Infrastructure Vulnerability in a Catastrophic CSZ Event and Implications on Disaster Response for the Oregon Coast

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Abstract

Evidence of the last great Cascadia Subduction Zone (CSZ) rupture and similar events during the Indian Ocean Tsunami of 2004, suggest that a future subduction zone rupture along the coasts of Oregon and Washington will put large portions of the population and much of the local infrastructure at significant risk. Disaster response planners should anticipate that ground and water lifelines may be whole or in part, unusable for a period of days to weeks – creating greater reliance upon aviation assets and placing more importance on local leadership and emergency managers to emphasize self-sufficiency and community preparedness. This project will assess potential lifeline degradation following a CSZ event, examine current plans for preparedness, and make recommendations to improve future planning and preparedness.

Introduction

Lifelines are "systems or networks which provide for the circulation of people, goods, services, and information upon which health, safety, comfort, and economic activity depend" (Platt 1991, 173). Community lifelines include: roads and bridges, rail, airports, port facilities, electrical power transmission, water and waste water systems, petroleum and natural gas pipelines, landline, cellular, radio, and television communications systems. In a disaster scenario, lifelines connect affected areas with the unaffected world outside . The disruption of lifelines can severely hamper the ability of disaster responders to bring aid to communities.

The Willamette Valley and Oregon Coast face potential devastation from a catastrophic rupture of the Cascadia Subduction Zone (CSZ). Coastal areas would incur additional damage as they are also at risk from a resulting tsunami. The implications to damage over a great distance is that outside aid may have to come from resources situated much farther away than originally anticipated and that neighboring communities upon which mutual response partnerships may have been made might in fact be struggling to support their own affected populations. Statewide damage estimates from a CSZ Mw8.5 earthquake alone approach 8,000 casualties, 30,000 buildings destroyed, 17,300 households displaced, and over $12 million in economic losses (Wang and Clark 1999). Studies also suggest that 65 percent of police stations, fire stations, and emergency operations centers, 66 percent of schools, 82 percent of bridges and 71 percent of broadcasting stations will be usable or functioning the day after the earthquake (Wang and Clark 1999).

Anticipated Damage and Lifeline Viability

The city of Newport, Oregon is situated on the Central Oregon Coast. The population of Newport is 9,532 (2000 US Census), however tourist and seasonal employee populations can result in an additional 6,500 people at-risk from an extreme event. The addition of at-risk individuals has planning and resource implications for emergency planners. Lincoln County emergency managers estimate number of deaths from a great CSZ event to be near 5,000 county-wide.

Lincoln County Mw 8.5 CSZ Event Damage Estimates
Earthquake Only
(Wang and Clark 1999)

Injuries	Deaths*	Displaced Households	Households Req Shelter	Operational the day after the earthquake				
				Fire Stations	Police Stations	Schools	Bridges	Communication Systems
358	7	592	401	26%	22%	19%	51%	26%

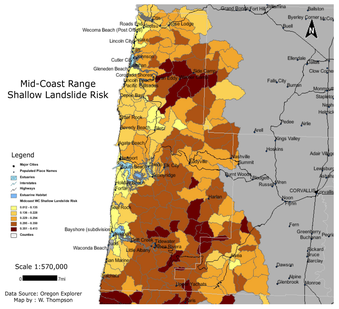
* Lincoln County Emergency Manager Estimates 5,000 people will die during a summer CSZ

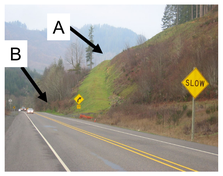
Communications – Degradation to communications will primarily come from the loss of broadcast and reception towers, transmission lines, and loss of power. In the 2004 Indian Ocean tsunami, cellular service was quickly restored, supplementing the loss of landlines (Ballantyne 2006).

Rail – During the 2004 Indian Ocean earthquake and tsunami railroad tracks were twisted like "pipe cleaners" (Ballantyne 2006). Similarly rail systems to the coast will most likely be unusable for an extended period of time.

