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The Impact of input data and system description on modelling of pluvial flooding: A literature Review

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Work package: WP2 Flood Risk

Introduction to PLUVIAL FLOODING

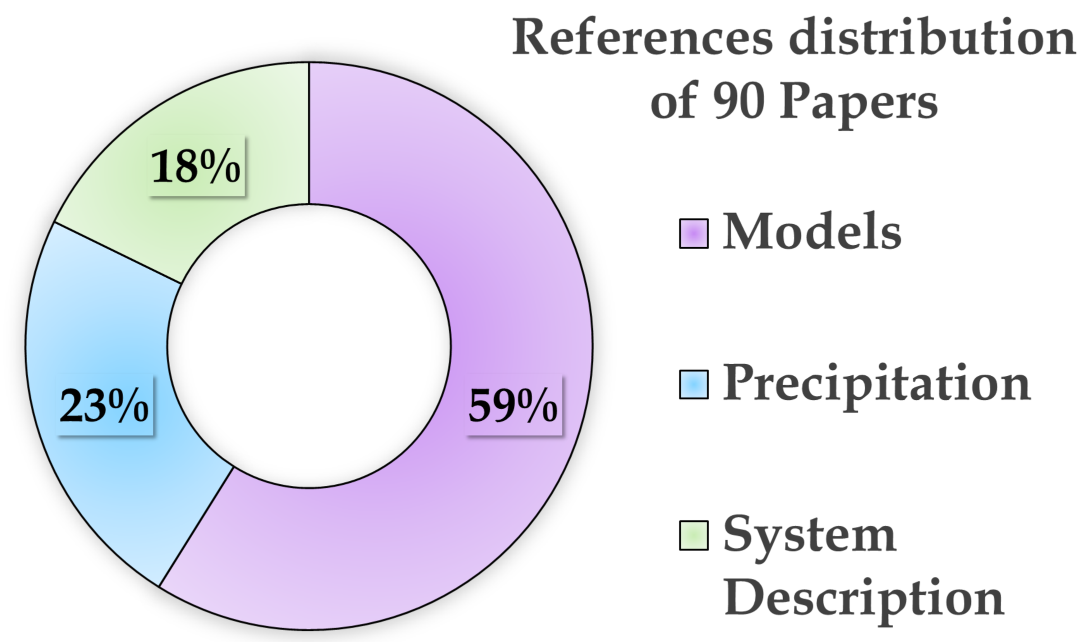
The European Directive 2007/60/CE defines in Art. 2 the term **«flood» as the temporary covering by water of land not normally covered by water. This shall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems.**

Recognizing its widespread occurrence as a hazard, flooding is typically categorized into three main types: fluvial, coastal, and pluvial. While all types of flooding have the potential to impact urban areas, this research will specifically target pluvial flooding.

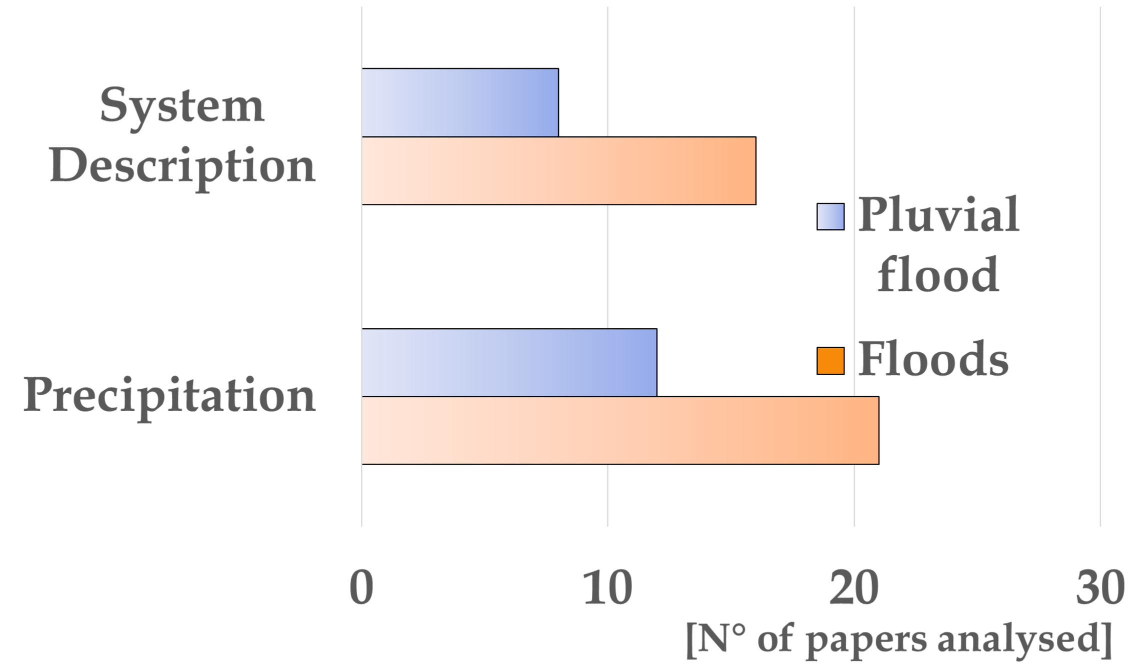
Pluvial flooding arises from a multitude of factors, such as restricted drainage capacity, urban expansion, the impact of climate change and deficiencies in the maintenance of sewer systems. Given the complex surface characteristics of urban environments, it is imperative to develop models that can effectively simulate rainfall-runoff processes, flood occurrences, and inundation patterns and, these factors collectively modify the hydrodynamic behaviour of metropolitan areas. *(Liu et al, 2020; Wang et al, 2023)*

