The Role of Interdisciplinary Field Studies in Fortifying Structural Recovery Modeling

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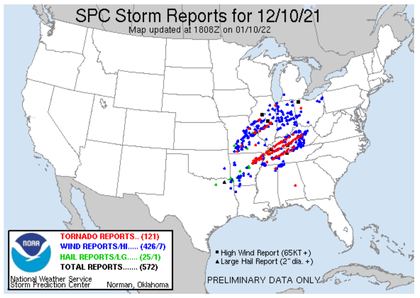
Tornado Outbreak

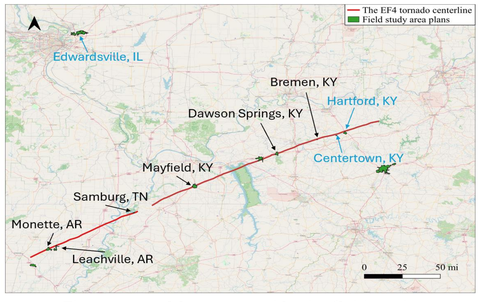
Tornado hazard (December 10-11, 2021)

- Quad-State Tornado
- $3.9 billion (2022 USD) in damages
- More than 90 fatalities and at least 667 people injured
- 2 EF4, 6 EF3, 15 EF2, 30 EF1, and 17 EF0 tornadoes
- The high-end EF4 tornado had a path length of 266.67 km (165.7 miles), a maximum width of 1.82 km (1.13 miles), and a peak wind speed of 84.94 m/s (190 mph)
- A team of 11 researchers developed a plan to launch a longitudinal field study in the impacted area



Community Selection

- Social susceptibility driven considering long-term outcomes for median household income, population, number of households, number of housing units, and educational attainment.



The communities surveyed in the field study

Metric implementation to select communities

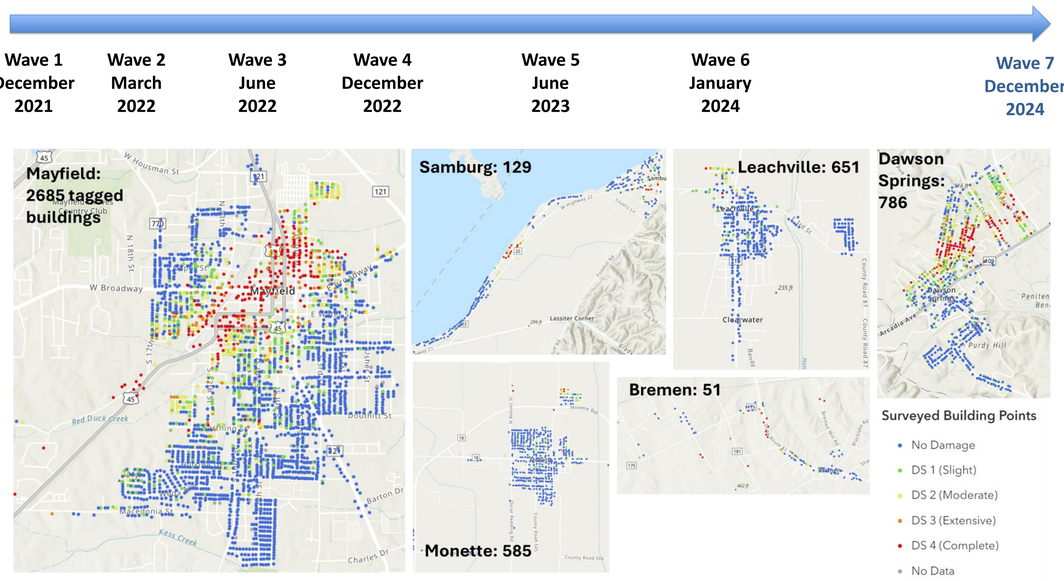
Town of Interest	Social Susceptibility Metric	Social Susceptibility Tier	Predicted Outcome for Monitoring Factors Based on Social Susceptibility	Qualitative Extent of Damage
Leachville, AR	0.895	Very Low Social Susceptibility	Marked Stability	Low
Edwardsville, IL	1.587	Very Low Social Susceptibility	Marked Stability	Very Low
Samburg, TN	3.470	Low Social Susceptibility	Stability	High
Mayfield, KY (Graves County)	5.101	High Social Susceptibility	Decline	*
Bremen, KY	5.395	Very High Social Susceptibility	Marked Decline	Moderate
Mayfield, KY	5.847	Very High Social Susceptibility	Marked Decline	Very High
Monette, AR	6.081	Very High Social Susceptibility	Marked Decline	Very Low
Centertown, KY	6.957	Very High Social Susceptibility	Marked Decline	Very Low
Hartford, KY	8.265	Very High Social Susceptibility	Marked Decline	Low
Dawson Springs, KY	8.453	Very High Social Susceptibility	Marked Decline	High

