



POST-EARTHQUAKE CLEARINGHOUSE ACTIVATIONS FOR RECENT U.S. EARTHQUAKES

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Abstract

Recent earthquakes in the U.S. have demonstrated the continued importance and growing number post-earthquake field investigations and reconnaissance. The reconnaissance community continues to grow and the number of individuals and teams conducting reconnaissance after earthquakes grows as well. Through its Learning from Earthquakes program, the Earthquake Engineering Research Institute (EERI) has increasingly played a role in the coordination of reconnaissance efforts, particularly for earthquakes in the United States. Through partnerships with U.S. federal and state agencies, EERI continues to build on the clearinghouse concept to facilitate collaboration and improve the efficiency and effectiveness of post-earthquake reconnaissance efforts. This paper describes the post-earthquake clearinghouse activation activities and outcomes for the 2014 South Napa, California Earthquake; the 2018 Anchorage, Alaska Earthquake; the 2019 Ridgecrest Earthquake Sequence; and the 2019-20 Puerto Rico Earthquake Sequence. Clearinghouse activations for these earthquakes leveraged advances in technology to improve the coordination and sharing of data and information. In-person and remote coordination meetings, a more robust virtual clearinghouse website for data and information sharing, and mobile data collection tools for capturing and mapping data were all used to support reconnaissance efforts. The 2014 South Napa earthquake clearinghouse activation was the first activation for an earthquake in a densely populated area of California since the 1994 Northridge earthquake. The South Napa clearinghouse coordinated over 100 participants, informed emergency management officials of public safety issues identified by participants, and captured impacts and lessons from the earthquake in a summary report. The South Napa clearinghouse also trialed new methods for collecting, mapping, and sharing information collected through reconnaissance. The 2018 Anchorage, Alaska earthquake response included a partial activation of the clearinghouse providing remote coordination of over 150 participants, 10 clearinghouse coordination calls, and information was shared through the an update virtual clearinghouse website. The Clearinghouse activation for this earthquake is being followed up with a one-year anniversary meeting to bring together the large group of people engaged in the earthquake response, recovery and research to highlight important lessons learned and identify areas for future study. The large earthquakes that occurred as part of the 2019 Ridgecrest Earthquake Sequence generated great interest among the technical community. The clearinghouse activation for the Ridgecrest Earthquake Sequence helped to coordinate over 200 participants through the 7-day activation of a physical clearinghouse location in Ridgecrest, 9 clearinghouse coordination meetings/calls, and continued efforts to collect and share information and findings from reconnaissance teams. The clearinghouse activations for these earthquakes have helped to ensure that the important lessons from these earthquakes continue to be captured, shared, and incorporated into plans and actions for increasing community resilience.

Keywords: Reconnaissance, Post-earthquake Clearinghouse



1 Background

1.1 EERI and the Learning from Earthquakes Program

The Earthquake Engineering Research Institute (EERI) is a technical society of engineers, practicing professionals, and researchers dedicated to reducing earthquake risk. Since its inception in 1949, EERI has conducted post-earthquake investigations for the purpose of improving the science and practice of earthquake engineering and earthquake hazard reduction. Formalized as the Learning from Earthquakes (LFE) program in 1973, the mission is to accelerate and increase learning from earthquake-induced disasters that affect the natural, built, social and political environments worldwide. The mission is accomplished through field reconnaissance, data collection and archiving, and dissemination of lessons and opportunities for reducing earthquake losses and increasing community resilience.

1.2 Technical Post –Earthquake Clearinghouses

In support of the LFE mission, EERI plays an important role in operating technical post-earthquake clearinghouses for major US earthquakes. A Post-earthquake provides a mechanism for field investigators to come together to coordinate and share observations. Post-earthquake clearinghouses play an important role in earthquake reconnaissance by facilitating and coordinating field investigation efforts. There are two components of a technical clearinghouse: a physical clearinghouse location and a virtual clearinghouse website.

