Earthquake Risks in Multnomah County

Yumei Wang, DOGAMI Geohazards Engineer, PE

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2011 M6.3

Outline

I. Oregon's Earthquake Setting

II. Seismic Vulnerabilities

- URM & Weak Buildings
- Liquefaction & Landslides
- Lifeline Service Disruptions

III. Earthquake Safety: Call to Action

- Increase Awareness
- Prioritize/Improve Oregon's Resilience
- Seismic Rehabilitation Examples

Origin of Earthquakes

Greek Mythology: Cerberus

Japanese Mythology: Namazu

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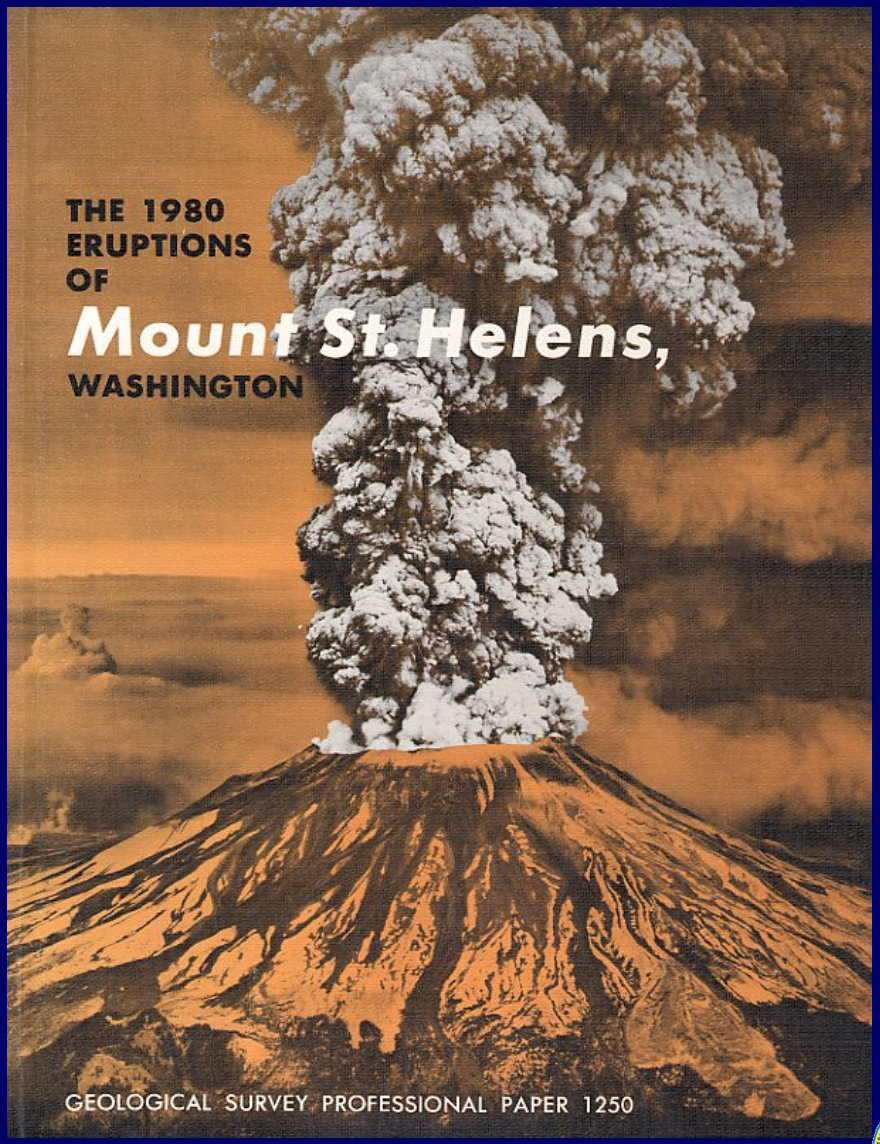
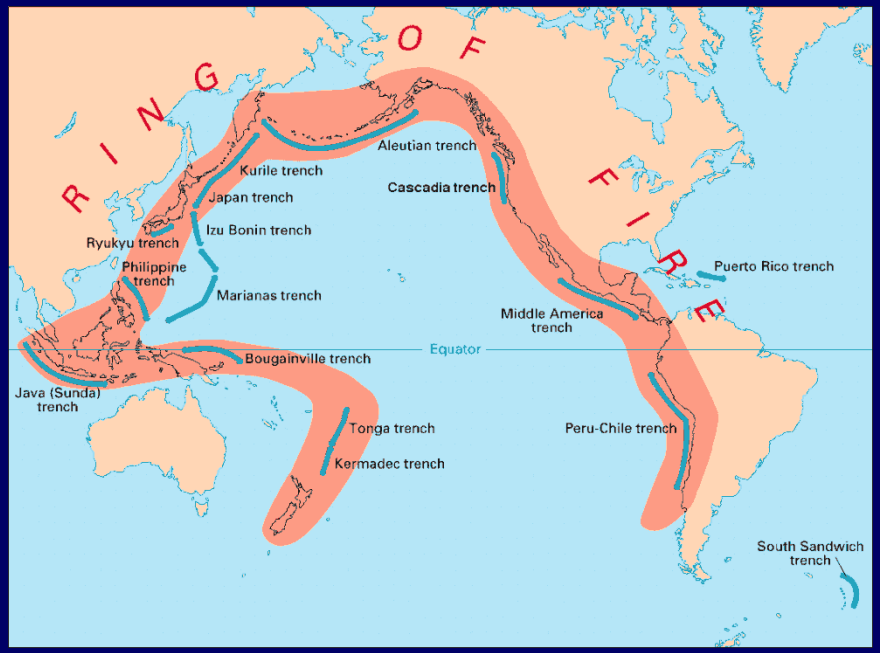
1980 Mt St Helens Eruption

In 1980, volcanoes were known, but geologists did not understand Oregon's earthquake potential



Late 1980s, Cascadia Fault "discovered"



http://celebrating200years.noaa.gov/magazine/dart_buoys/ring_of_fire.html

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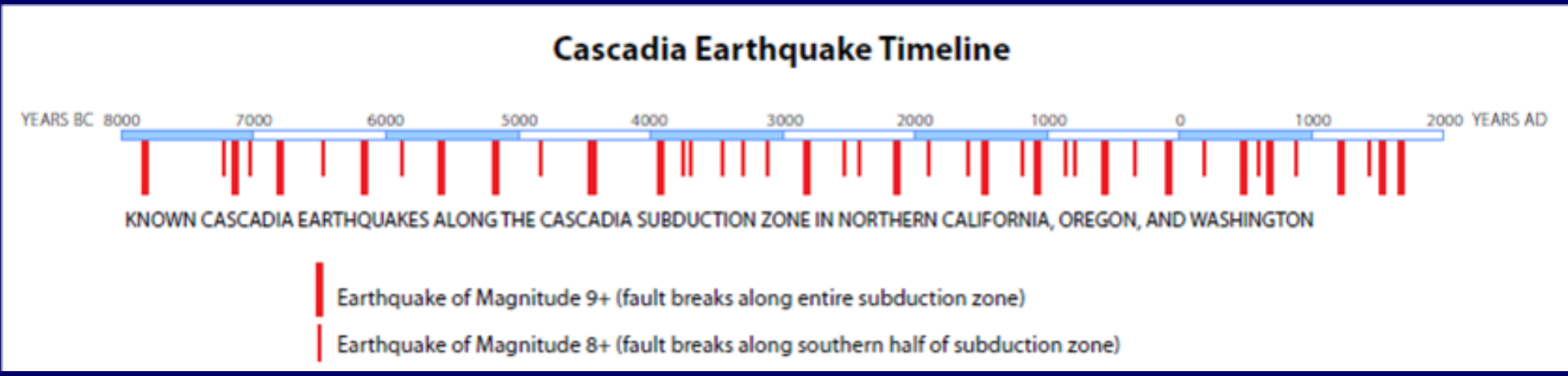
When, Where, How Big?

