Integrated urban drainage system modelling to support the development of the Hydraulic Risk Management Plan for Brescia (Northern Italy)

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Highlights

- Modelling, calibration, and simulation of the urban drainage network to assess the flood risk.
- Connections between the sewer network and the minor hydrographic network.
- Measures to mitigate urban flood risk fostered by the Italian adaptation strategy and new regional development rules.

Introduction

In a very recent report of the European Environment Agency dealing with urban adaptation to climate change (EEA, 2020), extreme weather events (heatwaves, heavy precipitation, flooding and droughts) are expected to cause the most pronounced impacts in European cities, besides vector-borne diseases. Namely, between 1998 and 2009, Europe suffered over 213 major damaging floods that caused some 1126 deaths, the displacement of about half a million people and at least €52 billion in insured economic losses. Flood risk management thus became a priority, aiming at protecting population and assets.

With the Flood Directive (Directive 2007/60/EC) , the European Commission wanted to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage, and economic activity associated with floods and promoting public engagement in the planning process. Besides water districts had to develop the Flood Risk Management Plans in agreement with the River Basin Management Plan, previously developed to comply with the Water Framework Directive (Directive 2000/60/EC).

According to the transposition into Italian law of the above mentioned European directives (Legislative Decree 152/2006 and Legislative Decree 49/2010), several Italian regional authorities adopted laws and new regulations, requesting in some cases plans and strategies for flood risk mitigation. Besides in 2017, the Lombardy Region adopted a new regulation that called for municipalities within the 'highly critical' area to develop their own Hydraulic Risk Management Plan, including measures to ensure compliance with the principle of the 'hydraulic' and 'hydrological' invariance, according to which surface runoff volumes and peak flows generated by heavy storms cannot increase with respect to pre-development conditions (BURL 2017a, 2017b, 2019). The idea arises from the need to manage the stormwater in urban areas, where most elements of the existing sewerage system are now quite old and not more efficient and the sewer pipe network is strongly connected to the minor surface hydrographic network. On this basis integrated hydraulic modelling is a fundamental tool to support for flood risk assessment and local regulation testing. This is the case of Brescia, a town located in Northern Italy (Lombardy Region) at the foothills of the Alps. The Municipality of Brescia is currently developing the Hydraulic Risk Management Plan and has just adopted its climate transition strategy (Comune di Brescia, 2021).

Methodology

The planned research activity requires a modelling framework accounting for both the minor hydrographic (open channel) network (traditionally addressing irrigation demand) and the sewer pipe network. While separate hydraulic models might help the management provided by separate authorities, an integrated

model is ensuring a complete representation of the system hydrodynamics. On the other hand two separate models still accounting for connections between the two main elements can provide a more flexible management framework, while a single model would be characterized by a much more complex structure requiring greater data accuracy for its construction and calibration in order to obtain realistic results (Palermo et al. 2019).

At this stage two separate hydraulic models are being implemented for the town of Brescia, where potential flood risk lies in the dense traditional irrigation and drainage channel network that crosses the urban area from north to south and the old city centre. More critical areas are those hosting the post-war urban development, where the waterways have been uncovered and covered in the last decades in a chaotic and uncontrolled way, in some cases even below houses and other buildings. Detailed modelling effort is being focused on those parts of the urban area showing critical issues.

Data for the construction and calibration of the models were kindly provided by A2A Ciclo Idrico, the company that manages water services in Brescia, and by the Municipality of Brescia. So far only some of the many steps needed have been taken to assess the hydraulic vulnerability of the town, by applying SWMM model for the minor hydrographic network (Rossman L.A., 2015) and InfoWorks model for the sewer pipe network (InfoWorks ICM 10.5.3).

