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Simulated response of urban drainage networks to heterogeneous precipitations

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In urban areas, drainage networks are usually formed by small subnetworks, hence resulting in small-sized basins with fast times of response. For this reason, the prediction of pluvial flood hydrographs in urban basins is hampered by considerable uncertainty due to the spatial and temporal variability of rainfall intensity, which is difficult to characterize with the sparse observations from the limited amount of rain gauges that are typically available. To better understand and quantify this uncertainty, the drainage network of Turin is considered as a case study. The city of Turin has >800.000 residents and is located in Northwestern Italy on a relatively flat area bordering a hill on the East. The area is mostly urbanized, and it receives an average precipitation of around 800 mm per year. The drainage network was developed since the end of the 19th century as a separate network that receives only stormwater from a catchment area of around 100 km², for a total network length of around 1200 km. At present, the network experiences some criticalities due to infrastructure ageing and urban development, and occasional flooding episodes are observed at some points.

The sensitivity of flood hydrographs at the basin outlet to spatial and temporal patterns of rainfall intensity is analyzed using a SWMM hydraulic model of different parts of the drainage networks. Spatial and temporal variability of rainfall intensity over the area is quantified using the observations of a set of 20 rain gauges. Then, the analysis of the sensitivity of the flood hydrograph in a monitored subnetwork is performed based on two rain gauges (2 km apart) and one flow meter at the basin outlet. The results provide valuable insight into the response of urban drainage networks to heterogeneous spatial fields of precipitation.