Workshop: the HayWired Scenario & Research Needs for Resilient New Buildings

A PEER-USGS Workshop at Sibley Auditorium, UC Berkeley

2:30 – 5:00 PM, January 17, 2018

Khalid Mosalam, UC Berkeley, PEER Director

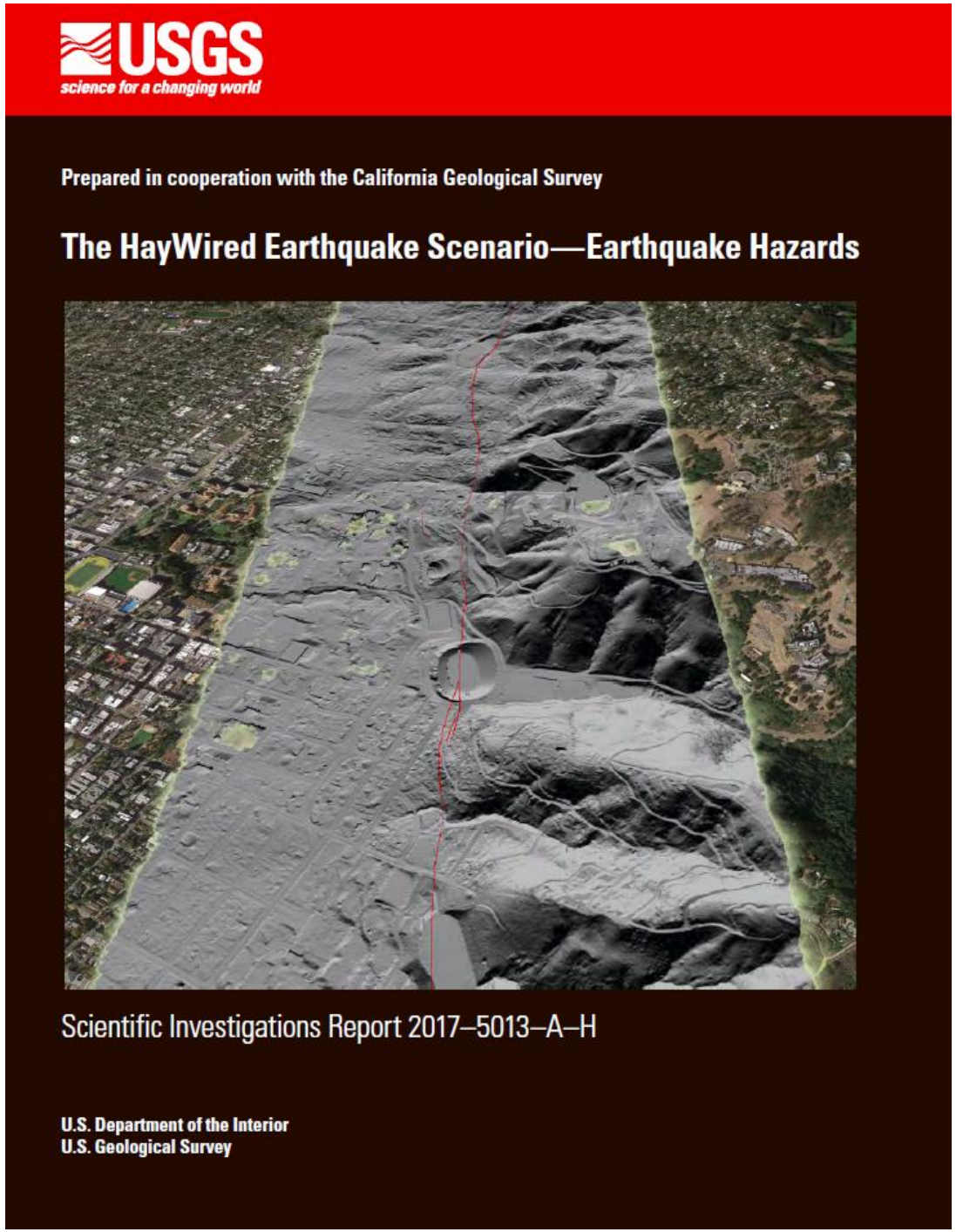
Keith Porter, University of Colorado Boulder, HayWired Engineering Coordinator

Background

SAFRR Scenarios: events worth planning for; not best, worst, or average, but realistic

HayWired: a Bay Area earthquake to test the interconnected world

We used HayWired as a lens through which to view the adequacy of code objectives in an interesting new way, & to consider one way for enhancing resilience



