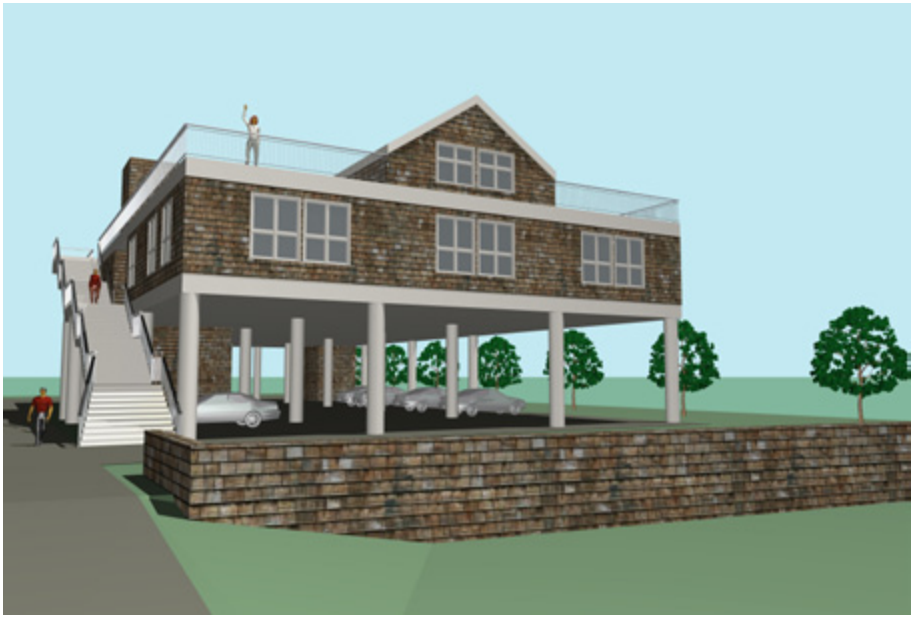
State of Oregon
Department of Geology and Mineral Industries
Vicki S. McConnell, State Geologist

Open-File Report O-10-02

TSUNAMI EVACUATION BUILDING WORKSHOP

SEPTEMBER 28-29, 2009
CANNON BEACH, SEASIDE, AND PORTLAND, OREGON



Compiled by
Yumei Wang[1]

2010

[1]Oregon Department of Geology and Mineral Industries, 800 NE Oregon Street #28, Suite 965, Portland, Oregon 97232

NOTICE

The Oregon Department of Geology and Mineral Industries is publishing this paper because the information furthers the mission of the Department. To facilitate timely distribution of the information, this report has not been edited to our usual standards.

Cover image:: Conceptual design of Cannon Beach City Hall as tsunami evacuation building; see Jay Raskin presentation, page 176.

Oregon Department of Geology and Mineral Industries Open-File Report O-10-02
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Office of the Senate President

Members of CREW-

Welcome to Oregon, we are delighted to be hosting you. Your workshop will lead to significant advances in tsunami preparedness for all of the Cascadia region.

Oregon knows a major Cascadia subduction zone earthquake is coming. In 2002 Oregonians passed bonding authority to start a grant program to seismically upgrade schools and emergency service buildings. With that program in place we need to continue to prepare for a seismic event so the casualties and damages can be minimized.

Seismic preparedness has always been a specific interest of mine. The benefits of preparation are undeniable. We have worked hard to get ready but there are still many schools and emergency service buildings that need seismic retrofitting. In addition, there are many other areas of preparation that are just beginning to be discussed.

I am excited that you are discussing tsunami evacuation buildings. The Oregon Coast has done much to prepare for a tsunami but there are still parts of the coast that lack the high ground for safe evacuation. In these and other highly populated areas tsunami evacuation buildings are a critical alternative.

We all need to work together to research a wide range of alternative options for the diverse needs of our coastal communities. I hope your efforts here, combined with legislation on the state and federal level will move us closer to that reality.

Thank you for your work,

Respectfully,

Peter Courtney

Peter Courtney
President of the Senate

OVERVIEW

The Cascadia Region Earthquake Workgroup (CREW) held the first regional workshop that addressed tsunami vertical evacuation as a new means to protect people and improve community recovery. This two-day workshop included representation from the Cascadia margin as well as from elsewhere (e.g., Hawaii, CA). Oregon, Washington, California, and British Columbia representatives presented their strategies on tsunami risk reduction. A policy session included the following panelists:

- Tamra Biasco, FEMA Region X
- Mark Ellsworth, Governor Ted Kulongoski's office
- Karmen Fore, U.S. Congressperson Peter Defazio's office
- Fritz Graham, U.S. Senator Ron Wyden's office
- Scott Maguire, U.S. Senator Jeff Merkley's office
- Steve Marx, U.S. Congressperson David Wu's office
- Tyree Wilde, NOAA NW regional office

Participants agree that vertical evacuation options should be adopted. Discussion on ways to move forward, as well as unresolved issues were discussed. A design team for the proposed Cannon Beach City Hall Tsunami Evacuation Building unveiled a conceptual design. Two outcomes include: 1) the goal to construct the proposed Cannon Beach Tsunami Evacuation Building by March 2014, the 50th anniversary of the 1964 Alaska quake/tsunami; and, 2) identification of the need for a regional strategic Tsunami Evacuation Building siting study along the Cascadia margin.

During the workshop, the magnitude 8.0 Samoa earthquake and tsunami occurred. This disaster, which claimed over 120 lives, supported the need for improved tsunami safety.

Sponsored and/or funded by:

- Cascadia Region Earthquake Workgroup (CREW)
- City of Cannon Beach
- Oregon Department of Land Conservation and Development
- American Society of Civil Engineers (ASCE)
- Oregon Emergency Management (OEM)
- Oregon Department of Geology and Mineral Industries (DOGAMI)
- Western States Seismic Policy Council (WSSPC)

Hosted by:

- Yumei Wang, Oregon Department of Geology and Mineral Industries (DOGAMI)
- Jay Raskin, Ecola Architects
- Althea Turner, Oregon Emergency Management (OEM)
- Bob Freitag, Cascadia Region Earthquake Workgroup (CREW)
- with organizers and Sue Graves as the note taker

The 4-page program flyer is reproduced on the following pages.

Tsunami Evacuation Building Workshop

September 28 & 29, 2009

Cannon Beach
Seaside
Portland

Workshop Locations

September 28, 2009
8:30 a.m. to 5:00 p.m.

Cannon Beach

Cannon Beach City Hall
163 East Gower Street
Cannon Beach, OR 97110

Seaside

Seaside Public Library
1131 Broadway Street
Seaside, OR 97138

September 29, 2009
8:30 a.m. to 5:00 p.m.

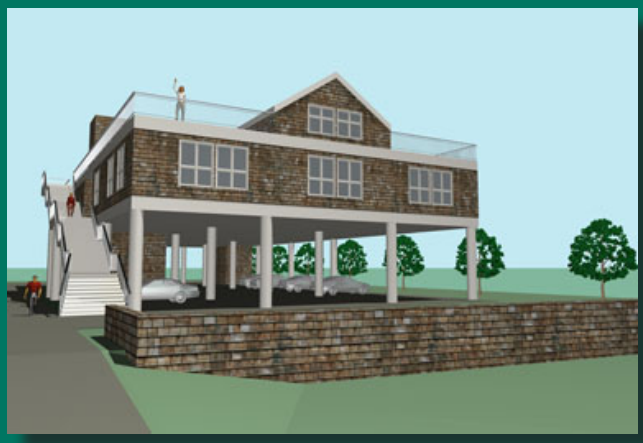
Portland

Portland State Office Building
Room 1-A
800 NE Oregon Street
Portland, OR 97232

Recommended Hotels

Tolovana Inn
3400 South Hemlock
Cannon Beach, OR 97110
1-800-333-8890

DoubleTree Lloyd's Center
1000 NE Multonomah Street
Portland, OR 97232
1-503-281-6111



Conceptual Design of Tsunami Evacuation Building: Cannon Beach City Hall

source: Ecola Architects, PC.

Sponsored by:

- Cascadia Region Earthquake Workgroup (CREW)
- American Society Civil Engineers (ASCE)
- City of Cannon Beach
- Oregon Department of Geology and Mineral Industries (DOGAMI)
- Oregon Emergency Management (OEM)
- Oregon Department of Land Conservation and Development (DLCD)

Program

September 28, 2009 Cannon Beach & Seaside

8:30 AM **Coffee and poster display**

9:00 AM **Presentation of Cannon Beach City/Tsunami Refuge**
Jay Raskin, Ecola Architects

Rob Schultz, Cannon Beach Police, and Mark Morgan, Cannon Beach Rural Fire District, will discuss history of CB tsunami efforts, with focus on fire district

Rich Mays, City Manager, will discuss the city's perspective and why they want to improve city hal
Yumei Wang, DOGAMI, will present overview of preliminary design and costs of new city hall with 3 options
Group discussion will involve above panelists and audience.

10:45 AM Break

11:00 AM **Walking Tour of Cannon Beach**
Jay Raskin, Ecola Architects

Tour will include evacuation are near City Hall, tsunami route signage, COWS loudspeaker, and visit to EOC at Fire Station.

12:00 PM Lunch provided

1:00 PM **No where to run: Seaside - driving tour**
Jay Raskin, Ecola Architects
Tom Horning, Horning Geosciences

Seaside is divided into three geographically distinct evacuation areas that are separated by two rivers and a marsh, all of which run parallel to the shoreline. The tour will visit two main surge corridors cutting through the south (Avenue N-Avenue I) and central (1st to 3rd Avenue) parts of Seaside, before meeting at the library for discussions. Bus tour picks up and drops off at the Cannon Beach City Hall.

2:00 PM **Public Meeting: Seaside Tsunami Refuge**
Althea Turner, OEM
Doug Dougherty, Superintendent of Seaside School District
Harry Yeh, Coastal and Ocean Engineering, OSU

This meeting will provide the public an opportunity to learn more about tsunami evacuation buildings and their role in tsunami preparation and mitigation. Tsunami simulations will be shown by Professor Harry Yeh of OSU.

Session ends at 5:00 PM

Program

September 29, 2009 — Portland

8:30 AM **Introductions, framework and goals of workshop**
Yumei Wang, DOGAMI
Jay Raskin, Ecola Architects

8:45 AM **TEB Policy Session**
Yumei Wang, DOGAMI
Jay Raskin, Ecola Architects

Seaside evacuation computer simulation by Prof. Harry Yeh, OSU, followed by panel discussion with representatives of federal, state and local elected officials/leaders on protecting tsunami prone communities

10:15 AM Break

10:30 AM **Tsunami Evacuation Buildings in Japan**
Tadashi Ishikawa, Kajima Corporation
Introduced by: Harry Yeh, Coastal and Ocean Engineering, OSU

Mr. Ishikawa of Kajima Corporation will explain a design guideline for tsunami refuge building structures.

11:30 AM **Fema P646 and P646A**
Jon Heintz, Applied Technology Council

The presentation of findings of a FEMA product on tsunami shelter for vertical evacuation. Includes structures built to withstand tsunami and earthquake loads. This presentation includes recommendations on siting concepts, design concepts, performance objectives, and design loads that should be considered in locating and designing tsunami vertical evacuation structures.

12:00 PM **If you build it, will they come?: Design and Space Issues**
Daniel Wirtala, Oregon State University, graduate student

Using visual cues and design to encourage use of a tsunami evacuation building during a tsunami. Because these are new concepts in the United States, there will need to be a concerted education effort to instill confidence in the event of a tsunami.

12:15 PM Lunch provided

Program

September 29, 2009 — Portland

State and Provincial Overviews of tsunami evacuaton building structure efforts.

1:00 PM **Oregon**
Yumei Wang, DOGAMI, Co-leader and risk engineer
Jay Raskin, Ecola Architects, Co-leader and architect
Harry Yeh, Coastal and Ocean Engineering, OSU; Tsunami expert
Kent Yu, Degenkolb, Structural Engineer, structural design
Javier Moncada, Berger Abam, engineer, wave deflection structures
Marcy Boyer, Chinook Geoservices, geotechnical engineer
Tim Fiez, Gartrell Group, software architect, tsunami evacuation modeling

Oregon's tsunami risk management efforts. An overview of selected risk reduction efforts that are applicable to all of Oregon's communities. A group presentation on conceptual tsunami evacuation buildings

2:00 PM **Washington State**
Tim Walsh, Department of Natural Resources

2:30 PM **California State**
Lori Dengler, Humboldt State University

3:15 PM **British Columbia**
Maiclaire Bolton, British Columbia Provincial Emergency Program

3:00 PM Break

3:45 PM **Group Discussion - Where do we go from here?**
Yumei Wang, DOGAMI
Jay Raskin, Ecola Architects

Moderators will lead a group discussion on how best to implement tsunami evacuation buildings when needed to protect life in coastal areas.