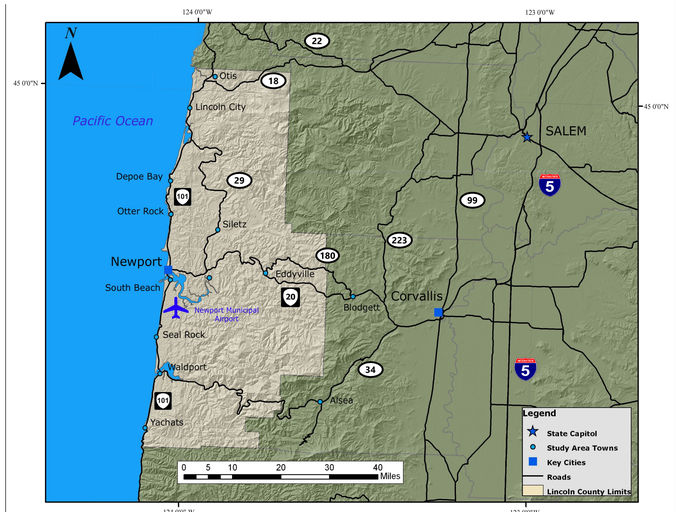
Roads – Roads are the primary lifelines into coast communities. Landslides in the Coast Range triggered by earthquakes, road surface rupture from shaking and displacement, and road loss from liquefaction will create temporary disruptions to surface movement. Professional estimates suggest that the Yaquina Bay Bridge will be destroyed if not by earthquake shaking, then by scour from the tsunami. Other, smaller bridges may experience similar affects. Planners should anticipate that all highways will be unusable.

Landslides





The map above depicts risk of landslide in the Coast Range. This risk is greater during periods of high precipitation or ground shaking. The image shows a road cut on Highway 20. A cut at mid-slope (A) allows moisture to infiltrate the slope, while the toe at B as has been removed. Both actions create conditions of instability. Research suggests that the 1700 Cascadia event caused numerous landslides (Ludwin et al. 2005). This scenario may repeat itself during a future CSZ event.



Airports – Estimates indicate that the Newport Municipal Airport will be usable after a CSZ event, although in a degraded capacity. The control tower and navigational aides will likely be destroyed, but the runway should remain fairly intact as the airport is located outside of areas subject to liquefaction and tsunami inundation. With runways of 5,400' and 3,000' the airport will be able to accommodate C-17s (3,500' min), C-130s (3,000' min) and C-27J (1,800' min).

Water and Wastewater – Pipe breakages will disrupt piped, potable water. Wells near the coast may experience salt water intrusion, rendering them unusable. Waste water transmission and treatment systems, to include septic systems, will also be disrupted and could pose a serious health risk.

Fuel Distribution Systems – The earthquake and tsunami will severely damage fuel delivery and distribution systems. Storage facilities will also be damaged if not in terms of their storage capacity, but in their ability to dispense fuel. A lack of fuel will severely impact the ability of systems (vehicles, generators, and heaters) to support the relief effort.

Port Facilities - Research (Wood and Good 2004) suggests that either an earthquake or subsequent tsunami will destroy most port facilities along Bay Street in Newport, to include docks, fuel, cold storage, power, marine repairs, and marine supplies. Main channel depth reductions from bank slumping and debris could render it unusable to fishing fleet craft.

Current Plans and Initiatives

Current planning incorporates the assumption that Newport can expect to be isolated to some extent for one to two weeks following a great CSZ event (Hawley 2008).

Fishing Fleet Agreement – The city of Newport has entered an agreement with the local fishing fleet to provide rescue and relief in the case of a large-scale disaster. At any given time one-third of the fishing fleet is out at sea, ensuring the relative safety of those assets and preserving them for a follow-on response effort.

Emergency Communications – Following a CSZ event many radio and television stations along the coast and in the Willamette Valley will be inoperative. In anticipation of this scenario, Lincoln County Emergency Managers have entered into a cooperative agreement with KBND 1100 AM in Bend, Oregon to broadcast emergency information following an earthquake or tsunami. Lincoln County also has a network of volunteer HAM radio operators. With access to electricity they will be able to establish contact outside of the affected area.

Helicopter Landing Zones – Lincoln County Emergency Managers have pre-identified helicopter landing zones. Helicopter landing zones can be used to stage casualties for medical evacuation and to receive and distribute bulk supplies.