Today's discussion

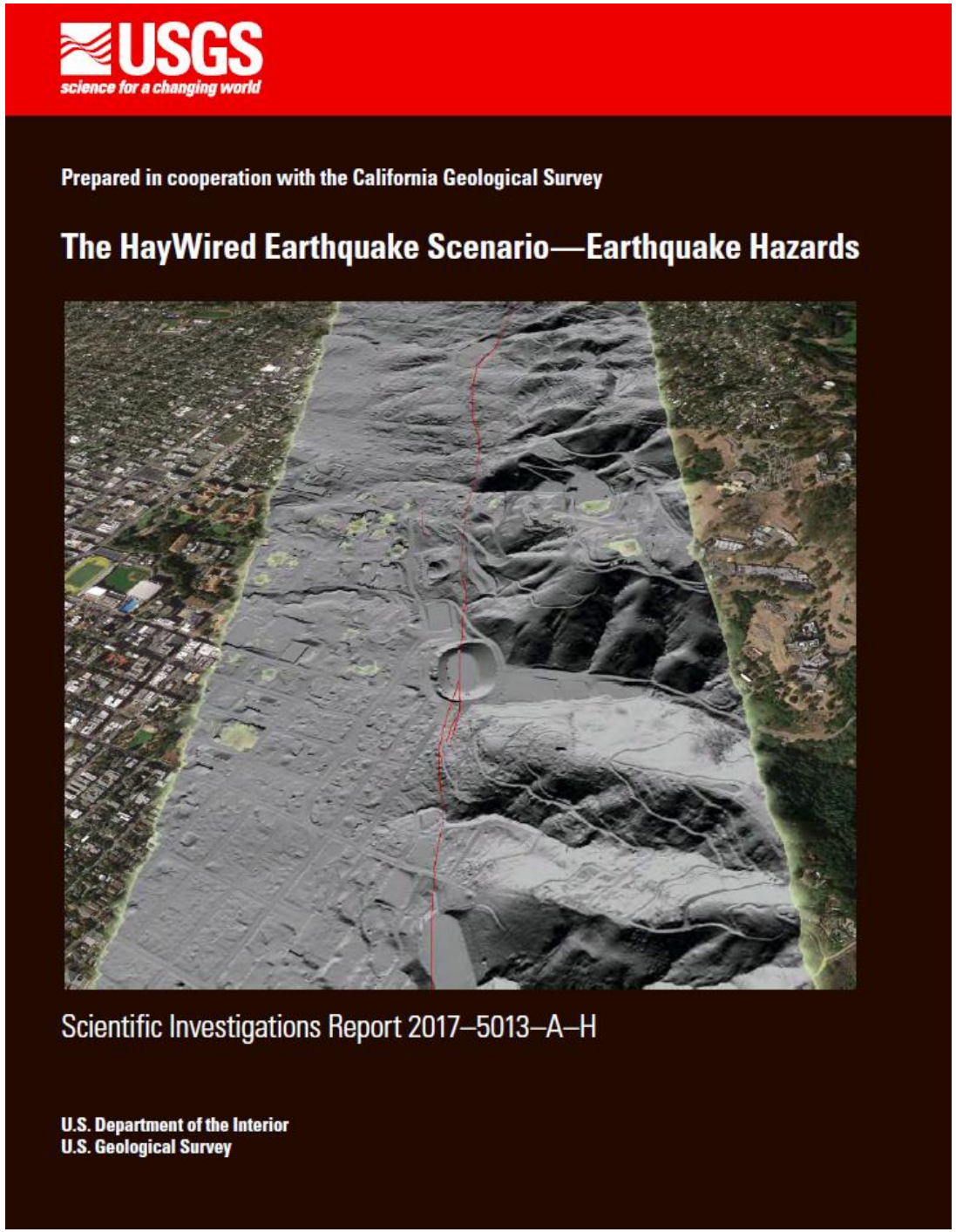
What can a scenario tell a code-writer or community leader about code adequacy?

Advantages and disadvantages of leading resilience options?

- Greater stiffness and strength
- PBEE-2
- Innovative structural systems
- Others

What additional information do policymakers need from engineers?

- Current research
- Research needs



Objectives

Dispassionate, scholarly advice or direction for code-writers and community leaders on code adequacy and resilience options

- Presentations to help inform the discussion
- For each of our 4 questions, what do we know and agree on that they can use to derive new value?
- What unresolved issues really matter to code-writers and community leaders that, once resolved, would provide useful information for real decisions?