1.2.1 Physical Clearinghouse Location

The physical clearinghouse location is a field office that provides investigators with a meeting location where they can hold informal meetings, understand the current state of investigations, and provides a place for in-person daily briefings. The most recent physical clearinghouse operations were for the 2014 South Napa Earthquake and the 2019 Ridgecrest Earthquake Sequence. For both of these events, the coordination provided through the clearinghouse helped to link investigators and facilitate information sharing.

1.2.2 Virtual Clearinghouse Website

In addition to operating physical clearinghouse locations, since 2009 EERI has also established Virtual Clearinghouse Websites for major earthquakes to quickly disseminate observations from investigators in the field with the broader community. Virtual Clearinghouse websites include multidisciplinary information such as media reports, data maps, and photos galleries to help inform field investigation efforts and the earthquake community in general. Most recently EERI has operated Virtual Clearinghouse Websites for the 2020 Puerto Rico Earthquake Sequence, the 2019 Ridgecrest Earthquake Sequence, the 2018 Anchorage, Alaska Earthquake, the 2015 Nepal Earthquake, and the 2014 South Napa Earthquake.

2 EERI's role in post-earthquake response in the U.S.

2.1 U.S. Post-Earthquake Investigations

“The Plan to Coordinate NEHRP Post-Earthquake Investigations,” (USGS Circular 1242), outlines a plan to coordinate a response to major U.S. and international earthquakes among the National Earthquake Hazards Reduction Program (NEHRP) Agencies and their partners. As a NEHRP partner, EERI has several roles defined in this plan. Specifically related to technical clearinghouses,



the plan states, “Within 24 hours following mutual consultation, the USGS, FEMA, and EERI will work with state agencies to organize a field technical clearinghouse.”

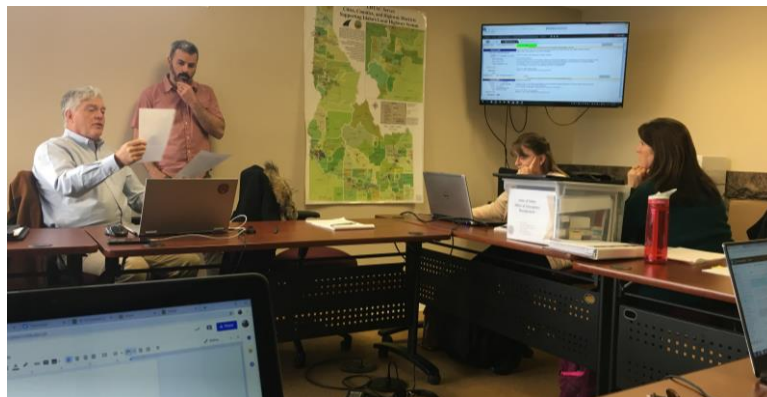
Following reports of a strong U.S. earthquake by the USGS, EERI coordinates with both the USGS and FEMA to determine the need and scope of a clearinghouse response for the earthquake. In some states, a state-specific clearinghouse plan exists. In these cases, EERI also coordinates with the appropriate state partners in considering the clearinghouse response.

2.2 California Earthquake Clearinghouse

EERI serves as vice-chair of the California Earthquake Clearinghouse which has been in continuous operation in some form since 1972. Since the 1994 Northridge earthquake there has been a more coordinated effort to include all organizations having responsibilities in post-earthquake investigations. The California Post-Earthquake Information Clearinghouse Operation Plan, outlines activation criteria and operations procedures for establishing and running a physical clearinghouse location after a major California earthquake. As vice-chair, EERI is responsible for operating clearinghouse locations in California and coordinating field investigators who check-in at the clearinghouse.

2.3 Idaho Clearinghouse

In partnership with EERI, the state of Idaho developed the Idaho Post-Earthquake Clearinghouse Operations Plan in 2019. Similar to California, EERI is a member of the Idaho Clearinghouse Management Team. The state exercised the clearinghouse plan as part of the Idaho statewide earthquake exercise in 2019. The clearinghouse management team set up a physical clearinghouse location and launched a virtual earthquake clearinghouse website as part of the exercise.



