Resilience
Challenges and Opportunities

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The Improvement of Structural Engineering and Resilience

Understanding Resilience

- Broad Concept:
  - The capacity of communities to survive, adapt and grow, now matter what kind of chronic stress or acute shock they experience
- Buzzword:
  - Every city, every government agency, every academic wants to be seen “doing something about it”
- Components:
  - Research
  - Policy
  - Implementation

The Resilience Research Questions

For the technical community:

- How do we evaluate the performance of the whole building and design infrastructure systems (both existing and new) to significantly reduce losses in order to simplify and shorten recovery time?
- How do we model the interdependencies in systems to accurately reflect long term performance?

Lessons from CA, Japan & NZ: Research Investments

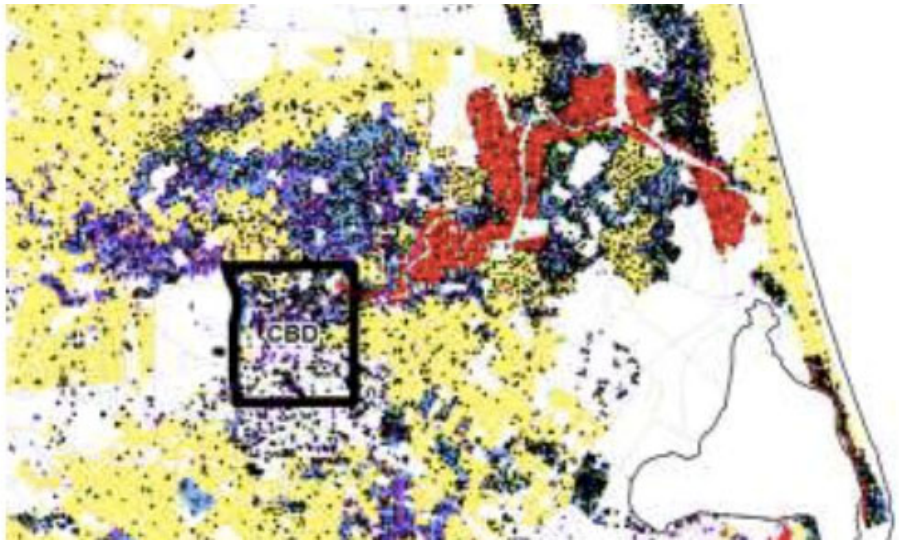
- **Research Investment in the last 30 years**
  - Focus on Performance Based Design Methods, Testing, Data systems, Modeling and Geo-mapping
- US: PEER, MCEER, and ATC
- Japan: E-Defense, Govt. and Corporate Support
- New Zealand: QUAKE CoRE. Quake Center & Resilience to Nature's Challenges

Lessons from CA, Japan & NZ: Public Investment in Seismic Upgrades

- **Billions Invested Beyond Recovery:**
  - Infrastructure Upgrading Investments
  - Retrofit of Public Buildings and Enhanced Seismic Codes for New and Existing Buildings
  - Improved Hazard Maps
  - Resilience Planning

