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URBAN FLOOD MODELLING USING IBER-SWMM MODULE: THE CASE OF SAMPIERDARENA DISTRICT (GENOVA)

Real case application

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BACKGROUND

In recent years, climate change has markedly impacted environmental systems and increased the frequency of extreme events, making them more challenging to predict and manage. One notable example is pluvial flooding in urban areas, which has become a growing concern not only due to climate change but also as a result of rapid urbanization. In response, a wide range of software tools has been developed to model such events, employing one-dimensional (1D) and two-dimensional (2D) hydrodynamic approaches, and integrated hydrological-hydraulic approaches to simulate both sewer and surface flows (1D/2D coupled models) *(Henonin et al., 2013; Russo et al., 2015)*. Although sophisticated models have been introduced to simulate these phenomena, persistent challenges remain—particularly regarding the quality of input data, including topographic resolution and integration with urban drainage systems *(Acquilino et al, 2025)*.

Fig.1:Schematic map of the study area with points used for sensitivity analysis. Photo A and B: real event of 24/09/2022 (Primocanale)

CASE STUDY

To better analyse the input data weights in the models, a small analysis example has been selected.

The case study chosen is a densely built urban area within the Metropolitan Area of Genoa, Italy, which is frequently affected by pluvial flooding caused by rainfall events characterized by a low return period (T between 1.5 and 3 years). The urban area under investigation (Fig.1) lies in the western part of Genoa, specifically in the Sampierdarena district, and includes a flat zone covering approximately 1 km². This district is an urban cluster located between the commercial port and the left bank of the Polcevera river. The study area includes three minor streams that are partially culverted: Fosso Bartolomeo, Fosso Promontorio, and Fosso Belvedere.

IBER-SWMM

Water flow in urban environments is significantly more complex than in non-urban settings due to the presence of impervious surfaces, structured drainage systems, and varied topography. **Iber** provides a robust framework for addressing urban drainage challenges by simulating both **rainfall-runoff processes** and **flow propagation** across streets and through sewer networks.

The key functionalities of the system include:

- ❑ **Two calculation engines**:
  - *Iber*, as a fully integrated tool that models both hydrological processes and sewer network flow.
  - *Iber-SWMM*, which combines Iber's surface runoff capabilities with SWMM's sewer network simulation.
- ❑ **Comprehensive rainfall-runoff assessment** tailored to urban environments.
- ❑ **Full integration with sewer networks**, supporting fully coupled simulations between surface (2D) and subsurface (1D) flows in both directions (2D/1D and 1D/2D).
- ❑ The **urban drainage module** enhances the capabilities of Iber's hydrological modeling, enabling simulation of the entire drainage process—either entirely within Iber (handling both surface runoff and sewer flow) or through the **coupled Iber–SWMM engine**, where Iber manages surface runoff and SWMM models the sewer system.