100%, don't know exactly when…



(Goldfinger et al, 2012; Image: DOGAMI Cascadia, 2010)

- Magnitude 9 on Jan. 26, 1700 (314 yrs ago)
- ~41 >Magnitude 8 in 10,000 year record

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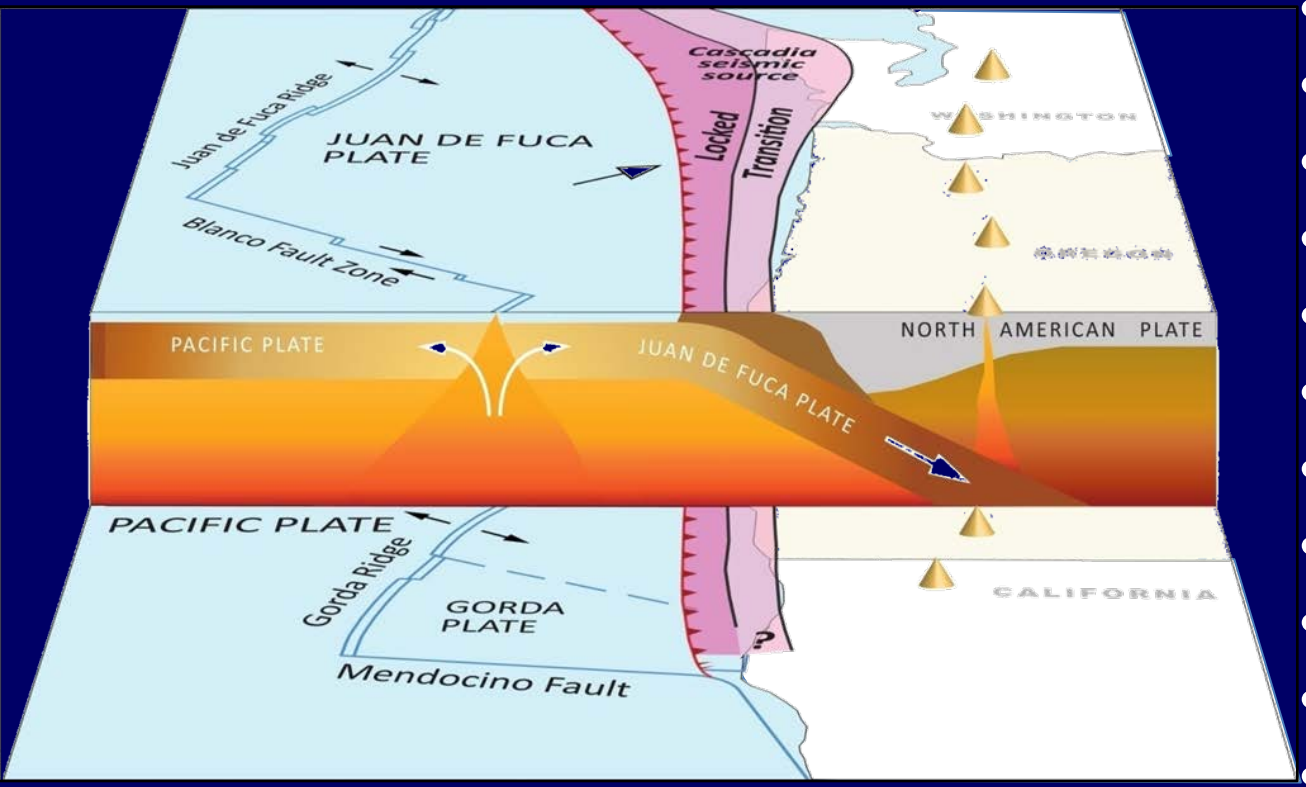
Cascadia Double Whammy!



- Ground shaking
- Tsunami (coast)
- Coast subsidence
- Liquefaction
- Lateral spreading
- Landslides
- Ground settlement
- Seiches (waves)
- Fires
- Hazmat spills
- Infrastructure damage
- Service disruptions

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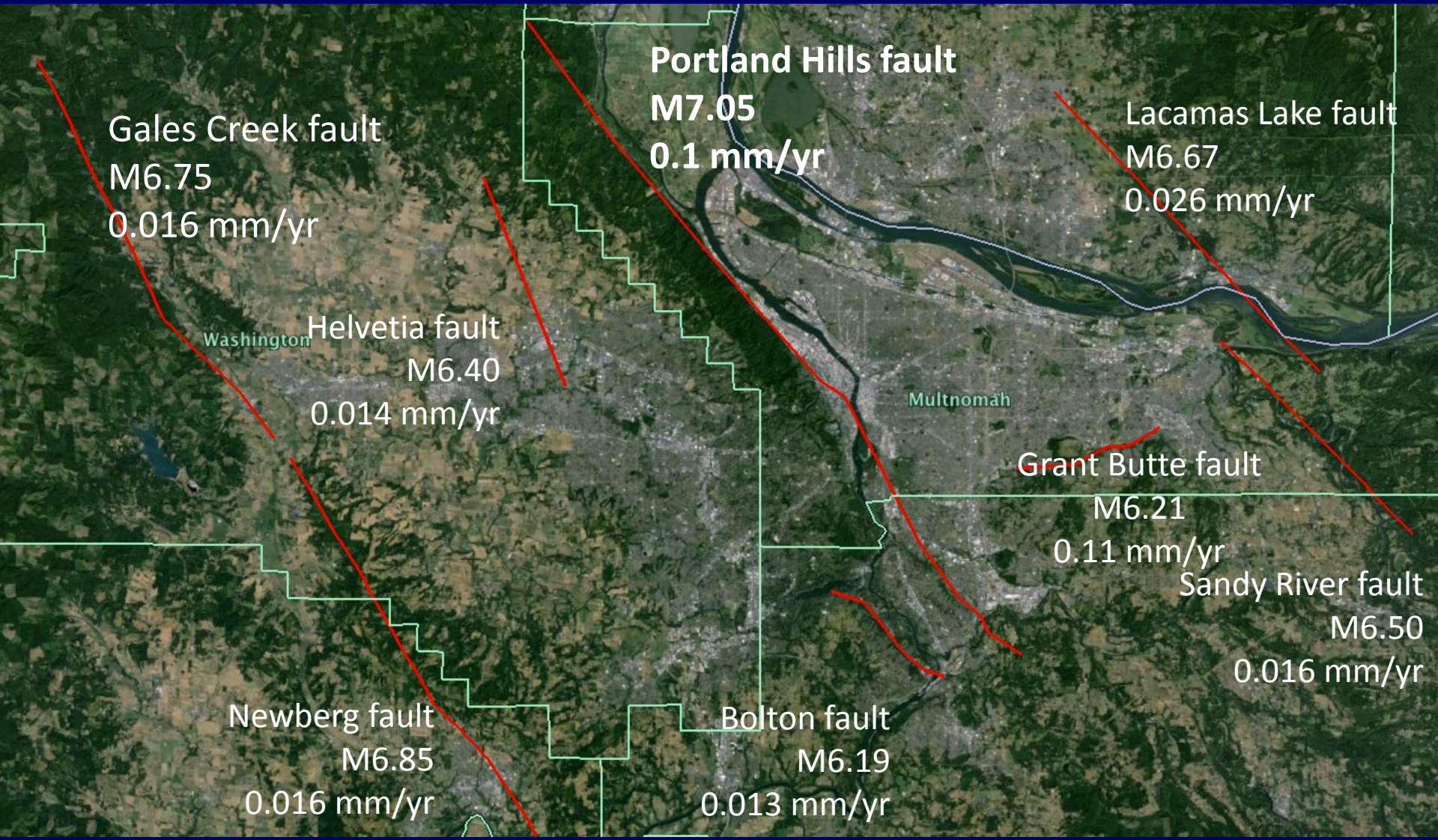
Cascadia Fault: Strong Shaking and Damage in Western OR & WA

- Extreme Damage by Tsunami
- Major Damage in Coastal Areas
- Significant Damage in Valley
- Light or No Damage in Central OR

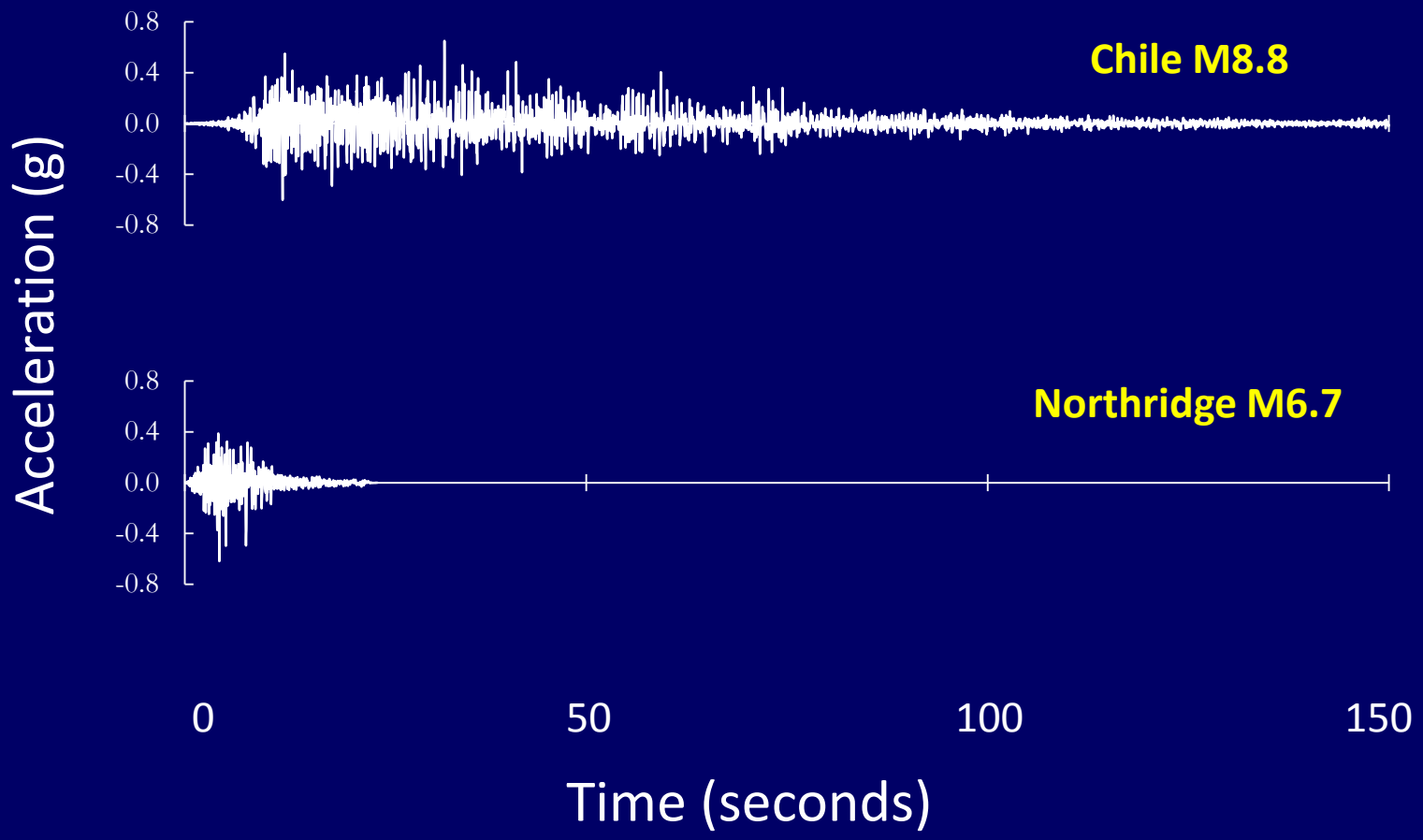
Source: DHS 2011 Analytical Baseline Study

