# Building a Resilient Community: Preparing for the Next Earthquake

William B. Joyner Memorial Lecture

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Earthquake Engineering Research Institute

Seismological Society of America

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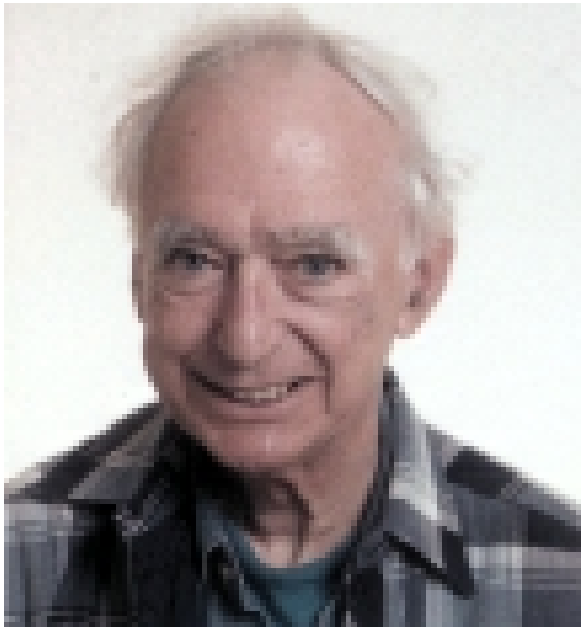
# William B. Joyner Memorial Lecture



*Exchanging information at the interface of earth science and earthquake engineering ….**and more***

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# ENGINEERING ETHICS

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Tell Them!

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# 150 Years of Progress in Seismic Safety

- Seismic risk is clearly understood nationwide
- Building codes protect lives and more
- Dangerous buildings are being rehabilitated
- Major Lifelines are being rehabilitated
- Need for “resilience” is being discussed

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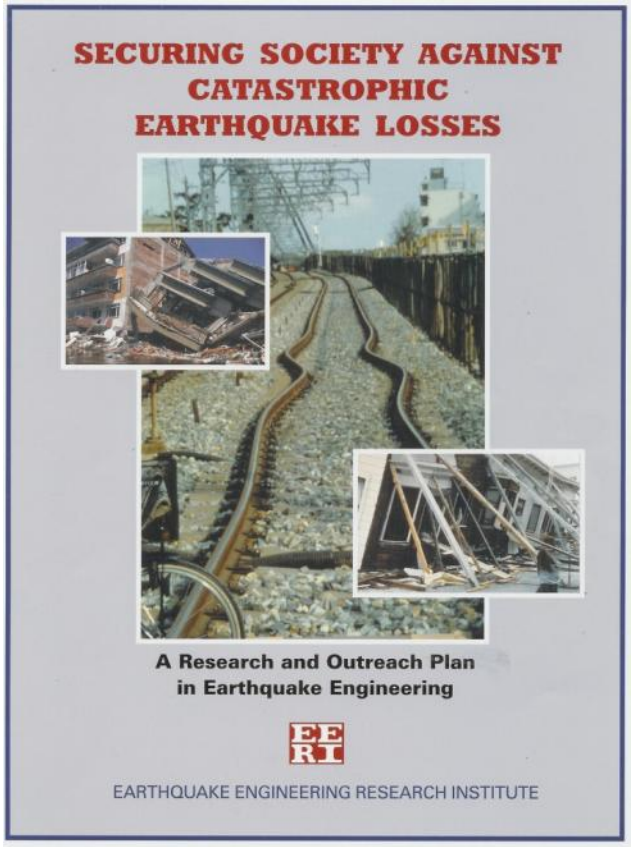
# Securing Society Against Catastrophic Earthquake Losses

**Opportunities to learn and build better with new knowledge**

- Assessing and reducing earthquake impacts
- Enhancing community resilience
- Expanding Public Education and Outreach
- Developing new means for preventing losses at an **affordable cost.**