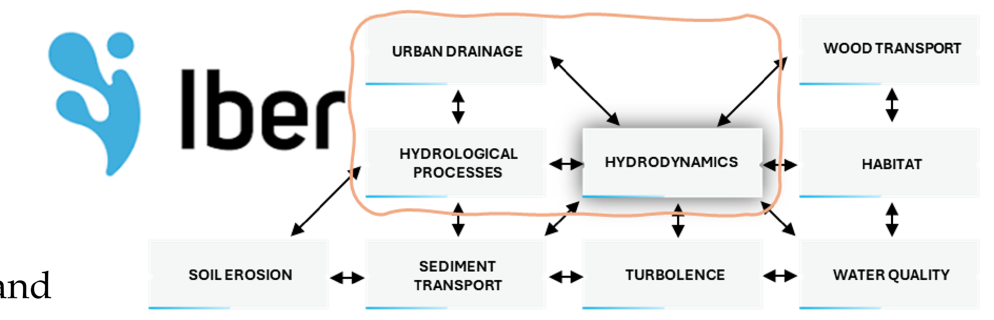


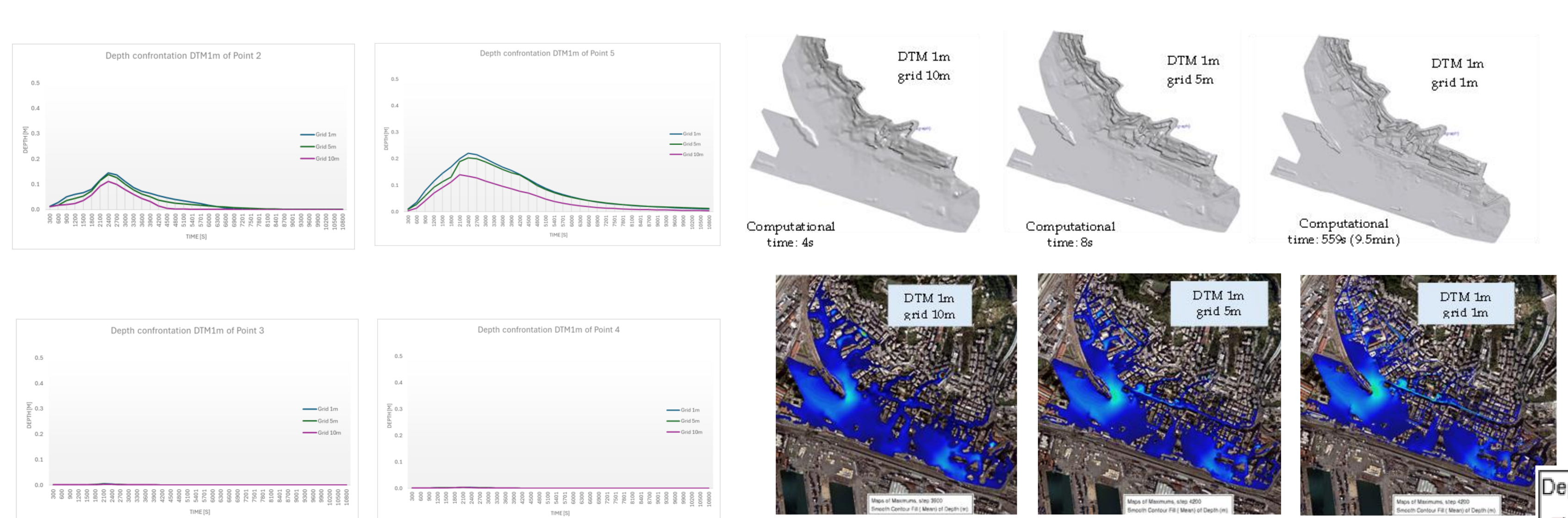
Fig.2:Schematic representation of IBER modules (vrs. 3.4, 2025). Focus on urban modules

SENSITIVITY ANALYSIS

(Fig.1, points 2,3,4,5)

