Research activities of the UNIGE RETURN Team on pluvial flooding hazard and risk assessment in urban area

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Abstract This presentation outlines the research activities carried out by the University of Genoa within the RETURN project, focusing on the assessment of the components of the risk equation for urban floods triggered by intense rainfall. These events, commonly referred in the literature as pluvial flooding, are characterised by rainfall-generated overland flow and ponding before the runoff enters any watercourse, drainage system or sewer, or cannot enter it because the network is full to capacity.

The study addressed both the sources of uncertainty in hazard estimation and the potential for improving exposure assessment—and thus damage estimation—under specific hazard scenarios. Concerning hazard-related uncertainties, the analysis investigated the effects of different representations of precipitation forcing and topography.

Because the spatial and temporal scales of precipitation associated with pluvial flooding are extremely small, reproducing the impacts of a specific event, particularly the flooded area, becomes challenging. A case study shows that the absence of rainfall measurements within a few kilometres of the affected area can lead to substantial discrepancies in the simulated flood extent, with direct implications for damage evaluation. Topography in flood models is represented through digital terrain models (DTMs), available for urban areas at varying resolutions and accuracies. The presented case study demonstrates how model resolution can influence the representation of flood hazard magnitude, again affecting damage and risk estimates. The choice of numerical parameters used to solve model equations can introduce comparable effects.

To quantify the implications of inaccuracies in hazard mapping, a detailed characterisation of exposed elements is required. The case study explored the classification of specific exposure categories, such as vehicles. Identifying the location of such vehicles was addressed as a problem of object detection from input remote sensing imagery of the considered scene. For this purpose, deep learning models from the YOLO (You Only Look Once) family were trained and applied to an extremely high-resolution orthophoto (5 and 20 cm of resolution). The performance of such techniques in the study area was evaluated for this purpose. The resulting datasets were then employed to quantitatively assess the impact of variations in hazard scenarios associated with differences in precipitation forcing.

Overall, the findings reveal that, in contexts where validation data for model outputs are scarce—as is common for pluvial flooding—the choice of input data, topographic

representations, and model parameters becomes highly critical. Approximations acceptable for larger-scale flood events can lead to significant inaccuracies when modelling pluvial floodings. This underscores the need to collect information at the highest possible level of detail, including comprehensive databases on meteorological forcing, historical flood and damage records, and high-resolution planimetric and altimetric descriptions of urban areas.