Session ends at 5:00 PM

WORKSHOP PARTICIPANTS

Participants in alphabetical order:

- James Bela, Oregon Earthquake Awareness, President
- Tamra Biasco, FEMA Region X, Earthquake Program Manager
- Maiclaire Bolton, Emergency Management British Columbia, Seismic Program Head
- Deborah Boone, Oregon Legislative Assembly, State Representative
- Marcella Boyer, Chinook GeoServices, Inc, Principal Geotechnical Engineer
- Bill Brehm, Cannon Beach E-prep Committee, Chairman
- Susan Brooks
- Josh Bruce, Oregon Partnership for Disaster Resilience, Project Director
- Melissa Cadwallader, Cannon Beach City Councilor
- Mark Carey, FEMA Region X, Mitigation Division Director
- Veronica Cedillos, Geohazards International
- Mark Chubb, Portland OEM, Operations Manager
- Patrick Corcoran, OSU Sea Grant Extension, Hazards Outreach Specialist
- Daniel Cox, OSU – Hinsdale Wave Research Laboratory, Professor
- Lori Dengler, Prof. Humboldt State Univ
- James Doane, OSSPAC, member
- Mark Ellsworth, Governor's office
- Karmen Fore, Congressman Peter DeFazio, District Director
- Bob Freitag, CREW, Executive Director
- Larry Givens, DOGAMI
- Fritz Graham, U.S. Senator Ron Wyden
- Sue Graves, Lincoln County School District, Safety Coordinator
- Don Haagensen, DOGAMI
- Jon Heintz, ATC
- Michael Heumann, OPHD
- John Hooper, ATC
- Don Hull, Dr., citizen
- Dennis Hunsinger, FEMA Region X, Deputy Regional Administrator
- Tadashi Ishikawa, invited Japanese engineer
- Don Lewis, DOGAMI
- Robert Lundy
- Steve Macnab, DOGAMI
- Ian Madin, DOGAMI
- Scott Maguire, U.S. Senator Merkley
- Mike Mahoney, FEMA HQ
- Thomas Manning, Tillamook Co/Clatsop Co, Emergency Manager
- Steve Marx, Congressman David Wu, Field Representative
- Nancy McCarthy, The Daily Astorian, Reporter
- Vicki McConnell, DOGAMI
- Scott McMahon, Berger ABAM Inc., Professional Engineer
- Yuriy Mikhaylov, University of Hawaii, Graduate Student
- Gene Miles, City of Long Beach, WA, City Administrator
- Javier Moncada, BergerABAM Inc., Engineer II
- Mike Morgan, City of Cannon Beach
- Robert Mushen, Cannon Beach E-Prep Committee
- Willie Nun, FEMA Region X, FCO
- Peggy Peirson, Management, Search & Rescue, Emergency Services Coordinator
- Lisa Phipps, DOGAMI
- George Priest, DOGAMI
- Jay Raskin, Ecola Architects
- Carlos Rios, OSU
- Ian Robertson, University of Hawaii, Professor
- James Roddey, DOGAMI
- Leslie Ryder
- Philip Slimko, Lower Elwha Klallam Tribe, Emergency Management
- Sam Steidel, City of Cannon Beach, City Council
- Bob Steiner, Tongue Pt Jobscorps
- Victoria Stoppiello, Cannon Beach Citizen, News writer
- Gene Strong, Clatsop County Sheriff's Office, Emergency Manager
- Patti Sutch, Western States Seismic Policy Council, Executive Director
- Deb Treusdell, OR E-Prep Outreach, Community Organizer
- Althea Turner, Oregon Emergency Manager, Geologic Hazards
- Charles Vaars, DOGAMI
- Randy Walker, OSU Hatfield
- Tim Walsh, Washington Geological Survey, Geologist
- Yumei Wang, DOGAMI, Geohazards Section Leader
- Tyree Wilde, NOAA, Warning Coordination Meteorologist
- Jay Wilson, Clackamas County Emergency, Hazard Mitigation Coordinator
- Holly Winston, ODOT, Sr. Local Bridge Std Engineer
- Daniel Wirtala, OSU, Student
- Rob Witter, DOGAMI, Coastal Geologist
- Nathan Wood, U.S. Geological Survey, Research Geographer
- Laren Woolley, DLCD/OCMP, Coastal Shores Specialist
- Harry Yeh, Oregon State University, Professor
- Kent Yu, Degenkolb Engineers, Associate Principal

Figure 1. Cannon Beach elementary school children discussing earthquakes, tsunamis, and evacuation drills.

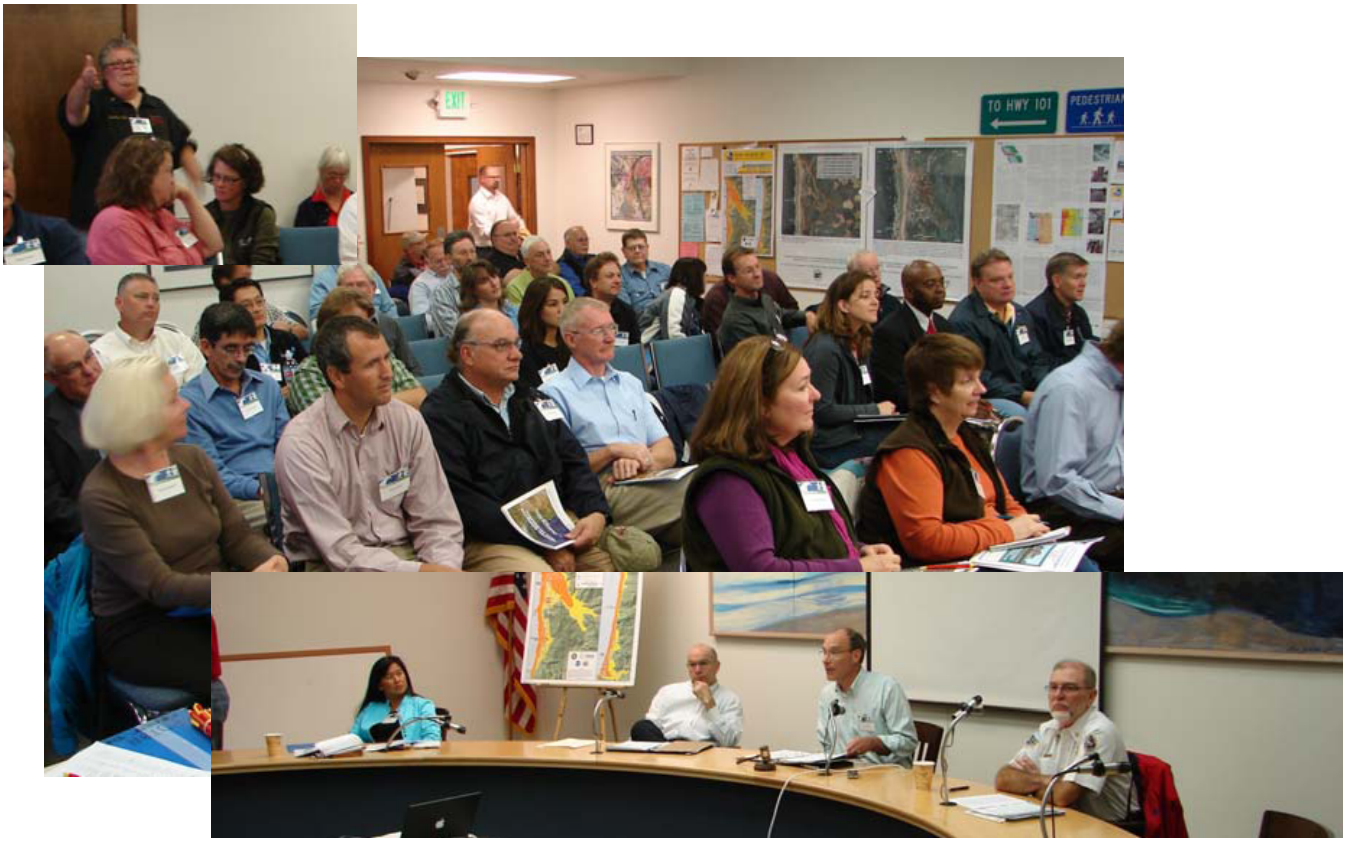


Figure 2. Workshop in Cannon Beach. Presenters include Yumei Wang, DOGAMI; Rich Mays, city manager; Jay Raskin, architect and former mayor; and Cleve Rooper, fire chief (left to right).

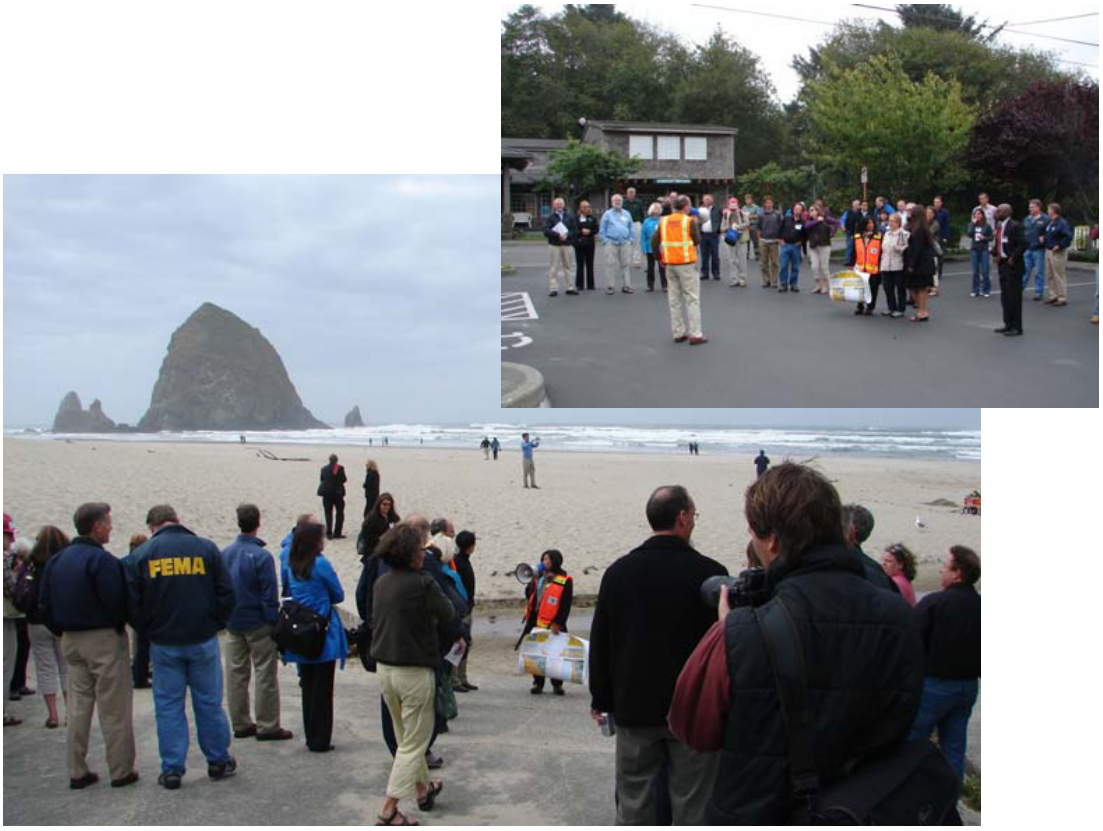


Figure 3. Walking tour of Cannon Beach.

Figure 4. Harry Yeh, OSU; Althea Turner, OEM; and Dennis Hunsinger, FEMA discussing vertical evacuation options with citizens in Seaside.

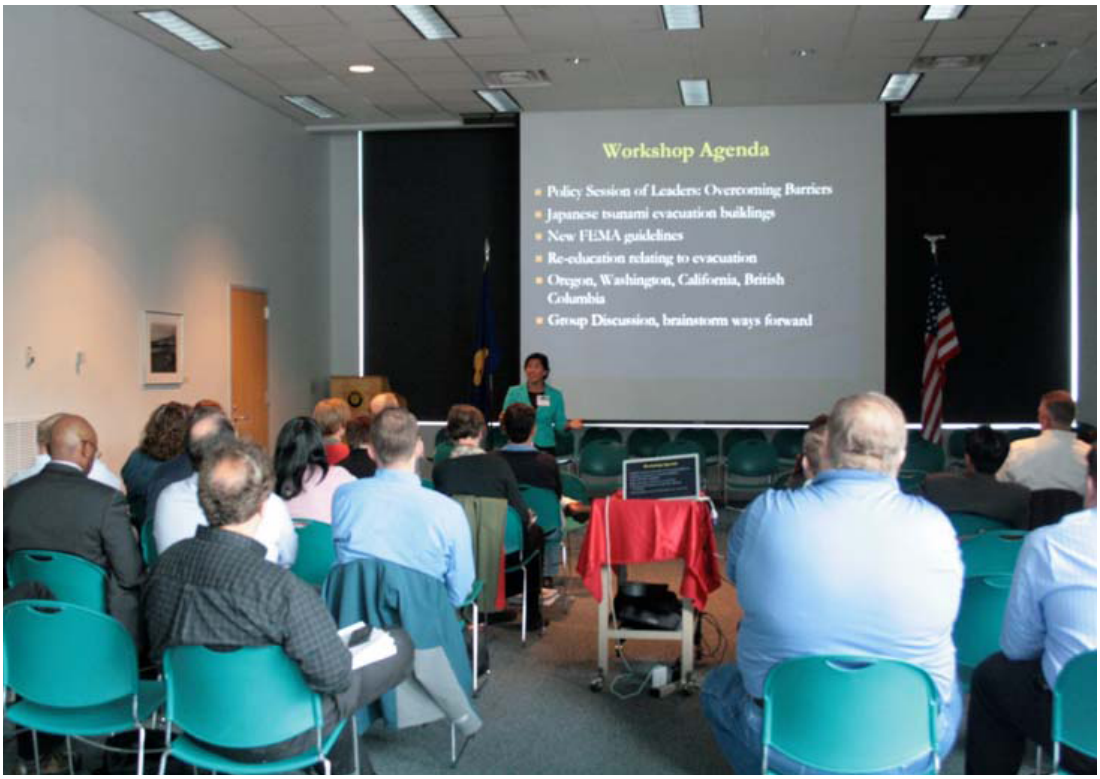


Figure 5. Yumei Wang, DOGAMI, discusses the workshop agenda in Portland.

