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Editorial: Recent advances in risk and community resilience analysis against windstorms

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Editorial on the Research Topic
Recent advances in risk and community resilience analysis against windstorms

Severe windstorms, such as tropical cyclones and tornadoes, are among the costliest natural hazards that significantly impact many communities around the world. The intensity and frequency of these hazards are exacerbated by climate change and the subsequent consequences are amplified by the current trend of urbanization in wind-prone areas. Recent windstorm events (e.g., Hurricane Ian in 2022, the 2021 Western Kentucky Tornado, Hurricane Ida in 2021, the 2020 Easter Tornado Outbreak, and Typhoon Goni in 2020) highlight the importance of improving the resilience of our built environment and its supporting infrastructure against these catastrophic storms. As a result, there is an urgent need to advance our modeling solutions to estimate the resilience of our communities against windstorms such that informed decisions can be made regarding mitigation strategies. The intricate interaction between various interdependent physical and socio-economic systems within the community with the multi-hazard nature of these storms offers many scientific and engineering innovation opportunities within this field. Within this context, this Research Topic contains four articles that aim to provide new insights into the various aspects of windstorm risk and resilience, from understanding the social and physical impacts of hurricane-induced winds to predicting building damage and designing structures to withstand extreme wind loads.

The first article, "Mazumder et al." presents a new framework for studying the social and physical impacts of hurricane-induced winds at the community level. The authors developed a computational framework to simulate the scenario of a hurricane impacting a community. Hurricane wind field is simulated using a parametric wind field model that creates synthetic hurricane tracks based on historical data. This approach enables the estimate of gust wind speed at the location of each building which is used by a stochastic damage simulation algorithm to assess the buildings' physical damage. The framework, then, uses the buildings' physical damage to estimate the direct financial losses and social impacts (e.g., household dislocation, employment disruption, and education disruption). The framework is applied to the community of Onslow County, North Carolina which develops a better understanding of the interplay between social and physical impacts.

The second article, "Klepac et al." presents a data-driven machine learning framework to predict building-level damage from future hurricanes. The framework uses exposure and hazard data as input for a classification algorithm (random forest) to categorize building vulnerability into discrete damage states (i.e., No Damage, Non-Structural Damage, and Structural Damage). The exposure data includes the building's structural, geometric, and geospatial features while the hazard data includes wind speed and water inundation. The framework is trained using available reconnaissance datasets for four hurricanes: Hurricanes Harvey (2017), Irma (2017), Michael (2018), and Laura (2020). The hindcast accuracy of the random forest algorithm is 76%. Finally, this article shows that the results from the framework outperform FEMA's Hazus Multi-Hazard Hurricane Model, which yielded 47% accuracy. This comparison offers insights into alternatives for forecasting models given the variability of rapidly available data used in the ML framework as presented.

The third article, "Bedwell et al." explores the influence of the changes to the wind-load provisions in ASCE 7–16, which is adopted in the Florida Building Code, on the vulnerability of residential construction in Florida. The authors, in this study, use the vulnerability model framework within the Florida Public Hurricane Loss Projection Model. The study focuses on the development and implementation of these changes within the model and provides more insights into the effectiveness of such changes to improve community resilience.

The final article, "Bain et al." focuses on the design of stick-framed wood roofs under tornado wind loads. The authors present a comprehensive study of the behavior of stick-framed wood roofs under tornado wind loads and provide design guidelines for improving the resilience of these structures. The study is conducted using a non-linear finite element model of a stick-framed roof that is designed following the guidelines in the National Building Code of Canada. The most notable findings, regarding design requirements to withstand EF-2 tornadoes, are an improved gable end frame, adding hurricane ties at all roof-to-wall connections, and increasing the number of nails at various connections.

In conclusion, this Research Topic provides valuable insights into the risk and resilience against windstorms and highlights the importance of continued research in this area. The articles presented in this Research Topic demonstrate the use of innovative approaches to understanding windstorm risk and improving resilience, and provide important contributions to the field of windstorm risk and resilience analysis. We hope that this Research Topic will serve as a valuable resource for researchers, practitioners, and policymakers working in this area.

Author contributions

AA wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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