

Takeaways and next steps from the Cascadia Subduction Zone workshop, 11/10/16

All:

Here are some reflections after our recent meeting and preliminary thoughts on possible next steps by BESR/COSG on this topic.

Key Science Gaps/Opportunities: Keynote and Panels 1 & 2

In the Keynote and first two panels we received an overview of the current state of knowledge about CSZ science – what we know and what we don't. Participants shared their views on science gaps/opportunities.

Keynote: Dr. Wang identified 4 in his keynote:

- 1) Is the subduction zone fully locked? He said this was the most important question in his opinion.
- 2) What is the role of Episodic Tremor and Slip (ETS) in CSZ earthquakes?
- 3) What is the nature of tsunami-generating seafloor deformation for the CSZ?
- 4) What are the along strike heterogeneities of the CSZ megathrust?

Panel 1: The source

- Dr. Vidale listed 3 gaps, but concurred with Dr. Wang that item 1 above was key (he reiterated this in the closing discussion). Additional seismometers and geodetic measurement on the seafloor to enable better monitoring were the critical needs in his view.
- Dr. Goldfinger also listed 3 gaps, including extending the geologic record further back in time, but also the need for more reflection seismic and bathymetric data. He also noted that we have sufficient data now to conclude the 50 year probability for a major CSZ earthquake is between ca. 10-30% - high enough to justify actions to mitigate risk now.

Panel 2: The hazards

- Dr. Gomberg noted the USGS was focusing its program on the CSZ on the history of event recurrence (there is still a range of views on the chronology of CSZ events, based on a variety of data). They are compiling the relevant regional data of all sorts on this question.
- Mr. Geist noted the biggest uncertainty (gap) in modeling nearby source tsunamis for locales like the CSZ was the variation in tsunami source (fault geometries associated with rupture, slip magnitude and extent). This created a wide range of possible inundation scenarios. This was significant given the variation in fault (and tsunami source) geometries already recognized along the CSZ.
- Mr. Walsh's comments are included with Panel 3.

My takeaway is that the top 2 science gaps are items 1 and 3 in Dr. Wang's list. I include item 3 as recent FEMA analysis (Cascadia Rising document, 2016) suggests that 90% of the fatalities of a CSZ will be due to the tsunami.

Key needs are:

1. Additional seismic and geodetic monitoring of the CSZ seafloor to address item 1. This could include some or all of the proposed CSZ Cable Observatory program, or other alternatives. A challenge is the \$300-500 mln cost for the full program.
2. A regional grid of modern, deep record reflection seismic data to map Quaternary faults and basin deformation from trench to shelf and along strike (will address items 3 and 4, and would also image the megathrust itself, and top oceanic basement). This would also help prioritize coring programs. There may be cost sharing opportunities with BOEM/DOI if the new administration decided to reassess the offshore energy potential of Cascadia (oil and gas is known in the area).

Key Mitigation Gaps/Opportunities: Panel 3

In Panel 3 we focused on mitigation of the CSZ hazards, including examples of current preparedness and mitigation programs, and introductions to new technologies to improve early warning for earthquakes and tsunamis.

Wang and Lopes focused how current knowledge is being applied to resilience and emergency planning by State and Federal agencies. The case for action for decision makers and emergency planners was made by Ms. Wang with the following slide:

“A Cascadia Subduction Zone (CSZ) event will have farther reaching impacts than that of Katrina and Sandy combined”

- KEN MURPHY, FEMA REGION X ADMINISTRATOR

	Cascadia	Japan Tsunami	Sandy	Katrina	Cascadia multiplier (of Sandy + Katrina)
Fatalities	12,000+	16,000	162	1,833	6x
People Needing Short-term Shelter	933,000	470,000	174,000	273,000	2x
Housing Units Damaged	961,000	>1,000,000	305,000	215,000	2x

SOURCE: KEN MURPHY

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A CSZ event will likely cause casualties and damage on par with the 2011 Japan event, and would be the biggest natural disaster in our nation's history. The loss of life would be much greater if the event occurred during a summer weekend when visitors flock to vulnerable coastal resorts in huge numbers. As Dr. Goldfinger noted in the closing session, there is already sufficient geoscience data to conclude that such an event in the next 50 years is a greater than 10% chance.

