

Identification of flood hazard zones of Uttarakhand

Manoj Kumar Diwakar*, Prajjwal Varshwal and Ashutosh Chaturvedi

Department of Civil Engineering, Malaviya National Institute of Technology Jaipur, Jaipur 302 017, India

Flooding is among the world's most damaging natural disasters, wreaking havoc on natural and man-made structures yearly. Therefore, the identification of flood hazard zones for each flood-prone region is essential. The present study focuses on identifying flood hazard zones in Uttarakhand using a geographic information system (GIS)-based analytical hierarchy process. The study considers six key flood-inducing factors—elevation, slope, drainage density (DD), topographic wetness index (TWI), land use and land cover (LULC), and precipitation—weighted and integrated within a GIS framework to delineate flood hazard zones. The flood hazard zones are categorised into four subdivisions (i.e., low, moderate, high, and severe) based on their severity of flood hazards. Flood hazard zones are delineated using annual maximum precipitation and average annual maximum precipitation over the study period. This approach identified larger areas under high and severe hazard categories compared to zones derived from multi-year average annual maximum precipitation, highlighting the system's greater sensitivity to extreme events. The present study highlights that slope, elevation, and precipitation are the dominant factors influencing flood occurrence, whereas LULC, TWI, and DD have a comparatively smaller impact. The flood hazard maps developed in the study provide useful information for supporting flood hazard planning and mitigation work.

Keywords: AHP, flood, flood hazard zones, GIS, Uttarakhand, weighted overlay.

caused by the hydro-meteorological processes is identified by the severity of the precipitation, soil characteristics, and drainage of basins. Flood hazard mapping is essential to reduce flood risk and land use planning in flood-prone areas⁴. India is highly susceptible to floods, landslides, earthquakes, and other natural disasters. Floods are described as a significant environmental problem in India that has devastating effects on life and property⁵. The state of Uttarakhand in India, situated at the foothills of the Himalayas and adjoining the borders of China and Nepal, is highly vulnerable to floods and flash floods. In the past 30 years, there have been several significant occurrences, including the Malpa flood and landslide in Pithoragarh in 1998, the Rudraprayag flood in 2001, the Tehri flood in 2002, the Varunavat flood in 2003, the Kedarnath tragedy in 2013, and the Chamoli disaster in 2021.

In flood risk assessment, a computer-based system known as a geographic information system (GIS) provides an effective platform to integrate diverse spatial datasets to derive hazard maps. It can handle geographical data through input, data management, data storage and retrieval, modification, analysis, and output⁶. GIS offers an extensive array of instruments for identifying regions impacted by flooding and predicting areas susceptible to flooding because of an increase in river levels⁷. The principal benefit of GIS in flood planning and management is its ability to generate a visual depiction of areas susceptible to flooding. This facilitates further product analysis aimed at ascertaining the probability of flood-related damages^{8,9}. Some studies utilised remotely sensed data, morphometric parameters extracted from the digital elevation model (DEM), and GIS to construct a hydrological model that estimates surface runoff.