



Towards Accurate Urban Pluvial Flood Predictions: IBER-SWMM Application in Sampierdarena, Italy

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Urban pluvial flooding has emerged as a critical challenge for contemporary cities, driven by rapid urbanization, ageing drainage infrastructure, and increasingly intense rainfall events. Reliable modelling of such floods is essential for risk assessment, urban planning, and mitigation strategies' design. However, model performance is highly sensitive to input data quality, particularly topographic information governing overland flow and the description of drainage system. Despite their recognized importance, those kinds of input data are frequently selected based on availability rather than systematic evaluation, resulting in potential inaccuracies in flood predictions.

This research examines the influence of input data quality and preprocessing on urban pluvial flood simulations, with a specific focus on 1D-2D coupled modelling. An integrated modelling framework combining IBER for surface flow (2D) and SWMM for drainage dynamics (1D) is adopted to explicitly represent the interactions between overland runoff and underground drainage systems. Particular attention is given to how terrain representation affects surface-subsurface exchanges, including flow concentration, inlet efficiency, and drainage surcharge behaviour, while the drainage network system is analysed focusing solely on the primary stormwater drainage network, modelled as 137 conduit links, 3 outfall and 137 junction nodes.

The study is conducted in the densely urbanized portion of Sampierdarena district of Genoa, Italy (1.43km²), an area frequently affected by pluvial flooding. Initial simulations are performed using the 2D IBER model under controlled conditions, applying a synthetic Chicago hyetograph with a duration of 1 hour, a time-to-peak ratio of 0.5, and a return period of 10 years. This preliminary phase allows the isolation of terrain-related effects by comparing model results obtained from different digital terrain models (DTMs).

High-resolution LiDAR-derived DTMs were compared with coarser photogrammetric products and derivative datasets commonly employed in practice. Model outputs, including water depth, flow velocity, inundation extent, and overland flow pathways, are analysed both qualitatively and quantitatively. Results show that reduced terrain resolution and excessive smoothing of micro-topographic features significantly alter surface flow patterns, shift flood extents, and modify peak

water depths. These effects are particularly critical in urban environments, where small-scale topographic features control flow routing toward drainage inlets and strongly influence surface–drainage interactions.

To overcome limitations inherent to purely 2D simulations, this study has advanced to a fully coupled 1D-2D IBER-SWMM approach enabling a dynamic and bidirectional exchange of water between the surface and the drainage network. This integrated framework explicitly accounts for inlet capacity, drainage surcharge, overflow locations, and the timing of interactions between streets and the underground system. As a result, the coupled model provides a more realistic representation of flood dynamics, improves identification of vulnerable infrastructure, and supports the assessment of adaptation measures such as green infrastructure, detention systems, and drainage network upgrades.

Overall, the research highlights the critical role of systematic terrain data selection and preprocessing within 1D-2D coupled urban flood models. The IBER-SWMM coupling constitutes the core methodological contribution, enhancing the physical consistency and predictive reliability of pluvial flood simulations and supporting more informed decision-making toward resilient urban flood management.