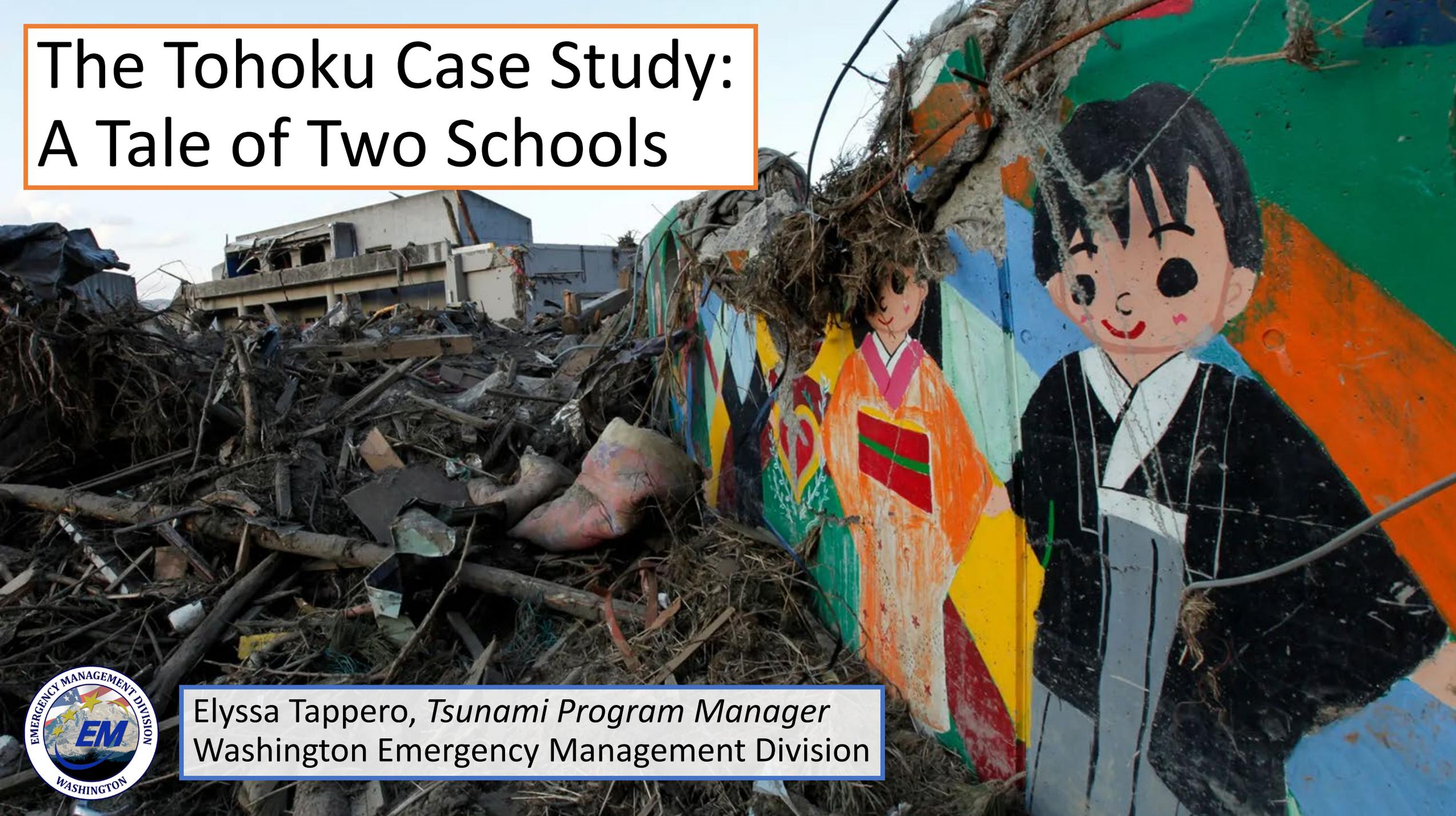


The Tohoku Case Study: A Tale of Two Schools

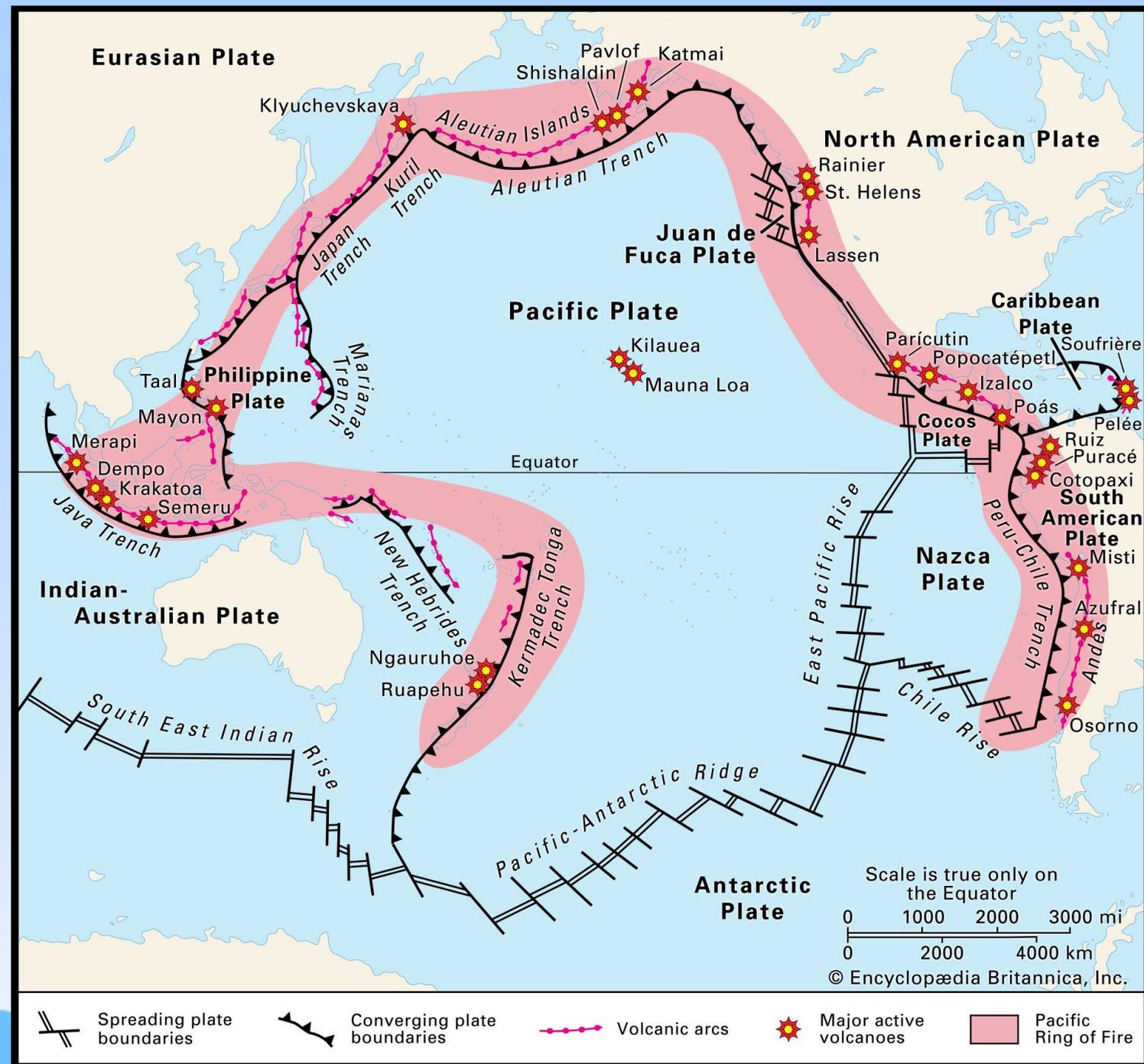


Elyssa Tappero, *Tsunami Program Manager*
Washington Emergency Management Division



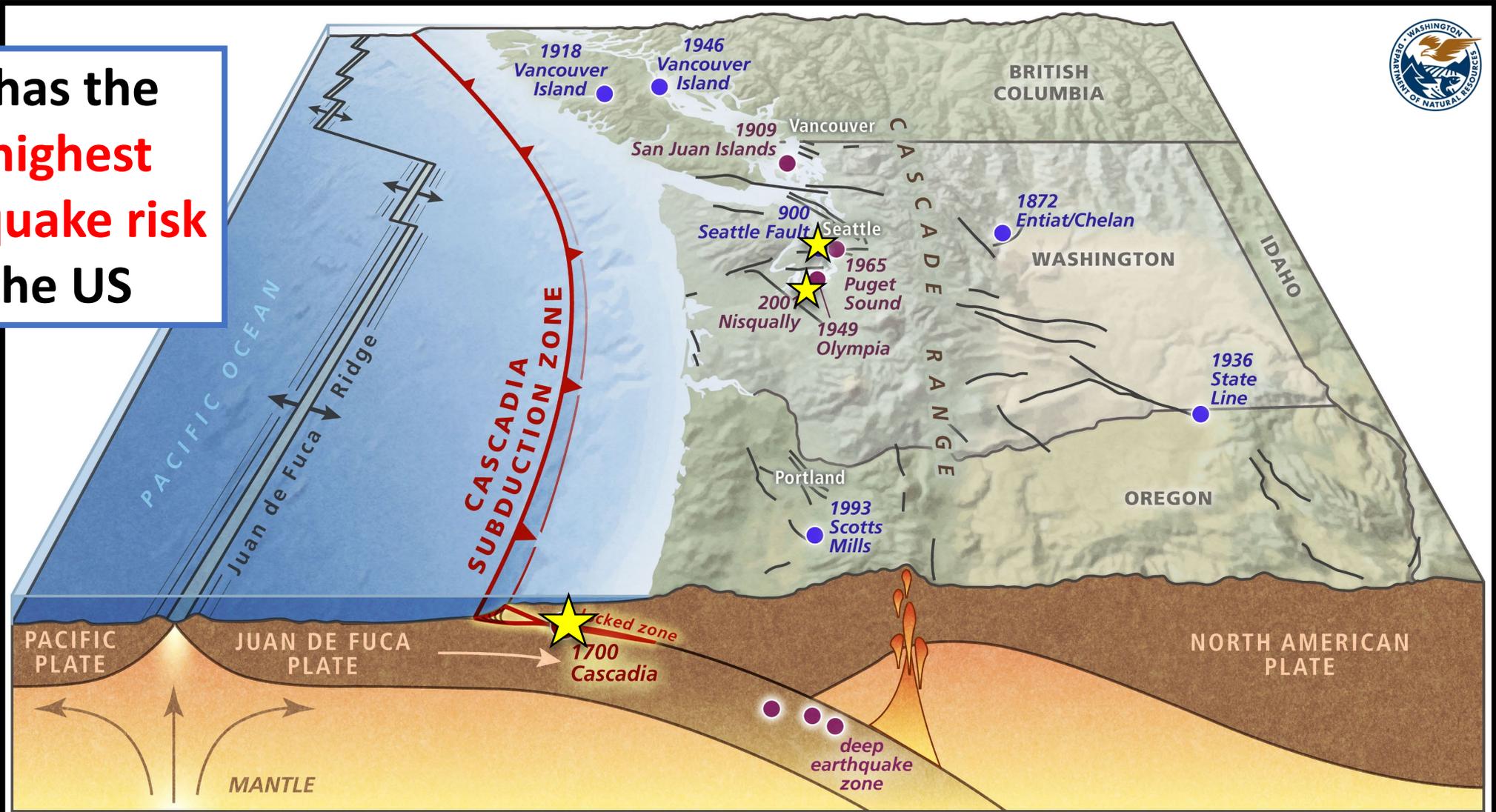
Japan and Washington: Seismic Sisters

- **Both are located on subduction zones** along the Pacific Plate, where heavy oceanic crust sinks beneath lighter continental crust
- **Both are surrounded by distant tsunami sources** around the Pacific, including other subduction zones, active volcanoes, etc
- **Both have similar extensive coastlines**, including many areas where flat beaches and rivers make coastal communities even more at-risk for tsunamis
- **Both have had M9.0+ EQs with tsunamis in the past and will again**



Earthquake Hazards in Washington

WA has the **2nd highest earthquake risk in the US**



- year → 1918 ● crustal earthquake
- deep earthquake
- subduction zone earthquake
- crustal fault

