



Research Brief Summaries
Public Health Extreme Events Research Network
Hurricane Beryl, Helene, and Milton Mobilization

Rapid Research Award Recipients

Can Social Media Save Lives During Hurricanes? Using Location-Based Social Media Data to Evaluate Disaster Relief Efforts in Houston

Ivy Liu, University of Mississippi

Chan Wang, Jacksonville State University

Summary of Findings:

- Areas with higher levels of critical-need tweets generally experienced greater accessibility to disaster relief resources. This association was particularly strong in centrally located ZIP codes, where logistical convenience and government visibility facilitated more rapid response.
- In contrast, the concentration of resources was less influenced by tweet activity alone. Rather, resource concentration was more closely tied to structural planning and pre-established logistical centers.

Policy and Practice Implications:

- Disaster response agencies should leverage real-time social media data as early indicators to dynamically adjust resource distribution, particularly in peripheral areas that may be overlooked in traditional logistical planning.
- To better take care of the digital divides, agencies should prioritize information-sharing strategies that reach populations without stable internet access. Community-driven reporting mechanisms could be established to complement online signals.
- There are significant needs for improved tools and partnerships to access location-based social media data during disasters. Enhanced privacy-compliant geolocation mechanisms could help responders quickly identify hard-hit areas and provide targeted relief.



Quantifying Healthcare Facility Disruptions in Hurricane Beryl Using Cell Phone Location Data

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To investigate healthcare visitation disruptions and recovery patterns in Harris County, Texas caused by the impacts of Hurricane Beryl's landfall on July 8, 2024, we leveraged human mobility data from SafeGraph and developed a Mobility Disruption Index (MDI) to quantify changes of visits to 4,113 healthcare facilities within Harris County. We integrated satellite-derived nighttime light imagery, meteorological data, and ZIP-code-level socioeconomic indicators to study the potential drivers of healthcare facility disruptions.

Summary of Findings:

- Hurricane Beryl caused significant, uneven declines in healthcare visits across Harris County, with smaller size hospitals showing relatively greater resilience when adjusted for local conditions.
- Key drivers of disruption included power outages (most impactful), meteorological severity, and socioeconomic vulnerability, with clear spatial spillover effects between facilities.
- The spatial lag model revealed that both internal attributes and surrounding community contexts influenced healthcare facility recovery, emphasizing the importance of localized vulnerability assessments.

Policy and Practice Implications:

- Location-based data (LBD) offers powerful tools for rapid disaster impact assessment and planning, enabling creation of quantitative indices like the Mobility Disruption Index (MDI).
- Emergency planners can use LBD to identify service gaps, prioritize healthcare restoration, and monitor recovery in underserved or high-risk communities in near real-time.



- Future resilience strategies should integrate LBD with diverse data sources and predictive analytics to enhance equity, responsiveness, and preparedness in disaster-prone regions.

PHEER Rapid Research Award Final Report: Uncovering Cooling Center Usage as an Adaptation Strategy for Hurricane-blackout-heat Compound Hazards during Hurricane Beryl (2024)

Tianle Duan, Purdue University

Fengxiu Zhang, George Mason University

Qingchun Li, Purdue University

To uncover the usage patterns of cooling centers during Hurricane Beryl, we used location-based data (LBD) from Dewey weekly pattern dataset, which records visitations from visitors' home Census Block Groups (CBGs) to their points of interest. We extracted the LBD in Harris County, TX, from July 1st to July 14th, 2024. Our study pays special attention to the usage patterns of communities with access and functional needs (AFNs). The AFN-related variables are available from the American Community Survey dataset.

Summary of Findings:

- Harris County distributed cooling centers closer to lower-income CBGs during heat stress after Beryl.
- CBGs with closer distance to cooling centers and lower household income show a high probability of visiting cooling centers during the compound hazards.
- Shorter distances, lower income, and older age are associated with a higher likelihood of visiting cooling centers than visiting hotels, while limited English proficiency acts as a barrier to accessing information about cooling center locations and services.

Policy and Practice Implications:

- LBD can help identify spatial disparities in the accessibility and usage of cooling centers during hazard events.



- Policymakers and emergency planners can use LBD to prioritize investments in infrastructure and services that enhance adaptive capacity in socially vulnerable communities.

