



The Impacts of the Cascadia Subduction Zone Earthquake on Oregon

Dr. Althea Rizzo

Oregon Military Department

Office Of Emergency Management





What are the geologic hazards in Oregon?



Earthquakes

Tsunami



Volcanos



Earthquakes

- **Earthquakes** occur when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake.

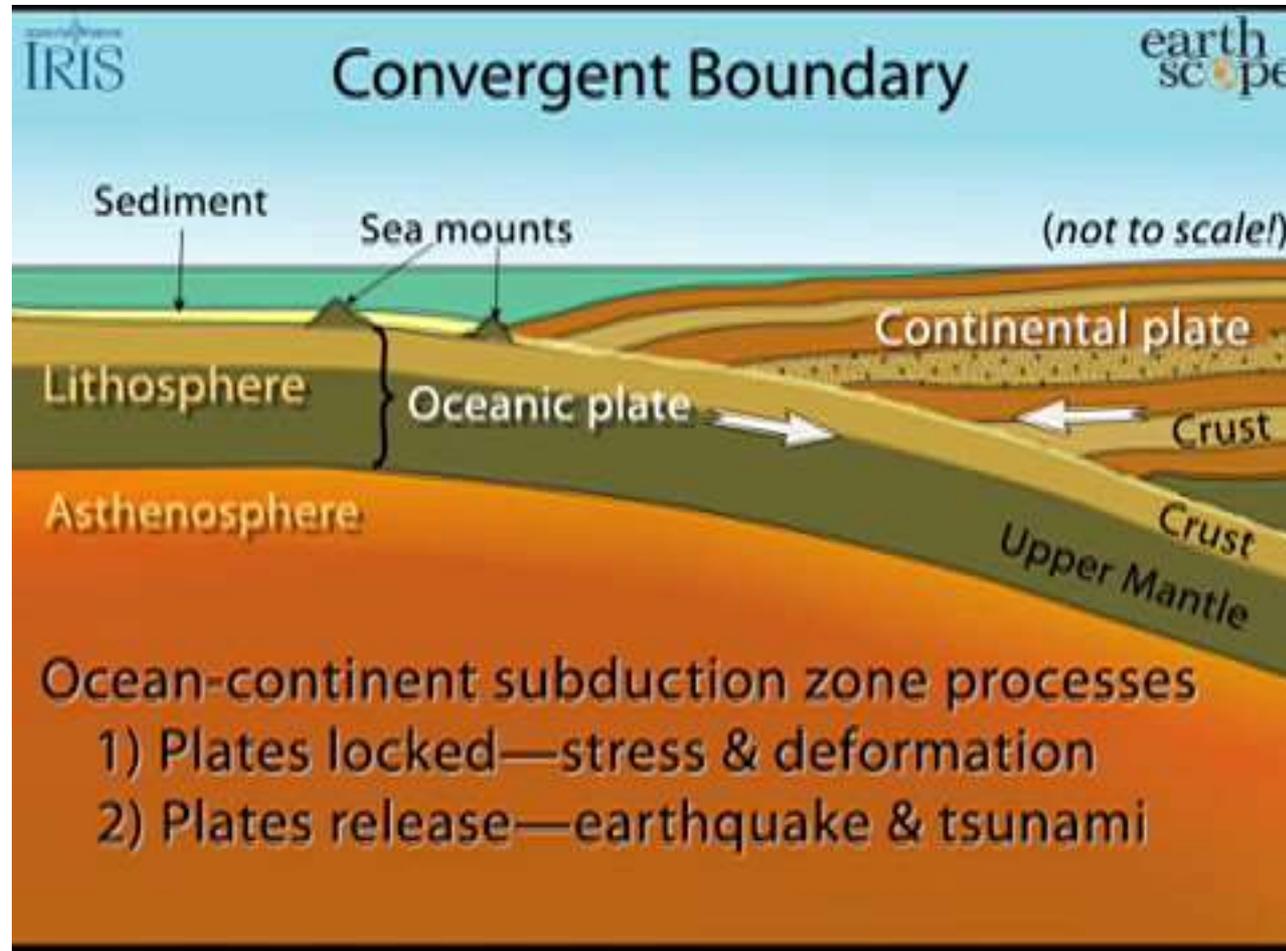


Tsunami

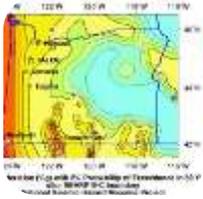
- **Tsunamis** are generated when geologic events cause large, rapid movements in the sea floor that displace the water column above.
- The Pacific Coast is at risk both from locally and distantly generated tsunamis.



What is the Cascadia Subduction Zone?



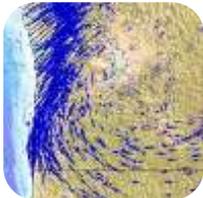
Know your Cascadia Subduction Zone



600 miles long, from northern California to British Columbia



Capable of producing very large earthquakes (M9+) that impact a wide area



Similar in size and impact to the 2004 Sumatra earthquake



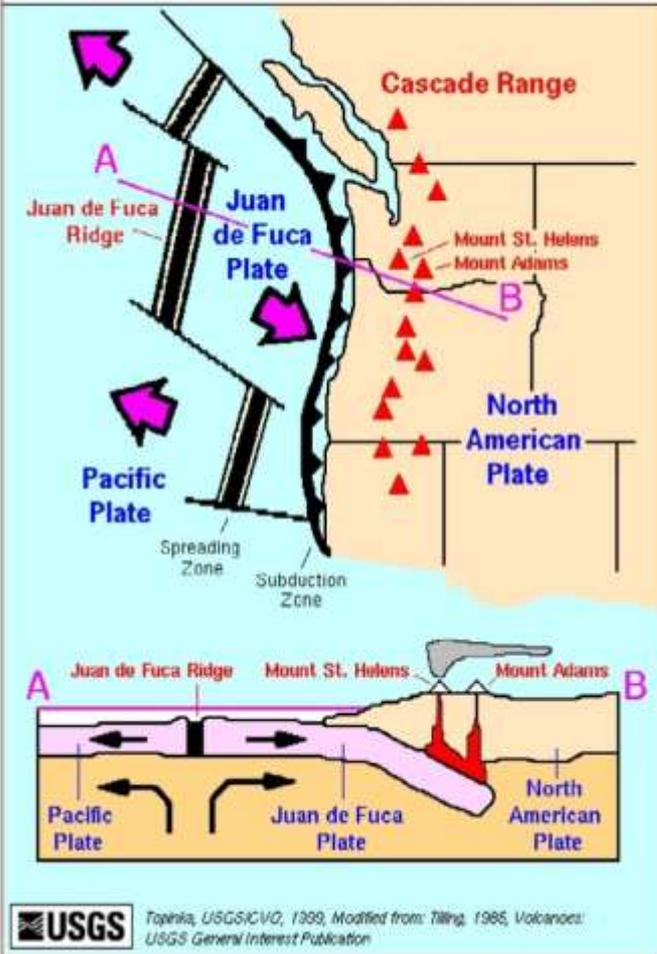
Can produce devastating tsunamis



37% chance of a mega-thrust earthquake in the next 50 years *



Plate Tectonics – Cascade Range



Last Cascadia Subduction Zone earthquake occurred in 1700

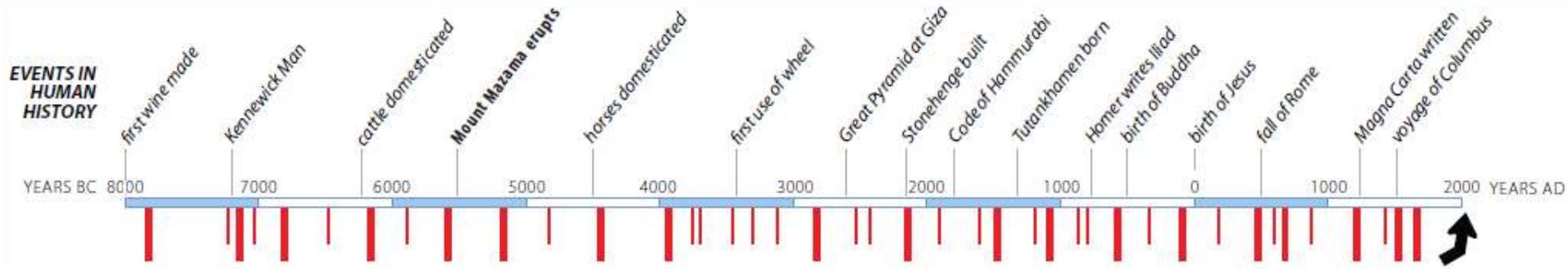
When will the next one occur?

• We just don't know

Average recurrence:

- 240 years (south of Cape Blanco)
- 5-600 years (entire length)
- 190-1,200 years between EQ

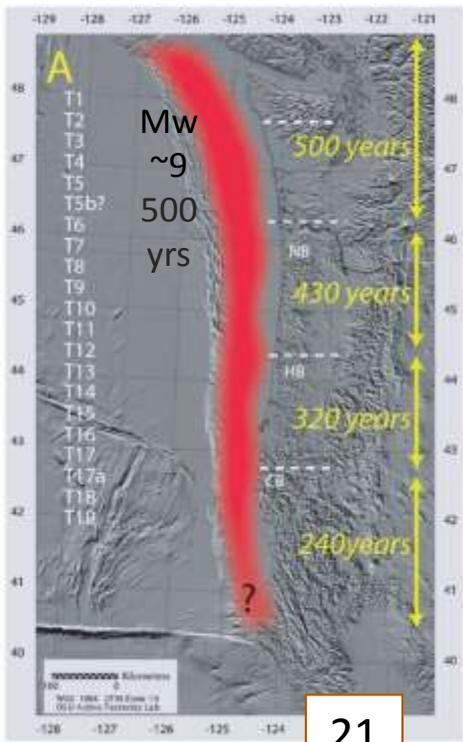




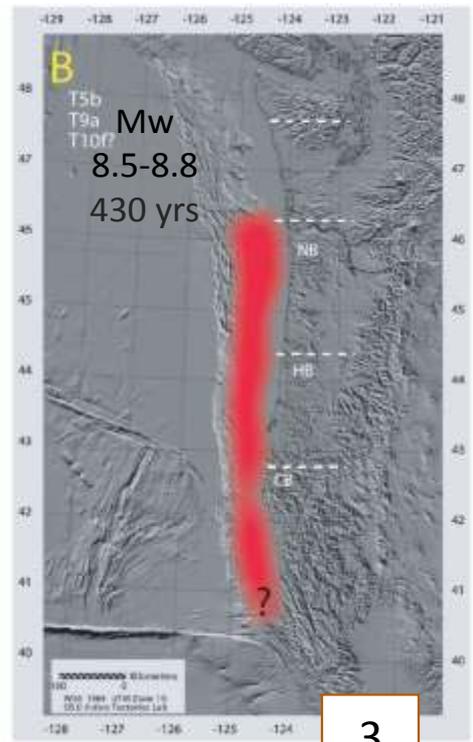
KNOWN CASCADIA EARTHQUAKES ALONG THE CASCADIA SUBDUCTION ZONE IN NORTHERN CALIFORNIA, OREGON, AND WASHINGTON

YOU ARE HERE!