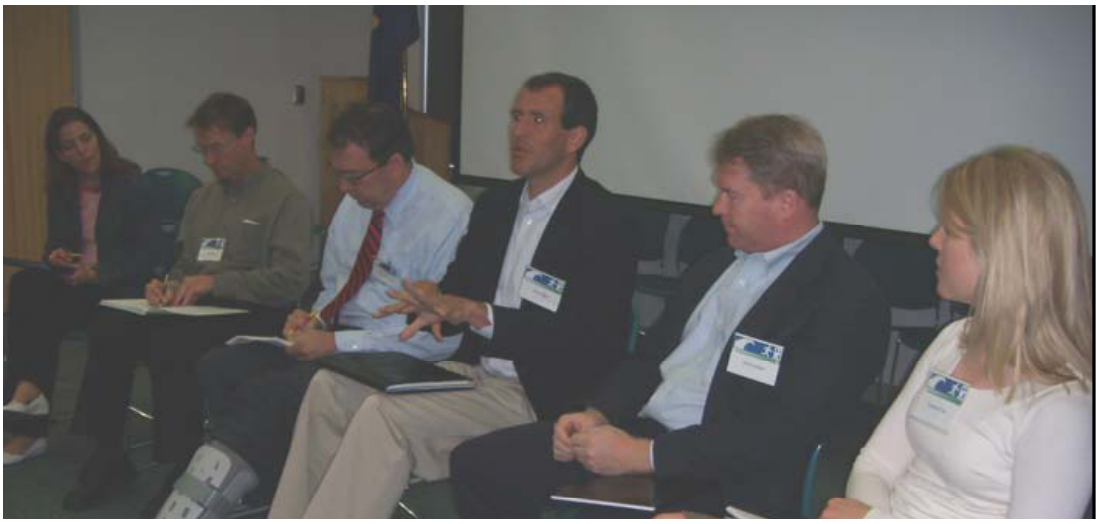


Figure 6. Policy session held in Portland, Oregon, on September 29, 2009 (the same day as the Samoa earthquake and tsunami). (left to right) Tamra Biasco, FEMA Region X; Tyree Wilde, NOAA NW regional office; Mark Ellsworth, Governor Ted Kulongoski's office; Steve Marx, U.S. Congressperson David Wu's office; Fritz Graham, U.S. Senator Ron Wyden's office; and Karmen Fore, U.S. Congressperson Peter Defazio's office.

Figure 7. A lively discussion between the Policy Panel (front) and Portland audience.

Figure 8. Workshop held in Portland OR on September 29, 2009. Scott Maguire, aide to U.S. Senator Jeff Merkley, in front row.

Figure 9. Tadashi Ishikawa, Kajima Corporation in Japan, presents Japanese design methods and TEB examples in Portland.

Figure 10. Informal gathering to discuss technical details on September 29, 2009. (left to right). Veronica Cedillos, Geohazards International; Kent Yu, Degenkolb Engineers; Javier Moncada, BERGER/ABAM Engineers Inc.; Yumei Wang, Oregon Dept of Geology and Mineral Industries (DOGAMI); Ian Robertson, University of Hawaii, Professor; John Hooper, ATC; Marcy Boyer, Chinook GeoServices, Inc.; Mike Mahoney, FEMA HQ; Tadashi Ishikawa, Kajima Corporation, invited Japanese engineer; Jay Raskin, Ecola Architects, PC; Joseph Zhang, OHSU; Yuriy Mikhaylov, University of Hawaii.

Figure 11. Ad hoc design team members for proposed Cannon Beach tsunami evacuation building with others at the post workshop technical session on September 29, 2009. (left to right). Veronica Cedillos, Geohazards International; Harry Yeh, Oregon State University; Kent Yu, Degenkolb Engineers; Javier Moncada, BERGER/ABAM Engineers Inc.; Yumei Wang, Oregon Dept of Geology and Mineral Industries (DOGAMI); Tadashi Ishikawa, Kajima Corporation, invited Japanese engineer; Marcy Boyer, Chinook GeoServices, Inc.; Jay Raskin, Ecola Architects, PC.

MONDAY, SEPTEMBER 28, 2009, CANNON BEACH & SEASIDE — WORKSHOP MINUTES

Note: These minutes are based on notes taken by Sue Graves; they are not verbatim.

9:00 am
PRESENTATION OF CANNON BEACH CITY/ TSUNAMI REFUGE

Jay Raskin, Ecola Architects, Moderator
Mayor Mike Morgan: Welcome

Jay Raskin: Welcome, introductions, described goals of this meeting, acknowledged elected officials, DOGAMI, CREW & FEMA.

Cleve Rupert, Cannon Beach Rural Fire District: History of Cannon Beach Tsunami Efforts. 1985 first siren, now have 6 total sirens (4 in Cannon Beach, 2 in Arch Cape area). Redundant notification systems are in place. 1994 bond measure passed to build new fire station on high ground built in 1996. Based on new tsunami mapping, now this building is not in the high ground zone. Joint Operations Center at Fire Station for city/fire/police, tsunami signage, informational materials, emergency management plan, caches of disaster supplies, public education forums for citizens and business community, Red Cross shelter sites & volunteers, generators for shelters and fuel supplier, helipad, Post-Earthquake evaluation of buildings, Mylar blankets, utility companies education, website, structure evaluations to shelters sites and upgrades, school district evacuation plans and drills, Tsunami Ready Designation, special needs citizens evacuation plan, siren pagers at motels, ham radio system.

Rich Mays, Cannon Beach City Manager: 2006 CREW workshop (Post disaster issues: population, economy, infrastructure, redevelopment issues). PER Committee, EPREP Committee, LTR Committee, 2007 DOGAMI study, looking at shelter options – biggest concern, high percentage of public and tourism in tsunami zone, trained several ham operators, upgraded Sat phones, trimmed trees around power lines, working on a new Emergency Operations Center for County at Camp Rilea.

Discussion of new study/map in terms of evacuation: Inundation much more dramatic than known in past, evacuation routes now under water, local population and school evacuation sites now vulnerable, bridges expected to fall down during earthquake, much greater distances to travel to get to higher ground now, school is at very serious risk – evacuation done last week took 23 minutes.

Discussion of new tsunami evacuation building as concept: Japan studies applied to Cannon Beach. It could be used as a shelter and a center of government.

Yumei Wang, DOGAMI: Tsunami Evacuation Buildings - think of this as a means of risk reduction. Some structures are better able to resist tsunami forces. If we can build one building in Cannon Beach, it can be an example for other areas. Very robust columns, deep foundation, people above harms way, siren or visible indicator, seawall structures in front and back of structure, must withstand tsunami and very strong ground shaking, wave energy and debris deflection structures in front and in back of site, looked at 3 options for Cannon Beach City Hall building. **[Go to PowerPoint slides, page 37]**

Public Discussion

Bill Brehm: $4 Million Building – what is the building height on second floor and roof?

Kent Yu: 2nd floor elevation 18 feet, add 10 feet for roof level. This will satisfy the 90% probability wave.

Tom Manning: Expressed concerned about terminology of Tsunami Evacuation Buildings - "evacuation", call it "escape" instead. You don't want people going on normal evacuation routes to redirect to the Tsunami Evacuation Building.

Yumei Wang: Suggested we have OSSPAC look into language.

Mark Carey FEMA Region 10: What process to decide City Hall was most important facility?

Jay Raskin: Already relocated fire station, city hall location is a good location – major beach access, downtown, would rebuild on current location.

Yumei Wang: Thinks Cannon Beach would need a couple of Tsunami Evacuation Building structures.

Mike Morgan: Would like a flexible foot bridge over Ecola Creek for school children. There was some discussion about the Cannon Beach school moving to Seaside in the next 10 years.

Rob Witter: Has the city looked into strengthening that bridge or other options to get across the creek? Q: What is the capacity of the escape structure? Need to educate people in other areas like Tolovana Park where to go for evacuation – not the Cannon Beach City Hall Tsunami Evacuation Building.

Jay Raskin: Yes, we need to educate. We have installed signs indicating pedestrian routes.

Rich Mays: Looked at costs to retrofit bridge.

Jay Raskin: We're also worried about subsidence issues re: bridge. Tsunami Evacuation Building Capacity – 1000 to 1500.

Patricia Roberts: Electric lines down after earthquake, consider requiring lines being underground along established evacuation routes. Rich – very costly

Maiclaire Bolton: Concerned about people jumping off-suicide (3 people brought that up to her).

Yumei Wang: There are many issues to think about – how do you prevent people from coming to "watch" the tsunami?

Audience Participant: Business Community incentive to hotels to build additional story – offering tax incentives, police protection – some carrot as a partnership.

Jay Raskin: Seaside Trendwest building – declined to meet higher seismic standards, security, costs, higher standards. Gene – Trendwest was given the land in order to construct the parking deck.

Yumei Wang: There are currently no structures in all of Cannon Beach that could be used as a Tsunami Evacuation Building.

Ian Robinson, UH: Since 1980s Hawaii has directed people to do vertical evacuation for any building 6 stories or more made of reinforced concrete and steel – go to third floor or above. None of those buildings have been designed for tsunami load. Likes this approach and the public/private partnering – parking garages produces a perfect site – easy access, never locked, easy to walk up the ramp. You could build a parking structure with a break-away-type store underneath.

James Bela: Wants to know the elevation here and highest Tsunami Evacuation Building elevation.

Jay Raskin: The group has picked the 90% confidence level – represents a good compromise in terms of the risk. For the worst case scenario, 30 feet is the next level.

Bob Freitag: Thinks this building would be a location of last resort for vulnerable populations.

Audience Participant: What is the 90% confidence level – how big of an earthquake does that represent?

Rob Witter: Explained scenarios that would simulate tsunamis for a variety of earthquakes.

Audience Participant: Has OCZMA come up with funding to help complete the mapping that has not been done?

Yumei Wang: NOAA has funded mapping including the current Cannon Beach map already done. Bandon is now being mapped by DOGAMI; plan to complete maps for entire Oregon Coast by 2013.

James Bela: What is the elevation Sea level here at Cannon Beach City Hall?

Javi Moncada: The parking lot of city hall is about 30 feet above sea level.

James Bela: Wouldn't feel comfortable with any evacuation staging area below 20 meters above sea level. Expressed concerned about 20,000 people on the beach on any given day. Consider calling it a Tsunami Survivable City Hall. How are you going to deal with the 20,000 people on the beach? Expressed concerned about not designing for the worst case scenario.

Jay Raskin: We're trying to understand what the risk is.

Bob Freitag: Rob took subsidence into account.

Yumei Wang: Our coastline has very complex geological conditions; most all communities have been built on alluvial. Some houses on hills and active landslides, but majority if not all Tsunami Evacuation Buildings would be on the flat line ground (alluvial) where there is less option for getting to high ground. We would require deep foundations to handle excessive scouring forces and buoyancy forces.

Cleve Rupert: Core samples are various layers of sand.

Audience Participant: Gearhart is in the process of drilling for oil and have hit basalt. For North Coast, it will be fairly deep before you could hit competent rock for foundation. Foundations may be 80-100 feet deep with a grade beam tying the structure together.

Deb Treusdell: We don't use terminology of "safe". We encourage people to get the best info available and make personal plans based on their own individual needs, location, and ability to move. Education is important for the average citizen to make decisions about evacuation.

State Representative Deborah Boone: Seismic Grant program: You're either on the bus or you're not on the bus. A program of grants for seismic upgrades, ($15 million this year and $15 million next year, $30 million total). Grants are for all community infrastructure, public schools, fire stations, police stations, acute care hospitals. (1.5 million cap per grant for seismic improvement). Hope to get all these facilities done within 17-27 years.

11:00 am
WALKING TOUR OF CANNON BEACH
Jay Raskin, Ecola Architects

Debrief: There are 8 schools in Oregon in the inundation zone…4 of them in the Cannon Beach/Seaside area.

Yuriy Mikhaylov: Next generation design guidelines that we hope people will adopt. Concerned about costs. Reinforced concrete and built for seismic zones C or D, increase for tsunami loads was virtually zero. If the tsunami building survives the shaking, chances are it will also survive the tsunami.

1:00 pm
NO WHERE TO RUN: SEASIDE – DRIVING TOUR
Jay Raskin, Ecola Architects
Tom Horning, Horning Geosciences

2:00 pm
PUBLIC MEETING: SEASIDE TSUNAMI REFUGE
Althea Turner, OEM
Doug Dougherty, Superintendent of Seaside School District
Harry Yeh, Coastal and Ocean Engineering, OSU

Althea Turner: Introduction and information about the Cascadia Earthquake threat.
[Go to PowerPoint slides, page 46]

Harry Yeh: Provided a PowerPoint presentation on Scenario Simulation System for Risk Management and Disaster Education. Need for man made Safe Havens – Berms or Safe Havens. Site location of Tsunami Evacuation Buildings is critical. **[Go to PowerPoint slides, page 49]**

Doug Dougherty: Provided a PowerPoint presentation. Very transient population, more information/education is needed. We want to inform but we don't want to frighten. 57 acres of Georgia Pacific property meets DOGAMI criteria. **[Go to PowerPoint slides, page 61]**

Tom Horning: Provided a PowerPoint presentation on the Tsunami history of Seaside and current tsunami mapping. **[Go to PowerPoint slides, page 67]**

Public Discussion

James Bela: What is the velocity at which a person can no longer stand?

