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Untangling Population Interaction with Climate Hazards using Location-based Data

Ali Mostafavi

Associate Professor

Director, UrbanResilience.AI Lab

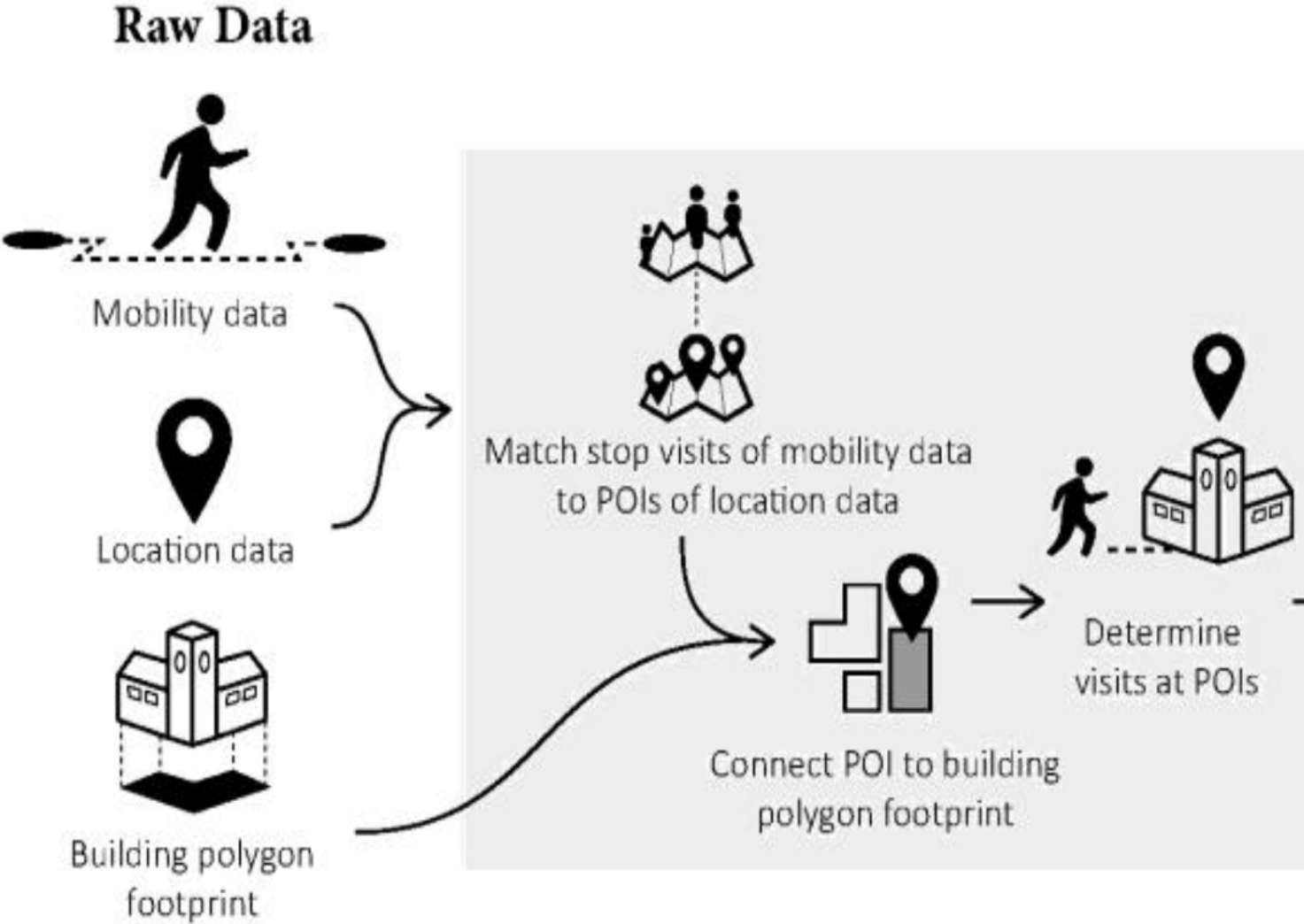
Department of Civil and Environmental Engineering

