POLICY BRIEF

Reducing Interconnected Vulnerabilities in the Restoration Resilience of Pacific Northwest Lifeline Infrastructures for Major Disasters, Most Notably the Magnitude 9 Cascadia Subduction Zone Earthquake

This policy brief addresses a major inter-infrastructural vulnerability and associated weaknesses we have observed in current Cascadia Subduction Zone (CSZ) emergency planning and the preparation for restoration response to a magnitude 9.0 earthquake. Our findings are based on U.S. National Science Foundation-funded interviews with first-responder emergency management personnel and with frontline and control center infrastructure managers and operators in Oregon and Washington State.

This research focuses on the capacity for inter-infrastructure resilience in the restoration of critical lifeline infrastructure service in the aftermath of M9 events. Lifeline infrastructures of interest are critical ones providing real-time power (electricity and natural gas), water (potable supply, and wastewater disposal and treatment), telecommunications and road transportation. Our findings apply to responses in other major disasters, including wide-ranging wildfires, regional ice storms and watershed flooding.

The research

1. Our specific research centered on the capacity of personnel on the emergency response frontlines and in control rooms and maintenance departments in the four lifeline infrastructures to respond both to the shifted interconnectivities of these infrastructures during major emergencies and to the uncertainty posed by the shifts that challenge real-time response and restoration of services.

   Of particular concern are those interconnections unobserved or even unimagined beforehand. These only reveal themselves when a natural disaster results in interconnected infrastructure failures, and in the emergent interconnections thereafter required to respond quickly in the restoration of critical services. What had been "latent" interconnectivity now becomes "manifest" and must be dealt with in real time.

2. The vulnerability we are most concerned with is the need to support and enhance the ability of frontline personnel to address these real-time challenges in advance of M9 CSZ events or other major disasters.

3. We offer specific policy and programmatic suggestions for how current vulnerabilities in post-event restoration resilience can be avoided in the lifeline infrastructures.

4. Our research point of departure is that shifting interconnections between and among critical infrastructures have different configurations and that these differences matter for effective disaster preparedness, response and restoration.

   For example, two or more seemingly unrelated infrastructures can suddenly become mutually dependent as specific problems present themselves, thus posing major challenges to be prepared for in immediate emergency response and initial service restoration. Box 1 provides examples from our previous and current research.

Box 1 Examples of interconnectivities shifting from latent to manifest in disasters

- A road atop a levee depends on the levee for its existence. But a levee leak can suddenly lead to active functional reciprocal interdependence in fixing the leak. The road becomes vital as the only landside repair route to the levee for transport of repair crews and fill material, while levee leaking can cut off access, hindering repairs.

- A major road and an airport next to each other take on shared functionality when the airport and the road become links for onward transport of emergency supplies. If either one is too damaged to use as intended, then onward supply transport ceases for both of them.

- Firefighters and electricity infrastructure become more interconnected when the former set their firebreaks under accessible rights-of-way for electricity transmission lines, creating conflict between backfires needed by the firefighters and the risk of particulates from backfire smoke shorting out the electrical flow along the transmission lines, disrupting power supplies for firefighters and others.

- Restoring electricity is essential for other critical infrastructures to restore their services, yet electric service restoration depends on working telecoms and/or transportation access to lines and related equipment.

Key findings

5. Many interviewees have experience with shifting interconnectivities like those in Box 1. This deep experience with interconnectivity has several notable features.

   Foremost, our interviews with first-responder emergency staff and with frontline and control center infrastructure managers and operators in the two states indicate that a clarity can and often does emerge in their perceptions of the urgency, functional needs and specific requirements for service restoration in a disaster.

   Particularly noteworthy is the collaborative capacity of personnel in emergency management and lifeline infrastructure operations to achieve a shared clarity about, and situational awareness of, the overlapping dependencies between infrastructures whose shifts pose challenges for immediate emergency response and rapid restoration.

6. However, our interviewees indicate that some higher-level officials and planners may not have anticipated such shifts nor fully appreciate the granularity or accuracy of this clarity at lower operational and maintenance levels.

   Within the official national and state emergency management systems, improvisational actions taken at lower levels among control operators and maintenance personnel may be seen as a drift away from accountability or an infringement of higher responsibility to set priorities in light of their "bigger picture." Yet ingenuity in the form of on-the-fly improvisations and workarounds has been essential to frontline effectiveness.

7. Given the uncertainties and surprises in major events—including lower-level personnel unable to reach incident command staff—we see both clarity and ingenuity as key resources for emergency response and service restoration by first-responders from emergency management and frontline infrastructure staff in the field and control rooms.

Key implications and recommendations

8. We argue that providing for and supporting these first-responders and frontline staff require different approaches to contingency planning for major disasters before, during and after the emergency. It is extremely challenging but vital for the planning and regulatory agenda to include identifying and allowing for the managing of unforeseen latent inter-infrastructural interconnections and vulnerabilities *before* a CSZ earthquake happens.

9. More specifically, greater facilitation of inter-infrastructural communication, coordination and problem-solving ingenuity in restoration efforts will occur through joint contingency planning efforts, including cross-infrastructure table-tops, shared improvisation exercises, and best utilization of county/city hazard mitigation plans.

Important planning recommendations across infrastructure organizations appear in Box 2.

Box 2 Key recommendations for enhanced contingency planning

- Provide contingent resources, including spare parts distributed over geographic areas, as well as greater interoperability among infrastructures in regard to critical parts and software.
- Expand the job bandwidths of managerial and operational levels in key interconnected infrastructures.
- Real-time operations and maintenance personnel need to be given more time to devote to preparing for these types of large-scale emergencies.
- Improve further the vertical and lateral communications between and among the lifeline infrastructures so infrastructure staff can better use different communication technologies and pathways before the disaster, not just during it.

The need for more time to prepare is especially important and not just for frontline staff in water, roads, electricity and telecoms. Calls by our interviewees for more administrative support to manage and coordinate their local emergency preparedness should not be treated as just another routine complaint or a small deal when compared to other organizational, or city and county, priorities.

10. We also offer programmatic recommendations for state governments in Box 3.

Box 3 Key programmatic recommendations for states

- Create a Governor's Commission devoted to the promotion of inter-infrastructural resilience for the restoration of connected lifeline services.

  Upgrading this resilience will require joint planning and investment in personnel, equipment and facilities. This would include working with existing initiatives and programs, including but not limited to regular simulation exercises, whose participants continue to learn the importance of interconnected infrastructures both in preventing failures and in restoring services after major disasters.

- Identify specific opportunities currently overlooked within existing state programs, budgets and guidelines to facilitate shared clarity and joint ingenuity in cross-infrastructure responses for both normal operations and emergencies, including but not limited to budget and staff reallocations.

- Create a special state program for two-week readiness training (i.e., self-sufficient two weeks after the event) for major private and public sector entities. Program specifics would be adapted to local conditions as one size will not fit all.

- Consider combined tax incentives and regulatory requirements for privately-owned infrastructures to invest in inter-infrastructural emergency planning, interoperability for collaborative service restoration, joint simulations, and development of robust systems for joint communications and data sharing.

- Consider tax incentives for certified training of households (or other private sector entities) trained in two- week readiness, including potential reliance on Portland State University's professional certificate program in emergency management and community resilience.

We advise taking up these planning and programmatic opportunities in consultation with the many public/private groups who already understand the complexities of interconnected lifeline infrastructures. Without such consultation, the response and resilience capacities available to cope with a future M9 earthquake and its aftermaths may well fall short of what is needed.

(The authors of the policy brief are Emery Roe, Paul R. Schulman and Branden B. Johnson. Dated May 2025.)