Christchurch and National Geotechnical Database

Tonkin + Taylor engineer
Dr Sjoerd van Ballegooy

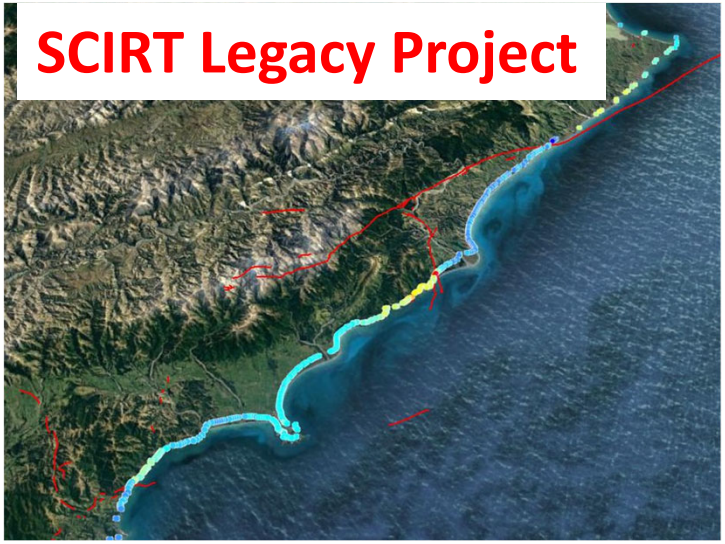


Infrastructure Investments Beyond Reconstruction

Freeway Bridges and Overpass

Transit/Water Upgrades

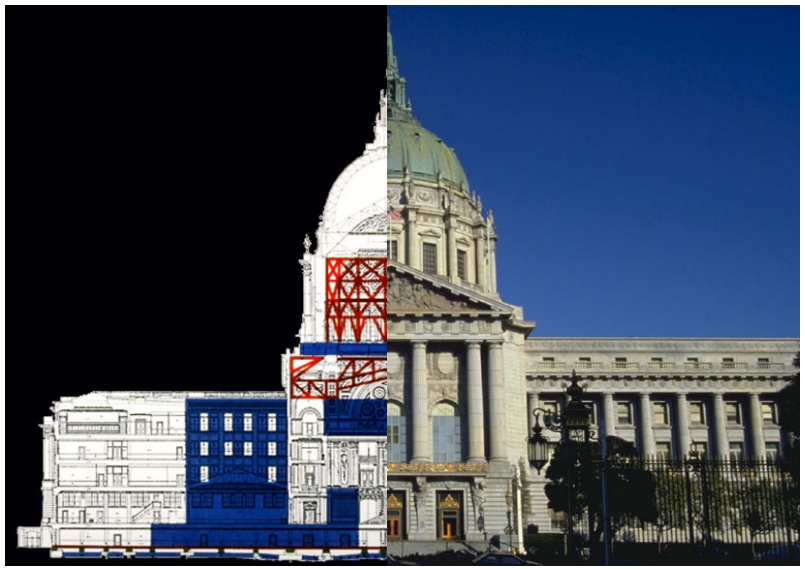
SCIRT Legacy Project



Miyagi Coast Roads/Seawalls

Building Design and Regulations

Retrofits Public Buildings, UC Disaster Resistant University



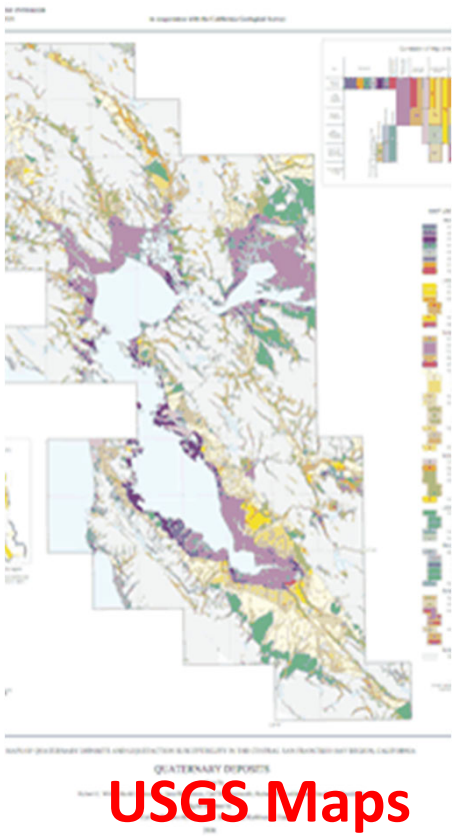
Soft-Story Apts.

US : 1997 Seismic Code and Code for Existing Buildings; PBEE Methods

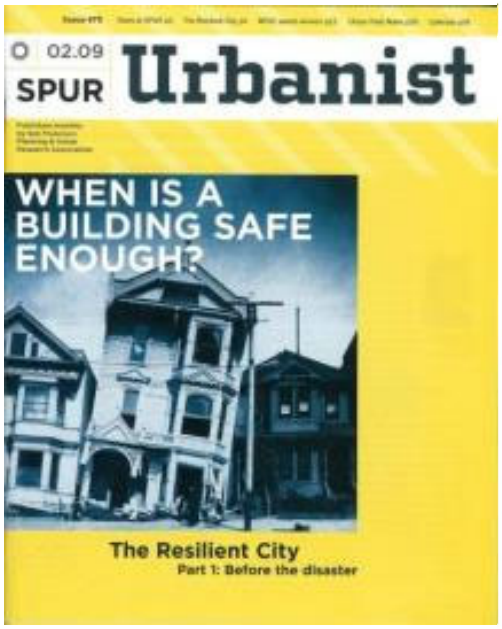
Japan: National Building Standards and City Planning Laws,
Land Readjustment Law

New Zealand: Introduction of Eq. Prone Buildings and
% New Building Standard ratings