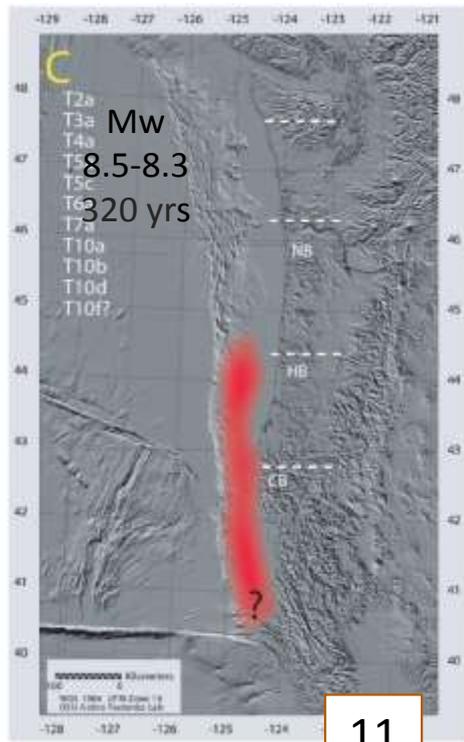
- Earthquake of Magnitude 9+ (fault breaks along entire subduction zone)
- Earthquake of Magnitude 8+ (fault breaks along southern half of subduction zone)



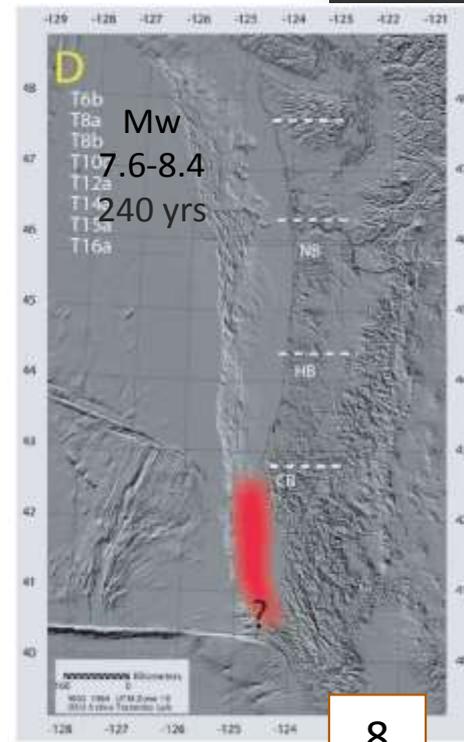
21



3



11

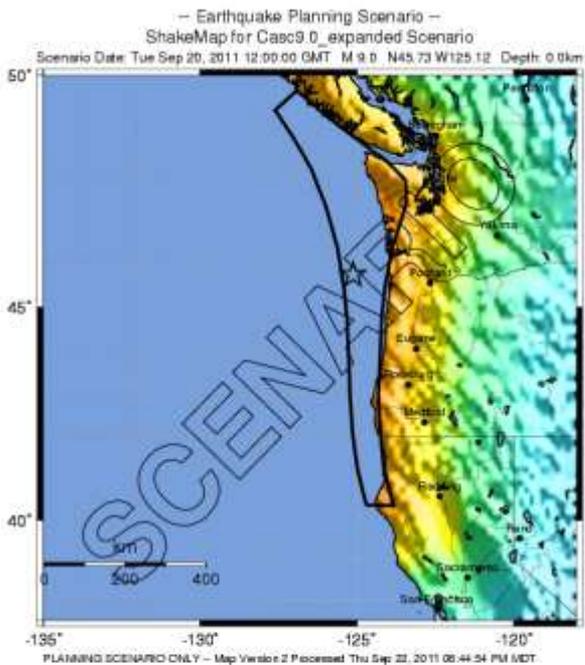


8

(Modified from [Linger et al. \(in press\)](#) by adding magnitude estimates and some labels)



Cascadia = Strong Shaking and Tsunami



PERIODS SPACING	Hurtles	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
NOTHING DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC (g)	<.77	.77-1.4	1.4-2.0	2.0-3.2	3.2-7.8	7.8-34	34-65	65-124	>124
PEAK VELS (m)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-18	18-31	31-60	60-110	>110
STRUCTURAL DAMAGE	I	II-III	IV	V	VI	VII	VIII	IX	X

- Strong Ground Shaking
 - M9 w/ 2 - 4 min shaking
- Tsunami
 - within 15 to 25 minutes



What happens during a Cascadia Subduction Zone earthquake?



Strong ground shaking



2010 Haiti earthquake



2011 Tohoku earthquake



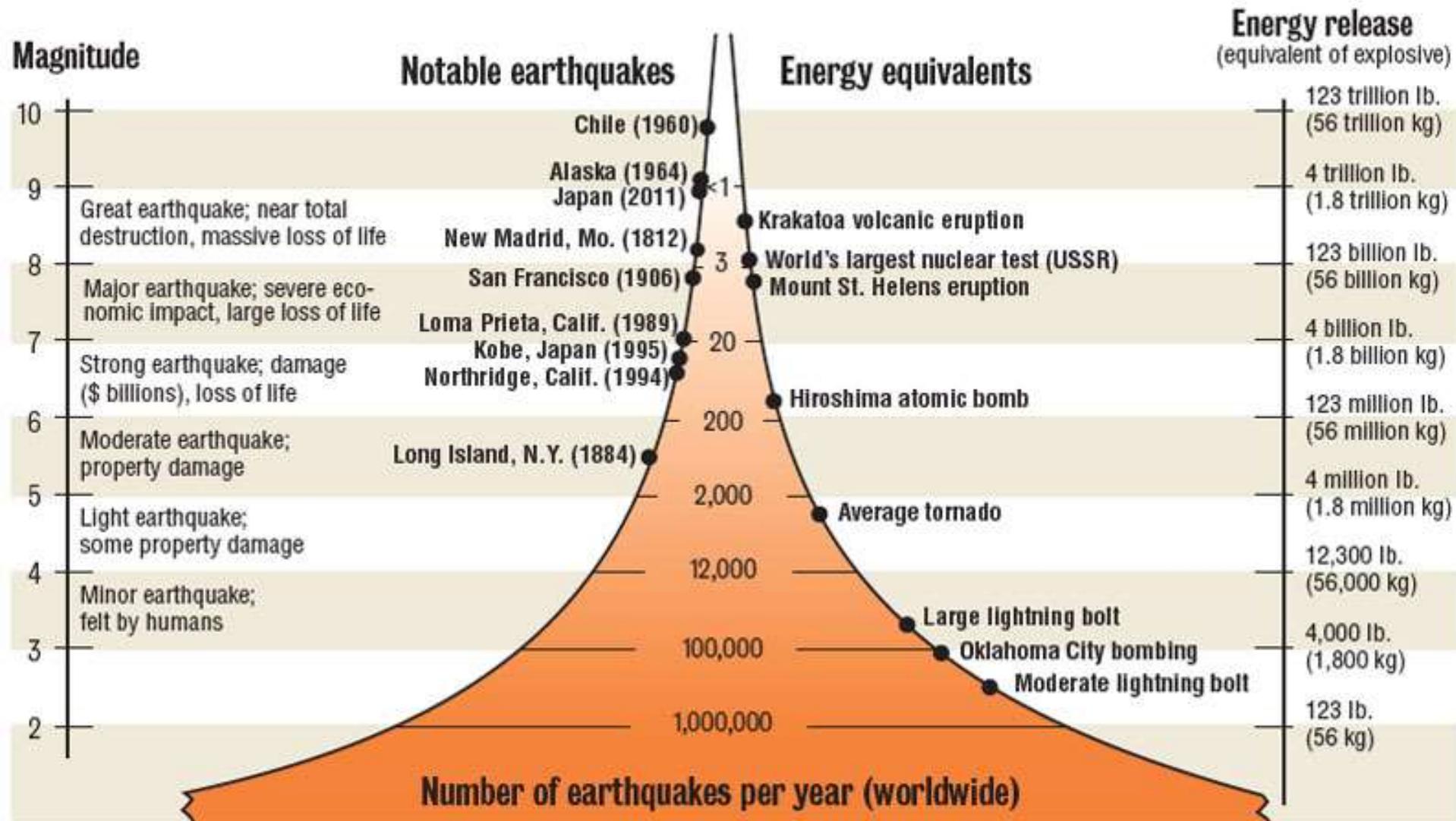
1993 Molalla High School



I	Instrumental	Not felt.	1-2
II	Just Perceptible	Felt by people sitting or on upper floors of buildings.	3
III	Slight	Felt by almost all indoors. Hanging objects swing. May not be recognized as an earthquake..	3.5
IV	Perceptible	Vibration felt like passing of heavy trucks. Windows, dishes, doors rattle. Glasses clink. In the upper range of IV, wooden walls and frames creak.	4
V	Rather Strong	Felt outdoors. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing. Pictures move. Pendulum clocks stop.	4.5
VI	Strong	Felt by all. People walk unsteadily. Many frightened. Windows crack. Weak plaster, adobe buildings, and some poorly built masonry buildings cracked.	5
VII	Severe	Difficult to stand or walk. Damage to poorly built masonry buildings. Fall of plaster, loose bricks. Some cracks in better masonry buildings.	5.5
VIII	Destructive	Extensive damage to unreinforced masonry buildings. Fall of some masonry walls. Wood-frame houses moved on foundations if not bolted	6
IX	Violent	General panic. Damage to masonry buildings ranges from collapse to serious. Wood-frame structures rack, and, if not bolted, shifted off foundations. Underground pipes broken.	6.5
X	Very Violent	Poorly built structures destroyed with their foundations. Even some well-built wooden structures and bridges heavily damaged and needing replacement.	7
XI	Extreme	Rails bent greatly. Underground pipelines completely out of service.	7.5
XII	Catastrophic	Damage nearly total.	8

