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Real time application for estimation of urban pluvial flood damage

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Abstract:

Heavy rainfall regularly leads to local flooding in Germany, urban areas with a lot of sealed surfaces are particularly at risk. In Berlin alone, heavy rainfall has caused damage of €174 million between 2002 and 2021 according to the German Insurance Association. To enhance preparedness and reduce losses, advanced methods for nowcasting are vital for disaster management and emergency response. Typical factors such as water depth and flow velocity give a first indication on the magnitude of an event. But how can this information be translated into impacts such as the expected number of affected households or potential damage to buildings?

For the rapid impact assessment in a real-time framework, we developed the "Flood Damage Estimation Tool" (FlooDEsT), a machine learning algorithm trained on survey data from past heavy rainfall events. Using recursive partitioning, the algorithm captures non-linear relations between variables addressing the hazard and potentially affected objects. In its application, the trained model only requires the forecasted maximum water depth and velocity. Further, building characteristics are needed for a specific damage estimation. If missing, these variables are sampled randomly from the survey data distributions, while providing an uncertainty range. With a short running time, the model is applicable in real-time. Regardless of the property's size or market value, relative qualitative damage classes are provided on the building level. FlooDEsT offers a fast identification of potentially affected objects and associated impacts to complement real-time hazard information and predictions for the near future. Based on the information output, impact-based warnings can be issued for a better understanding of the situation-related consequences within the population.

Additionally, regional available data can be added to the results for further information. For example, evaluating the affectedness of critical infrastructures and points of interest (e.g., fire brigades, hospitals), which are important for emergency response teams. By masking population density with the affected areas, the number of potentially affected people can be estimated, too.

Apart from the real-time application the model can be used for scenario-based risk analysis. Data aggregation and intersection with additional data can show regional hot spots of vulnerability. The model thus allows a prospect of impacts for regional planning in hot spot regions and the potential for increased resilience towards heavy rain events. These outcomes can therefore support risk communication and raise awareness.

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