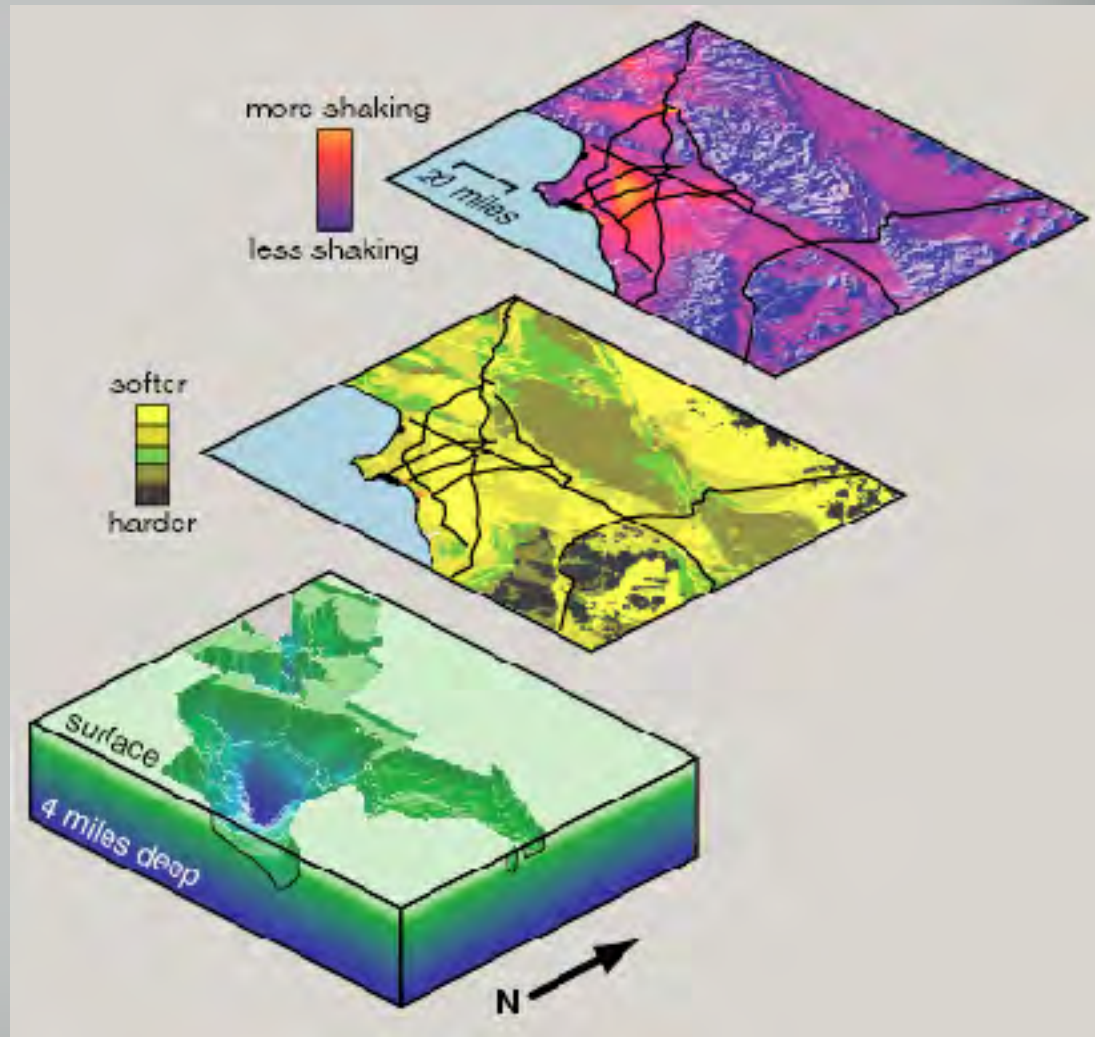


What Controls the Level of Shaking?

- Magnitude
 - More energy released
- Distance
 - Shaking decays with distance
- Soil conditions
 - Soft soils amplify shaking

Site Effects

- 30 m velocities
- Basin depth
- Amplify the shaking by up to 7x



What is your earthquake risk?

$$\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Fragility} \div \text{Response} \div \text{Recovery}$$

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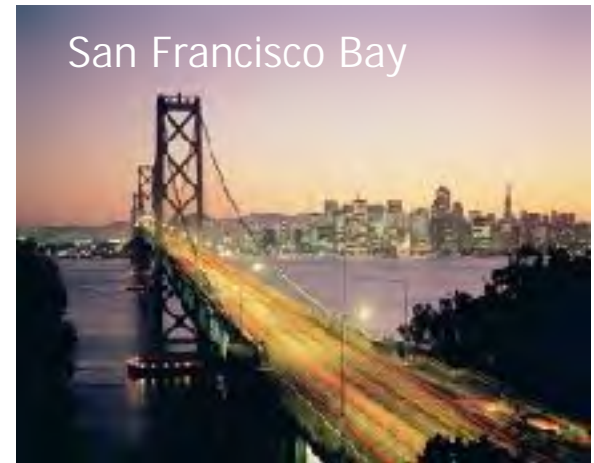