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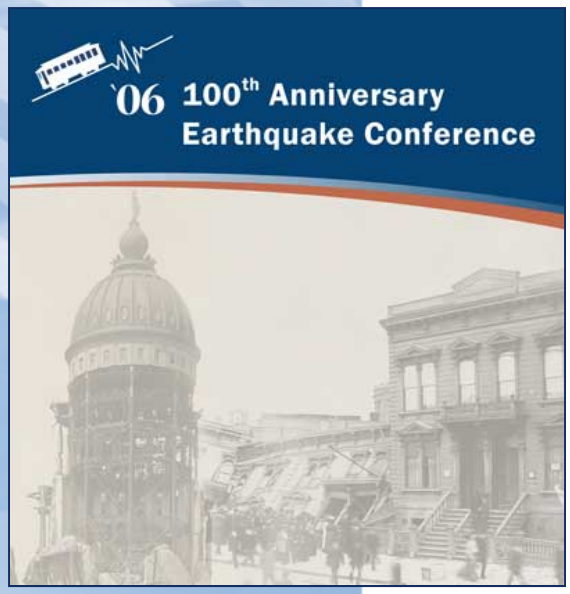
# Earthquake Professionals Top 10 Actions




***Unprecedented Collaboration***

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## Develop a Culture of Preparedness

1. Know your Seismic risk
2. Prepare to be self sufficient for 72 hours
3. Plan to care for vulnerable populations
4. Prepare to respond and exercise often

## Invest in Reducing Losses

5. Mitigate collapse hazard buildings
6. Retrofit essential facilities
7. Retrofit vulnerable infrastructure

## Ensure Resiliency in Recovery

8. Plan for housing displaced households
9. Plan for financing the cost of reconstruction
10. Governments plan to fund reconstruction

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# Progress?

- Risk is growing
- Community misunderstanding abounds
- Funding for research and mitigation is shrinking due to a lack of priority attention

***Suggestion:***

- ***Understand how it fits within the big picture of creating livable-sustainable communities***
- ***Use transparency to tackle misunderstanding***
- ***Seek a full range solution***

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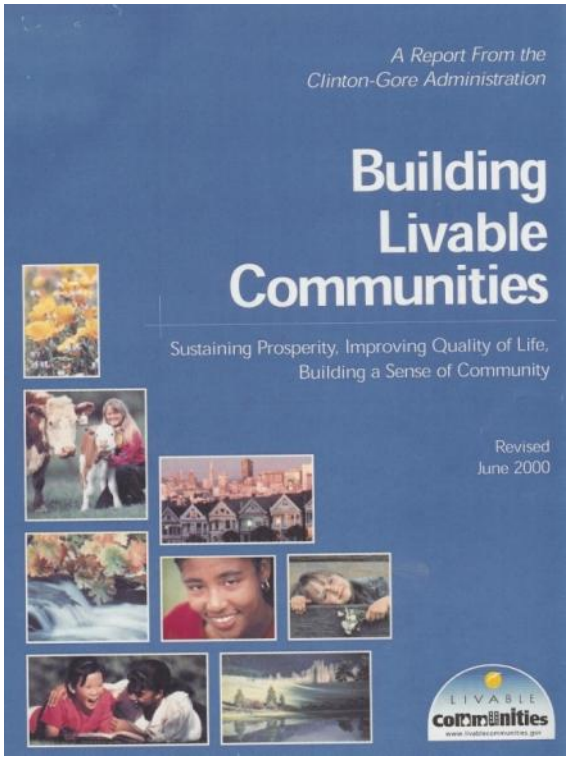
# The Big Picture – Building Livable Communities

***Sustaining Prosperity, Improving Quality of Life, Building a Sense of Community***




- Economic development, reuse
- Transportation, water, waste water, power, clean air
- Healthcare, affordable housing, jobs, education, open space
- Safety and livability through disaster resilience

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# The Resilient City:

