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How the shape of heterogeneous precipitation affects the response of urban drainage networks in SWMM modelling

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The prediction of pluvial flooding in urban environment shows many uncertainties due to the structure of drainage network and the usual limited amount of available rain gauges. These two aspects, joint with the increasing frequency of intense rain events, highlight the need to a better comprehension of the main impact of temporal and spatial variability of the rain in the modelling process.

Within the PNRR RETURN project, a SWMM model of an urban subnetwork has been used to perform a sensitivity analysis on the influence of the shape and location of a simulated rain event for different return periods and rainfall durations. Spatially heterogeneous rainfall events are simulated as exponential distributions, and the decay constant is used to quantify the degree of spatial heterogeneity of the events. A first explorative phase aims to recognize global indicators to describe multiple response scenario, comparing the effects of rain events with the same rainfall volume and different spatial distributions. Then, the increasing number of simulations should allow to identify the best indicators that will drive to describe the network response through topological techniques.

The results show a non-linear correlation between the number of flooded nodes and the rainfall volume occurred in a specific duration. When the spatial distribution of rainfall is more heterogeneous (i.e. high decay constant) the network faces more severe criticalities. Furthermore, the response of the drainage system is non-linearly correlated to the rainfall volume intercepted by the basin, highlighting the complexity of the response and the central role of the structure of the drainage network.

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