Texas A&M University

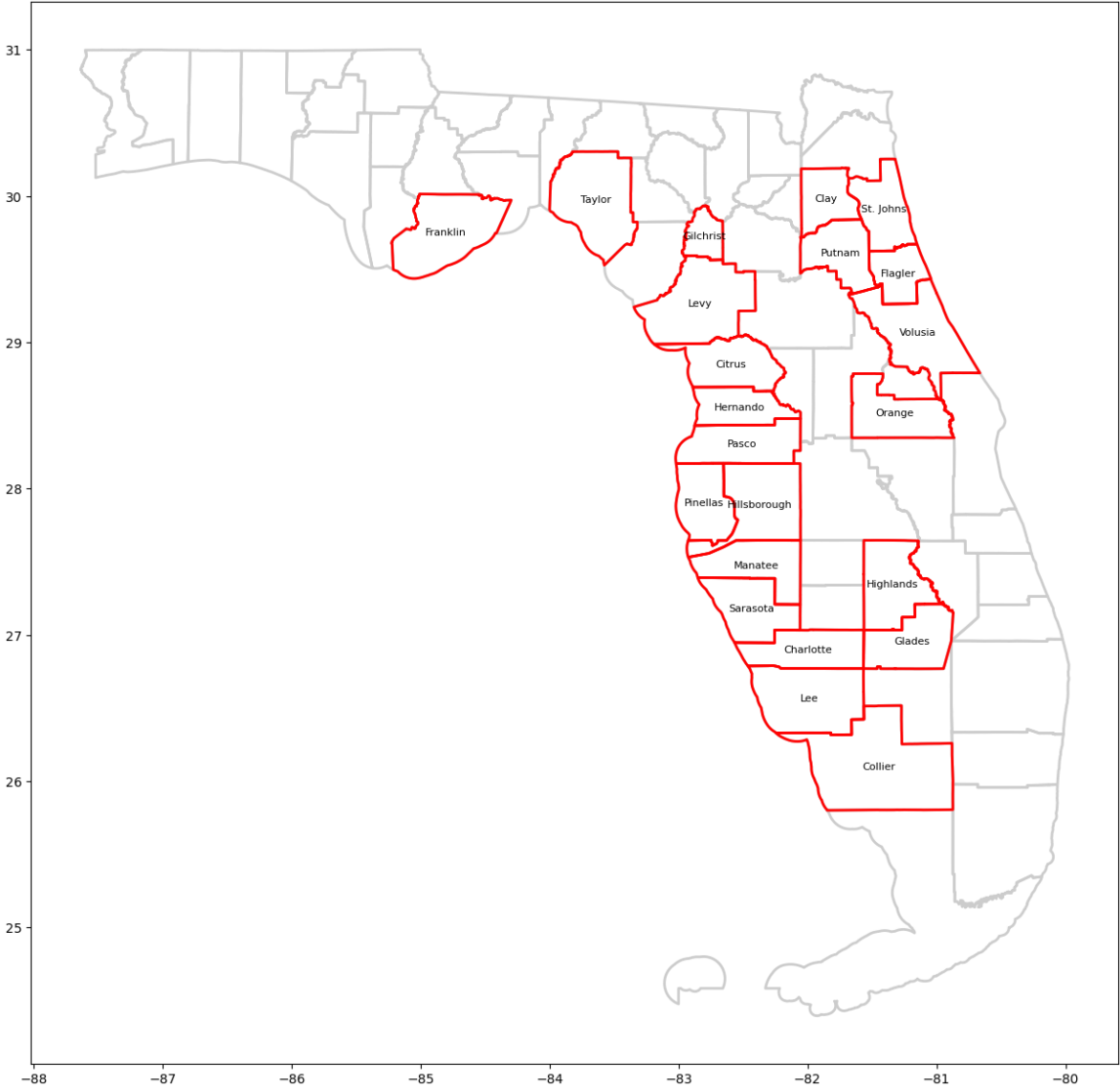
NASEM Workshop

March 2024

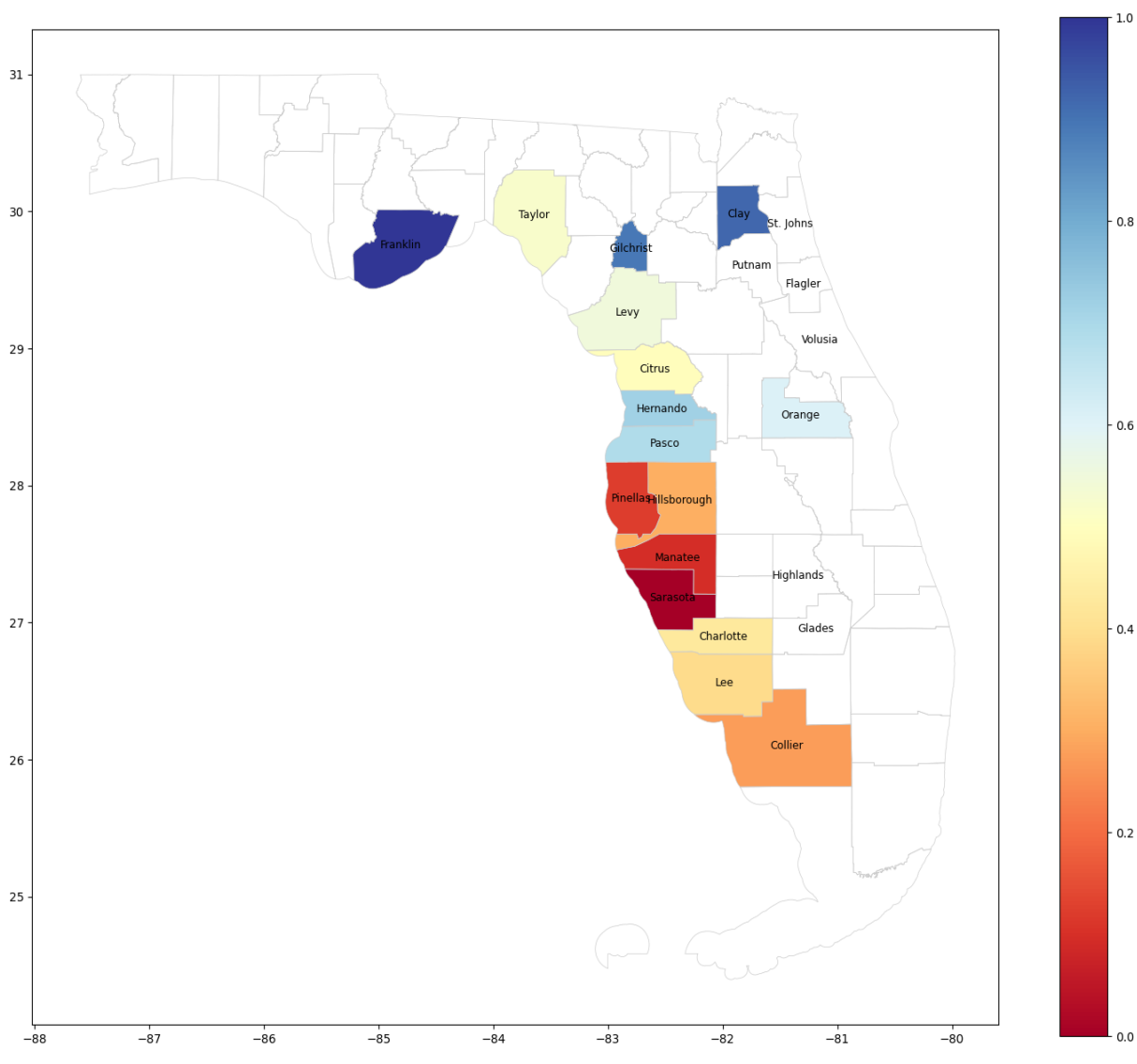
Location-based Human Mobility Data



Study 1: Hurricane Evacuation Monitoring

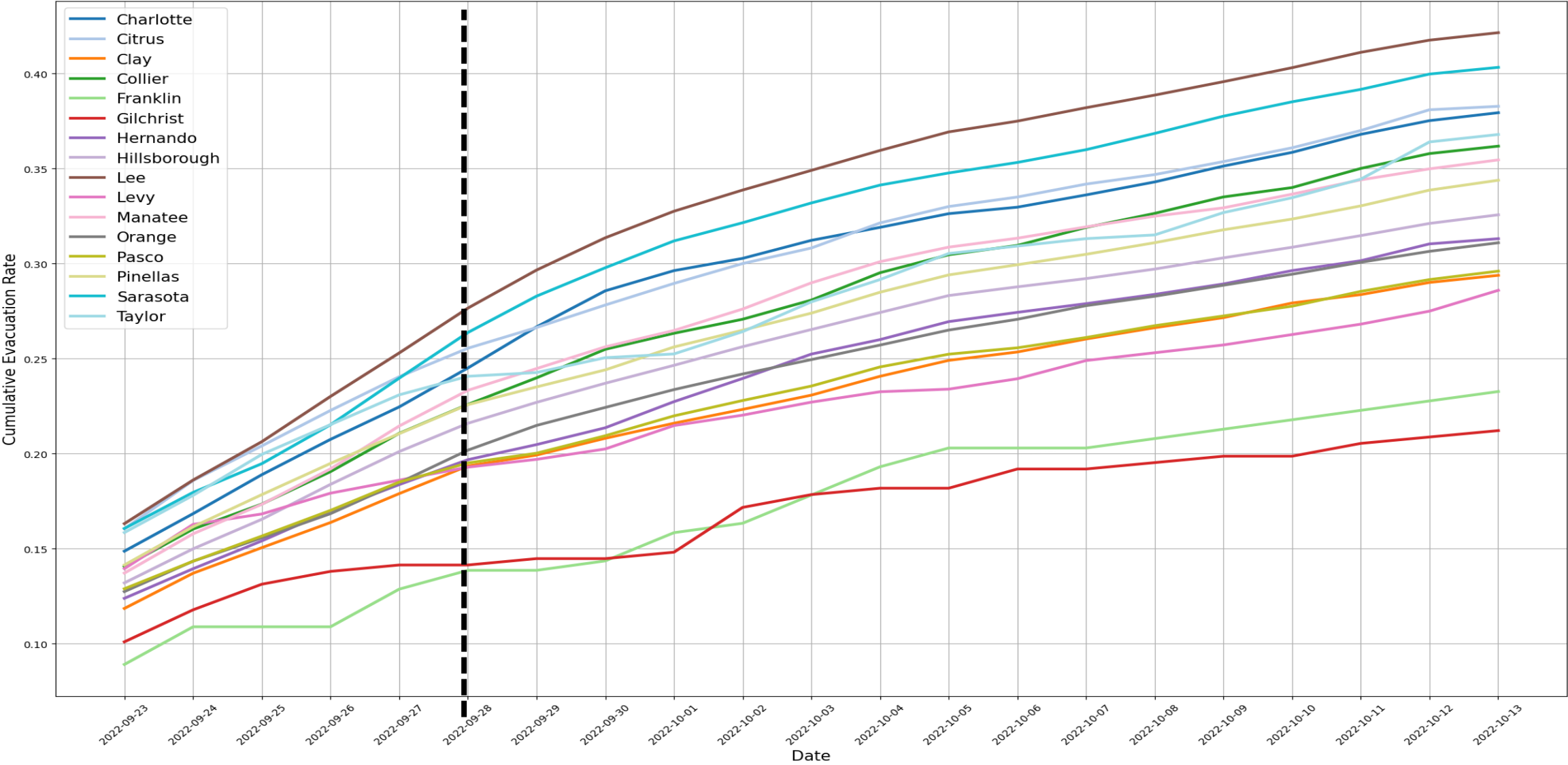


Counties in Evacuation Zone

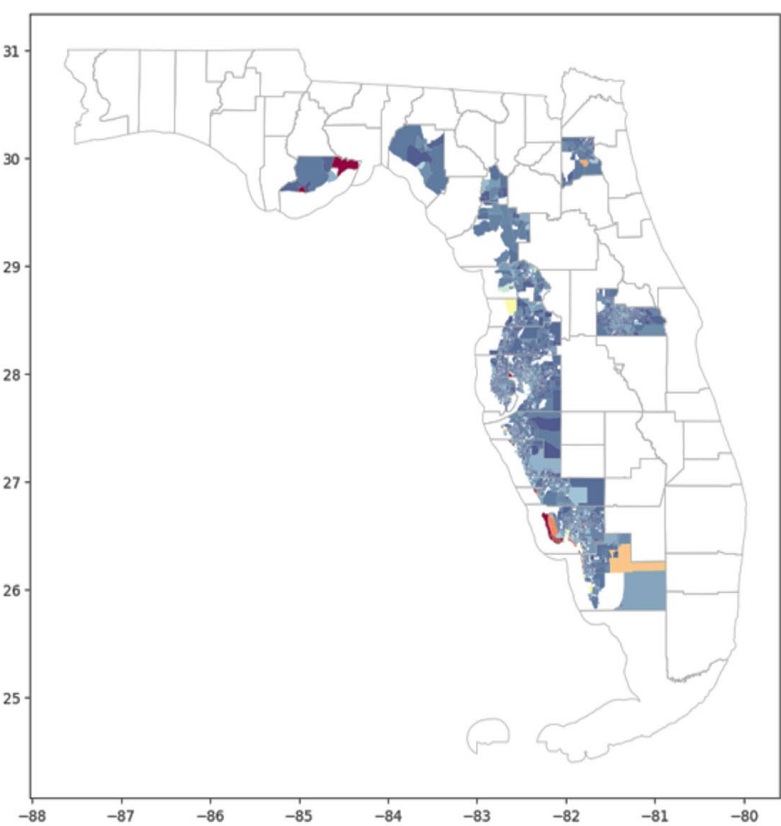


Evacuation Proactivity

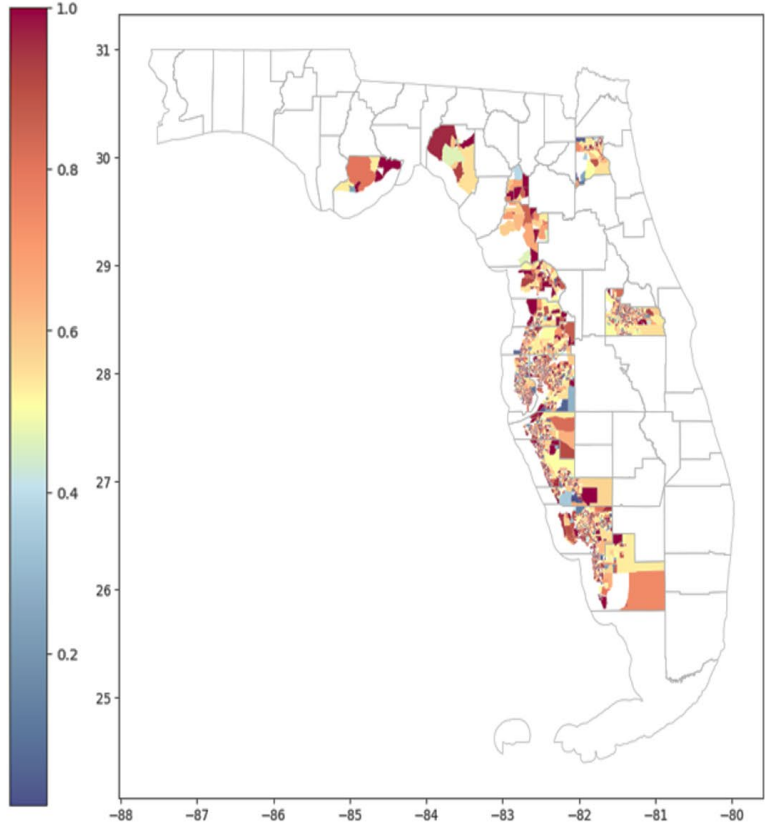
Tracking Evacuation Trends



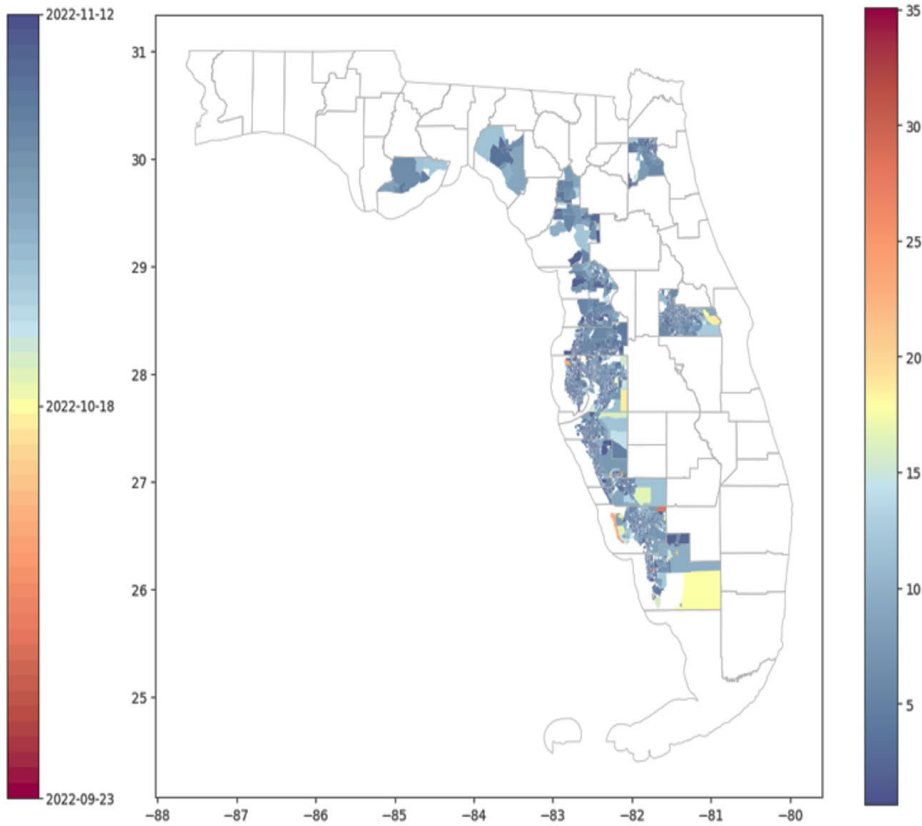