## *Defining what San Francisco needs from its seismic mitigation policies*

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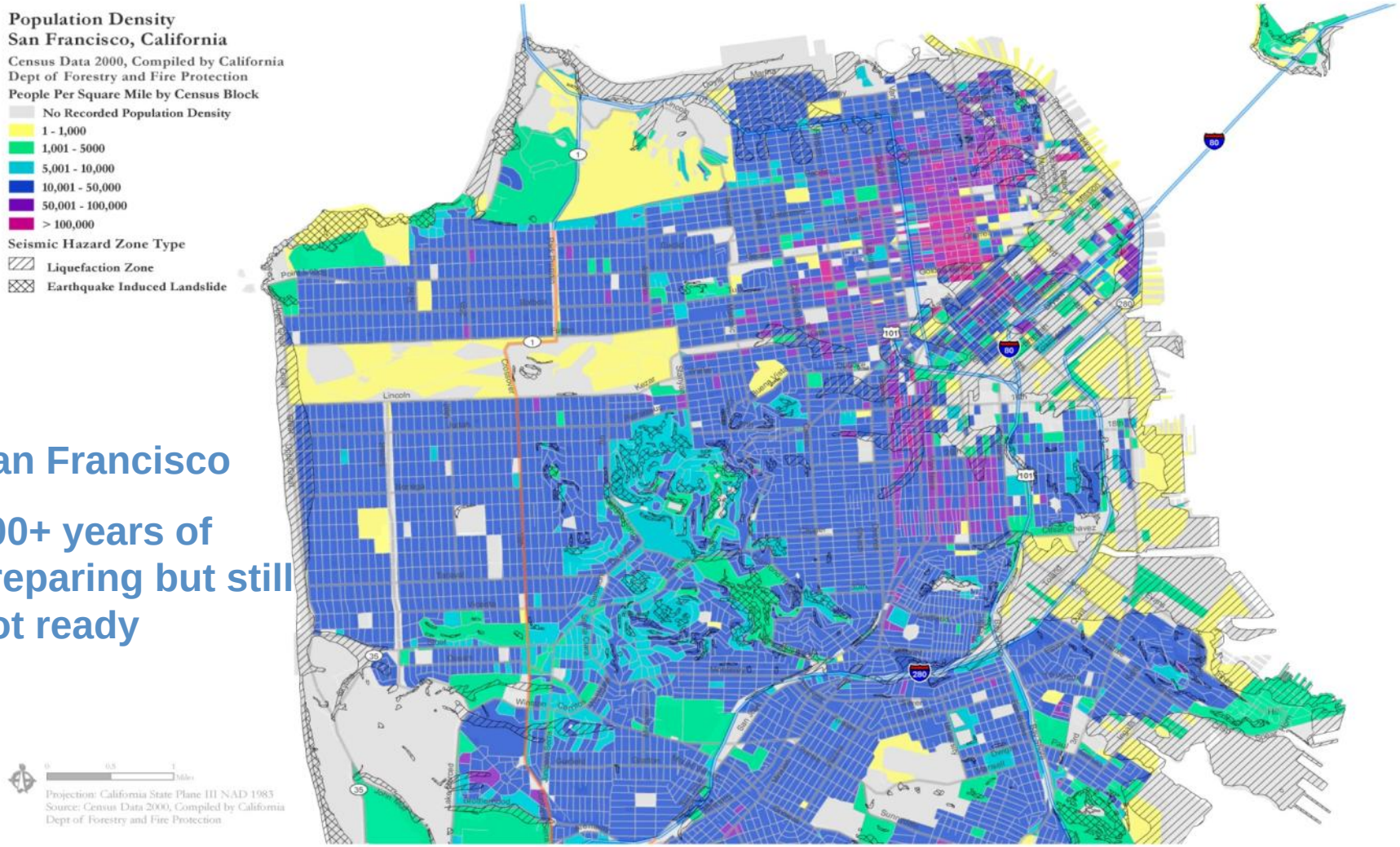


## San Francisco

## 100+ years of preparing but still not ready

*Repeat of 1906*

*100's deaths, 1000's injuries, 30,000+ buildings damaged,*

*60,000 displaced households, no utilities for weeks*

*Can we bounce back?*

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# SPUR's Disaster Planning Initiative

- **Hazard Mitigation** – *building to assure recovery*
- **Emergency Preparedness**- *beginning with neighborhood response*
- **Rebuilding** – planning *for the 21st century*

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# Hazard Mitigation Task Force

- Overarching Framework – *setting goals*
- New Buildings – *building right*
- Existing Buildings – *rehabilitate only as needed*
- Lifelines – *to support recovery*

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# Big Concepts:

- Define concept of ***resilience*** in the context of disaster planning and recovery
- Establish ***performance goals*** for the "expected" earthquake that supports of definition of resilience
- Define transparent ***performance measures*** that help us reach our performance goals
- Suggest ***next steps*** for San Francisco's new buildings, existing buildings and lifelines

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# What is seismic resilience?

Seismic resilience is the ability of the city

- ***contain the effects*** of earthquakes
- ***carry out recovery*** activities in ways that minimize social disruption
- ***rebuild*** in ways that mitigate the effects of future earthquakes.

