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Flood Vulnerability Assessment Using AHP and GIS: A Study in Morigaon District, Assam

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ABSTRACT

Climate change's extreme events have triggered various natural hazards in every part of the world causing huge impacts every year. Floods occur when water overflows catchment due to high intensity rainfall. The occurrence of flood impacts on human habitation and different sectors of the economy. Floods mostly occur in Assam during the south - west monsoon period that spreads from June to September accompanying a trail of destruction. Morigaon district is prone to severe flood hazard by the river Brahmaputra. The present paper is based on secondary sources of data. Flood vulnerability mapping plays a significant role to asses vulnerable areas. Arc GIS 10.3 and GIS dataset has been carried out for the purpose of flood vulnerability mapping of the study area. In the present study physical and socio-economic parameters such as slope, elevation, rainfall, land use land cover (LULC), Normalized Difference Vegetation index (NDVI), Literacy data, population density and non-workers (2011 census data) data have been taken for the preparation of flood vulnerability mapping of Morigaon district. The present paper is an attempt to identification of flood prone areas, vulnerability areas of the study area by mapping the flood hazard areas of the district.

KEYWORDS: *Flood hazard, AHP, Geospatial technique, Morigaon.*

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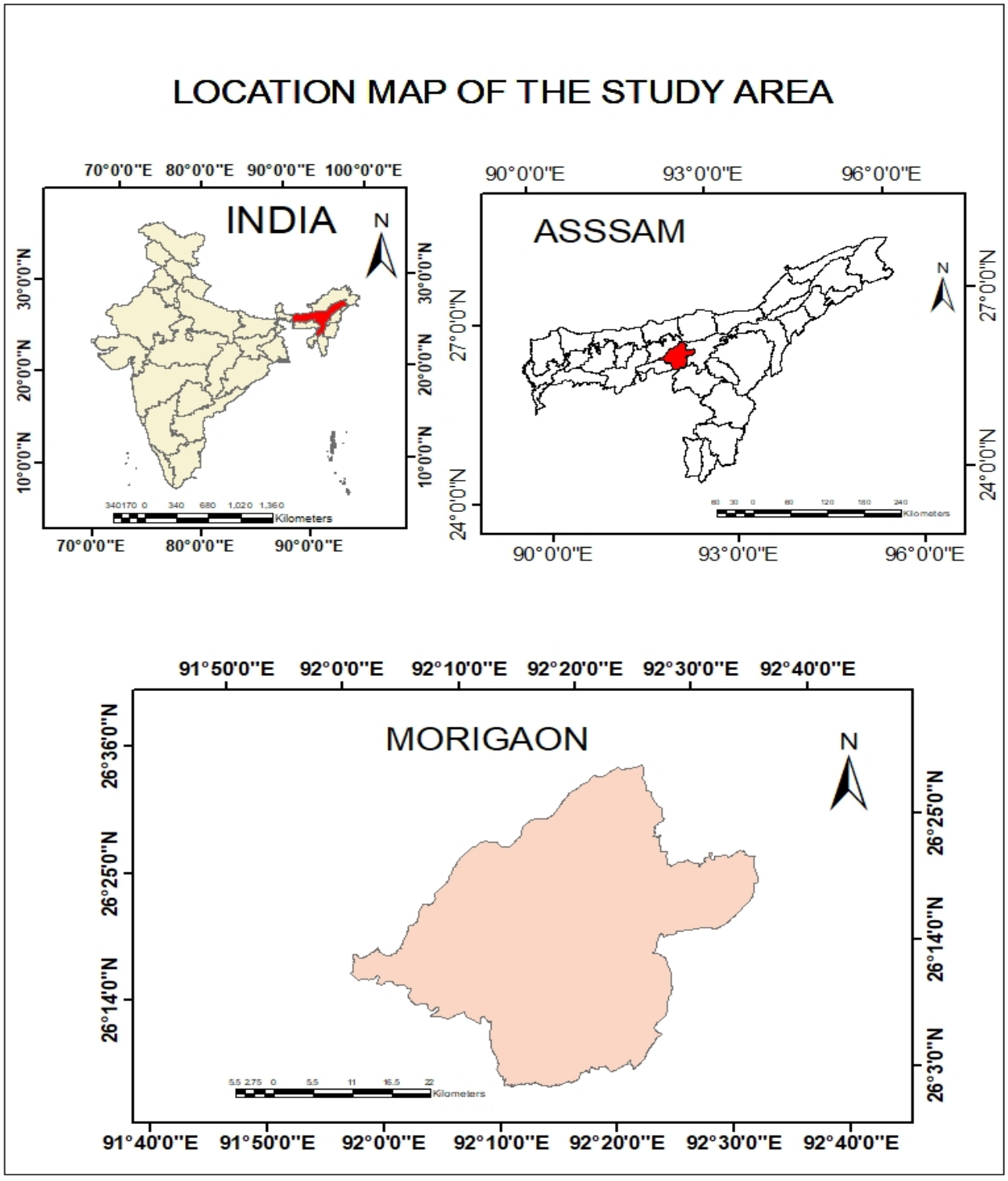
INTRODUCTION

