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# Flood Susceptibility Mapping with Integrated GIS and Analytical Hierarchy Process: A Case Study from Mayadevi Rural Municipality, Rupandehi District, Nepal

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**Abstract: Flooding is the most frequent natural disaster, affecting millions of people worldwide. Nepal is highly vulnerable to flood risks due to its topography, geological setting, and monsoon-dominated climatic conditions. Floods often hit Terai regions in Nepal due to its flat terrain and proximity to major rivers. Mayadevi Rural Municipality, situated in the Terai region of Rupandehi district, is at significant risk of flooding due to its proximity to the Tinau River and Dano Khola. Mapping flood susceptible zones is highly essential in effective and sustainable flood management.**

**Integrated Remote Sensing (RS) and Geographic Information System (GIS) tools, together with the Analytic Hierarchy Process (AHP), offer an effective framework for the integration, manipulation, and analysis of data from diverse sources to assess catastrophe and vulnerability more efficiently. For this, ten parameters that are relevant to the hazard of flooding in the areas: Topographic Wetness Index (TWI), elevation, slope, drainage density, Normalized Difference Vegetation Index (NDVI), precipitation, distance from river and distance from road, land use, and soil type were considered in the study. The GIS tool was used to create all the necessary input layers and the AHP technique was adopted to generate normalized weights to each parameter. All parameters were integrated as distinct layers in GIS utilizing the weighted overlay approach to provide a conclusive flood susceptibility map of the area.**

**The resulting flood susceptible zones were further classified into low, medium and high flood risk zones based on vulnerability to the potential of flood hazard. Sites that had previously seen flood occurrences were then used to validate the flood susceptibility map. These results suggested that RS and GIS-based geospatial analysis, in conjunction with AHP, are effective and reliable methodology for mapping flood risk and plan for disaster mitigation.**

**Keywords:** ***Flood, Flood susceptible maps, Geographic information system, Analytic hierarchy process, Remote sensing.***

## Introduction

Flood hazard is the most common natural hazard occurring most frequently around the globe with significant socio-economic consequences (Sar et al., 2025; Ahmad et al., 2025 and Khosravi et al., 2018). Globally, the flood events and duration have been reported to significantly increase due to change in climatic conditions, especially in South Asian countries (Bronkhorst, 2012). Nepal, a South Asian country sitting atop the Himalaya having complicated geology and rugged topography, is incredibly prone to disasters including earthquakes, floods, landslides, GLOFs, droughts, high temperatures, avalanches, and storms (MoHA, 2024 and NDRRMA, 2025).

## Study area

Mayadevi Rural Municipality is in the Rupandehi district, Lumbini Province of Nepal (Figure 1) and it's a region that is at high risk of flooding due to its proximity to the Tinau River.

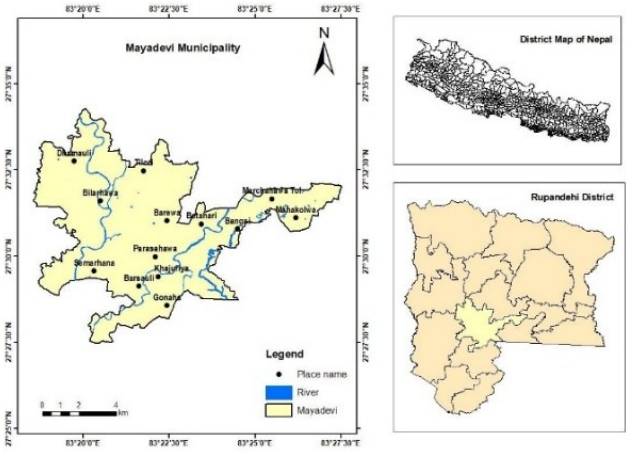


*Figure 1, Location map of the study area.*

## Methodology

Among the multi-criteria decision-making methods (MCDM), the most used method is the Analytic Hierarchy Process (AHP), which was developed by Saaty (1980). AHP is a decision-making method developed by mathematicians and used in this research (Figure 2).

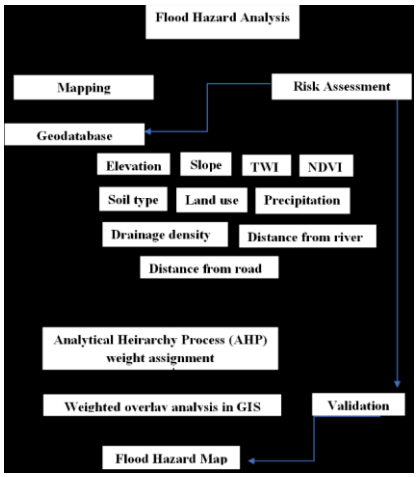


*Figure 2, Methodological framework of the research.*

## Results and discussion

Figure 3 shows the Mayadevi Municipality's flood susceptibility map (ArcGIS Desktop version 10.8 developed by Esri), which was generated by implementing AHP methodologies and weighted overlays including flood-generating parameters like elevation, land use/cover, distance from roads, distance from rivers, drainage density, slope, rainfall, NDVI, TWI, and soil type.

Regions within the proximity to the Dano River and Tinau River are at highest risk of flood disaster. On the other hand, it is seen that relatively flat lands close to the stream beds are moderately risky, while the high areas far from the main streams are at lower risk. The high precipitation together with the TWI and distance from the river seems to be the major reason for the high risk at low elevations in the northwest and northeast regions. The average risk in the overall regions is due to low land elevation, slope and moderate precipitation.

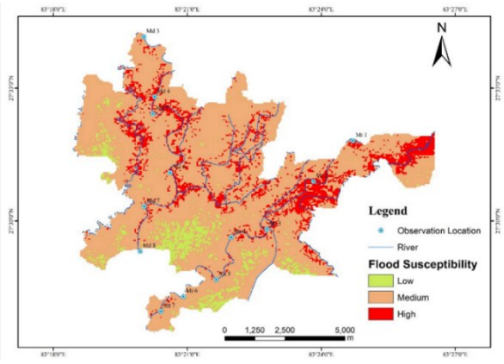


*Figure 3, Flood susceptibility map of the study area.*

Since mapping and analyzing the flood susceptible zone identifies the most vulnerable locations based on physical circumstances that define the propensity for flooding, it is one of the most crucial components of early warning systems or methods for prevention and mitigation of future flood events. These results enable well-informed decision-making for focused mitigation measures by offering policymakers and local populations insightful information about flood management in Mayadevi Municipality.

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