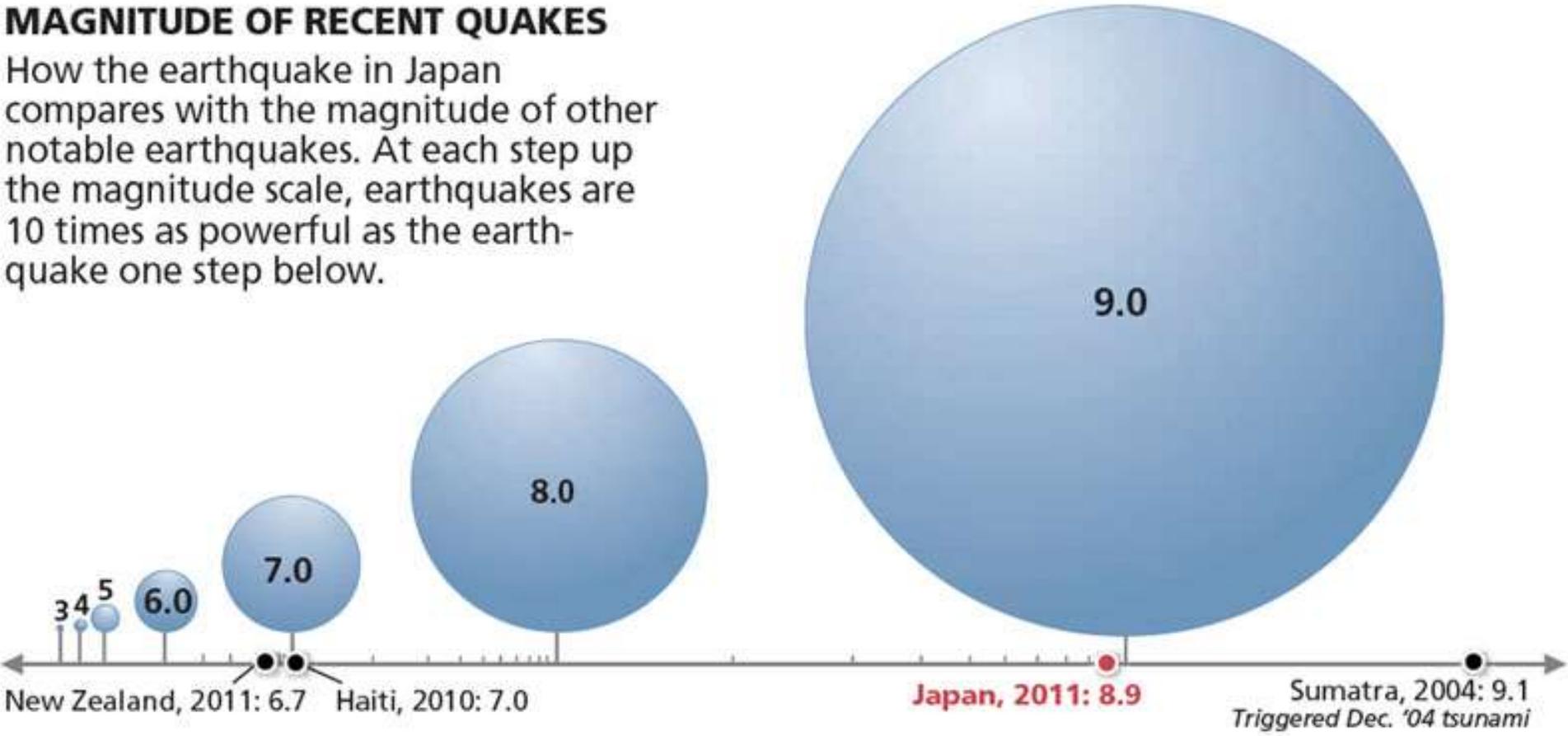
Earthquake frequency and destructive power

The left side of the chart shows the magnitude of the earthquake and the right side represents the amount of high explosive required to produce the energy released by the earthquake. The middle of the chart shows the relative frequencies.



MAGNITUDE OF RECENT QUAKEs

How the earthquake in Japan compares with the magnitude of other notable earthquakes. At each step up the magnitude scale, earthquakes are 10 times as powerful as the earthquake one step below.

