# Estimation of flooded areas from post-event survey and mitigation scenarios using permeable pavement solutions: a case study in the Italian territory

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## Abstract

The Italian territory is increasingly prone to damage due to flooding events as a consequence of increasing urbanization. The imperviousness of soil reduces the infiltration process resulting in increased flood hazard, while the growth of population and its economic welfare enhance the exposure and vulnerability with a resulting amplification of the risk associated with flooding events. The National project “Return – multi-Risk sciEnce for resilienT commUnities undeR a changiNg climate” addresses this topic within the activity of work package 2: “Flood risk under environmental and climatic changes”.

During the three years of the project, the envisaged activities include the collection of post-event datasets composed of rainfall measurements (from in-situ and remote sensors), extension of the flooded areas, water depth and velocity, assets at risk, damage estimation, surface and subsurface drainage network information in terms of size and maintenance degree, etc. The collected information will support future mitigation strategies and/or warning systems based on an easy-to-perform flooding simulation model.

The present work focuses on the urban flooding event occurred in the Sampierdarena district of the town of Genoa (Italy), on September 24th, 2022. Rain gauge measurements at the five-minute resolution were collected as well as the extension of the flooded areas and the occurred damages. The post-event survey was conducted based on photographs, videos and reports made available by citizens, authorities and operators present during the emergency interventions. From the available documentation, selected reference locations were identified to derive water depth values needed to reconstruct at least the extension of the flooded area.

Fig 1: The urban district of Sampierdarena (left hand side – from GoogleMaps), and flooding features on a street (central picture – from genova24.it) and a commercial activity (right hand side – from imperiapost.it).

With the aim to provide an easy-to-use procedure to reconstruct the extension of the flooded area, for use by civil protection and/or the municipality, the estimated water levels at the reference locations were implemented in a Geographic Information System (GIS) and using the Digital Terrain Model (DTM) the morphologically expected extension of the flooded areas was derived. The proposed methodology allows to reconstruct the flooded areas a-posteriori and to predict the flood prone areas under the assumption of total failure of the sub-surface drainage system, as shown by Lanza et al. (2023) for the investigated rainfall event and study area.

The same analysis was conducted by introducing storm water retention scenarios within the investigated area using permeable pavements and green areas mainly replacing pedestrian sidewalks and traffic islands. The proposed permeable pavement solutions (see Figure 2) were recently installed in another district of the town within a reconversion project (see Cauteruccio and Lanza 2022) and their hydrological performance were investigated in a testbed facility available at the hydraulic laboratory of the University of Genova. Different rainfall intensity and bed slope combinations were tested, and laboratory results were interpreted in terms of both surface and subsurface runoff coefficients.

Fig 2: Two permeable pavement solutions installed in the laboratory testbed, with a honeycomb grid and resin-gravel pavement (left-hand panel) and with meadow (right-hand panel).

The estimation of the flooded areas with the associated water volumes after the application of the derived retention coefficients allows to quantify the benefit introduced by the adoption of permeable solutions as a mitigation strategy to reduce the risk of flooding in a highly urbanized district. Results will be presented in terms of the expected and observed (reconstructed) flood hazard maps, as well as in the form of non-dimensional ratios between summary parameters in the present configuration and the proposed scenarios.

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## References

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