Portland Area Faults



Source: USGS, 2014

Duration: Cascadia vs. Portland



Source: D. Baska, Terracon

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Why Does Oregon Have Seismic High Risk?

Late Knowledge on Cascadia Fault

+

Inadequate Seismic Design & Building Codes

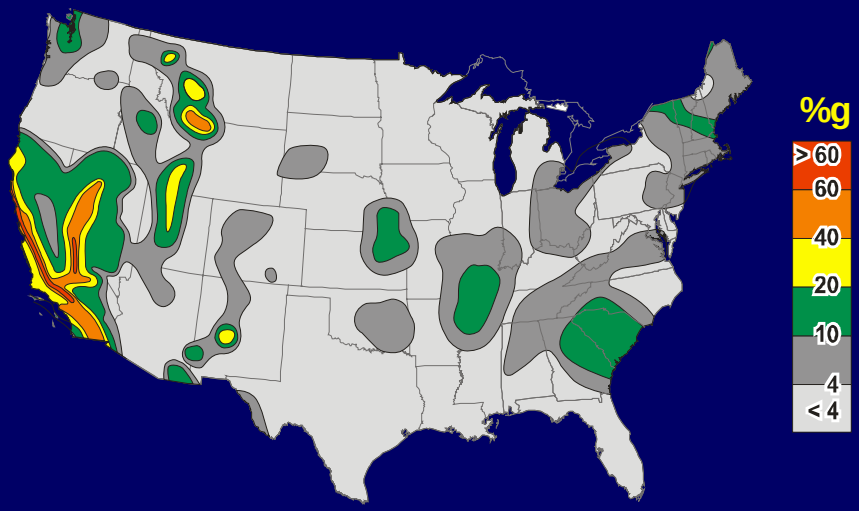
=

Vulnerable Infrastructure

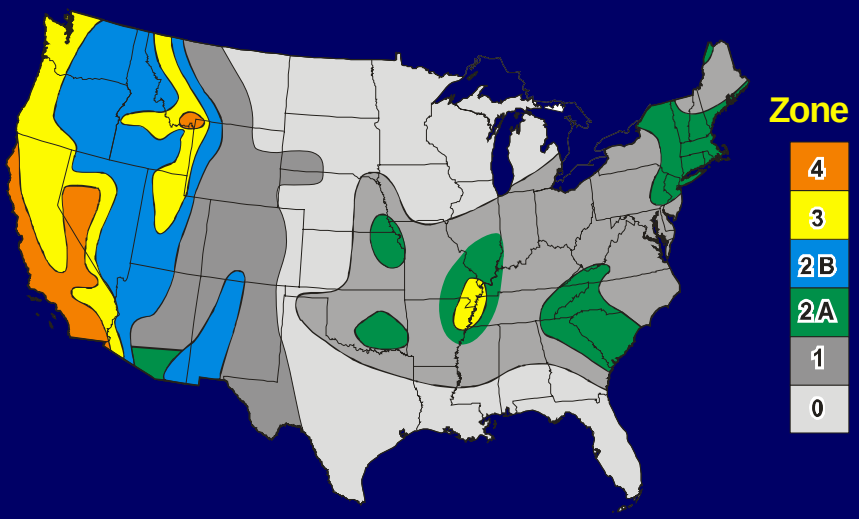
Seismic Building Code Maps

1976

(10% PE in 50 yrs) (Algermissen & Perkins)



1994



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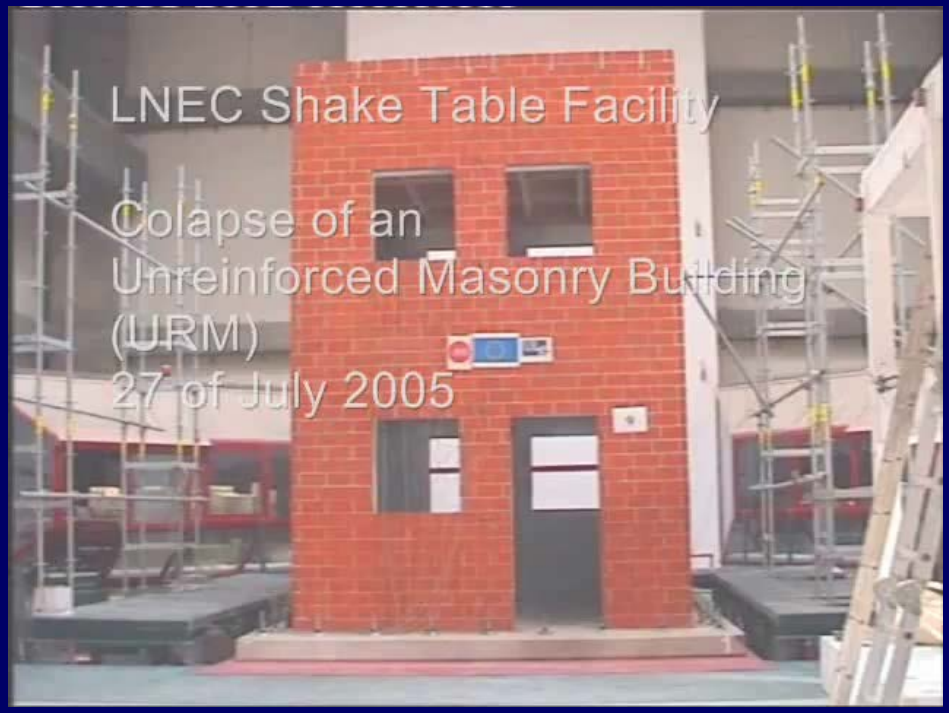
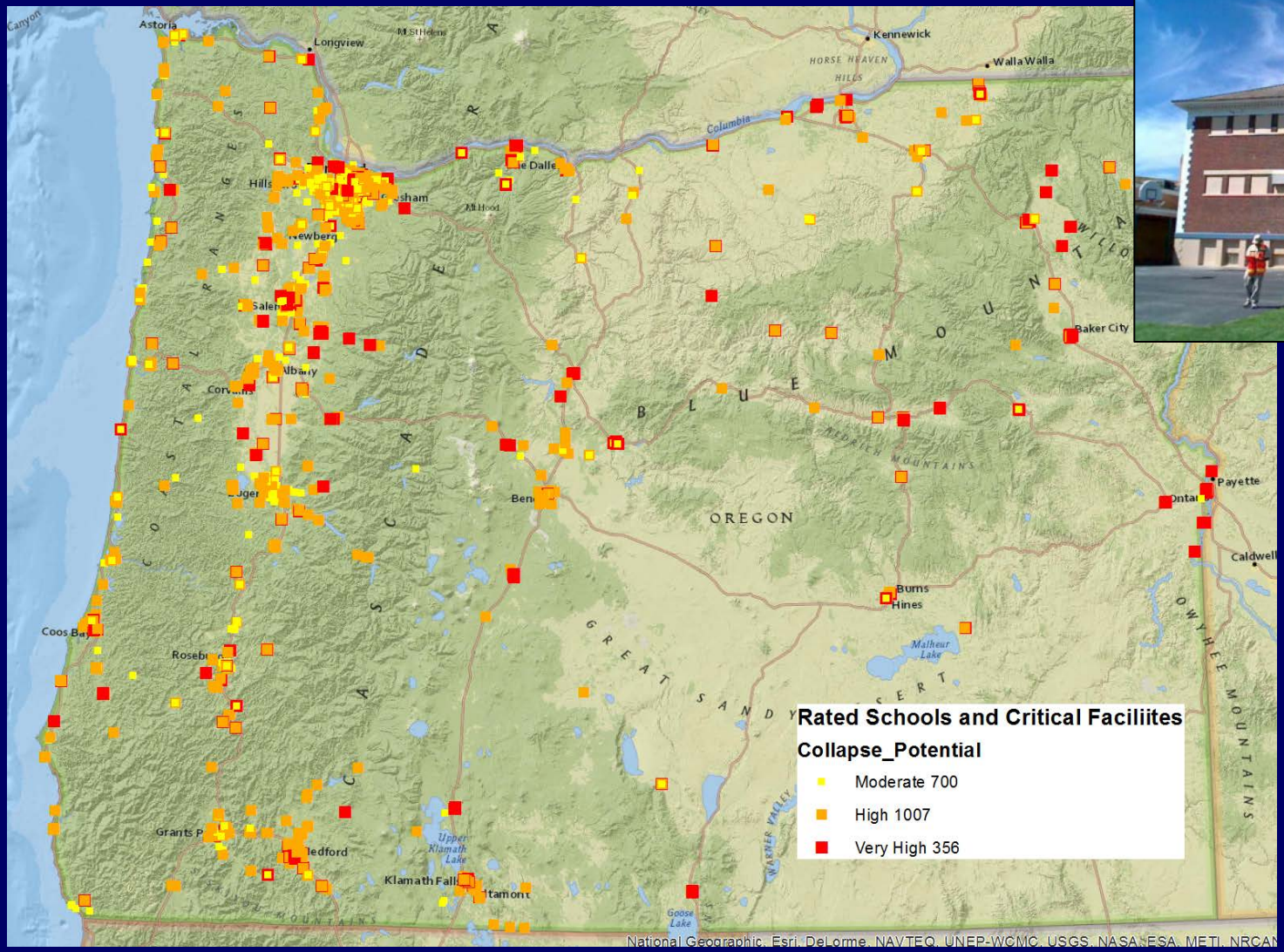
Wood vs. Unreinforced Masonry (URM)