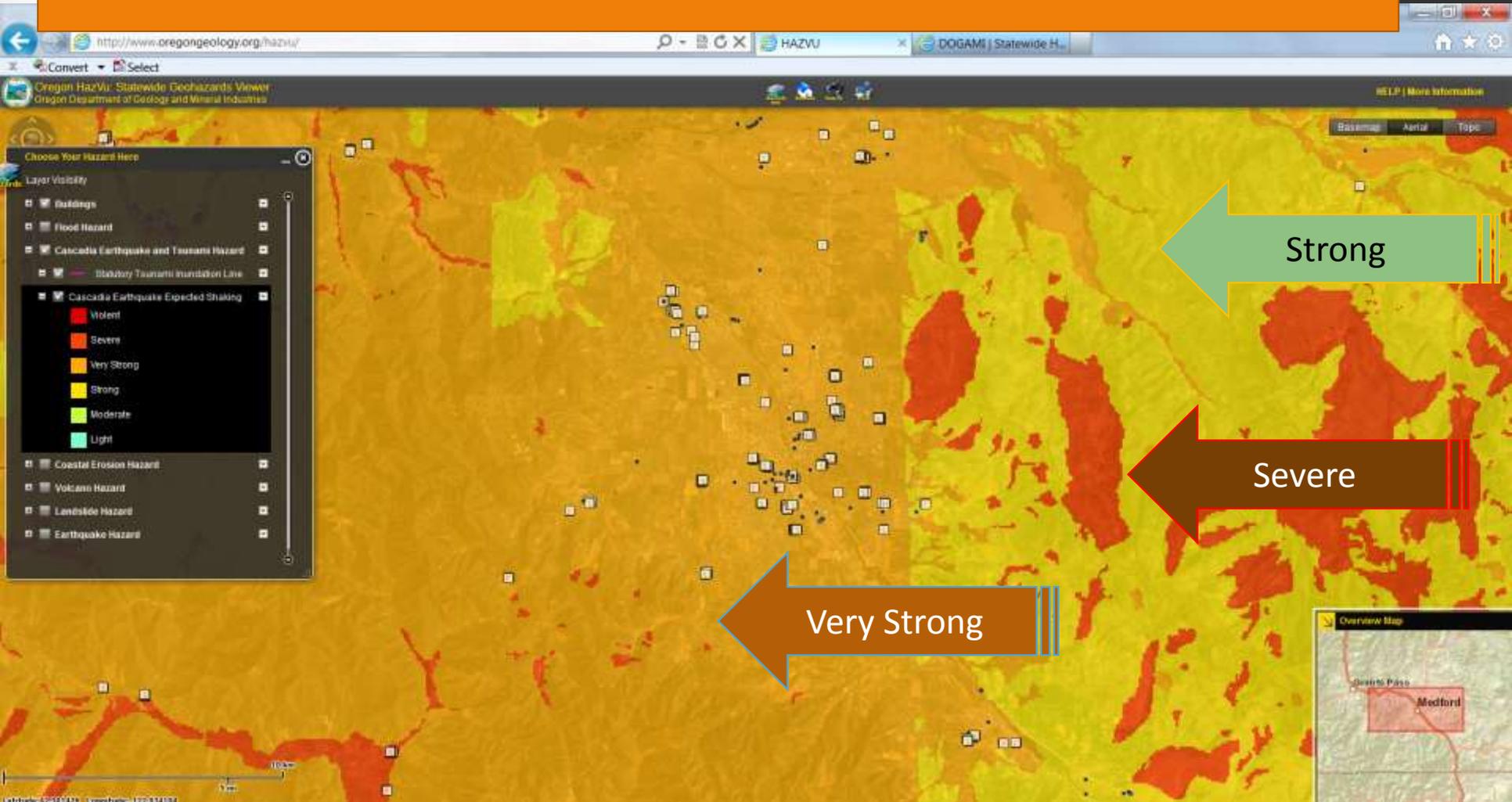


Sources: U.S. Geological Survey, Washington Post

THE ARIZONA REPUBLIC



Shaking intensity - CSZ



Source: <http://www.oregongeology.org/hazvu>



Coastal subsidence



2004 Sumatra



Mainichi Shimbun, Reuters



Landslides



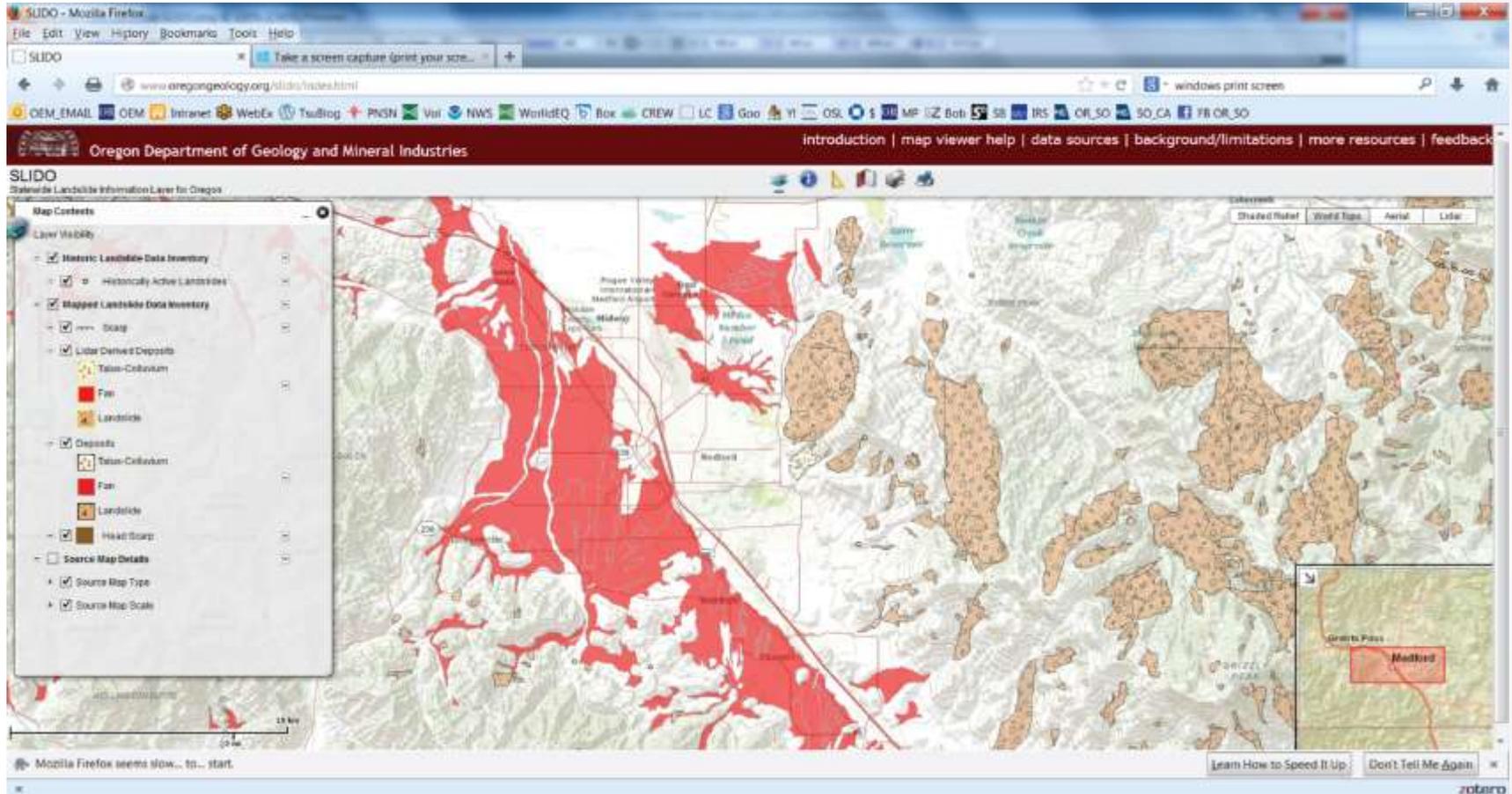
Landslides in Ferndale, WA



2010 Taiwan



Landslides in Jackson County



<http://www.oregongeology.org/sub/slido/>

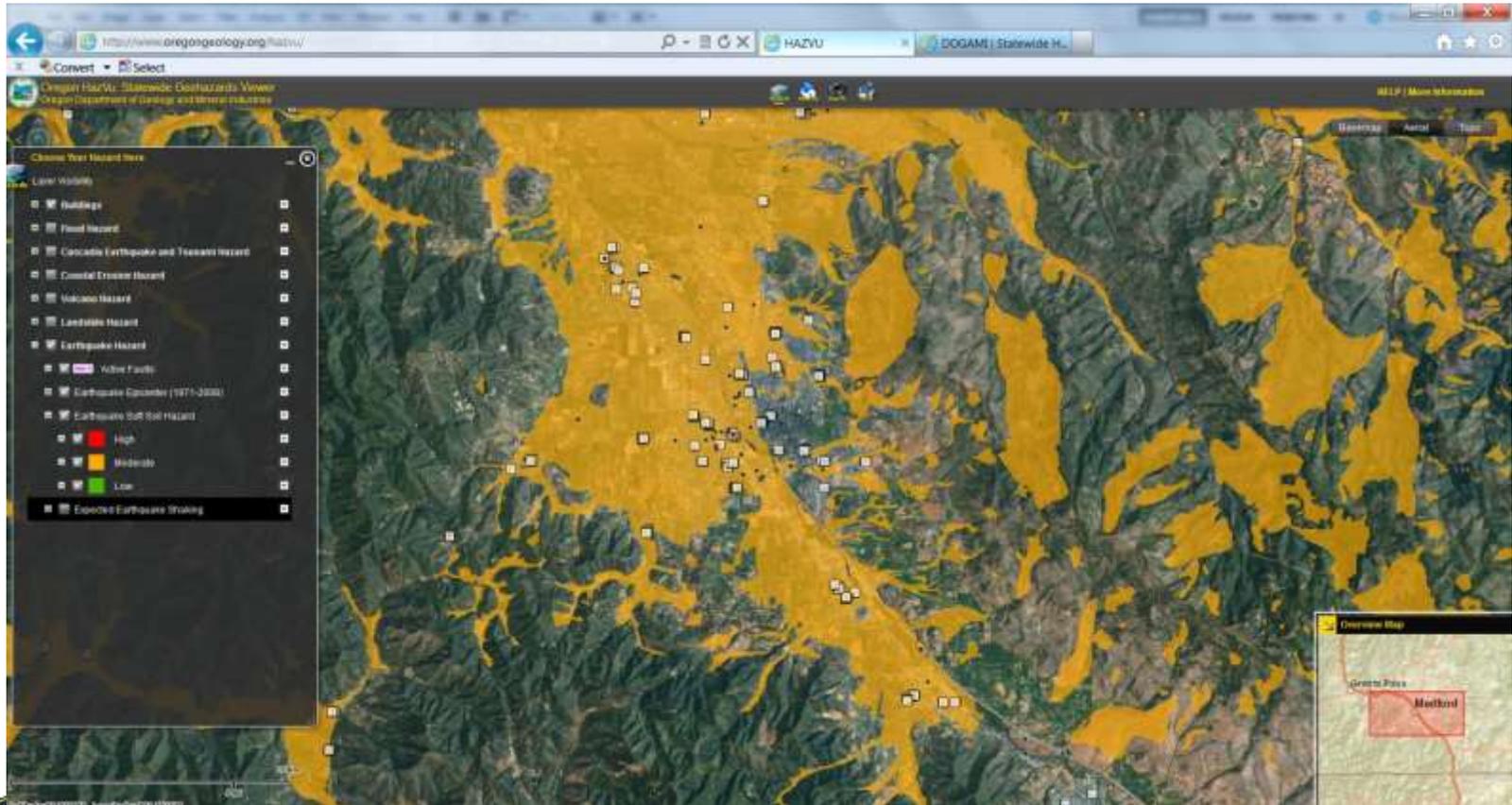
Liquefaction



1964 Alaska



Liquefaction



Source: <http://www.oregongeology.org/hazvu>

Tsunami



2004 Indonesian tsunami

2011 Tohoku tsunami



Tsunami

Local – Caused by a subduction zone earthquake near the Oregon shore

Distant – Caused by a subduction zone earthquake far away from the Oregon shore



Distant Tsunami

- Arrives 4 + hours after the earthquake
- Lower damage and flooding than local tsunamis
- National Tsunami Warning System can warn you
 - Warning and Advisory require protective action
- National Tsunami Warning Center
 - <http://wcatwc.arh.noaa.gov/>



Local Tsunami

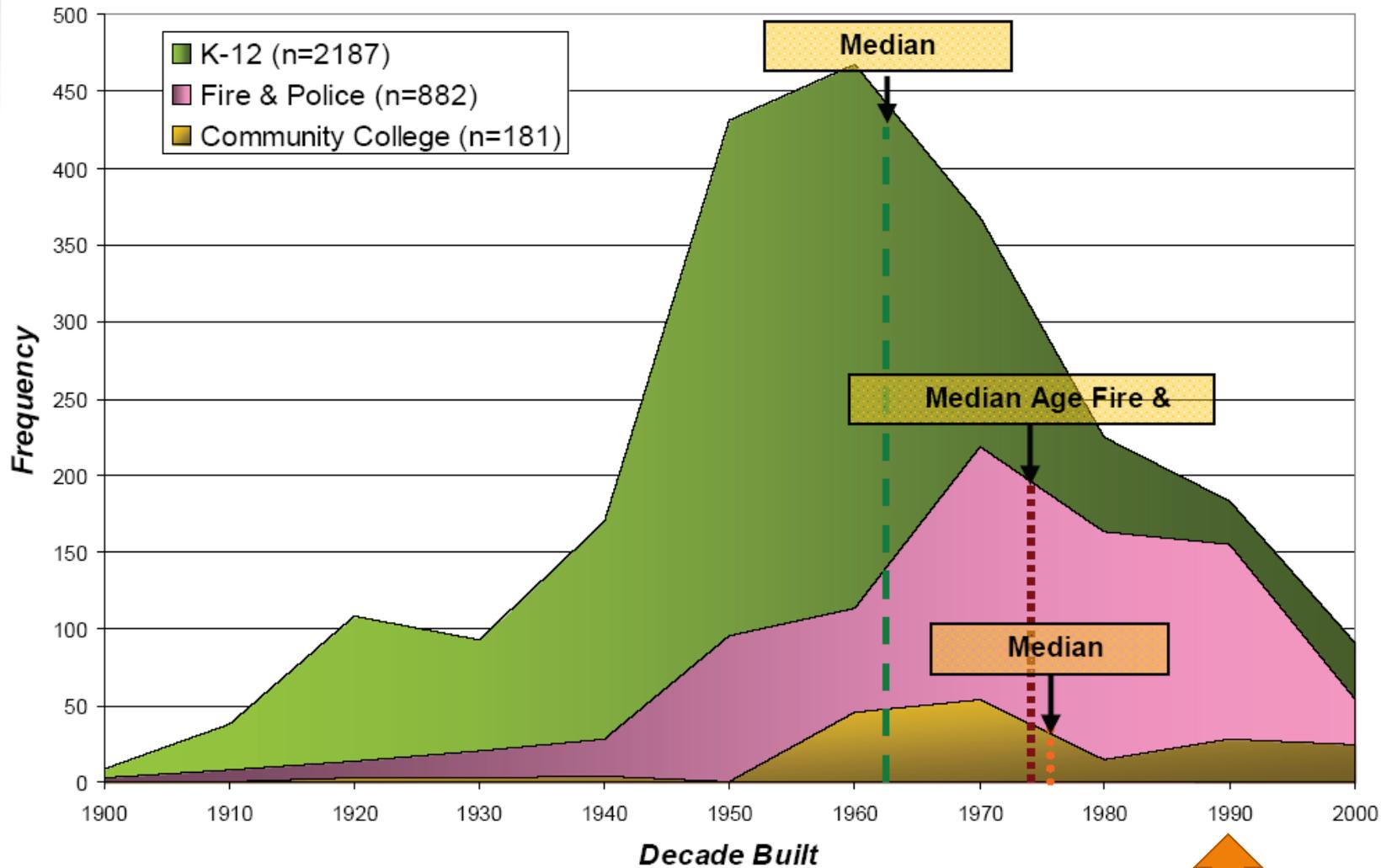
- Arrives minutes after the earthquake
- Much higher waves
- Much further inland penetration
- NOAA Tsunami Warning System ineffective
- Earthquake = Only Warning
 - NO OFFICIAL WARNING!
 - Self Evacuation required



What are the Implications for Oregon?