Key Objectives

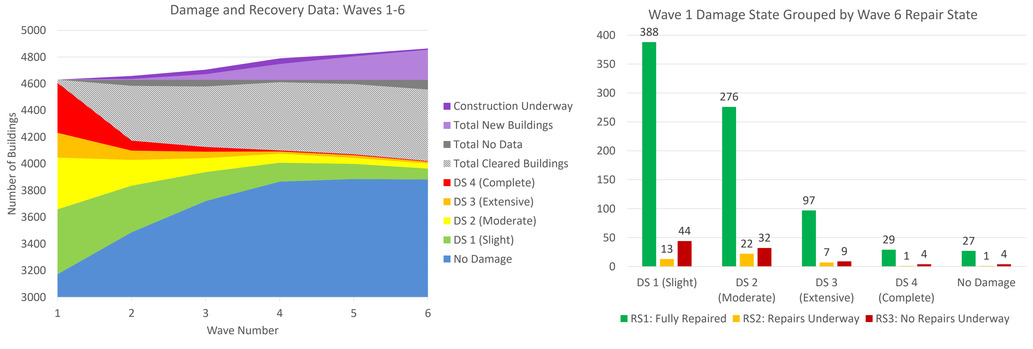
1. **Document initial damage in a set of communities simultaneously impacted by the tornado outbreak using both IN-CORE Damage State tiers and EF-Scale Degree of Damage tiers to develop robust mapping between metrics.**
2. **Track recovery of the building stock in these communities in the form of both repairs and reconstructions.**
3. **Compile results to augment public data repositories and to help in validating generalizable damage and recovery models.**

Data Collection, Data Processing, and Data Visualization

- Passive, vehicle-mounted, 360° video data
- Extreme Events Web Viewer (EEWV) for long-term preservation, processing, and data attribution



Wave 1 damage state results for the communities surveyed



Damage states across waves

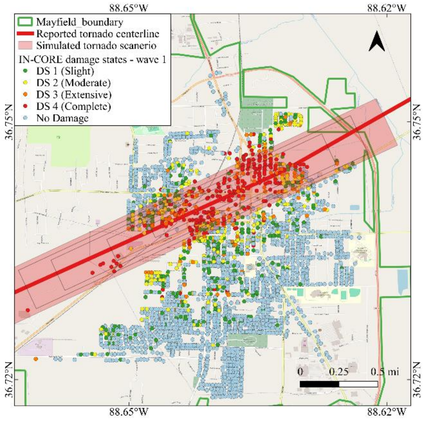
What is IN-CORE?

- The CoE, funded by the National Institute of Standards Technology (NIST), developed a multi-disciplinary computational environment that models natural hazard impacts and resilience planning called IN-CORE (Interdependent Networked Community Resilience modeling Environment).
- This open-source computational environment is designed to integrate physical infrastructure with socio-economic systems and to perform community resilience assessment affected by various natural hazards.

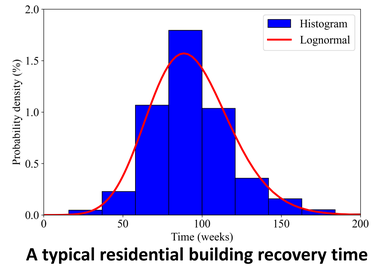
Scan here to see the IN-CORE manual and example analyses!

Community Resilience Model Validation

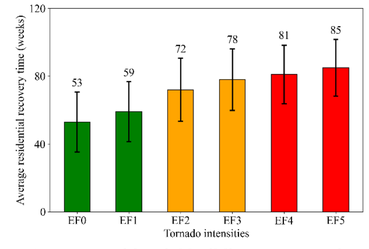
- The recovery model is a two-step recovery process prediction: functional downtime due to delay and repair.
- Another building cleared and reconstruction case will soon be incorporated into the current recovery model.



Mayfield building damage states with the idealized tornado model



A typical residential building recovery time



Average residential building recovery time

References

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Acknowledgments