Tracking Evacuation Behaviors at Scale



Evacuation Rate



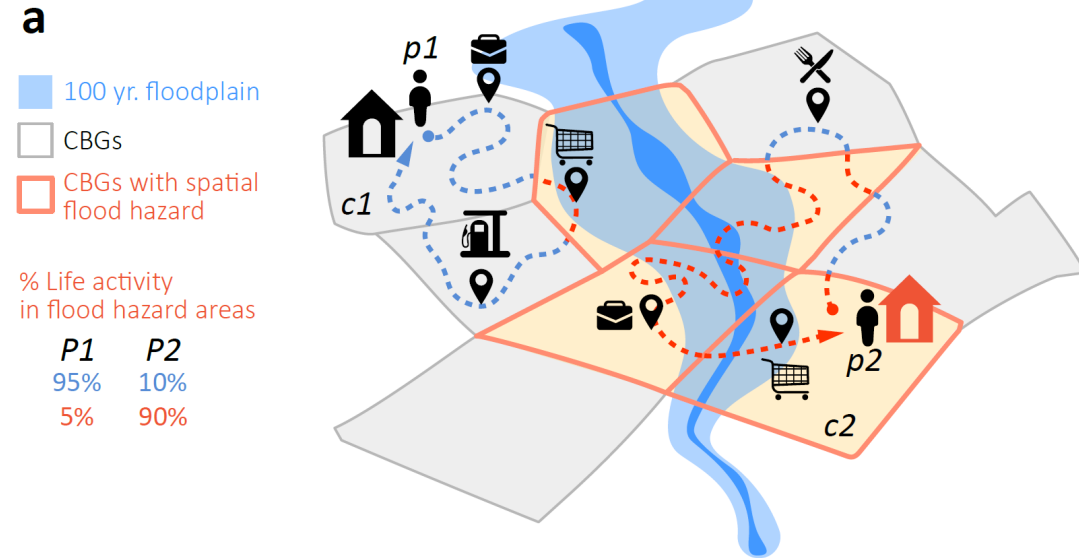
Evacuation Date



Evacuation Distance

Study 2: Human-centric Flood Risk Assessment

- **LAFE:** life activity flood exposure
- **PLAFE:** population life activity flood exposure
- **Latent Flood Exposure:** populations residing outside recognized flood-prone areas at considerable risk due to daily activities
- **Latent Flood Immunity:** flood-hazard zones show surprisingly low LAFE due to dwell time in places outside flood-hazard areas

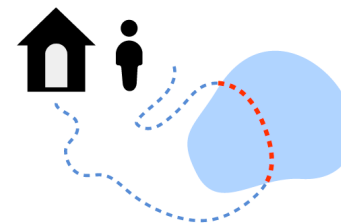


$$PLAFE = \frac{\text{(population life activity flood exposure)}}{\text{(Population Life activity flood exposure)}} = \frac{pop_{c1} \times 0.05 + pop_{c2} \times 0.9 \dots}{pop_{c1} + pop_{c2} \dots}$$

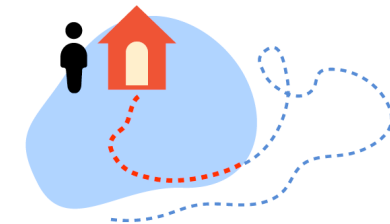
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$$\left\{ \frac{\text{CBG population} \times \text{LAFE}}{\text{County population}} \right\}$$