Office of Emergency Management



**First seismic building codes
in Oregon**



Roads Damaged



State of Oregon's bridges

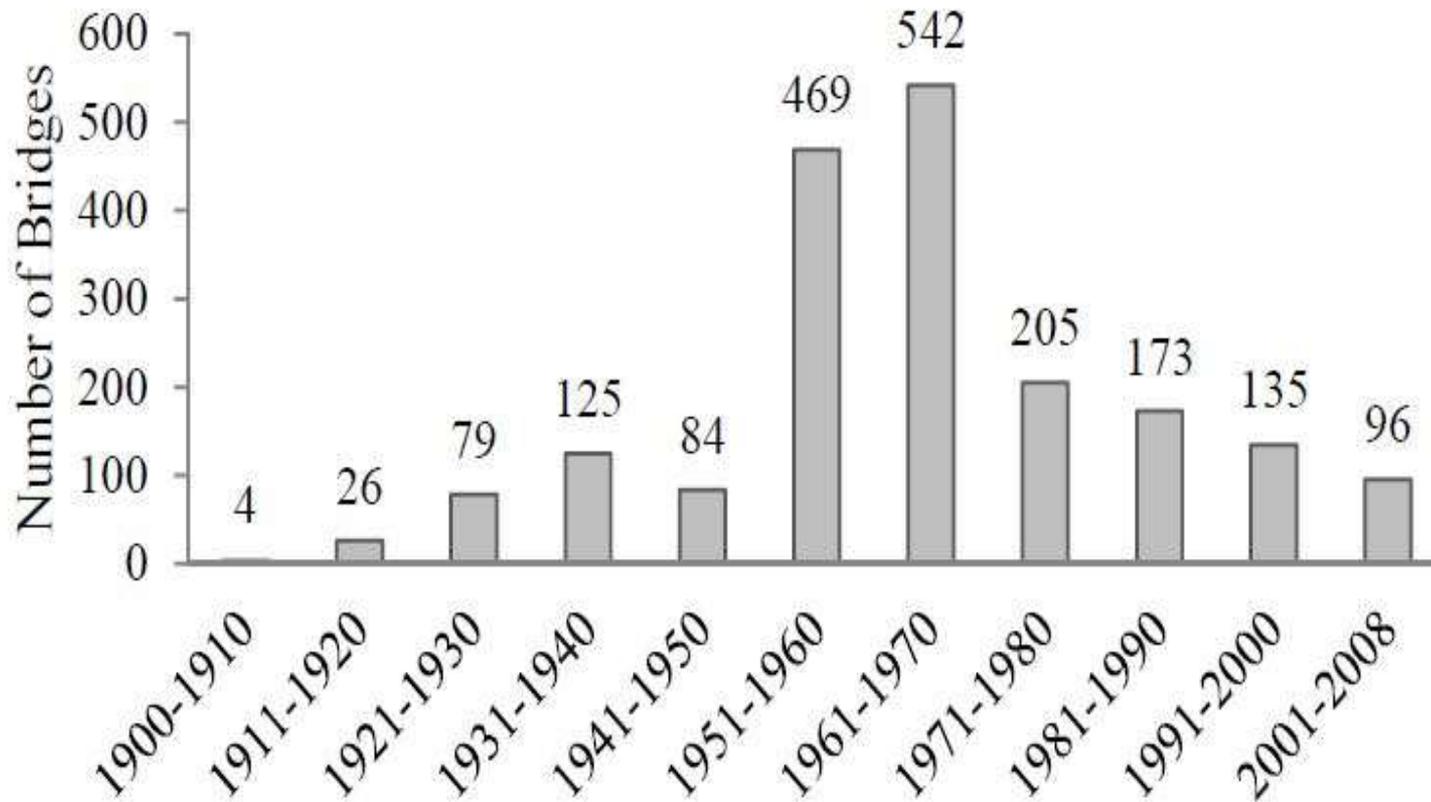


Figure 3: Distribution of year of construction completion

Oregon is at risk
from an earthquake and
tsunami that can significantly
impact our people and
economy for decades.



Cascadia Planning Assumption

Widely accepted that a very large, 9+ subduction zone earthquake is not just possible, but probable

Strong to Very Strong shaking inland to Cascade mountains

Three metropolitan cities in impact zone

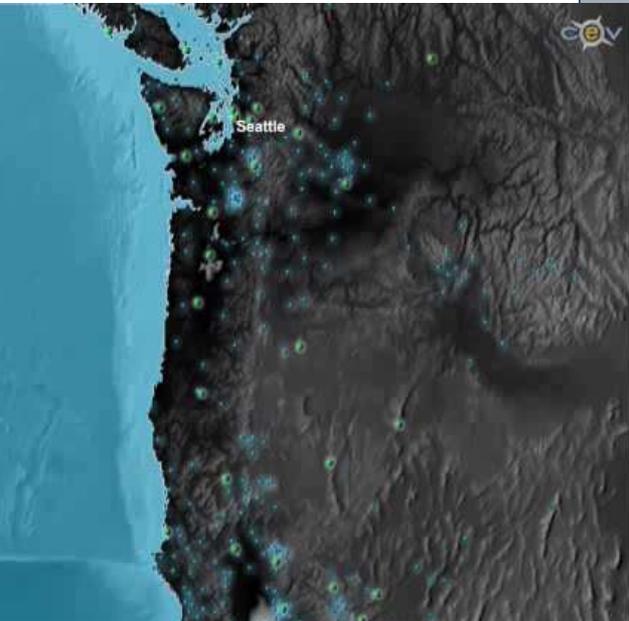
- Portland
- Seattle
- Vancouver, B.C.

Heavy urbanization along the I-5 corridor



What will Oregon look like if Cascadia happened today?

- 15 million people live in the impact zone
 - No power for weeks/months/years
 - No fuel for weeks/months/years
 - No deliveries of food/water for weeks/months
 - No running water for weeks/months/years
 - No sewer system for weeks/months/years



Earthquake mitigation in Oregon

- Oregon Resiliency Plan (OSSPAC)
- Cascadia Catastrophic Plan (OEM)
- Land-use planning guidance (DLCD)
- Natural Hazards Mitigation Plan (DLCD)
- Tsunami inundation mapping (DOGAMI)



ORP Key Findings

- Casualties (1,250 to more than 10,000)
- Economic Loss (close to 20% state GDP)
- More than one million truck loads of debris

Liquid fuel vulnerability

How much liquid fuel do you use in one month?



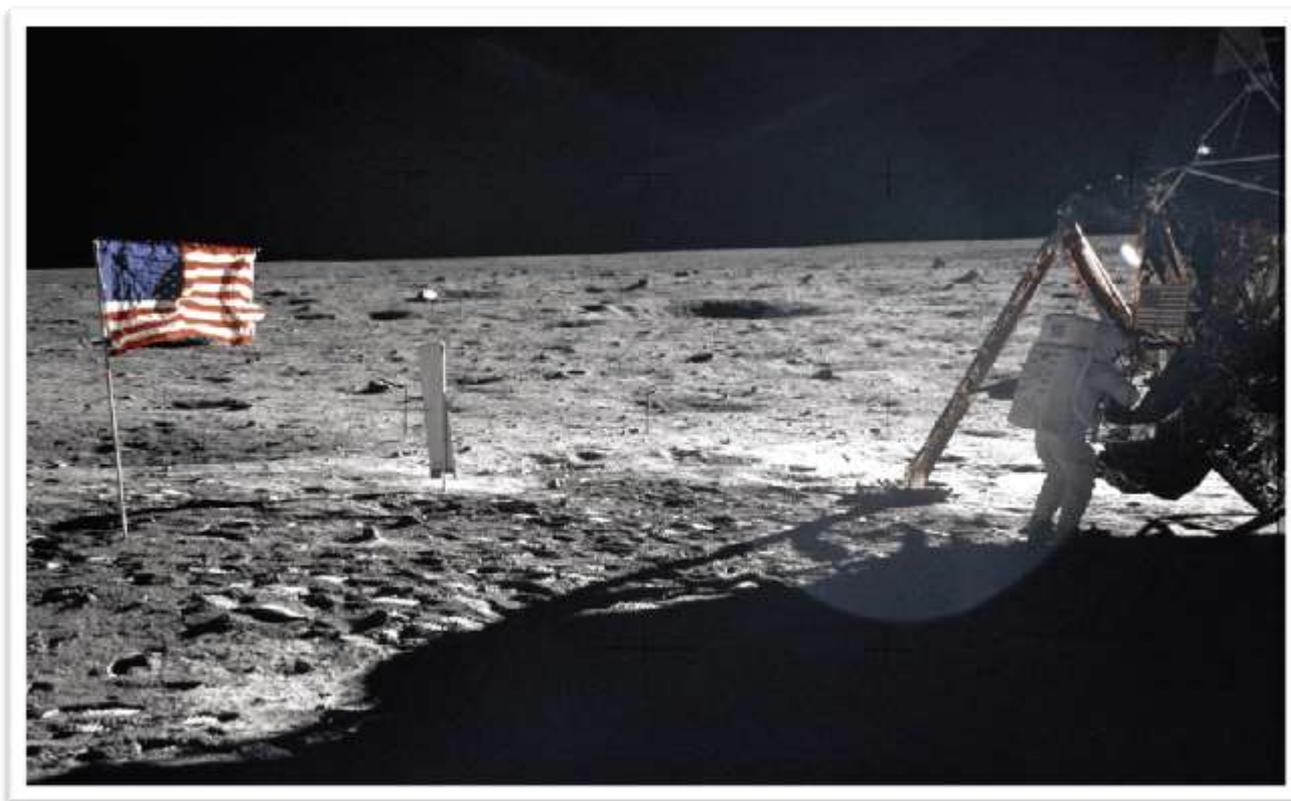
A new normal?



Office of Emergency Management

How do we get to where we need to be?

- Acknowledge that it can be accomplished



Cultural shift that will take a generation

Improved personal preparedness



Less than 30% U.S. trained in first aid



90% in Norway
80% in Germany



Cultural shift happens ...

- ... because people taking control and ownership



Cascadia cultural shift – *it's seismic!*

- **Preparedness: a part of daily life**
 - Starts with talking about it



Resiliency CAN be achieved

- After the February 27, 2010 M8.8 Maule Earthquake, Chile
 - 90% communication services and 95% power supply within two weeks, and re-start commercial flights after ten days.
- After the March 11, 2011 M9.0 Tohoku Earthquake,
 - 90% power supply in ten days, 90% telephone lines in two weeks, and 90% cellular base stations in 19 days.



