Publications of the Institute of Geophysics, Polish Academy of Sciences
Geophysical Data Bases, Processing and Instrumentation
vol. 453 (E-14), 2025, pp. 127–129
DOI: 10.25171/InstGeoph_PAS_Publs-2025-061
XLII International School of Hydraulics, Radocza, Poland, 20–23 May 2025

Urban Resilience to Floods: Real Challenges and Misleading Myths

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Abstract

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 involved physical processes.

In the last decades, European cities are increasingly facing challenges associated with urban sustainability and urban water issues.

Floods are normally a consequence of extreme rainfall events, but they can also happen because of infrastructure failures. Climate change also leads to flood risk increase, due to hydrological alterations, including changing patterns of precipitation and rising sea levels.

Hazard and risk assessment is an essential issue in the reduction of adverse effects of extreme events. Here, the term "hazard" refers to the occurrence probability of a potentially damaging event, while the term "risk" refers to the extent of consequent damages and losses. Several procedures, less or more detailed, are available in scientific literature for the assessment of hazard and risk maps, in most cases designed to provide 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. A crucial tool for the achievement of these objectives is the preparation of flood hazard and flood risk maps. This activity calls for an active involvement of all the stakeholders in developing flood risk management plans.

1. INTRODUCTION

Catastrophic floods and devastating hydrological phenomena have been systematically hitting the Old Continent in recent decades, causing enormous impacts in terms of number of victims and financial losses.

The European Union (EEA 2022) states that hydrometeorological events are responsible for approximately two-thirds of the damage caused by natural disasters since the 1980s.

The numbers are impressive when we concentrate on Floods and Mudflows, as confirmed by the records available from the International Disaster Database (Centre for Research on the Epidemiology of Disasters, CRED, Université Catholique de Louvain – UCL, Brussels, Belgium; http://www.emdat.be):

- during the last century, the total amount of estimated economic losses is larger than five hundred billion Euro;
- during the same period, almost thirty million persons have been affected by destructive hydrological events, with more than twenty-nine thousand fatalities;
- a definite trend shows a significant increase of the number of events per year over the last decades.

On October 23, 2007, the European Parliament approved the so-called "Floods Directive" 2007/60/CE (hereafter referred to as the FD), aiming to regulate the procedures for the Hydraulic Risk assessment within the borders of the EU member States. The implementation process of the FD involves 27 Countries and 110 River Basin Districts (RBDs), including 40 transnational and eight extra-continental districts.

2. RISK ASSESSMENT

According to the UNISDR (2017), Risk *R* is the probability that a negative outcome will affect people, systems, or assets. The risk results from the combination of Hazard *H*, Exposure *E*, Vulnerability *V*, and capacity *C*, according to the following relationship:

$$R = \frac{H \times E \times V}{C} \tag{1}$$

where:

- *H* is the probability of occurrence of a potential source of harm, such as an extreme hydrological event;
- *E* consists of possible threats in terms of people, infrastructure, and other assets;
- *V* is the likelihood of an element being harmed by an event of a certain intensity;
- *C* represents how well a system or community can withstand a hazard.

The adverse impacts of hazards, especially for hydrogeological events, are often not fully prevented, but their severity can be significantly reduced by various strategies and actions. Engineering techniques and hazard-resistant construction are among the measures that can be implemented to prevent damage; these measures are as important as the improvement of environmental and social policies and raising public awareness. In general, the term "mitigation" is extensively used in climate change policy, and refers typically to the reduction of greenhouse gas emissions that are the source of climate change; for the case of the urban flood risk, the term "adaptation" measures is certainly more appropriate.

The assessment of flood risk in urban areas cannot neglect the so-called the "underlying risk drivers" (i.e. increasing levels of exposure and vulnerability and/or decreasing capacity) that may significantly influence the level of disaster risk (Fig. 1a).

Indeed, several dangerous situations persist due to either uncontrolled urbanization (Fig. 1b) or wrong design of urban hydraulic infrastructure. The destructive effects of these anthropogenic factors can be demonstrated through some study cases.

Actually, the state of implementation of the FD is quite heterogeneous among the various the EU member states, often presenting different methodologies and approaches to assess hazard levels, with particular reference to urban areas.

(a) (b)

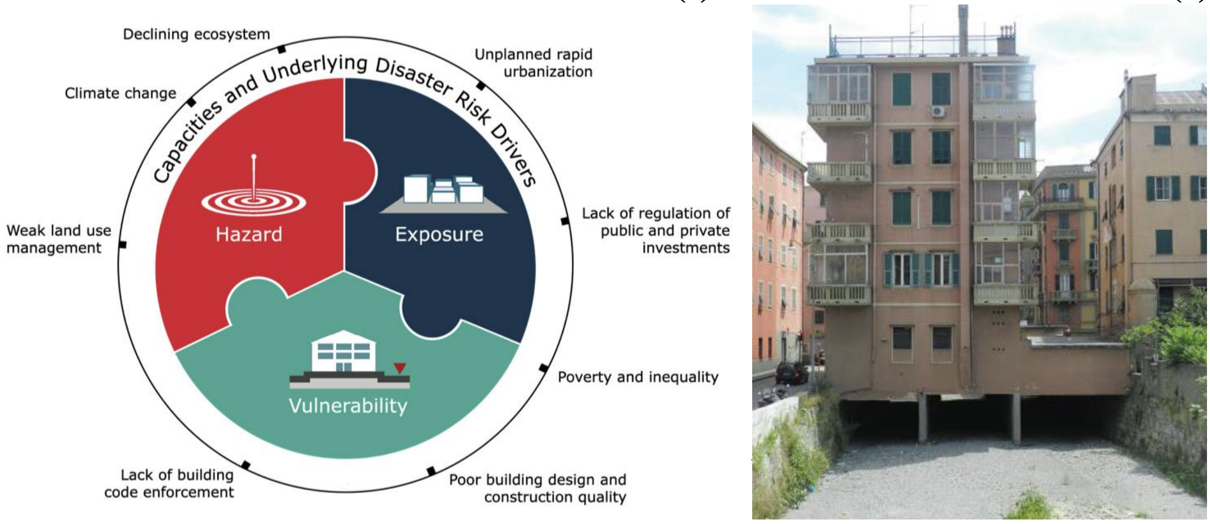

Fig. 1: (a) Components concurring to flood risk assessment (UNISDR 2017); (b) Building obstructing the Chiaravagna Torrent and provoking severe urban flooding in the city od Sestri Ponente (Liguria, Italy) on October 4, 2010.

3. HYDRAULIC HAZARD IN URBAN CONTEXTS

In urban areas, the highest levels of hazard are due to the impact of a flood stream on people, according to two different categories: (i) *direct* exposure, i.e. instability of a person impacted by the flow, and (ii) *indirect* exposure, i.e. effects of drifters (such as vehicles or urban/household furniture) washed away by large floods and investing persons or provoking blockages at bridges, culverts, and urban drainage infrastructures.

This invited lecture aims to propose the state of the art of different criteria, based on recent research findings, that should be considered to evaluate the hydraulic hazard/risk in anthropized environment.

Nowadays, there is still a lack of standardization between countries in terms of assessing flood hazard in urban contexts. Moreover, the procedures for flood hazard assessment for pedestrians are not updated to the latest available methods; in some cases, this aspect is even completely ignored.

Based on the available data, it is possible to conclude that the recent increase of urban flooding events is *probably* determined by the evolution of the climate, but it *certainly* depends on anthropogenic factors directly or indirectly linked to the use of land and water.

References

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