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# Performance goals for the "expected" earthquake

| Phase | Time Frame | Condition of the built environment |
|---|---|---|
| I | 1 to 7 days | Initial response and staging for reconstruction |
| II | 7 to 30 days | Workforce housing restored – ongoing social needs met |
| III | Several years | Long term reconstruction |

***Lifelines and workforce are the key elements***

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# Performance goals for the "expected" earthquake

| Phase 1 | | Phase 1: Initial Response | | | Phase 2: Ongoing Social Needs | | Phase 3: Long Term Recovery | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Service | Within 4 Hours | Within 12 Hours | Within 24 Hours | Within 3 Days | Within 30 Days | Within 60 Days | Within 4 Month | Within 3 Years | Over 3 Years |
| | Mayor Declares Disaster | ▒ | | | | | | | | |
| | Emergency Operations Center Online | ▒ | | | | | | | | |
| | Non-City Resident Workers Return Home | ▒ | | | | | | | | |
| | Emergency Responders Mobilized | | ▒ | | | | | | | |
| | Hospital Receiving Patients | | ▒ | | | | | | | |
| | 95% Residents Sheltered In Place | | ▒ | | | | | | | |
| | Emergency Shelters Open | | | ▒ | | | | | | |

Target States of Recovery (shown as ▒) and current expectations ( shown as a ▒ )

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## Phase 2

| Service | Phase 1: Initial Response | | | Phase 2: Ongoing Social Needs | | Phase 3: Long Term Recovery | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Within 4 Hours | Within 12 Hours | Within 24 Hours | Within 3 Days | Within 30 Days | Within 60 Days | Within 4 Month | Within 3 Years | Over 3 Years |
| Water 90% Online | | | | ■ | | | ☒ | | |
| Power 90% Online | | | | ■ | | ☒ | | | |
| Sewers 90% Online | | | | ■ | | | | ☒ | |
| Phone Service 90% Online | | | | ■ | ☒ | | | | |
| 90% Of Major Transportation Arteries Opened | | | | ■ | | | ☒ | | |
| Transportation Available For Energy and Construction Crews | | | | ☒ | | | | | |
| Essential city services restored | | | | ■ | | ☒ | | | |
| All Remaining Utilities To 95% | | | | | ■ | | | ☒ | |
| Transportation To 95% | | | | | ■ | | ☒ | | |
| Schools Repaired & Reopened | | | | | ■ | | ☒ | | |
| Medial Providers Offices Repaired & Reopened | | | | | ■ | | | ☒ | |
| Residents Repaired To Point Where People Can Return | | | | | ■ | | | ☒ | |
| Community Retail Services Reopen | | | | | ■ | | | | ☒ |
| Airport Reopens | | | | | ☒ | | | | |

Target States of Recovery (shown as ■ ) and current expectations ( shown as a ☒ )

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## Phase 3

| Service | Phase 1: Initial Response | | | Phase 2: Ongoing Social Needs | | Phase 3: Long Term Recovery | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Within 4 Hours | Within 12 Hours | Within 24 Hours | Within 3 Days | Within 30 Days | Within 60 Days | Within 4 Month | Within 3 Years | Over 3 Years |
| Public Transportation Resumes 90% | | | | | | ▒ | | | |
| Minor Transportation Routes Repaired & Reopened | | | | | | ▒ | | | |
| Yellow And Red Tagged Residences Fully Repaired | | | | | | | ▒ | | ☒ |
| All People Out Of Temporary Shelters | | | | | | | ▒ | ☒ | |
| All Businesses Reopen | | | | | | | ▒ | | ☒ |
| Remaining Lifelines To 100% | | | | | | | | ▒ | |
| Yellow And Red Tagged Buildings Repaired Or Demolished | | | | | | | | ▒ | ☒ |
| Businesses Return At Pre-Event Level | | | | | | | | ▒ | ☒ |
| Non-Emergency City Services Restored To Pre-Event Level | | | | | | | | ▒ | |

Target States of Recovery (shown as ▒) and current expectations ( shown as a ☒ )