Hazards Maps and Resilience Planning



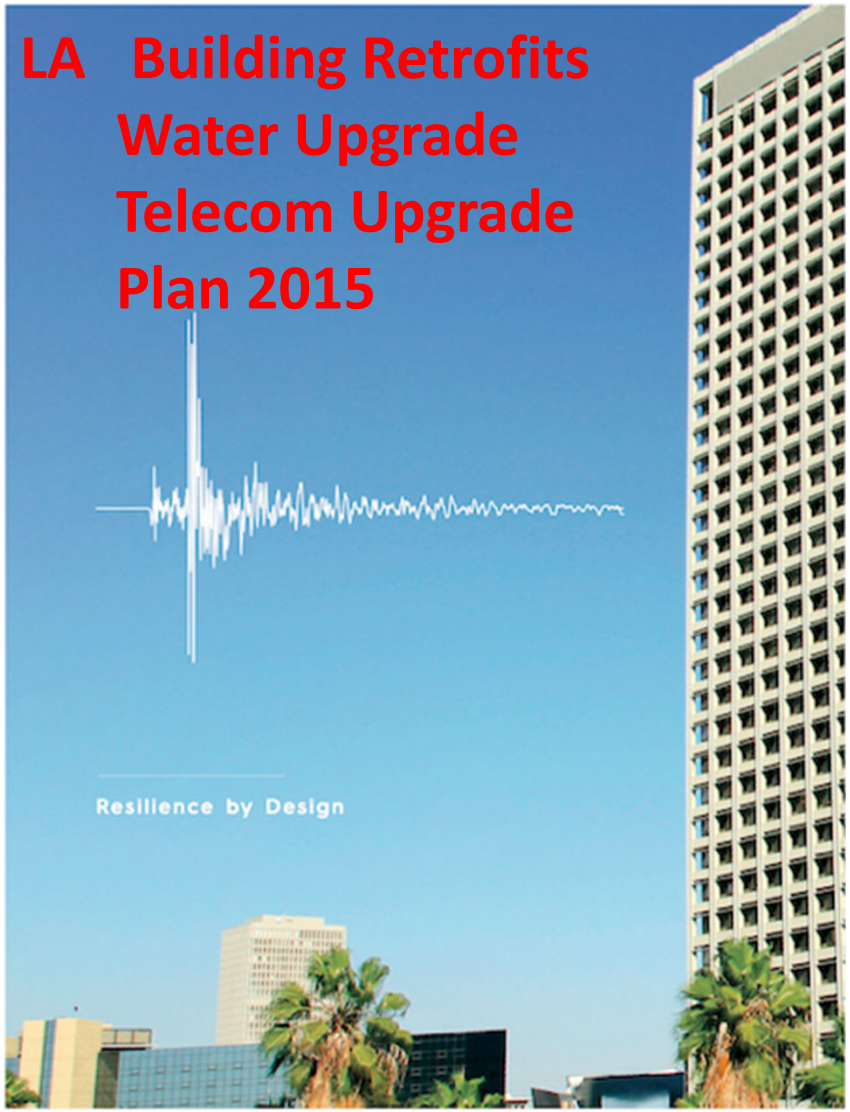
USGS Maps



San Francisco:
CAPSS to SPUR
2000-2014

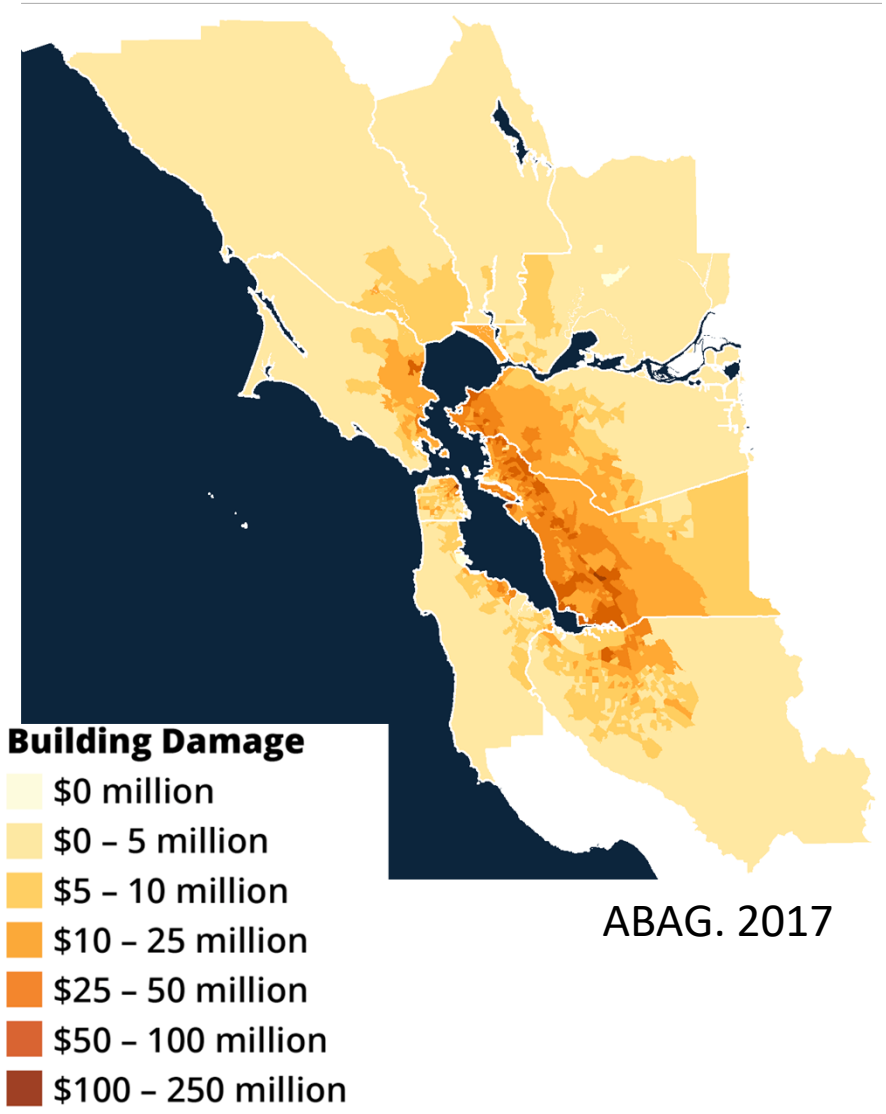
City and County of San Francisco
LIFELINES COUNCIL