Harry Yeh: modeling is a first step, body size and weight, formation of waves, etc have an impact. Water depth of 70 centimeters, people die. If the flow of speed is swift enough, people cannot sustain upright positions.

Bill Brandon, Cannon Beach Emergency Preparedness Committee and parent of 3rd grader at Cannon Beach Elementary: This morning we heard 1-2 most severe earthquakes over 10,000 years apart…now you're saying 300-380 year interval.

Harry Yeh: Always says 300-350 year interval. Max size of earthquake must be 9.5.

Doug Dougherty: Talked about Chris Goldfinger's research and the frequency/severity of earthquakes on the Cascadia Subduction Zone.

Tom Horning: In this area, we are a cluster and should have a large earthquake in the 300-350 year interval.

Althea Turner: Stated that there are two different kinds of ruptures on the Cascadia and explained the difference of the North Oregon Coast and Southern Oregon Coast. Ruptures occur twice as often in the south as it does for the entire coast. 10-18 percent in next 10 years for Northern Coast, 85% in next 50 years for Southern Coast.

Bill Brandon: Why can't we speed the change in the urban growth boundary? Who can do it?

Doug Dougherty: We will do everything we can do move this as quickly as we can. We have no evacuation point/building and our schools would be built as evacuation sites for our community. The schools could also be used for the more normal disasters/storm that happen here.

Lauren Wooley, Department of Land Conservation with Coastal Program: Has met with school to discuss what would be necessary for amending an urban growth boundary. There is a process that takes findings to be developed and community decision making (takes 6 months approximately) and the process has not yet begun. We have a desire to work with the school and community on this. There are questions about what occupies the sites that are vacated. Also making sure all the geo-technical stuff is done on a site. Not insurmountable at all, just needs to be looked at in a comprehensive way. I think they'll get through it. The issue of funding is even a bigger issue to us in working through the land use process. We're really interested in this stuff going on in this workshop and field trip because it provides options to look at. It might be a piece of the overall solution, including other evacuation routes. We'll review all options.

James Bela: In hazardous areas, you can't apply regular boundaries. I encourage the school district to declare an emergency and go to the legislature to get some action. You can't leap a 20 foot chasm in two 10-foot jumps.

Lauren Wooley: There hasn't been an attempt to amend an urban growth boundary related to this particular hazard at this point and we are encouraging the discussion and working together on this.

Doug Dougherty: We just recently identified this site and are still waiting on the geological findings.

Jay Raskin: It seems like a better solution for this particular school district to move them out of the tsunami zone rather than use TEB's as solutions for them.

Jay Raskin: Asking Ian Robertson (structural engineer), is this similar to the discussions in Hawaii?

Ian Robertson: you are far ahead of us in Hawaii. Driven by tourism – big concern to put up signs saying you're entering a Tsunami Evacuation Area. Only one island (the big island) has done this so far. There is this concern and he's glad to hear that it is not negatively affecting tourism. The state civil defense does have plans that we practice every year, but we don't evacuate the public. The public is totally unaware. Buildings not designed for tsunami evacuation, many of them will survive. If you're in a major building, over 6 floors, stay there. In Waikiki, that's our only option. We're not at this point yet; we're not even at the point of putting decent signs on the highways. The Kona coast is the worst scenario – tsunami will spread to Waikiki within 30 minutes. We had a 6.7 earthquake, we felt, people wondered why the sirens were not going, we had an educational problem. In Hawaii we feel like the coastal folks will struggle, but most of us will get along. Sirens sound every first Monday of every month. Entire islands are covered by this, but we're not sure the public is convinced what to do. Hurricanes are more of a focus for us.

Maiclaire Bolton: you are miles ahead of us. We have three communities in the entire province that have sirens. There is a project to put signs up in the at-risk communities, but a couple communities took the signs down because their public officials thought they would hurt the economy. Several others realized early on that the signs didn't hurt them. A lot is being done but there's still a lot left to do. I'm in awe to learn of all you do - public education and tourist education.

Sam Steidel, Cannon Beach City Council: At the tsunami sign down town, tourists get their picture taken by it.

Sherry Roff from Long Beach: A few years ago, talking about tsunami and bird flu, if it's coming to us from Asia, we have about 3 hours, if it's the Cascadia Subduction Zone – all the way to I-5 consider that major destruction. If you survive the quake and can get out and walk – with near shore, chances you will have something to climb-will be minimal – we will be on our way even if we make it to an evacuation site, because the help will be coming to the population centers. The dump is her evacuation site.

Gene Miles, City Administration in Long Beach: Building a new water plant above the dump. It will be supplied with a cache of emergency supplies. Issue of vertical evacuation, people could move to this site afterwards so you can maintain people's health and their condition for a couple weeks.

Sherry Roff: she heard on National Public Radio, in tsunamis most people don't die of drowning, but are hit by debris. Can you attach oneself to a tree?

Althea Turner: In absence of a building, you take all measures necessary to give yourself a better chance. Best bet is education and get those people up and out.

Tom Horning: We've got great ideas, science behind it, policy is being developed, and we need the tools in order to make the action happen. We need funding, federal and state programs. It may not be enough. Why not bill the people we would be saving through some type of room tax. We need to make the coastal strip a variance from the normal taxes so we can charge $1 a night to be restricted for tsunami mitigation use only. We need to do this – it only makes sense that the people we save should pay for this. It is chump change. Altogether this could make several thousand dollars a year in order to accomplish these things we're talking about. Education is very important so that your community will vote for passing bonds and stuff to pay for a bridge, etc. Plan for education and outreach on a continual basis until it's a part of your community culture to be ready for these things.

Althea Turner: We need to have a fundamental shift in the way we think – a culture of preparedness. It's in their best interest, it's good business to promote tsunami education and preparedness. You are telling your visitors we value you.

Dennis Hunsinger, acting regional administrator for FEMA: Extremely impressed regarding all this tsunami work from the various communities. Want to remind you that the most prepared community you have in this state is the little town of Hermiston and Pendleton. These folks can probably help you a lot. School administrators should talk to the school administration there, police to police, and fire to fire. These citizens do evacuations, shelter-in-place. One of the cornerstones of preparedness is individual and family preparedness. Granted they have a lot of money from The United States Army. Every home in those two counties has a home alert radio. It's phenomenal what a lot of money can do for your community. They've learned a lot of lessons that they can share with you. A lot of those lessons will apply to what you're doing. Individual and family preparedness is the cornerstone.

Jay Raskin: Asked about federal funding opportunities - is Tsunami Evacuation Buildings something that can be funded?

Dennis Hunsinger: Funds are limited. At this time FEMA is not funding this. They are being suggested for your hazard mitigation grant and go through your plan. We're still looking into the PDM thing.

Tamra Biasco, FEMA: Pre Disaster Mitigation Grant is $100 million annual, nation wide that states apply for competitively. TEB is not eligible at this time because it deals with an environment. It could be eligible under the post-disaster HMGP.

Tom Horning: Are there people here that could glance at an 8-story building and give us an idea if it would withstand an earthquake/tsunami?

Ian Robertson: It does take a structural and geo-technical analysis. Since your seismic requirements have been upgraded recently, buildings before that are not. The ones that are standing after the earthquake are the ones I would use.

Maiclaire Bolton, CREW: Thanks to everyone for coming, very impressed with the work that's being done in Cannon Beach and Seaside.

TUESDAY, SEPTEMBER 29, 2009, PORTLAND, OREGON — WORKSHOP MINUTES

Note: These minutes are based on notes taken by Sue Graves; they are not verbatim.

8:30 am
INTRODUCTIONS, FRAMEWORK AND GOALS OF WORKSHOP

Yumei Wang, DOGAMI
Jay Raskin, Ecola Architects

Jay Raskin: Welcomed everyone to the second day of the conference and reviewed Monday's session.

Yumei Wang: Thanks for coming and being interested in Tsunami Evacuation Buildings. Introduction and expectations for today with PowerPoint presentation. This is a very informal workshop. We want people to feel very comfortable bringing up ideas and brainstorming. Thanked organizers and sponsors.
[Go to PowerPoint slides, page 85]

8:45 am
TSUNAMI EVACUATION BUILDING POLICY SESSION

Moderators: Yumei Wang, DOGAMI and Jay Raskin, Ecola Architects

Prof. Harry Yeh: PowerPoint presentation on Vertical Evacuation & Scenario Simulations. The siting of Tsunami Evacuation Buildings is very important depending on where people are inclined to move.
[Go to PowerPoint slides, page 94]

Yumei Wang, inviting panelists. We have a very diverse audience, need to brainstorm and get everyone's ideas.

Policy Session Panelists:
Tamra Biasco, FEMA Region X
Mark Ellsworth, Governor Ted Kulongoski's office
Karmen Fore, U.S. Congressperson Peter Defazio's office
Fritz Graham, U.S. Senator Ron Wyden's office
Scott Maguire, U.S. Senator Jeff Merkley's office
Steve Marx, U.S. Congressperson David Wu's office
Tyree Wilde, NOAA NW regional office

From U.S. Congressperson Peter DeFazio's Office, Rep Karmen Fore, District Director: We hear intermittently from communities on the south coast about tsunami concerns both from citizens and local elected officials. Also, communications from state regarding seeking funds for doing mapping of the coast. Looked at a lot of hazard mitigation maps related to where people live and where they want to put projects. Years ago, she remembers someone wanting to put in an assisted living facility for seniors – it seems to Karmen it would be better to build a facility for seniors outside the tsunami zone. Folks who don't have a lot of resources, they're very aware if they do or do not live in a tsunami hazard zone. They feel like they're on their own and will be cut off. In one situation, a tsunami warning bell had to be turned on manually and was in the tsunami zone – would have to go into zone to turn it on and then flee the zone. We tend to intersect with people seeking resources and seeking assistance in order to improve notifications/communications. In the south coast, many are retirement communities, heavy senior population, added concern about how to move these people in an emergency – these are time sensitive issues.

From U.S. Senator Ron Wyden's Office, Rep Fritz Graham: Fritz is the field rep in Salem, and the defacto emergency management person in our office. Since the 1996 flood, there have need 12 presidential declarations. He works with communications, post-disaster work with Vernonia and Tillamook, mostly around flooding. We've dealt with people who realize they're on the flood plane and want to get out of it and they need to move. From yesterday's meeting, the Seaside school district has all but one school in flood plane. We put in a request for an earmark, but numbers are going down and we'll put it in again for next year, but we'll see. Worked on a siren system for the last year, June in our Eugene office worked with sirens on north and south coast. The siren system for us to leave the beach means the opposite in Hawaii. He is interested in looking into a federal system to provide consistency to things such as this.

From U.S. Congressperson David Wu's Office, Rep Steve Marx: Seaside and Cannon Beach have been very proactive. People like Deb Treusdell and Pat Corcoran and others have done incredible work on outreach and public warning systems. A few years ago got $500,000 earmark for seaside to fund a tsunami barrel program which provides a cache of post tsunami supplies for the community to create a place for people congregate and have supplies to survive for a period of time after a tsunami. Folks are here from FEMA about the federal programs available, as far as the efforts of this group to get behind Tsunami Evacuation Buildings and the technical requirements of that. The earmarking process is another mechanism we can go after to try and support communities to build these things. Capital construction is always hard to get things funded, but sometimes we can get behind it. Tsunami preparedness and disaster preparedness, floods, windstorms, snowstorms, they happen just about every year, we need to be thinking about it and we need to support at the federal, state, and local levels, and I think our efforts are moving in that direction and we're grateful to be part of that.

From Governor Ted Kulongoski's Office, Rep Mark Ellsworth: I've been thinking about disasters in preparation for this conference, I've had in my mind some of the consequences of disasters, they happen suddenly, you're not prepared for it, there are real consequences of disasters. They change your plans, they inconvenience you, they can be very painful and they can be catastrophic, horrible. I appreciate Yumei and Jay to put this event on. This type of forum is where it begins. First exposure working with Oregon legislature we had bills and hearings on this, how do we prepare for tsunamis, we're in a world of no money, no budgets, how do we fund stuff, how do we cobble together little pieces of funding from disparate sources to take care of public safety and these essential key functions of government to prepare and protect us. These are tough times and they will be tough for a while. How do we operate and work in this environment to push this key agenda forward. We wouldn't be able to do this without our federal partners. Talking with Representative Deborah Boone, this is a key issue for her, we have to be united. That is part of what is going to come out of this conference, the work, the unity, the purpose we can feel as a group and then we can go for funding if we have purpose and a plan. Then funding options become much easier and our federal partners are ready to step in and help us. We've had disasters in Oregon and we're going to have more and it's a higher priority for the state all the times as we figure out how to deal with these. This meeting is a perfect next step.

