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Improving flood protection and wastewater reuse through the integration of urban sewage systems and irrigation canal networks

Giulia Ercolani (1), Daniele Masseroni (2), and Claudio Gandolfi (2)

(1) Department of Civil and Environmental Engineering, University of Florence, Via S. Marta 3, 50139 Florence, Italy, (2) Department of Agricultural and Environmental Sciences, University of Milan, Via Celoria 2, 20133 Milan, Italy

Most sewage collection systems designed between 19th and early to mid-20th century use single-pipe systems that collect both sewage and urban runoff from streets, roofs and other impervious surfaces. This type of collection system is referred to as a combined sewer system. During storms, the flow capacity of the sewers may be exceeded and the overflow discharged into a receiving water body - RWB - (often rural canals that are part of larger networks mainly intended for irrigation and drainage of rural areas) through spillways without any control and remediation. The continuous release of combined sewer overflows (CSOs) in these RWBs can increase the risk of a chronic pollution, affecting water used in agricultural and environmental contexts (i.e. for crop irrigation and, indirectly, aquifer recharge).

In this paper, a novel strategy to improve quality of downstream flow propagation of a CSO is tested through a modelling exercise on a real case study in the area of the metropolitan city of Milan.

The approach is based on the combination of grey, green and blue infrastructures and exploits the integrated storage and self-depuration capacities of a first flush tank, a constructed wetland and a natural stream to obtain admissible flow rates and adequate water quality in the RWB. The results, evaluated through a modelling framework based on simplified equations of water and pollutants dynamics, show good performances for the integrated system, both in terms of flow control and pollution mitigation. The pollution, using biological oxygen demand concentration as a proxy of the whole load, was reduced by more than 90%, thus reaching the standards for marginal water use for irrigation purposes (according to ISO 16075 guidelines for treated wastewater use in irrigation). Moreover, concerning the economic point of view, a preliminary estimate of the costs shows that the system may allow reducing the investment of approximately one third compared to the traditional CSO controls based solely on flow detention tanks. The proposed approach, as well as the modelling framework for its implementation, appear scalable in different world contexts and may contribute to improve the coordinated management of urban drainage systems and rural channel networks for reducing flood risks and improving wastewater reuse in irrigation.