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Hydraulic modelling of permeable pavements to mitigate pluvial flooding in the city of Genoa, Italy

Arianna Cauteruccio, Enrico Chinchella, Giorgio Boni, and Luca G. Lanza
Dept. of Civil, Chemical and Environmental Engineering, University of Genova, Genova, Italy
(arianna.cauteruccio@edu.unige.it)

Rapidly evolving pluvial floodings are typically experienced in cities due to the inefficiency of the urban drainage system in terms of the hydraulic failure of the storm water pipes and/or the insufficient capacity of the storm drain inlets. This is mainly due to the limited extension of the urban catchment areas, with a high building density and largely impervious surfaces. In addition, the rainfall regime in the Mediterranean region is characterized by short-duration and high-intensity events, which typically have a rather limited spatial extension and a very rapid evolution. The case study investigated in the present work is located within the metropolitan area of Genoa (Italy), which has recently experienced pluvial flooding, although associated with a rainfall event characterised by a low return period (between 1.5 and 3 years). The studied urban catchment is characterised by a flat area of about 1 km^2, bordered to the north by hills and to the south by the seaport.

With the aim of partially restoring the natural retention and detention capacity of the catchment area, the conversion of selected impervious pavements around buildings into permeable pavements is tested by means of hydraulic simulation. The hydrological behaviour of the applied solution has been experimentally derived in the “E. Marchi” hydraulic laboratory of the Department of Civil, Chemical and Environmental Engineering (DICCA) of the University of Genoa (Italy). A special in situ survey was preliminarily carried out to determine the number, type and degree of clogging of the rainwater inlets located in the study area.

Hydraulic modelling is carried out using the HEC-RAS 2D software code (v. 6.3.1). The stormwater drainage inlets are simulated as pumping stations with a customised stage-discharge relationship based on the available literature studies, while the hydrological response of the permeable pavements is set in terms of flow hydrographs along linear boundary layers enclosing the converted areas. Results are presented in the form of flood hazard maps and flooded water volumes within the study area for different return periods of the forcing rainfall event. Various extensions of the permeable pavement are tested to quantify the mitigation effect associated with the investigated sustainable urban drainage solution.

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