Physical clearinghouse location established according to the Idaho Post-Earthquake Clearinghouse Operations Plan which was trialed as part of the March 5-7, 2019 Idaho State Earthquake Exercise. (Photo: Emily Kleber)

2.4 Clearinghouse Partners

Successful clearinghouse activations depend on the participation and engagement of a wide range of partners. The number of individuals and organizations that participate in post-earthquake investigations and reconnaissance continues to grow. As demonstrated by the number of participants in the recent clearinghouses, there is a strong and passionate multi-disciplinary community conducting post-earthquake investigation to reduce the impacts of earthquake. Partners including academic researchers, practitioners, government agencies, professional societies, and non-profits are crucial to successful information sharing and coordination through the clearinghouse.



3 Recent clearinghouse activations

3.1 2014 M6.0 South Napa Earthquake

3.1.1 Clearinghouse Activation

In 2014, EERI staff operated the South Napa earthquake clearinghouse for three days after the event. The activation was extremely successful clearinghouse and coordinated investigations by over 100 individuals from 40 organizations, held 3 nightly, webcast briefings, and operated a virtual clearinghouse website for information dissemination.



South Napa Earthquake Clearinghouse Briefing in Napa, CA. (Photo: Anne Rosinski)

3.1.2 Dissemination of Findings

On Monday, September 15, 2014 the Earthquake Engineering Research Institute (EERI) and the Pacific Earthquake Engineering Research Center (PEER) cohosted a reconnaissance briefing of preliminary observations from the August 24, 2014 South Napa Earthquake. The briefing included the following presentations:

- Welcome by Jay Berger, EERI and Stephen Mahin, PEER
- Reconnaissance and Clearinghouse Overview by Marko Schotanus, Rutherford+Chekene, EERI & SEAOC
- Seismological and Geological Observations by Timothy Dawson, California Geological Survey
- Geotechnical Engineering by Jonathan Bray, UC Berkeley, GEER & PEER
- Structures by Andre Barbosa, Oregon State University, PEER & EERI
- Business Interruption and Resilience by Ibrahim Almufti, Arup & EERI
- Lifelines by Charles Scawthorn, PEER, SPA Risk, EERI & TCLEE
- Bridges by Abolhassan Astaneh-Asl, UC Berkeley

The briefing provided an opportunity to share reconnaissance findings with the broader community.

3.1.3 Capturing Lessons Learned & Research Needs

EERI coordinated with clearinghouse participants to develop a collaborative report to summarize reconnaissance efforts, earthquake impacts, and lessons learned. The multi-disciplinary report



includes sections on geosciences, geotechnical engineering, lifelines, performance of structures, emergency response, and economic impacts.

3.1.4 Lessons for Future Clearinghouse Activations

The California Earthquake Clearinghouse management team documented operations during the South Napa clearinghouse activation. A summary of activities, lessons learned, and recommendations for future clearinghouse activations are captured in the after-action report.

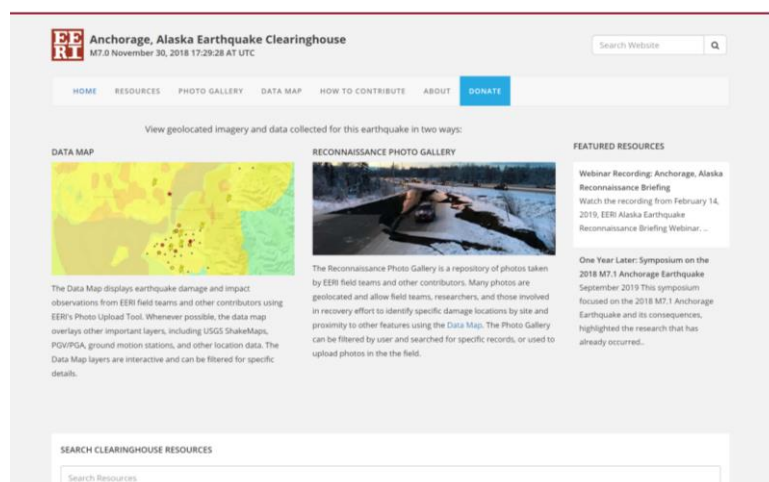
3.2 2018 M7.1 Anchorage, Alaska Earthquake

3.2.1 Clearinghouse Activation

Following the November 30, 2018 M7.1 Earthquake near Anchorage, Alaska, EERI coordinated with NEHRP partners USGS and FEMA to determine the need for a clearinghouse activation. EERI staff along with USGS and FEMA representatives, considered the earthquake magnitude, shaking intensity, and initial reports of impacts in determining whether a clearinghouse response was warranted. The presence of strong scientific and engineering community in Alaska was also considered.