Edwin M. Lee, Mayor
Naomi Kelly, City Administrator



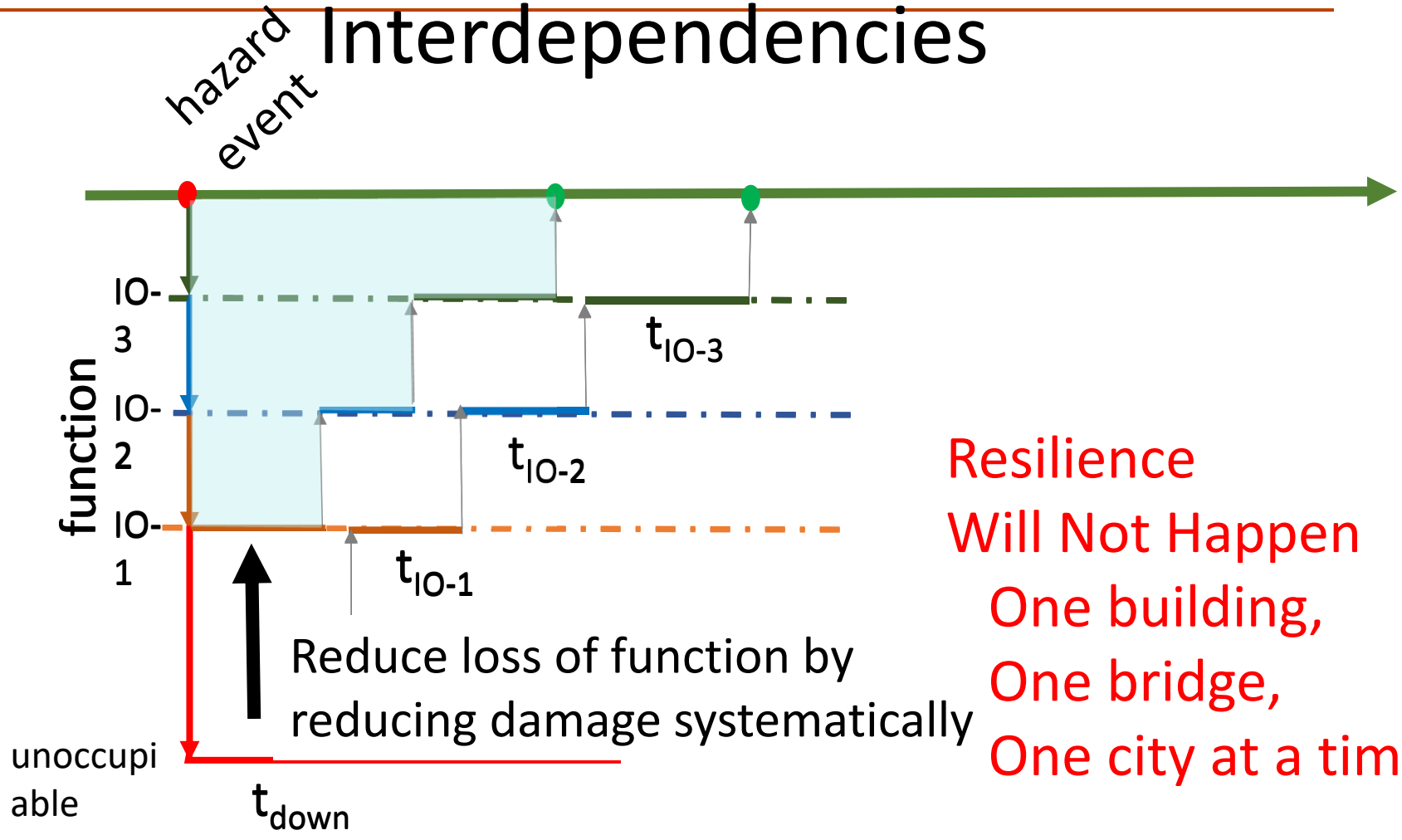
ALL Scenarios Project Heavy Losses

- Scenarios in all countries show staggering losses despite investment efforts
- California Example:
  - $80-$100 Bil Losses
  - Buildings and Unimproved Infrastructure
  - 150-200,000 Households Displaced
  - US: Only 10% with Insurance



ABAG. 2017

Limit Losses & Reduce Recovery Time: Model Whole Buildings, Systems, Interdependencies



Resilience
Will Not Happen
One building,
One bridge,
One city at a time

Slide: Prof. Greg Deierlein, Stanford Univ.

