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INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/20800
DOI URL: <http://dx.doi.org/10.21474/IJAR01/20800>



RESEARCH ARTICLE

FLOOD HAZARD ZONATION OF NOA-MANGALDAI RIVER BASIN, ASSAM USING GIS AND REMOTE SENSING

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Manuscript Info

Manuscript History

Received: 15 February 2025

Final Accepted: 19 March 2025

Published: April 2025

Key words:-

Hazards, flood plain zone, flood causing factors, multi-criteria evaluation method, GIS

Abstract

Among all the geomorphic hazards the flood is the most frequently occurring hazards in riverine landscape. The Noa-Mangaldai River basin is a part of the Brahmaputra River basin, Assam. The basin has such a unique and diverse geo-physical as well as hydrological setup that the natural processes and factors alone can create frequent devastating floods especially in the middle and lower reach of the river. Considering the gravity of the flood hazard and flood plain management various governmental and non-governmental organizations and also the researchers have made some attempts towards floodplain zoning at different times. In the present paper, the flood hazard zonation map of Noa-Mangaldai river basin, has been prepared applying multi-criteria evaluation method using GIS and categorize the basin into four flood hazard zones Viz. Very high, high, moderate, low and flood free zone. Result shows that, more than 30% area of the basin has fall under very high to moderate flood prone category.

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Introduction: -

The geomorphic hazards are the threats to human resources that causing from dynamicity of the earth's surface (Ayala, 2002). As a part of nature, all the geomorphic hazards in general and fluvio-geomorphic hazards in particular are capable of bringing heavy damage to human society not only at the time of their occurrence but also even for long time by the associated consequences. In the Brahmaputra valley of Assam various fluvio-geomorphic hazards which mainly include flood, bank erosion, landslide, bank line migration, channel shifting including avulsion, heavy sedimentation on the bed, banks and over the flood plain, drought (low-flow) etc. are found in active operation under various scales and dimensions (Goswami, 1985). Among them flood is one of the worst natural disasters affecting the social and economic life of millions of people every year. India, due to its geographical location, climate, topography and large population, witnesses greater impact of flood disaster (Sharma, S.V.S.P et.al 2012). The Noa-Mangaldai river basin is located in the central Brahmaputra valley and is an important part of the Brahmaputra basin. As a part of the Brahmaputra River basin, the floods characteristically of high magnitudes, large extension, long duration and wide devastating dimensions and the bank erosion of various intensities have formed the core of fluvio-geomorphic hazards in this small basin. The basin has about 63.75% flood plain area (470 km²) of which 58.57% (278 km²) area has been identified as flood affected area where 3-4 waves of flood having various magnitudes and duration commonly seen during every monsoon period. Maximum damages in the basin occurred in

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the year 1988 and it amounts to Rs 885.18 lakh at 1997 price level. Out of these total damages that had occurred during flood in the year 1988, crops, houses and public utilities amounting to Rs 749.05 lakhs, Rs 136.05 lakhs and Rs 0.08 lakhs respectively. Thus, the agriculture sector of the basin was extensively suffered than the other sectors. Agriculture alone showed about 84.62% damages to the total damages. Thus, in view of the increasing severity of flood management measures for overall development of the basin have become very urgent. Flood Hazard Zonation (FHZ) is one of the most important non-structural measures, which facilitates appropriate regulation, and development of floodplain thereby reducing the flood impact (Sharma SVSP, 2012). So, flood hazard zoning using remote sensing and GIS is very much important for proper land use planning and effective development of the basin.

Study Area

Noa-Nadi is a north bank tributary of the Brahmaputra river system originating from the Khampajuli hill ranges across the Indian border in SamdrupJongkhar district of Bhutan. The source of the head stream of the river is at an elevation of about 1750 m and the basin covers an area of 745 km² with latitudinal and longitudinal extensions of 26^o 21' N to 26^o 58' N and 91^o 56' E to 92^o 05' E respectively. The river maintains a steep channel gradient in its upper reach and relatively a gentle gradient along its lower plain course. Out of its total basin area only 94 km² (12%) lies in the sub-Himalayan tract of Bhutan. Though this upper reach accounts for a limited extent of the total catchment area, yet the river carries sufficient amount of water as well as sediment discharge that cause severe floods during monsoon period in the lower reach of the river.