Ms. Wang suggested the following actions to make the impacted states more resilient:

“1) raising awareness on CSZ hazards to political decision makers, 2) advancing scientific knowledge, 3) mitigating critically vulnerable infrastructure that will protect many lives (bridges, hospitals, etc), and 4) building tsunami vertical evacuation structures where evacuating inland and uphill is not feasible.”

Item 1 above was one of the objectives of this workshop, and should be a further objective of any follow up activity.

Item 4 is being acted on now, but more resources are needed according to Mr. Walsh and Ms. Wang. Mr. Walsh gave the example of the science, engineering, and political process that led to construction of the first tsunami vertical evacuation structure in coastal WA. The process was a long one, and as he and Dr. Lopes noted the long-term support of the Federal Tsunami hazard program was key, as was Federal/State/County level cooperation.

There may be some “best practices” from their stories for improving preparedness and mitigation with current technologies that could be deployed more widely to both items 3 and 4 on Ms. Wang's list. It was instructive to see how even limited

investments (less than \$1mln) from a Federal Agency like NOAA could have such large leverage in enabling key safety investments. This kind of leverage will be important in a time of limited budgets, where “bang for the buck” could be a key metric.

In the area of future technologies for mitigation, Dr. Allen summarized the potential and progress to date on earthquake early warning, with the Shake Alert program (which originated in California). This is being extended to the Cascadia region and has potential to provide key minutes of alert particularly to the I-5 corridor where most of Cascadia’s population and economic assets are located. Dr. Bawden discussed a broader vision of improved earthquake and tsunami early warning from space, which also has considerable potential, particular for those at risk from distant source tsunamis. In both cases however, it still appears that those on the CSZ coast, where the near source tsunami will be the gravest threat to life, will not be able to count on early warning systems as much as they must count on effective education, evacuation plans and structures, and informed action to save lives.

Hence, one of the challenges for decision makers will be finding the right balance in investments based on current knowledge and technology (like the VES programs and community education) and investments in potential “breakthrough” mitigation technologies. Both will be needed.

Key needs are:

1. Raising awareness on CSZ hazards to political decision makers and Cascadia communities (including visitors/tourists). This includes investments in community outreach and education.
2. Prioritized and long-term investment for key infrastructure, including vertical evacuation structures as needed.
3. Review the potential benefits/costs of new early warning technologies for the CSZ hazards.

Next Step: Consensus Study on the CSZ earthquake and tsunami:

Consensus studies are the most credible and effective product the NAs can provide to decision makers and community stakeholders concerning key science related challenges our nation faces. Geologic hazards related to active subduction zones (nearby and far away) are threats to several parts of the USA. Near sources events are particular threats for Alaska, Puerto Rico and the Caribbean, and Cascadia. At this time, the largest exposure in terms of lives and economic assets at risk is in Cascadia. A consensus study on the CSZ could serve as a model for later studies to examine hazards and resilience in the other areas. Stakeholders would thus include communities beyond the Pacific Northwest, and the Federal agencies with assets at risk in that area. Given the multi-disciplinary nature of the challenge, it seems appropriate to discuss a joint effort between the NAS and NAE on such a study. Given the magnitude of the threat, there may be opportunities for support from certain foundations as well.

Key questions to address:

- What do we know about the hazards of the CSZ? What science and engineering information should be the key basis for actions now?
- What do we still need to learn and what resources are needed to answer the questions?
- What actions should Federal, State, and County decision makers take to improve resiliency, save lives, and mitigate economic losses from a major CSZ earthquake and tsunami?

Scott Cameron, 11/18/16