Earthquakes in OREGON: Are we ready for the “Big One”? 

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New Yorker Article: 7/20/15
“The Really Big One”
by Kathryn Schulz

• “Everything west of I-5 is toast!” (FEMA)
• Worst disaster in American history
• 13,000 Dead & 27,000 injured
• Shelter needed for a million people
• Food and water needed by 2.5 million people
Earthquakes

- 800,000 recorded each year
- 100,000 felt each year
- 1,000 cause damage each year
- 10 major disasters each year

10,000 deaths/yr (1900-2000); 44,000/yr (2004-now)
Magnitudes

- 5.6 (Spring Break) 1993
  - 30x energy released
- 6.6
  - 30 x 30 = 900 times energy released
- 7.6
  - 30 x 30 x 30 = 27,000 x energy
- 8.6 (Subduction Quake)
Magnitudes

- $> 2.5$ You can feel it
- $> 5.5$ Damage to property
Subduction Quakes: Megathrusts

• Biggest earthquakes on earth in magnitude!
• Last one: 1964: Good Friday, Alaska: 9.2
• 2004: Indonesia: 9.1
• 2010: Chile: 8.8
• 2011: Japan: 9.0
• All on the “Ring of Fire” – Really the Ring of Subduction!
Indonesia: December 26, 2004

9.0 magnitude earthquake

4th largest earthquake in the world since 1900

Tsunami caused more casualties than any other in recorded history

283,100 people died
14,100 missing
1,126,900 displaced
10 countries affected
(2/15/05)
February 27, 2010:

**Chile** – 8.8 (7th largest since seismograph), tsunami, 800 dead

9.6 is the largest recorded in 1960 - Chile
Mar. 11, 2011: Tohoku, Japan, 9.0, 16,000 dead/12,000 mi
Fukushima Meltdown: $220 Bill = largest quake in Japanese history = Japan – most prepared country!
190,000 buildings affected, 12,000 missing, 90% of dead were drowned, PGA >2, length 3-5 minutes,
January 12, 2010: Haiti – 7.0, 220,000 dead, shallow, no building codes
Sept. 3, 2010: Christchurch, NZ, 7.1
Feb. 22, 2011: Christchurch, NZ, 6.3, 180 dead
Student Volunteer Army, organized by Sam Johnson through Facebook, cleaning up after liquefaction
Radio Tower
PGC building, on Cambridge Tce
Central Christchurch after a 6.3 quake
Losses in Christchurch, NZ

1) 390,000 people: 2\textsuperscript{nd} largest in NZ; 450 km\textsuperscript{2} area
2) $40 billion in damage
3) 60,000 houses affected; 20,000 houses significant damage; 8000 houses deconstructed
4) Business buildings: 2400 of 3000 deconstructed
5) Liquifaction, rockfall and lateral spread main causes of destruction
6) 12,000 aftershocks
7) 3 months to restore water
8) 15 months to restore sewage
6.6 million people affected over 40% of the country; 8,000 people died
April/May, 2015

Nepal: 7.8 Mag
PLATE TECTONIC RELATIONSHIPS IN THE PACIFIC NORTHWEST

- Oceanic Crust
- Continental Crust
- Subduction Zone
- Gorda Plate
- Cascade Mountains
Peak Horizontal Accelerations (%g) Having 10% Probability of Being Exceeded in 50 Years

site: NEHRP B-C boundary
Earthquake Hazards

• Ground Shaking and Amplification

• Liquefaction

• Landslides

• Tsunamis
New Zealand - sunken vehicle in a sand blow after quake
Niigata, Japan, 1964
Waves slowed to ~45 km/hr and grew to heights of ~10 m
TSUNAMI HAZARD ZONE

IN CASE OF EARTHQUAKE, GO TO HIGH GROUND OR INLAND
### Quakes Felt in Oregon:

<table>
<thead>
<tr>
<th>Year</th>
<th>Magnitude</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) 1873</td>
<td>6.3</td>
<td>Port Orford</td>
</tr>
<tr>
<td>B) 1949</td>
<td>7.1</td>
<td>Olympia, WA</td>
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<tr>
<td>C) 1962</td>
<td>5.1</td>
<td>Portland, OR</td>
</tr>
<tr>
<td>D) 1968</td>
<td>5.1</td>
<td>Crump Lake</td>
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<tr>
<td>E) 1993</td>
<td>5.6</td>
<td>Scotts Mill</td>
</tr>
<tr>
<td>F) 1993</td>
<td>6.1</td>
<td>Klamath Falls</td>
</tr>
</tbody>
</table>
Maximum Quake Magnitudes in Oregon

- North American Crust 6.5
- Juan de Fuca Oceanic 7.3
- Subduction Zone 9.0+
Cascadia Subduction Zone Quake

- Magnitude 9.0 + and last 3-4 minutes
- Coast will drop 6 feet and rebound 30-100 ft in a west direction from compression release – will displace sea water for tsunami
- Tsunami 20-30 minutes later: 15-50 ft. high
- Landslides, liquefaction, shaking!
Ghost Forest
Copalis River, Washington:
Cascadia Story!