Community actions



Educate the
Public

Educate Public
Officials



Mitigate what
you value



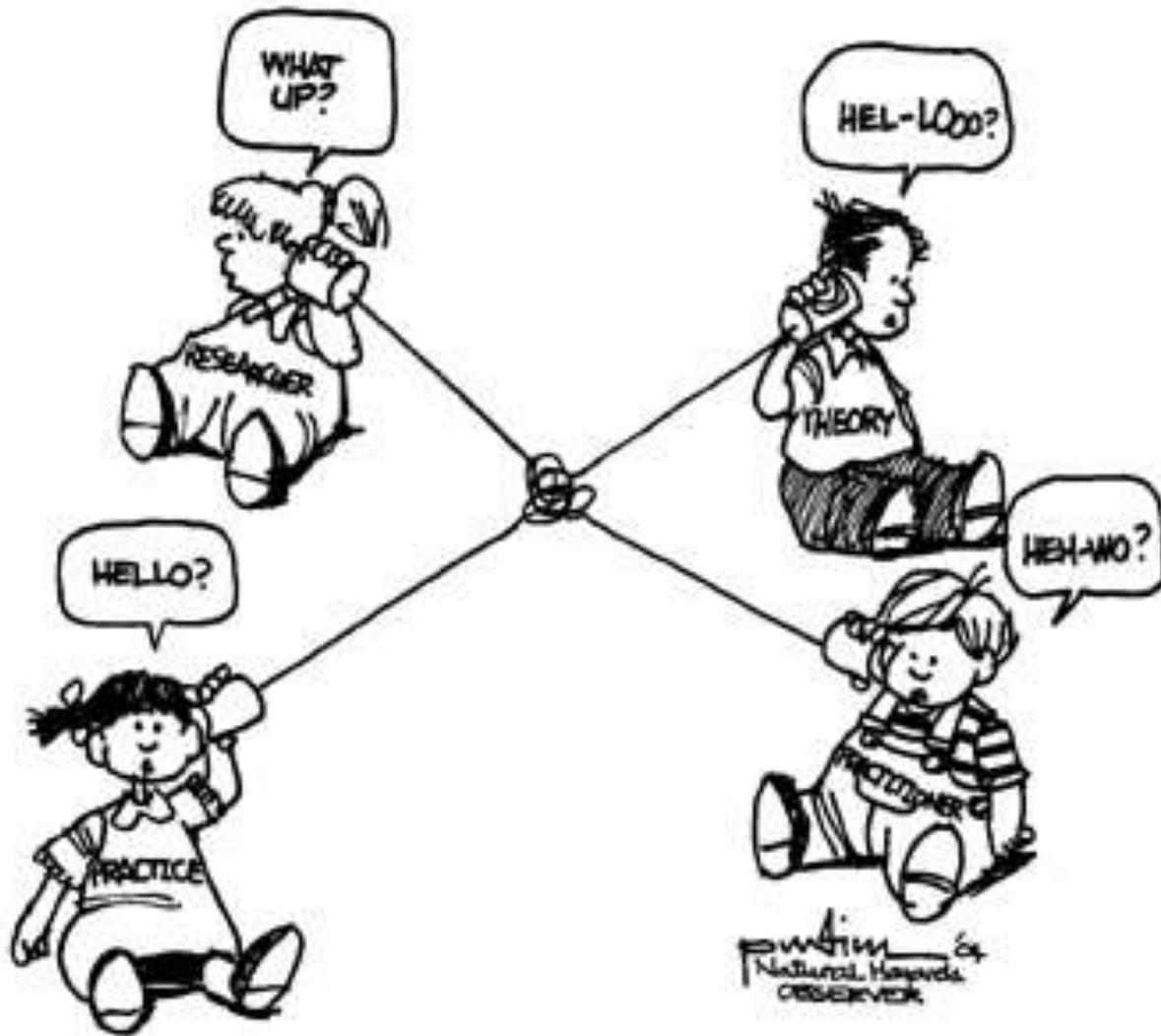
You are the community you seek

Family

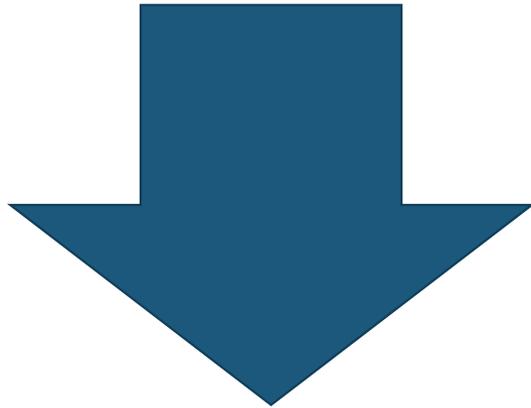
Neighbors

Community





Survive the Earthquake



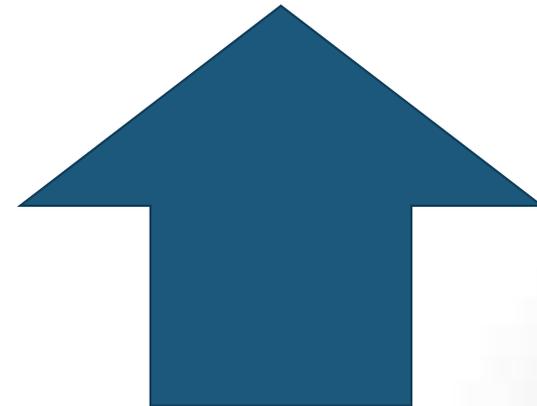
Prevention

- **Modify Your Environment**



Protection

- **Modify Your Behavior**



Create a safe space

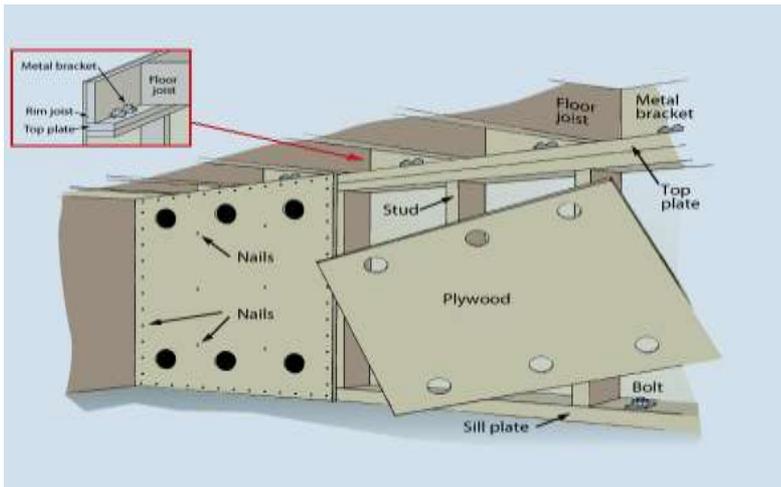


Secure your space by identifying hazards and securing moveable items



Common building problems

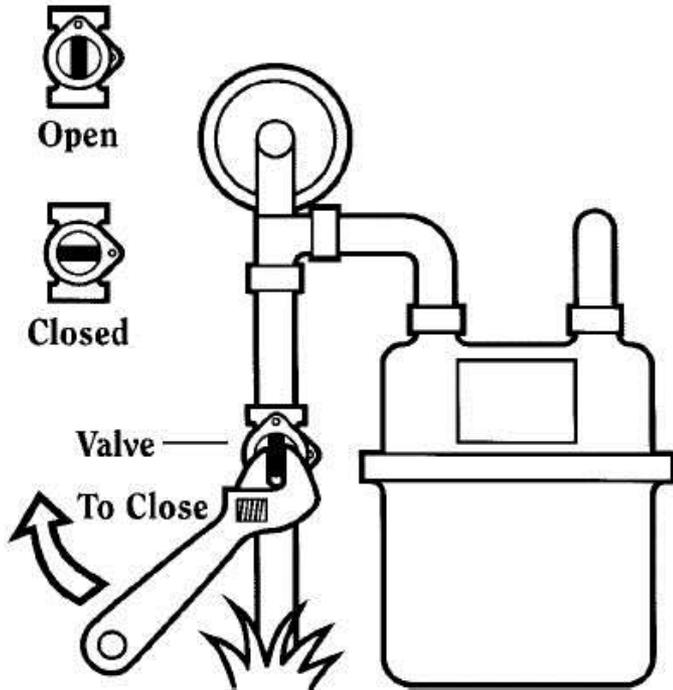
- Inadequate foundations
- Un-braced cripple walls



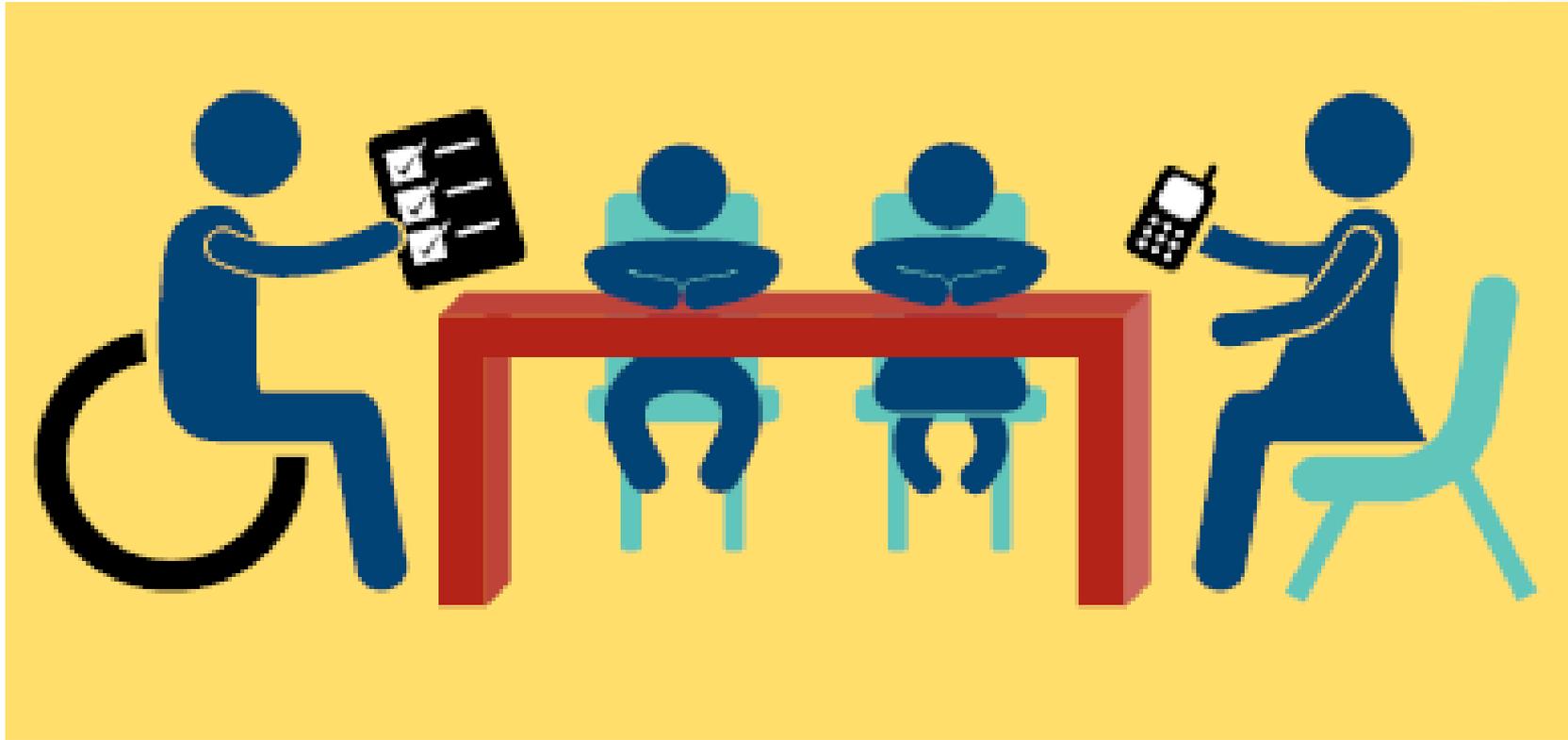
FEMA Earthquake Safety Guide for Homeowners