Will to recover

Ability to
respond



Our Hazard

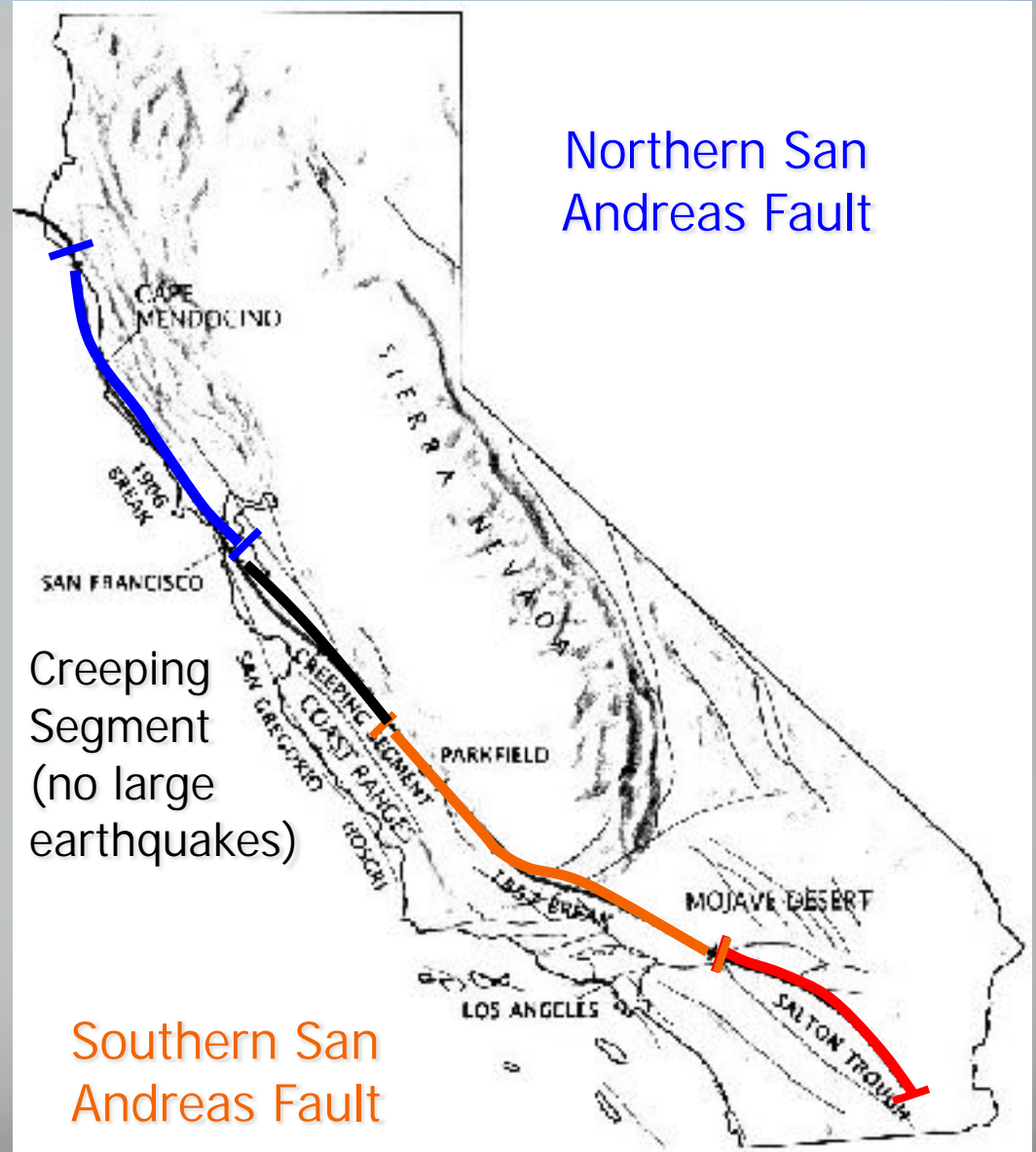


San Andreas Fault



San Andreas Earthquake History

- 1906 M7.8
- 1857 M7.8
- 1680 M7.7

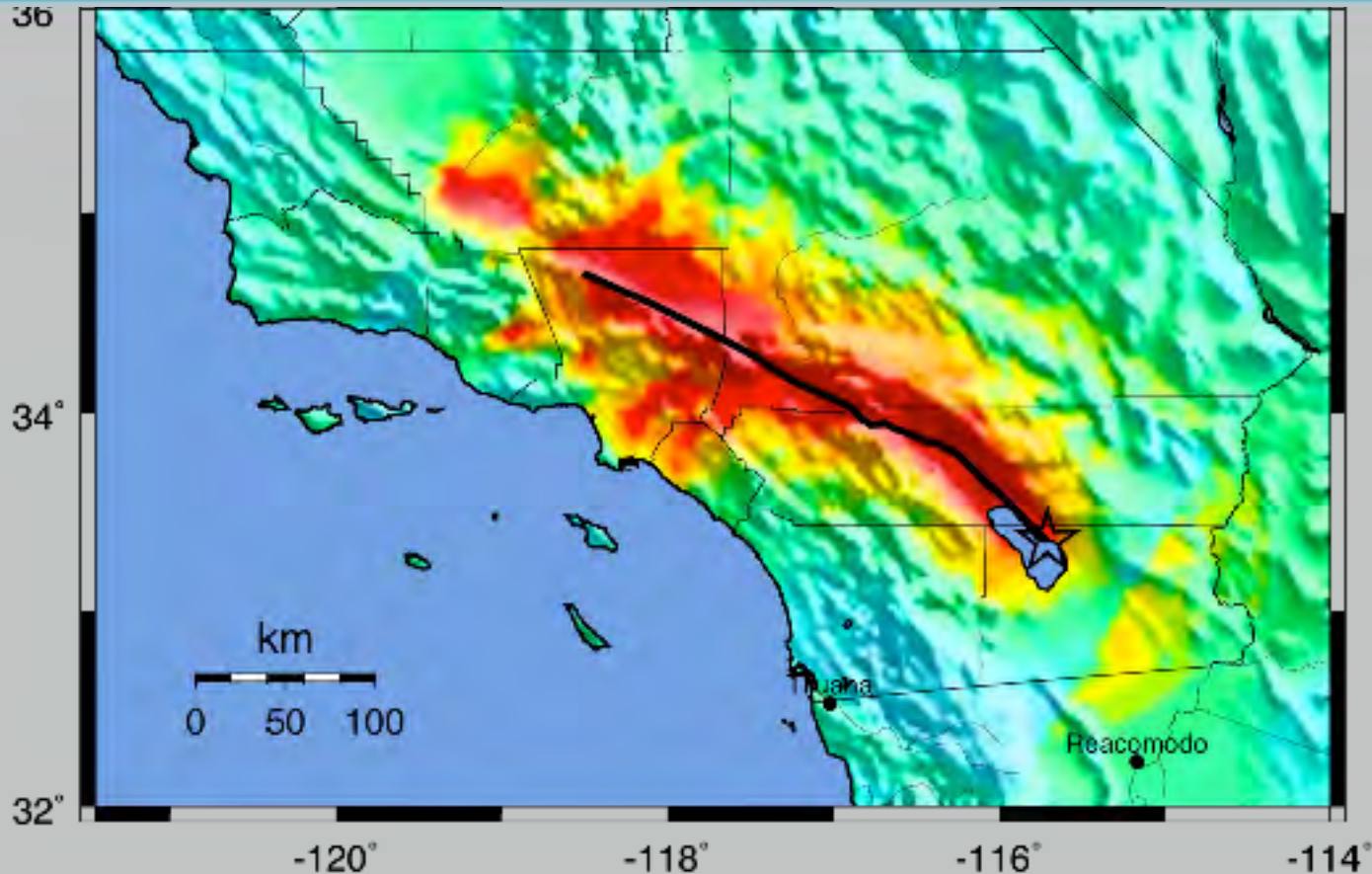


Paleoseismology

- Cut into the fault
- Find evidence of earthquake
- Date sediments above and below
- 6 earthquakes on San Andreas fault in Coachella between 800-1680



ShakeOut Simulation of M7.8 on San Andreas



Map Version 2 Processed Fri Mar 28, 2008 08:05:57 AM MDT -- NOT REVIEWED BY HUMAN

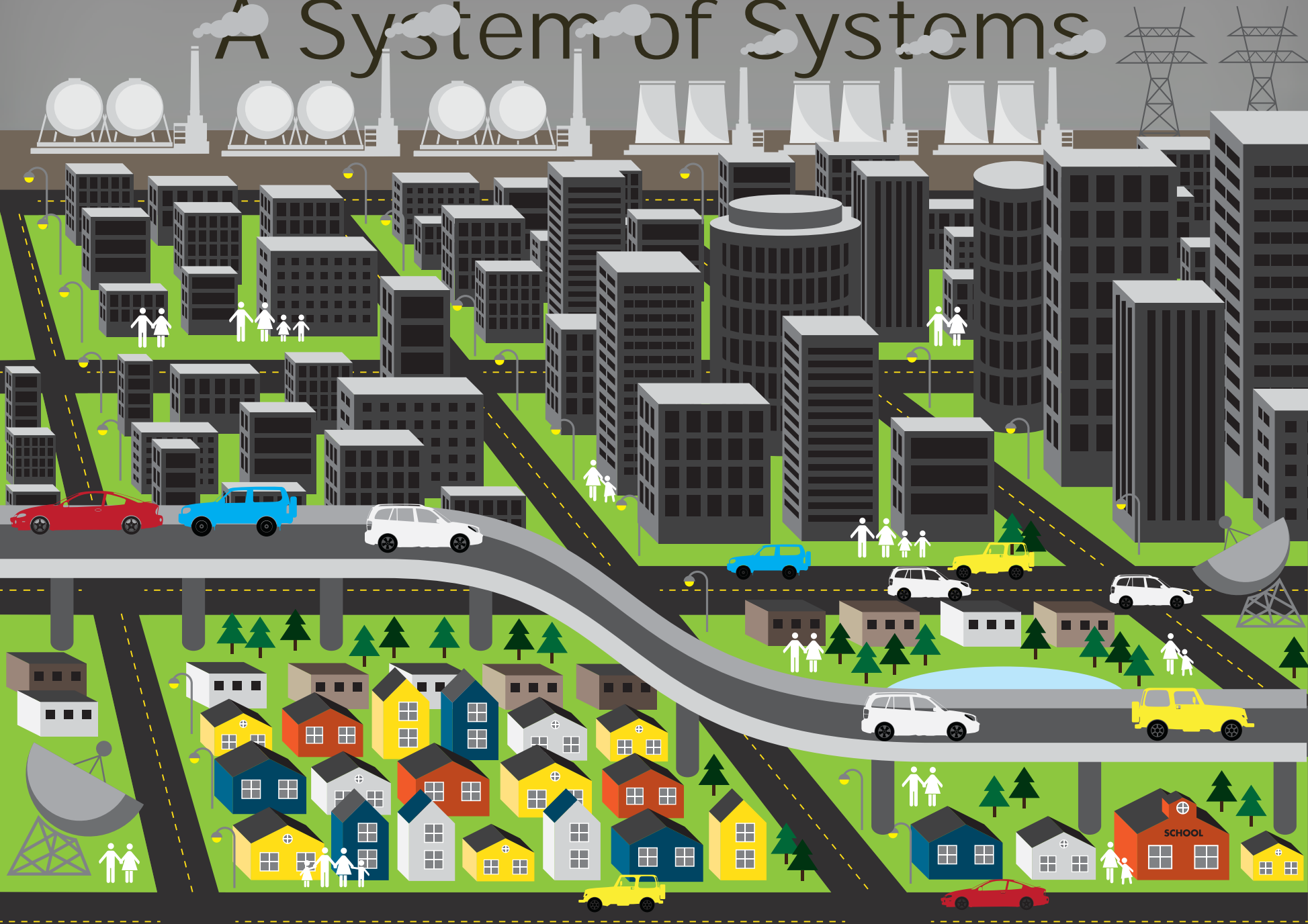
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	< 0.17	0.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Our Urban Society Is At Risk