Methodology

Among all the geomorphic hazards the flood is always seen to be the most frequently occurring hazards in the basin though the occurrence of bank erosion is also not uncommon. Generally, many factors of both natural and anthropogenic are involved for occurring floods. Thus, the causes of alluvial river floods are highly complex and even dynamic (Singh, S., 2015). The climatological factors are the most important (Ward, 1978). The characteristics of basin, channel and stream network are the three fundamental flood intensifying conditions (Barman, 2011). Covering a wide range of topographic, geologic, climatic, hydrologic, vegetational and socio-cultural bases the floods of Noa-Mangaldai basin are seen to have their diverse genetical manifestations. For the preparation of flood hazard zonation map multi-criteria evaluation method has been applied taking geomorphology, elevation, slope, rainfall, drainage density, landuse land cover and population density as flood hazard causing criteria. Using Arc GIS tools, the necessary features like streams, water bodies, small watershed and village boundaries have been digitized. The thematic maps of elevation, geomorphological units, rainfall distribution, population density, landuse and landcover, drainage density and slope are also prepared applying Arc GIS 9.3 software and assigned weightage for each group (Table 1.1). All these layers of thematic map are converted into raster map and then reclassified. Thereafter, the raster maps are integrated in ARCGIS Weighted Overlay Spatial Analysis tool considering the importance on causing factors of flood hazards. Thus, the integrated flood hazard zone map for the basin has prepared and also compared with the MODIS Dartmouth flood inundation map and flood inundation map prepared by NRSC.