Tsunamis

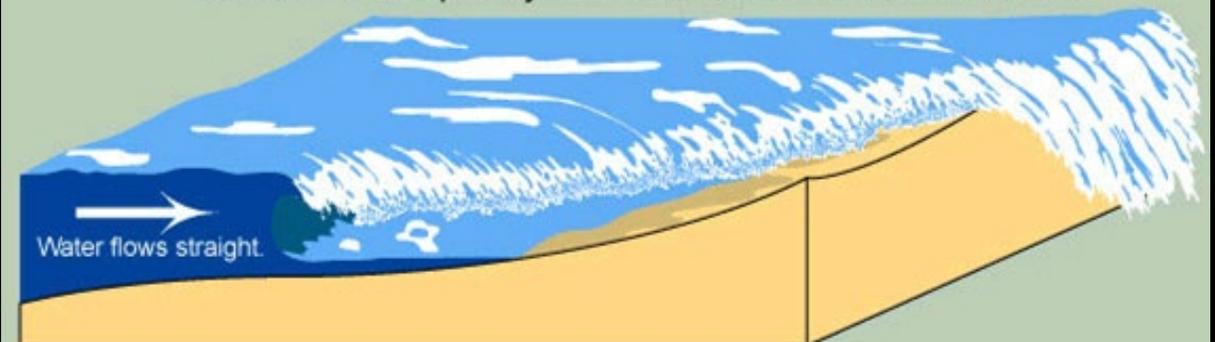
- Caused by the **displacement of a column of water** by an earthquake (esp. subduction zones and crustal faults), landslide, volcanic eruption, weather event, meteor, etc
- Series of long waves **lasting 12-24+ hours**
- The **first wave is often not the highest or most destructive** wave
- Fast and powerful, **like a moving wall of cement**
- Produce tons of **mixed and hazardous debris**
- Low probability but **very high impact**



Wind waves come and go without flooding higher areas.

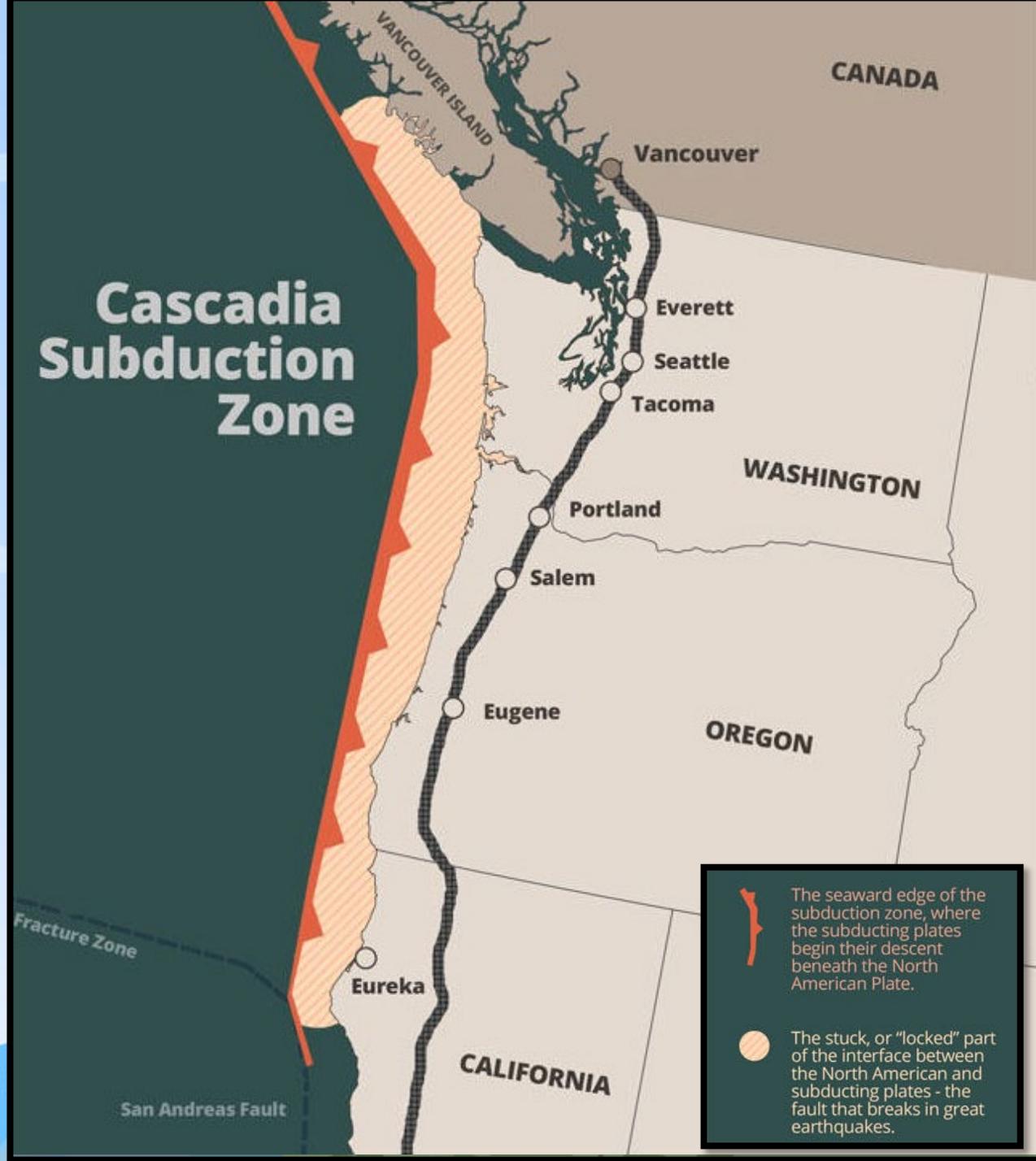


Tsunamis run quickly over the land as a wall of water.



Cascadia Subduction Zone (CSZ)

- 700 miles long
- Breaks every 300 – 600 years; last great rupture in 1700
- **15-25% chance within next 50 years**
- Causes magnitude 8.0-9.0+ earthquakes
- **Shaking felt for 3–6 minutes** throughout state and west coast
- Followed by a **major tsunami hitting WA's outer coast in 10-15 mins** and **inner coast in 90-120 minutes**
- Subsidence and uplift will permanently change the WA coastline
- **Many large aftershocks will follow** main quake which **could also produce tsunamis**; thousands of smaller aftershocks will continue for decades



 The seaward edge of the subduction zone, where the subducting plates begin their descent beneath the North American Plate.

 The stuck, or "locked" part of the interface between the North American and subducting plates - the fault that breaks in great earthquakes.