Urban Disaster Resilience is having a society that functions after the disaster



A System of Systems

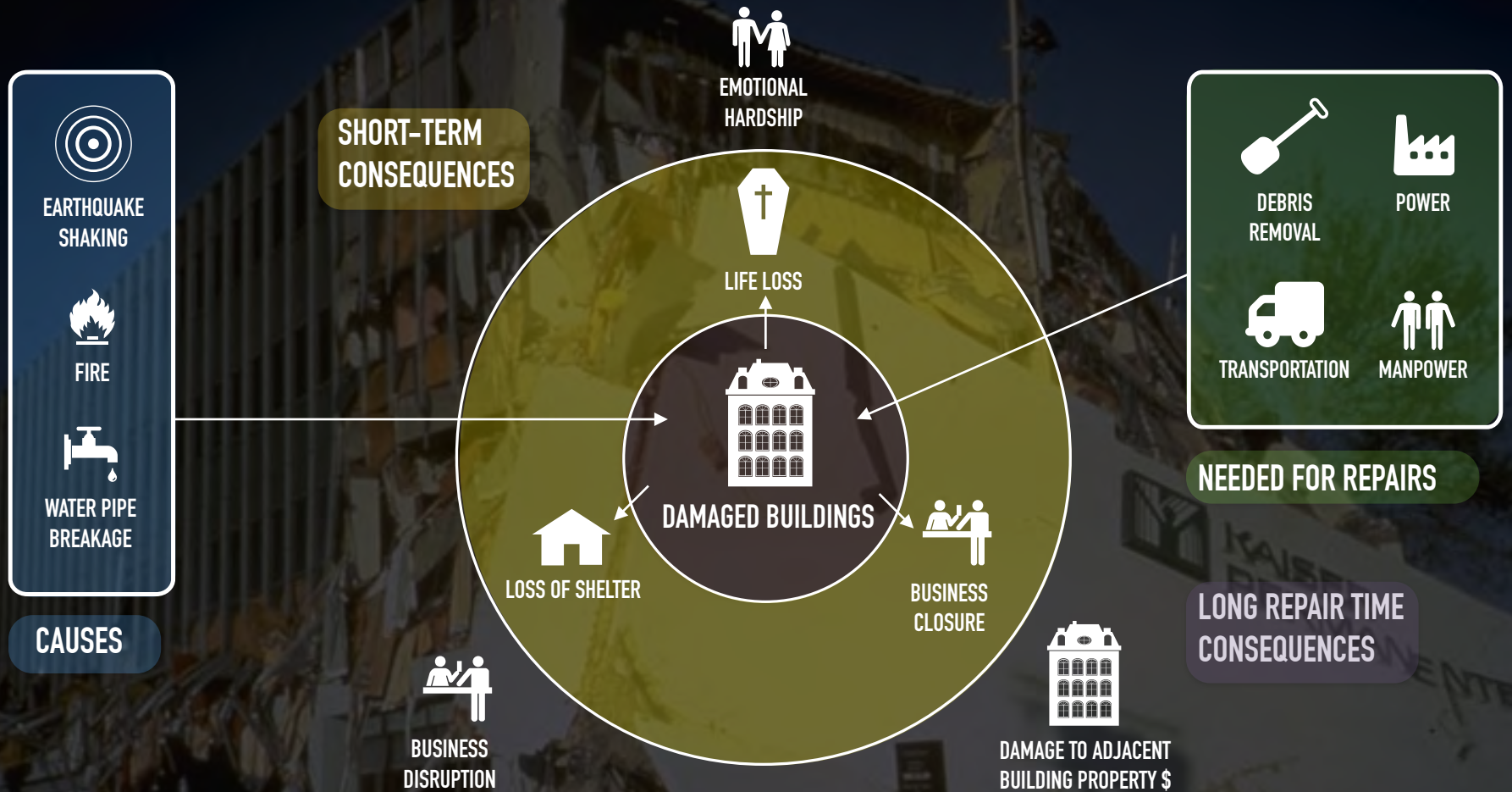


ShakeOut Damage to Buildings

- Concrete buildings:
 - Commercial buildings from 1950s and 1960s
 - In highest shaking areas, 10% collapse
 - Biggest life loss in scenario
- Unreinforced masonry
 - Collapse of 300+ buildings
 - Complete financial loss for 90% within 30 km of fault
- Pre-1994 steel frame high rises could collapse
- 300,000 buildings with loss $>10\%$ of value

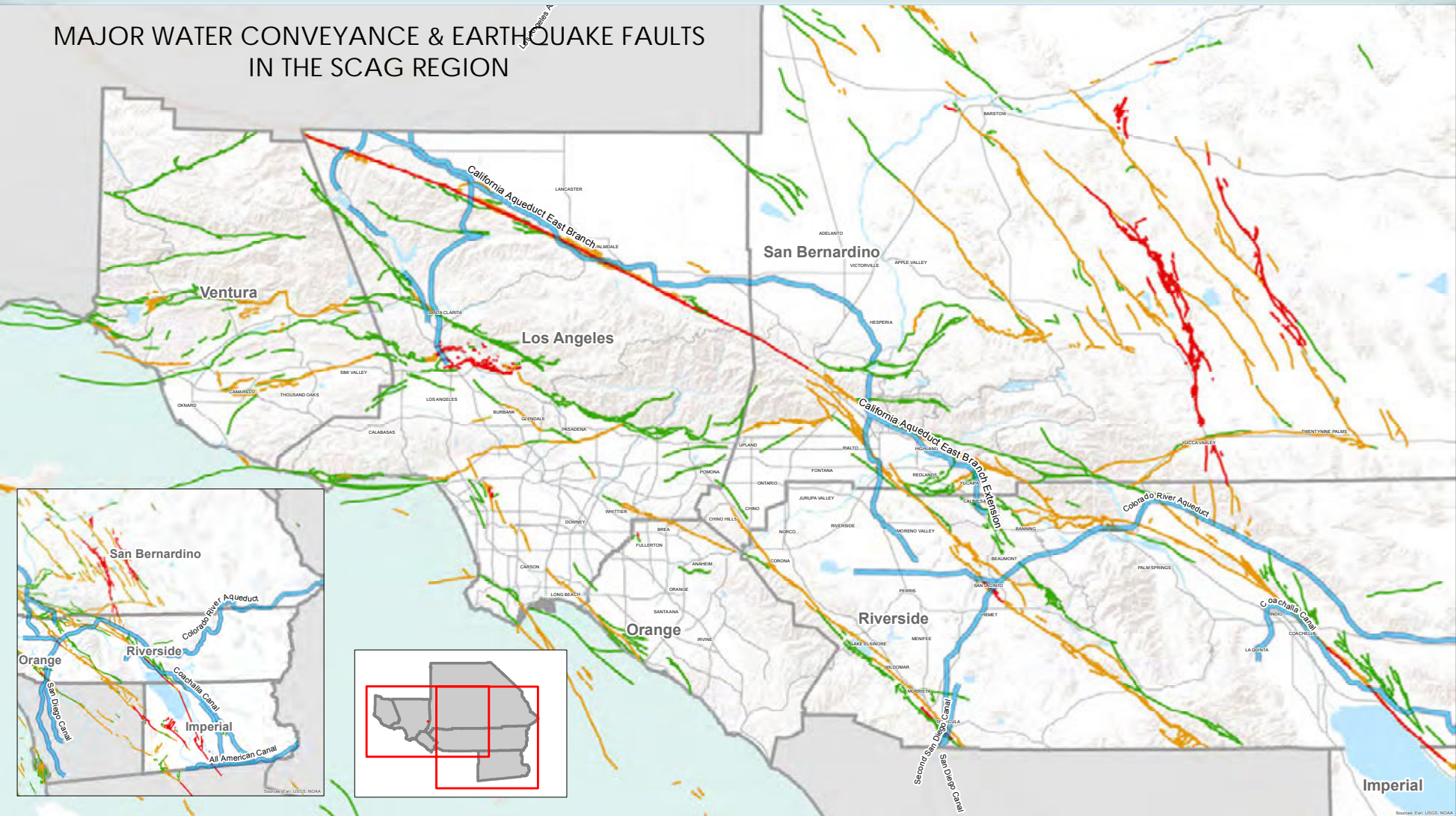


Building Damage and Destruction



Water and the San Andreas Fault

MAJOR WATER CONVEYANCE & EARTHQUAKE FAULTS IN THE SCAG REGION

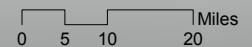


WATER SYSTEMS

- Major Water Conveyance
- Nature Water Features

EARTHQUAKE FAULTS

- Historic
- Holocene & Latest Pleistocene
- Late Quaternary



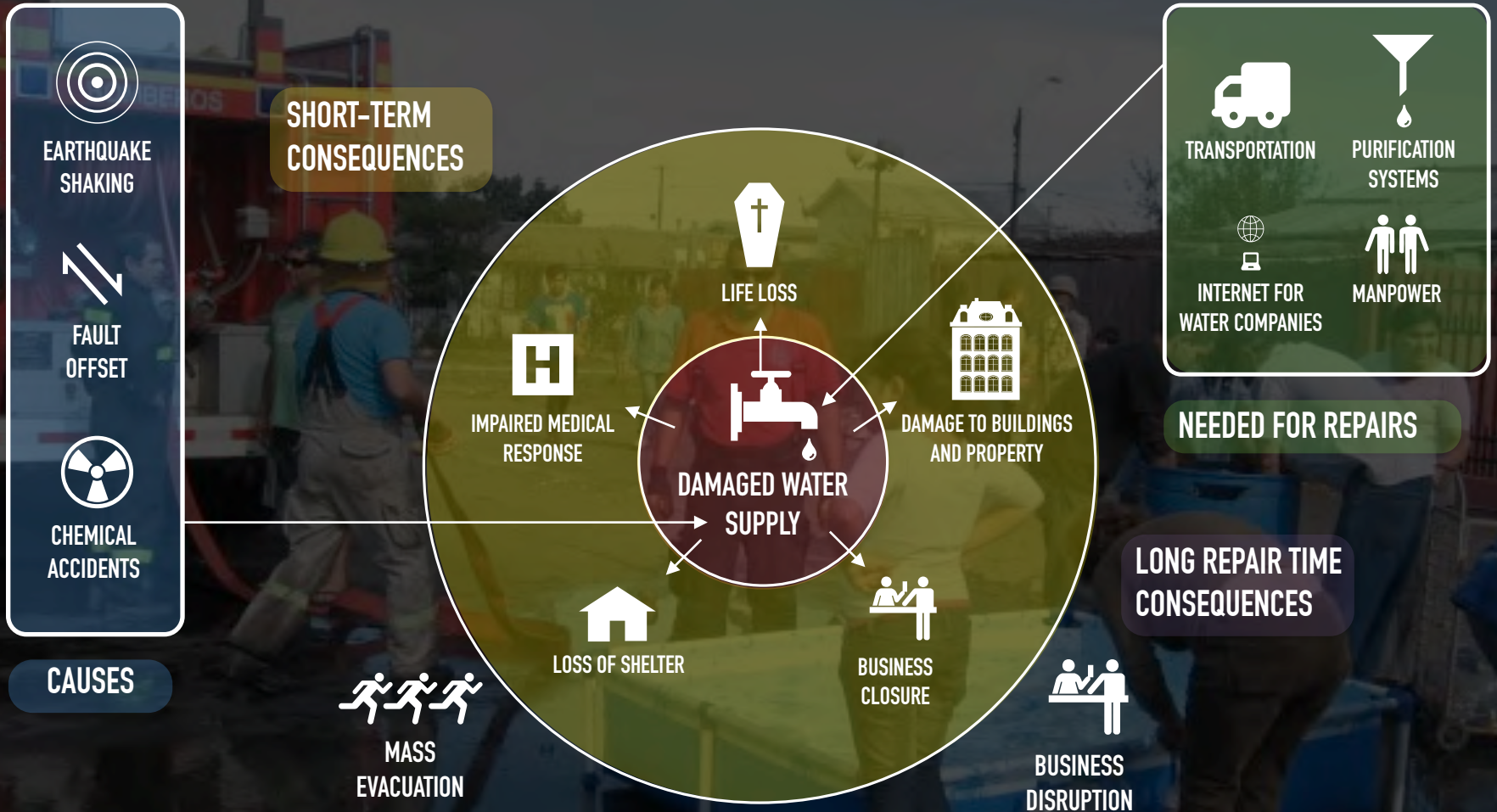
Source: Esri, USGS, NOAA

Damaged Water Supply Network

- All aqueducts cross the San Andreas to get to southern California and will be broken.
 - 18 months to repair
- Widespread damage to pipes in the ground
 - 6 months to restore all service



