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Modelling stormwater mitigation effects by LID controls over high flood risk urban areas

Daniele Masseroni (2), Giulia Ercolani (1), Enrico Chiaradia (2), Pier Carlo Anglese (3), Marco Callerio (3), Mayra Ventura (3), Gian Battista Bischetti (2), Claudio Gandolfi (2), and Fabio Castelli (1)

(1) Department of Civil and Environmental Engineering, University of Florence, Florence, Italy , (2) Department of Agricultural and Environmental Sciences, University of Milan, Milan, Italy, (3) Cap Holding spa, Assago, Milan, Italy

The increasing need to introduce mitigation measures that reduce storm runoff in urban areas, has led many regional water agencies to promoting directives addressed to the concept of “hydrologic-hydraulic invariance”, namely the condition under which the peak flow released from a transformed area has to remain unvaried before and after the land use change. The adoption of this concept, however, requires to design appropriate mitigation/compensatory measures and to define their distribution at the urban catchment scale in order to decrease the runoff where it is most needed.
In this work, we present a tailored software that has been developed specifically to support designers and planners in structuring LID (Low Impact Development) actions at the urban catchment scale. The software aims to be a straightforward but accurate tool to investigate the impact of different requalification scenarios on stormwater quantity and quality. It is composed of two main blocks: (i) the distributed hydrological modelsystem, named MOBIDIC-U and (ii) the GIS based Graphic User Interface (GUI) dedicated to the preparation of the input data and the analysis of the results. MOBIDIC-U derives from a distributed hydrological model (MOBIDIC), originally designed for real time flood forecasting at the river basin scale, where new capabilities have been implemented specifically for the urban environment. Basically, hillslope runoff propagation has been adapted to urban surfaces complexity and a flow routing scheme targeted for urban drainage networks has been added. In addition, specific modules simulating the functioning of the main LID systems (e.g. green roofs, permeable pavements, reservoirs) have been implemented, which can be easily plugged into the layout of the urban drainage system through the GUI and taken into account into the MOBIDIC-U simulations in order to assess their impact on stormwater flow and quality. Although potentially able to run continuous simulations over long periods, MOBIDIC-U is specifically designed for event based runs.
A pilot study application of the model in the Sedriano, a municipality in Northern Italy of about 12.000 inhabitants, is presented. The model was calibrated and validated over a series of high flow events occurred from August to November 2016. Then, a scenario where all the traditional roof covers (53% of the total impervious area) were transformed into green roofswas run for two design events (2 and 10 years return period), and the impact on stormwater quantity was assessed.
The results show a significant reduction of the discharge at the outlet of the urban drainage network, i.e. 58% and 44% in volume and 72% and 32% in the peak flow for the 2 and 10 years return period, respectively. However, we observed that in some areas the structure and the characteristics of the urban drainage network appear as limiting factor, e.g. the degree of filling of conduits is not changed after green roofs application. In these cases, only a flow control inside the drainage network can provide discharge reductions.