b Latent flood exposure

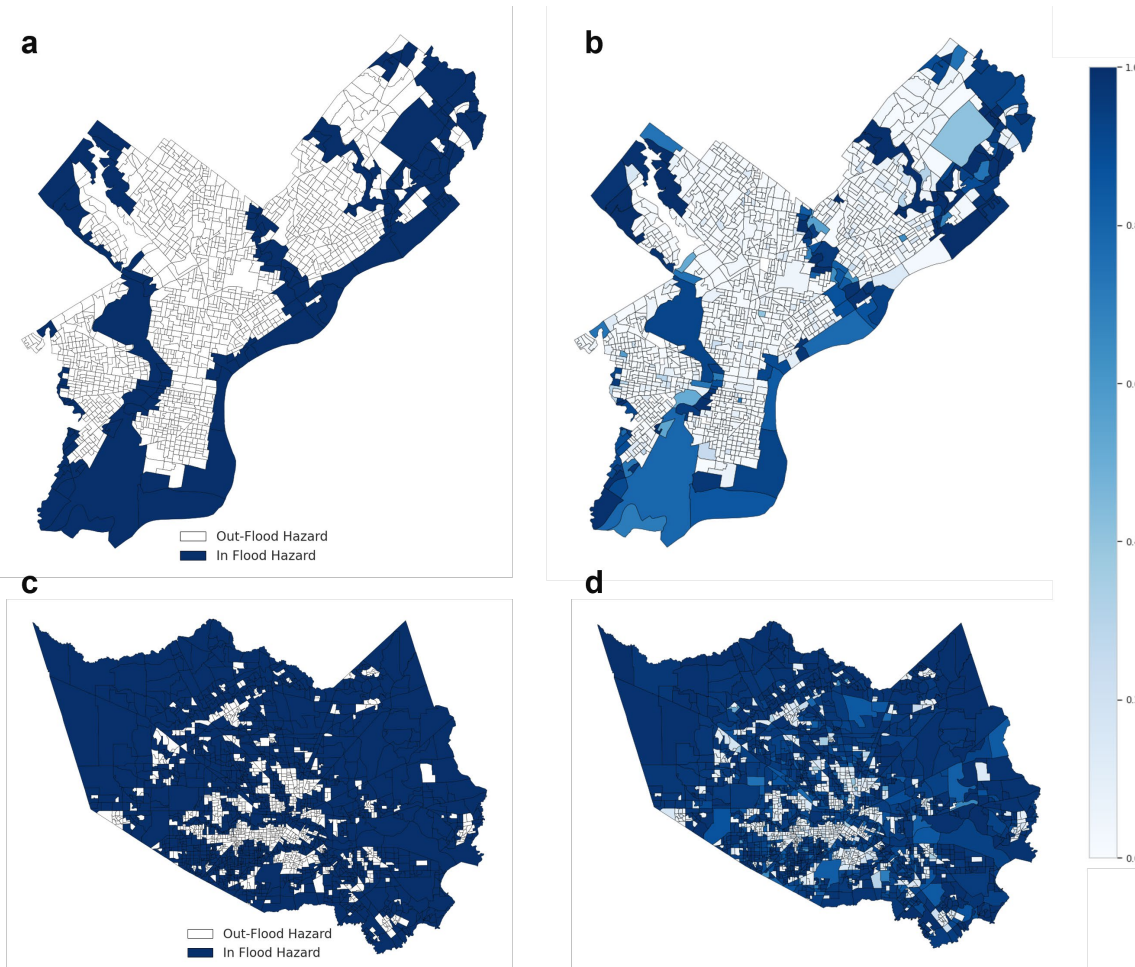


c Latent flood immunity

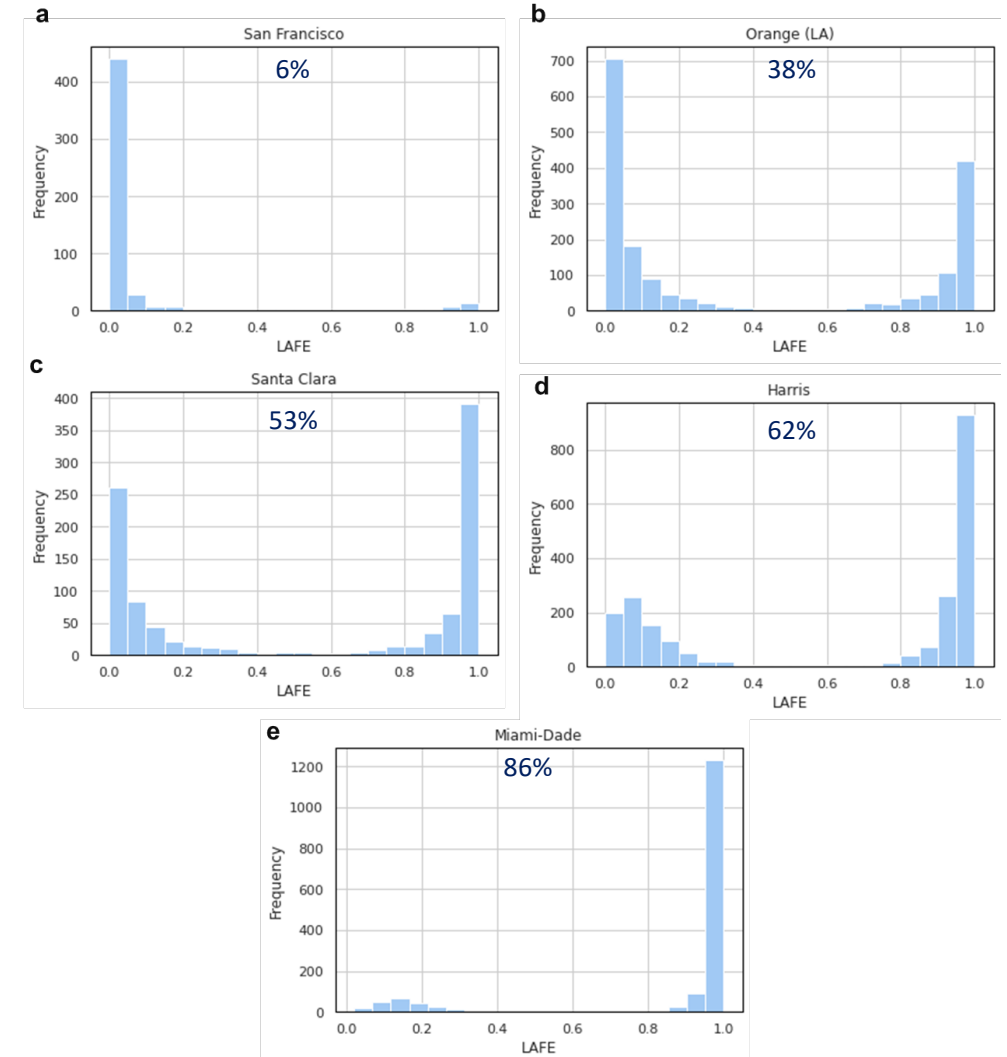


Disparities in Life Activity Flood Exposure

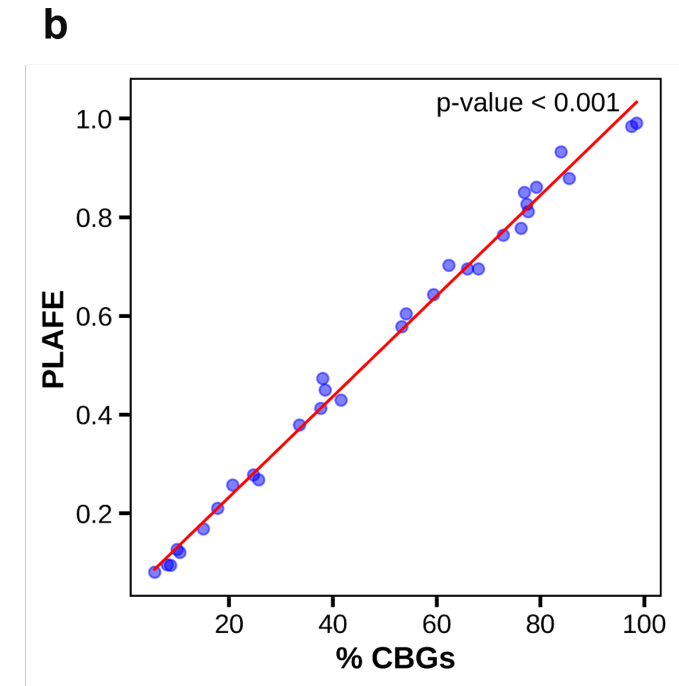