Viewing the Code through HayWired

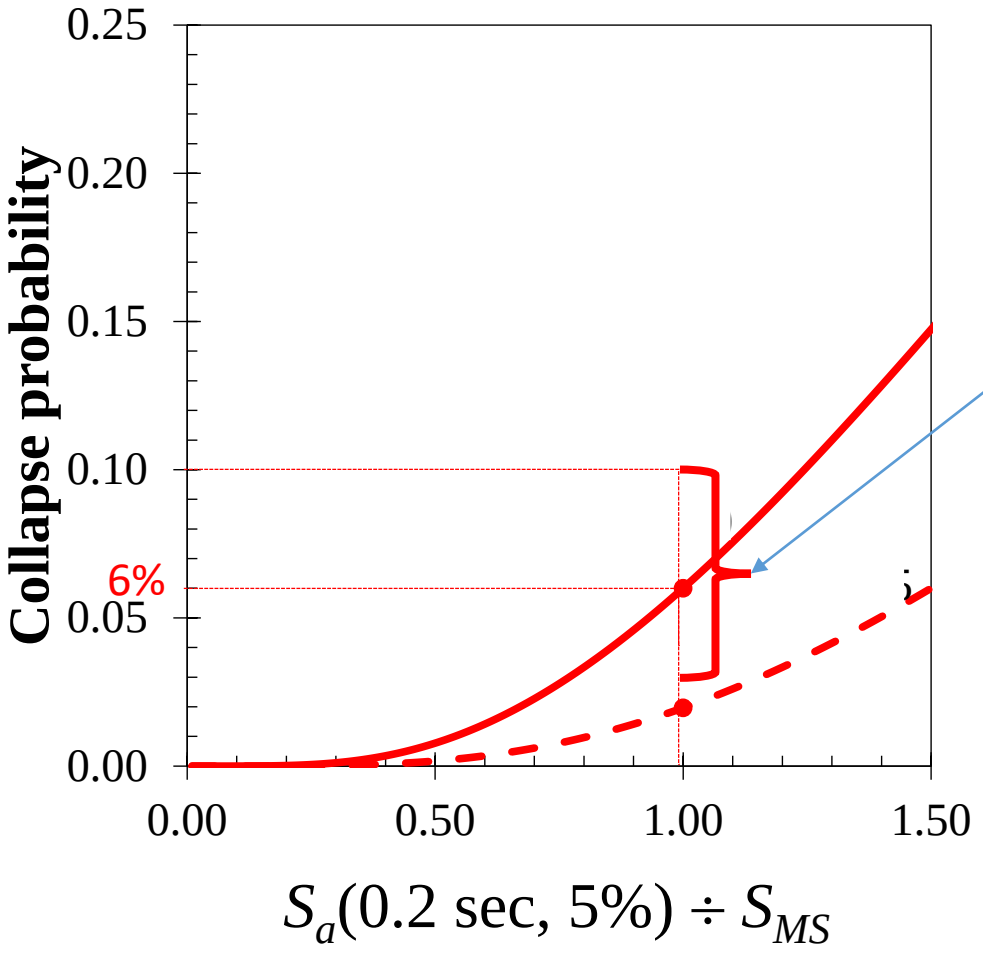
Keith Porter, CU Boulder, HayWired Engineering Coordinator

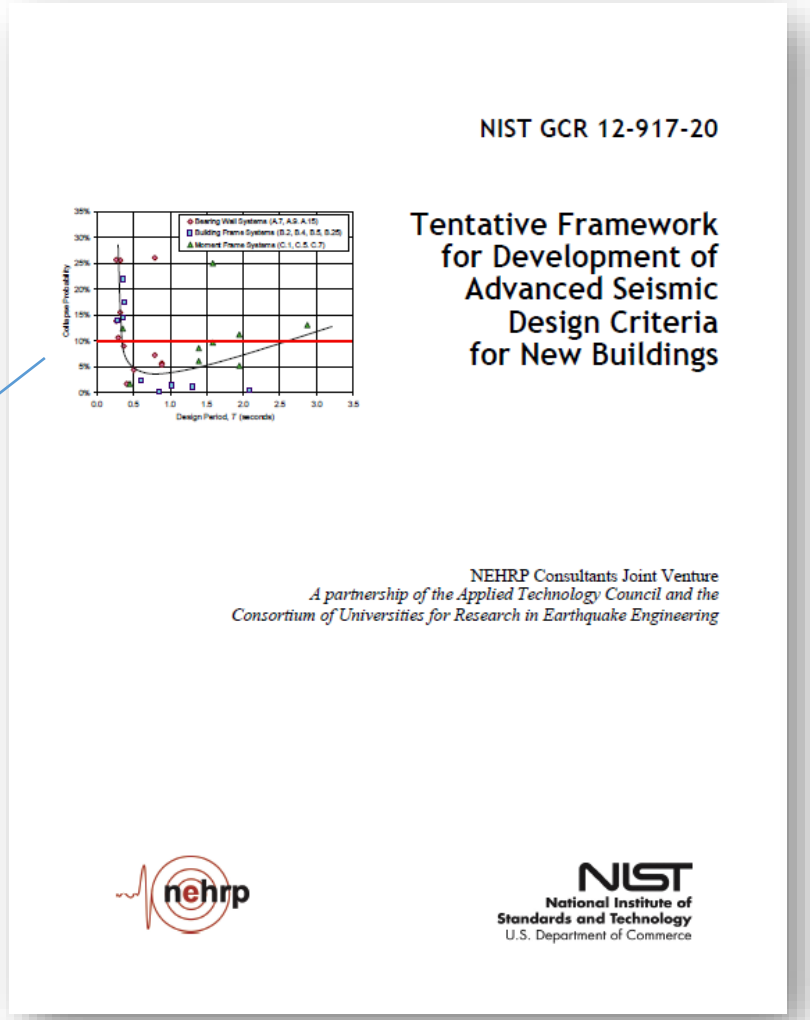
What if every building met code?