Essential Elements of Resilience

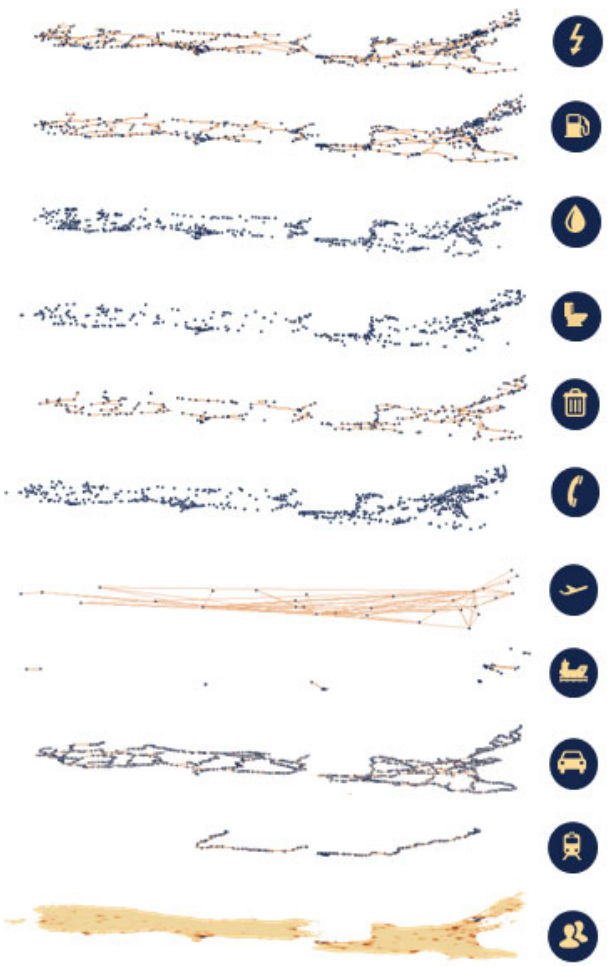
SAFE & FUNCTIONAL PHYSICAL ENVIRONMENTS

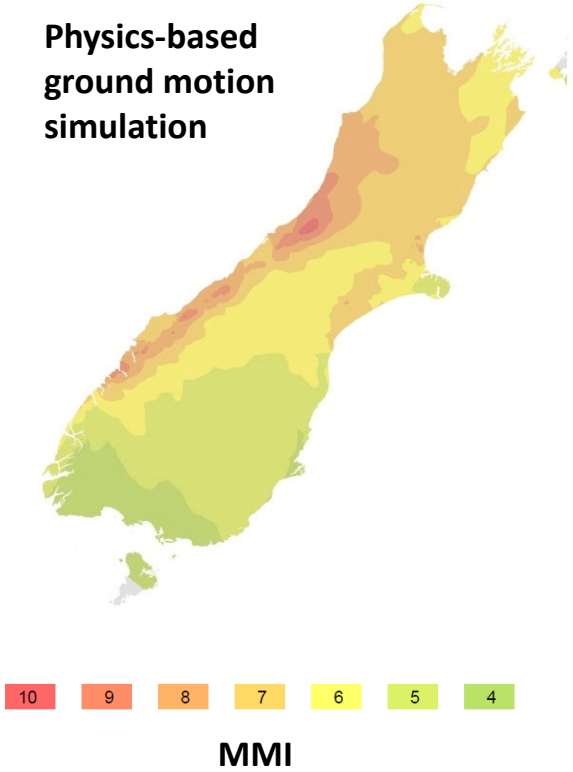
- Infrastructure
- Building for Repair-ability
- Geotechnical and Hazard Data in Land Use Planning

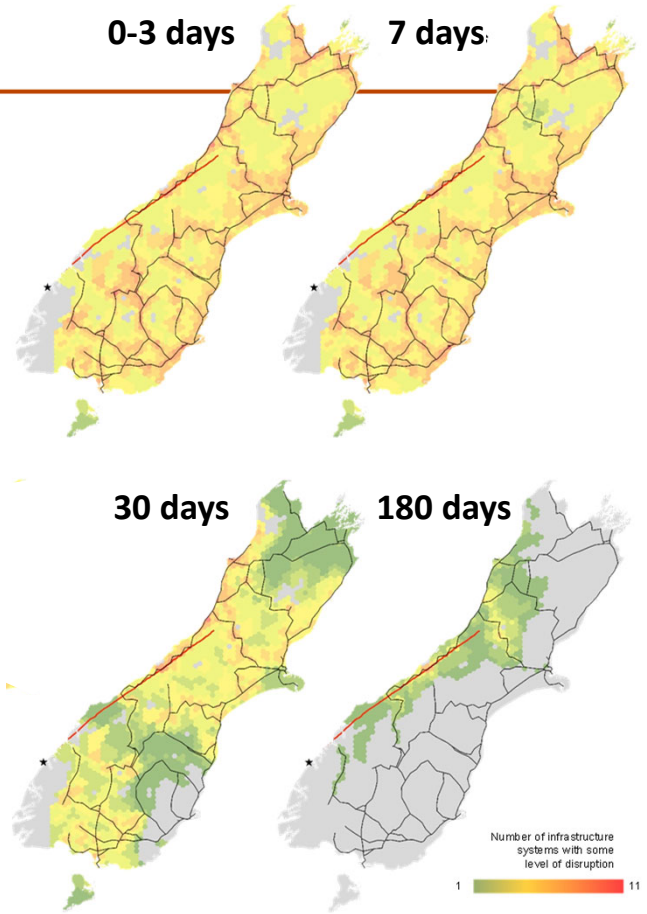
EQUITY, SOCIAL & ECOLOGICAL RESPONSIBILITY

- Serve the community everyday, and be prepared for limiting losses in future disasters