Damaged Water Supply Network



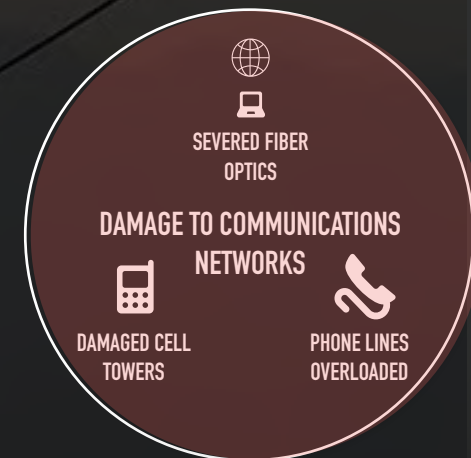
Fire Following the Earthquake

- 1,600 ignitions requiring a fire engine
- 1,200 exceed capability of 1st engine
- 200 million square feet burnt
 - ≈ 133,000 single family dwellings
 - ~1.5% of total building stock
- Property loss: \$65 billion

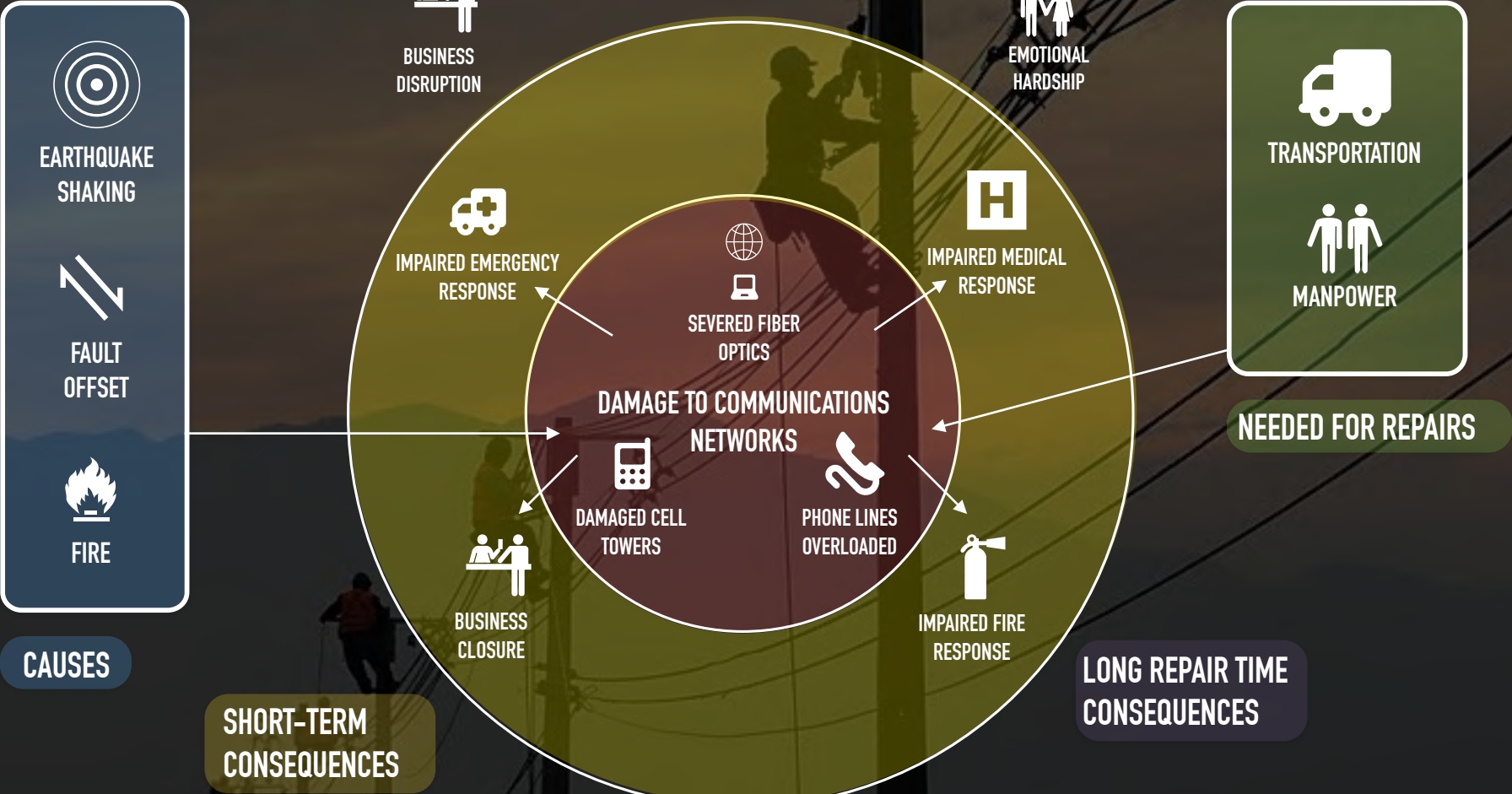


Communication disruption

- Electricity could be out for weeks
- Cell tower backup power lasts 4 hours
- Two-thirds of Internet bandwidth in fiber cables across the San Andreas