Brian Atwater &
David
Yamaguchi
Buried soil from the year 1700 – Trees killed quickly not slowly
Subduction Quakes in the Past based on soils and dead trees

- 300 BP
- 800 BP
- 1100 BP
- Recurrence Interval for Oregon
  - 500 years
Subduction Earthquake

RI = 500 yr

M = 9.0+

Last one: Jan. 26, 1700 – “Orphan Tsunami by Kenji Satake 1996

Buried soil
Cascadia Subduction Zone Earthquakes

- 41 events in 10,000 years
- 19 full margin events
- 22 additional events in southern Oregon and northern California

Source: Professor Chris Goldfinger, OSU
Recurrence Intervals Cascadia Quakes

• Whole Margin = 500 years (8.7-9.2)
  – “The Really Big One” or “The Big One” (me)
• Southern Oregon Coast = 243 years (7.8-8.6) – “The Big One” or “The Mini-Big One” (us)
  – Note: Chance of Early Warning System : 5’

Whole Margin: 15% in 50 years
Southern Oregon: 37% in 50 years
Cluster Hypothesis & RI

• Goldfinger and Wong: Of the 19 full margin events, they occur in clusters so RI for whole 10,000 years is about 500 years (14% prob. In 50 years) but within the clusters, it is 260 years (37% prob in 50 yr)!

• Periods between clusters: 1500-2500 BP; 4900-5800 BP, 6600-7100 BP and 8300-8700 BP
Two Important Happenings

- App for phone: Shake Alert – in beta testing stages – will be the phone app for the Big One
- June 7-10, 2016: Cascadia Rising – Government practice of preparing for Cascadia
- Oct. 16, 2016: Great Oregon Shakeout
Warning System for Mini-Big Ones: 5 minutes

- Shut down railroads and power plants
- Get people outside of buildings
- Hospitals stop operations
- Clear people out of elevators
- Fire doors up
- Vehicles off of bridges
Seismic Building Codes in Portland

• 1974: Oregon’s First Building Codes
• Portland excluded any seismic until 1972
• 1988: Adopts 2B – some minor seismic
• 1994: Switch from 2B to 3 and along southern Oregon coast to 4 (1998) – Performance Based Engineering – no fall down but may not be functional
• 2002: Switch to International Building Code
Cascadia Megathrust Effects on Infrastructure of Oregon:

- 75% of structures not designed for Megath.
- Million buildings compromised
- 3000 schools compromised
- Half of bridges (15 of 17 in Portland –bad)
- 1/3 of fire stations compromised
- Half of police stations compromised
- 2/3 of hospitals compromised
Oregon Resilience Plan (House Resol. 3 (2011))

90% of State’s Liquid Fuel is here

Prepare Oregonians for Impending Earthquake
Los Angeles, CA: 6th St viaduct opened in 1933 in need of repair and update
Recovery from the Big One

- Electricity: 1-3 months
- Water: 1 month
- Sewer: 6 months
- Highways: 6 months
- (Remember the Aftershocks!)
- (Taxpayers will pay 75% of the damage)
Important Ideas

• Earthquake Insurance – large deductible but important for large subduction quake
• Oregon more prepared today than in 1994 – schools, fire departments, police departments and hospitals (Emergency Response)
• Infrastructure (long way to go to be ready – no codes before 1994)
• Are you prepared at home? Neighborhood Plan?
• Are we prepared in our businesses? Does the business have a resiliency plan?
• We still cannot predict them, but we are hopeful that we will respond well
Home Preparation!

- Red Cross list for disaster preparation: best!
- Water and food
- Gas shut-off (California Valve)
- Strap on water heater
- Strap house to foundation
- Near bed: flashlight and old shoes
- Insurance!
- Toilet Paper
When earthquake shaking begins....

Drop, Cover, and Hold