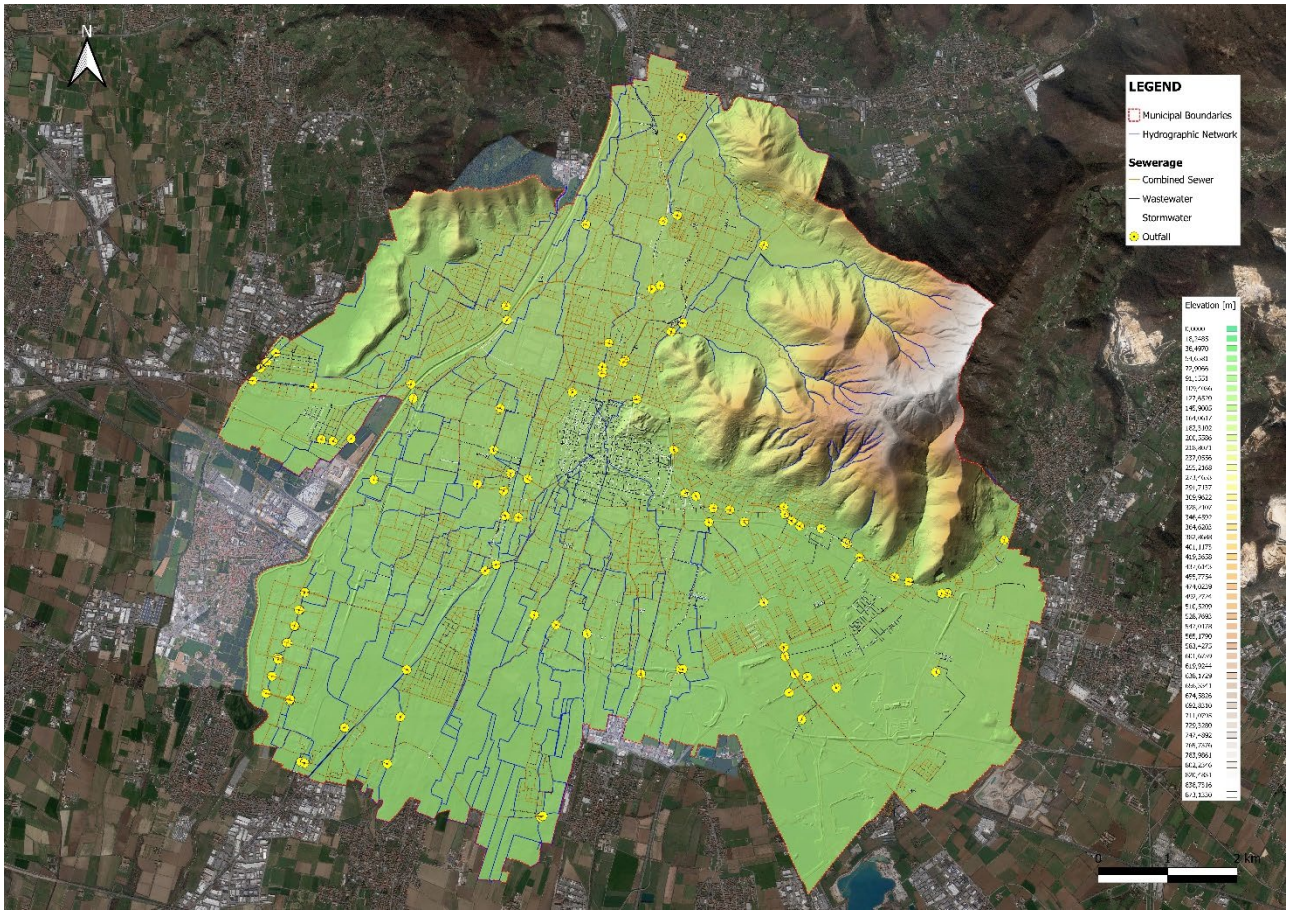

Figure 1. Brescia Digital Elevation Model 5x5 m cell resolution with minor hydrographic and sewerage network.

Results and discussion

Preliminary results of the hydraulic simulation of the complex system show some critical issues mainly related to the uncontrolled urbanization of the last decades and the many connections between the hydrographic network and the pipe network, especially during heavy storms. The modelling framework supports the analysis of specific subareas where the efficiency of potential structural and non–structural measures can be tested.

Besides in the part of the town hosting most industrial activities, the high level of soil sealing is the main responsible of some critical issues that might be solved through a combined used of NBS (Grossi et al., 2021,

Turco at al., 2020) and real time control of water volumes stored in the pipes. On the other hand, stormwater management in the old town centre can benefit only from reduced inflow from upstream areas.

Conclusions and future work

The development of the Hydraulic Risk Management Plan, as requested by local rules in Lombardy Region, needs to be supported by an integrated modelling framework accounting for both the minor hydrographic network and the sewer pipe network and their connections. Several issues have been highlighted for Brescia, mainly related to the high level of soil sealing and the strong interaction between the sewer pipe and the hydrographic network. Moreover, climate change scenarios might enhance critical issues in the future.
Accounting for new rules and regulations, urban planning tools might play an active role in flood risk mitigation by fostering the adoption of NBS and Best Practices to support new stormwater management strategies (as expected in the municipal strategy for climate transition), relying on a more detailed modelling framework and real time control devices.

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