Based on these factors, it was decided that a partial clearinghouse activation was most appropriate. As part of the partial activation, EERI established a Virtual Clearinghouse website with photos, data, and reports from the earthquake: <http://www.learningfromearthquakes.org/2018-11-30-anchorage-alaska/>. EERI named two local EERI members in Anchorage, John Thornley, Golder Associates, and Wael Hassan, University of Alaska, Anchorage, as the reconnaissance leads for the earthquake. Thornley and Hassan facilitated on-the-ground coordination of teams and individuals that travelled to Alaska to conduct reconnaissance. Beginning on December 1, 2018, EERI hosted regular clearinghouse briefings. Briefings were held both via web-conferencing and an in-person location. Over 100 individuals participated in the nine Clearinghouse Briefings in December 2018/January 2019. Notes from all briefings were distributed to call participants.

The calls provided an opportunity for participants to share observations, information, and data, and also allowed teams and individuals to coordinate their efforts.



Screenshot of the 2018 M7.1 Anchorage, Alaska Earthquake Virtual Clearinghouse Website.



3.2.2 Dissemination of Findings

In order to share reconnaissance findings with a broader audience EERI organized two information-sharing events. On February 14, 2019, hosted a webinar titled, “Anchorage, Alaska Earthquake Reconnaissance Briefing Webinar.” Over 400 people attended the 90 minute webinar. The webinar featured speakers who conducted reconnaissance following the November 30, 2018: M7.0 earthquake. Presentations included:

- EERI Response and Coordination: Heidi Tremayne, EERI;
- Earthquake Overview: Mike West, Alaska Earthquake Center;
- Emergency Management & Response: Amanda Siok, FEMA Region X;
- Geotechnical Impacts: John Thornley, Golder; and
- Structural Engineering Impacts: Wael Hassan, University of Alaska, Anchorage

On March 8, 2019, a session on the Anchorage Earthquake was conducted at the EERI Annual Meeting in Vancouver, British Columbia. Over 50 people attended the session. This session included the following presentations:

- Geotechnical Engineering Reconnaissance of the 2018 Mw 7.0 Anchorage, Alaska Earthquake by Christine Beyzaei, GEER/SAGE Engineers
- Strong Ground Motion Observations and Aftershock Deployment by Jamison Steidl, USGS
- USGS Instrumented Buildings Anchorage, Alaska by Erol Kalkan, USGS
- Structural and Nonstructural Damage by Wael Hassan, University of Alaska, Anchorage
- NIST Deployment to Anchorage, AK 2018 Cook Inlet Earthquake by Jay Harris, NIST

Presentations from these sessions are available on the virtual clearinghouse website for the earthquake.

3.2.3 Capturing Lessons and Research Needs

The M7.1 November 30, 2018 Anchorage, Alaska earthquake presented a major learning opportunity for the U.S. earthquake risk reduction community. With support from the USGS and the National Science Foundation, EERI co-led the organization of, “One Year Later: Symposium on the 2018 M7.1 Anchorage Earthquake.”

The symposium provided the opportunity to bring the community together to assess the scope of post-earthquake investigations, summarize the major lessons learned, and identify areas for future research and improvements in practice.

The summary brought together over 130 diverse stakeholders who participated in response, recovery, and post-earthquake investigations. The meeting began with opening remarks from state and local officials including Alaska Lt. Governor Kevin Meyer, Anchorage Mayor Ethan Berkowitz, and an emotional presentation from Anchorage Municipal Manager William (Bill) Falsey, who emphasized that despite the lack of widespread impacts to the built environment, the 2018 earthquake had a profound impact on the people who lived through it.