Tyree Wilde, NOAA: My apologies that Jenifer Rhodes could not be here as she is in Washington, D.C. We operate the tsunami warning program for U.S.. We have two tsunami warning centers. One in Ewa Beach, Hawaii and one in Palmer, Alaska. Since the Indonesian tsunami in 2004, NOAA has been strengthening the TsunamiReady program. Tsunami warning centers are now staffed 24/7/365. We maintain a lot of the expanded DART system. Before the Indonesian tsunami, there were 6 buoys, now we have 39. There are 150 tidal gauges down the coast. The Tsunami Warning Centers have access to all seismic activity. We also run the Weather forecast center. In the event of a tsunami, we help to disseminate the warning to the communities. We work with county emergency managers and state partners (Oregon Emergency Management, Washington Emergency Management) and we're out there doing community education and outreach on an ongoing basis. We maintain and operate the TsunamiReady program.

FEMA Region X, Tamra Biasco (Regional Earthquake Program Manager) AK, OR, WA, ID, also sits

on NOAA's National Tsunami Hazard Mitigation Program as a rep for FEMA and participates in mitigation education subcommittee: We have a good relationship with NOAA and other state and federal agencies. In the FEMA Mitigation Division: risk analysis, risk reduction, and flood insurance program. We do provide grants to the state and we encourage you to work with your state and allow them to identify what their needs are. Everything we do is in support of our state counterparts. We work with locals, but when it comes to a disaster, we look to the state for what their needs are. We have two types of grants. Pre and post disaster grants. At this time, we are encouraging our states to use Tsunami Evacuation Buildings as pilot projects for disasters - they have to meet the requirements for hazard mitigation planning and must meet priorities of your state, be cost effective, and have an environmental study. Document on Tsunami Evacuation Buildings and we hope to move this along. It would be nice to see Oregon step up to the plate and be the first one to get the funding.

Jay Raskin: read a letter from President of the Senate, Peter Courtney. [See page iv of this document.]

U.S. Senator Jeff Merkley Rep, Scott MaGuire: We're here to listen being the newest of the federal contingency on the block, we're paying careful attention to what is being said today. We haven't lived though this but intend to be there for you as a strong partner. Thank you for all your work.

Public Discussion

Jay Wilson: County Emergency Manager for Clackamas County and is here as a representative from the OR Seismic Safety Policy Committee (SSPC), he is a public representative on that committee. He'd like to raise a few issues, 1) it's a technical problem on how do we design these structures, implementation and education integrated into the communities. It's more difficult than simply building the structure. We need to rely on a body like the SSPC to resolve problems and work with stakeholders. There is an existing Oregon Tsunami Advisory Council for being a clearing house for representing the public needs - it gives the public a voice rather than a top down approach. The end user is ultimately being benefited that way. He will have more to say later.

Audience Participant: Education is the biggest part of tsunami mitigation and tsunami preparedness. Someone who lives in Tolovano Park told him yesterday, that it's one piece of a larger effort. There are options of how to get to high ground. Education is a critical component of any education program whether it involves a Tsunami Evacuation building or not. Buildings could hold between 1000-1500 people, summer population is much larger.

Tim Walsh, Washington State National Resources: Sirens mean the same things everywhere. Washington, not only as a siren, NOAA Weather radio on a stick, tells you what the siren means. Voice activated. Installed 16, 2/3 done, getting the whole coastline done. The future.

Harry Yeh: Comment about education – most effective way to save lives not question about it. In this county, so rare, maybe it happens next year or 1 year from now. If it's not going to happen for next 50-100 years, I don't trust human beings, I think we are more stupid. We will forget if it's not soon. If we build a Tsunami Evacuation Building in Cannon Beach or other place, then people will see it. It's a very visible monument, providing education to the general public. If we have a Tsunami Evacuation Building everywhere this can attract tourists in some way. Question for FEMA people: it's difficult to find defendable cost-benefit ratio on these. We do know that making something to save lives is important. How do you make convincing cost-benefit ratio so we can move the state people to get together for this very important proposition.

FEMA: That is a challenge and the cost of a vertical evacuation building, after putting out the document, FEMA stepped back, looking at grant programs, we don't get enough to put that many up along the west coast. It would rob us of our whole budget. We know it does cost a lot; we juggle all sorts of hazards.

Jay Raskin: Can we ask the panel that same question about funding.

Karmen Fore: Smaller communities really rely on their newspapers. They do a lot of stories on evacuation

planning, will print the map and talk about this issue a lot in their communities. Taking advantage of those resources, use the papers to educate the public. They literally look right at the ocean. Funding – working with policy leaders in congress to restack priorities is the key and that's a long-term ongoing process. Education - we reacted to change codes since the earthquake in San Francisco, we know better now than we did before about the tsunami risk on the coast in the pacific. It is just as much of an education process for the elected officials, so we can better spend federal resources to prepare communities. Those things can be done.

Yumei Wang: Follow up question: I appreciate we need to educate elected officials of tsunami risk, your member is very aware of that risk, how important is it to educate the other members of congress not on the coast.

Karmen Fore: It's hugely important. Those who live in a coastal area will know more, but if you are a representative is in Kansas, Nebraska or Minnesota, tsunami risk will not be in your mind like other issues. We have to work with that body to educate members, work with key partners on relevant committees, polices or appropriation committees. Members educate other members. The best advocates in congress are other members of congress. I.E. we have better research coming out of Oregon State University that can save lives. They need the information.

Yumei Wang: Would tieing Tsunami Evacuation Buildings with tornado structures be a good way to education.

Karmen Fore: No, we can talk about the tsunami impacts on Oregon coast and they can understand it.

Fritz Graham: One of the challenges of FEMA, we have to increase the funding, make our case and expand that.

Yumei Wang: How can we more effectively make our case?

Steve Marx: Cost-benefit analysis – a $4 million building can save 1000-1500 lives, how does that compare with other mitigation efforts. FEMA has great programs, for education, communication equipment for counties. FEMA, they have grant programs for all sorts of disaster preparation. It's important to realize that FEMA is part of the solution, but not the only person to look to for funding this kind of thing. For example, Cannon Beach could float a bond measure, county can kick in, state funding, you could go at it through an earmarking process like the tsunami barrels in seaside. Show that we're not just looking at federal government. We have community support, state support and looking for final piece from fed. Those are the kind of projects that get funded.

John Heintz, From Applied Technology Council: Hurdle is to go from something like the Cannon Beach city hall and the normal city hall and a vertical evacuation structure. Look at opportunities where you're going to do something already and it makes sense to upgrade it to a Tsunami Evacuation Building.

Pat Corcoran: Education focus – is the most effective way to deal with tsunami mitigation. Funding is #10 on the list. Oregon doesn't have a full-time tsunami educator on the coast. When I see a $4 million price tag for a physical structure, I see a disconnect on things verses people. I have a proposal worthy of consideration. Currently Oregon has a 1% art. I propose 3% for education on the Oregon coast. That's one $60,000 for an Oregon tsunami educator for two years. Make connections to integrate the education piece with the building. I agree with Harry that it's hard to educate 50 years out, we need to have both. I absolutely support and would love to see it in Cannon Beach, but I'd hate to see all our dollars move away from education.

George Priest: Consideration – the idea that we look at this problem holistically. Look at the whole coastline, that looks at where the hotspots are, where these structures might actually be needed .If that document be funded, it would give us a platform to go to the fed government to show where these monies best be spent. Also to go to FEMA, we're a priority spot and we deserve funding because we're number 1 or 2 on this list. Reminded us that there is a private sector out there that builds big vertical building son the coast – integrate them, they're encouraged and maybe required to be a vertical evacuation structure. Residence might be more likely to welcome the large structure if it doubles as a Tsunami Evacuation Building.

Mark Ellsworth: Portland State University is trying to figure out how we're going to fund a building. They leased out restaurant space in the bottom. That's part of the work we're living in now. When you're going to build, how are you going to be creative in your financing, who are your partners. Change in state government is incremental It's hard for big dramatic bold earmarks from the sky. Regress back to education outreach. We've done a lot of work in Oregon already that we've got to build on and partner with. We have the bottle bill, beach clean up, Solve, state land-use rules. Let's put tsunami preparedness on that list in how we do things in Oregon. How we sort of over time prioritize – then we get the funding.

Jay Raskin: We're a small coastal community. The earthquake will damage must of the Pacific Northwest. How the congress dist and the other states will actually pull together and look at this globally. It's a Pacific Northwest problem. The interconnected is something lacking.

Fritz Graham: Use existing infrastructure like the Trend West in Seaside, parking garage, reinforce it go down a little deeper so you're not starting from ground zero. Look at Seaside, Newport, Depoe Bay, what can we best leverage of what's already going to work with that.

Karmen Fore: After 911 there was an enormous amount of work around national disasters, one key thing that happened at time, they were planning at looking at broader range of services, first responders, hospitals, what would happen in a large earthquake. How do we deal with getting emergency services to Willamette valley and coast to assist people? Education – when I got into Eugene/Springfield (Thurston shooting in 1998) they have pulled together and have continued to meet and develop multiple scenarios on what to do for various hazards and develop relationships. Part of our work is to educate ourselves and we might be surprised at what local communities are already doing and the ongoing work at the state level.

Tyree Wilde: I've been involved in a lot of tsunami education with many people in this room. We always hit the same audience. We need to integrate that into our education system right down from the very lowest level in the earth sciences. That's where we're going to save lives. Funding issue: Congress passed Tsunami Warning and Education act in 2006. That's NOAA's guiding light – there's a big component on community education. Tie yourself to that document if you want to approach the federal government. Also work with the National Tsunami Hazard Mitigation Program (NTHMP) and put a sound proposal together to compete for grant money.

Yumei Wang: 2006 Tsunami Act – is that money suitable for using to build a Tsunami Evacuation Building which would provide long-term education coupled with tsunami education center with hands-on things for the public.

Tyree Wilde: Some of the monies go to running tsunami warning center, and some for grant projects. Make your case and compete with other projects.

Jay Wilson – Education – One of things happens when earmarks are the tool for funding things, really is there equity involved in how this money is getting distributed. We're coming here to talk about the viability of these engineered projects and where the money is coming from. A comprehensive approach is needed. It's not just building one of these for $4 million. I remember at the time that $500,000 was brought into Seaside - that was twice the annual funding budget we got for the entire state for tsunami preparedness. The south coast counties don't have maps like these. We need a tsunami audit for where the needs are help to spread the limited amount of funds around.

Karmen Fore: Earmarks are not the best way to get money. You're absolutely right. The better process is the granting process. The money and rules are already there. They're telling you exactly what they're looking for. It's more robust funding source than earmarks. Accessing fed funds is hard. It's the people's money. Communities gain significantly greater success accessing grant funding programs. FEMA pre-disaster preparedness grant funds are available. As policy shifts change, at the fed level, funding changes. Articulate that as a priority, backed with resources and why. Macro-agency level. There is going to not be enough, we know that. Lobbyist do perform a very important func-

tion because they cross communicate and educate each other on what's going on.

Yumei Wang: Is there funding through NEHRP to include capital funds for Tsunami Evacuation Buildings or a regional strategy like George Priest was talking about.

Steve Marx: More through the jurisdiction of the 2006 Tsunami Act – it might be a more appropriate place.

Tom Manning: State parks own over 90% of beaches in Oregon. State parks were able to secure tsunami warning sirens. They might be able to do this project using lottery funds, maybe 1 structure per year. They have a problem with evacuation in the State Parks. This could help solve this problem. You might end up with the first.

Mark Ellsworth : That was the mechanism, design, all options could be available, but lottery funds are declining right now, they've got to be part of the picture.

George Priest: The NTWS did the whole budget; there was only $35 million for the entire budget. NOAA's mission is to warn people about tsunamis. That mission is the conflict with our coast since the warning system does not work. NTHMS has partners, FEMA, their mission is mitigation. Since they're a full partner, what do they put into this budget? They've always been a week sister to NOAA, they show up to meetings and vote, but they don't put much money in. FEMA needs a real budget so they can fund things like this. This is mitigation with a capital M. If you want this to happen, give it to an agency whose mission is mitigation. Don't make them dig it out of their current budget.

Tim Walsh: F EMA did contribute 35-40% of funding that went to ATC 64, the rest came from NHMP. The NTHMP, I'm a current member, has formally decided not to fund capital projects. Temporarily the NTHMP has access to funds from the sale of spectrum, extra $25 million funds for mitigation for the next 3-4 years. George's proposal of a coast-wide strategy – has a high probability of being funded right now.

Mark Carey, FEMA Region 10: Harry mentioned some difficulties with the federal cost-benefit ratio, that's not a FEMA requirement, that's a federal requirement. George is right, if you get more money to FEMA, hurdling a $4 million investment is only going to benefit 1000-1500 people. Not unlike issues in Alaska, to relocate AK villages that are already falling into the ocean. The question I have, what I didn't hear, is to turn it around and look at the city. What options has the city addressed, capital improvement, tourism taxes, private sector, what has city and county done to take a look at what can be done to build the infrastructure from local level up.

Jay Raskin: We relocated the fire station from the tsunami zone. Funded warning system, ongoing education efforts, put $5-$15,000 per year into emergency preparedness efforts, telephones, helicopter landing pads, we're a community of 1600 people. City Hall, this is our new goal. We're going to put out a bond issue to our local voters. The $4 Million is based on a concept not a building.

Yumei Wang: Cannon beach put in their cold hard cash for this workshop so we could get people here to talk about this.