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# Transparent Performance Measures for Buildings

| Category | Performance Standard |
|---|---|
| Category A | ***Safe and operational**:* Essential facilities such as hospitals and emergency operations centers |
| Category B | ***Safe and usable during repair**:* "shelter-in-place" residential buildings and buildings needed for emergency operations |
| Category C | ***Safe and usable after repair**:* current minimum design standard for new, non-essential buildings |
| Category D | ***Safe but not repairable**:* below standard for new, non-essential, buildings. Often used as a performance goal for existing buildings undergoing voluntary rehabilitation |
| Category E | ***Unsafe – partial or complete collapse**:* damage that will lead to casualties in the event of the "expected" earthquake - the killer buildings |

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# Transparent Performance Measures for Lifelines

| Category | Performance Standard |
|---|---|
| Category I | Resume 100% service within 4 hours - ***hospitals*** |
| Category II | Resume 90% service within 72 hours - ***workforce*** |
| | 95% within 30 days |
| | !00% within 4 months |
| Category III | Resume 90% service within 72 hours - ***commercial*** |
| | 95% within 30 days |
| | 100% within 3 years |

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# Transparent Hazard Definitions

| Category | Hazard Level | CAPSS |
|---|---|---|
| Routine | Likely to Occur routinely in San Francisco | **(M = 5.0)** |
| Expected | Reasonably expected to occur once during the useful life of a structure or system | **(M= 7.2)** |
| Extreme | Reasonably be expected to occur on a nearby fault | **(M=7.9)** |

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# Policies for Achieving Resilience

- **New Buildings –**
  - Link consideration of Structural and Non-structural elements
  - Add transparency by declaration
  - Develop incentives for building better
  - Improve/assure quality in design and construction

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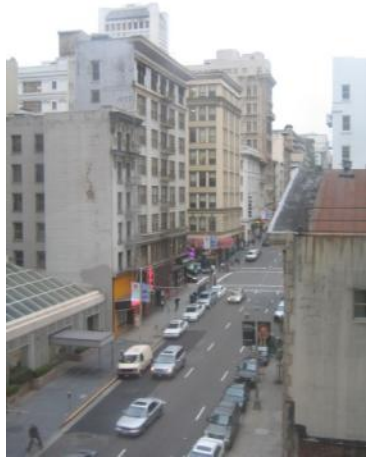
# Policies for Achieving Resilience

- **Existing Buildings** - A balance of voluntary, triggered, encouraged with incentives, and mandatory requirements
  - Mandatory retrofit of soft story buildings
  - Mandatory retrofit of emergency shelters
  - Initiate a non-ductile concrete building program
  - Require gas shut off valves
  - Reassess the URM Program



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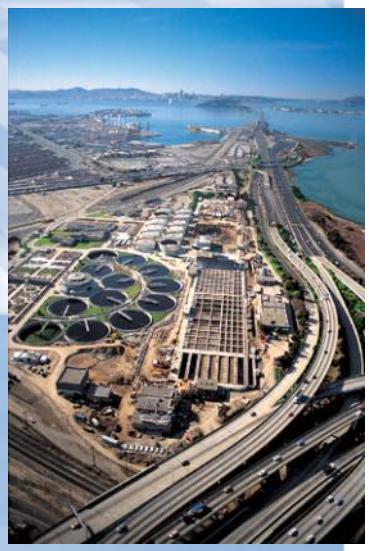
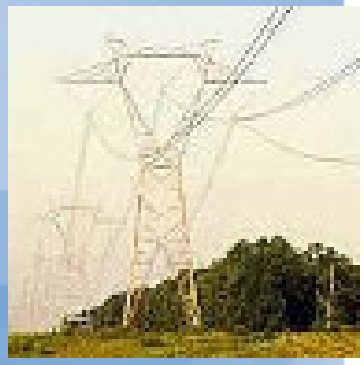
# Policies for Achieving Resilience





**Lifelines** – Community developed program based on an assessment, standards and incentives

- Establish a lifelines council
- Assess conditions and expected performance
- Set priorities for mitigation
- Improve City owned systems
- Provide automatic shut off valves for high-risk areas
- Set up regional partnerships

