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FLOODS IN CITIES: NEW INSIGHTS FOR INTEGRATING PLUVIAL FLOODING INTO FLOOD RISK MANAGEMENT PLANS

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ABSTRACT

In the last years, Italian cities are increasingly facing challenges associated with urban sustainability and urban water issues. Specifically, the risk associated with extreme rain events in urban areas has dramatically increased. For this reason, integration of pluvial flood risk management into Flood Risk Management Plans by regional and local water authorities becomes fundamental.

The project INSPIRING, financed by the Ministry of University and Research – MUR (Italy) for the 2020 PRIN (Research Projects of National Interest) program, aimed to improve management capacities of public authorities to mitigate heavy rain risks by integrating pluvial flood risk management into management plans according to the EU Floods Directive. Project outcomes aim to help decision makers in planning and design of storm water control actions to mitigate the impacts of heavy rainfalls causing floods in urban areas, allowing "citizens and cities" to be better prepared to challenge due to global changes. For this reason, the focus of the project was the identification of joint and shared public strategies and actions to manage the risks consequent to this type of extreme event.

To build an effective cooperation between science and society regarding the assessment and management of the risk of pluvial flooding in urban areas, the most recent and advanced knowledge in the field of urban hydraulics and hydrology, of the planning and design of the sustainable and multi-functional solutions

(complementary to traditional solutions) is needed, according to the more comprehensive definition of the Flood Risk Management Plans contained into the Flood Directive.

Keywords: Pluvial flooding; EC Flood Directive 2007/60; risk evaluation; risk mitigation; risk communication.

1. The project INSPIRING

Flooding is one of the most challenging weather-induced risks in urban areas, due both to the typically high exposures in terms of people, buildings and infrastructures, and to the uncertainties lying in the modelling of the physical processes involved. Climate change also leads to flood risk increase, due to hydrological alterations, including warming seas, changing patterns of precipitation and rising sea levels can lead to flood risk increase.

Hazard and risk assessment is an essential issue in the reduction of adverse effects of extreme events. Several procedures, less or more detailed, are available in scientific literature for the assessment of hazard and risk maps, in most cases designed to achieve maps or charts from the combination of probabilistic analysis of historical records and geographic information knowledge. In many countries, standard procedures are also available, mainly for planning purposes.

The European Directive 2007/60/EC (Flood Directive) establishes the framework for the assessment and the management of flood risks. In the last years, Italian cities are increasingly facing challenges associated with urban sustainability and urban water issues. Specifically, the risk associated to extreme rain events in urban areas has dramatically increased. For this reason, integration of pluvial flood risk management into Flood Risk Management Plans by regional and local water authorities becomes fundamental.

Many models, codes and software exist that can be of aid in the investigation of urban flooding, with different purposes such as timely prediction, hazard/risk mapping, design of adaptation measures. However, several challenges are posed in modelling by the amount and detail of data required by the code, the detail and variety of outputs, temporal and spatial resolutions involved, general unavailability of suitable data for validation. In this perspective, complex and detailed models could be unsuitable for large areas or when a high number of simulations are needed, as happens with scenario analysis. There is a general lack of guidelines with reference to the hydraulic peculiarities of the urban environment, the discretization of the physical domain, the choice of numerical model and simulation parameters.

As part of this more flexible and holistic approach, the use of flood resilience and flood resistance measures at property and community scales should be advocated. While large scale engineered defenses, remain important, there is an acceptance that the risk cannot be managed solely by holding back water through a narrow focus on heavy structural approaches. Instead, a deep and distributed understanding of flood risks, where structural measures are complemented by non-structural, and adaptation should be considered alongside mitigation and uncertainty throughout the analysis process in a transparent way by shifting from the traditional approach to an integrated approach with attention to socio-economic aspects such as improving flood preparedness and resilience at various spatial scales.

In this context, the implementation of Sustainable Urban Drainage Systems are particularly beneficial where it is difficult to justify expensive capital expenditure, to protect critical infrastructure, to limit the visual disruption in cultural and heritage areas and where traditional defenses are inappropriate, such as in the case of urban flooding.