Shaking Response Differences Shown in Lab



Collapse Potential: Schools & Critical Facilities

(www.oregongeology.org/sub/projects/rvs/default.htm)



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Data from DOGAMI Statewide Seismic Needs Assessment

Multnomah County

DOGAMI (2007) (www.oregongeology.org/sub/projects/rvs/default.htm)

331 school & emergency response buildings

293 constructed before 1993

6 hospitals (original building date and licensed beds)

Good Samaritan (1921, 539 beds)

Emanuel (1936, 554 beds)

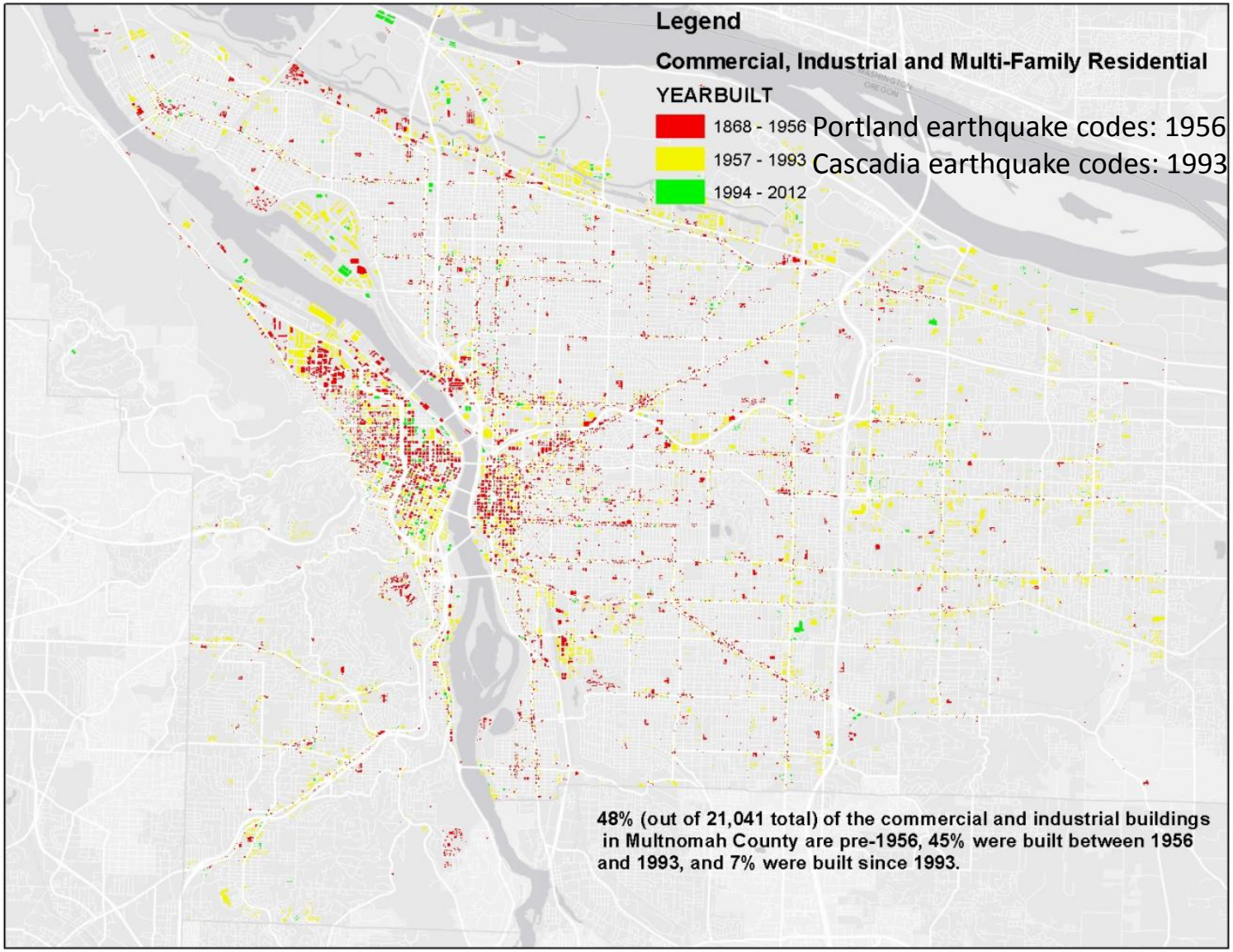
Providence (1941, 483 beds)

OHSU (1956, 560 beds)

Adventist (1977, 302 beds)

Mt Hood (1983, 115 beds)

Portland Area Non-Residential 1868-2012



Data from METRO 2011 taxlot database

Deaths: Concentrated Fatalities

Weak buildings that collapse

Weak in “lateral” strength

Un-Reinforced Masonry “URM”

Calif. has URM ordinances

People in Tsunami Zones

Low lying coastal towns

Seaside, Rockaway,

Bandon, more

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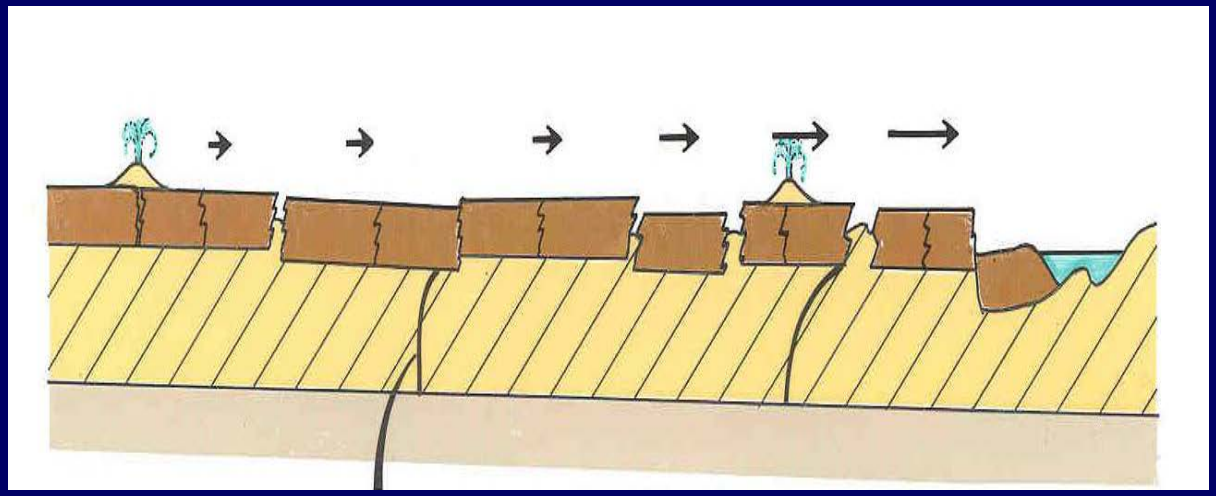
Liquefaction (sandy soils) & Landslides