During the two days of the symposium, colleagues discussed major lessons learned from the earthquake and looked forward to next steps for mitigation in Alaska and beyond. Along with 11



breakout sessions on technical topics, the meeting featured lunchtime plenaries focused on impacts on teachers, parents, and students and a media panel describing the role of media in disseminating earthquake impact information. The meeting closed with a day-long field trip to locations impacted by the earthquake including the Port of Alaska and Gruening Middle School in Eagle River which remained closed due to major structural damage caused by the earthquake last year.

3.2.4 Lessons for Future Clearinghouse Activations

The partial clearinghouse activation provided another opportunity to make incremental improvements in clearinghouse operations including formalizing best practices for facilitating clearinghouse briefing calls. The activation also highlighted continued needs to improve data sharing protocols to ensure that data collected is shared and accessible to the broader community.

3.3 2019 Ridgecrest Earthquake Sequence

3.3.1 Clearinghouse Activation

Immediately following the M6.4 July 4, 2019 earthquake, as Vice-Chair of the California Earthquake Clearinghouse, EERI coordinated with the California Geological Survey to activate and establish a physical clearinghouse location in Ridgecrest, California. The physical clearinghouse location was opened on Friday, July 5, 2019. Two EERI staff members and one intern traveled to Ridgecrest to staff the clearinghouse. EERI staff met with all participants who checked into the clearinghouse, described preferred methods of collecting data, and provided an overview of other reconnaissance efforts. EERI also facilitated nightly briefing calls to allow participants to share information and coordinate with each other. The physical clearinghouse was operational from July 5th to 12th. There were a total of nine evening briefings, six were held in Ridgecrest from July 5 – July 11, and after the Clearinghouse physical location closed, three more virtual clearinghouse briefings were conducted on July 15, 22, and August 12. More than 150 people participated in the briefings over the course of the 9 calls. EERI also established a virtual clearinghouse website for the earthquake sequence to compile preliminary reports and data: <http://learningfromearthquakes.org/2019-07-04-searles-valley/>.

During its seven days of operation, over 60 experts visited the physical clearinghouse location and participated in reconnaissance activities. Their expertise spanned many disciplines: geosciences, geotechnical engineering, structural engineering, nonstructural components, insurance, lifelines, transportation, government, risk analysis, and business continuity. They represented over 20 organizations.



Ridgecrest Earthquake Clearinghouse Briefing in Ridgecrest, CA. (Photo: Maria Luisa Jiminian)



3.3.1 Dissemination of Findings

On August 14, 2019, EERI hosted the Ridgecrest Earthquake Sequence Reconnaissance Briefing Webinar. During this webinar, speakers presented their initial observations from field investigations conducted shortly after the earthquake. The briefing included the following presentations:

- Welcome: Cindy Pridmore, California Geological Survey
- Earthquake Overview: Ken Hudnut, USGS
- Geological Observations: Janis Hernandez, CGS
- Geotechnical Engineering Impacts: Jon Stewart, UCLA/GEER
- Structural Engineering Impacts: Wayne Chang, Structural Focus

3.3.2 Capturing Lessons Learned and Research Needs

With the large number of earth scientists and engineers in California, there have and will be many opportunities to share lessons and findings. In order to highlight major findings, with support of the USGS and NSF, EERI is developing 3 sessions to be part of the 2020 National Earthquake Conference in San Diego, California. These sessions will highlight major findings and lessons learned in engineering and science. Posters will also provide an opportunity to help capture the breadth of post-earthquake investigations. A plenary session will provide an opportunity to capture lessons from local responders.

3.3.3 Lessons for Future Clearinghouse Activations

As the first activation of a physical clearinghouse since the 2014 South Napa earthquake, there were many improvements that had been adopted into operations that enhanced the functionality of the clearinghouse. However, there were also many new lessons learned that can improve future clearinghouse operations. Staffing approaches, communication with a local community, and coordinating technical investigations to identify gaps are all areas where improvements can be made. These lessons will be documented in an after action report to be produced by the California Earthquake Clearinghouse.

