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Editorial

Flood Hazard and Risk in Urban Areas

Pedro Pinto Santos [1,2]

[1] Centre of Geographical Studies, Institute of Geography and Spatial Planning, University of Lisbon, 1600-276 Lisbon, Portugal; pmpsantos@edu.ulisboa.pt

[2] Associate Laboratory TERRA, University of Lisbon, 1600-276 Lisbon, Portugal

1. Introduction

Floodplains and valleys have always been preferential locations for human presence. The first great cities in human history, regardless of the continent, are associated with the valleys of large rivers. The advantages of such settlements were evident, as were the hydrological risks, reflected in disasters of varying magnitude, which became a seasonal—more or less expected—part of the lives of riverside populations.

Approaching the first quarter of the 21st century, the physical process of flooding, its triggering and conditioning factors, is now sufficiently understood—despite the continuous discovery and new perspectives on knowledge taken for granted decades ago, which continues to exist, supported by global data and models, e.g., [1], but it takes on added complexity in urban areas. This complexity arises not only from the modeling of flood susceptibility and hazards, but also from the presence of diverse elements at risk, each with its own vulnerability characteristics and adaptive capacity [2].

On the hazard side, in addition to the uncertainties in using precipitation data series, due to changing patterns of intensity and frequency, the complexity of modeling the hydrodynamic behavior in such an altered environment must be considered: the underground channeling of runoff, the role of retention basins, the effect of riverbed restoration or renaturalization, and the interaction with compound or cascading hazards (sea-level rise, upstream ice melt, more intense and frequent ocean storms, coastal erosion. . .).

On the societal side of the flood risk equation, the continued growth of cities is still insufficiently addressed by spatial planning regulations, or when accounted for, there is often an over-reliance on gray infrastructure, which gives a false sense of security. This calls attention to concepts such as socio-hydrology, which deals with the behavioral patterns of communities in the face of given probabilistic and perceived flood risk scenarios [3,4]. Land occupation is also unequal, often reserving the most hazardous areas for the most vulnerable populations.

Almost all the contributions to this Special Issue referred to historical records of flood events and losses, whether to simply provide context, or in support of more thorough analysis and modeling, which underpins the necessity to invest in the standardized, holistic, and detailed reporting of events [5], with the recognition that one cannot know what it needs to address risk and reduce losses, when what is lost is not entirely known [6].

Citizen participation is crucial in reducing flood losses in urban areas, whether by improving hazard assessment models through the provision of local data, by playing a role in emergency and recovery operations, or, most importantly, by participating in decision-making processes ideally before disasters occur.

The scientific community is strongly committed to addressing these challenges [7] in a process that requires the involvement of both the public and business sectors, as well as organized civil society (as stakeholders) or through stigmergy models, following the principles and best practices of citizen science. In an intrinsically complex and connected world, informal and formal processes of emergency and risk management are desirable, with learning and the incorporation of best practices taken from both sides [8]. Risk

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governance models suggest this approach, placing participation and engagement of all interested parts at the core of pre-monitoring, assessment, judgment, decision making, and management processes.

This Special Issue of *Geosciences* brings together seven scholarly articles that delve into critical aspects of flood risk, the impact of climate change, urbanization, and the growing importance of sustainable land use and infrastructure resilience. The contributors highlight innovative methodologies, case studies from diverse regions, and interdisciplinary approaches to understanding and mitigating the complex challenges posed by flood hazards and risks in urban areas. Below, a summary of the key contributions of each article is presented.

2. Overview of Contributions to the Special Issue

Shen et al. [9] address the growing threat posed by climate change-induced coastal flooding in urban settings. Their dynamic modeling study focuses on Norfolk, Virginia, USA, a city that faces rising risks from both inland flooding and storm surges. By simulating current (2020) and future (2070) climate scenarios, the authors assess how transportation infrastructure, especially critical roadways, is likely to be affected. The research highlights the compounding effects of sea-level rise and increased storm intensity, urging urban planners to integrate these projections into the design and maintenance of resilient infrastructure. The results from a more simplistic "bathtub" approach and from a more complex dynamic model are discussed. The study's findings provide a valuable framework for policymakers in coastal cities to prepare for future flood events, emphasizing the need for robust adaptation strategies that account for evolving climate patterns.