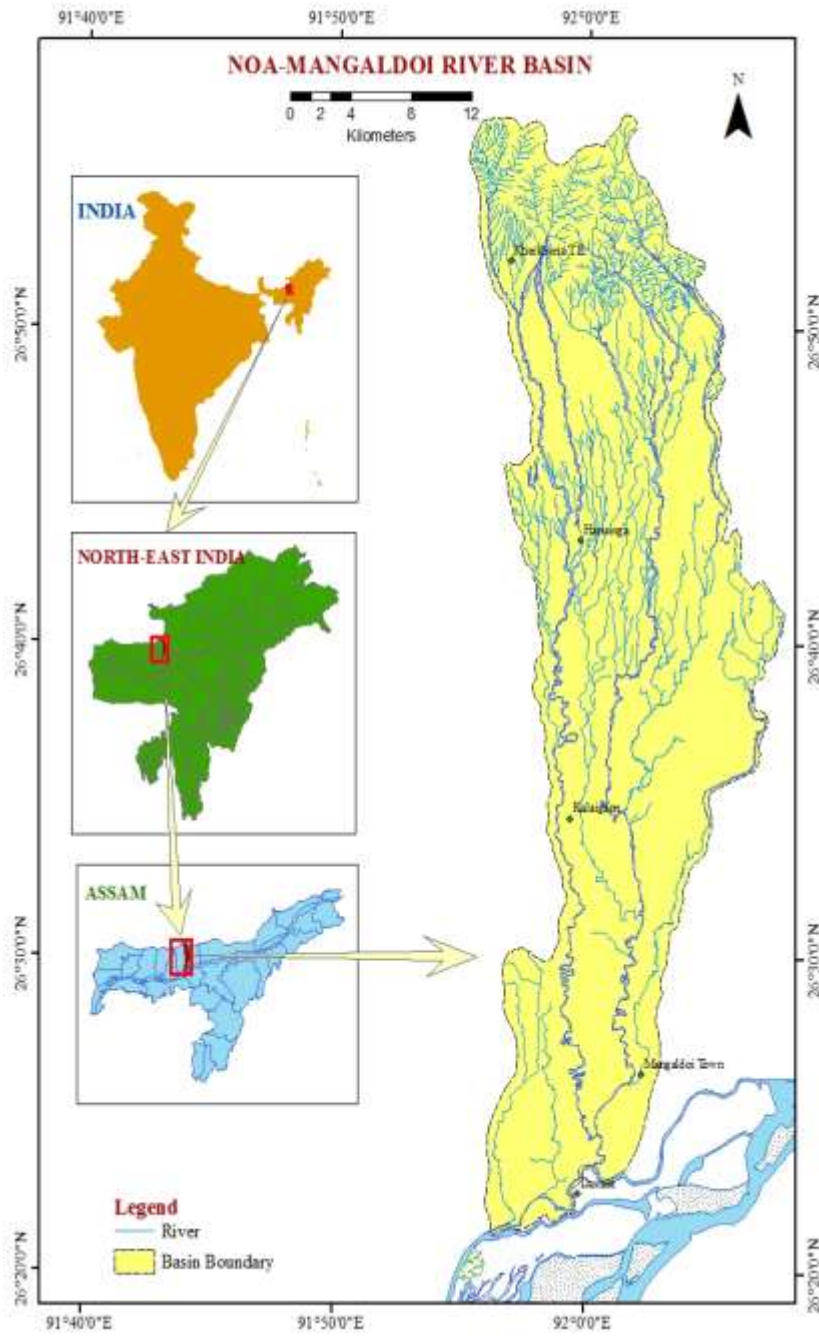


Fig 1.1 The Study Area

Table 1.1 Weightage for flood causing factors

Sl.No.	Contributing factor	Class	Rank	Weightage
1	Slope	> 1	1	7
		1 to 5	2	
		5 to 15	3	
		15 to 25	4	
		25-50	5	
		< 50	5	
2	Population density	>300	5	6
		300-500	4	
		500-1000	3	
		1000-1500	2	
		< 1500	1	
3	Geomorphic Units	Structural Hill	5	5
		Pediment plain	4	
		Old alluvium	3	
		New alluvium	2	
		Active Flood plain	1	
4	Elevation	> 60 m	1	4
		60-80	2	
		80-100	3	
		100-120	4	
		< 120	5	
5	Landuse and land cover	Forest	5	3
		Vegetation	4	
		Agricultural land	2	
		Settlement	3	
		River	1	
		tea garden	5	
		Wetland and pond	1	
		Riverine Grassland	1	
		Sand	1	
6	Drainage density	> 1.00	4	2
		1.00- 2.5	3	
		2.5-4.00	2	
		< 4.00	1	
7	Rainfall	> 1900	5	1
		1900-2200	4	
		2200-2500	3	
		2500-3000	2	
		< 3000	1	

Discussion

Flood plain zoning of a river basin is an essential management strategy to regulate land use in order to restrict the damages in frequently flooded areas. The basic concept of flood plain zoning mainly involves regulating the land use of the flood plains to restrict and minimize the probable damages caused by recurring floods. Generally, many factors of both natural and anthropogenic origin are involved in causing floods. Therefore, an attempt has been made to categorise the entire flood plain of Noa-Mangaldoi on the basis of geomorphic units, elevation, slope, rainfall, drainage density, land use land cover and population density by applying multi criteria evaluation method.