What if:

1. Every building had an average 6% collapse probability in MCE_R shaking
2. Every building had ASCE 7's assumed probability distribution of collapse capacity at other levels of shaking
3. New buildings exhibited the same ratios of red tags to collapse and yellow tags to red tags as *existing* building exhibited in Loma Prieta and Northridge
4. An earthquake occurs and produces the Aagaard et al. (2010) ground motion map for Mw 7.0 Hayward Fault (NH+HS) bilateral rupture

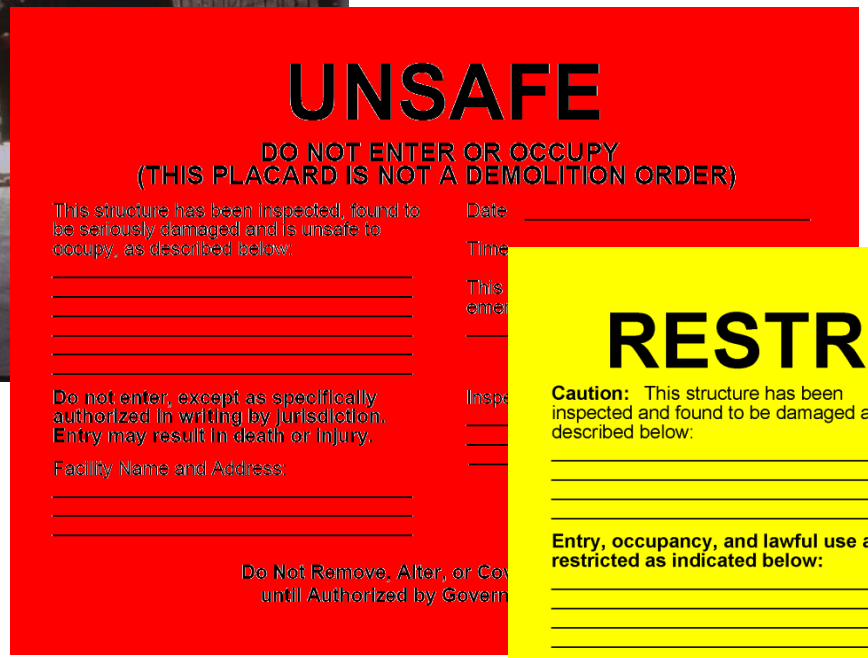
Collapse

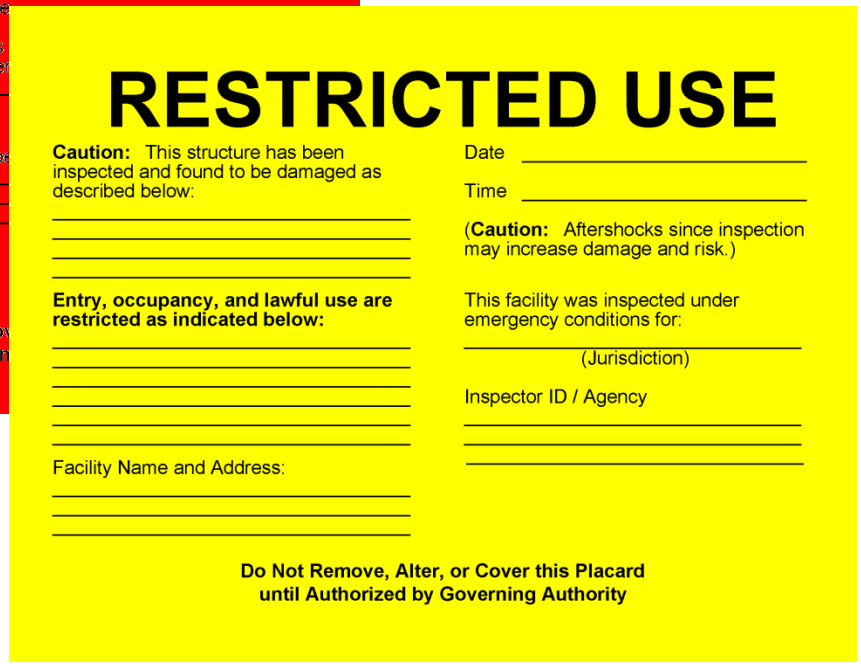

0.25
0.20
0.15
0.10
6%
0.05
0.00
Collapse probability
0.00
0.50
1.00
1.50
$S_a(0.2 \text{ sec}, 5\%) \div S_{MS}$


NIST GCR 12-917-20
Tentative Framework for Development of Advanced Seismic Design Criteria for New Buildings
NEHRP Consultants Joint Venture
A partnership of the Applied Technology Council and the Consortium of Universities for Research in Earthquake Engineering
nehrp
NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Let’s call this “impairment”