Communication disruption

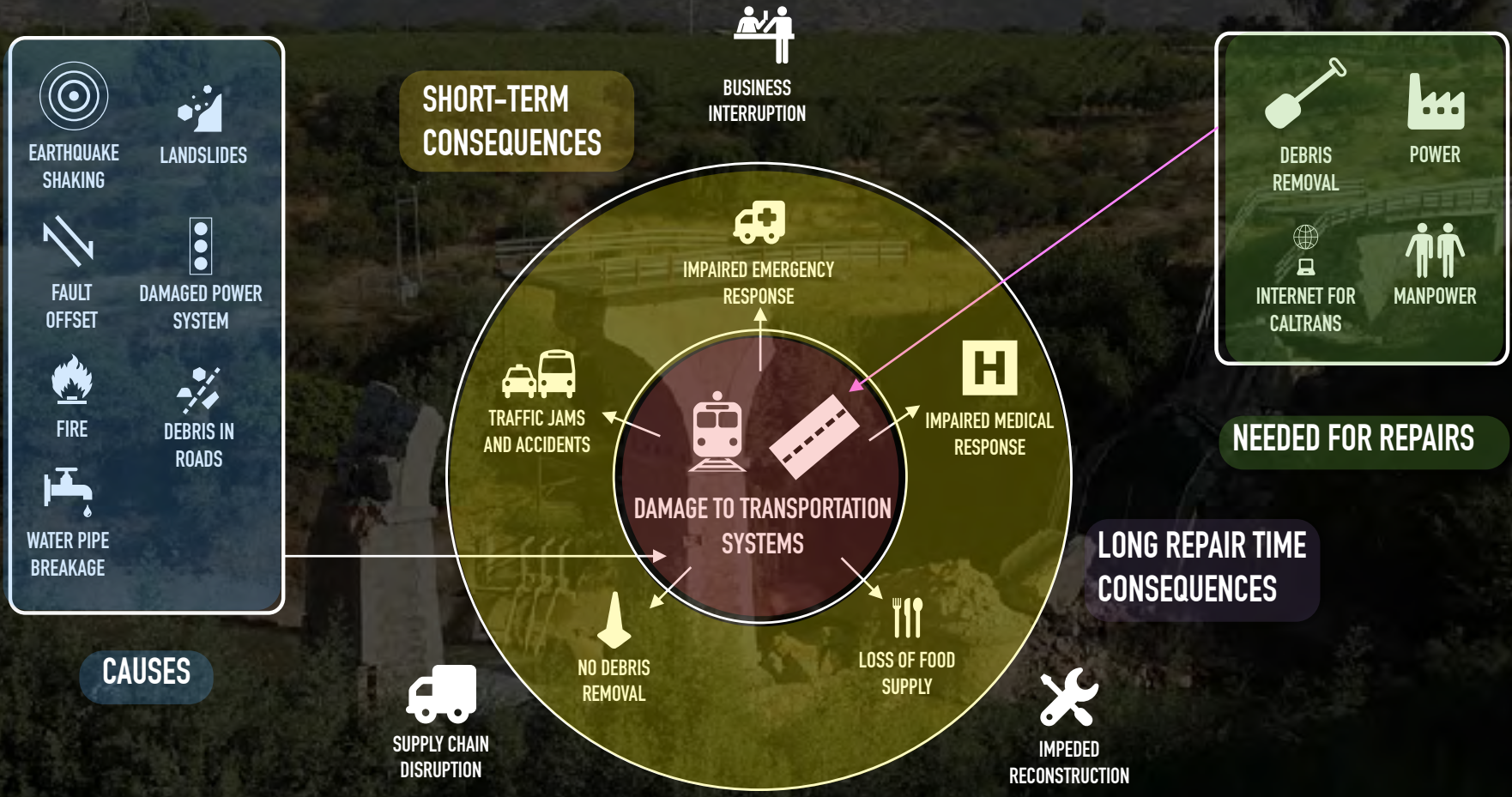


Damaged Transportation



Maule, Chile, M8.8
February 27, 2010

Damaged Transportation



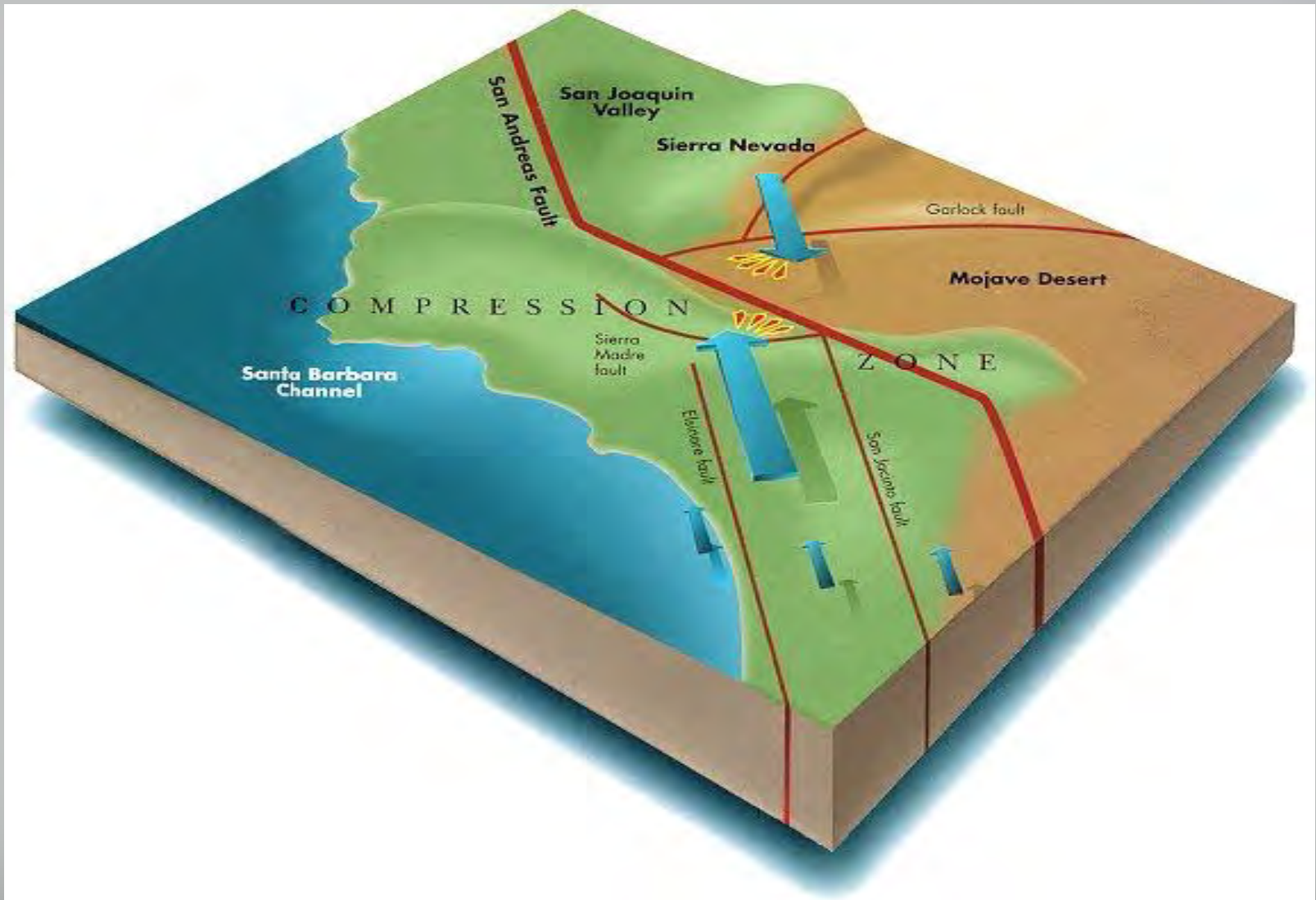
San Andreas Fault at Cajon Pass

- Co-located lifelines
- Loss of gas, petroleum, electricity, transportation, supply chain
- Potential for uncontrolled fire

Biggest Issues from San Andreas

- Life loss in old buildings
- Fire following earthquake
- Loss of housing
- Business disruption
 - Unusable commercial properties
 - Transportation disruption
 - Utility outages
- Region-wide disruption

The other faults of southern California



Big Earthquakes of California



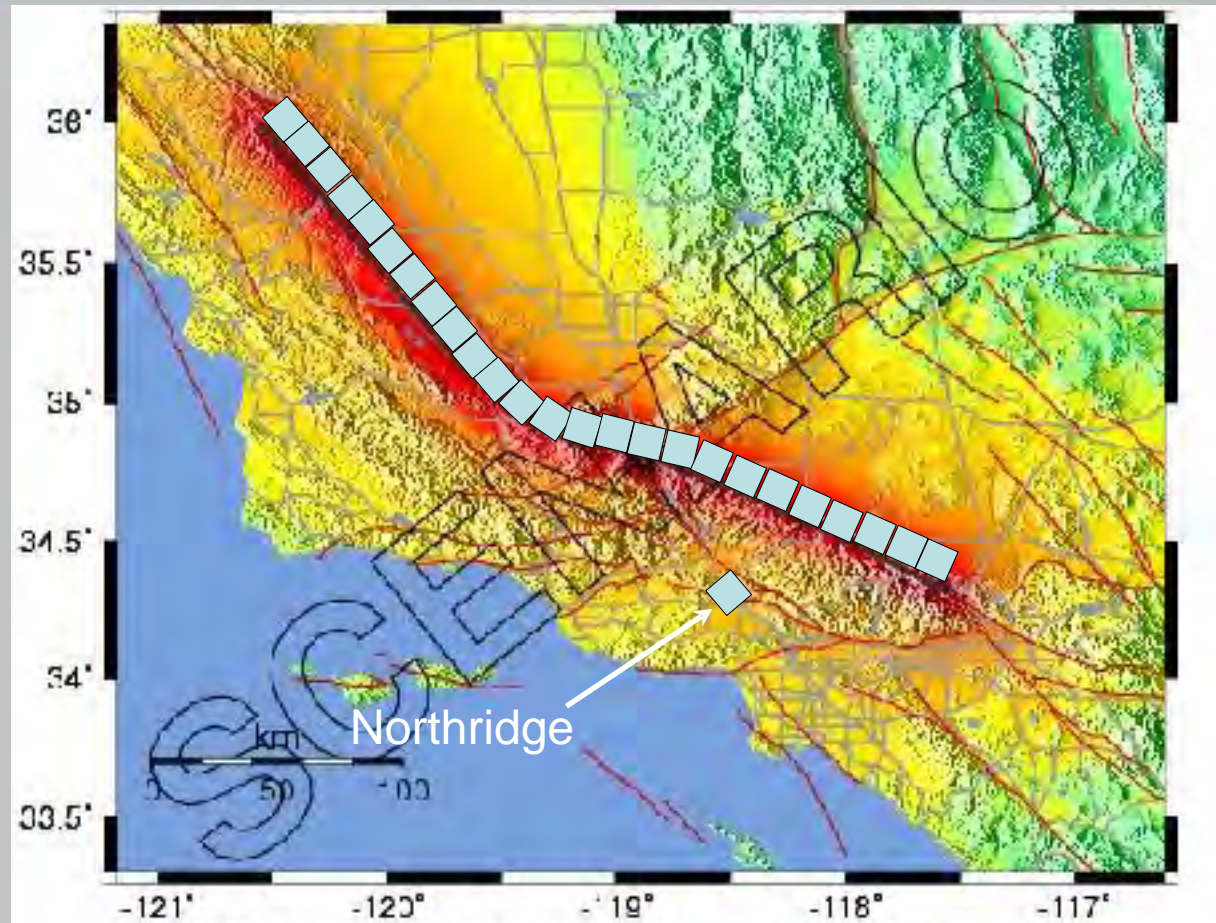
Courtesy:
T. Rockwell
SDSU

The other faults of southern California



January 9, 1857 M7.9

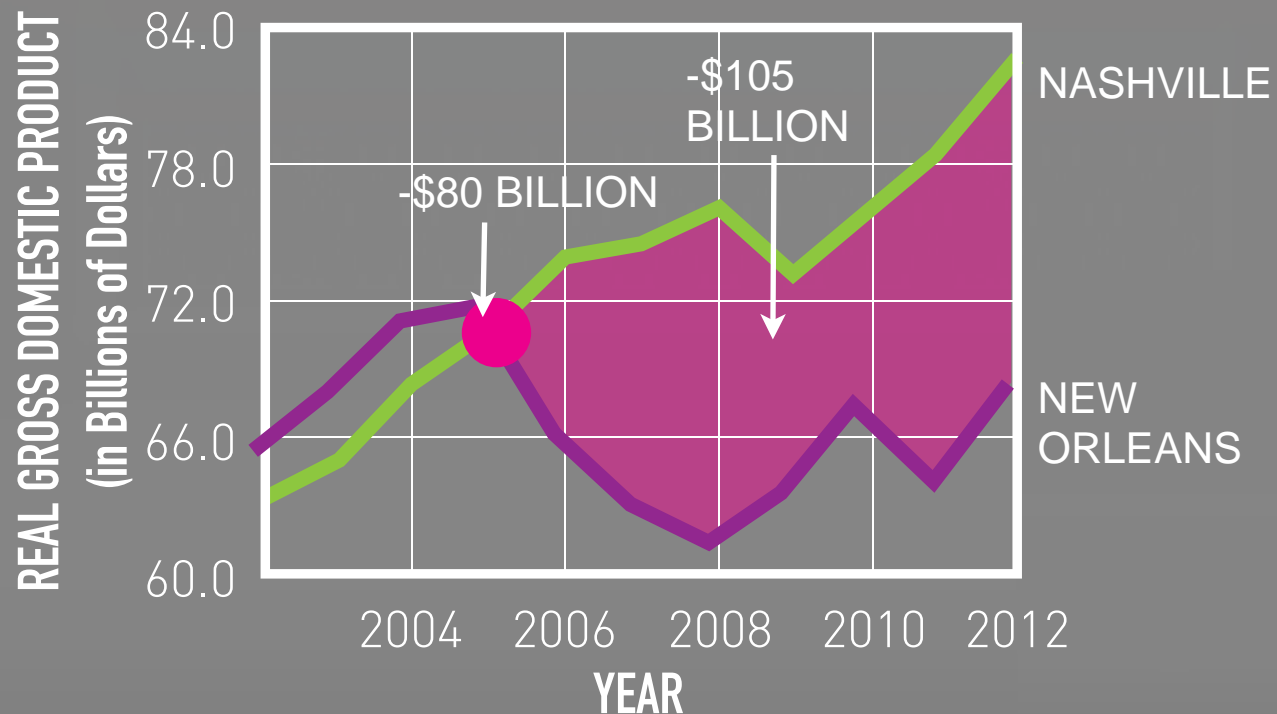
Twenty five
Northridge-sized
faults laid end to
end



PEAK GROUND ACCELERATION	Notice II	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)	<0.17	.17-1.4	1.4-3.0	3.0-6.2	6.2-12	12-24	24-65	65-124	>124
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INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X

WHAT'S AT STAKE?

