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Regardless of Performance, Flood Assessment in Urban Environments

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Editorial

In metropolitan locations, impermeable surfaces obstruct natural drainage and send surface runoff to storm drainage systems with limited capacity, making these regions vulnerable to pluvial floods. The existence of minimal areas for surface runoff generation and concentration is required for pluvial flooding to occur. Simulations of hydrologic and hydrodynamic processes are computationally expensive and time-consuming. The TELEMAC-2D hydrodynamic numerical model was used to benchmark a comparison of two simpler methods for identifying urban pluvial flood-prone locations, namely the fill spill merge method and the topographic wetness index method. From a high-resolution digital elevation model, the FSM approach leverages conventional GIS operations to locate flood-prone depressions. The TWI approach uses the maximum likelihood method to probabilistically calibrate a TWI threshold for a particular spatial window within the metropolitan region based on inundation maps from a 2D hydrodynamic model. In terms of model performance, we discovered that the FSM technique clearly beats the TWI method both conceptually and practically.

Massive human and economic losses result from pluvial floods. They are seen as a constant threat in both urban and rural regions. Pluvial floods are triggered by intense and short-duration precipitation events, which result in the formation of overland flow that moves across the terrain, depressions, and road networks, creating a surface flow network known as the "major system." The overland flow could be transferred over a long distance by the major system, causing flooding in a place far away from where the minor system's capacity was exceeded.

Flood hazard maps for rivers and coastal areas are widely implemented under the European Flood Directive, while similar attempts for pluvial flooding are rare. The goal of this study is to compare and contrast the FSM and TWI methods for assessing and mapping pluvial flooding, as well as to emphasise the limitations of each method. We used the TELEMAC-2D hydrodynamic numerical model for benchmarking and validation, and applied the two methods to two urban areas in Berlin for different precipitation depths ranging from 30 to 150 mm (10 mm increments), to show how these methods can mimic the behaviour of a 2D-hydrodynamic model in terms of inundation depth and extent. Finally, we go over the benefits and drawbacks of each strategy. Rainfall is converted to evapotranspiration, infiltration, or surface and sewage system runoff in general. In terms of inundation of areas in depressions, runoff at the surface and in the urban storm drainage system could contribute to pluvial floods. The upslope contributing area per grid length is represented by the parameter a, and the local slope angle is represented by the parameter. In Berlin, we used the TWI approach to identify flood-prone zones (also known as FP). The basic idea is that if a location's TWI exceeds a specific level, it is flood-prone.

Although the loss and damage caused by pluvial floods is increasing around the world, high computational costs and the resource-intensive model setup of hydrodynamic models continue to obstruct the creation of reliable hazard and risk maps. At the same time, the availability of high-resolution DEMs is expanding, implying that data availability constraints are not as severe as they were, say, a decade ago. Still, in order to fully exploit the potential of these data, we need effective and efficient approaches. The Fill–Spill–Merge (FSM) approach and the Topographic Wetness Index (TWI) method were examined in the current study to identify urban regions that are prone to pluvial flooding, as proposed in recent literature. We used the hydrodynamic model TELEMAC-2D as a benchmark for this analysis. We chose two neighbourhoods in Berlin, Germany, as case examples for our evaluation.

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