First waves of a Seattle Fault tsunami arrive in seconds to minutes



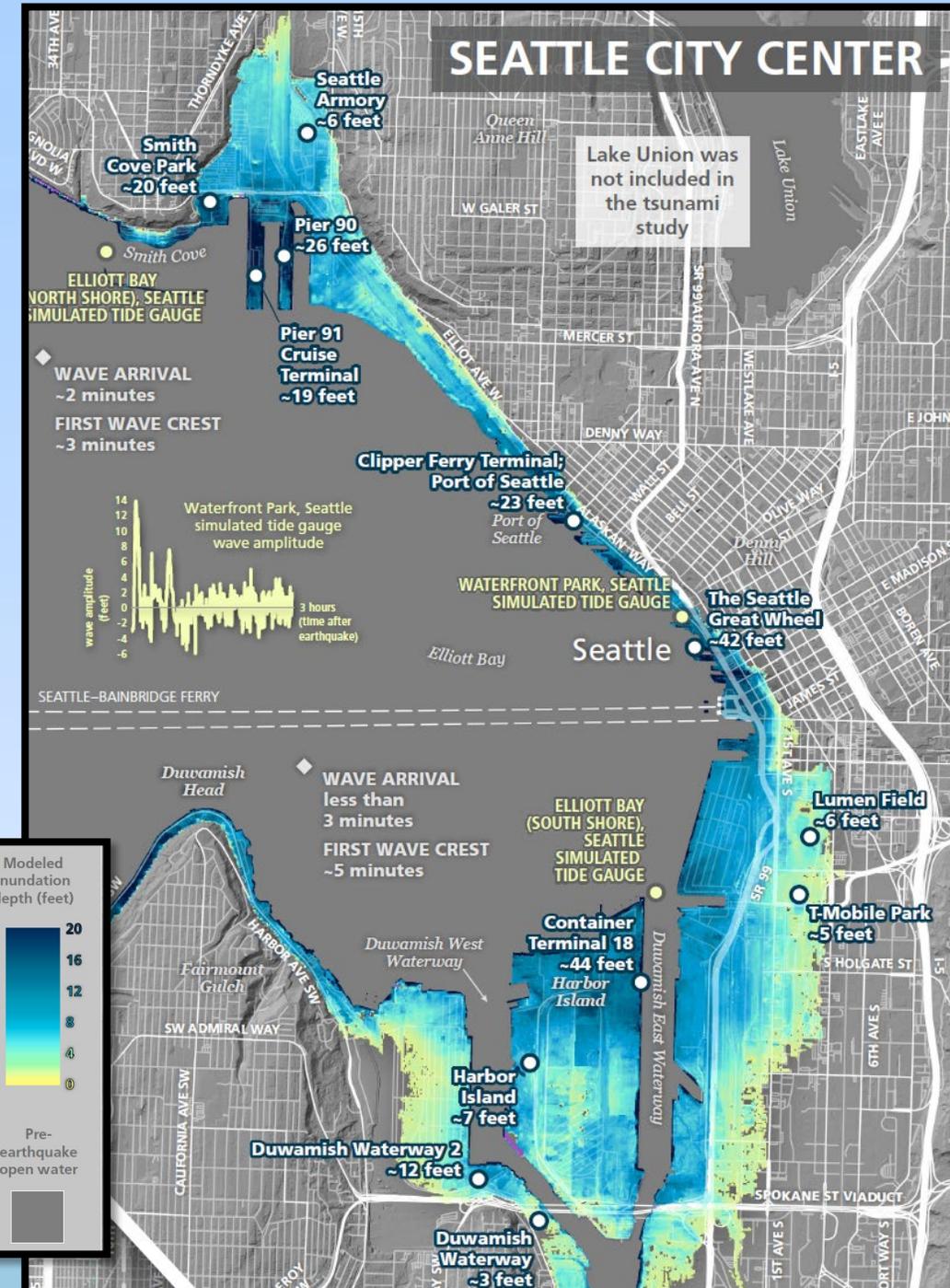
Earthquake

Seismogenic Folds, Known or Suspected

- Visible fold trace
- Inferred fold trace
- Concealed fold trace

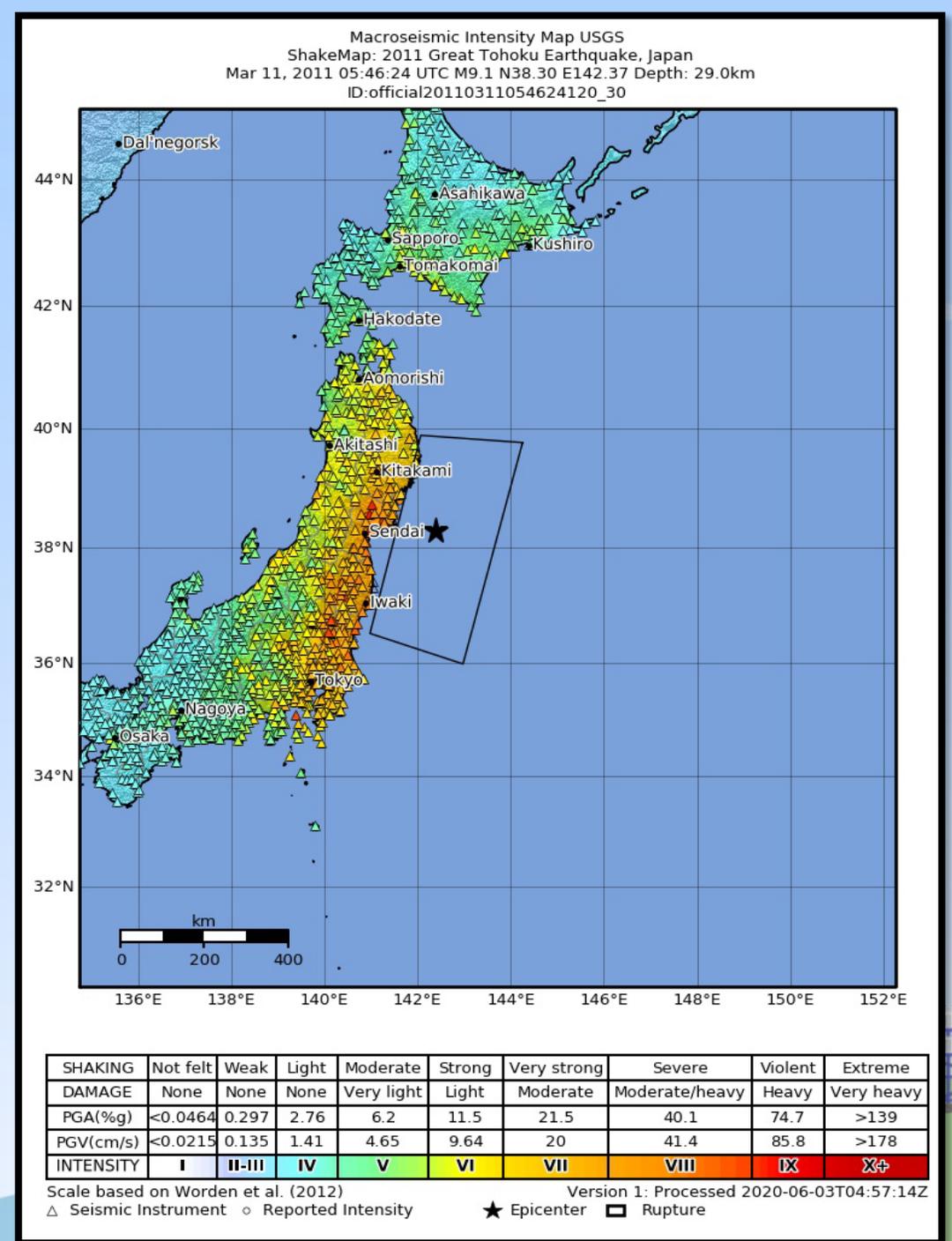
Active Faults, Known or Suspected

- Visible fault trace
- Inferred fault trace
- Concealed fault trace



The Great East Japan Earthquake and Tsunami

- **March 11th, 2011**
- **2:46 PM:** M9.1 undersea megathrust earthquake struck 45 miles east of Japan's Oshika Peninsula
- Ground shaking lasted approx. **6 minutes**
- **2:49 PM:** Japan Meteorological Society issued initial tsunami warning