For every 1 collapse

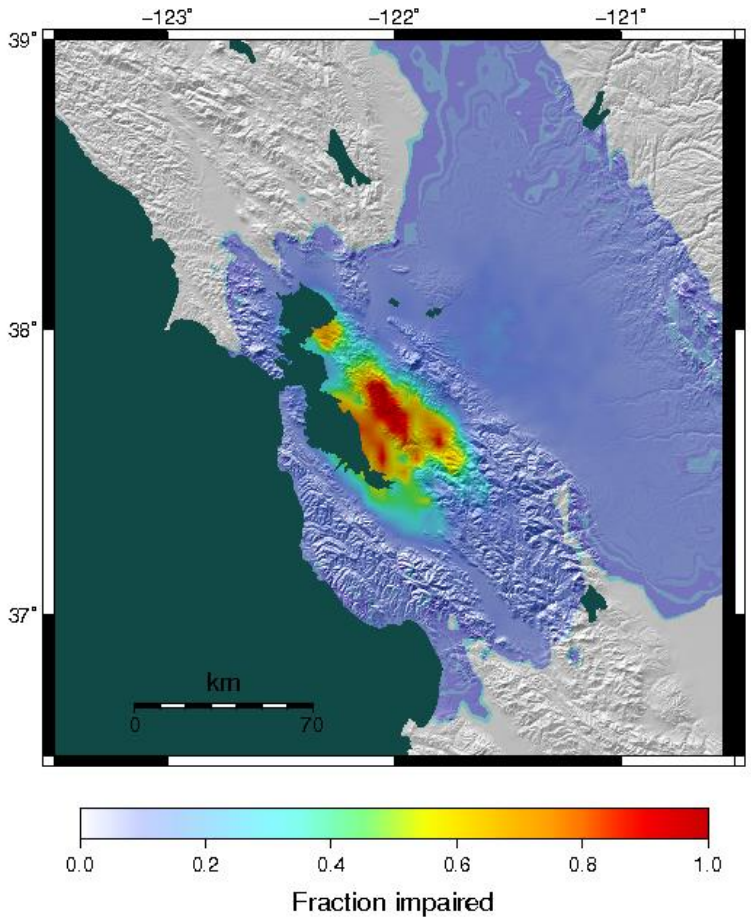




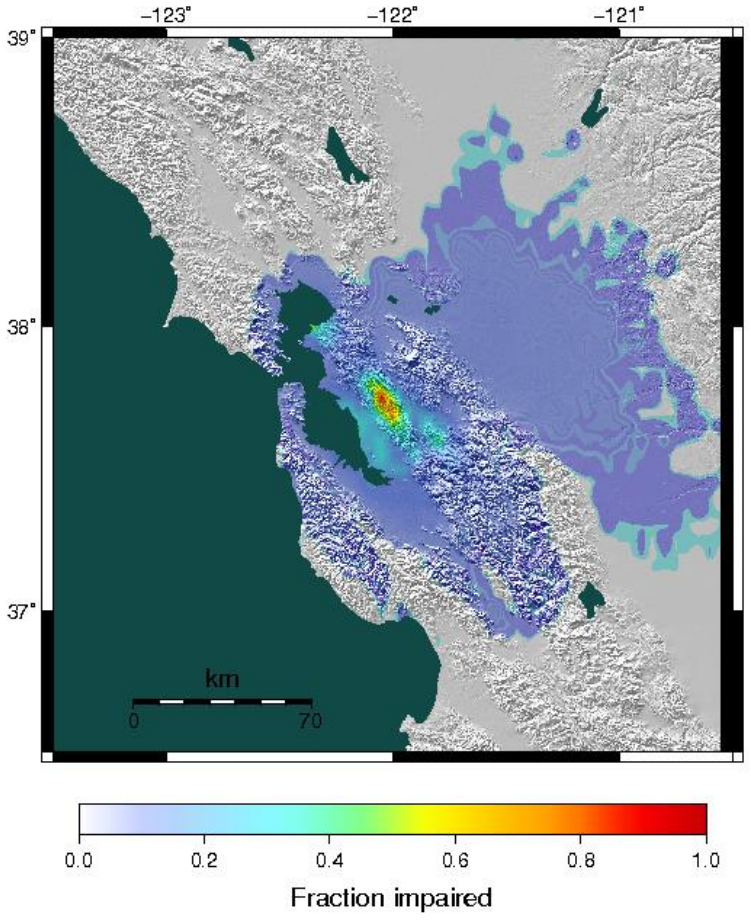
+ 13 red tags

+ 49 yellow tags

Impairment in HayWired



I = 1.0: 24% impaired



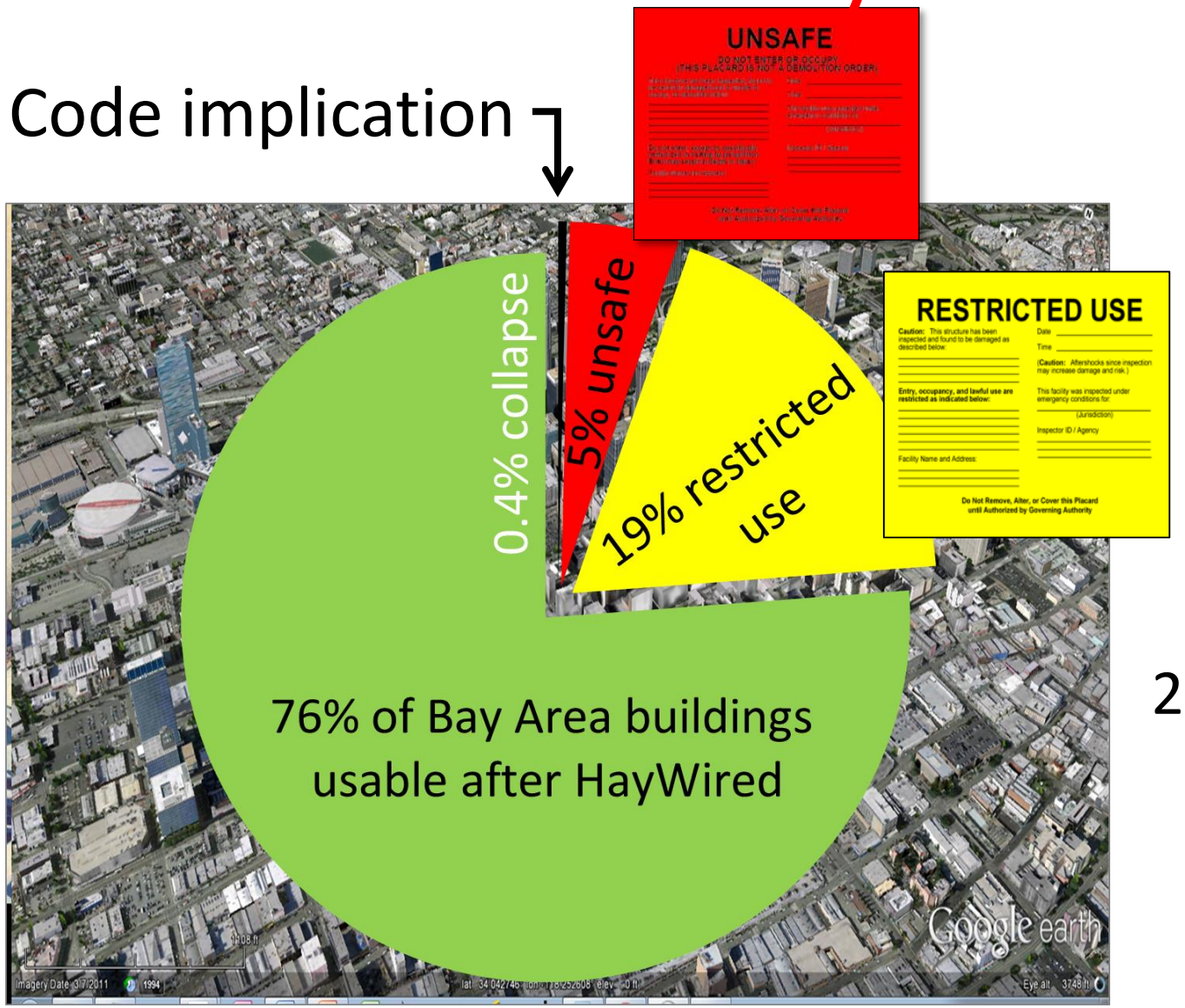
I = 1.5: 6% impaired

Impairment in HayWired

Condition	Buildings affected	
	I = 1.0	I = 1.5
Collapsed	8,000	2,000
Red tagged	102,000	27,000
Yellow tags	390,000	100,000
Total impaired buildings	500,000	130,000
People in impaired buildings	1,500,000	390,000
Businesses in imp. buildings	150,000	39,000
% of 2 million Bay Area buildings	24%	6%