10:30 am

TSUNAMI EVACUATION BUILDINGS IN JAPAN

Tadashi Ishikawa, Kajima Corporation
Harry Yeh, Coastal and Ocean Engineering, OSU

Tadashi Ishikawa, presented a PowerPoint presentation on: Tsunami Load of Structural Design and Tsunami Refuge Buildings (See PowerPoint presentation and transcript below.) **[Go to PowerPoint slides, page 100]**

TRANSCRIPT: Tsunami Load of Structural Design and Tsunami Refuge Buildings PowerPoint Presentation

Slide 1: *I am Tadashi Ishikawa. I came from Japan. Please excuse for my poor English today. I have prepared for a note; I will see it and proceed.*

I have worked at the construction company for more than 11 years where I have designed for building structures. 5 years ago, I had worked temporarily at Building Center of Japan for assist from the construction company. The building Center of Japan is famous for evaluating the buildings in Japan. But I didn't do it. One of what

I did was to research tsunami load of building structures and to make up the "structural design method of building for tsunami resistance." I think, therefore I am here.

Today I'll talk you about it, mainly tsunami load. I want to add what I talk you today is what was formed by the team. The team was organized mainly by researches of BCJ including the people from other construction company, and received expert advice through the committee from professors of university and researchers of other institutions. Well, it doesn't become difficult, so please relax and listen.

Slide 2: *This is a brief overview of contents for today's presentation. In 2004 the giant tsunami was generated by the Sumatra earthquake, but we start to research before it, we start it about April in 2004. In my memory, so I want to speak basically following chronological order.*

At first, I introduce you to the background of tsunami research in Japan. Second I will report on a survey and analysis of the existing literature relating to "the tsunami load." Third, I will report one proposed structural design method for Tsunami refuge buildings based upon the literature survey of previous experimental studies regarding Tsunami load to harbor structures. Fourth, I will report on verification studies of the method applied to buildings that suffered from the Sumatra earthquake tsunami on December 26, 2004. At last, I will report on some case studies about the safety of model buildings. Let's move to topic 1 "introduction."

Slide 3: *In Japan, it is said that there is a few tsunami within a century. In 1993, the Southwest Hokkaido Earthquake caused tsunami, and occurred serious damage entering on Okushiri Island. The magnitude of the earthquake was 7.8, the number of the dead and the missing was 230. Okushiri Island is located at the west of Hokkaido. It is said that tsunami attacked Okushiri Island within 5 minutes. About 3,900 people lived in Okushiri Island; the number of the dead and missing was 198 of them.*

Slide 4: *This is a map of Okushiri Island. Aonae district is especially said that the shape of the cape is likely to gather the wave.*

Slide 5: *These are photographs showing the damage of tsunami. The photo of the upper left is a primary school which was inundated and destroyed the left side wall. The lower right is a photo of landslip.*

Slide 6: *The upper left is a photo of seaweed which was thrown up on an electric wire. The lower right is the photo of Aonae district. In Aonae because of the earthquake, there was a fire too. You can see that tsunami washed away many houses. The high ground is seen from this photo near a residential area, but time was so short from the earthquake occurring to the tsunami arrival, therefore the toll of victims was so large. By the way, there were few RC buildings in Okushiri Island.*

Slide 7: *Because of these damages, many measures were taken against tsunami in those days. I visited Okushir Island on August in 2004. This photo shows the embankment was set up to the tsunami height, and the tsunami height was recorded on the plate. In this case, the tsunami height is 11m. 11m is nearly equal to 36.1ft.*

Slide 8: *The photo shows evacuation routes to high ground have been prepared. I actually went up the high ground; it took 1.5 min at quick pace. I think it is so difficult for elderly people to go up the high ground within the tsunami arrival.*

Slide 9: *This photo shows the primary school. This schools is not same above-mentioned. This school lies high ground rather than low-level ground, but the tsunami attacked through the river. You can see two openings at the frontage of this building.*

Slide 10: *In this photo you can se this school was planned with piloti style. These openings are perhaps scuppers. I measured the length of diameter; it was nearly equal to 2.6 ft. It is thought the piloti style and the openings are planning for letting the tsunami force out.*

Slide 11: *Next photo is fishing port in Aonae district. This structure was also planned with piloti style.*

Slide 12: *I think ground level is used for work place and 2nd floor is used for parking lot. The height from ground level to 2nd floor level is about 21.7 ft. This was assumed the rise of stairs and the number of steps. People worked ground level is immediately able to escape from tsunami*

attack and directly go to the high ground. It is thought this piloti style is also planning for letting the tsunami force out. It is thought these measures are qualitative planning but not quantitative planning. Because in those days there was few studies which tried to reveal the load for structures against the inland incursion of a tsunami.

Slide 13: *In this photo the sign have shown with the record of tsunami run up high. It is recorded about 76.4 ft. This sign was the highest record I came across, but according to the literature, it was recorded about 95.1 ft.*

Slide 14: *This is the figure of relationship between the damage and structure type presented in 1994. This is much informative and we can find out from this RC structure damaged less than other structures. I think it is near the quantitative study but not the quantitative study, either. Because Japanese buildings are mainly designed against the seismic force, and the seismic force is related to the building weight, so heavy building like RC is designed strong from the beginning. But is difficult to relate between the actual damage of structure type and building weight, because the tsunami rarely occur. Actually, in Okushiri Island, there were few RC buildings.*

Slide 15: *I have just introduced you to the example of damages by the tsunami in Japan. Then I will introduce you to the possibility of tsunami in Japan. X, Y, Z of the figure on the left shows the hypo central region of the tectonic plate boundaries along the Japan Islands in the Pacific Ocean.*

X is Nankai Earthquake
Y is Tonankai Earthquake
Z is Tokai Earthquake

Seeing the figure below, big earthquakes occurred periodically with 100 years to 150 years. Especially Tokai earthquake don't occur for more than 150 years, the possibility of occurrence is strongly pointed.

Slide 16: *In recent years, the earthquake preparedness to scenario earthquakes such as Tokai, To-nankai and Nankai earthquakes have been intensively carried out in Japan. Since they are considered to occur, not only severe ground shaking but also high Tsunami waves are expected at many cities along the coast. According to the assumption compiled by Central Disaster Reduction Council, if Tokai earthquake happen, in the worst case, about 9000 people will die. If Tonankai and Nankai earthquake happen, in the worst case, about 18,000 people will die. This distribution is about 9000 people will be killed by tsunami and about 7000 people will be killed by building destruction. So, the damage of tsunami about people is bigger than the damage of earthquake. I think in this assumption, above-mentioned relationship between the damage and structure type was used. This assumption was done on September in 2003. And it was proposed as follows:*

Slide 17: *One of the measures against Tsunami is to provide Tsunami refuge buildings for evacuation when a Tsunami warning is issued. For tsunami buildings, private strong buildings are supposed to utilize. However, very few studies have been carried out concerning the structural evaluation of building safety against tsunami wave loads. Therefore, in order to evacuate people safety to such buildings, it is necessary to establish a methodology to evaluate the structural safety of Tsunami refuge buildings against tsunami loads.*

Slide 18: *Previous Studies of Tsunami Load*

Now I will introduce you to previous studies of tsunami load.

Slide 19: *Here in previous experimental studies of wave pressures and forces on structures of the inland incursion of a tsunami are reviewed. The report of "Tsunami Assessment Technology for Nuclear Power Plants" in 2002 by civil engineering institution of Japan introduces these five equations.*

Slide 20: *Equation 1 and 2 are empirical formulas based on tests of tsunami wave flowing over perpendicular revetment. Equation 1 is adapted for tsunami wave pressure without soliton breakup, and Equation 2 is adapted for with soliton breakup. These bring the head of tsunami wave into focus. It is thought that these are adapted for the structure relatively near a shore line.*

Slide 21: *Equation 3 is an empirical formula based on measurements of tsunami wave pressure simulated water tank filled with water. It is thought that this*

experiment has an intermediate character of the tsunami which run-up onto land, and the tsunami in the deep-water part of the harbor.

Slide 22: *Equation 4 is a time history analysis for the experimental results of equation 1 and 2. In this result, Tsunami force is assumed to be composed of drag, inertia, impulse, and hydraulic gradient force. Drag is directly proportional to the square of velocity.*

Slide 23: *Equation 5 is an equation for drag force. This study's major point is to show a make relationship between drag force and damage degrees of houses. This brings the back of tsunami wave and uniform flow into focus. It is thought that this is adapted for the structure relatively far from a shore line.*

Slide 24: *We decided to employ equation 1 as a design of tsunami loads. Because the tsunami load on the building is estimated to nearly equal among these five equations And equation 1 is simple, and easy-to-use, and is a function of the inundation depth. I just say "nearly equal", but I think this nearly equal means to be different from 0.5 to 2.0 against 1. At the time I say about wave force or fluid, I become so careful because I am a structural engineer. But I want to talk more detail. We chose Equation 1 rather than Equation 3 because the experimental has an intermediate character and Equation 1 is the bigger pressure than Equation 3. We chose Equation 1 rather than Equation 4 because this is a time history analysis and isn't suitable for design. And this is originally equal to Equation 1 and 2. We chose Equation 1 rather than Equation 5 because it is difficult to use. Equation 5 is used with drag coefficient proposed same researcher and with velocity, but it is difficult for general structural engineer to reach velocity information. And the force integrated Equation 1 is bigger than Equation 5. I think refuge buildings for unspecified large number of people should be taken the safety into account, and must not destroy or collapse.*

Slide 25: *Then, only Equation 2 remains. It is difficult to explain. Equation 2 is partially bigger pressure than Equation 1, bigger pressure is this low part, but the study is doing about the case with soliton breakup. I think Equation 2 is a rare case; Effect of soliton breakup is tend to be stronger near the shore line. Refuge buildings will not be designated near the shore line. And in Japan, embankment is generally set up along the coast. Pressure is bigger than Equation 1 but Force integrated Equation wasn't written clearly in the literature. Force integrated Equation 1 was read about 1.3 times bigger than experimental force. So we chose Equation 1 rather than Equation 2.*

Slide 26: *This is a proposed equation for tsunami load. Tsunami pressure effect the building structures directly, and tsunami force is calculated with integrating this equation. This equation is not considered the effect of debris. Tsunami wave pressure for structural design is derived from calculated by this equation. Tsunami wave pressure qz is p g(3n-z) n is maximum inundation depth in the thesis. But n is a design inundation depth for the case of design. According to this equation, inland incursion of a tsunami acts on a building as this wave pressure distribution. Which have 3 times height of inundation depth n, and static pressure distribution. A necessary parameter is design inundation depth n(m). Here we must use this equation with consciousness that if tsunami is flow, tsunami force is originally thought to be directly proportional to the square of velocity. Tsunami force from this equation is directly proportional to the square of y. We use this equation as a matter of consciousness.*

3. Structure Design for Tsunami

Slide 27: *Next, I will explain about Structural Design for tsunami.*

Slide 28: *Based on the proposed equation for tsunami load, we suggest a properly organized sequence of structural design procedures for tsunami. It is summarized as follows. We applying this design method, the tsunami design inundation depth must be appropriately determined based on numerical simulations and past experience. When apply this design method to new buildings, as a matter of course, the building should be designed to resist the earthquake. And then estimate tsunami load, and based on this load, design the building to resist the tsunami load. When applying this design method to existing buildings, earthquake safety should be confirmed through the Seismic Evaluation Standard for Existing Buildings or present Building Standards Law of Japan. And then estimate tsunami load, and based on this load, design the building to resist the tsunami load.*

Slide 29: *In order to estimate the design tsunami load, inundation depth prediction is necessary. In Japan some local governments prepare a hazard map, which predicts the inundation depth, like this map. This is available. Using this map, one can set up the design inundation depth with a safety factor and then calculate the design tsunami wave pressure.*

Slide 30: *By using this tsunami load, one can design the pressure exposed surfaces and the structural frame. When designing pressure-exposed surfaces, pressure-resistant and non-pressure resistant members must be clearly differentiated. Pressure-resistant member means member that is directly exposed to tsunami pressure. Non-pressure-resistant member means member that is directly exposed to and yields to breakage by tsunami pressure, glass windows, window frames, light-weight-partitions and so on. Pressure exposed surface means that is directly exposed to tsunami pressure and is composed of pressure-resistant member and non-pressure-resistant member. The structural frame shall be designed to resist the effects of tsunami loads.*

Slide 31: *The proposed equation for tsunami load is usually treated in this condition. But buildings are various in shape, so we thought the simple rule to adapt this equation.*

Slide 32: *When pressure-resistant members are lower than 3 n, load to the lost portion is disregarded.*

Slide 33: *When there are no pressure-resistant members between 0 and n, no load act on building because the tsunami passes under the building.*

Slide 34: *When pressure-resistant members are missing between 0 and n, load acts on building as interpolating distribution.*

Slide 35: *It has to be confirmed that the structure does not overturn and slide due to tsunami load, and buoyancy is taken into account in the examination of sliding and overturning. And also scour has to be considered.*

4. Review of the Proposed Design Equation for Tsunami Wave Pressure

Slide 36: *Next component is "Review of the Proposed Design Equation for Tsunami Wave Pressure"*

Slide 37: *A large number of reinforced concrete constructions, concrete block walls, and brick constructions suffered major damage due to the giant tsunami generated by the Sumatra earthquake. Nakano et al have conducted extensive surveys in the areas of Sri Lanka and Thailand, in order to examine the validity of this design equation for tsunami load, he collected many data of damaged structures.*

Slide 38: *Nakano et al examined the validity of this design equation for tsunami load as follows:*

1. *Calculate the bearing capacity of the damaged structure.*
2. *Calculate a which equal to bearing capacity.*

When a is smaller than 3, the damaged structure could bear, if it designed a equal to 3.
When a equal to 3, the structures just destroyed.
When a is bigger than 3, tsunami force is bigger than the design equation.