WHY Infrastructure Matters







1 Interdependent National Infrastructure Model

2 Alpine Fault event (AF8+ Scenario – geohazards out to 10 years)

3 Modelled direct and indirect disruptions over time

Bradley et al. 2016, Davies et al. 2018, Zorn et al. 2018

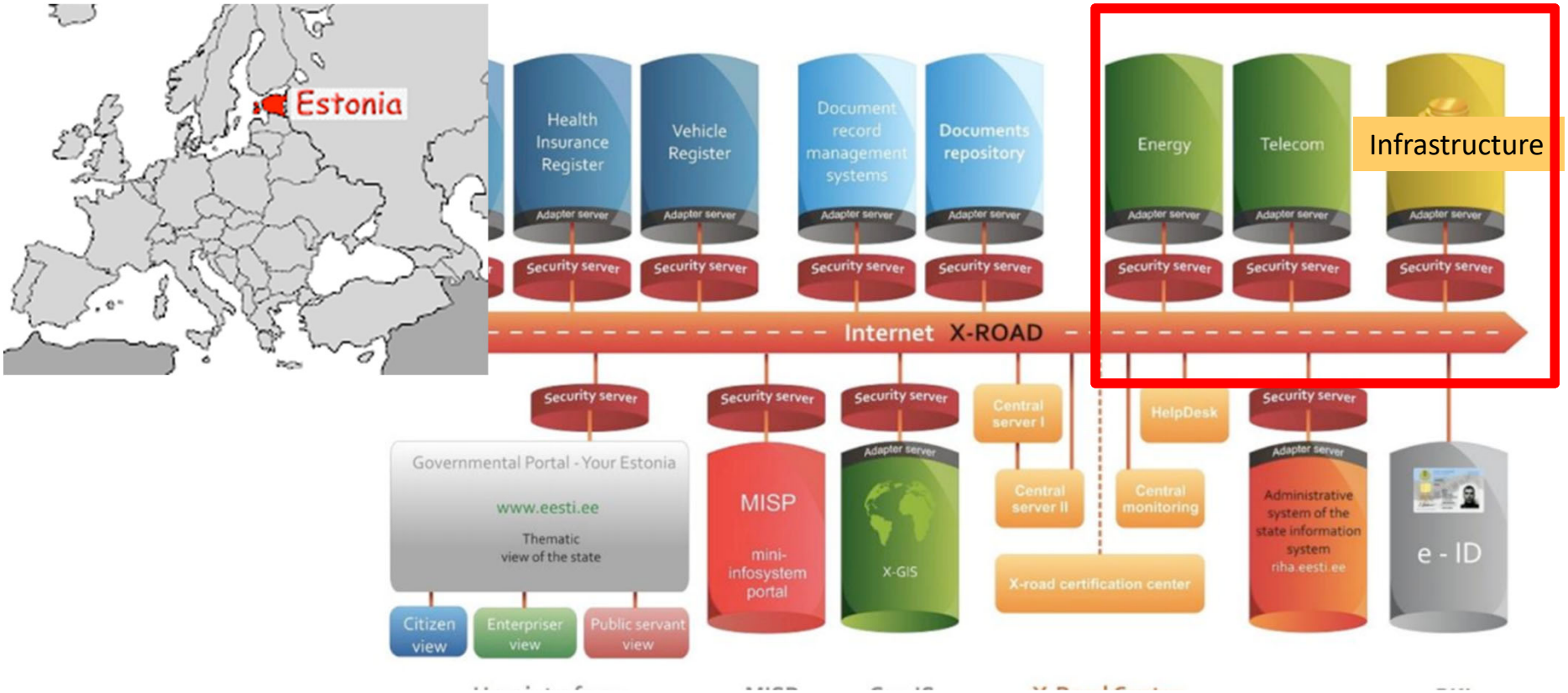
QuakeCoRE
NZ Centre for Earthquake Resilience

ITRC mistral
multi-scale infrastructure systems analytics

National SCIENCE Challenges
RESILIENCE TO NATURE'S CHALLENGES
Kia manawaroa – Ngā Ākina o Te Ao Tūroa