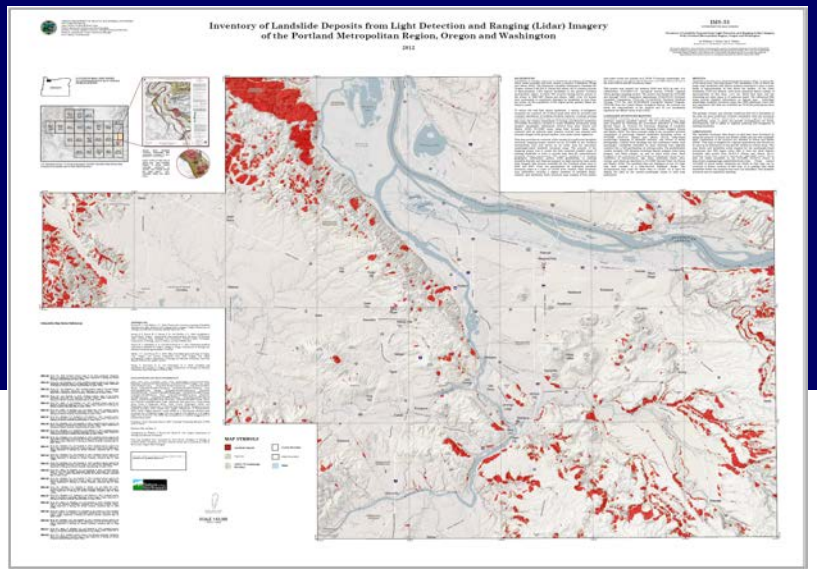
8/07 Japan quake

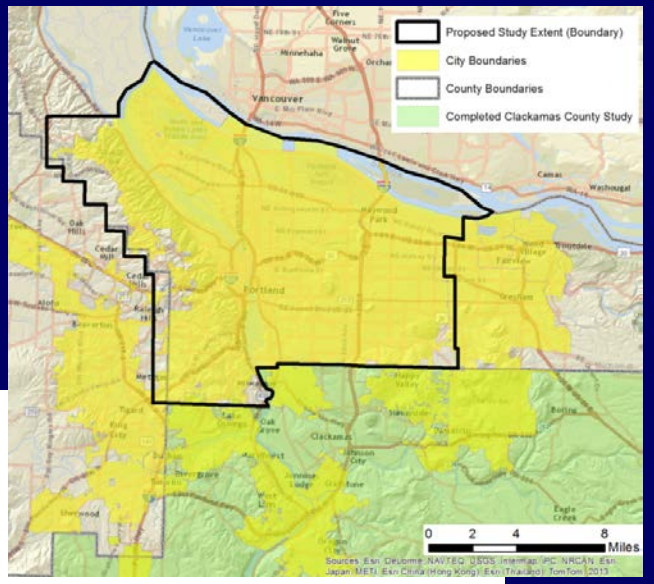
8/07 Japan quake

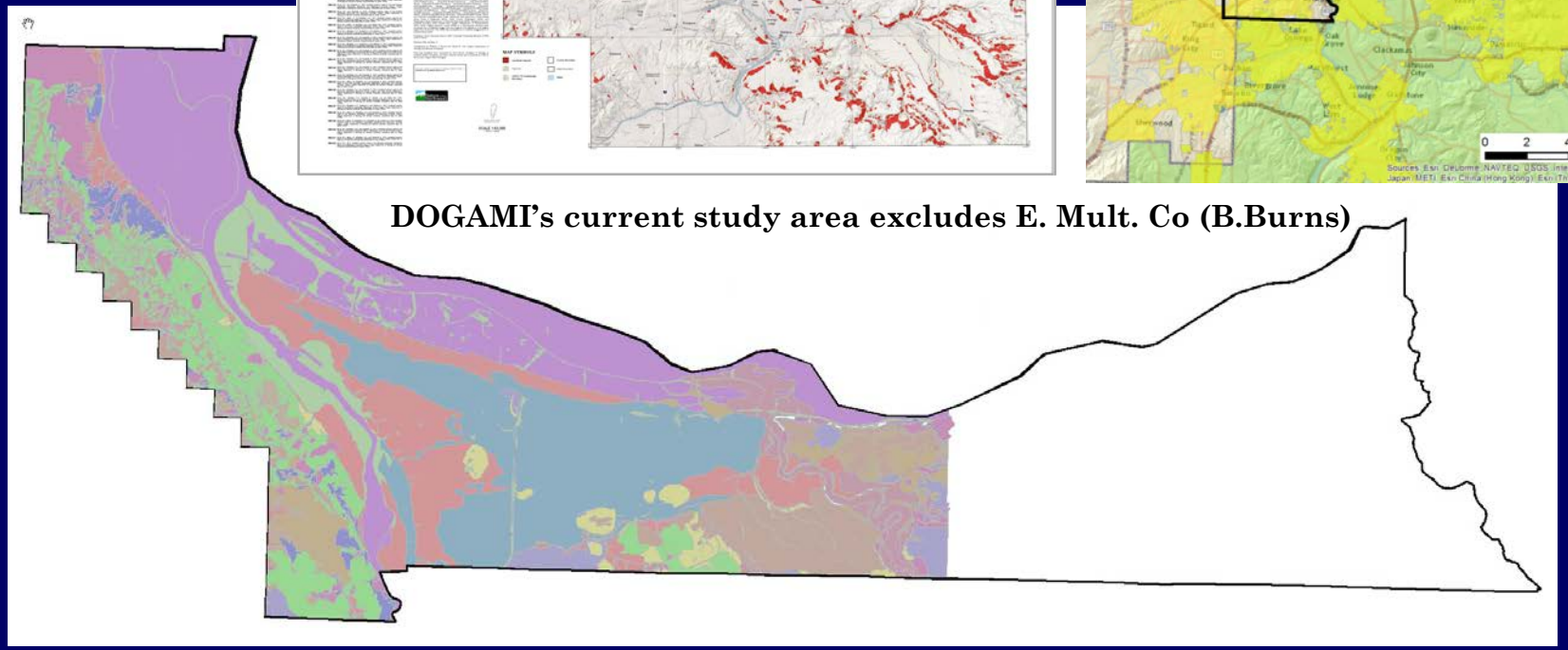
Portland Riverbanks & Floodplains



Portland Landslide Mapping Efforts

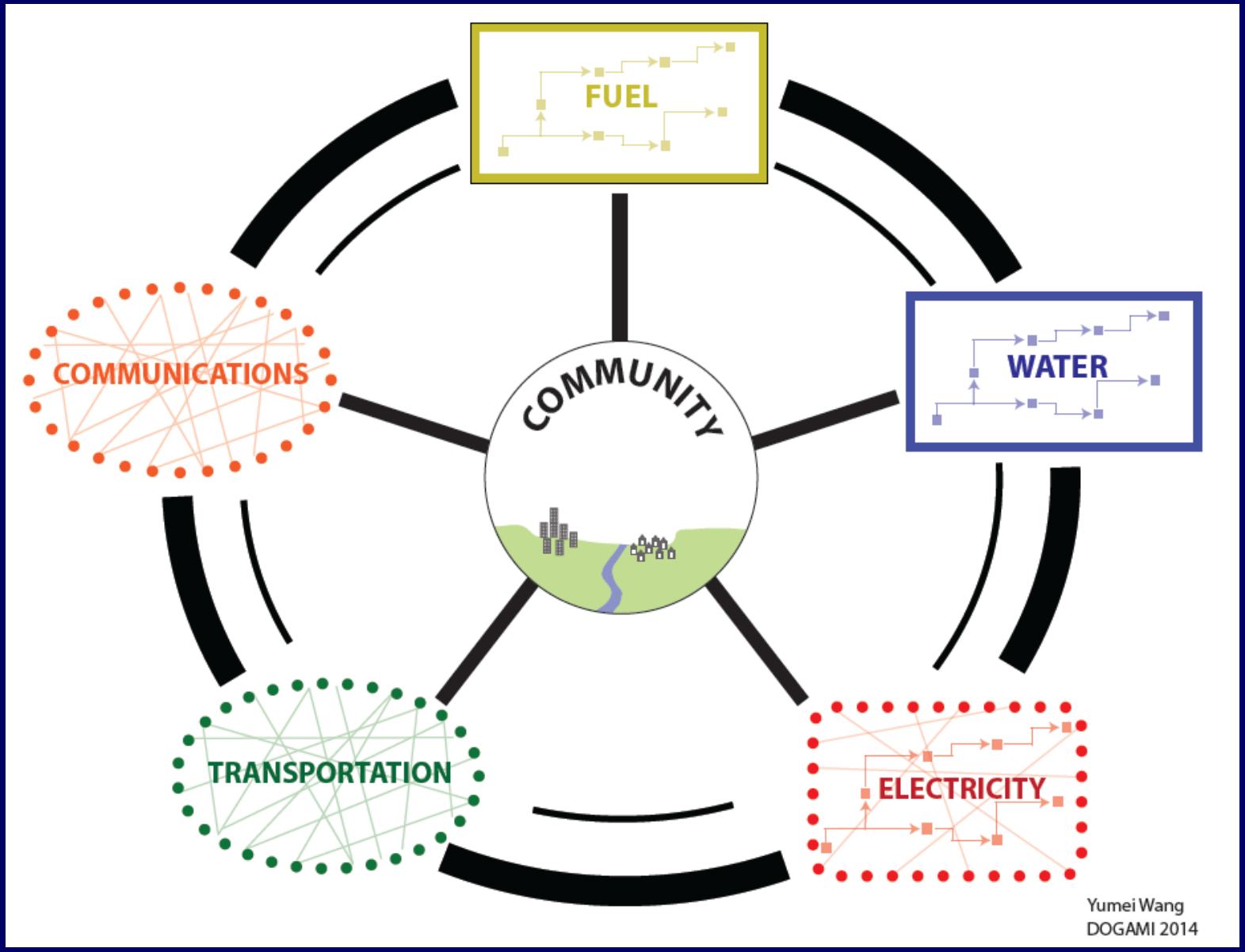




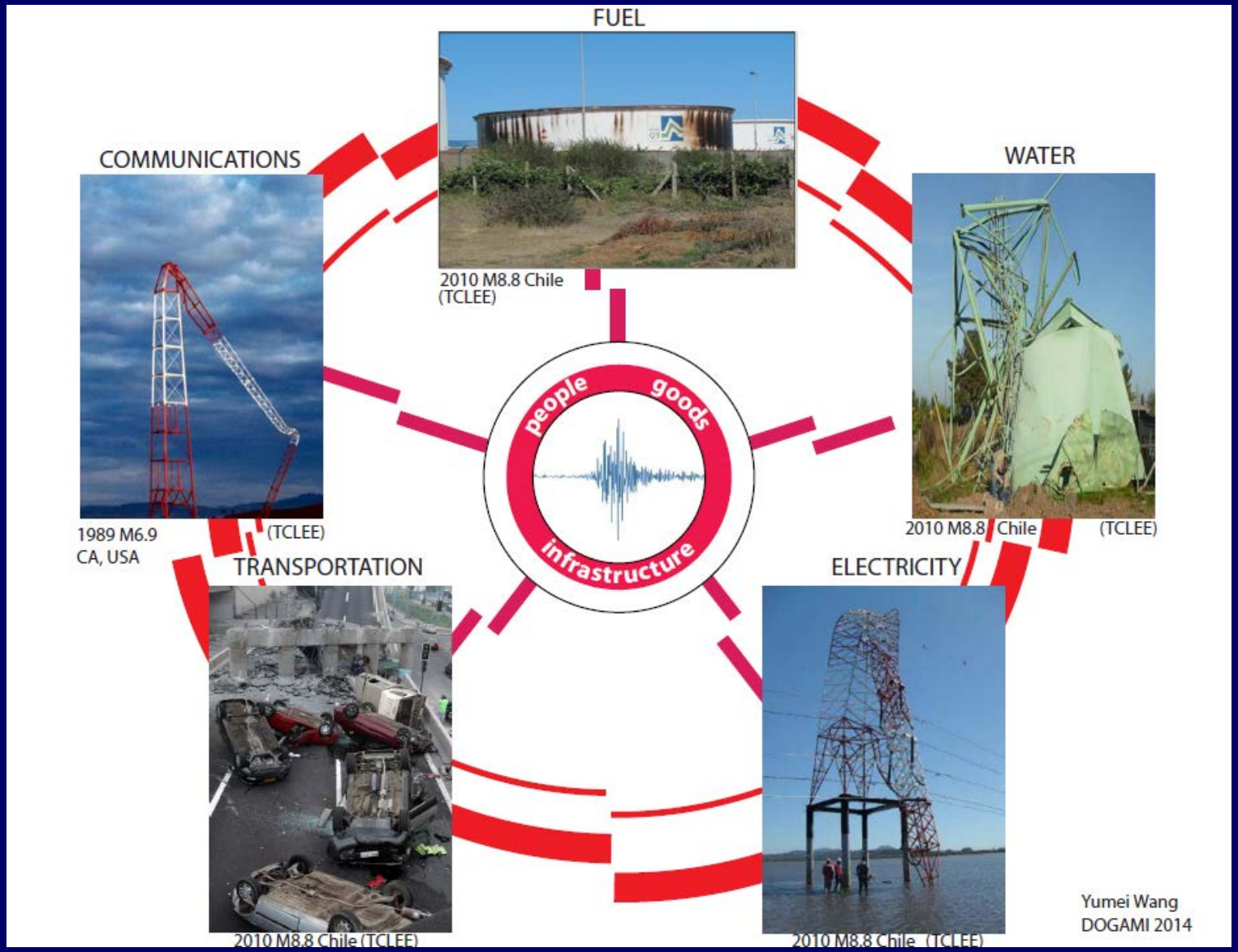


DOGAMI's current study area excludes E. Mult. Co (B.Burns)

Lifelines: Community Interdependencies



Earthquakes Damage Lifelines



Emergency Lifeline Services

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CALL TO ACTION

Build Human Resilience

Resilience Advisor & Public Education (Resilience Task Force, Sept 2014)

Similar to Recycling

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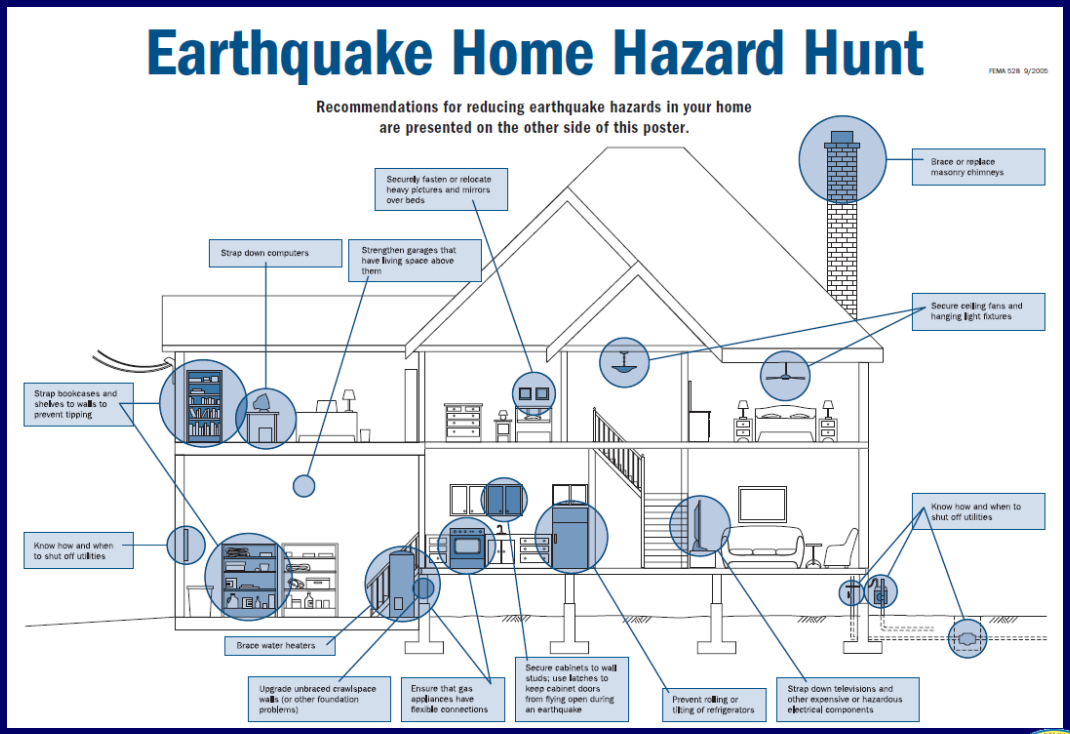
