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Editorial: NHERI 2015–2025: a decade of discovery in natural hazards engineering

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Editorial on the Research Topic
NHERI 2015–2025: a decade of discovery in natural hazards engineering

Natural hazards such as earthquakes, windstorms, tsunamis and storm surge are all occurring with increased frequency and intensity. These events often cause significant disruptions to our built environment consisting of buildings, roads, bridges, parks, streets, and systems that provide transportation, water, power, and more, bringing to the forefront our need for resilient solutions. In the United States alone from 2015–2024, there have been 13 earthquakes of magnitude 6.4 or greater resulting in 2 deaths, 134 injuries, 250 houses destroyed, and 1937 homes damaged. The total cost of these events was 6.1 billion dollars (NGDC/WDS, 2025). Internationally earthquakes pose an even greater threat with deaths counted in the thousands, e.g., Nepal, 2015; Indonesia, 2018; Haiti, 2021; Turkey, 2023; Myanmar, 2025. Over the last 5 years (2020–2024), there were just 16 days on average between U.S. billion-dollar disaster events compared to 82 days in the 1980s. Billion-dollar severe storm events including tornadoes, hail and high winds have caused on average $37.9 billion in damage, while hurricanes are the costliest hazard type since 1980, with an average cost of $23.0 billion per event (NOAA, 2025). Furthermore, the U.S. has been impacted by landfalling category 4 or 5 hurricanes in six of the last 8 years (i.e., Harvey, Irma, Maria, Michael, Laura, Ida, Ian, Helene), which is the highest frequency on record (AOML, 2025).

In response to the increasing threat of natural hazards, the National Science Foundation funded the Natural Hazards Engineering Research Infrastructure (NHERI) starting in 2015. NHERI is a national, 12-component, distributed network of institutions focused on research that both mitigates damage and increases resilience from natural hazards such as hurricanes and other extreme windstorms, storm surge, tsunami waves, and earthquakes (see Figure 1 in Blain et al. this Research Topic). After almost a decade of operations, the Research Topic "*NHERI 2015–2025: A Decade of Discovery in Natural Hazards Engineering*" examines

how the NHERI network has changed the way people practice and conduct research in natural hazards engineering. This capstone Research Topic expands upon early advances (Ramirez et al., 2020; Blain and Ramirez, 2023) and emphasizes the NHERI network's lasting impact—specific ways that NHERI has innovated engineering research and practice that leads to resilience of the built environment in the face of natural hazards that are ever more frequent and destructive.

Five state-of-the-art, experimental facilities that tackle hazards from wind and earthquakes are highlighted in this Research Topic. Stokoe et al. describe advances in seismic subsurface imaging and *in-situ* characterization of liquefaction, among other things, using large-scale, one-of-a-kind, mobile field shakers and associated instrumentation. DeJong et al. detail how hypergravity experiments conducted with unique, world-class geotechnical centrifuges provide a new approach to explore the motion of multiphase media such as soil-foundation-structure interactions. The value of the tallest ever shake of a full-scale building structure, a ten-story mass timber building equipped with nonstructural components conducted by the outdoor shake table (LHPOST), is illustrated in McCartney et al. Metwally et al. discuss the value of integrating a downburst simulator with hurricane winds generated by the "Wall of Wind" to understand the complex interactions between wind forces and urban environments. Lastly, Cao et al. portray how directional structural testing in real-time using a cyber-physical simulation technique can be extended to include multi-physics (soil-foundation-structure interactions and fluid-soil-structure interactions) and multi-hazard (wind and earthquake) applications.

Other important components of the NHERI network whose impact is included in this Research Topic include DesignSafe, the leading and accredited cyberinfrastructure for engineering and social science research related to natural hazards. Rathje et al. share the vast capabilities and resources of the DesignSafe cyberinfrastructure that enable sophisticated simulations and data-driven workflows that accelerates natural hazards engineering research across the network. Within NHERI is a social sciences hub, CONVERGE, that connects seven Extreme Events Research/Reconnaissance (EER) networks. Innovations that unify and streamline the acquisition of post-event reconnaissance data is conveyed by Alam et al. Pham and Arul provide an example of DesignSafe data re-use. At the SimCenter, an open-source, modular framework detailed by Zsarnoczay et al. integrates performance-based engineering methodologies with regional scale assessments to enable multi-hazard, multi-scale simulations; key contributions include improved inventory generation, damage simulation, and recovery analysis, with applications extending across multiple hazard domains. Finally, activities of the Network Coordination Office (NCO), detailed by Blain et al., engage all facilities within NHERI through centralized governance, communication, and education activities that unite the natural hazards research community and amplify NHERI's impact. The components and impact of the extremely successful pipeline for engineering education designed and executed by the NCO are described by Nelson et al. and Meselhe et al. presents a case study of student authors' experience participating in one such program, the NSF NHERI Research Experience for Undergraduates (REU).

While NHERI's first decade is certainly marked by its groundbreaking experiments, the articles in this Research Topic not only archive continued advancement of knowledge and innovations aimed at mitigating the harmful impacts of natural hazards, but also reveal its defining legacy in the creation of a fully integrated research ecosystem. This Research Topic of papers demonstrates that weaving together physical testing, cyberinfrastructure, advanced simulation, and a coordinated community, NHERI has not only established a new paradigm for natural hazards engineering but continually raises the bar for what is possible in the field, laying the groundwork for the discoveries of the decade to come.

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