NEW ORLEANS VS NASHVILLE ECONOMIC GROWTH

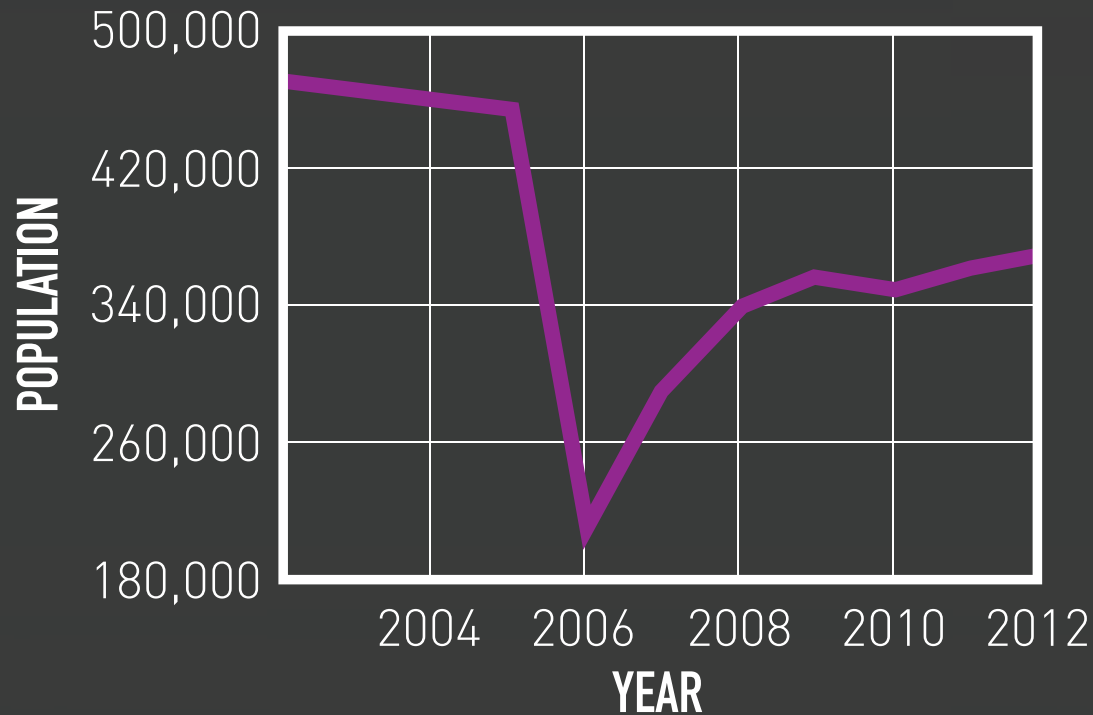


SOCIAL REPERCUSSIONS



SOCIAL REPERCUSSIONS

NEW ORLEANS POPULATION GROWTH



Break

- Which of these is the worst problem for your city?

- Life loss in old buildings
- Fire following earthquake
- Loss of housing
- Business disruption
 - Unusable commercial properties
 - Transportation disruption
 - Utility outages



What is your earthquake risk?

$$\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Fragility} \div \text{Response} \div \text{Recovery}$$

Faulting, shaking,
landsliding,
liquefaction



Extent & density
of built
environment



Structural
weaknesses



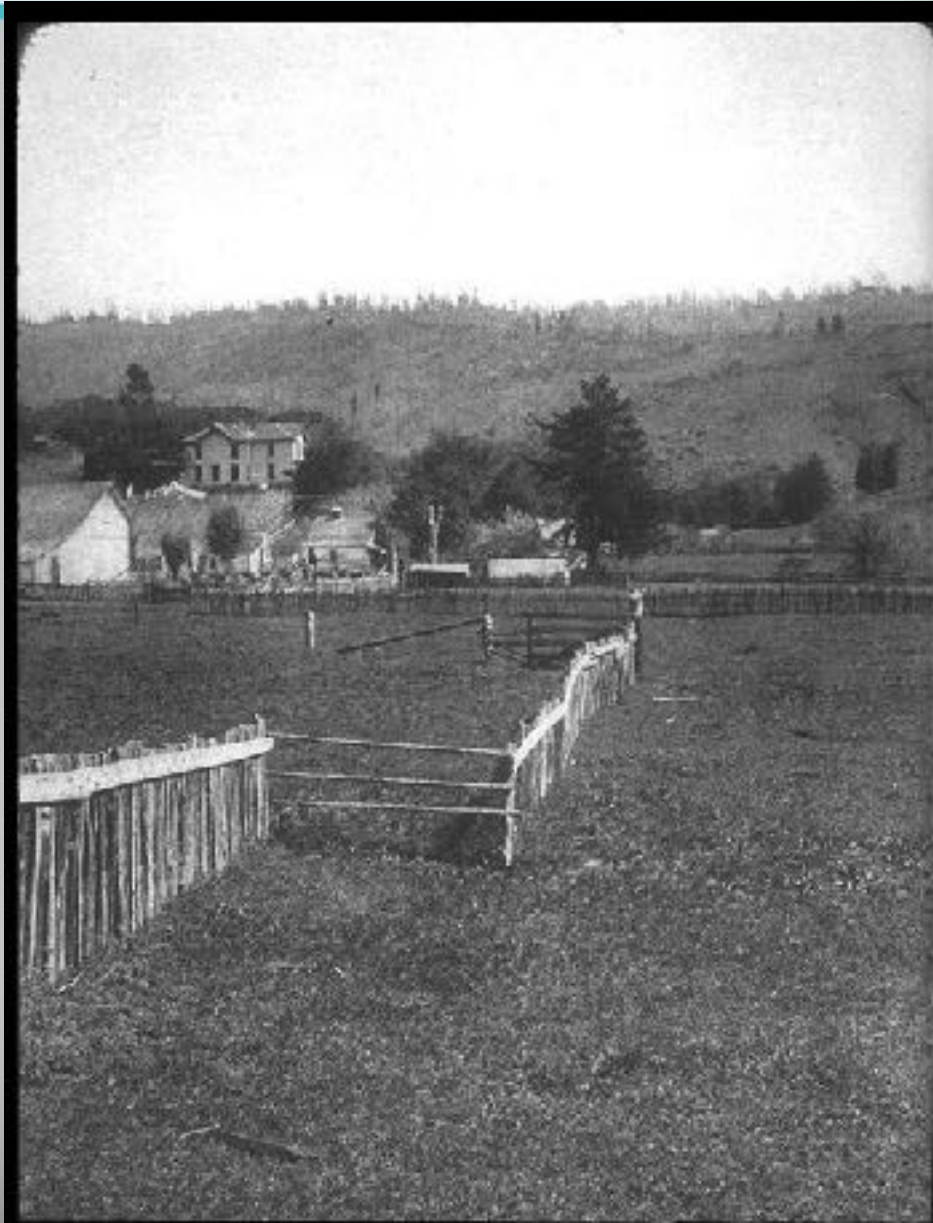
Will to recover

Ability to
respond



Hazard

Use science to
understand it



Exposure

Stay off
the faults

Too late!



Response

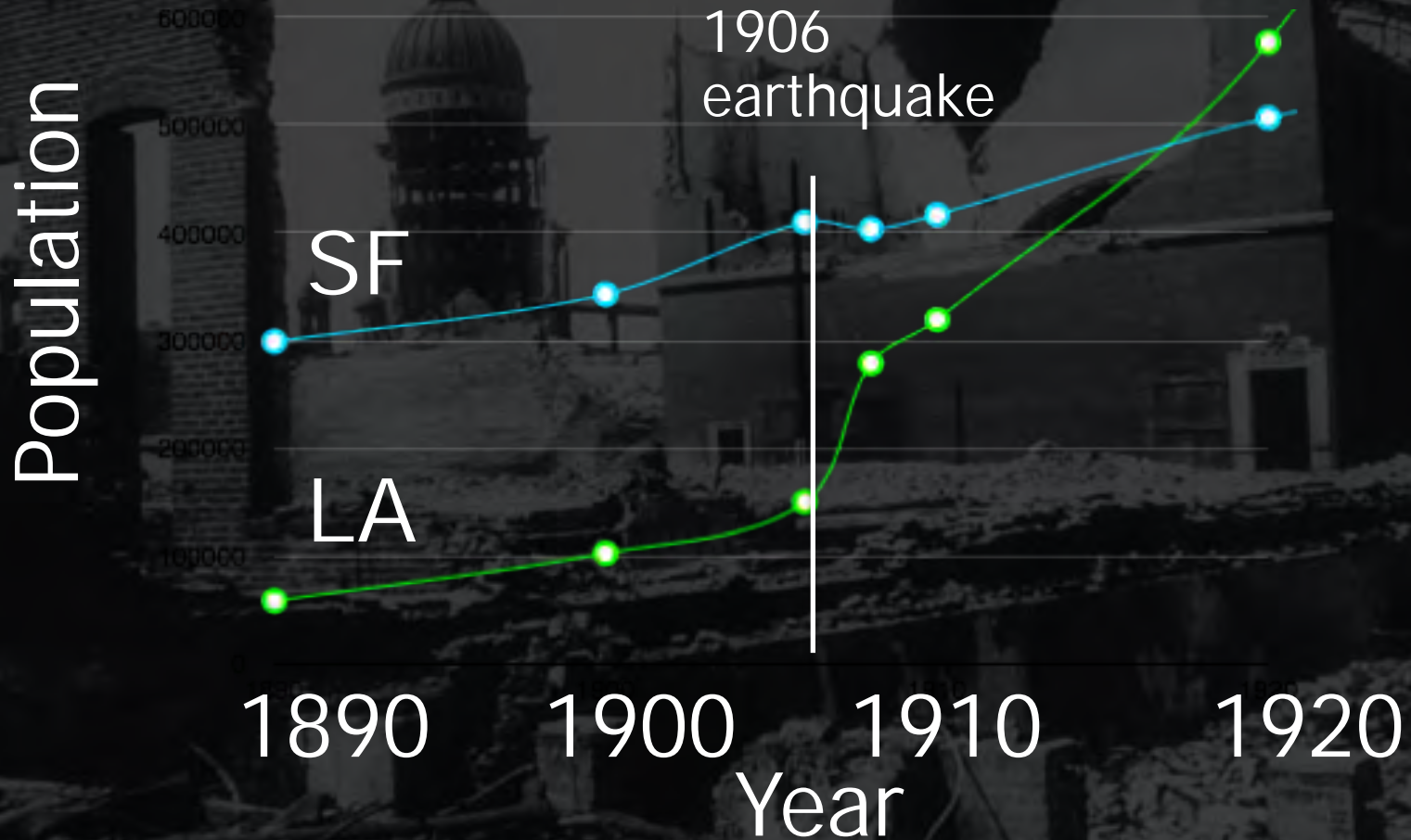
We've got
the best



Fragility

- Buildings are as good as the building code when they were built
- Current building code protects lives, but not property