- **First tsunami waves arrived approx. 10-20 minutes after the start of the earthquake;** waves reached 45-60+ ft (runup height above sea level) in many places and traveled up to 6 miles inland



The Great East Japan Earthquake and Tsunami

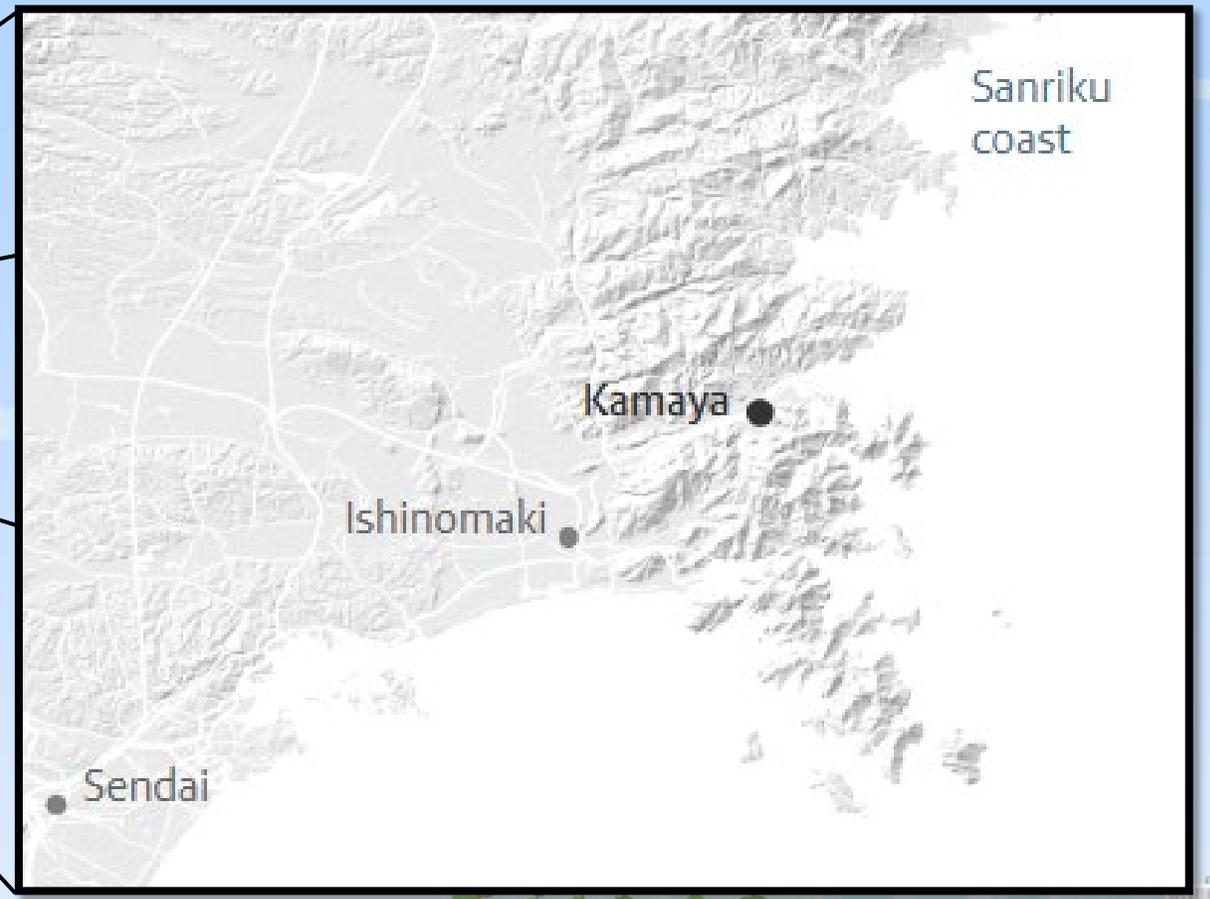
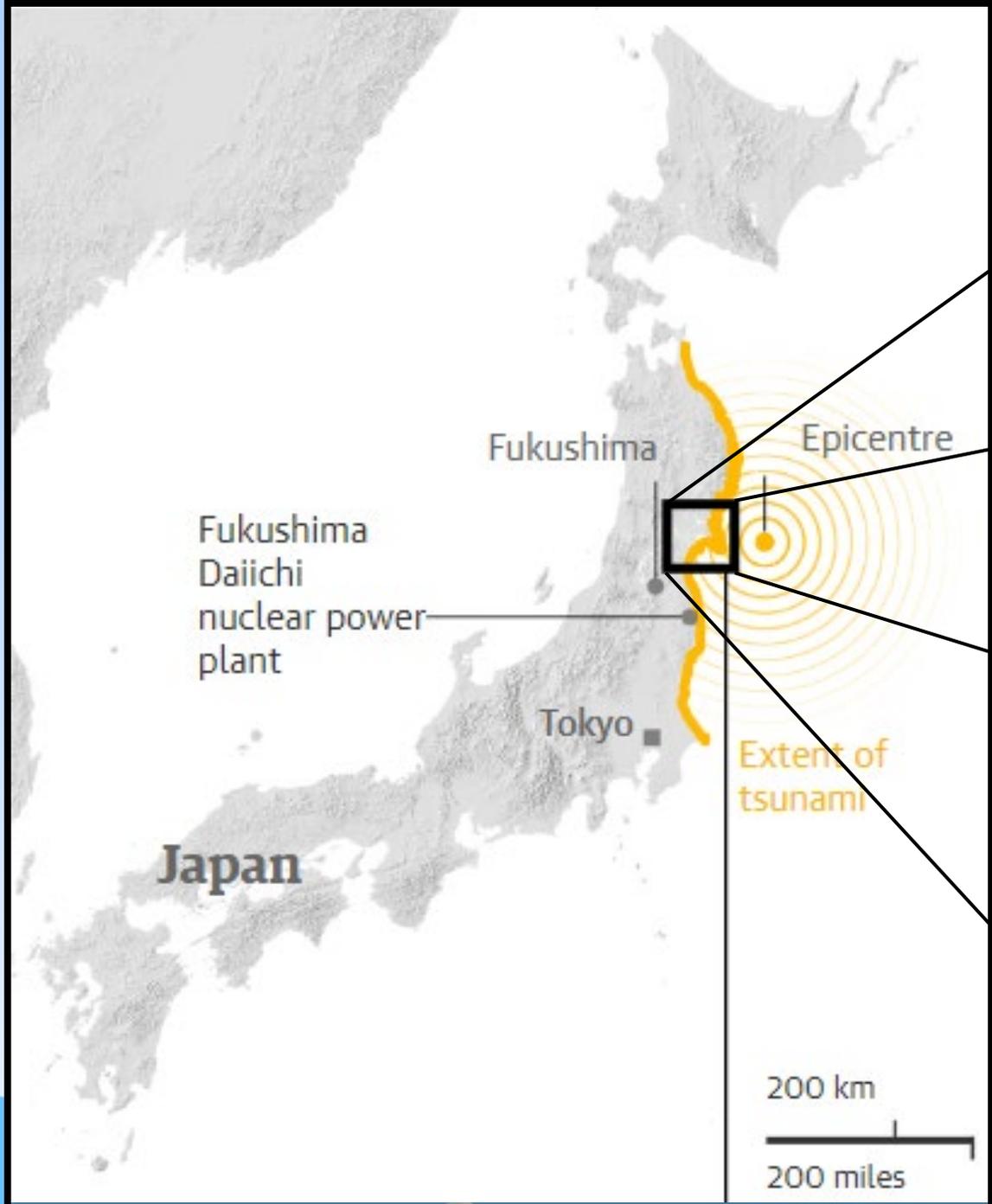
- **Impact by the numbers:**
 - 19,759 deaths (majority by drowning)
 - 2,553 missing
 - 400,000+ people displaced
 - 402,700+ buildings partially or totally collapsed
 - 2,100+ roads and 50+ bridges damaged
 - 28,000+ ships destroyed
- **900+ aftershocks** in the decade following
- **Currently the costliest “natural” disaster in history** (second only to the ongoing covid-19 pandemic and Chernobyl nuclear disaster)