A Lesson From Estonia

X Road: A Blockchain Digital Ledger
A Vision for Infrastructure Management

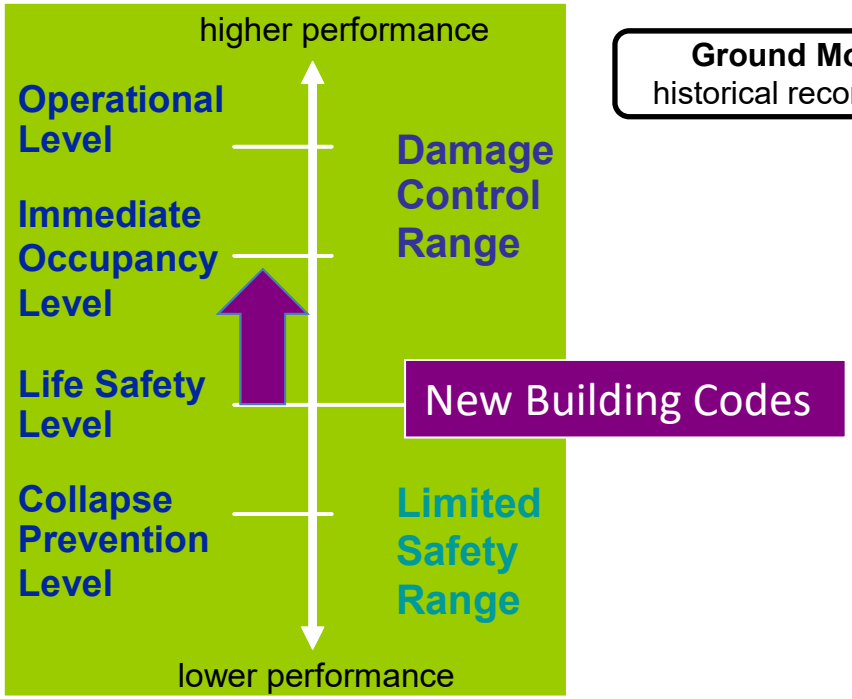


A secure data exchange for residents, public institutions, and private companies

Why Buildings Matter (Both Systems & Functions)

Wellington: Smart Seismic Cities

Absolutely Positively **Wellington** City Council
Me Heke Ki Pōneke
QuakeCoRE NZ Centre for Earthquake Resilience
GNS SCIENCE TE PŪ AO
RiskScape