Slide 39: *In this study, concerning about wall members design tsunami force is little bigger than estimated tsunami force, a equal to about 2.5. Concerning about column members design tsunami force is bigger than estimated tsunami force, a equal to about 2.0. As a result, the design equation for tsunami wave pressure is validated as a tsunami load equation for building structures. The paper also points out that there are examples of damage caused by the impact of floating debris. After giant tsunami generated by Sumatra earthquake, I often heard discussing the validity of 2n. I understand 3n is relatively bigger without soliton breakup, but 3 n is totally appropriate.*

5. Tsunami Load on a Building Model

Slide 40: *No. 4 is so short, but it is so important to confirm the validity of this equation. Now we will focus on a Next content is Tsunami Load on a Building Model.*

Slide 41: *hese are some cases studies about the safety of model buildings. A simple building model is postulated,*

and shear forces on the building due to tsunami and earthquake are compared. The structure model is shown here. A vertical load acting on the unit area of the floor is assumed at 13kN/m2, and the depth of the building is assumed to be 15m. At first, the number of floors of the building is fixed 4 floor, and Inundation depth is taken as a parameter, from 2m to 6m.

Slide 42: *In Building Code of Japan the design for seismic force is 2 steps of Primary design and Secondary design. Primary design is allowable stress design method which is elastic design. In Secondary design we confirm the bearing capacity and required bearing capacity. This is elasto-plastic design. I think it should be recommended to adopt elastic design but tsunami force is so big that we per haps can't elastic design perfectly. Refuge buildings for many people should be taken the safety factor into account. But we judged from as follows: Once again, the proposed equation for tsunami force is estimated of the head of tsunami wave near a shore line and in part of uniform flow following the head, tsunami force is little smaller than in part of the head. The proposed equation for tsunami force is a little bigger than maximum experimental force except for with soliton breakup. Bearing capacity of building is perhaps a little bigger than evaluation. I expect that structural engineers of refuge building recognize it.*

Slide 43: *This is equation of required bearing capacity Qun.*

If balanced building, Fes =1.0
In many regions, Z=1.0
If low building, Rt=1.0
If 1st floor, Ai=1.0, and story is upper, Ai is bigger
Usually Co=1.0
Ds and Wi are remained.

Slide 44: *Ds and Wi are so important factors for required bearing force (Qun) as to seismic force.*

Wi means the weight of this part. Ds means factor of ductility. If RC building, Ds=from 0.3 to 0.55.

The bigger Ds is, The more brittle building is. The building designed bigger Ds, bearing capacity (Qu) of building is demanded bigger capacity. In other words Brittle building is demanded big bearing capacity. The building is ductile, bearing capacity is demanded lower capacity than brittle building. In Japan structural design is ruled by seismic force, we compare tsunami force with Qun.

Slide 45: *Once again, a simple building model is postulated, and shear forces on the building due to tsunami and earthquake are compared. The structure model is shown here. A vertical load acting on the unit area of the floor is assumed at 13kN/m2 and the depth of the building is assumed to be 15m. The number of floors of the building is fixed 4 floor, and inundation depth is taken as the parameter, from 2m to 6m.*

Slide 46: *This is a figure comparing tsunami and earthquake for RC structure. The vertical axis is a story of building. The horizontal axis is a horizontal force, tsunami force on seismic load. This figure shows that for inundation depth 2m, the tsunami load is smaller than the earthquake load. Consideration of pressure-exposed surfaces may be needed, but consideration of structural frame is not so needed.*

Slide 47: *This figure shows for inundation depth 3m. If the inundation depth is deeper, tsunami force becomes bigger. Naturally, seismic load is not change.*

Slide 48: *This figure shows for inundation depth 4m.*

Slide 49: *This figure shows for inundation depth 5m.*

Slide 50: *This figure shows for inundation depth 6m. Tsunami force is much bigger than seismic force.*

Slide 51: *Next, Inundation depth is fixed at 3.0m, and the number of floors of the building is taken as the parameter from 2story to 6story.*

Slide 52: *This figure shows that for a 2-storey building, the tsunami load is bigger than the earthquake load. Both first and second floors require consideration of tsunami load.*

Slide 53: *This figure shows for a 3-storey building.*

Slide 54: *For a 4-storey building, the earthquake load is bigger than the tsunami load except for the first floor. All floors except the first floor may be omitted from consideration of the tsunami load.*

Slide 55: *This figure shows for a 5-storey building.*

Slide 56: *For a six-storey building the earthquake load is bigger than the tsunami load except Ds=0.3. As the number of floors of a building increases, the shear force due to the tsunami load becomes relatively small because the shear force due to earthquake becomes bigger. Like the same of this, as the depth of building becomes longer, the weight of building becomes heavier, the shear force due to tsunami becomes relatively small.*

Slide 57: *Lastly I will introduce you to the topics from the result of experimental designs for building structure. We used the plans of existing building and calculated 2 case which are a new building and an existing building. The way to consideration was the same I am talking today, and I will not talk the result. But there are interesting topics through the process of consideration. There are openings such as glass windows in front of the buildings and also back of the building. How should the glass windows be handled? When tsunami force act the glasses, they break and tsunami force is reduced. But there isn't no tsunami load. Supplementally, I will not talk today, we must take care of the refuge direction which is different from the case of fire.*

Slide 58: *Tsunami force is not perfectly clear for design, when it act the non-pressure-resistant member such as glass windows. In experimental design the equivalent pressure is used. The equivalent pressure is fixed the height 3 n.*

Slide 59: *These are the refuge buildings in some local government of Japan. But I'm sorry I don't grasp how to designate these buildings.*

Slide 60: *I wanted to introduce you to the equation of 3 n, and to comparison of the seismic force in Japan. Of cause, if the new building is planned, comparison with the seismic force is not needed, but I think the sense of load, tsunami, earthquake, wind, snow, permanent, and so forth is very important for structure engineer.*

Thank you for giving the chance to talk to you today.

Audience participant, thanked Mr. Ishikawa for his presentation and requested a transcript.

Public Discussion

Yumei Wang: All the PowerPoints will be available.

Kent Yu: What is the Performance level for building for earthquake shaking. Global force of tsunami verses global force of tsunami - Impact loading from cars and ships taken into consideration.

Harry Yeh: With bearing hinge, it is very good. Impact from debris – a countermeasure could be planting trees in front of the building.

James Bela: If a tsunami, could they measure the strains and pressure the building experiences?

Mr. Ishikawa: I do not think they are doing such.

Jay Wilson: Regarding existing tsunami evacuation structures in Japan, how have they dealt with issues of capacity regarding local population verses visiting population?

Mr. Ishikawa: It's similar to the diagram from Harry Yeh earlier. They tried to determine the area of the people who might go there. The existing shelters they just do consider how many people are going to put there. They try to accommodate all the people in that area. The tower is multipurpose right now and you couldn't afford to build many of those.

Maiclaire Bolton: There has been a lot of talk about public education. What is Japan's strategy? Do people understand about the use of these structures?

Harry Yeh: In Japan, it's different, it happens too many time and people become complacent. It's different in the United States – we forget. They try to educate and try to focus on K-12 education. They have a town meeting and the last few times they issued a warning, they found people don't go.

Jay Wilson: Design Codes question, will come back to it.

Kent Yu: What probabilities are required to design as Tsunami Evacuation Building, what other than school

buildings? How does the code, regulate the design requirements?

Harry Yeh: They don't have such kind of code – even for schools.

Jay Wilson: For the long-period shaking of the subduction zone earthquake, we have no code for a long-duration? Does Japan?

Harry Yeh: No, they don't have such kinds of codes yet. Whenever they think of a high-rise, they tend to think of long-duration shaking and try to design for that.

Javier Moncada: What is the cost of constructing a Tsunami Evacuation Building? In Japan, they try to utilize existing buildings.

11:30am
FEMA P646 AND P646A

John Hooper, Applied Technology Council, presented a PowerPoint presentation to discuss the following documents for Vertical Evacuation funded by FEMA and NOAA. He said these buildings have been done elsewhere; can it be done in the United States? YES! **[Go to PowerPoint slides, page 125]**

Guidelines for Design of Structures for Vertical Evacuation from Tsunamis (FEMA P646/June 2008)

Vertical Evacuation from Tsunamis: A guide for Community Officials (FEMA P646A/June 2009)

Design and Construction Guidance for Vertical Evacuation from Tsunami (ATC-64)

Jon Heintz: – FEMA told us there are greater possibilities in their grant program for possible funding than we were previously aware of.

12:00 noon
IF YOU BUILD IT, WILL THEY COME?: DESIGN AND SPACE ISSUES

Daniel Wirtala, Oregon State University graduate student, housing studies, presented a PowerPoint presentation. **[Go to PowerPoint slides, page 142]**

Jay Wilson: Glad to see this component addressing the public use/interface aspects that are practical applications of how well this gets integrated into the community – that's important if this is going to function and last for several generations. For this to work, the planning has to be tied to how it's utilized in the community – a functional component, a very smart approach. For Jay, to integrate City hall, with points being made for 24/7 accessibility it makes a lot of practical challenges of thinking through a lot of these.

STATE AND PROVINCIAL OVERVIEWS OF TSUNAMI EVACUATION BUILDING STRUCTURE EFFORTS

1:00 pm
Oregon State

Yumei Wang, DOGAMI, Co-leader and risk engineer: provided a PowerPoint presentation of what is currently going on in Oregon regarding tsunami preparedness. **[Go to PowerPoint slides, page 148]**

Harry Yeh, Coastal and Ocean Engineering, OSU, tsunami expert, provided a PowerPoint presentation of tsunami studies related to goal of a Tsunami Evacuation Building in Cannon Beach. **[Go to PowerPoint slides, page 162]**

Jay Raskin, Ecola Architects, Co-leader and architect: provided a PowerPoint presentation on the conceptual design of the Cannon Beach Tsunami Evacuation Building. **[Go to PowerPoint slides, page 176]**

Marcy Boyer, Chinook Geoservices, geotechnical engineer, provided a PowerPoint presentation regarding the anticipated site conditions and the effect on the soil surrounding Tsunami Evacuation Buildings during an earthquake/tsunami. The ground consists of Alluvial material that is generally liquefy-able and the rock that is not. **[Go to PowerPoint slides, page 179]**

Kent Yu, Degenkolb, Structural Engineer, structural design, provided a PowerPoint presentation on structural considerations of Tsunami Evacuation Buildings in Cannon Beach. **[Go to PowerPoint slides, page 182]**

Javier Moncada, Berger Abam, civil and coastal engineering: provided a PowerPoint presentation on wave deflection. **[Go to PowerPoint slides, page 189]**

Jay Raskin, provided a PowerPoint presentation on the implementation issues of the Cannon Beach Tsunami Evacuation Buildings. **[Go to PowerPoint slides, page 176]**

Public Discussion:

Daniel Cox: Lifelines, if you're going to use the building after the disaster, are you expecting there to be fresh water, sewer and water.

Jay Raskin: There will be a generator, will need storage water on site, missing link is a mechanical engineer.

Tim Walsh: Need an ADA ramp, elevator not sufficient.

Jay Raskin: We talked to people who said the elevator can be ADA and work after a large earthquake.

Peggy Pierson: If there is significant liquefaction, how to get to stairs if there is no ground there?

Marcy Boyer: We can do some type of ground improvement right by the stairs.

George Priest: What is the number of people using the meter squared number and how does that compare with the number you actually arrived at?

Jay Raskin: Harry's evacuation modeling is an important part of the feasibility study and still needs to be done.

2:00 pm
Washington State

Tim Walsh, Department of Natural Resources, provided a PowerPoint presentation on Washington tsunami preparedness efforts. **[Go to PowerPoint slides, page 192]**

Holly Winston: ODOT. Regarding a couple of bridges, she is wondering what Washington is doing on bridges and transportation network.

Tim Walsh: The bridges across Lake Washington are floating bridges, they are much more susceptible to tsunami damage than ground shaking damage. The 520 bridge will be replaced eventually, presently could withstand a 6 ft positive wave, but a 4 ft negative wave would make it slide off and fail completely. Those are the only 2 bridges we've been thinking about. We also thought bout the Hood Canal Bridge, but we don't know about any tsunami.

Holly Winston: Oregon Department of Transportation has done studies, earthquake is much more severe than tsunami forces, the gi liquefaction , we're scheduled to do three more studies in bridges in Lincoln City, south of Lincoln City. We were considering Washington and California for some of the studies for transportation.

Yumei Wang: Cal Trans has done a statewide tsunami study on their bridges –that's preliminary. Hawaii is working on it. California has not.

George Priest: Modeling a lake called Bradley Lake, certain number of time steps, subsidence is part of the model. We were really surprised of the amount of sloshing – it was difficult to tell if it was lake sloshing or tsunami wave action. Using PRML, you might have some real serious modeling problems.

Tim Walsh – We just had a landslide induced tsunami last month and killed two kids. Lake Spokane arm of Lake Roosevelt…tsunamis as big as 8 feet.

2:30 pm
California State

Lori Dengler, Professor of Geology at Humboldt State University: Provided a PowerPoint presentation on California's perspective on tsunami readiness and vertical evacuation. Found a partner that hasn't been mentioned here today, namely the Army Corps of Engineers to study the feasibility of a tsunami burm in a particular site. We need congress to write legislation to give them permission to do this study. **[Go to PowerPoint slides, page 208]**

Question from audience: Why is Crescent City affected so dramatically?