Get Citizens Prepared

- Earthquake Drills
- Encourage home inspections
- Prepare citizens to "Camp at home" (3 wks of supplies)



(FEMA 528)

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Identify Vulnerable Infrastructure Prioritize and Fix Before Earthquake

- Home, School, Work
- Community Services
- Utility Services
- Transportation & Fuel

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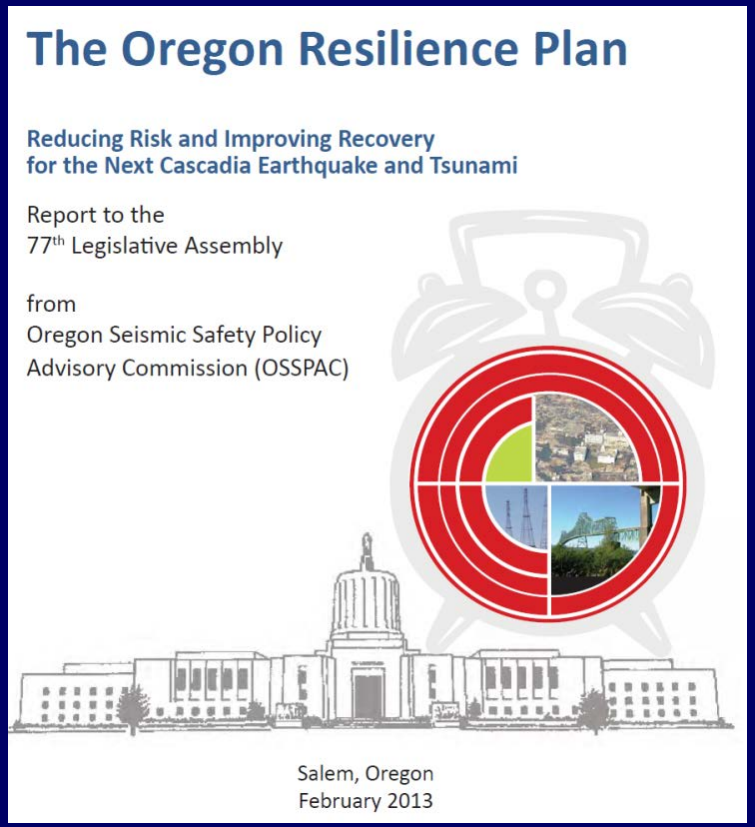
2013 Oregon Resilience Plan &
2014 Task Force Recommendations

www.oregon.gov/omd/oem

50-Year Vision



2015 Priorities

- Oversight: Resilience Advisor to Governor
- Transportation
- Land Use
- Energy
- Critical Facilities & Seismic Rehabilitation Grants
- Research
- Training & Education
- Water & Wastewater