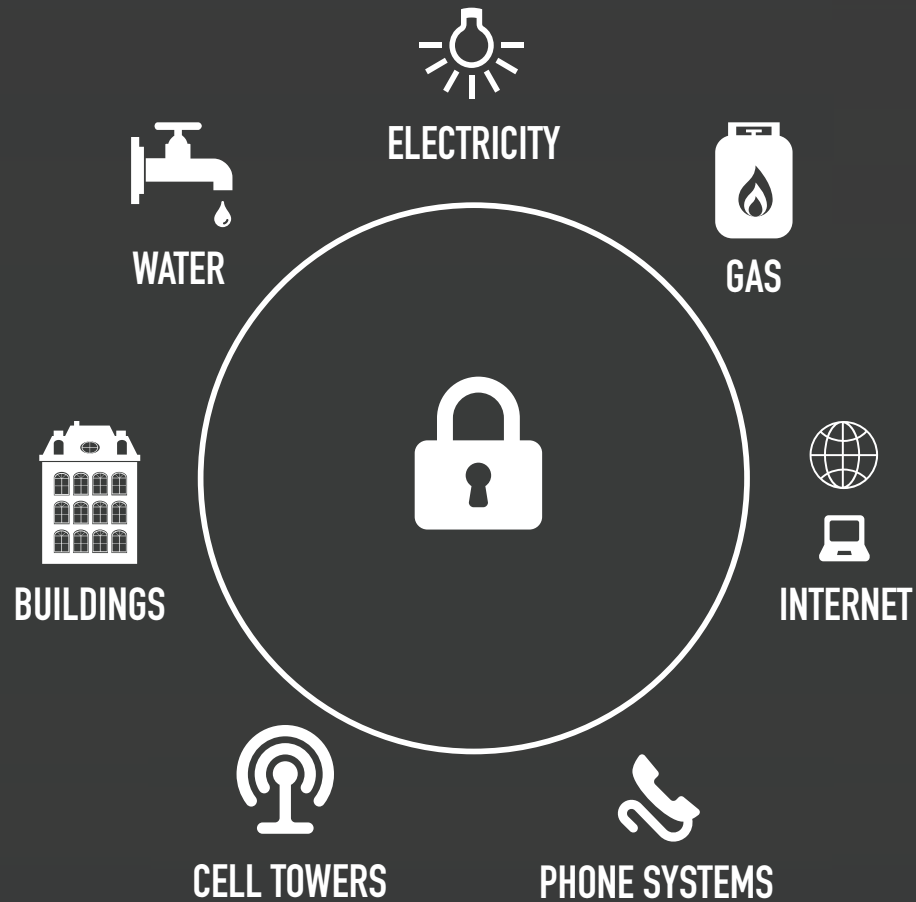
Recovery



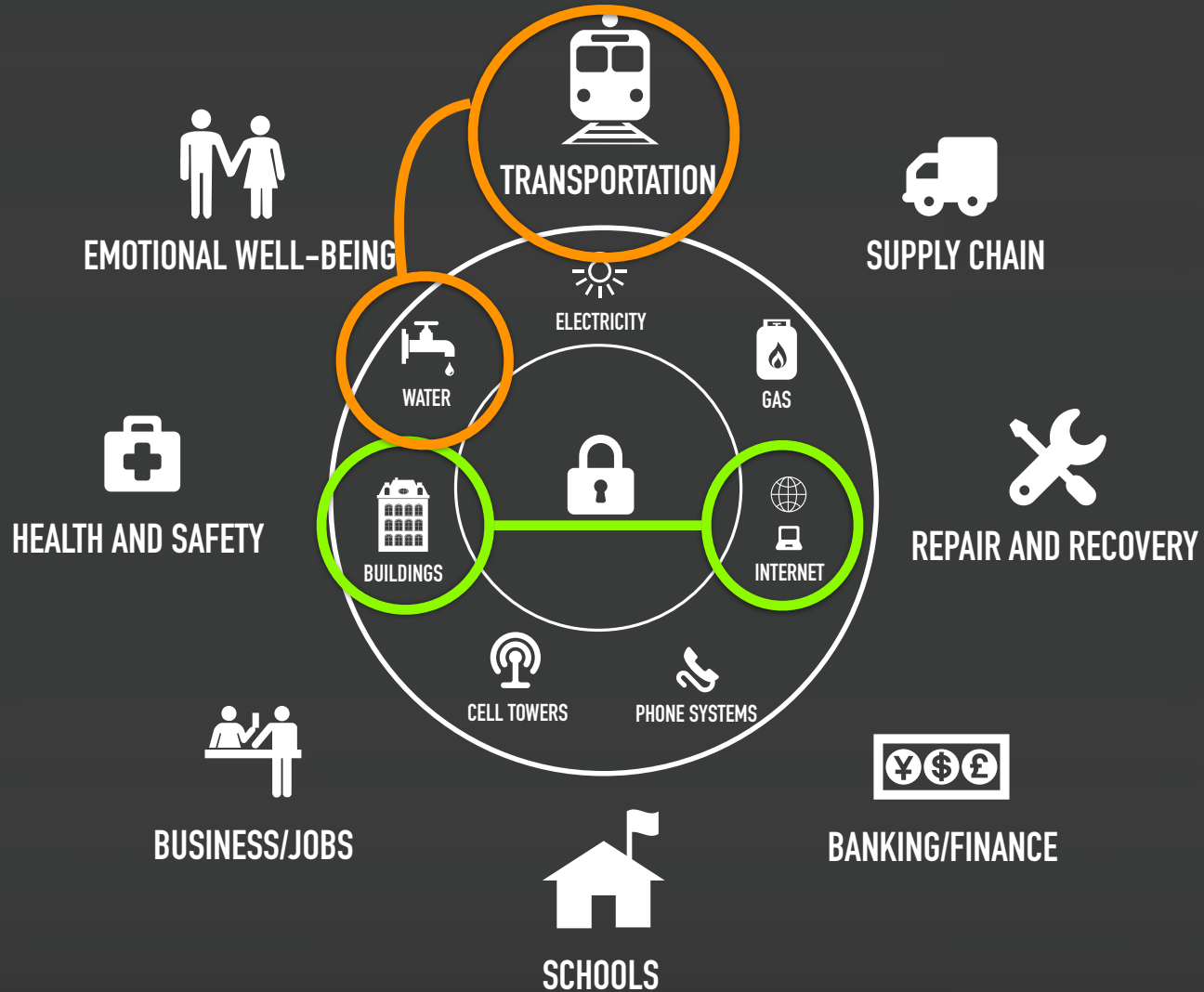
NECESSARY SYSTEMS



CRITICAL INFRASTRUCTURE



NECESSARY SYSTEMS



Buildings that Can Kill

- Unreinforced masonry (pre-1935)
- Soft-first-story (pre-1980)
- Non-ductile concrete (pre-1980)
- Steel moment frames (pre-1997)



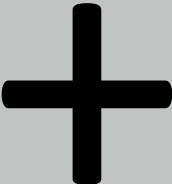
Retrofitting URMs has saved lives

- In the Northridge earthquake:
 - No one died in a URM
 - Only 19% of inspected URMs needed repairs compared to 33% of buildings overall
- Statewide
 - Jurisdictions have retrofitted or demolished 88% of URMs with mandatory programs
 - Only 22% with voluntary programs

Current building code

- In worst earthquake, 90% probability of not collapsing
- 10% probability of collapse = 10% of new buildings collapsing

Impaired buildings are economic loss



UNSAFE
DO NOT ENTER OR OCCUPY
(THIS PLACARD IS NOT A DEMOLITION ORDER)

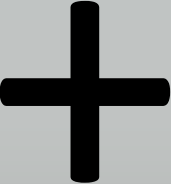
This structure has been inspected, found to be seriously damaged and is unsafe to occupy, as described below:

Date _____
Time _____
This entry _____
Inspe _____

Do not enter, except as specifically authorized in writing by jurisdiction. Entry may result in death or injury.

Facility Name and Address:

Do Not Remove, Alter, or Cover until Authorized by Governing Authority



RESTRICTED USE

Caution: This structure has been inspected and found to be damaged as described below:

Date _____
Time _____

(Caution: Aftershocks since inspection may increase damage and risk.)