Leveraging Population Mobility Data to Assess Health System Capacity after Hurricane Beryl

Anu Ramachandran, Stanford University

To examine the changes in health system facility load caused by population movement in the Mexican state of Yucatan during Hurricane Beryl, we used two location-based datasets: Healthsites.io, a crowd-sourced repository of health facility locations and types, and MetaData for Good's user mobility data. We constructed baseline measures of population per health facility in each municipality of Yucatan, then examined how this metric changed with movement of populations during the hurricane event.

Summary of Findings:

- Baseline health facility load was highest in regions just outside of the state capital, Merida
- Municipalities in central and southern regions of the state experienced the greatest increases in health facility load during the 5-day period evaluated, with some regions having a 30-40% increase on Day 1 of the hurricane landfall
- Health facility load increases were short-lived in this setting, with 76 municipalities seeing increases on Day 1 and only 17 regions by Day 5, compared to a pre-hurricane baseline

Policy and Practice Implications:

- Combining location-based datasets can rapidly provide a simple and dynamic measure of health system facility overload to inform allocation of emergency medical infrastructure or hospital load-sharing programs in near real-time
- Many opportunities exist to build on this metric with the addition of different health facility datasets to optimize usefulness for disaster responders



Location-Based Data Operations Groups

Impacts of System and Social Disruptions for the Population Health

Bolanle Kayode, Bayero University Kano, Nigeria.

In investigating the impacts of social and system disruptions for the population health following Hurricane Helen landfalls, analysis of location-based data that included satellite imageries, pictures and pertinent reports revealed health risks that are not unusually connected to poorer outcomes for the population's health.

Summary of Findings:

- Survivors in communities affected by Hurricane Helene are not unlikely to suffer mental illnesses such as depression, anxiety, posttraumatic stress disorder etc., all of which may exacerbate several other health threats.
- Those requiring urgent medical treatment during the Hurricane Helene event, especially dialysis patients but unable, due to supply chain disruptions or road closures may have been severely impacted therefore, possibility of increased mortality.
- Homes close to floodwaters are likely to experience dangerous levels of mold growth not uncommonly linked to asthma and other pulmonary health outcomes.

Policy and Practice Implications:

- Extending the federal grant programs to provide mental health support beyond one year may ensure that initiative fully meets the MH needs of survivors.
- Increased visits to ED are likely pivotal for healthcare practitioners to have holistic strategies in meeting health needs.
- Public enlightenment could help to educate on pathways that hurricane landfalls endanger the population health



Identifying High-need Areas through Social Media and Facility Data in Hurricane Helene and Milton

Sangung Park, University of Florida

Xilei Zhao, University of Florida

Mónica Rodrigues, University of Coimbra, Portugal

Yuran Sun, University of Florida

David Eisenman, University of California, Los Angeles

Summary of Findings:

This study examines causal relationships between systemic disruptions (power outages) and social disruptions (population movement) during and after Hurricanes Helene and Milton. Using daily mobility and power outage datasets, it finds that systemic disruptions significantly influence social recovery trends, with high-need areas exhibiting more volatility and longer time lags in returning to normal movement levels. Granger causality analysis reveals key directional links: population movement patterns not only respond to outages but also influence them, especially movements ending at evacuation zones.

Policy and Practice Implications:

The findings suggest that movements ending in evacuation zones—previously underemphasized—are critical for understanding disaster response dynamics. These movement patterns can serve as early indicators of recovery bottlenecks. Moreover, extended time lags in mobility and power restoration within high-need areas offer a new metric for preemptively identifying regions requiring prioritized recovery support. Integrating time-delay analysis into recovery planning enables agencies to allocate resources and personnel more effectively, accelerating aid to areas with delayed recovery trajectories. This approach improves situational awareness and supports more equitable disaster management decisions.



Developing a Dynamic Social Vulnerability Index for Public Health (DSVI-PH) Using Location-based Data in Hurricane Beryl

Sangung Park, University of Florida

Yuran Sun, University of Florida,

Shangkun Jiang, University of Florida

Xilei Zhao, University of Florida

Summary of Findings:

This study introduces the Dynamic Social Vulnerability Index for Public Health (DSVI-PH), which integrates traditional Social Vulnerability Index (SVI) metrics with real-time population movement data from Meta and hospital accessibility data in the context of Hurricane Beryl in Texas. The DSVI-PH effectively captures daily fluctuations in vulnerability, especially in response to disaster events and holidays. Findings show that dynamic changes in hospital accessibility and sociodemographic shifts significantly affect public health vulnerabilities, particularly in coastal and inland areas. Spatial disparities within cities like Houston and San Antonio highlight persistent inequities in healthcare access during disaster responses.