Nouaceur et al. [10] conduct a statistical analysis spanning nearly 50 years of meteorological data and 33 years of flood events from the French Mediterranean Basin, a region known for its susceptibility to heavy rainfall and flash floods affecting urban areas. The authors thoroughly document the frequency, intensity, and distribution of extreme precipitation events in 24 h and 48 h, correlating them with observed flood occurrences. Climate indexes such as the NOA, WMOI, and SSTMED were computed using the coherence diagram (WCO). Their analysis reveals discernible trends that reflect broader shifts in regional climate dynamics. This study offers crucial insights into how climate variability is amplifying flood risks in the Mediterranean, providing a scientific basis for future flood prediction and mitigation efforts. The authors call for targeted policy interventions that address the escalating environmental and societal impacts of these events.

Khouz et al. [11] conduct a flood susceptibility assessment in Essaouira Province, Morocco, using both statistical models—the hierarchy process (AHP) frequency ratio model (FR) and the weights of evidence (WoE)—and the HEC-RAS hydrological simulation tool. Their study evaluates various factors contributing to flood risks, including topography, land use, and rainfall patterns. The authors identify areas of high susceptibility and perform hydrodynamic modeling upstream, covering one of the most critical urban areas identified. Finally, they propose mitigation measures that could enhance sustainable flood management in the region. By combining statistical analysis with detailed hydrological modeling, this study provides a comprehensive hazard assessment framework that can guide policymakers and land managers in reducing the impacts of future flood events. The study highlights the importance of integrating statistical methods—applied at the basin level—with detailed 2D modeling using on-the-ground data, in the most susceptible reaches, to improve flood risk management in vulnerable areas.

Hossaki et al. [12] explore a novel flood detection method by integrating both physical rain gauges and social-based data collection methods. Using a case study in Brazil, the authors demonstrate how combining technological tools with community-driven reporting can improve real-time flood detection in urban areas. The statistical correlations between in situ sensors, radar data, Twitter posts, and flood events were evaluated. The study highlights the limitations of traditional flood monitoring systems that often fail to capture localized flood events. By involving citizens in the monitoring process, the authors propose a more inclusive and accurate approach to flood detection, which can enhance the responsiveness of early warning systems. This study underscores the importance of participatory science in addressing urban flood challenges and improving disaster preparedness.

Lazzarin et al. [13] present a comprehensive analysis of flood risk evolution over four decades at a micro-scale, focusing on a case study in Italy. Their research employs an innovative hydrodynamic model (2DEF), coupled with a damage model, to evaluate the impacts of urbanization and land use changes on flood hazards. The study finds that unplanned urban expansion has significantly increased flood exposure and vulnerability, particularly in areas where natural drainage systems have been altered or obstructed. By assessing historical land use planning decisions and their long-term consequences, the authors provide actionable recommendations for future urban development. Their work underscores the need for well-informed, sustainable land use policies that prioritize flood risk reduction in the context of growing urban populations.

García-Botella and Ramón-Morte [14] analyze the impact of tourism-driven urban growth on ephemeral Mediterranean watercourses, with a focus on the popular tourist destination of Benidorm, Spain. The authors explore how the rapid expansion of infrastructure and drainage networks have exacerbated flood risks in this region. They argue that the hydrological and environmental impacts of tourism-related urban expansion, particularly on water systems, are often overlooked in urban planning. The applied methodology highlighted the importance of official, standardized, and open databases in support of peak estimation and hydrodynamic modeling. This study calls for more stringent regulations and better management of water resources to ensure that economic growth does not come at the cost of increased environmental and urban degradation and flood vulnerability.

Schismenos et al. [15] provide an in-depth investigation into the nexus of flood risk management, renewable energy, and humanitarian engineering. Their study focuses on two geographically distinct regions: Aggitis in Greece and Dhuskun in Nepal. Through these case studies, the authors emphasize the role of renewable energy technologies, such as micro-hydropower systems, in flood-prone areas, where the coexistence of critical facilities for power generation in flood prone areas is a challenge. They argue that by integrating sustainable energy infrastructure with local disaster risk reduction (DRR) practices, vulnerable communities can significantly enhance their resilience. The lessons drawn from these diverse contexts underline the necessity of cross-sector collaboration and community engagement in implementing effective flood mitigation strategies that serve both environmental, energy, and humanitarian purposes.

3. Conclusions

Taken together, these articles present a multidimensional perspective on flood risks and the urgent need for sustainable solutions in the face of climate change and rapid urbanization. The contributions illustrate the importance of adopting interdisciplinary approaches that blend scientific research, technological innovation, and community engagement. As cities and regions worldwide continue to grapple with the increasing frequency and intensity of flood-triggering factors, along with the aggravation of natural and human-related conditioning factors, the insights and methodologies presented in this Special Issue will serve as valuable resources for both researchers and practitioners seeking to foster resilient and sustainable livelihoods in urban areas.

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