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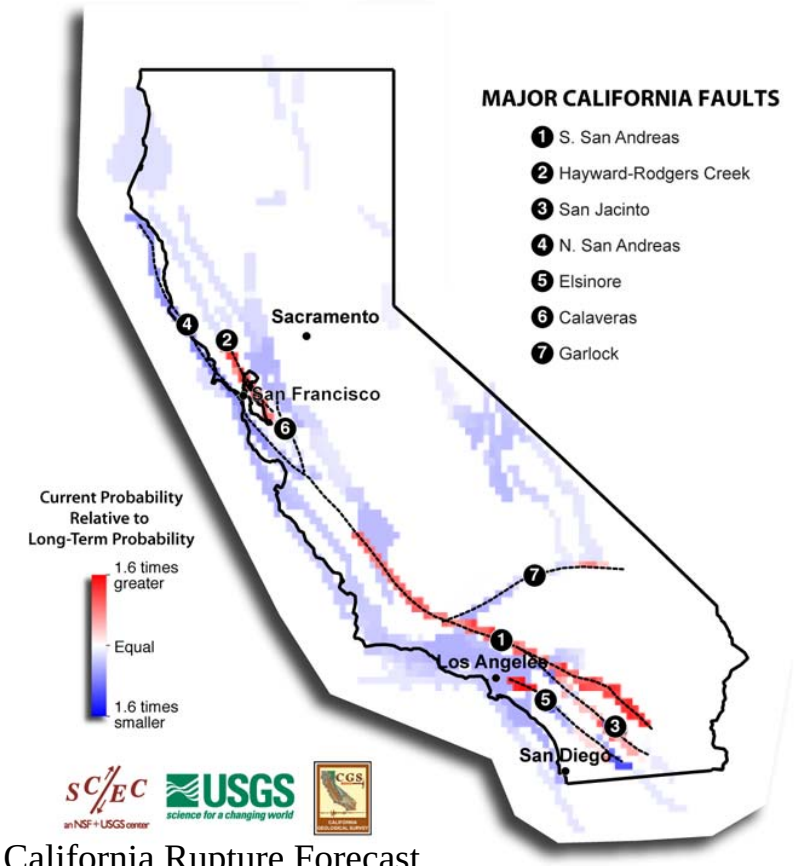
# What are the "Expected" Earthquakes?


Uniform California Rupture Forecast

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# Predict the Performance of Structures

## 1999 Taiwan Earthquake

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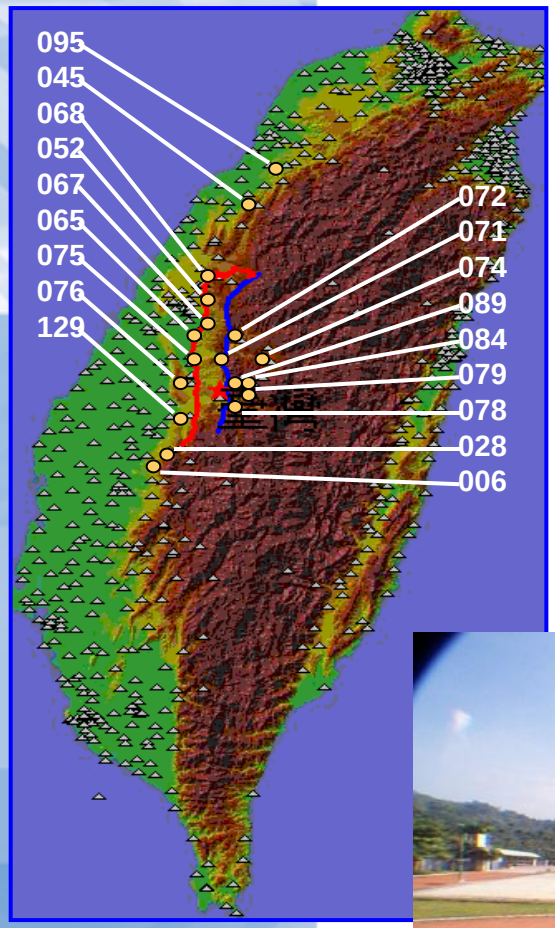
# Instrument Location Visited

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# Creating a Resilient Community

- **Craft a Mitigation program**
  - Set Goals
  - Catalogue Lifelines, understand vulnerabilities, strive toward new standards all projects
  - Refine new building standards, assure quality
  - Develop mandatory, incentive driven, encouraged, and voluntary programs based on resilience needs
- **Refine disaster planning**
  - Add neighborhood response planning
- **Think through a plan for rebuilding**
  - Set new goals for livable-sustainable Cities

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# Please!

- Keep the big picture in mind
- Advocate for a Resilient City and tailor policies to achieve
- Refine and declare the hazard level and performance categories used in design.
- Predict performance accurately
- Set and implement specific standards for lifeline structures and systems
- Speak with a common voice

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