Examining Spatial Clusters for Identifying Risk-Hotspots of Communities Susceptible to Flood-Induced Transportation Disruptions

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ABSTRACT

The objective of this paper is to propose a comprehensive resilience assessment of disaster-induced disruptions in transportation networks and use Harris County, TX in 2017 during Hurricane Harvey as a case study. In this research, we integrate network percolation theory and spatial analysis of household survey data to holistically examine the spatial patterns of risks caused by disaster-induced road closures. The overall risk of infrastructure disruptions is measured in terms of a community's experienced hardship. Hardship is a collective influence of the exposure of transportation networks, represented by connectivity, the duration of disruption of commuted roads, and the social susceptibility of households (tolerance) to the road closures. Integrating the spatial analysis of tolerance and duration of disruption with network percolation theory reveals the hotspots or coldspots of hardship. The results of the comprehensive resilience assessment show that the spatial patterns of risk to the road closures are the function of network connectivity, duration of disruption, and tolerance. Moreover, these together could explain the emergence of the risk hotspots. The emerging hotspots of hardship in the east of Harris County are due to clusters of low tolerance and a low connectivity of roads, and not duration of disruption. The west of Harris County did not have any significant clusters of hardship due to their high tolerance despite experiencing high duration of disruption and having a low connectivity in the road network. These results highlight the importance of a comprehensive resilience assessment when assessing prolong disruptions in the transportation network, which leads to devising effective plans for hazard mitigation.