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Opportunistic rain sensors and flood modelling to assess the risk of failure of surface drainage in urban areas

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High-resolution space-time measurements of rain fields in urban areas are crucial to support the assessment of the risk of failure of urban drainage systems. In this work, opportunistic rain sensors based on optical principles and mounted on board moving vehicles are tested and used as an input to a hydraulic model to assess the risk of flooding of selected urban areas. Opportunistic sensors can be joined with other innovative measurement techniques (satellite links) and traditional instruments (radars and rain gauges at the ground) to provide the best real-time estimate of the space-time rain field for selected events. Synthetic hyetographs based on the local DDF curves are also used to assess the return period of flooding scenarios.

The focus of this work is on the impact of the inlet number, positioning, and efficiency on the risk of flooding. Detailed information about the inlet characteristics, including the potential degree of clogging, were obtained from the archives of the company in charge of the street and inlet maintenance, corroborated by a dedicated survey in the study area. This allowed obtaining a complete definition of the geometric and hydraulic characteristics of the surface drainage system (inlets), connecting the runoff produced during rain events with the underground storm sewers. It is assumed here that the capacity of the storm sewers is sufficient to drive away the water conveyed through the inlets, therefore no backflow is considered.

Hydraulic modelling is performed by using the HEC-RAS 2D software code (v. 6.3.1) and inlets are simulated as pumping stations with a customised stage-discharge relationship based on the available literature studies. Results are presented in the form of maps of the water depth and velocity over the study areas, and critical regions are identified based on the observed frequency (return period) of the expected flooding.

This study aims at providing suitable information to plan priorities in the maintenance interventions (cleaning and repairing of inlets) and possible expansion of the surface drainage system. The model is applied to a case study of an urban district of the town of Genoa (Italy), to support the activities of the project RUN – “Urban Resilience: Now-casting of the risk of flooding with IoT sensors and Open Data”, funded within the ROP-ERDF (Regional Operational Programme of the European Regional Development Fund).