Using Cell Phone Location Data to Determine Evacuation Departure Time and Evacuation Location

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Software
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OVERVIEW

Algorithm detects hurricane evacuations using cell phone location pings analysis

- Increases accuracy and automation over manual or survey-based evacuation monitoring
- Disaster response, emergency planning, and real-time evacuation analysis

BACKGROUND

Accurately monitoring population movement during natural disasters, like hurricanes, is crucial for effective emergency management and response. Historically, authorities have relied on survey-based self-reporting, road traffic monitoring, or sporadic observations to estimate who evacuated and from where. Such approaches often suffer from sampling bias, limited spatial and temporal resolution, and delayed reporting. These shortcomings hinder the timely and accurate estimation of evacuation rates and hinder targeted, efficient disaster response. Today's widespread use of mobile phones presents new opportunities, as devices continually generate location data that can be analyzed at scale and in near-real time. However, methods to responsibly and accurately infer evacuations from raw location pings—capturing both the timing and origin of evacuations—have been lacking. Thus, an improved, automated, and scalable method is needed to accurately estimate evacuations using modern digital data while ensuring the results can be validated and trusted.

INNOVATION

The presented algorithm advances hurricane evacuation monitoring by harnessing aggregated cell phone location data and a robust, three-step analytical process. First, it determines each phone user's home location by identifying where devices are most frequently present during nighttime over a month. Second, departures from this home location are flagged based on duration and distance thresholds, providing individualized mobility patterns. Third, a dynamic, impact-forecast-informed sub-area is defined within the overall region; any departure from this area is classified as an evacuation. This approach automates what used to be a labor-intensive process, providing fine-grained, timely, and accurate evacuation metrics. Rigorous validation, using census data, land use maps, and comparison to peer-reviewed studies, ensures reliability. This technology's real-world applications include supporting real-time emergency response, improving evacuation planning, informing disaster research, and aiding government resource allocation during hurricanes and similar natural hazards.

ADDITIONAL INFORMATION

PROJECT LINKS:

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DEPARTMENT/LAB:

• Seth Guikema, Industrial and Operations Engineering

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