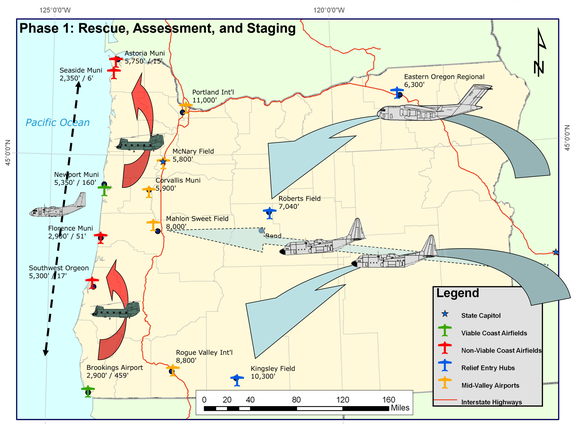
Recommendations

1. Relief planners must develop a Western Oregon response plan that supports near and deep action simultaneously. They must plan for an *air bridge*, which will deliberately bypass relief requirements in the Willamette Valley and direct their efforts and resources beyond the Coast Range to coastal communities.

2. The Coastal Natural Hazards Policy Working Group (OSG 1994) made a series of recommendations to mitigate potential lifeline loss in coastal communities. The group recommended that a multi-level, multi-agency group complete a lifeline infrastructure evaluation. This has not been completed. Specified agencies must complete an infrastructure evaluation, identify non-hazard related deficiencies, estimate the potential for hazard-related damage, and implement a plan for repairing deficiencies and/or developing redundant systems.

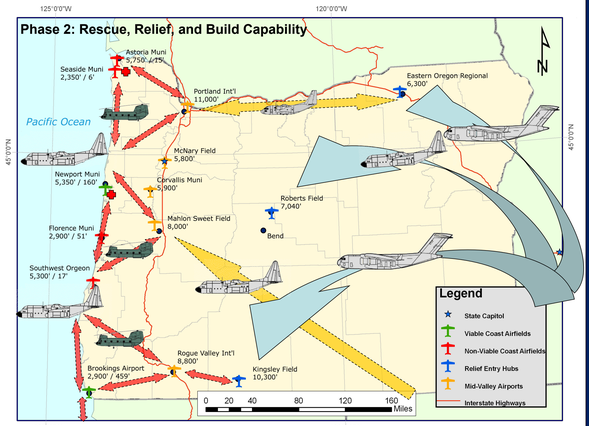
3. As a great CSZ earthquake will result in many communities being isolated, local preparedness and self-sufficiency is vital for survival. Individual households should create home emergency kits. Neighborhoods should hold disaster preparedness meetings during which they identify those with special needs, those with unique capabilities (medical, electrical skills, engineering, etc.), and the location of critical resources (generators or chainsaws). Community leadership should exercise current disaster plans, insisting that key personnel and community members participate.

Air Bridge Concept Recommendation



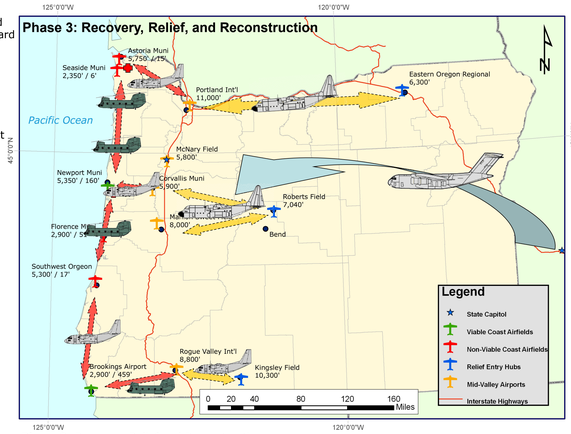
Phase 1: Rescue, Assessment, and Staging
Assumptions: Relief Entry Hub airfields are viable; one mid-valley airfield can accept short take-off and landing (STOL) aircraft; Oregon National Guard CH-47s can forward deploy from Pendleton; strategic airlift and cargo will come from outside of the Pacific Northwest; ground movement to and in-between coastal communities does not exist; I-5 disrupted in locations.
Actions:
- Bulk relief supplies are stocked in Relief Entry Hubs
- Fixed-wing aircraft conduct reconnaissance of coastal airfields.
- Emplace forward liaison teams to collect relief requirements.
- CH-47s confirm reconnaissance, deliver priority relief and air-evac urgent casualties.
- Container Delivery System (CDS) or bundle drops are used to re-supply areas where fixed-wing cannot land.

