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Safeguarding heritage sites from hydrometeorological extremes: the Santa Croce district in Florence

Paolo Tamagnone et al. ▶

Humankind is currently living in an era governed by continuous climate warm-up and unstoppable urbanization, in which the ongoing climate change is leading to an exacerbation of hydrometeorological events. With an intensification of magnitude and frequency of extreme rainfall events, engineers and scientists are striving to develop methodologies and strategies to effectively defend people and assets from pluvial flooding. Pluvial floods produced by local, intense, and fast rainstorms cause the surcharge of urban drainage systems inducing the inundation of streets and buildings before the runoff reaches the receptor watercourse. Pluvial flood damage has been defined as an 'invisible hazard' but it increasingly weighs on the budget of direct flood losses, raising the costs incurred by flood damages. Besides the tangible losses, the costs may be even higher when the intangible share is considered, such as the potential loss of heritage held in ancient towns. For this reason, the inestimable cultural and artistic heritage preserved in historical buildings require a high-level of protection against hazards induced by natural calamities. The present study investigates extreme rainfall-related impacts and hazards threatening the cultural heritage situated in the most vulnerable areas of the Santa Croce district (Florence, Italy). The district hosts some of the most important buildings of the city: the National Central Library of Florence and the Opera di Santa Croce. The geographical location of this monumental complex makes the cultural heritage guarded inside of it dangerously exposed to multiple sources of flood hazard. Firstly, river flooding due to the proximity to the Arno River (this area has been already harshly damaged by the catastrophic flood in 1966). Secondly, flooding by sewage since that the internal drainage network is linked with one of the main sewer conduits of the city. Then, surface runoff flowing down from the headwater. Considering this framework, the pluvial flood hazard assessment is performed using a 1D/2D dual drainage model specifically implemented to simulate all hydraulic phenomena occurring both on the surface and through the sewer network. The analysis comprehends a series of scenarios designed to simulate the impact of hydrometeorological extremes on the study area and each possible concatenation of consequences or failures. The hydraulic model incorporates different layers of information: the high-resolution digital surface model of the area and buildings, the public sewer network, and the internal rainfall collection system of the district. Geometrical features and technical specifications of the sewer network have been retrieved from detailed field surveys and research in historical archives. Model's outcomes allow identifying the critical nodes within the drainage network, delineating the most vulnerable areas, and prioritizing the rescue efforts in case of severe cloudbursts. Results may help site managers to improve the efficiency of their hazard management and emergency plans. Furthermore, the study intends to propose suitable technical solutions for safeguarding the cultural heritage where designing intrusive engineering works hardly fits within the historical urban context.

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