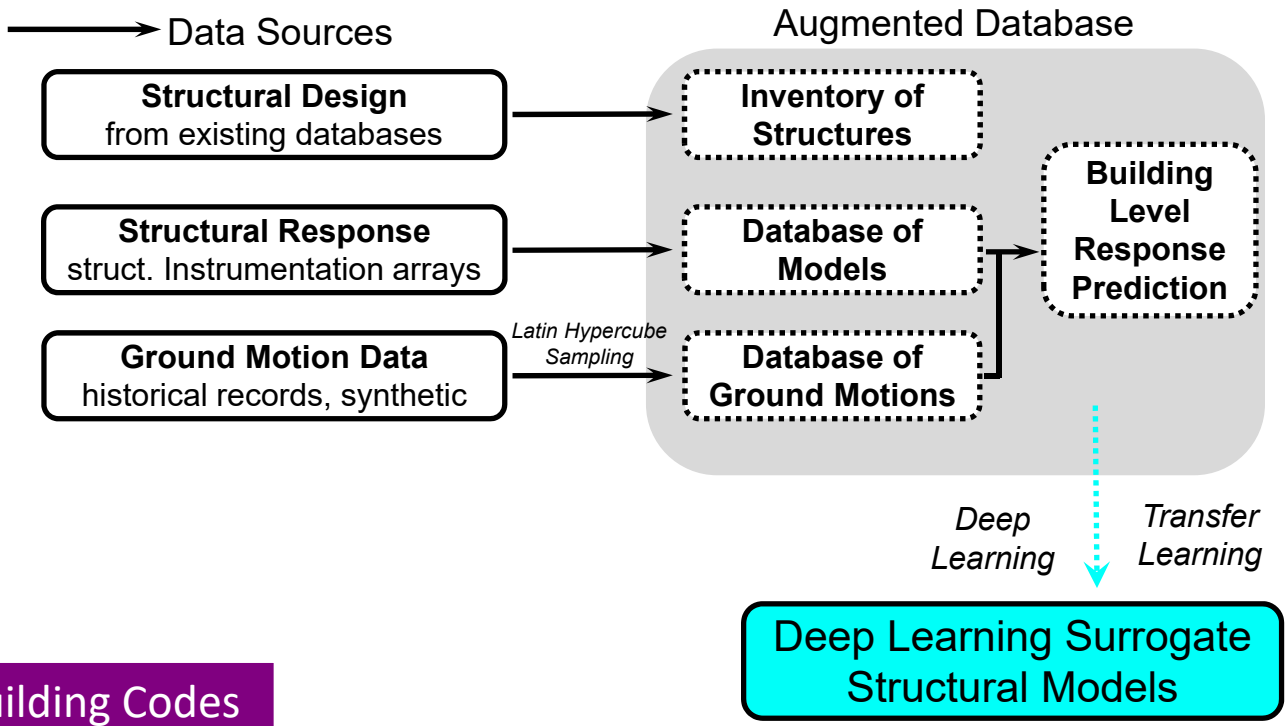
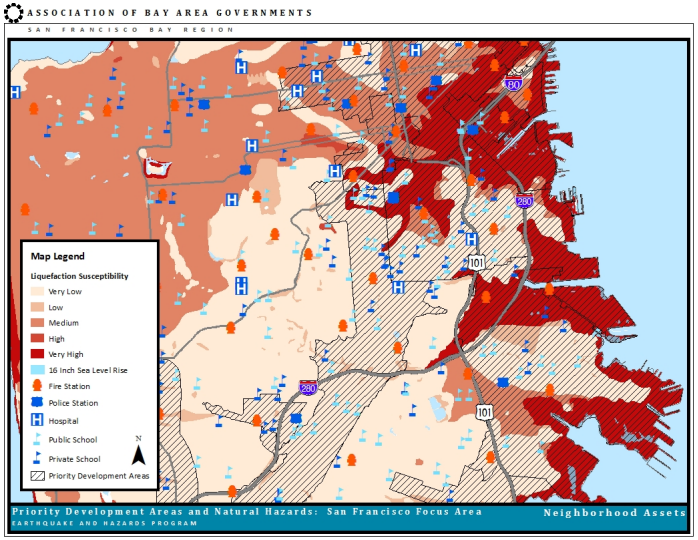
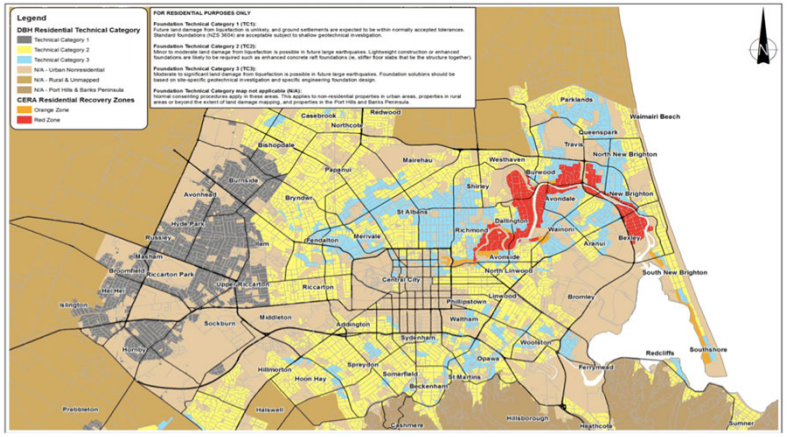
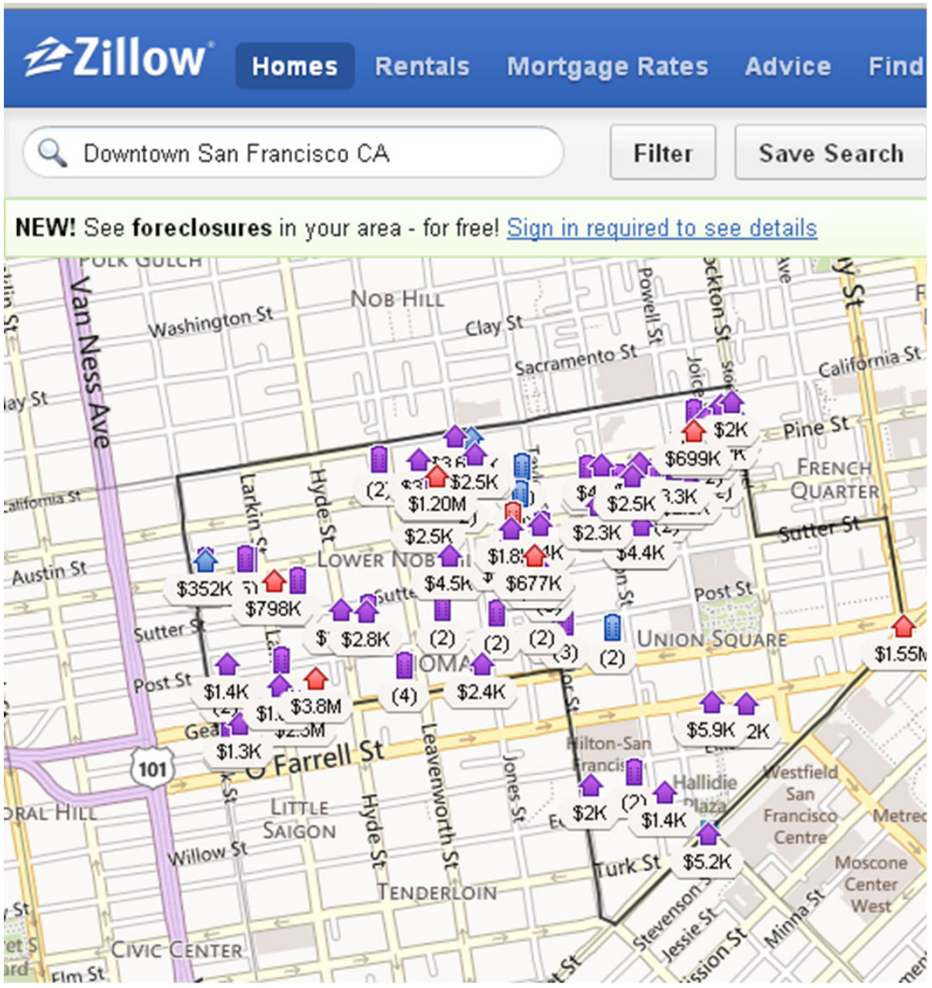


Image: Max T. Stephens
University of Pittsburgh

Why Hazards and Geo Data Matters to Land Use Planning







NEED Parcel Based Land Use Data and Regulations

Conclusion

Research Challenges as Opportunities
A Realistic Resilience Framework

SAFE & FUNCTIONAL PHYSICAL ENVIRONMENTS RESEARCH

- Infrastructure Systems Interoperability
- Building for Repair-ability and Function
- Hazard and Geotechnical Data for Land Use

POLICY AND IMPLEMENTATION:

COMMUNITIES THAT SERVE INHABITANTS DAY TO DAY AND PERFORM WELL IN DISASTERS