EGU24-6148, updated on 07 Dec 2024
https://doi.org/10.5194/egusphere-egu24-6148
EGU General Assembly 2024

Functionality assessment of road network combining flood roadworthiness and graph topology

Ke He[1], Maria Pregnolato[1,2], Neil Carhart[1], Jeffrey Neal[3], and Raffaele De Risi[1]
[1]University of Bristol, School of Civil, Aerospace and Mechanical Engineering, United Kingdom of Great Britain – England, Scotland, Wales (ju20423@bristol.ac.uk)
[2]Department of Civil Engineering, Delft University of Technology, Mekelweg 5, 2628 CD Delft, Netherlands
[3]School of Geographical Sciences, University of Bristol, Bristol, BS8 1SS, UK

In the realm of critical infrastructure, the road network plays an indispensable role in facilitating daily activities, communication, and economic interactions. However, it remains susceptible to the persistent challenge of flood hazards, leading to both structural and non-structural damages (e.g., physical collapse and service interruption). In normal flood disasters, physical collapse may not occur, but service interruptions often occur. Such disruptions manifest in the form of increased travel distances, prolong the travel times, and, in severe cases, complete travel impossibility. This has resulted in a reduction in transportation efficiency, leading to an increase in the social cost of transportation.

This study presents a novel approach that integrated flood hazard, transportation network topology, and vehicle vulnerability to evaluate the functionality of road network. A severity factor is defined to assess the accessibility of expected links (roads and bridges), considering different vehicle types such as cars and SUVs. Then, this study analyses the overall road network functionality loss under varying flood return periods by evaluating the severity of each network link based on the different types of vehicles. Identification of links with the lowest functionality allows for the assessment of the entire network's performance using topology-based measures, including the average node degree, average clustering, average shortest path, and reachable areas (isochrones). This research employs the transportation network of Bristol, UK, as a case study to investigate the dynamic relationship between the network status and vehicle typology in the context of flooding events. Findings reveal a discernible correlation, wherein the resilience of the network in influenced by the specific characteristics of different vehicle types. Notably, SUVs emerge as inherently more resistant to flood-related disruptions compared to conventional cars.

The insights presented in this paper hold significant implications for the development of robust mitigation strategies geared towards bolstering the resilience of road networks and optimizing the rerouting of emergency response vehicles in flood-prone areas. By elucidating the interplay between vehicle characteristics, network functionality, and flood impacts, the research provides a foundation for informed decision-making in the formulation and implementation of effective preparedness measures. The outcomes of this study offer a strategic roadmap for authorities and policymakers, enabling them to proactively address the challenges posed by future flood events

and enhance the overall adaptability and responsiveness of road networks in emergency situations.