Lori Dengler: Five reasons: 1)offshore bathymetry 2) shape of shelf, 3)shape of basin, 4)exposure, 5)modifications done after 1964 redevelopment made susceptibility to modern tsunamis even greater.

3:15 pm
British Columbia

Maiclaire Bolton, British Columbia Provincial Emergency Program: Provided a PowerPoint presentation on they we have done in the province of BC.
[Go to PowerPoint slides, page 225]

George Priest: How are you defining high, medium, and low risk?

Maiclaire Bolton: The exposed outer side of the west coast has a higher risk.

Harry Yeh: Consider the landslide.

George Priest: I find your zone D astonishing – we're talking about a Cascadia – it's dead on for a local tsunami.

Harry Yeh: It's the inside of the Juan de Fuca though.

Tim Walsh: Modeling the tsunami coming into Victoria at about 3.5 meters.

Audience participant: Are there cliffs?

Maiclaire Bolton: There are areas wide open.

George Priest: We actually found quite a big difference in a distant and local tsunami coming into the Oregon Coast.

Maiclaire Bolton: The zones were designed for notification purposes rather than by hazard. These are the zones that have been defined for notation.

Audience participant: In terms of evacuation around midnight, how did people get out?

Maiclaire Bolton: I don't know how everyone got out when it was so dark. Everyone said that the first wave was their warning and figured it was going to get worse. Maximum wave was 10 meters for 1964 tsunami.

Althea Turner, OEM: Gave a report on the actual tsunami advisory in effect for the entire west coast.

3:45 pm
Group Discussion – Where do we go from here?

Yumei Wang, DOGAMI
Jay Raskin, Ecola Architects

Yumei Wang: It's been a very productive day, opening for Q/A.

Dan Cox: You talked about 1995 mapping from George Priest, policy was go to high ground, now we're thinking about vertical evacuation…is the mapping method changing to reflect that as well as maximum velocity data?

George Priest: No. The line is the line it's set in law and there are no velocities associated with it.

Dan Cox: If DOGAMI is encouraging vertical evacuation, what are they doing for this?

George Priest: We are remapping the coast over the next 4 years and we will publish the maximum velocity data with each of those studies.

Jay Raskin: We were able to use the data generated from that mapping for the Cannon Beach study.

Harry Yeh: It's such a simple method to estimate the forces for the flat bottom. That gives me some more confidence for that. We have to use similar different approach to make up the confidence.

George Priest: The caveat is that the Cannon Beach city hall's location. That simple model would break down in many other complex geometries.

Tim Walsh: What Harry was arguing is that numerical modeling value should never fall more than 20% below the analytical model.

Dan Cox: Why do you say that?

Tim Walsh: Harry's guidance was put in the manual to help other places who have not been able to do this.

Dan Cox: If you had two big buildings and you'd want to site something in between that?

Harry Yeh: That is different. If the numerical model for conservative, use the higher model…80%.

Mark Chubb Portland Emergency Management: Safety factor is 1.3 how is it used?

Harry Yeh: 1.3 comes from some uncertainties of the maximum run-up height. In the past experience, differences were about 30% gives you a little more confidence. Impact loading initial force, drag force. How quickly the material will stop at the impact, we do not know.

Mark Chubb: The uncertainties come first – how to estimate those uncertainties but what importance factors we should use for those uncertainties.

Jon Heintz: Load factors on tsunami loading are 1.0… same concept.

Ian Robertson: The importance factor is the 1.5 that we put on critical facilities.

Yumei Wang: That needs to be really transparent as we move forward. We all need to keep these issues in mind.

Bob Freitag: Discussion on regulation. National Flood Insurance Program produces a map which maps flood plane which maps velocity zone, etc. As the frequency information becomes more tight, and the frequency is actually lower, then the national flood insurance maps will take into account. Entire area would be designated a flood plane. Newer homes would have to be built a foot above it. If tsunamis are thought of a frequency of a 100 year event, they become part of the flood insurance program. I would like to see the flood insurance regulations start to take effect. A whole new set of tools come available.

Jay Raskin: Hilo this has already taken affect.

Nate Wood: Psychological issue – psychology standpoint there are examples of we know we can engineer it, we build it, moral hazard, people transfer responsibility – that will save me. Are we entering a world that creating one structure 3-4 blocks away from where someone might be saved. That could create a culture that if they're building that structure, there's no way I can make it to high ground. How do we make sure we're not creating more damage by making a Tsunami Evacuation Building. You could get one county coordinator that their whole job was to run evacuation drills. Funding wise this could make the communities more resilience.

Tim Walsh: George's priories of doing regional coastwide studies.

Nate Wood: They ran actual drills, out of hundreds of people, only 2 didn't make it. Let's maybe get DOGAMI or Oregon Emergency Management to run these drills. He wants to caution it to us all of a sudden embracing this as our solution. We have to be careful with that.

Tim Walsh: We encourage them to do the drills on a local basis, we make sure it's a photo op.

Nate Wood: The states and national programs could provide consistency on the national level.

Jay Raskin: We practice moving to high ground any time the ground shakes. We have local knowledge about how long it takes to get out of town – mostly for distant event. People tend to go to higher ground (2 or 3 times) than what we ask them to.

Tim Walsh: That's actually essential to make that work – those who can go to higher ground have to.

Jay Raskin: Education is very important.

Bob Freitag: Snoqualmie flooded in 80s every 5 years. Built 2 or 3 homes on stilts – they became acceptable. Now there are 100 homes elevated and the area can live with flooding. It could be so with Cannon Beach. The other side is the Pierce County issue. They put in sirens (Lahar problem), now realtors now say we don't have a Lahar problem because we have sirens.

Yumei Wang: We really need to address the social science aspect which often engineers and physical scientists don't appreciate as much. We need to expand our toolbox and just having this workshop does that. How we educate people will definitely need to change and we'll need to give clear, coherent directions to people.

Kent Yu: Studies, identify how many Tsunami Evacuation Buildings we need, in the meanwhile we are racing against time. We know FEMA has some funding there – how can we change the rules, win this race in the short term. Long term solution, we shouldn't think linear like engineers – we can do things simultaneously and work together toward this long term solution. We can't keep waiting.

George Priest: The obvious answer is it's dead simple that there are two or three places that will be at the top of the list. We can begin to move ahead with some no-brainers. After past those first 1 or 2 it gets difficult. Population issues, how do you balance that stuff – shades of gray.

Bob Freitag: When does the solution become the problem. It's built in Cannon Beach and it becomes like a levy and people start thinking differently and start doing more building in places like long beach.

George Priest: In the ideal world, it would only be senior citizens and the disabled.

Philip Slimko: Thanked the organizers and presenters, very excited about this application. What I've heard missing, (education of policy makers and public). You have to appeal to people emotionally, a marketing strategy, make it something they want to do, is it going to be of benefit to the community, beyond a structure to run up to for a tsunami. Involve the private sector, leasing retail space, restaurants, elevated structure with beautiful views, office space. Grants, if you use the right carrot and you can get a lot of private monies and you don't have reporting requirements. I hope you will work out some sort of strategy to make it work – work on a plan to make this work, because I think it's just excellent and it will work.

Yumei Wang: We need a strategic regional plan that looks for hot spots that prioritizes things and addresses social issues. This group should be committed to moving forward. At the same time, we need to take a multiple prong path so we can provide safety right now with implementation for those areas that are no-brainers. Phil, do you have some tangible ideas for magic carrots? U.S. Corps of Engineers, State Parks, Lottery Funds, Department of Transportation improving safety of their bridges

Philip Slimko: Private money – what are they interested in – making more money. Provide a structure, tax breaks, etc that they couldn't get through the legislature, where they could see a financial benefit. It makes business sense to them. Also helps the community by providing this safety structure.

George Priest: The stick approach works well too, honestly, for very little cost, small tweaking of the building code, you might very well be able to add a little bit more requirement. If you're pulling large number of people into the tsunami zone, you should help to pay for the Tsunami Evacuation Building structure – nice sign on the building saying a Tsunami Evacuation Building.

Philip Slimko: Like an earthquake area, alter the building codes.

Yumei Wang: If you're doing a major renovation of a hotel in a tsunami zone, you need to upgrade for tsunami codes.

Jon Heintz: There's a code change proposal IBC for tsunami upgrades, by Mike Mahone.

Kent Yu: In coastal region, when we design and build, they have to be Tsunami Evacuation Buildings, casinos, convention centers, they must be treated as Tsunami Evacuation Buildings.

Yumei Wang: Major occupancy buildings must have to be built to Tsunami Evacuation Building criteria. Jay said that's already part of the code – basic evacuation path…interpreted as if you can show there's a route to high ground, you're good.

Ian Robertson: If you're in a community that a horizontal evacuation is not available in a local tsunami, that's not adequate. In Hawaii, there is window protec-

tion on every new building. If it's a large community, building (300 or more) must be designed as a refuge.

Yumei Wang: We do not do that here.

Audience participant: I've worked in building code for a long time. Anything of this scale that you try to advance building code process almost always fails on first attempt. I encourage you to think more robustly about the social science things along with the other. We looked for more than 10 years on how to improve vertical evacuation buildings, elevators, American's with Disabilities Act, disabled people, we had pitiful solutions for getting folks out of buildings. We saw major (ASME) stakeholders withdraw their support because they didn't want to be liable. They delayed for more than 10 years (3- 3-year code cycles). The more you can integrate the social science part in, the stronger your proposal will be.

Veronica Cedillos: Glad people mentioned social issues, visited Banda Ache in March, one structure was completely locked. It wasn't being used at all. They couldn't pay the electricity bill. It's extremely important to focus on how the community will have ownership of the building (like access issues).

Yumei Wang: Especially for public private partnerships.

Philip Slimko: Could be based on the need for the community (i.e. basketball on the rough) it's very important you have uses for these things – daily use.

Jay Wilson: Daily use needs to be thought out because this may happen 1 time in our lives or our grandchildren's lifetime. This can't be an afterthought. Jay was looking at the difference between the two maps – zonation issues regarding building codes. High occupancy structures like schools, restrict that they could only be built in certain areas and would be made mandatory Tsunami Evacuation Buildings for schools. Look at both code and land use issues.

George Priest: Good point, you can't make zones unless the lines are drawn.

Jay Raskin: The nice thing about this latest generation of mapping, is that it gives us hard data for planning.

Veronica Cedillos: Bridges – it seems to me like if bridges can get people to higher ground, it would be cheaper to building earthquake/tsunami resistant bridges. Makes better case for cost-benefit and a lot of social issues as well.

Jay Raskin: Bridge, you go from state to state, individual situations are incredibly important. In Cannon Beach, we have a bridge the earthquake will destroy. If there is major subsidence, we might actually build a bridge but be the approaches could be eroded away. Let's just do a pedestrian bridge, a lot less expensive.

George Priest: Spoke with an Oregon Department of Transportation engineer, a pedestrian bridge is actually quite expensive because people weigh a lot. You have to design it to hold tremendous loads.

Javier Moncada: Private and public funded buildings – Tim mentioned tax incentives pushed in Washington.

Tim Walsh: We failed. What's necessary, you need to find a leg sponsor – at the moment we don't have one.

Yumei Wang: Have we every had parallel issues for the legislature, we get hit by winter storm every year, go to FEMA friends for money every year for a little bit of wind and a little bit of rain. Compared loss from Cascadia event than a storm. Jay's point about things being local – Washington has a sales tax and Oregon doesn't.

Kent Yu: Since OR, WA, AK, CA all share the same problem, a lot of people in congress. Should they form an alliance to approach the people in Washington DC. Individually we don't have enough power, as a group we would be more effective.

Tim Walsh: The NTHP exists for this purpose.

Jay Wilson: Was just talking with Patty Sutch (Western States Seismic Policy Council WSSPC) things underutilized are WSSPC and CREW as a mechanism for having that kind of regional buy-in. There is a national hazards congressional caucus that meets to discuss these issues. Some times the strongest decisions come

from them talking amongst themselves. Also the state commissions. These are very underutilized.

Peggy Peirson: Benton County will be a resource to coastal communities. We spend a lot of time on the coast and share the risk, please involve inlanders. Risk to vulnerable populations, lesson learned from hurricanes in gulf in 2005. A lot of these people vulnerable are very predictable – we know that now. If there isn't some kind of vertical evacuation and we don't do it now, we will be in the position of building a memorial later.

Tim Walsh: The Sholewater Indians, for elderly and infirmed, placard on their door when they're in and take it away when they're gone.

Bob Freitag: Showed a graph of a 1 story building and a 12 story building. Zero increase cost to build to tsunami standards. The higher the structure the more energy/design goes into it, and less cost to build to tsunami standards. Partnerships where the community can provide an additional floor, spaces, tax incentives, parking, etc that could be cost effective.

Maiclaire Bolton: Vice President of CREW talking. As CREW, when we sit down and look at projects for funding. This one had a huge champion in Yumei Wang. It's really nice to see that this has a region-wide application. Thank you to everybody. Great discussions and conversation amongst everyone. Thanks to the organizing committee. Well done.

Lori Dengler: This is a media moment due to the current tsunami advisory in effect.

Yumei Wang: Closing comments. Let's keep the conversation up and do more than we're doing to protect the public for tsunami safety. Thank you all for coming.