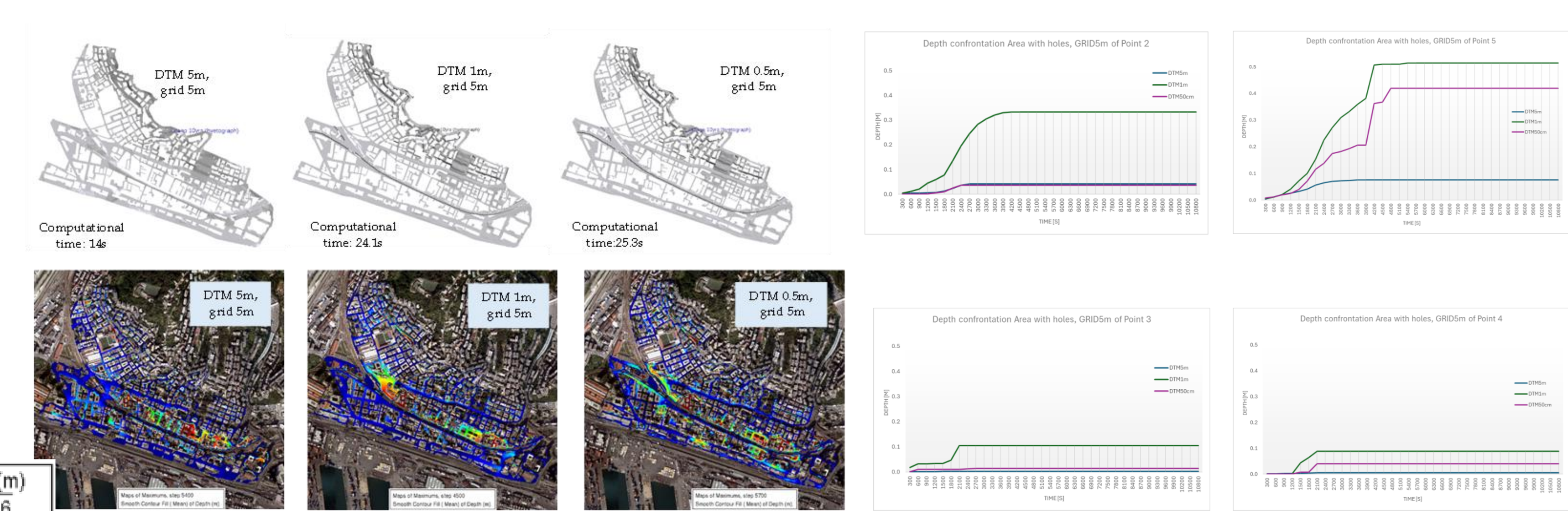
WHOLE AREA (deflux area 0.96 km²)

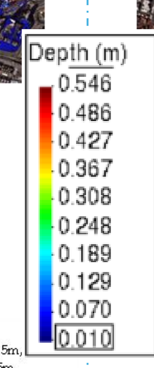
Same DTM, different grid



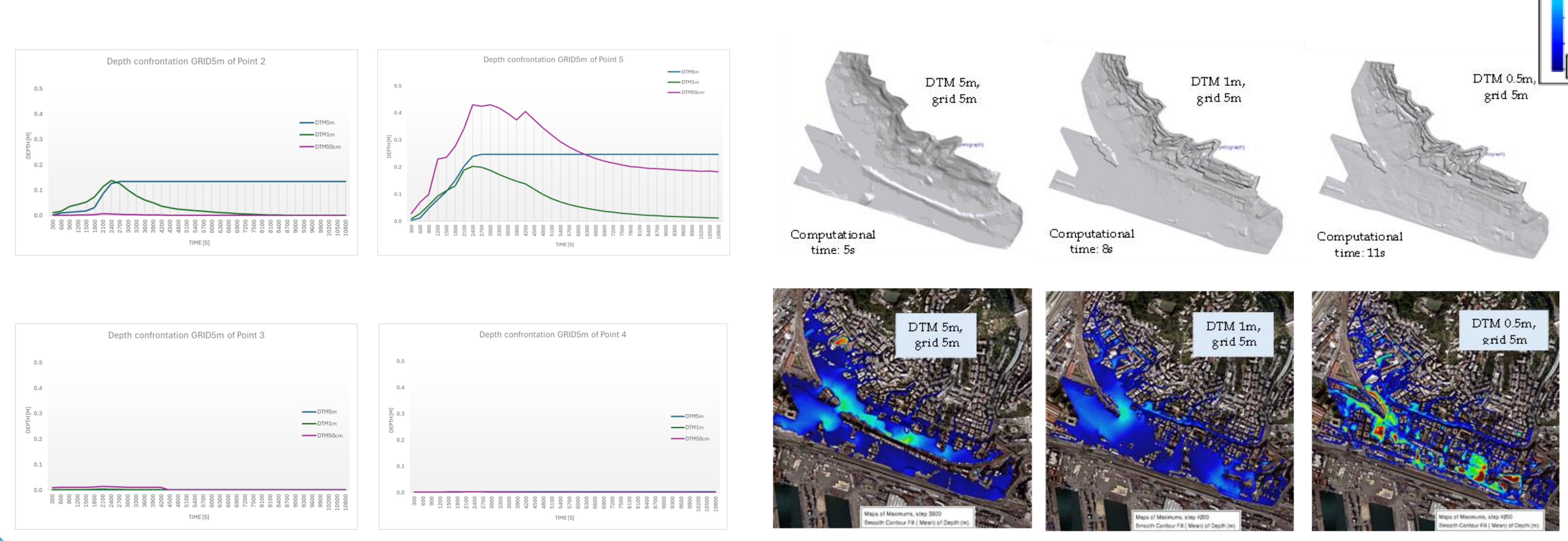
BUILDINGS AS HOLES (deflux area 0.53 km²)