Policy and Practice Implications:

DSVI-PH enables more timely and spatially nuanced resource allocation by identifying evolving vulnerability patterns. Policymakers can use this dynamic tool to prioritize communities with heightened vulnerability, inform adaptive recovery strategies, and mitigate health inequities. Incorporating real-time mobility and infrastructure data ensures disaster response efforts are more equitable and responsive to shifting population needs. Further validation will support its integration into public health and emergency management frameworks.



Understanding the Impacts of Hurricane-induced Health System Disruptions through Facebook Utilization Data

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Mónica Rodrigues, University of Coimbra, Portugal

Saria Hassan, Emory University

To examine patterns in health system disruptions from Hurricane Helene, we used location-based data (LBD) from Meta's Facebook Population During Crisis dataset, which provides average user presence by Bing Tile (2.4 km²) from September 24th to October 21st, 2024. We matched this with the Center for Disease Control and Prevention's most recent Social Vulnerability Index, which is available at the census tract-level and including overall and domain-specific scores.

Summary of Findings:

- More vulnerable counties had fewer healthcare facilities per area square mile and higher levels of disruption than less vulnerable counties.
- Higher levels of disruption were marked by an increased number of days after Helene made landfall for population activity to return to baseline population activity.
- The level of storm impact moderated these relationships: counties that experienced higher impact from the storm experienced higher levels of disruption regardless of social vulnerability or population density.

Policy and Practice Implications:

- LBD and collaboration between researchers and healthcare facilities can help measure health system disruptions and community impact after natural disasters.
- Disaster Science Practitioners can use LBD to pinpoint where and how disruptions unfold across communities, enabling more informed decisions for planning, emergency response, and long-term recovery efforts.



Social Connectedness and Evacuation Decisions among communities affected by Hurricane Helene in North Carolina

David Shoham, East Tennessee State University

Marissa Sogluizzo, Stony Brook University

Mónica Rodrigues, University of Coimbra, Portugal

Implications for Policy & Practice

To examine how social connectedness affects evacuation in the absence of official mandates, we combined Facebook movement data with Meta's Social Connectedness Index (SCI) at the zip-code level in the context of Hurricane Helene, along with other geospatial data sources. We hypothesized that areas with stronger internal social ties (higher SCI) would have lower evacuation rates.

Summary of Findings

- Zip codes with higher SCI scores had significantly lower odds of evacuation (Unadjusted OR = 0.43, 95% CI [0.23, 0.82], $p < 0.05$).
- SCI remained a significant predictor even after adjusting for vehicle access, racial/ethnic minority status, poverty, and education level.
- Minority status and education were also significant, suggesting these factors may shape both social connectedness and evacuation behavior.

Policy & Practice Implications

- Location-based data can clarify how social connectedness influences evacuation decisions.
- Strengthening community social ties before disasters may improve preparedness by enabling shared evacuation planning, knowledge exchange, and support networks.



Hurricanes Helene and Milton Disaster-Induced Transportation Barriers and their Impact on Access to Health Facilities for Socially Vulnerable Communities

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Nicholas Kman, The Ohio State University

Our research focused on the transportation access to hospitals after the Hurricanes Helene and Milton in Florida and North Carolina, and whether these were disproportionate among socially vulnerable groups. This work included collecting and analyzing county-level data for both states, identifying the variables influencing social vulnerability, including transportation network and health-related variables, using Principal Component Analysis. Second, we developed regression models with post-disaster location-based data to analyze transportation delays, including travel time to hospitals before and after the hurricanes. Our preliminary findings from the regression model results suggest that disaster-induced transportation barriers impacted people's access to healthcare, particularly in areas with a higher proportion of people with lower education, unemployed, uninsured, and people aged 65 or higher.

Summary of Findings:

- Social vulnerability in the Southeastern US is influenced by access to healthcare facilities, network capacities, and the region's socioeconomic and household characteristics.
- Disaster-induced transportation barriers in Florida after Hurricane Milton impacted healthcare access and disproportionately affected older adults, those with low educational backgrounds, and the poor population.
- Disaster-induced transportation barriers in North Carolina after Hurricane Helene impacted healthcare access and disproportionately affected the elderly, the unemployed, and the uninsured.

Policy and Practice Implications:



- Modeling post-hurricane delays and hospital travel times from road incidents provides opportunities to improve medical emergency response.
- Identifying socially vulnerable groups will help prioritize special health access needs when transportation infrastructure fails after a disaster.