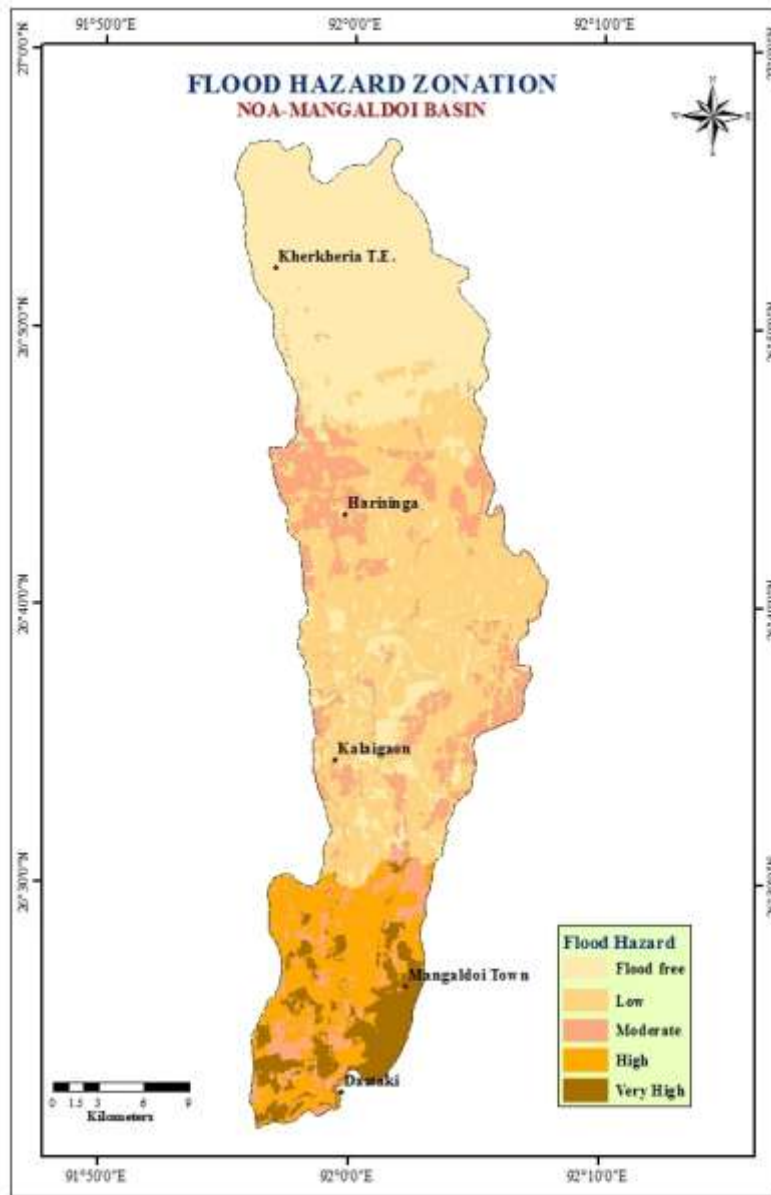


Fig 1.2 Flood hazard zonation map of the study area

Table 1.2 Area and percentage of different flood hazard zones

Flood Hazard Zone	Area in km ²	% to the total basin area
Very high	40.34	5.41
High	98.97	13.28
Moderate	100.274	13.45
Low	231.602	31.08
Flood free	273.82	36.75

The hazard zones are categorized as very high, high, moderate, low and flood free. Table 1.2 shows the area and percentage of these flood hazard zones. From the map and table, it is clear that about 5.41% area falls under very high hazard zone. The villages like Cherengchapani, Mowamari, Barkumarpara, Satkhali, Monitary, saloipara, Borachuba, Medhichapani, etc. are found under this zone. The factors like very low elevation, low slope, proximity to active channels, 1900 mm annual rainfall and high population density may be attributed for such very high hazard zone. About 98.97 km² or 13.28% of the basin area has been considered as high hazard zone. This zone covers most of human settlements and cropland of lower reach. About 22 villages of lower reach are seen under the high hazard zone. Of course, apart from 22, some others are also partly included within this zone. The main villages under this zone are Jhakuwapara, Bhokelimara Dal, Niz-Rangamati, Kachai chuba, Ghatua para, Boinajoa para, Patalsinga para, Kuia pani, Kowarpar, Barmanpara, Chamuapara, Dariapara, Medhipara, Gadhiapara, Gariapara etc. Moderate to low elevation, high population density, high annual rainfall, partially nearness to active channels and extensive cropland are some contributing factors for such high flood hazard characteristics. It is seen that the moderate, low and flood free zones have shared about 13.45%, 31.08% and 36.75% of the basin area respectively. Many villages scattered throughout the middle reach characteristically of high to moderate population density, low to moderate elevation, some of them proximity to active channels, high to moderate rainfall are considered under moderate hazard zone. The low and flood free zones are not affected by floods owing to their location relatively at moderate to higher elevation, moderate to high slope, low population density and considerable distance from the active channels.

Conclusion

Flood is the common natural hazards which lead to the loss of lives, properties and resources. For minimizing the loss and damages created due to flood, it is important to prepare flood hazard zonation map. Both natural and anthropogenic factors are responsible for creating flood hazard. The study has been carried out for delineating the flood hazard zones using remote sensing and GIS based on the available data. Thus, it may be concluded that for flood plain management hazard hazard zonation is an important approach which will help the planners for future planning and decision making.

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