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GRAph-based Model (GRAM) to assessment of flood impacts in the complex metropolitan area of Mexico City

Marcello Arosio (1), Mario L.V. Martina (1), Rui Figueiredo (1), and Enrico Creaco (2)

(1) Scuola Universitaria Superiore IUSS di Pavia, Pavia, Italy (marcello.arosio@iusspavia.it), (2) DICAr, Università degli Studi di Pavia, Pavia, Italy

The development of new approaches for comprehensive analysis and mitigation of complex and severe risk in metropolitan contexts is an important and challenging problem. To stimulate the discussion on these directions, we present an application of a holistic methodology based on the Graph Theory to assess the flood impacts in Mexico City.
The proposed methodology considers the whole system as a unique entity of interconnected elements, where those connections are taken into account in order to more thoroughly assess impacts. The exposed elements are organized as nodes in a network, while Graph Theory concepts enable impacts propagation from directly affected nodes to other nodes across network links. Differently from the traditional approach, which is able to identify only direct impacts, the main advantage of the adopted methodology lies in the possibility of identifying impacts of higher order and cascade effects. The application concerns floods numerically reconstructed in Mexico City, in response to rain events of different return periods. The simulation was carried out using a simplified hydrological/hydraulic model of the urban drainage system, implemented in the EPASWMM environment.
The results of this work showed that the total impacts, which includes both direct and indirect effects, is much larger than the direct impacts alone, especially for the more intense rain events. The total impacts are due to the sum of nodes affected at each order: i.e. state of the graph obtained by removing the nodes affected at the previous stage. The increments of affected nodes between two following orders are not proportional with the increments of flooded extension associated to different return periods.
The methodology will be discussed with regard to its potential use for multi-hazard, integrated risk assessments. The presentation will also identify the assumptions and the main needs of this work and finally propose areas of future development.