Why did the tsunami take so many by surprise?

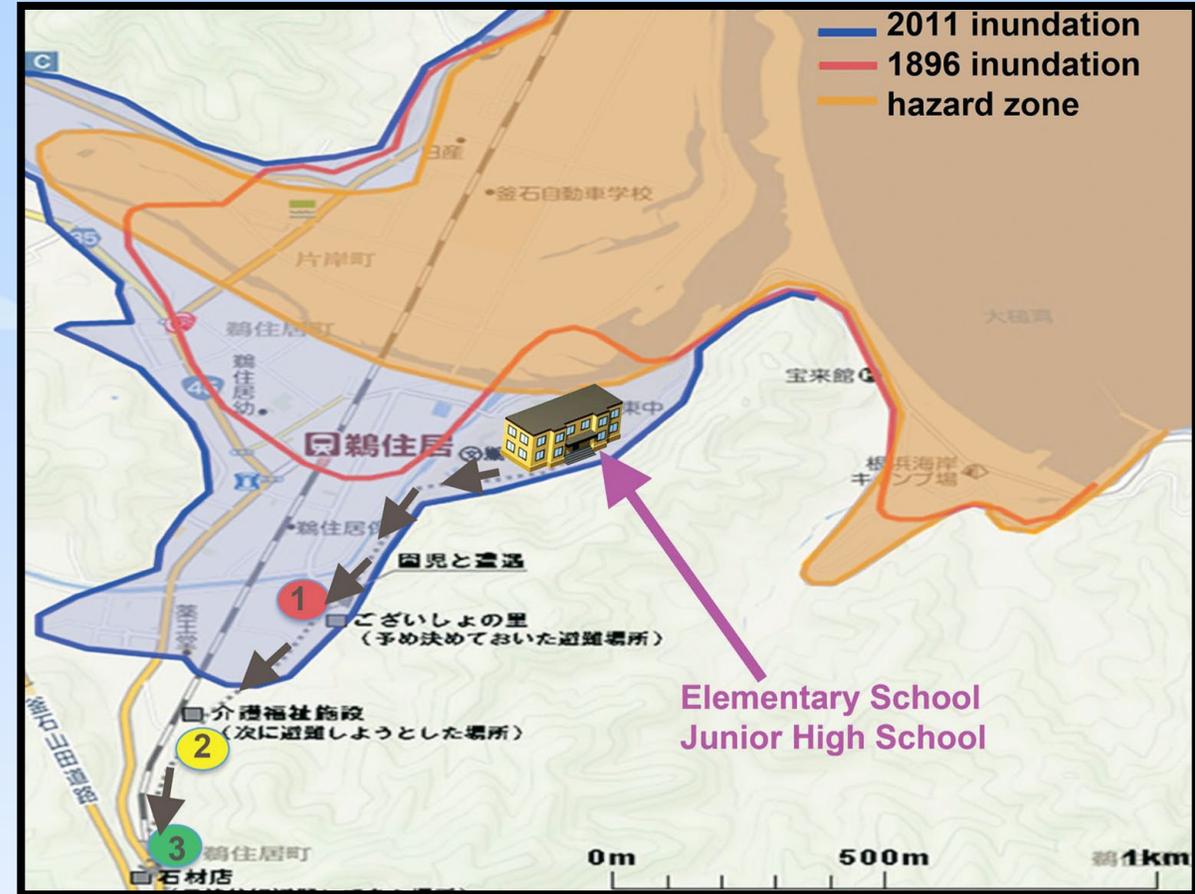
- **Earthquake early warning saved thousands of lives** and reduced damage from shaking, but...
- **Many sea walls were built to withstand tsunamis that had been proven to occur repeatedly, not the maximum potential tsunami possible;** because of this, sea walls were overtopped and many evacuation sites inundated
- **Initial wave height calculations underestimated the waves;** this caused many people to not heed the tsunami warnings in time
- **Power loss and other communications issues decreased the number of people who received the second tsunami warning**





