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Short Communication

GIS-Based Flood Risk Mapping and Disaster Preparedness

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DESCRIPTION

Floods are among the most frequent and damaging natural disasters, affecting millions of people each year and causing extensive damage to infrastructure, agriculture and ecosystems. In many regions, particularly in low-lying or densely populated areas, the increasing frequency of extreme rainfall events, urban expansion into floodplains and inadequate drainage infrastructure have contributed to growing vulnerability. To manage this risk effectively, there is a need for tools that can visualize flood-prone areas, assess hazard levels and support disaster preparedness planning. Geographic Information Systems (GIS) provide a dynamic platform for flood risk mapping by integrating spatial data, topographic models and hydrological information to identify areas at risk and plan accordingly [1-3].

GIS allows the integration of various layers of information, such as elevation data, land use, soil type, rainfall intensity, river networks and built-up areas. One of the foundational inputs for flood risk mapping is a Digital Elevation Model (DEM), which represents the terrain's surface and determines the direction and accumulation of water flow. High-resolution DEMs derived from LiDAR or satellite imagery help model surface runoff and identify depressions and low-lying regions susceptible to inundation. Hydrological models, when integrated with GIS, simulate water movement across landscapes during rainfall events, accounting for infiltration, evaporation and channel flow [4].

Flood hazard mapping involves estimating the extent and depth of water inundation under different rainfall scenarios or return periods. These maps are generated using hydraulic models, such as HEC-RAS or MIKE FLOOD, which simulate water flow in rivers and floodplains. GIS plays a key role in visualizing the outputs of these models and overlaying them with socio-economic data [5]. The resulting maps can show flood zones under different scenarios, such as 10-year, 50-year, or 100-year floods. These zones are then used to assess exposure of residential areas, infrastructure, agricultural land and public facilities.

Risk assessment involves not only identifying flood-prone zones but also evaluating the vulnerability and value of exposed elements. GIS supports this by incorporating data on population density, building types, road networks, schools, hospitals and economic assets. Vulnerability indices, based on factors like housing material, access to services and past flood experience, can be spatially modeled and linked to hazard layers. The combination of hazard, exposure and vulnerability results in a comprehensive flood risk profile for any given area.

In urban environments, flood risk mapping must consider the effects of impervious surfaces, blocked drainage and rapid runoff. GIS-based tools are used to model storm water flow in cityscapes, identify drainage chokepoints and evaluate the impact of planned infrastructure projects. Municipal authorities can use such data to guide zoning regulations, design flood-resistant structures and prioritize investment in drainage systems [6-8]. Flood hazard maps also support the designation of evacuation routes and the placement of temporary shelters and emergency services.

The use of remote sensing data further enhances the capabilities of GIS in flood risk management. Satellite imagery can detect changes in land use over time, helping to identify trends that increase flood risk, such as urban sprawl or deforestation. During flood events, optical and radar satellite data can capture the extent of inundation in near real-time, providing updates for emergency response teams. Sentinel-1 radar imagery, for example, is widely used for mapping flood extents even under cloud-covered conditions, a common occurrence during storms.

GIS-based flood risk mapping also contributes to community awareness and engagement. Interactive platforms and web-based dashboards allow stakeholders to explore flood risk scenarios for their neighbourhoods'. This promotes better understanding of local risks and encourages community preparedness. Educational institutions and local governments use these tools in awareness campaigns, school curricula and training workshops. In many cases, residents are also involved in collecting data on flood history and drainage conditions, which is then incorporated into local GIS databases [10].

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Planning for climate change adaptation is another important application. Climate projections indicate that many regions will experience more intense and frequent rainfall events, leading to increased flood risk. GIS-based models can incorporate these projections to simulate future flood scenarios and assess long-term vulnerabilities. This information supports the development of adaptation strategies, such as relocation of critical infrastructure, adoption of green infrastructure for water retention and enforcement of no-build zones in high-risk areas.

While GIS-based flood risk mapping has proven effective, it requires accurate data and institutional capacity. In many regions, gaps in hydrological monitoring, outdated topographic maps and inconsistent data standards pose challenges. Strengthening local capacity through training, data sharing and institutional coordination is necessary to ensure that GIS tools are effectively used. Advances in open-source GIS platforms and the availability of global datasets are helping to bridge these gaps and extend the reach of flood risk mapping efforts.

GIS has become an essential tool for flood risk assessment and disaster preparedness. By integrating spatial, environmental and socio-economic data, GIS enables the identification of flood-prone areas and supports the planning of effective mitigation and response strategies. The ability to visualize complex risk scenarios and inform both short-term emergency responses and long-term resilience planning makes GIS-based flood mapping a valuable asset for governments, researchers and communities. As climate variability increases and urbanization continues, the demand for spatially-informed flood risk management will grow, underscoring the importance of accessible, reliable and adaptive GIS solutions.

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