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Concept of a Critical Infrastructure Network Modelling Approach for Flood Risk Management

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In flood risk analysis it is a key element to determine consequences of flooding to assets, people and infrastructures. However, damages to critical infrastructure networks (CIN) are not always restricted to inundated areas. The effects of directly impacted objects cascade to other infrastructures, which are indirectly affected by a flood. Modelling critical infrastructure networks is one possible answer to the question 'how to include indirect and direct impacts to critical infrastructures in a flood risk analysis?'.

The modelling of complex CIN is utilized for different purposes: For modelling transportation routing, for damage assessments due to cyber attacks or infrastructure and interdependency analysis of water and waste water flow. For the purpose of flood risk assessments and, finally, in flood risk management application cases are scarce. The presented work introduced a method to overcome this gap. Major challenge is to balance the simplicity of a modeling approach with the resemblance of real interdependencies in a CIN and their task to supply services to end users. The more complex and realistic the network model is desired to be, the harder it is to gather the necessary data and the more expertise is necessary for potential users of this method. Additionally, users are required to switch from a raster or cell-based calculation philosophy to a network-based philosophy including points, connectors (edges) and areas (surfaces).

In this work, a network-based and topology-based method for a catchment-wide analysis is presented. The basic model elements (points, connectors and polygons) are utilized to model the complex CIN interdependencies. The CIN-module of the freely available software package ProMaIDes[1], a state-of-the-art flood risk analysis tool, is used. The module is suited for an analysis of critical infrastructure damages, disruption of infrastructures and quantifies those damages by the number of disrupted users and the disruption duration. In a case study in Accra, Ghana, the method capabilities are showcased in a multisectoral model. Sectors included are electricity supply, fresh water supply, telecommunication services, health sector, emergency services and transportation. The model consists of 419 point elements, 472 polygon elements and 1124 connector elements. A synthetic precipitation event is used to visualize the reactions of the model as well as display first results. The case study has shown the flexibility and scalability of the introduced method to differentiate CI sector specifics. Consequently, the potential of the method to support flood risk management is discussed.

[1] https://promaides.h2.de