3.4 2020 Puerto Rico Earthquake Sequence

3.4.1 Clearinghouse Activation

Similar to the 2019 Anchorage Earthquake clearinghouse activation, in discussions between EERI, the USGS, and FEMA, a partial clearinghouse activation was conducted in response to the 2020 Puerto Rico Earthquake sequence. EERI established a virtual clearinghouse website and conducted virtual clearinghouse calls. To date, five calls were hosted providing an opportunity to for over 100 participants to share information and coordinate plans.

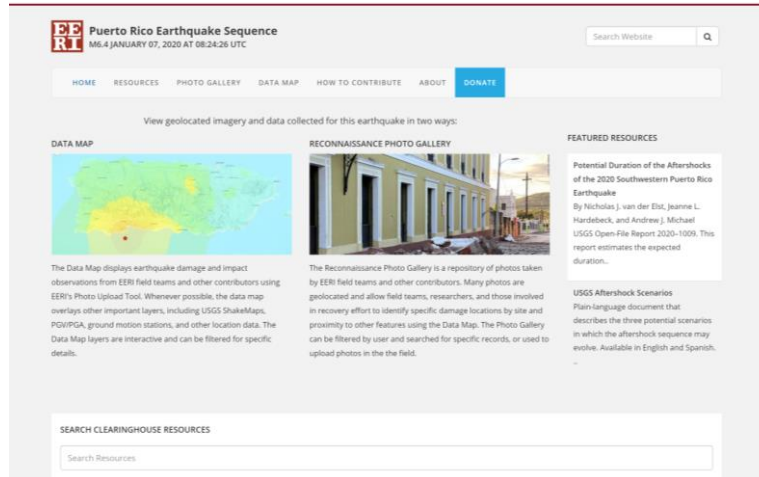
3.4.2 Dissemination of Findings

In order to share preliminary findings from earthquake investigations, two sessions are being organized as part of the 2020 National Earthquake Conference. One session will summarize reconnaissance findings and one session will provide an opportunity to hear experiences and lessons learned from local responders.



3.4.3 Lessons for Future Clearinghouse Activations

EERI plans to assess clearinghouse operations and capture lessons for future clearinghouse activations.



Screenshot of the 2020 Puerto Rico Earthquake Sequence Virtual Clearinghouse Website.

4 Future Opportunities for Improved Clearinghouse Activations

4.1 Improved Coordination with Local Responders

While recent clearinghouse activations have successfully helped investigators coordinate, a clear area for improvement is the need for better communication flow between the clearinghouse and local officials and responders. In both the 2014 South Napa and 2019 Ridgecrest activations, clearinghouse participants identified public safety issues that were communicated to local officials through state partners. Improved protocols for this type of information sharing would streamline communication of this important information.



Left: *South Napa Earthquake Clearinghouse participants shared observations that initial barricading practices could potentially pose a public safety risk given the likelihood of aftershocks. (Photo: David L. McCormick).* **Right:** *Building in Ridgecrest, California that was red-tagged following observations from a clearinghouse participant (Photo: Janiele Maffei)*



4.2 Increasing Disciplinary Diversity of Clearinghouse Participants

Participation of earth science and engineering investigators has been strong in recent clearinghouse activations. There is a need to increase the participation from the social science fields. Broadening the participation of clearinghouse participants will capture the broader impacts of the earthquake on individuals and communities.

4.3 Improved International Clearinghouse Coordination

The extent of impacts of recent U.S. earthquakes have limited the participation of international reconnaissance teams. However, it is anticipated that a major earthquake near a large urban center, in the U.S. or around the world, will draw many international researchers. Recent earthquakes such as the 2017 Puebla-Morelos, Mexico earthquake and the 2018 Palu, Indonesia Earthquake and Tsunami demonstrate the international interest in learning from these events. By developing best practices for coordination between local partners and international teams through a clearinghouse, the burden on the local community can be decreased and the documentation of important lessons can be achieved.

5 Conclusion

Recent earthquakes have highlighted the benefits of a coordinated clearinghouse response and demonstrate areas for improvement for future activations. EERI continues to collaborate with clearinghouse partners to be able to operate a clearinghouse after the next major U.S. earthquake and to be able to provide support to international colleagues for a non-U.S. earthquake.

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