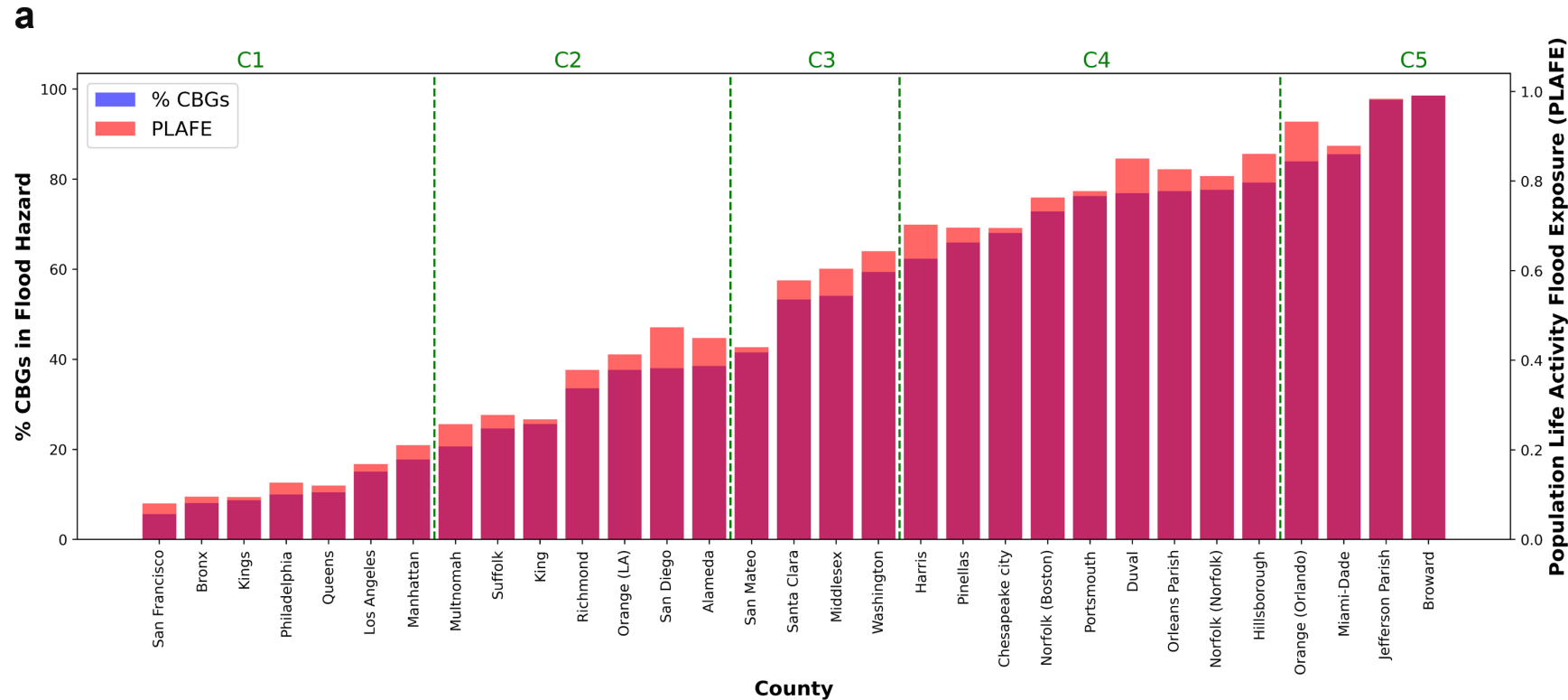
LAFE distribution in Philadelphia (b) and Harris County (d)



Bimodal Nature: **a** to **e**, increasing spatial flooding extent:
% CBGs in spatial flood hazard

