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Flood Susceptibility Analysis for Sylhet Area in the Surma River Basin of Bangladesh

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Abstract: Floods are among the most destructive natural hazards, causing severe loss of life, property damage, and economic disruption. Bangladesh, situated in the Ganges–Brahmaputra–Meghna (GBM) delta, is particularly vulnerable, and the Sylhet District in the northeast has experienced increasingly frequent and severe floods. This study focuses on Sylhet due to its high flood susceptibility and seeks to identify the key physical and human-induced factors contributing to flood hazards. Although previous research has examined individual drivers, integrated assessments that also incorporate community perspectives remain limited. To address this gap, a mixed-method approach was adopted. Primary data was collected through a questionnaire survey of 400 respondents, supported by secondary data sets and field observation. Eight major influencing parameters were selected and analyzed using the Analytical Hierarchy Process (AHP) to assign relative weights. Elevation, slope, and rainfall emerged as the most influential factors. Weighted thematic layers were combined using a Weighted Linear Combination (WLC) model in a GIS environment to produce the Flood Susceptibility Index (FSI). The results show that approximately 60% of Sylhet District falls under high to very high flood susceptibility zones, with Companiganj and Bishwanath being the most affected. The findings offer important insights for planning and implementing effective flood management strategies.

Keywords: ***Flood, Susceptibility, Sylhet, Surma river basin, Bangladesh.***

Introduction

The Surma River Basin, located in the northeastern floodplain region of Bangladesh, is an agriculturally productive and densely populated area that plays an important role in the national economy (Ahmed et al., 2024). Agriculture is the primary source of livelihood for most inhabitants, and the fertile floodplain significantly contributes to both regional and national food production (Nahin et al., 2023). However, despite its high agro-ecological value, the basin is highly vulnerable to recurrent flood hazards (Hossain and Paul, 2019).

Both climatic and anthropogenic drivers have intensified flood risks in recent decades. Increased frequency of extreme rainfall events, combined with extensive land use and land cover (LULC) modifications, has disturbed the natural hydrological balance of the basin (Ghosh et al., 2023). The predominance of low-lying haor landscapes and very gentle slopes further enhances flood susceptibility (Sarker et al., 2018; Dutta et al., 2023). Additional contributing factors include the basin's low drainage density, seasonal wetness of soil, lithological characteristics, and the proximity of settlements to river channels (Sadler et al., 2018). Socio-economic constraints such as low-income levels and inadequate infrastructure further exacerbate community vulnerability (Ahmed et al., 2024).

Rapid and unplanned expansion of built-up areas has also obstructed natural drainage networks, leading to poor discharge capacity during high-intensity monsoon rainfall (Dutta et al., 2023; Nahin et al., 2023). As a result, large volumes of upstream runoff often result in severe, prolonged, and damaging floods in the Surma River Basin (Hossain and Paul, 2019; Ahmed et al., 2024). Therefore, systematic flood hazard assessment is essential for protecting lives, livelihoods, and property (Mourato et al., 2023). However, flood monitoring remains challenging due to limited hydrological data availability. In this context, high-resolution satellite imagery, combined with Geographical Information System (GIS) and remote sensing techniques, provides an effective approach for flood susceptibility mapping. Analytical Hierarchy Process (AHP) and Multi-Criteria Decision Analysis (MCDA) have been widely applied for such assessments (Dutta et al., 2023).

Despite this, limited research has focused on flood susceptibility analysis for the Sylhet region of the Surma River Basin. Therefore, this study aims to assess flood hazard susceptibility in the Sylhet area using GIS and remote sensing techniques.

Methodology

The Sylhet District in the Surma River basin in northeastern region of Bangladesh was selected as a study area for this study. The elevation, slope, rainfall, distance from the river, drainage density, Topographic Wetness Index (TWI), Land Use Land Cover (LULC) change, and lithology were adopted in this study to

assess the susceptibility of flood hazards. The data of the mentioned factors were collected from different secondary.

The elevation, slope, TWI and drainage density data were acquired from the Shuttle Radar Topography Mission (SRTM) with 30 m spatial resolution operated by the United States Geological Survey (USGS) of the United States. The PERSIANN-CDR daily rainfall estimates with a spatial resolution of 0.25 degrees provided by the Center for Hydrometeorology and Remote Sensing (CHRS), University of California, Irvine (UCI) was used for rainfall analysis for the period of 2005-2024. For LULC analysis the LANDSAT 8 raster images with 30-meter resolution provided by the United States Geological Survey (USGS) were used for the recent year of 2024. The useful vector data for polygon type representation of the geological units provided by the USGS Earth Explorer was used to study the lithology of the study area for the year 1997. Finally, the gridded vector data provided by the Bangladesh Bureau of Statistics (BBS) and Local Government Engineering Department (LGED) was used to study the distance from water body parameters during the period of 2022-2024.

The study considers the secondary data including satellite images, DEM data, and hydrometeorological data to identify flood susceptibility of Sylhet District in Surma River basin. GIS technique using ArcGIS Pro was incorporated to analysis the remote sensing images of the selected parameters in the study area. The details of the methodological steps are shown in Figure 1.

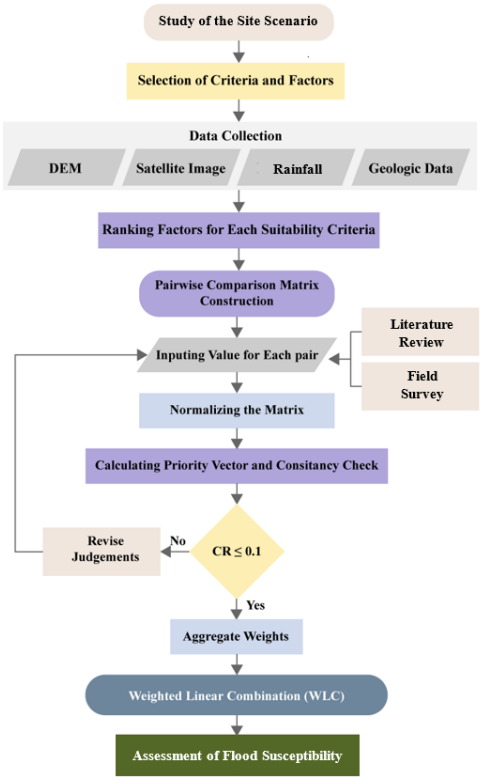

Figure 1, Methodological steps of the study.

Conclusion

This study assessed flood susceptibility in Sylhet District using eight parameters and found elevation, slope, and rainfall to be the most influential. The Flood Susceptibility Index (FSI) shows that southern and northwestern areas—especially Companiganj and Bishwanath—are highly flood prone, with Gowainghat, Sylhet Sadar, Dakshin Surma, and Balaganj also vulnerable. Golabganj has moderate susceptibility, while other Upazilas are less affected, underscoring the key role of topography and rainfall in flood management.

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