Impairment in HayWired

Code implication



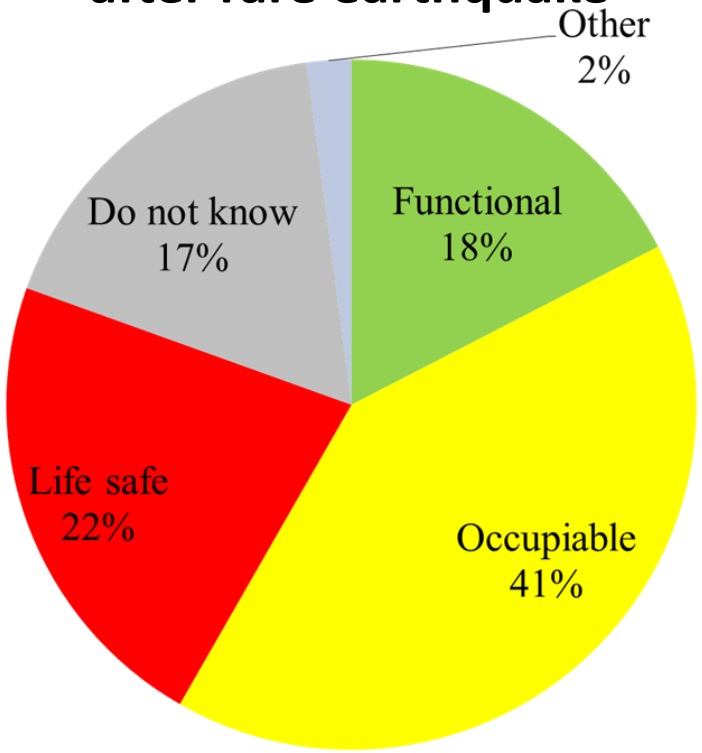
2 million Bay Area buildings

$I_e = 1.0 \rightarrow$ 24% impaired

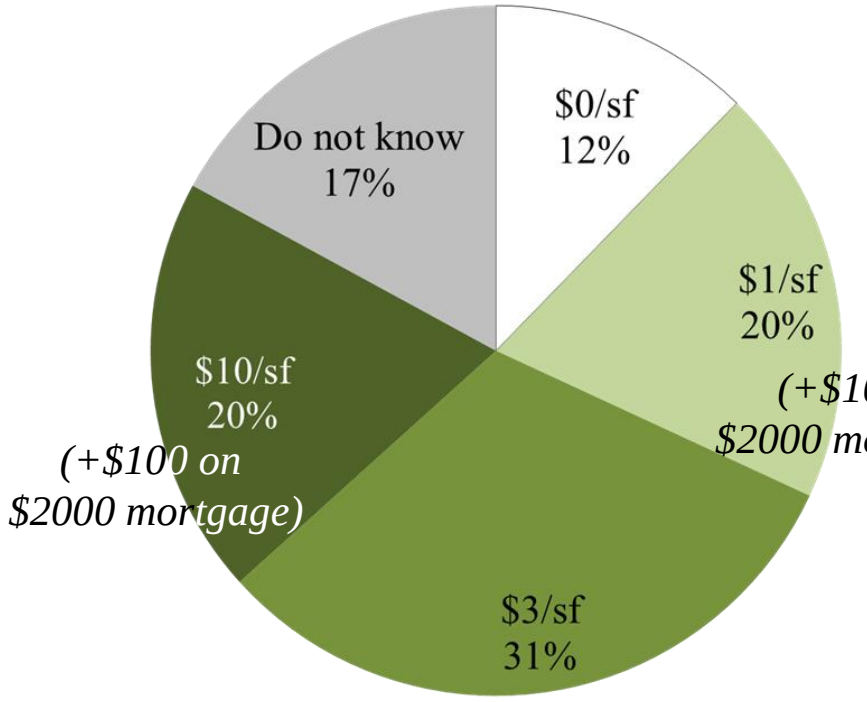
$I_e = 1.5 \rightarrow$ 6% impaired

Public preferences

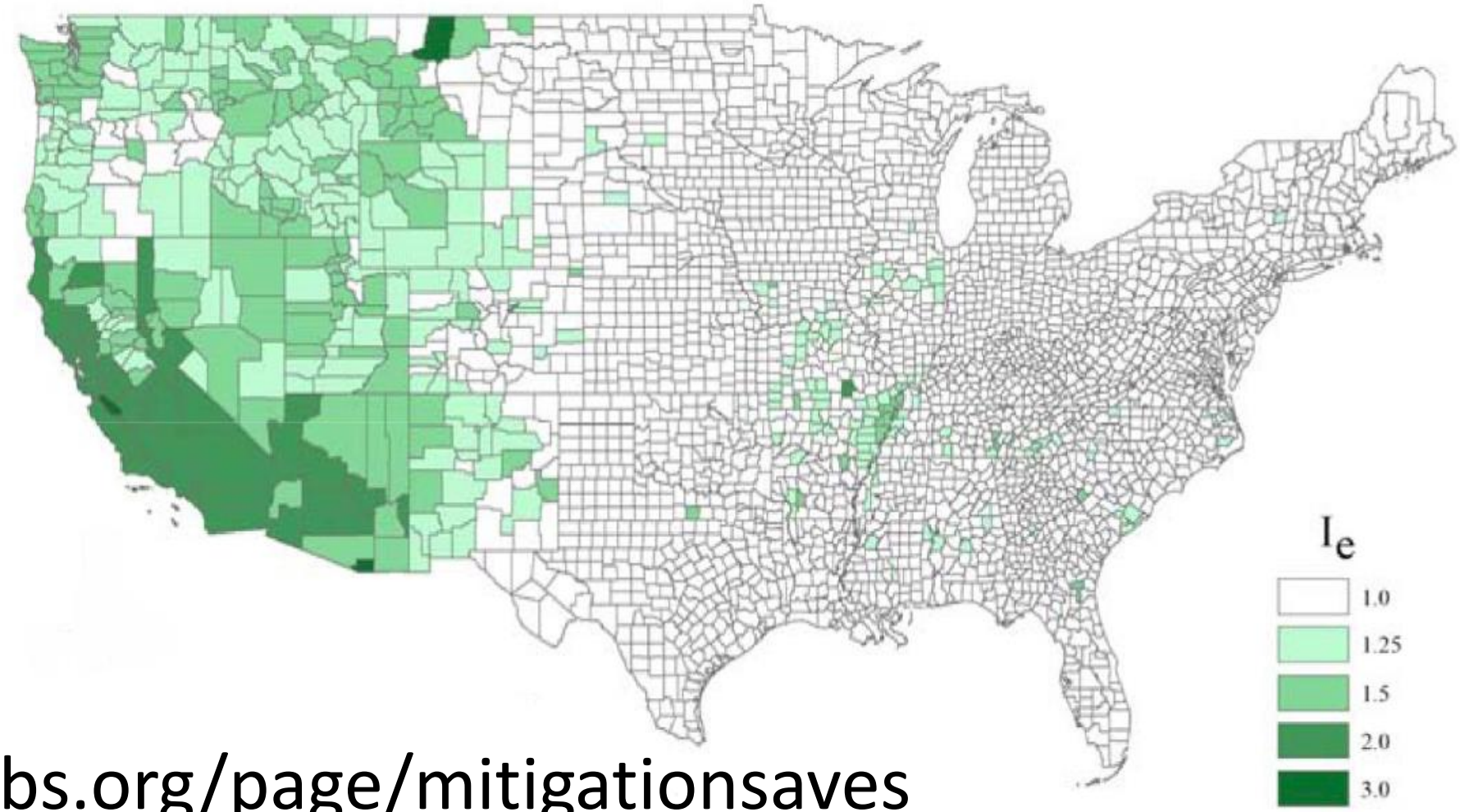
Public preference for new buildings after rare earthquake