Case Study #1: The “Miracle” of Kamaishi City Schools

- **2:50-2:55 PM:** Students at Kamaishi East Junior High School evacuate and encourage nearby elementary school and community members to do the same
- **3:05 PM:** Students arrive at official evacuation site (1), but move to another location nearby (2) due to slope stability concerns
- **3:20 PM:** Students watch as official evacuation site (1) is destroyed by the waves and decide to evacuate farther to a third site (3)
- Both schools destroyed but **no students killed during the evacuation**
- City lost more than 1,000 lives to the disaster, but only 5 were school-age children, and none were at school when the earthquake hit



Case Study #2: The Tragedy of Okawa Elementary School

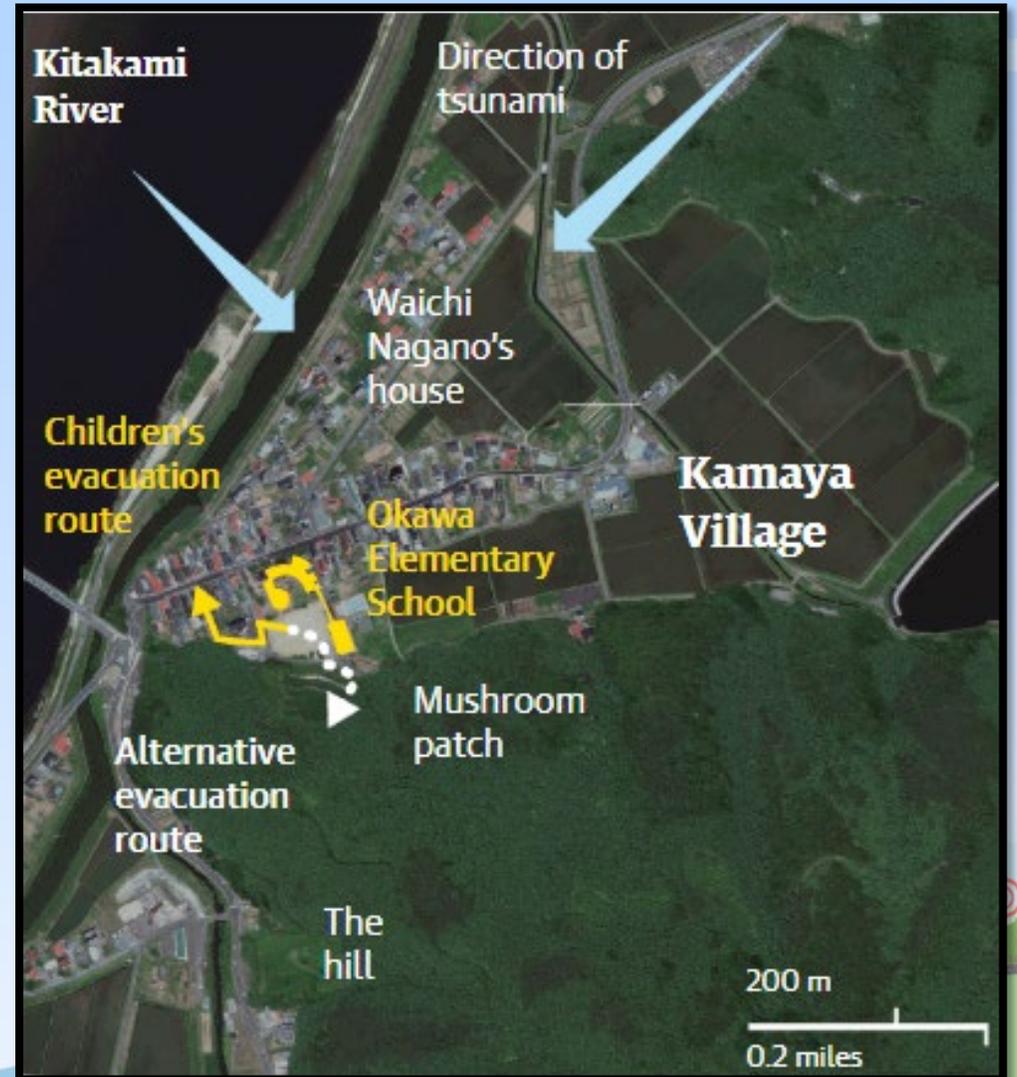
- Located in Ishinomaki City, Miyagi Prefecture, **approx. 2.25 miles from the coast**
- School was just letting out when the earthquake struck
- **74/78 children and 10/11 teachers** located at the school at the time of the tsunami **killed**
- *No other school in Japan experienced a loss of this magnitude*
- 51 minutes passed between the time of the quake and when the tsunami waves, having traveled 2+ miles up the nearby Kitakami River, hit the school

What happened in that 51 minutes?