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Findings for Cascadia Magnitude 9 Scenario

Source:
ORP 2013

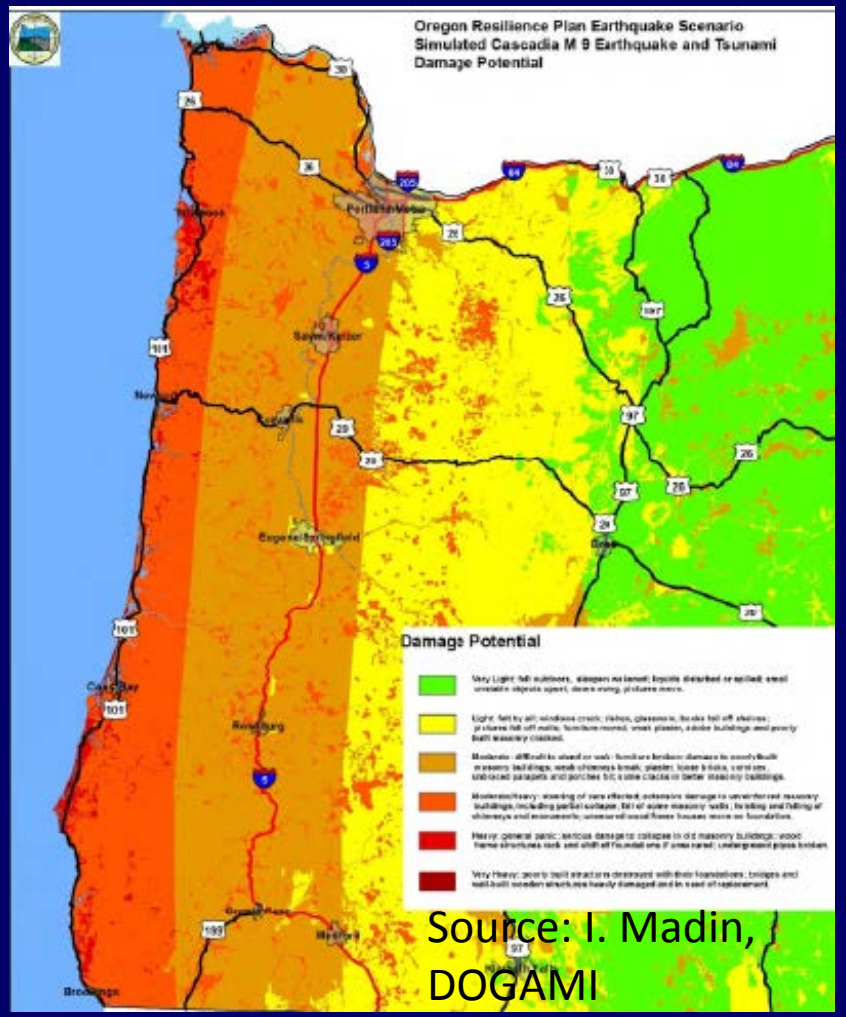
<u>Business Group</u>

Tolerate 2 to 4 wks

outages or gone …

<u>Portland/Valley “Downtime”</u>

Electricity:	1 to 3 mo
Fire & Police:	2 to 4 mo
Water:	6 to 12 mo
Healthcare:	18 mo



Source: I. Madin, DOGAMI

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Deaths, Dollars & Downtime

- Portland multi-modal transportation corridor
  - Union Pacific & BNSF rail yards (rail)
  - Port of Portland & other ports (marine)
  - Interstate 5, I-205 & I-84 (highways)
  - PDX (air)
- Oregon's fuel supply hub on liquefiable soils

Oregon's Critical Energy Infrastructure Hub Located in Portland

2013 DOGAMI Energy Sector Report

- Intersection of:
  - Petroleum
  - Natural Gas
  - Electric
  - **Liquefaction Risk**

Liquefaction Hazards

Energy Facilities Built on Hydraulic Fill

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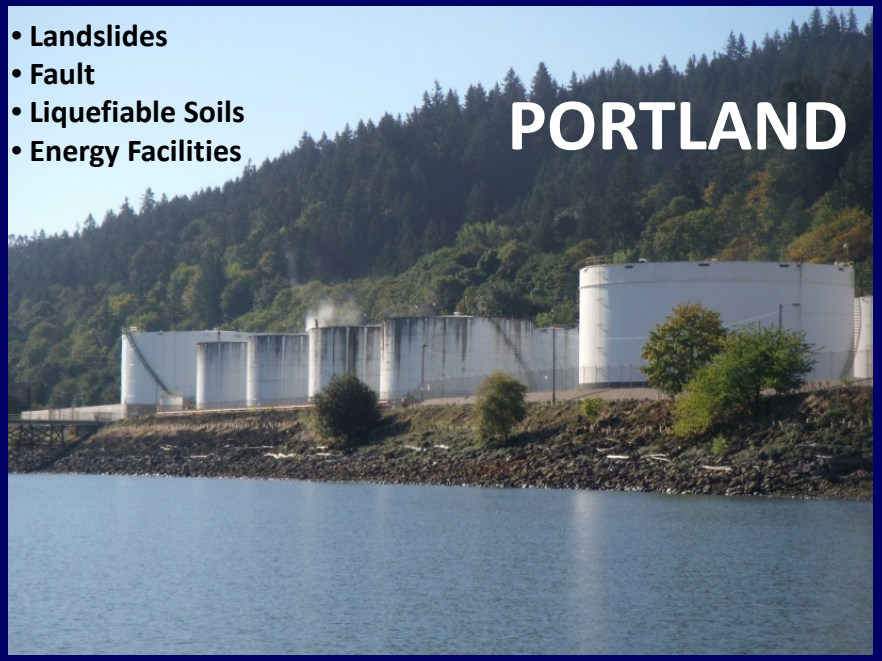
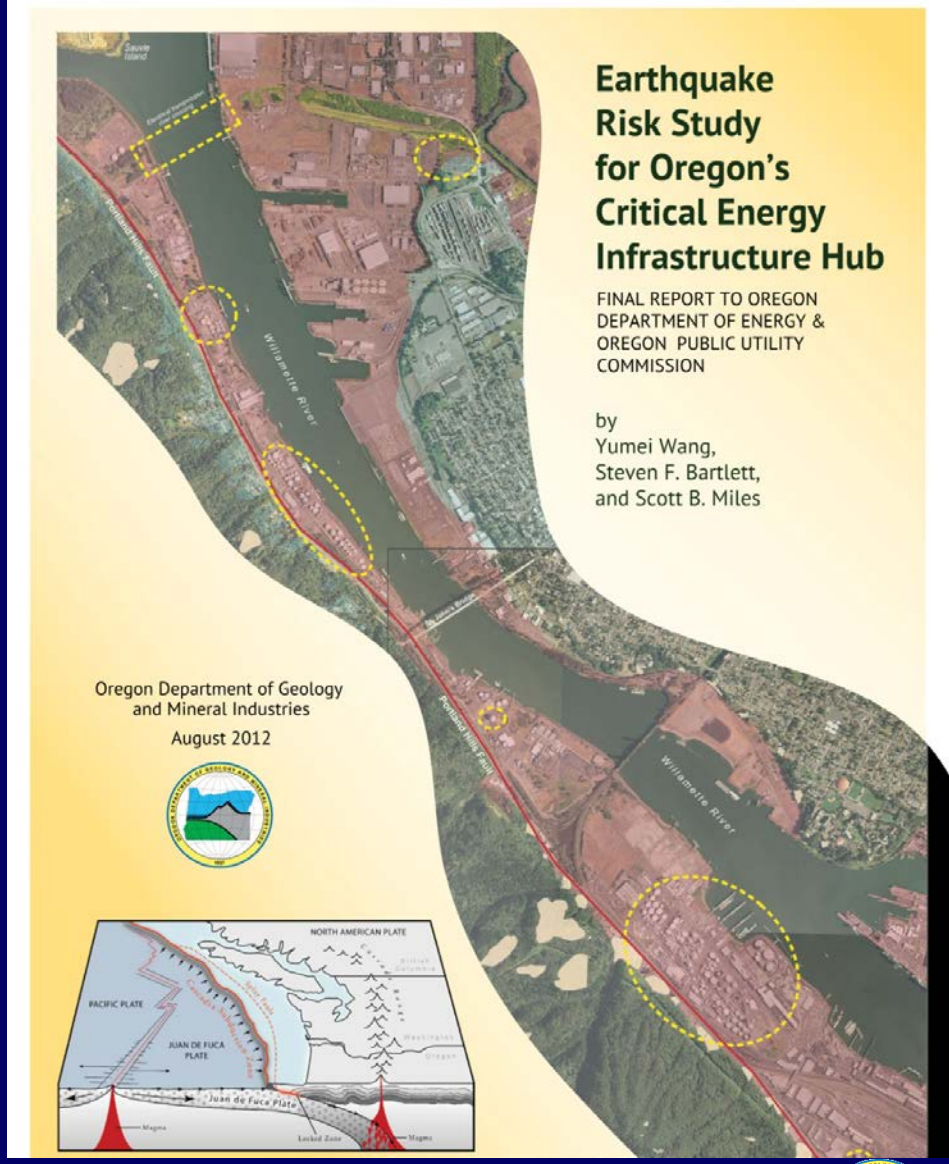
Pre-Disaster: Geohazards & Risk Identification