Willingness to pay for occupiable or functional new buildings

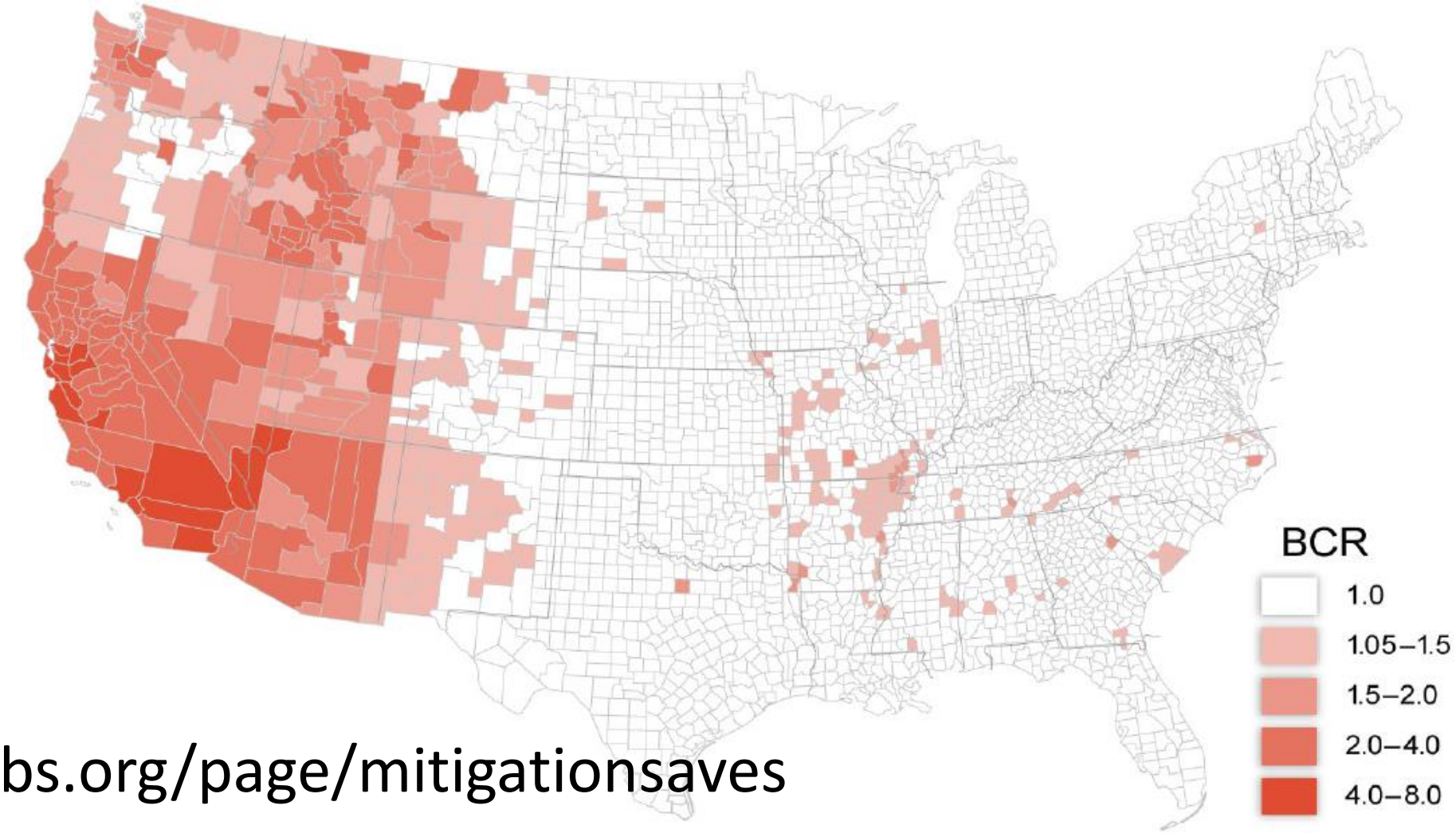


Maximum efficient stiffness & strength from benefit-cost analysis basis



www.nibs.org/page/mitigationsaves

Benefit-cost ratio at maximum efficient stiffness & strength



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Moderated discussion

1. What can a scenario say about building code adequacy that code writers should consider? How does this compare with what communities should consider?

2. Under what conditions is PBEE a practical resilience option for new buildings? What about increasing design strength and stiffness? Other options such as self-centering frames? Others?

3. What current research could inform building code-writers' and code-adopters' decisions about resilience options?

4. What new research is needed to inform those decisions?