Entry, occupancy, and lawful use are restricted as indicated below:

This facility was inspected under emergency conditions for:

(Jurisdiction)

Inspector ID / Agency

Facility Name and Address:

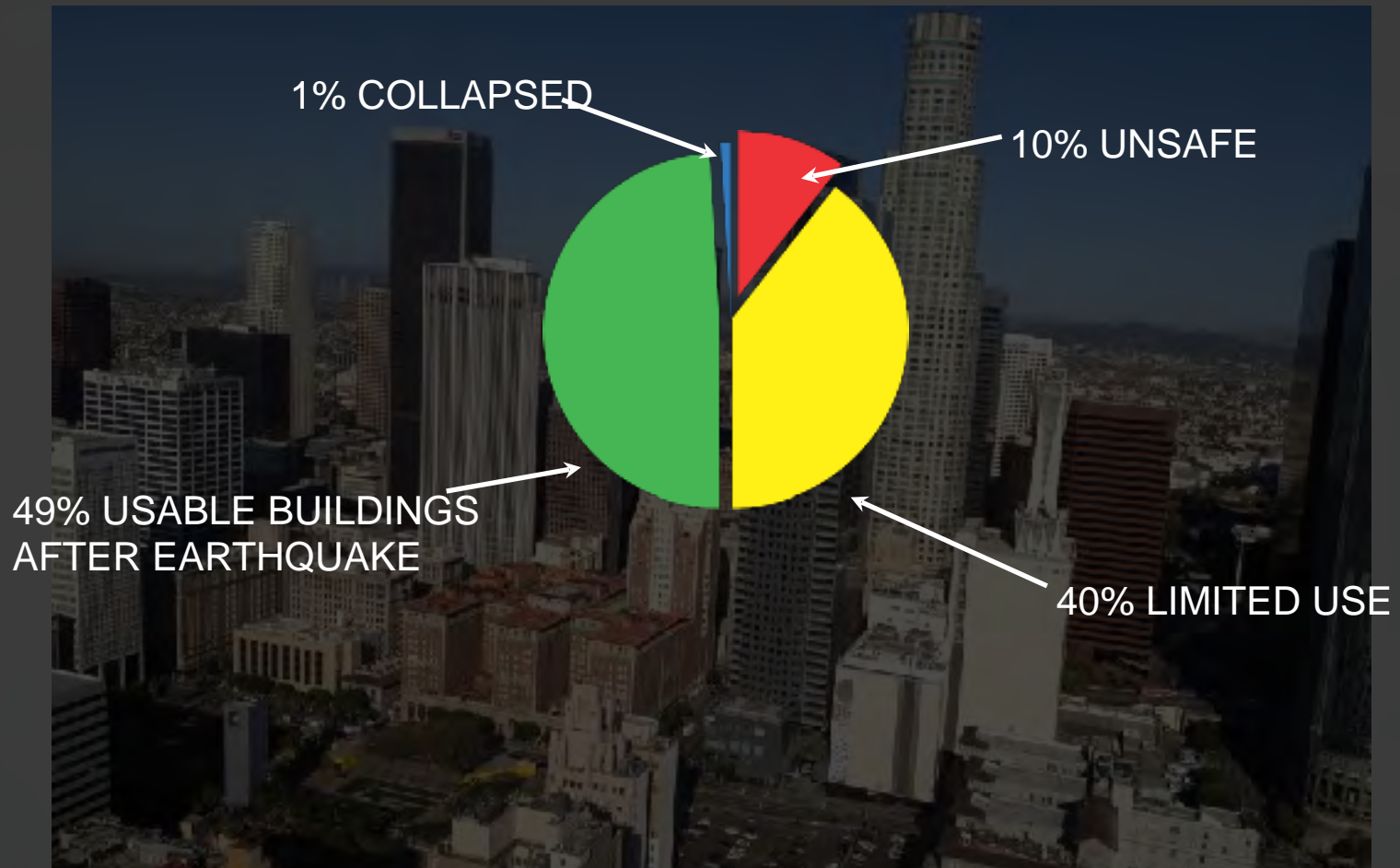
Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority

In California, many more buildings impaired

- Average of Loma Prieta & Northridge
- For each collapse
+ 13 red tags
- For each red tag,
+ 3.8 yellow tags
- = 63 impaired per collapse

Check: Napa 2014 had 57 impaired per collapse

CAN WE SURVIVE "THE "BIG ONE"?"



Christchurch 2010



Christchurch, February 22, 2011 M6.3

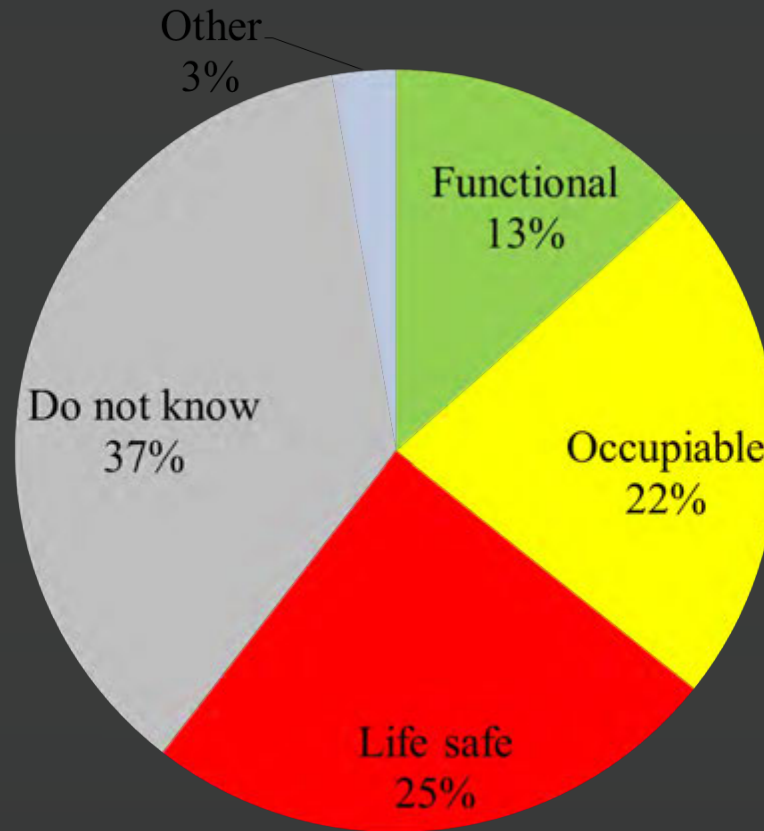


Christchurch 2015



Most people don't know what the code provides

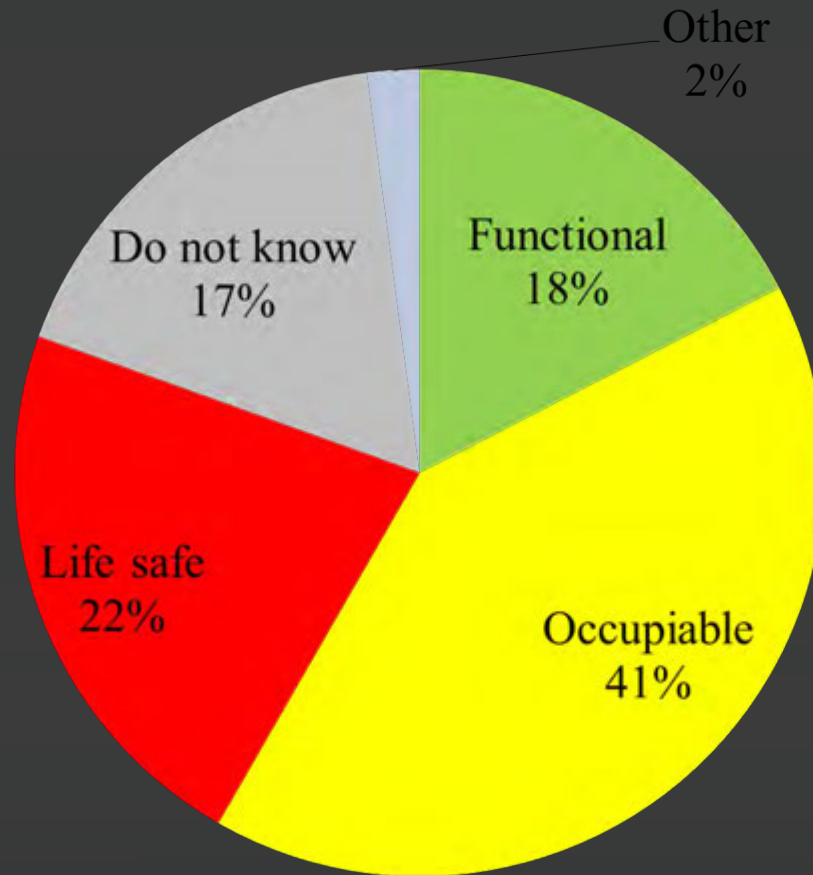
What is the building code's objective?



Survey of 814 people by Dr. Keith Porter, U. Colorado:

Most people want more than the code provides

What should it ensure?



Four example cities

- San Francisco
 - Community-driven
- Los Angeles
 - Mayoral leadership
- Santa Monica
 - Staff initiative
- West Hollywood
 - Council initiative



Community Action Plan For Seismic Safety (CAPSS)

- San Francisco's seismic safety plan
- 2002 - 2013
- 30 year plan to address building deficiencies

Here Today—Here Tomorrow: The Road to Earthquake Resilience in San Francisco

A Community Action Plan for Seismic Safety



Resilience by Design

- Los Angeles seismic safety plan
- 2014



Fortify Our Water System

- Water for fire fighters
- Protected fault crossings for the aqueducts
- Less dependence on imported water
- Seismic resistant pipes
- Resilience By Design Program



Enhance Reliable Telecommunications

- MOU with service providers to manage emergencies
- More resilient power
- Promote City-wide Wifi access
- Stronger towers

Cell tower in Tokyo after
March 2011 M9



Strengthen Our Buildings

- Mandatory retrofit of soft-first story buildings
- Mandatory retrofit of concrete buildings
- Voluntary rating system
- “Back to Business” inspection program
- Excessive Damage ordinance



Santa Monica

- Initiated ordinances after Northridge
- City staff is working with City Council to develop new approaches
- Holding community meetings
- Several ordinances to be considered in winter

West Hollywood

- Started with survey to determine issues
- Soft first story
- Concrete
- Steel moment frame

West Hollywood

- Initiated by City Council
- Staff brought in consultants
- Established expert advisory committee
- Took about a year to come to Council
- Council asked for more outreach
- weho.org/seismic

Where are you?

Self-evaluation form

What's next?

- Take self-evaluation back to your jurisdiction
- Plan to attend all-day Workshop in SCAG's Earthquake Preparedness Initiative*

* See Exit Survey

Contact

drlucyjonescenter.org