After a literature review since 2020 [Fig.1], it came out that the research interest of the last years mainly focused on the models' development (60%), while **inaccuracy and gaps in pluvial flood modelling persist** due to a lack of **high-quality** input data and system descriptions, with **appropriate spatial and temporal resolution (40% of the surveyed papers)**. One third of the latter are focused on pluvial flooding.

In this work, the areas where further research and refinement are necessary for a more comprehensive understanding and effective management of pluvial flood risk are addressed.



[Fig.1]: Analysed literature distribution ***since 2020*** *of a total of 90 papers. The histogram below highlights how the questions of system description and precipitation input have been addressed in relation to floods and pluvial floodings.*



In urban areas, hydrological processes are highly variable in both space and time, making them sensitive to small-scale changes in rainfall patterns. A key issue that needs attention is the accuracy and gaps in input data, particularly concerning precipitation. (*Maier et al, 2020; Cristiano et al, 2017*).

The acquisition of such data presents challenges, encompassing instrument calibration, coverage limitations, and the heterogeneous nature of data sources, all of which engender inaccuracies and gaps, even across divergent instrument types.

It is still typical to rely on rainfall data collected from a single **rain gauge**. In fact, local rain gauges provide relatively accurate point rainfall estimates near the ground surface *(Ochoa-Rodriguez et al, 2019).*

To address this spatial limitation, **radar data** can provide valuable insights if available. However, conventional wide-range C-band radar systems, do not scan close enough to the surface to capture accurate intensity readings and their resolution may not meet the requirements of pluvial flooding modelling.

Additionally, the reliability of radar data depends on ground-level rain gauges to calibrate intensity measurements into accurate rainfall volume, which can be compromised if the rain gauge resolution is too coarse *(Maier R. et al, 2020; Ochoa-Rodriguez et al, 2019).*

INPUT

PRECIPITATION ? **SYSTEM DESCRIPTION: DIGITAL ELEVATION MODEL *(DEM)* & URBAN DRAINAGE SYSTEM *(UDS)***

IMPACT ON ↓

MODELLING

Model categories according to [8]:

- *rapid flood spreading (RFS)*
- *one-dimensional sewer (1D-S)*
- *one-dimensional overland (1D)*
- *two-dimensional overland (2D)*
- *coupling sewer-overland (1D–1D and 1D–2D)*

Surface elevation data are crucial for flood modelling as they represent the physical land surface. High-resolution DEMs are essential for accurately estimating how water interacts with the environment and identifying areas prone to flooding.
The reliability of simulated water depth is closely linked to **the accuracy and spatial resolution** of the DEM, with higher resolutions better preserving topographical features *(Ghalandari, 2023).*

Many elements are often overlooked when focusing solely on designing conventional urban drainage systems to handle specific recurrence intervals of rain. Factors such as the **absence of proper UDS mapping, the type and hydraulic capacity of drainage systems, the extent and distribution of impervious surfaces, soil type, initial soil moisture, and terrain properties** (e.g., slope and elevation) **also significantly influence the location, spatial extent, depth, onset speed, and duration of flooding.** Also, the **gully pot/inlet blockages** can be cause of pluvial flooding, highlighting the importance of maintenance and rehabilitation *(Haghighatafshar et al., 2020)*

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