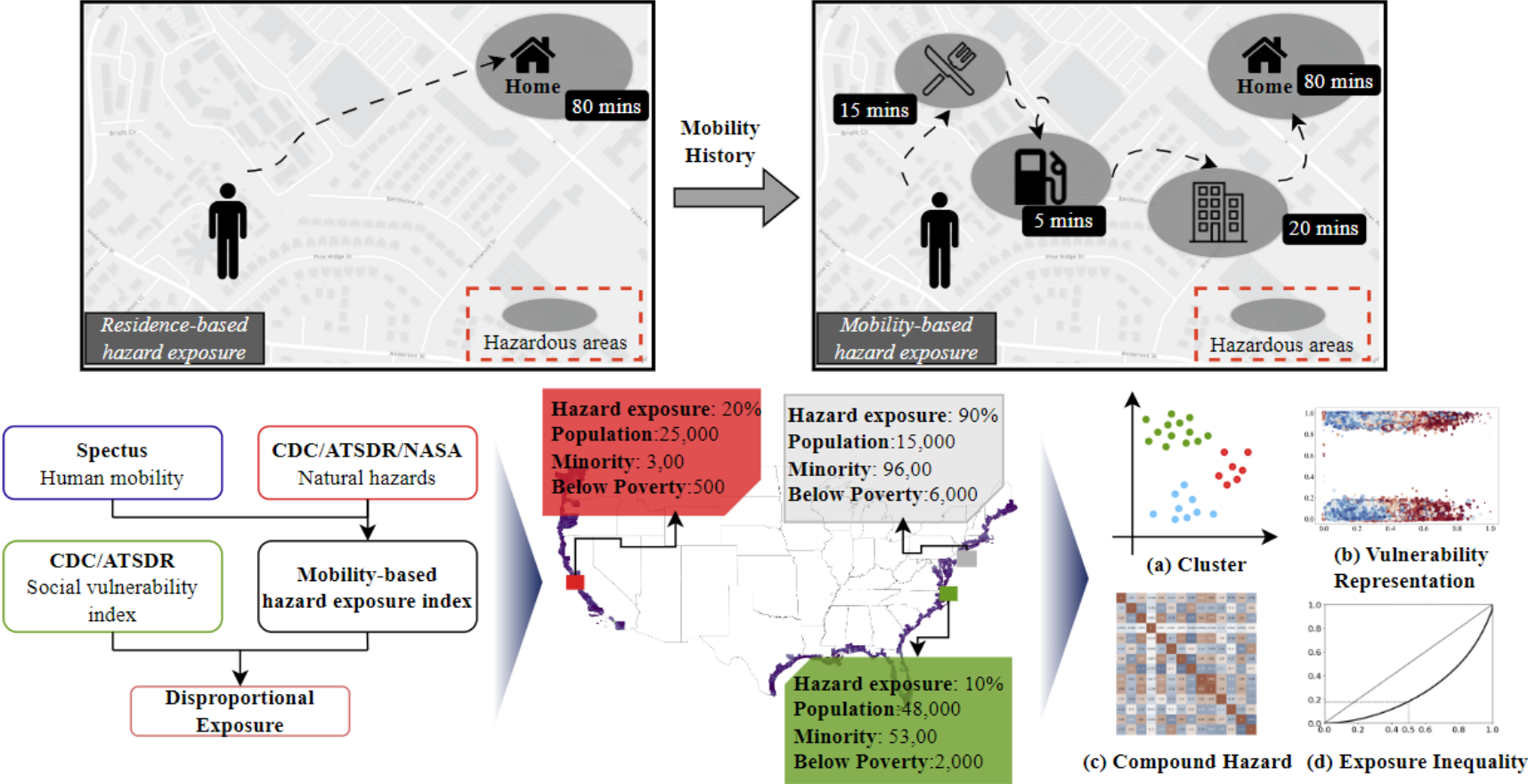


Population Life Activity Flood Exposure Across Cities



- Regions with greater spatial flood hazards have a greater PLAFE
- Counties with comparable spatial flood hazards show disparate levels of PLAFE

