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Statistical analysis of the uncertainty linked to flood risk evaluation

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The principal objective of the drainage system is to safeguard the security of people and the urban activities avoiding water flowing in the buildings and houses, and allowing pedestrian walk and traffic move safely. In general, in urban areas two connected drainage systems can be identified: a minor system constituted by underground drainage and a major system made by open channels and storages(streets network, squares, parking areas, etcĚ). In normal conditions, the major system collects storm water that is subsequently disposed to the minor system through gullies and other inlets. Sometimes the surface runoff cannot be completely collected by the minor system, and water flows through the major system generating flooding. In other cases, the minor system collects runoff water but its cross section results insufficient to convey peak discharges generating flooding by drainage system overflow. For the complexity of the involved phenomena, the analysis of urban flooding is characterised by more uncertainties than the simpler analysis of the underground drainage. These are basically due to the interaction between major and minor systems and the uncertainties linked to the knowledge of the major system geometry. For this reason, flood risk quantification and evaluation in urban areas is very complex. In the last decades, many definitions have been proposed to explain the concept of flood risk in urban areas and many methodologies have been defined in order to quantify the risk in the most objective and general way. This aim is usually pursued defining the risk by the evaluation and the integration of three criteria: the probability that a system deficiency can cause flooding; the vulnerability of the objects "at risk" to be affected and damaged by the flooding; and finally the exposure that is directly connected with the level of damage that is expectable once the object "at risk" is affected by the flooding. The flood risk is thus assigned by three set of indicators: Deficiency Indicators (DIs), Vulnerability

Indicators (VIs) and Exposure Indicators (EIs). Frequently, the indicator variables are compared with corresponding user-defined threshold values or curves (penalty curves or matrixes) that represent the various levels of deficiency, vulnerability and exposure allowing for finally assess the flood risk corresponding to the analysed area. The vulnerability or the exposure quantifications of the structure located into a given area is strictly dependent on the building features and location and for this reason can be considered less affected by the uncertainty connected with the experience and ability of the user.. This statement can not be assert referring to the quantification of the flooding deficiency, linked to the flooding evaluation in terms of water depth or velocity or to their combination. In fact, the values of these variables are not often available for each part of the urban centre or affected by measures errors and modelling errors that are typical of hydraulic numerical analysis. In urban flooding risk analysis, another source of uncertainty is the assignment of penalty curve and thresholds defined by the operator according to his experience and personal risk perception. The major consequence of this statement is to make risk analysis subjective and, consequently, mainly useful for comparison between different scenarios applied to the same system or for analysing the system behaviour in different situations or contexts. Aim of this study is a statistical analysis of flood risk in urban areas, by the mean of Monte Carlo Analysis, in order to quantify the uncertainty affecting the evaluation of Deficiency Indicators and consequently the Risk Assessment, linked to the subjective selections of threshold values or curves (penalty curves) that take part during the procedure. The analysis has been applied to the real case study of the “Centro Storico” catchment in Palermo (Italy), an highly urbanised area of about 2.5 km2 affected by local surface flooding due to the drainage system insufficiency even for high-frequency rainfalls. The flood risk analysis procedure has been applied using some mathematical models simulating the surface runoff generation and propagation as well as the water flow in pipes and manholes. Simulations have been carried out using a set of synthetic rainfall events. Many deficiency threshold values or penalty curve shapes have been used in order to quantify the uncertainty affecting the deficiency assignment linked to the operator choices. For each defined matrix or penalty curve shape, a frequency-risk relationship has been obtained by fitting the risk values with a suitable probability distribution. Even if computationally onerous, the statistical flood risk analysis increases the robustness of the method and allows for some general considerations about the user-dependency of the classical risk assessment methodology and for increasing the user confidence in the method results.