Flood is one of the most devastating hazards among the various natural hazards faced by the people. Flood hazard mapping proves to be invaluable for identifying areas at risk of flooding. Numerous studies have been conducted at global level, regional level and at national level proposing various approaches that integrate data and tools through geospatial methods such as remote sensing, GIS (Geographic Information System) to explore various aspects of flood risk assessment.

Flood is one of the most disastrous problems not only in assam but also all over the world. Flood causes damage to life and property, leads to displacement and adversely effects on income, occupation, psychological wellbeing etc. The frequently occurring of flood in Morigaon district threats towards their livelihood, forced people to move another place and socio-economic development of the people.

STUDY AREA

The district lies between 92º20´50 and 92º33´32´´East longitude and 26º06´25´´ and 26º28´47´´ north latitude. The geographical area of Morigaon district is about 1551 sq km. It comprises 1.85% of the total area of Assam. The district bounded by Nagaon district in the east, Kamrup district in the west, Darrang district in the north and Karbi Anglong district in the south. There are five circles in Morigaon district i.e. Lahorighat, Bhuragaon, Mikirbheta, Morigaon, Mayong.



OBJECTIVES

- The main objective of the present paper is to find out the flood and river bank erosion scenario of Morigaon district and to assess the flood vulnerability areas of the district through Geo- spatial technology.

DATABASE AND METHODOLOGY

The present study is based on both primary and secondary data. Aster DEM is used here for slope and elevation map, Landsat 8 OLI is used for NDVI and LULC map and for rainfall data CHRS data has been used. The data regarding to socio economic aspects of the people of the study area have been collected from 2011 census data. AHP & Arc GIS software is used for flood vulnerability mapping.