To deliver this aim, the INSPIRING project collectively addressed an integrated set of research objectives, namely:

- Improving pluvial flooding risk mapping (hazard and impacts).
- Increasing understanding of the causes, probability and consequences of surface water flooding.
- Reviewing the resilience of infrastructure networks against extreme pluvial flooding scenarios.
- Identifying opportunities where structural and non-structural measures can play a more significant role in managing pluvial flooding risk and contribute to fulfilling the requirements of the EC Flood Directive 2007/60.
- Increasing awareness of the duties and responsibilities for managing pluvial flood risk.

- Improving public engagement and understanding of surface water flooding.
- Developing new guidance for Flood Authorities on local flood risk management strategies for identifying measures to mitigate surface water flooding.

The produced guidelines integrated the most advanced knowledge in hydrological-hydraulic modelling in urban environments together with both new sustainable and traditional mitigation measures, promoting risk communication as means to increase citizens' awareness and participation. To this aim and to validate and improve the developed procedure, the research was applicated on two pilot case-studies placed in Italy, respectively in Sicily (Fig. 1) and Campania (Fig. 2) regions, and the results were generalized to make the findings suitable for all the diverse Italian contexts.

Fig. 1. Pilot case of the Ganzirri lakes in Messina (Sicily, IT).

More in particular, the first pilot case is placed in the town of Messina (Sicily) around the area of "Ganzirri lakes" in the northern part of Messina city area (Fig. 1). The site is located close to the sea and it is a natural reserve (Special Protected Area). In this area, many touristic and residential settlements are located while the lakes and the lakefront are used for leisure, sports, walking, etc. This area is subjected to frequent pluvial flooding due to its very peculiar topographic characteristics (the area is close to the sea and very flat). The main concerns mostly regard the accumulation of surface runoff in the central part of the pilot area (which, along with the overall poor conditions of manholes, make the storm water collection hard) and to the contributions in terms of additional surface runoff volumes coming from a number of adjacent catchments characterized by very steep slopes and large drainage areas.

The second case study is, instead, located in Fuorigrotta (Fig. 2), one of the administrative units of the city of Naples (Campania), located in the western part of the urban area, that is particularly suitable to exploit pluvial flooding analysis. The pilot area chosen for the analysis is about 2 km^2 and it roughly coincides with the stormwater drainage catchment serving the neighborhood, which, in turn, is part of the complex and stratified combined sewer system of the City. Due to its peculiar topographic features, the drainage efficiency of the sewer system in the area has always been limited, and a large number of enhancements, retrofitting and extraordinary maintenance interventions have been proposed.

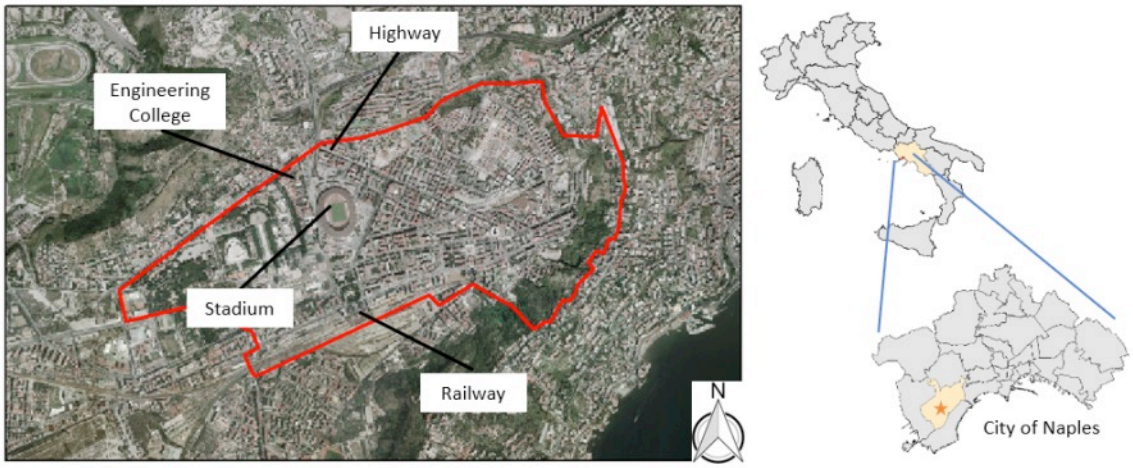

Fig. 2. Pilot case of Fuorigrotta in Naples (Campania, IT).

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