Case Study #2: Okawa Elementary School

- **2:49 PM:** Lead teacher received tsunami warning on emergency radio
- **~3:00 PM:** Whole school evacuated after the earthquake in less than 5 minutes
- **3:14 PM:** Tsunami warning updated with prediction of 35 ft waves
- **3:25 PM:** Loudspeaker van urging evacuation passed Okawa Elementary
- **~3:30 PM:** Teachers decided to evacuate the school to a nearby traffic island close by the Kitakami River and away from high ground; those evacuating were caught by the tsunami before they arrive
- **3:37 PM:** The first tsunami waves reached the school building



Case Study #2: Okawa Elementary School

School emergency plan

- **Had not been updated** yearly as required
- Based on a template; Okawa **did not change the generic wording in the tsunami section** which designated “vacant land near school, or park, etc” as a secondary evacuation place
- **Tsunami evacuation was never drilled**, and school officials admitted they assumed inclusion of the “word” in the emergency plan was good enough
- **No city or prefecture officials had reviewed the school’s emergency plan** or confirmed what drills the school was holding

Other factors in evacuation delay

- Locals **did not understand risk posed by the Kitakami River**
- **Confusion and disagreement** among teachers and community members **over where to evacuate**, with a strong contingent opposed to going up nearby hill
- **Voices of children and mothers were superseded** by older generations; many long-time **community members disregarded sirens and local EMs** urging evacuation

Case Studies: Lessons Learned

- ✓ Understand strengths and weaknesses of hazard modeling
- ✓ Develop, review, and drill emergency plans frequently
- ✓ Identify and clearly mark evacuation routes
- ✓ The next incident could be worse than all previous incidents, so pay attention to changing conditions and respond accordingly
- ✓ Empower community members, especially children, to act quickly and independently in emergencies

Survival isn't about miracles, it's about preparation and mitigation!



What Washington is Doing

- **Inner and Outer Coast Tsunami Workgroups**
 - Meet quarterly, next meeting is April 13th
- **AlertSense tsunami list** for receiving official tsunami alerts and event information
- **Outreach materials and resources** for all ages and groups on WA State Preparedness Basecamp
- **Tsunami Maritime Response and Mitigation Strategies** for major ports, harbors, and marinas
 - Completed: Port of Bellingham, Westport Marina
 - In progress: Port of Anacortes/Guemes Channel
- **Evacuation route wayfinding project**
 - Final phase to be completed in summer 2023; 150+ miles of evacuation routes walked already!
 - Providing evacuation signs to local jurisdictions upon request



JOIN US!



**Westport Marina Tsunami
Maritime Strategy Discussion**

**Thursday
Dec. 16th
11:00 - 12:30**

**McCausland
Hall, Westport**



What Washington is Doing

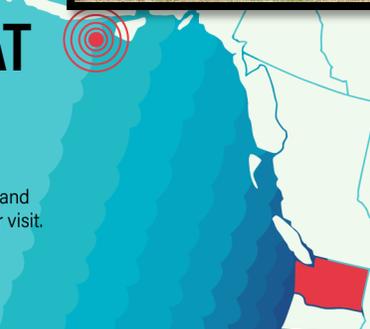
- **Social media canned messaging** for tsunami events with focus on accessibility
- **Yearly tsunami seminar and workshop**
 - 2023 seminar and workshop is June 22nd
- **Public outreach:** Great WA ShakeOut, webinars, in-person events, social media, etc
- **Stakeholder support** for mitigation and response planning, exercises, TsunamiReady applications, outreach events, etc
- **Large ongoing projects:** Seismic retrofits for public schools, vertical evacuation structures, hazard modeling, mapping, and simulations
- **Email Elyssa.Tappero@mil.wa.gov for more information!**



TSUNAMIS CAN HAPPEN AT ANY TIME.

Are you in a tsunami hazard zone?
Learn about Washington's tsunami hazard and how to be prepared where you live, work, or visit.

 mil.wa.gov/tsunami



Are you registered for the Great WA ShakeOut?

- The Great ShakeOut is the largest earthquake and tsunami drill in the world
- **10:19 AM on October 19, 2023**
- Participants include individuals, families, businesses, non-profits, schools, local government, and more!
- **All WA public schools must conduct 1 earthquake drill per year**
- **All WA public schools located in mapped tsunami inundation zones must conduct 1 tsunami evacuation drill per year**

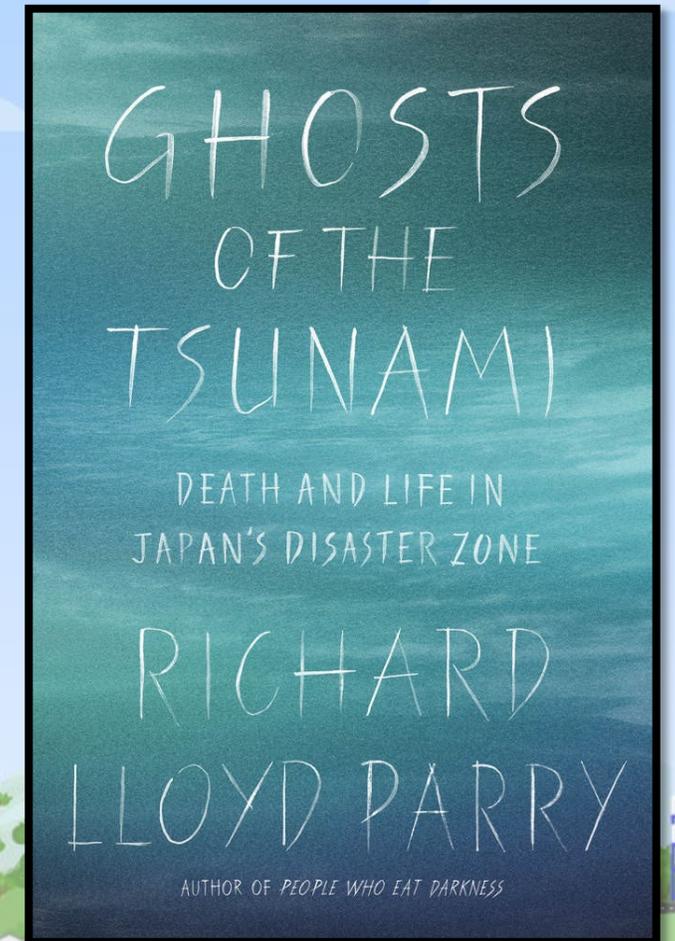


Register at shakeout.org/washington



Presentation Resources

- [*Ghosts of the Tsunami: Death and Life in Japan's Disaster Zone* by Richard Lloyd Parry](#)
- [Learning from the Great Tohoku Earthquake, Tsunami \(WA EMD blog\)](#)
- [The 'Miracle of Kamaishi': How 3,000 Students Survived March 11 \(JFS Newsletter\)](#)
- [The school beneath the wave: the unimaginable tragedy of Japan's tsunami \(Richard Lloyd Parry\)](#)
- [2011 Tōhoku Earthquake and Tsunami](#)



You CAN survive IF you get prepared!



mil.wa.gov/tsunami



mil.wa.gov/alerts



dnr.wa.gov/geologyportal



@WaEMD



@WaShakeOut



@WashEMD

Questions?

Elyssa.Tappero@mil.wa.gov