Study 3: Population Exposure to Environmental Hazards



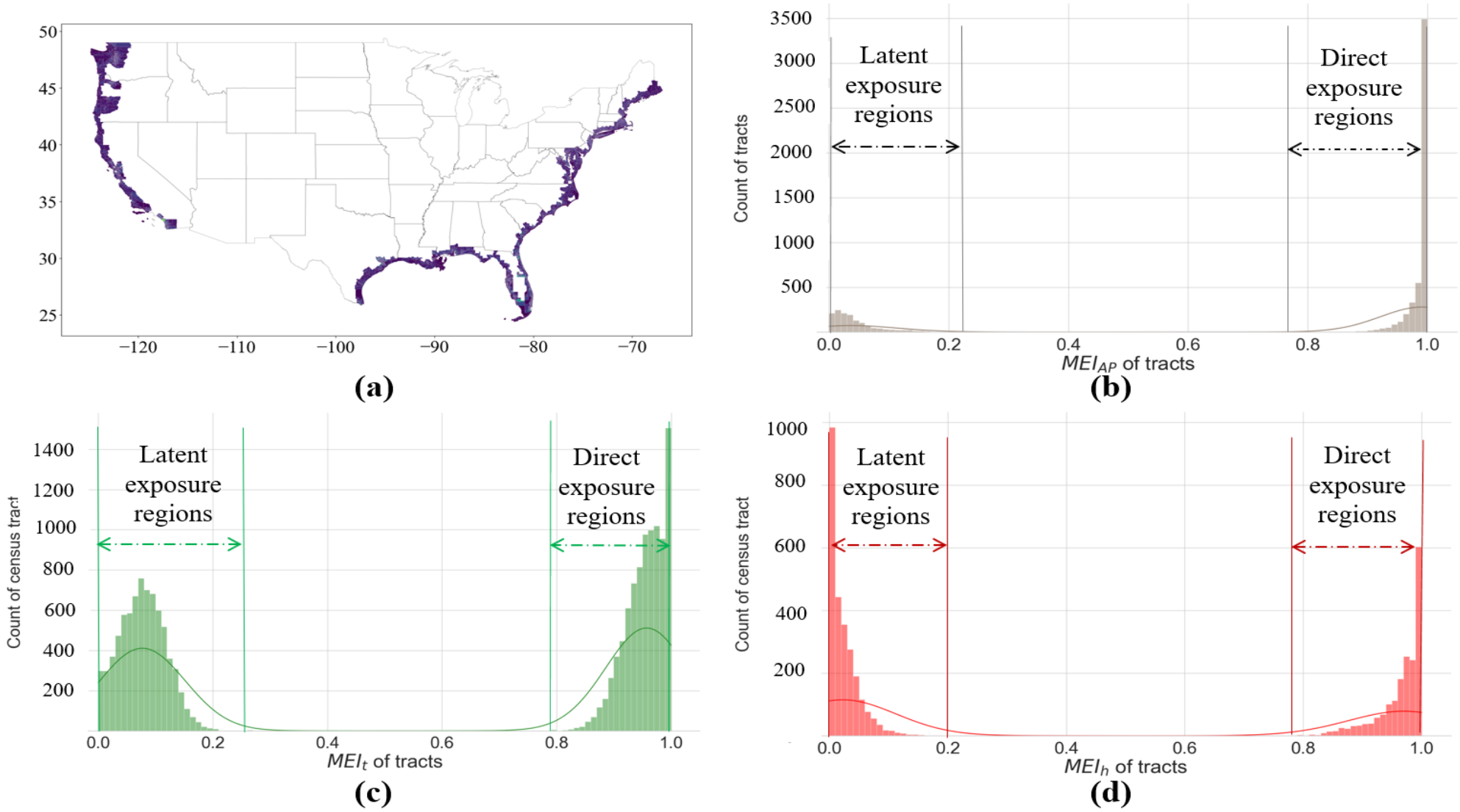
1. Dataset and Preprocessing

2. Spatial Distribution of Hazard Exposure and Demography

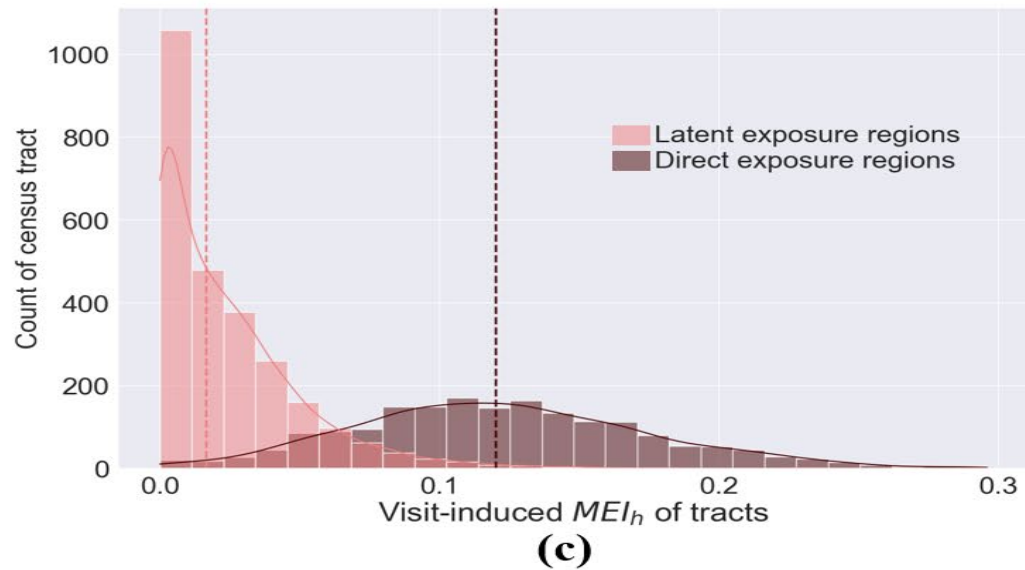
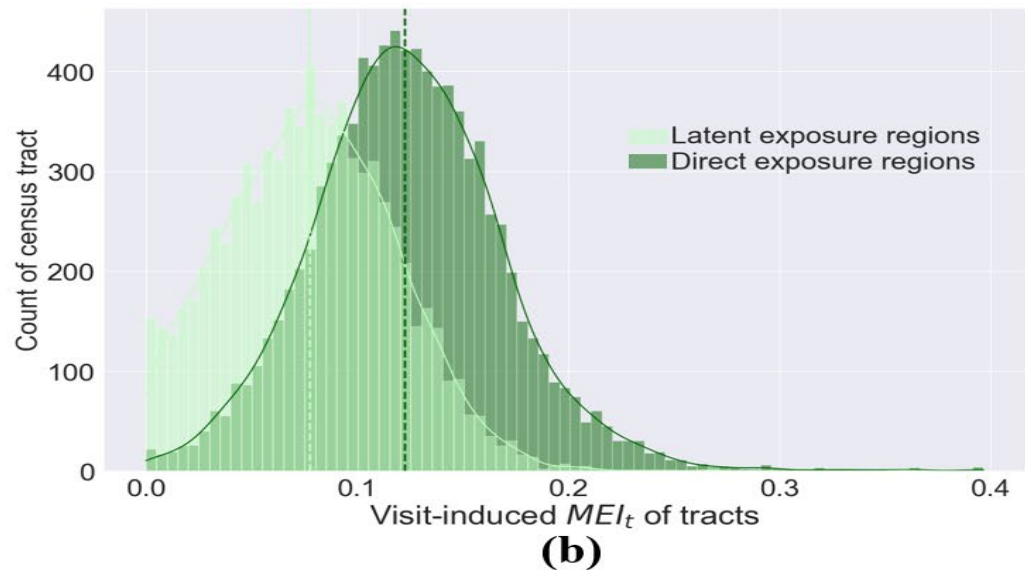
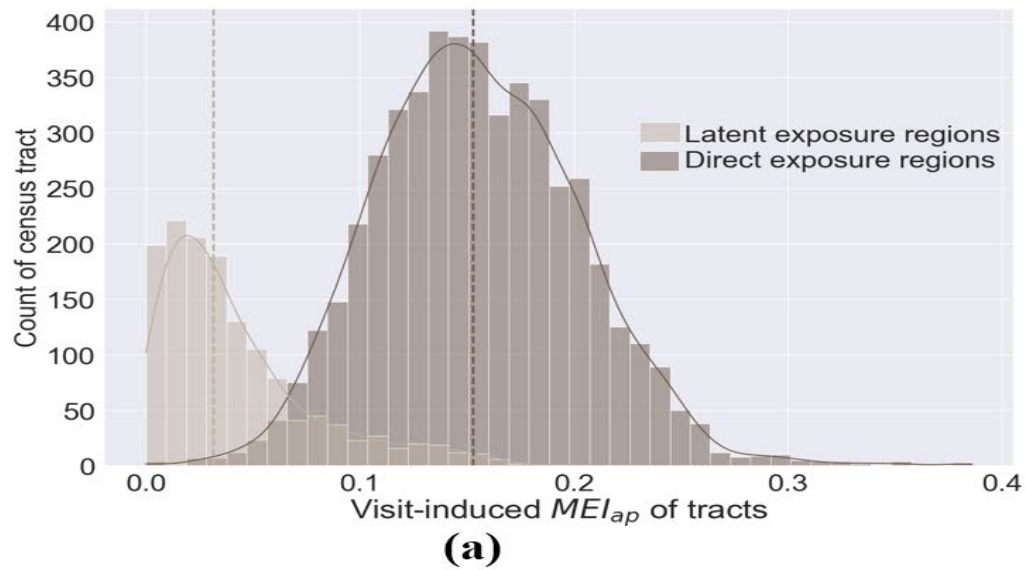
3. Vulnerability and Disparity Analysis



Population Exposure to Environmental Hazards



Population Exposure to Environmental Hazards



Challenges for Using Location-based Data in Evaluating Population Migration under Climate Change Interplay

1. **Privacy Concerns:** Ensuring the privacy and security of individuals' location data is paramount. Ethical guidelines and legal frameworks must be adhered to, to protect individuals' anonymity while utilizing such sensitive data.
2. **Data Quality and Accessibility:** The variability in the quality, resolution, and coverage of location-based data can significantly affect the reliability of migration studies. Also, accessing comprehensive and consistent datasets often poses a challenge due to proprietary restrictions and lack of open data policies.
3. **Bias and Representativeness:** Location-based data may not accurately represent all demographic groups, leading to biased understandings of migration patterns. Ensuring representativeness in the data is crucial for accurate analysis.

Opportunities for Using Location-based Data in Evaluating Population Migration under Climate Change Interplay

1. **Real-Time Monitoring and Prediction:** Location-based data enables the real-time monitoring of migration patterns, offering opportunities to predict future migration trends in response to climate change events, such as natural disasters or long-term environmental changes.
2. **Enhanced Understanding of Migration Dynamics:** The use of high-resolution mobility data can provide detailed insights into the causes and effects of migration, enhancing our understanding of how climate change drives human movement at various scales.
3. **Innovation in Data Collection and Analysis Techniques:** The challenges associated with using location-based data for migration studies drive innovation in data collection, processing, and analysis techniques, fostering interdisciplinary approaches and technological advancements.
4. **Collaboration and Data Sharing:** The global nature of climate change and migration encourages international collaboration and data sharing, offering opportunities to develop standardized methodologies and share best practices for analyzing human mobility data.

Mostafavi@tamu.edu
UrbanResilience.ai