Know how to shut it off



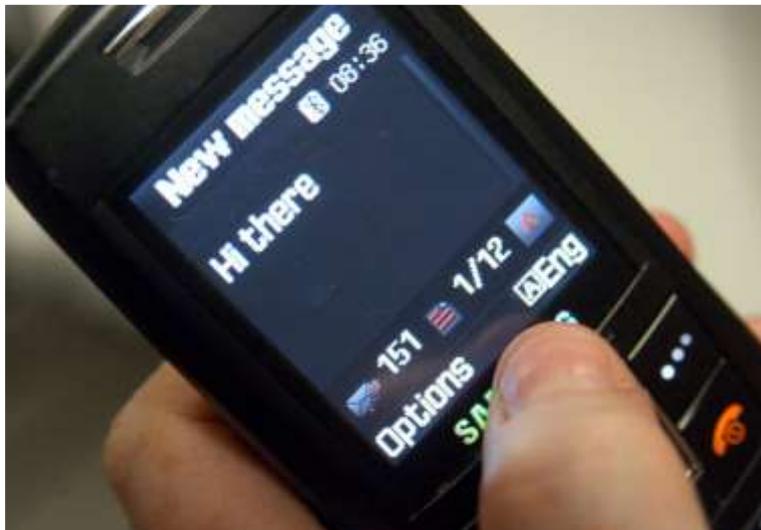
Plan to be a survivor



Talk it through



Who ya gonna call?



Safe. Walking home.

If you can send one text... to whom would it be and what would you say? ...



Plan your route



Personal disaster supplies kits

- Go-Kit – minimum of 72 hours
- Car – 7 to 10 days
- Home – 3+ weeks



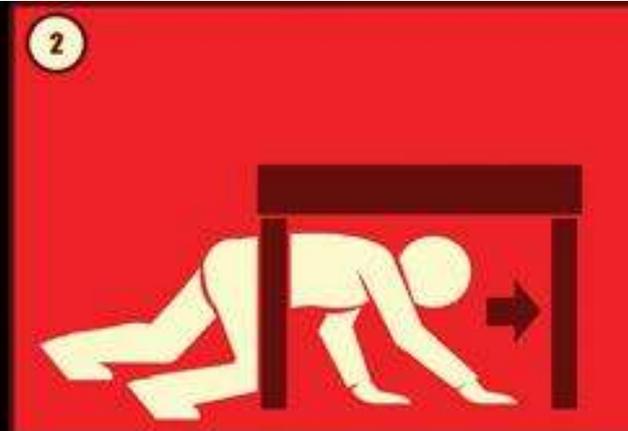
<http://www.ready.gov/america/getakit/>



Protect yourself during earthquake



DROP!



COVER!



HOLD ON!

Protect Yourself. Spread The Word.



3 Common MISTAKES

- **DO NOT**
run out of the
building!

Run



- **DO NOT**
get in a
doorway!

Doorway



- **DO NOT**
believe the triangle
of life!

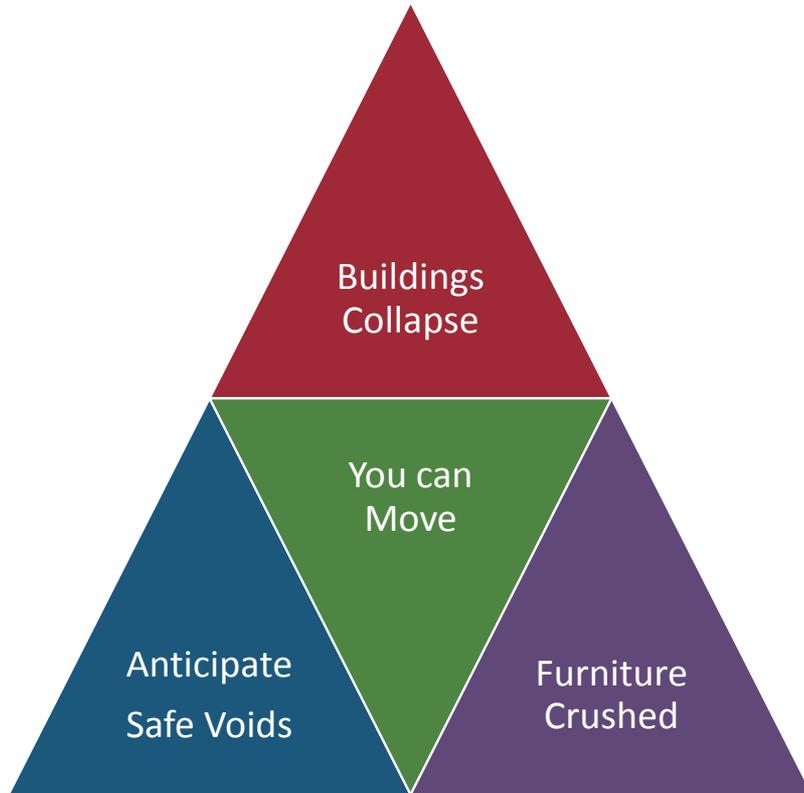
**Triangle
of Life**



The Triangle of Life MYTHS

MYTHS

TRUTH



1. **Collapse:** Most buildings do not collapse
2. **Moving:** Strong shaking makes moving very difficult and dangerous
3. **Voids:** The direction of shaking and unique structural aspects of the building make this impossible.
4. **Furniture:** People DO survive under furniture or other shelters.



Improve safety immediately after an earthquake by **evacuating if necessary, helping the injured and preventing further injuries or damage.**



After the Earthquake

Assess

- Glass
- Dust
- Fire
- Darkness

Protect

- Gloves
- Mask
- Flashlight

Evacuate

- Obstacles
- Routes
- Assistance



1

- After the earthquake

2

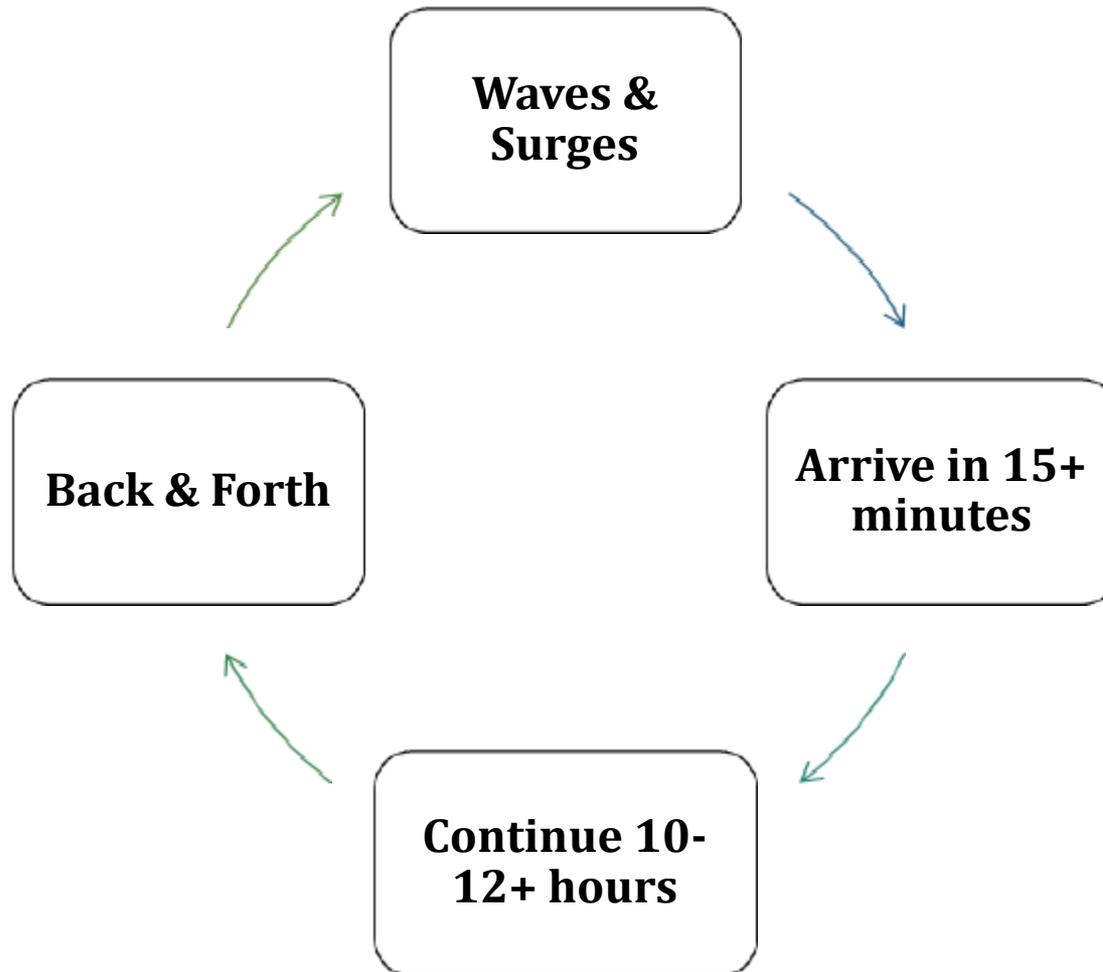
- Comes the tsunami

3

- Know what to do!



Local (Cascadia) Tsunami



Feel the
Ground Shake

Drop, Cover,
and Hold on!

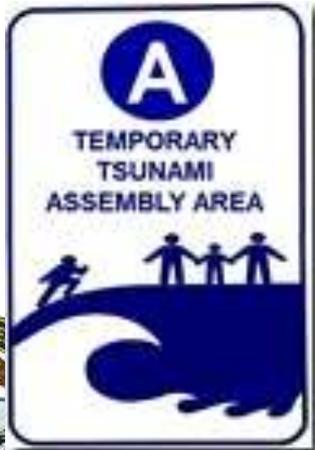
Get to high
ground!

