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Quantitative flood risk assessment in historic cities: sensitivity to hydraulic modeling and open socio-economic data.

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The assessment of flood risk in urban areas is considered nowadays a crucial issue to be addressed by technicians and public authorities and requires the estimation of hazard, vulnerability and exposure. Each step of the risk assessment brings its uncertainties to the final result, thus the analysis of the sensitivity to the different contributors is required. Since the damages are generally evaluated through stage-damage functions one of the most important contribution is the estimated value of the water depth. Water depth is the outcome of hydraulic models that can be implemented with different modeling approaches and levels of spatial detail, thus providing flood depth maps that may differ in the extension of the inundated area and in the flood depth value. It is generally argued that 2D models are the most suitable to describe flood behavior in the urban environment although most of applications are carried out in small and sparse urban areas. In the historic cities a 2D model provides reliable results if the grid size is small enough to describe the street/building pattern, implying long simulation runs. Another contribution is given by monetary values assigned to the damage categories that may come from different proxy variables and may oscillate according to the real estate quotations. The risk assessment here presented is made possible thanks to a methodology based on the open data, both socio-economic and territorial, that are available in the web. In this work the risk assessment procedure and the sensitivity analysis are applied to the main cities located along the Arno river, Pisa and Florence (Italy) that are usually considered of broad interest for the importance of urban and cultural heritage. The risk is estimated accounting for structures, household contents, commercial and tertiary sectors which are the most representative of the studied areas. The evaluation and mapping of micro-scale flood risk is carried out in a GIS environment using open data aggregated to the census polygons. It results that, for a flood event of similar magnitude as the one of 1966, the flood risk analysis for the city of Florence estimates a total damage of about 6 billion euros without considering the damage to cultural heritage. This value is larger than the annual income of the whole municipality. The average flood risk per unit surface of territory (m^2) is about 10 €/year for the historic centre in Florence and 4 €/year for Pisa. A discussion of the sensitivity analysis is also presented.