Chapter 9
Integrating GIS and Remote Sensing in Early Warning Systems for Real-Time Disaster Preparedness

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ABSTRACT

This chapter per the authors explores how Geographic Information Systems (GIS) and Remote Sensing (RS) are transforming early warning systems for hydrometeorological disasters through real-time, data-driven approaches. It examines the integration of multi-source datasets topographic, climatic, and socio-economic to assess flood and drought risks with high spatial and temporal precision. The discussion highlights how cloud-based platforms such as Google Earth Engine and Copernicus Open Access Hub, combined with artificial intelligence and Internet of Things (IoT) networks, enable dynamic monitoring and predictive modeling of environmental hazards. Methodological frameworks including multi-criteria decision analysis, machine learning, and digital twin technologies are reviewed for their capacity to

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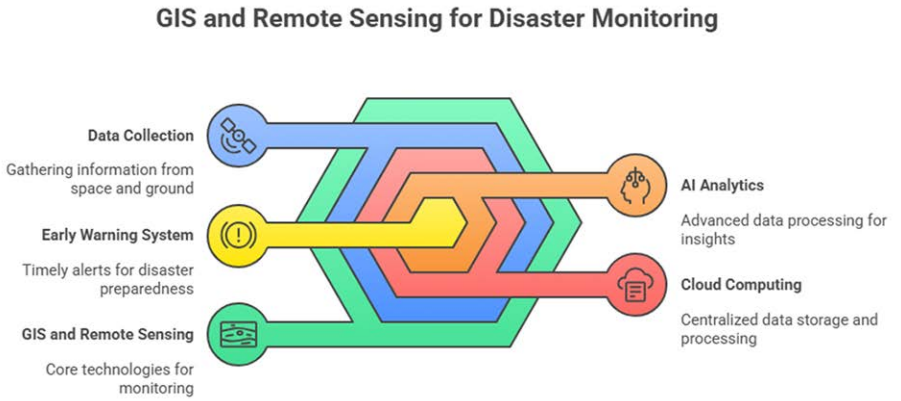
support adaptive management and policy decision-making. The chapter concludes by emphasizing the role of open data, interoperability, and ethical governance in advancing global disaster preparedness and climate resilience.

1. INTRODUCTION

Figure 1. Conceptual Integration of GIS and Remote Sensing for Flood and Drought Early Warning Systems



Two of the most destructive hydrometeorological disasters in the world, flooding and droughts impact millions of people annually and result in significant socioeconomic and environmental damage. Climate unpredictability, changes in land use, and growing human demands on natural ecosystems are the main causes of these catastrophic events. Global climate change has increased the frequency and severity of these disasters in recent decades, especially in tropical and subtropical countries where prolonged dry spells and heavy rains are becoming more frequent. Creating successful mitigation and adaptation plans requires an understanding of the temporal and spatial dynamics of these hazards. (G. Liu et al., 2026). The foundation for integrating diverse datasets, such as digital elevation models (DEM), land use, soil characteristics, rainfall, and socioeconomic indicators, is GIS. Researchers can assess exposure, measure susceptibility, and spatially depict flood and drought threats using GIS in a logical manner. On the other hand, remote sensing offers real-time observations from satellites and aerial sensors, obtaining vital environmental data like the amount of surface water, vegetation health, soil moisture, and rainfall intensity (Abdelkrim & Eslamian, 2026). These technologies work in concert to create a special synergy that turns static data into knowledge that decision-makers may use. The potential of GIS and RS in environmental research has been greatly increased in recent years by the growth of cloud computing, open-access satellite