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Vulnerability analysis in Complex Networks under a Flood Risk Reduction point of view

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In a scenario of global change, extreme weather and climatic events are expected to increase in frequency and intensity and cause more social and economic impacts in several sectors, such as Critical Infrastructures, like transportation system and urban mobility. The measurement and mapping of transportation network vulnerability constitute subjects of global interest.

During a flood, some elements of a transportation network can be reached, causing damages directly (to people, vehicles and roads/streets) and indirect damages (services) with great economic impacts. The vulnerability mapping is an important tool for Flood Risk Reduction. This work represents a conceptual discussion on this topic.

The Complex Networks approach may offer a valuable perspective considering one type of vulnerability especially related to Disaster Risk Reduction on critical infrastructures: the topological vulnerability. The shortest path length dij between two generic nodes i and j is the smallest sum of links throughout all the possible paths (without loops) in the graph from i to j. The efficiency eij in the communication between vertices i and j can then be defined to be inversely proportional to the shortest path length. The topological vulnerability index associated with an element in a graph is defined as the damage (variation) on the network's average efficiency due to the removal of that element.

The first paper that considered the pointwise vulnerability index was Goldshtein et al. (2004). In that paper, the authors cited two relevant previous works: Latora & Marchiori (2001) and Latora & Marchiori (2004) – those works presented the ideas about efficiency and vulnerability.

Recently, in Pregnolato et al. (2016), a framework for assessing the disruption from flood events to transport systems was proposed, combining a high-resolution urban flood model with transport modeling and network analytics to assess the impacts of extreme rainfall events.

Beside that progress, there are a lot of open questions in that area, for example: 1. what is the spacial relationship between flood risk areas and the most vulnerable elements in a transportation network?, 2. are the recurrent impacts in an area related to its vulnerability? and 3. how to incorporate the spatial-temporal urban mobility dynamic in those models? In this work are shown some recent advances and perspectives related to those questions.