A C-130 drops supplies using container delivery systems (CDS). Such means of delivering bulk aid have been used in the past when lifelines were disrupted.



Phase 2: Rescue, Relief, and Build Capability
Assumptions: Two mid-valley airfields can accept fixed-wing traffic; two coastal airfields are viable – at least one can accept STOL aircraft.
Actions:
- Establish two forward medical treatment facilities on the coast.
- Build bulk fuel capacity in mid-valley and on coast.
- CH-47s run "ring routes" from mid-valley to coast in order to deliver relief and evacuate casualties.
- Expand reconnaissance to rural areas of coast range.
- Continue to build logistics base at Entry Hubs – prepare for jump these assets forward to Willamette Valley.
- Continue CDS drops as needed.

A CH-47 helicopter delivers bulk fuel. Each fuel blivet contains 500 gallons. Adequate fuel supplies are crucial to supporting disaster response activities.



Phase 3: Recovery, Relief and Reconstruction
Assumptions: Four mid-valley airfields can accept fixed-wing traffic; two coastal airfields can accept STOL aircraft and have bulk fuel available; mid-valley hospitals can meet all theater medical requirements; Interstates 5 and 84 can accommodate commercial trucking so that bulk aid, recovery, and reconstruction materials can move by surface; limited road access from mid-valley to coast now available; forty-percent of Highway 101 is usable.
Actions:
- Move main logistics and operations hubs to mid-valley locations.
- Create forward logistical operating bases at two coastal airfields
- Inter-theater airlift is on an as-needed basis, intra-theater airlift continues.
- Assist in restoration of lifelines.
- Coastal ring routes continue - CH-47s supplemented with C-27s.

Response Support Aircraft

CH-47 Chinook	
Cargo Capacity	Range
26,000 lbs.	300 NM
Litter Capacity	Min Runway
24	N/A

C-27 Spartan	
Cargo Capacity	Range
15,600 lbs.	1,500 NM
Litter Capacity	Min Runway
24	1800'

C-130 Hercules	
Cargo Capacity	Range
36,000 lbs.	2,049 NM
Litter Capacity	Min Runway
74	3,000

C-17 Globemaster III	
Cargo Capacity	Range
170,900 lbs.	2,400
Litter Capacity	Min Runway
36 / 54 ambul	3,500'

Images and maps by author unless noted.

References
Ballantyne, D. 2006. Lifelines - Summary Report on the Great Sumatra Earthquakes and Indian Ocean Tsunamis of 26 December 2004 and 28 March 2005. *Earthquake Spectra* 22:46-52.
Hawley, J. 2008. Personal communication with Jim Hawley, Lincoln County Emergency Manager. 9 February 2008.
Ludwin, R., Thrush, C., James, K., Buerge, D., Jonientz-Trisler, C., Rasmussen, J., Troost, K., and A. de los Angeles. 2005. Serpent Spirit-power Stories along the Seattle Fault. *Seismological Research Letters* 76(4):426-431.
Oregon Sea Grant. 1994. *Improving Natural Hazards Management on the Oregon Coast: Recommendations of the Coastal Natural Hazards Policy Working Group Sea Grant Report ORESU-T-94-002.* Corvallis, Oregon: Oregon State University.
Platt, R. 1991. Lifelines: An Emergency Management Priority for the United States in the 1990s. *Disasters* 15(2):172-176.
Wang, Y. and J. Clark. 1999. *Earthquake Damage in Oregon: Preliminary Estimates of Future Earthquake Losses.* Oregon Department of Geology and Mineral Industries Special Paper 29.
Wood, N. and J. Good. 2004. Vulnerability of Port and Harbor Communities to Earthquake and Tsunami Hazards: The Use of GIS in Community Hazard Planning. *Coastal Management* 32:243-269.

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