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Fuel Oil Terminals in Portland

Many facilities built before seismic design codes & vulnerable

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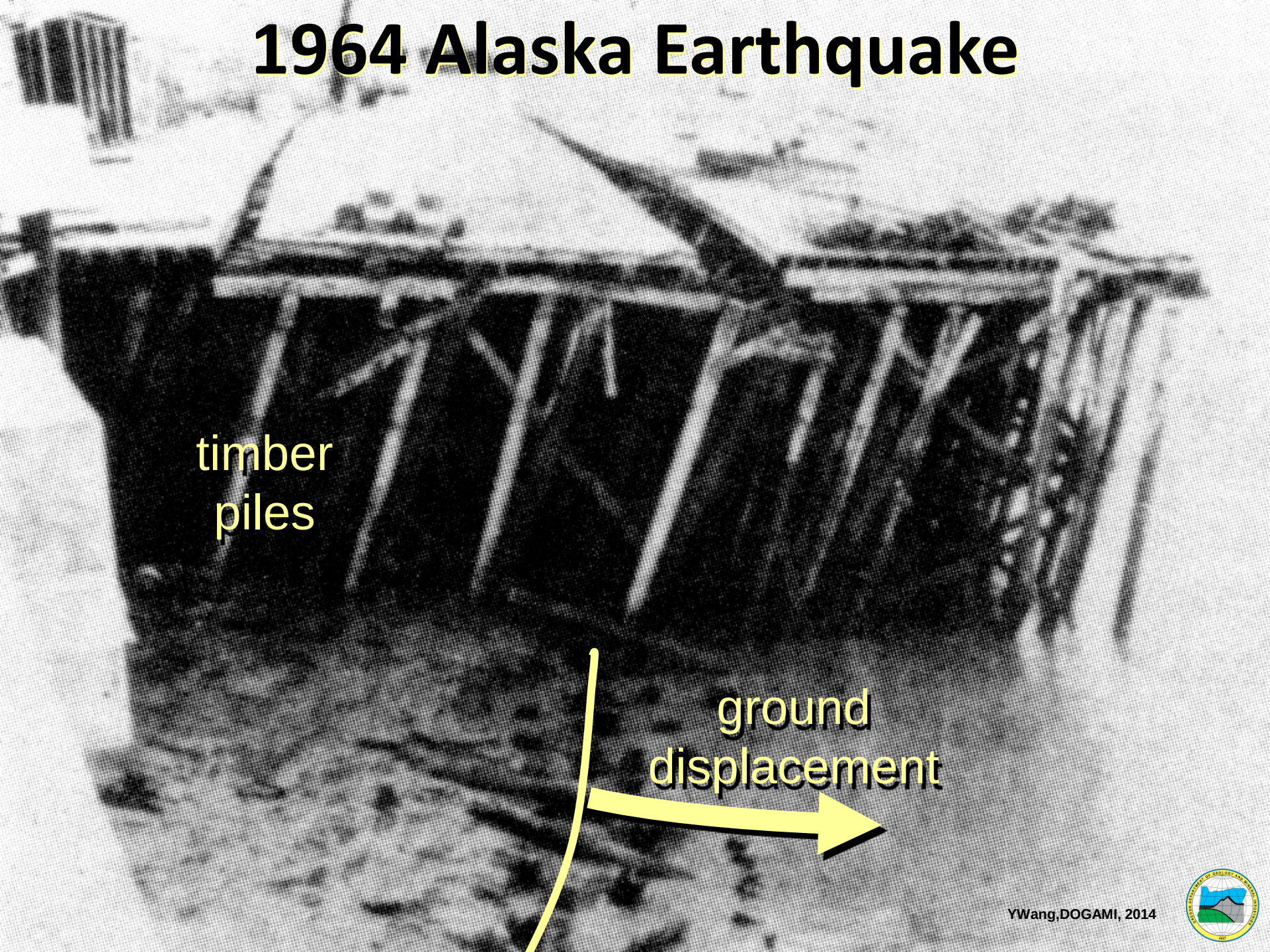
1964 Alaska Earthquake



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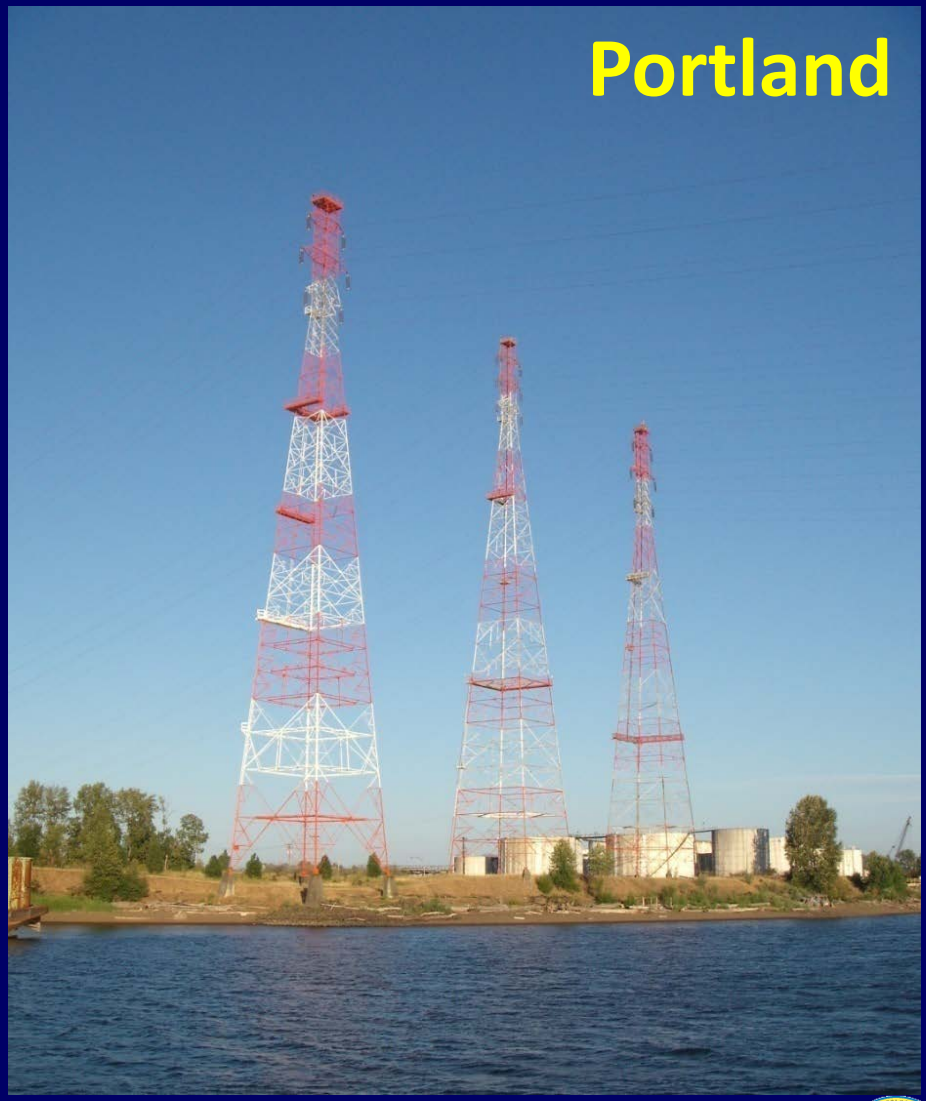
Electrical Transmission Towers

BPA estimates up to 25 Ft movement towards river. Mitigate in 2015



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ODOT Vulnerable Bridges

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Highway Planning Activities

ODOT Prioritization: Tier 1 Highway in Cascadia earthquake

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1926 Burnside Bridge

2002 Phase 1 Seismic Retrofit: Life Safety

But not Serviceable

Phase I
1.Longitudinal restrainers at each abutment
2.Longitudinal restrainers at Piers 1 and 4
3.Strengthening approach span end diaphragm
4.Strengthen fixed span connection to pier wall
Phase II
1.Strengthen approach span bracing
2.Approach span base isolation
3.Counterweight restrainer
4.Bascule pier collar beam
5.Bascule leaf strengthening
6.Post-tension Bascule Pier
7.Soil Densification at abutments
8.Restore bar through trunnion
Jon Henrichsen, Multnomah County, Bridge Engineer

2010 Chile Magnitude 8.8

Overpass in Santiago (inland)

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Mitigation Examples

Emergency Facilities

- City of Portland
  - All fire stations seismically upgraded
  - New Emergency Coordination Center
- State of Oregon's Seismic Rehabilitation Grant Program
  - Hospitals, Fire & Police Stations, & Emergency Op. Centers

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Mitigation Examples

Water Systems

50 MG Powell Butte Reservoir
City of Portland PWB

Mitigated 15-Story PSU Residential Hall to Prevent Building Collapse

Plus energy efficiency upgrades

2010 Chile apartment collapse

Portland State University

Beams, Rebar, Steel & Concrete Walls

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Questions?

www.oregongeology.org

Oshiokuri Hato Tsusen no Zu (Fast Cargo Boat Battling The Waves) 1805
http://thesoundsinsidemyhead.blogspot.com/2008/05/hokusais-great-wave.html