Modelling the integrated drainage network to support the management of the hydraulic risk: a case study in Northern Italy

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ABSTRACT

According to a very recent report of the European Environment Agency (EEA, 2020), urban adaptation to climate change requires special attention to extreme weather events and particularly heavy storms, as they are expected to cause the most pronounced impacts in European cities. In agreement with this direction, some Italian regions are setting regulations to limit surface runoff production in urban areas. Most of them include measures to ensure compliance with the principle of the 'hydraulic' and 'hydrological' invariance for the urban area, meaning that runoff volumes generated by an intense meteoric event must remain unchanged or at least must be limited. In some cases, municipalities are even requested to prepare the Hydraulic Risk Management Plan, as a response to the need of a more effective stormwater management. The planning activity requires a modelling framework accounting for both the open channel network (mainly addressing irrigation demand) and the sewer pipe network. Preliminary results are presented here for Brescia, a town located in Northern Italy, at the foothills of the Alps. Potential flood risk is linked to the dense historical irrigation and drainage channels network that cross the urban area from north to south and the old city centre.

1. Methodology

According to a recent regulation approved by Regione Lombardia (BURL, 2019), some Italian municipalities are requested to prepare a Hydraulic Risk Management Plan. A modelling framework was set to account for both the surface drainage network and the sewer pipe network operating in the Municipality of Brescia (Lombardia, Northern Italy) through separate hydraulic models. In the urban area, the flood risk lies separately in the two networks, and also in the dense traditional irrigation and drainage channel network that crosses the town from north to south and collects many combined sewer overflows (Fig. 1). Most critical areas are those hosting the post-war urban development, where the waterways have been modified or covered in the last decades, disregarding their fundamental role during heavy storms. Some other critical areas, deserving special attention, are modelled in more detail, such as some urban areas at the bottom of some side slopes.

Data for the construction and calibration of the models are kindly provided by A2A Ciclo Idrico, the company that manages water services in Brescia, and by the Municipality of Brescia. So far, some of the many steps needed have been taken to assess the hydraulic vulnerability of the town by applying SWMM model (Rossman, 2015) for the minor hydrographic network and InfoWorks model (InfoWorks ICM 10.5.3) for the sewer pipe network. For the modelling activities the geometric data (diameters, shapes, materials, lenghts etc.) of both the main trunks of the sewer system and of the minor hydrologic system were available. This geometric information is being constantly updated and integrated through on-site verification and measurements, gradually increasing the detail level of the models. Besides, critical overflows are assessed through field observation and past event simulations.

Both scale event analysis and continuous simulation are carried out to test the resilience of the drainage system, also with respect to future climatic conditions. In fact, design event simulation can support sizing and testing of single devices during heavy storms, while continuous simulation shows the performance of the system not only during one event but also when a sequence of events occurs, as well as during interstorm periods. Future climatic conditions are accounted for both at the event scale and in continuous simulation by applying climate scenarios built based on regional climate model outputs.

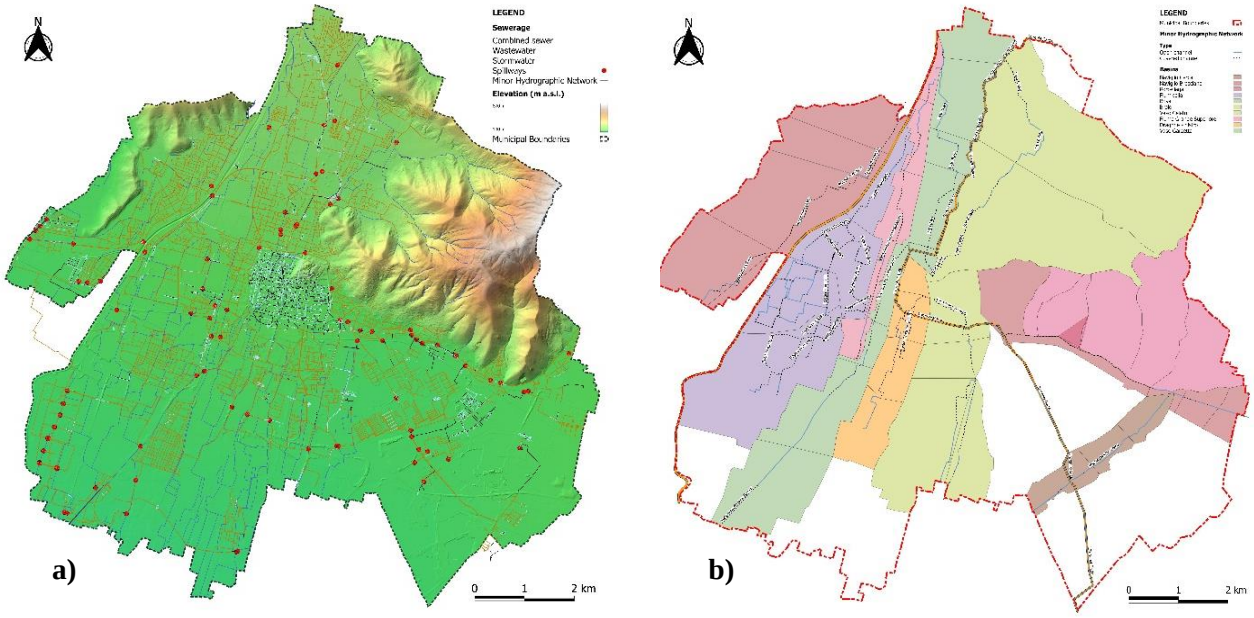

Fig. 1. a) Brescia Digital Elevation Model 5x5 m cell resolution with sewerage system and minor hydrographic network. b) Minor hydrographic network basins.

2. Results

Preliminary results of the hydraulic simulation of the complex system show some critical issues mainly related to the urbanization of the last decades and the many connections between the surface network and the pipe network. Uncontrolled soil sealing is the main problem responsible of the increased hydraulic risk affecting the town and making it more and more vulnerable to climate change. Critical combined sewer overflows are mainly related to a large upstream drained area and increased imperviousness.

Besides, in the part of the town hosting most industrial activities, a combined used of NBS (Natural based Solution) and real time control of water volumes stored in the pipes is expected to be effective. On the other hand, stormwater management in the old town centre can benefit only from reduced inflow from upstream areas and desealing is planned in some other areas. Taking advantage of the modelling framework, the efficiency of potential structural and non–structural measures under current and future climate are being tested.

3. Future work

The building of the modelling framework is still in progress and it is expected to be continuously updated as field survey data become available. A progressive validation of the models is essential to build an effective tool for the development of the Hydraulic Risk Management Plan, as requested by local rules in Lombardy Region. Further scenarios, including different solutions and future climate conditions, might also be applied to increase the reliability of the performance testing of the whole drainage system.

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