Same grid, different DTM. Bridge incorporated

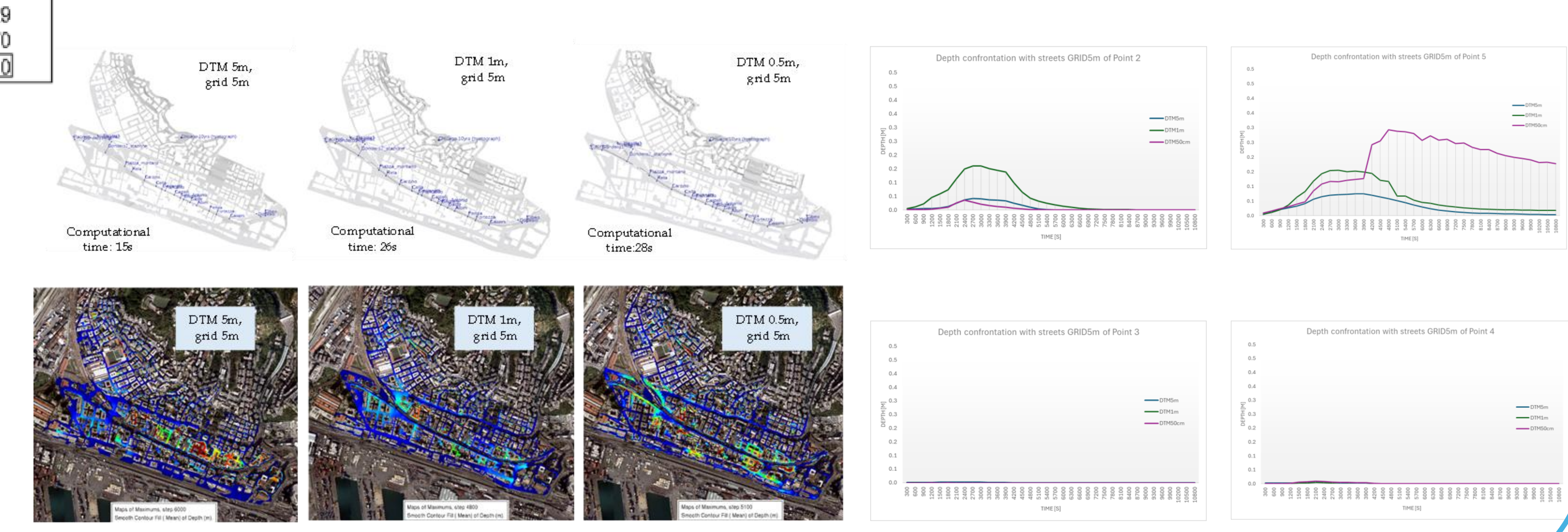




Same grid, different DTM

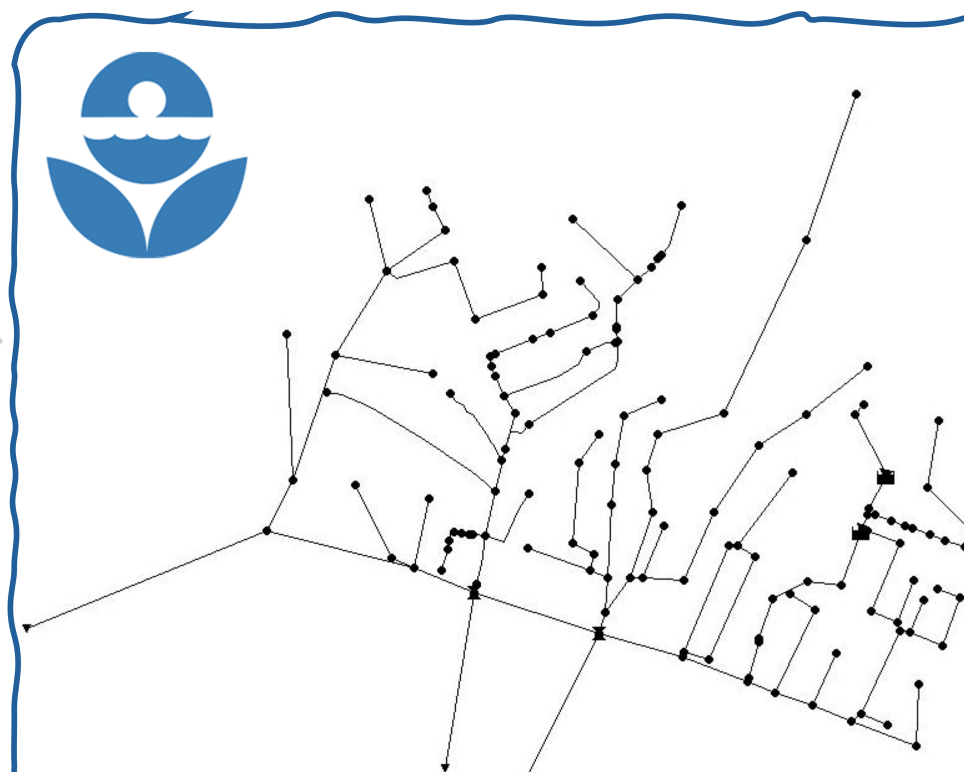


Same grid, different DTM. Simulation with streets



IBER 2D

SWMM



A preliminary **hydraulic and hydrologic description** of the stormwater drainage network was obtained from a separate study conducted within the **URCA!** ("Urban Resilience to Climate Change: to activate participatory mapping and decision support tool for enhancing sustainable urban drainage") project (*Gnecco et al., 2024*). The **URCA! project** adopts an integrated methodology combining **top-down** and **bottom-up** approaches, notably through participatory mapping (Pmap), to guide the design and deployment of **Sustainable Urban Drainage Systems (SUDS)** (e.g., green roofs, permeable pavements, blue roofs) in flood-prone urban areas .

Within this framework, the extensive complexity of the case-study area—marked by pronounced topographic variation and layers of overlapping infrastructure, including three naturally occurring streams that have been culverted over time—posed a significant modelling challenge. Recognizing both practical limitations and the need for robust analysis, the research team focused solely on the **primary stormwater drainage network**, deliberately excluding secondary or legacy culverted systems (*Creaco et al., 2025*).

This focused model encompasses:

•**137 junction nodes**,
•**3 outfall nodes**,
•**137 conduit links**, and
•**90 sub-catchments**.

This configuration strikes a balance between capturing the essential structure of the drainage network and maintaining manageable complexity in modelling and simulation efforts.

FUTURE STEPS

In the near future, efforts will be directed toward integrating the work carried out so far, with the goal of fully leveraging the module's potential. Particular attention will be given to the implementation of the IBER-SWMM interface and to the use of the QGIS plugin currently under development. Additionally, the 1D component (SWMM) will need to be adapted to ensure consistency with the ongoing IBER-based study. As a result, the interaction between the 1D and 2D models—specifically the treatment of inlets and the discretization and assignment of sub-catchments—will need to be reassessed and redefined based on the selected 2D data configuration.

Referencies

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