Stay there

Do not wait for a
warning



Identify High Ground

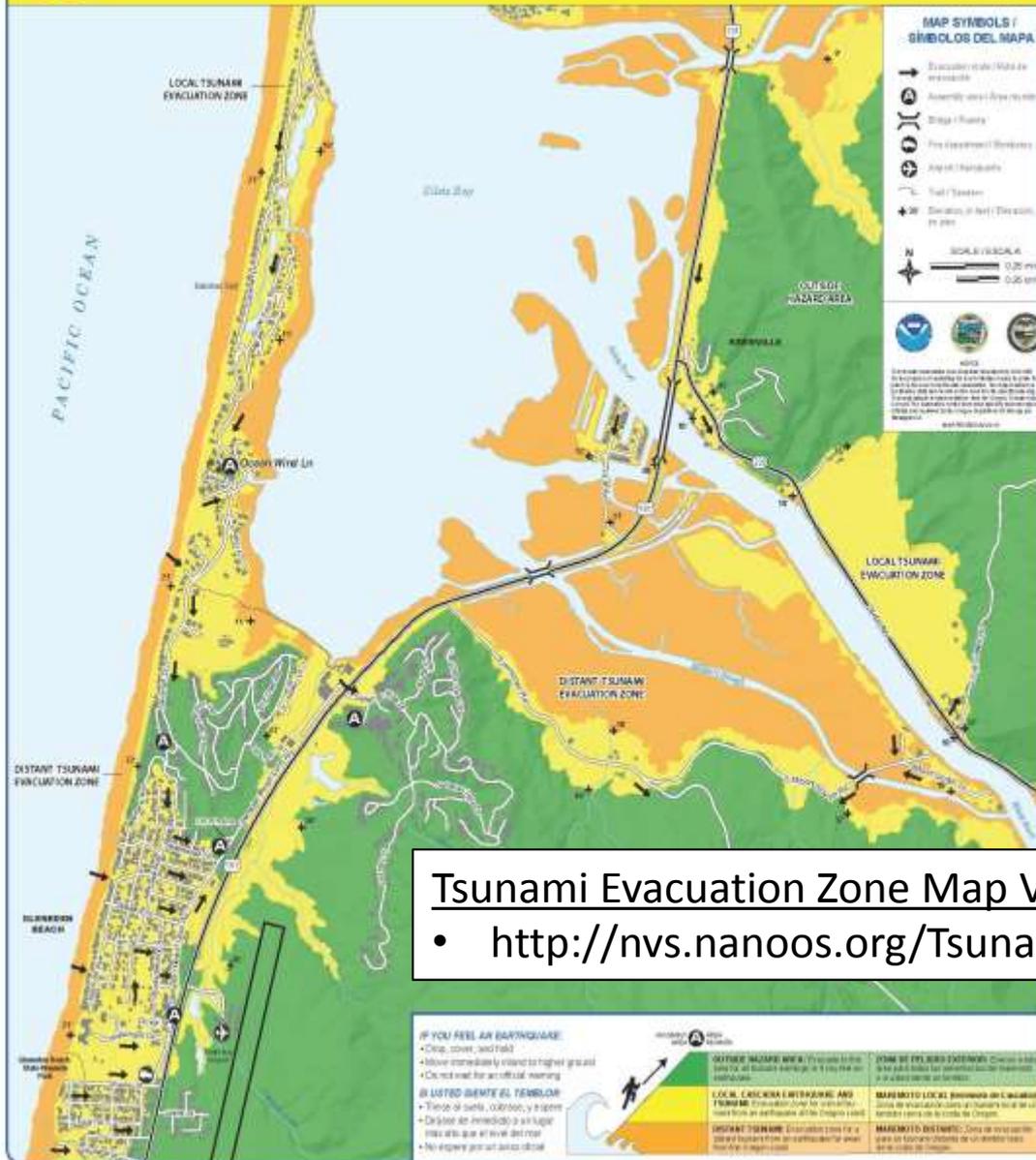


- Signs
- Evacuation Routes
- Safe Areas
 - Temporary Assembly Areas
 - Vertical Evacuation Options





TSUNAMI EVACUATION MAP GLENEDEN BEACH, OREGON



Tsunami Evacuation Zone Map Viewer

- <http://nvs.nanoos.org/TsunamiEvac>



IF YOU FEEL AN EARTHQUAKE:

- Drop, cover, and hold!
- Move immediately inland to higher ground
- Do not wait for an official warning

SI USTED SIENTE EL TENDOR:

- Tíense de suelo, cubriéndose, y agárrase
- Déjese de inmediato a un lugar más alto que el nivel del mar
- No espere por un aviso oficial

IF YOU FEEL A BARTHQUAKE:

- Check cover, and hold!
- Move immediately inland to higher ground
- Do not wait for an official warning

SI USTED SIENTE EL TENDOR:

- Tíense de suelo, cubriéndose, y agárrase
- Déjese de inmediato a un lugar más alto que el nivel del mar
- No espere por un aviso oficial

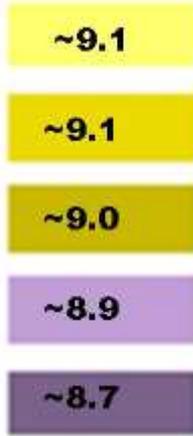
LOCAL EVACUATION (NEARSHORE AND TSUNAMI) Evacuation zone for nearshore waves from an earthquake off the Oregon coast.

DISTANT TSUNAMI: Evacuation zone for a tsunami triggered from an earthquake off the west Pacific or Indian Oceans.

TIME TO FLEE (LOCAL DISTANT) Evacuation zone for a tsunami triggered from an earthquake off the west Pacific or Indian Oceans.

MAPAS DE LOCAL EVACUACION DE TSUNAMI: Zona de evacuación para olas de tsunami generadas por un terremoto fuera de la costa de Oregon.

MAPAS DE DISTANTE: Zona de evacuación para olas de tsunami generadas por un terremoto fuera de la costa de Oregon.



Tsunami Inundation Maps

- <http://www.oregongeology.org/tsuclearinghouse/pubs-inumaps.htm>



Distant Tsunami

Earthquake Far Away

You won't feel the ground shake

4+ hours before waves arrive

Limited Inundation



Know the “Distant” Zone

Beaches

Harbors

Rivers, Inlets

Other low-lying areas



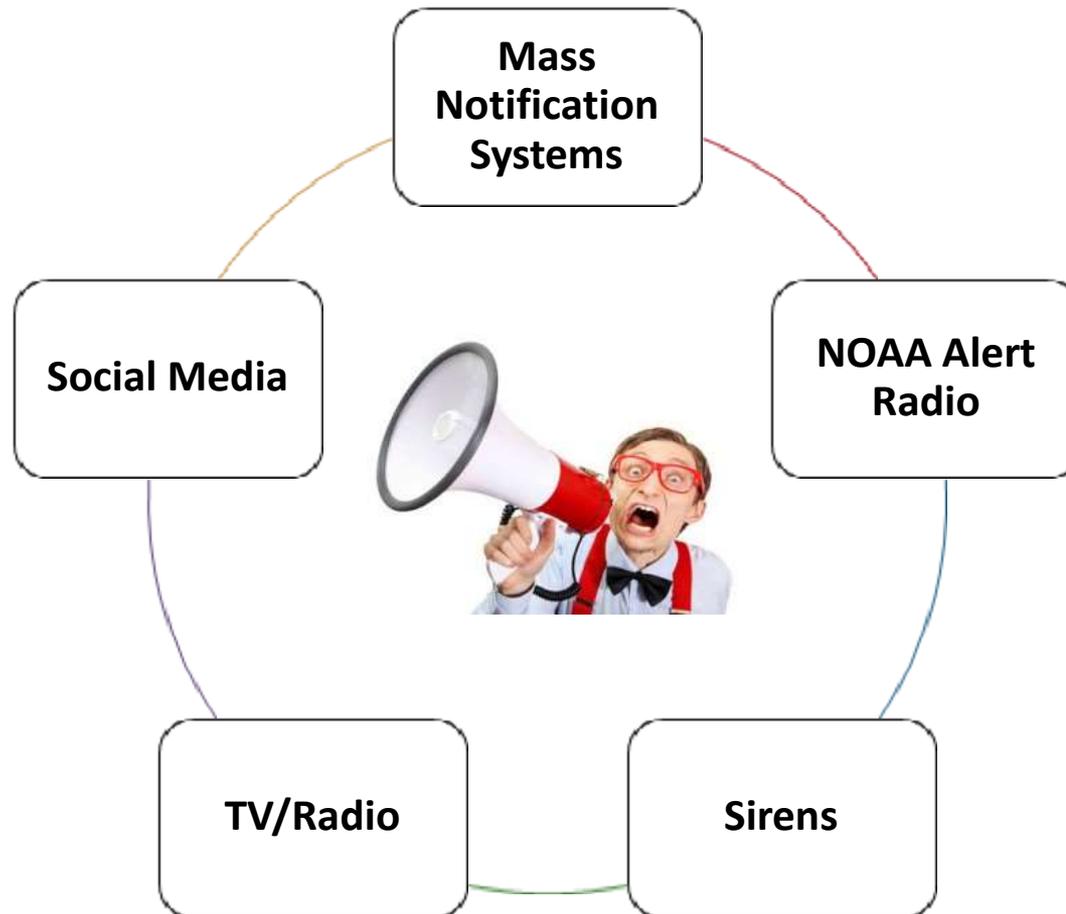
Tsunami Alert Messages

National Tsunami Warning Center

Alert Level	Threat	Action
Information Statement	Minor waves at most	No action suggested
Watch	Danger level not yet known	Stay alert for more info
Advisory	Strong currents likely	Stay away from the shore
Warning	Inundating waves possible	Full evacuation suggested



Distant Tsunami Notification



Distant Tsunami Evacuation



WHO: Only those in the distant tsunami zone

HOW: Probably by car

WHERE: ???



Re-entry After a Distant Tsunami

- Cancellation Message
- Re-enter with Caution
- Damage
 - Harbors
 - Beaches
 - Low-lying areas
 - Roads, Bridges
- Clean up



**SHOULD ANYONE DIE
FROM A DISTANT TSUNAMI?**

NO





Great Oregon ShakeOut October 16, 2014

**A state-wide
Drop, Cover and Hold On
Earthquake drill.**

Shakeout.org/Oregon



Contact Information

Geological Hazard
Program Coordinator

Althea Rizzo

(503) 378-2911 ext.
22237

Althea.rizzo@state.or.us

