Chapter 1
Flood Risk and Inundation Mapping in a Changing Climate:
Advances in GIS, Remote Sensing, and Artificial Intelligence Methods

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ABSTRACT

Floods are among the most recurrent and destructive natural hazards worldwide, posing significant threats to human life, infrastructure, and ecosystems. They lead to widespread socioeconomic and environmental consequences, including the displacement of populations, disruption of livelihoods, contamination of water supplies, and degradation of natural resources. In recent decades, the impacts of climate change, rapid urbanization, and anthropogenic alterations to natural landscapes such as

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deforestation, land-use change, and the construction of impervious surfaces have intensified both the frequency and magnitude of flooding events. These evolving environmental and societal conditions have created unprecedented challenges for flood risk assessment, prediction, and mitigation, necessitating the development of more sophisticated and comprehensive approaches to understanding and managing flood hazards.

INTRODUCTION

Floods are the most disturbing natural phenomena, termed disasters in terms of frequency, financial cost, and, most significantly, the impact on the population and interruption of socioeconomic activity (UNDRR, 2021). Flooding is the inundation of an area caused by an unexpected rise in water, dam failure, or severe rainfall duration and intensity, putting the lives and property of those in the affected area at risk (Ward et al., 2020). According to the European Environment Agency (EEA, 2010), floods and wind-water storms were Europe's most expensive natural disasters from 1998 to 2009, with total losses of almost EUR 52 billion for floods and EUR 44 billion for storms. One thousand one hundred twenty-six people died as a result of 213 flood disasters, while 729 people died as a result of 155 storms, by 2009 (EEA, 2010). The extreme events with return periods exceeding 100 years are projected to double in frequency in Europe by 2035, according to collaborative efforts of EURO-CORDEX climate projections using the RCP8.5 scenario, with a further increase through the end of the century (Kotlarski et al., 2014).

Between 1985 and 2009, numerous flooding events occurred in Europe to chronicle the spatiotemporal role of inundation under weather and geographical changes. In recent years, several authors have employed empirical studies, including field surveys, GIS, remote sensing technologies, and various statistical methodologies, to address the complexities of flood inundation (Cvetković et al., 2024). Different combinations of inundation data and DEM can build valuable flood extent maps within a GIS environment. Herein, remote sensing, GIS, geological data, fuzzy logic, and statistical analyses of peak discharge and rainfall intensities have been combined to form reliable flood hazard maps (Hamidifar et al., 2024). Likewise, using optimized weighting methods, GIS combined with multi-criteria analysis techniques was employed to assess flood susceptibility, exposure, and risk accurately. Key variables such as DEMs, land use, precipitation, geological features, and catchment geometry have been utilized to construct detailed flood risk maps.

The problem with satellite pictures produced by optical sensors is that bad weather or very dense established vegetation cover might affect their reception. Synthetic aperture radar (SAR), a newly created technology, can be critical to the extent