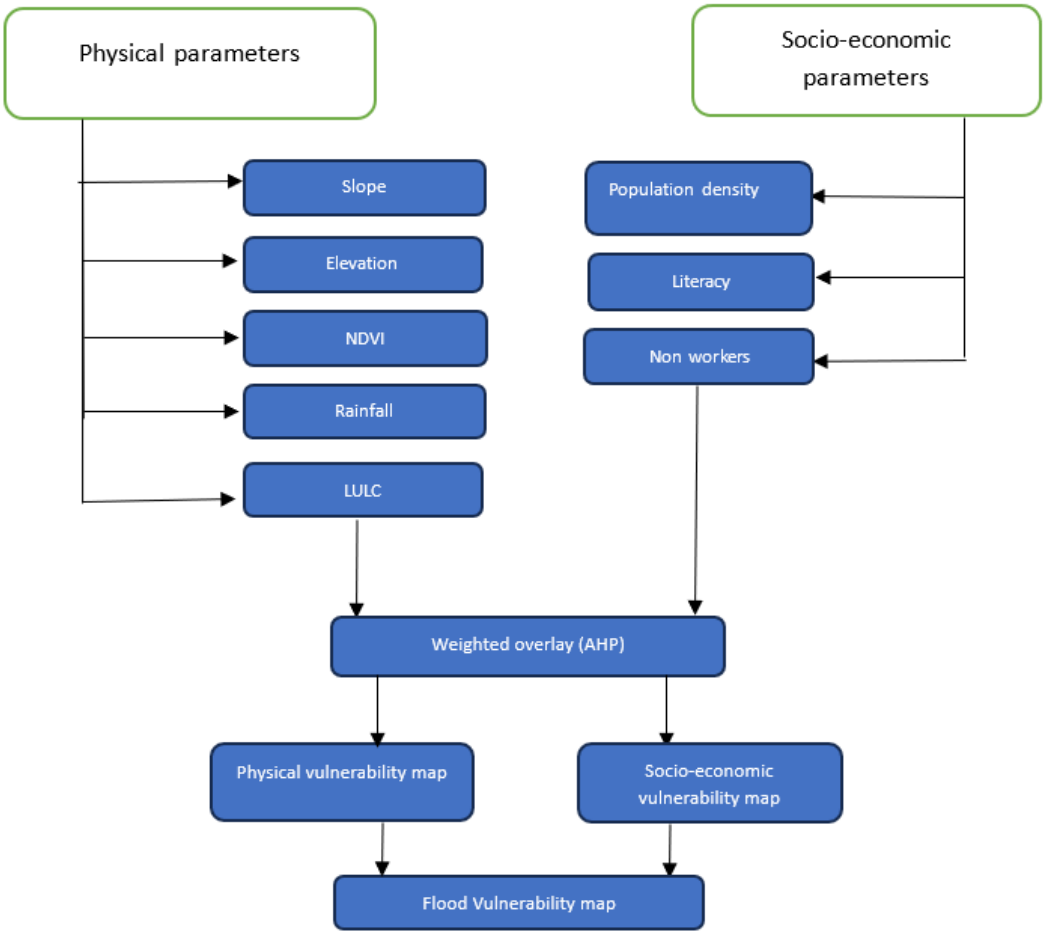


Fig: Conceptual framework of Flood vulnerability mapping

Result and findings of the study

In hydrological study slope plays a vital role. Land surface slope is one of the effective factors in floods i.e. lower the slope higher is the intensity of flood and the higher the slope lower is the intensity of flood occurrence. The slope of a channel in a region is having a direct relationship with the low velocity (Das & Pardeshi, 2018). The slope map of Morigaon district has been created from ASTER, DEM and categorised in to high, moderate and low slope.

The elevation of an area is the most important parameter for flood hazard mapping. The areas of higher elevation generally have the lower potentiality of flood whereas the areas of lower elevation have high intensity of flooding. The tendency of water flows towards the lower region from a higher region and as a result low elevated regions with a flat surface area have a higher potential of flood occurrences (Das et.al. 2018). The elevation map of the study area has been classified in to high, moderate and low elevation zone and form the elevation map it is seen that most of the areas of Morigaon district fall under low elevated zone.

Rainfall is one another parameter for flood hazard mapping. During monsoonal period the district receives high amount of rainfall from south west monsoon especially from June to September. Through the help of interpolation tool in Arc GIS software rainfall map of the study area has been prepared and categorised in to three zone i.e. high, moderate and low rainfall zone.

Land use land cover is one another parameter to determine the changing landscape of a specific area. In the present study LULC map of Morigaon district has been prepared through Arc GIS software and categorised the area in to five divisions i.e. sand, agricultural field, built up land, forest and waterbodies. NDVI determine the distribution of vegetation ranges between -0.16- 0.50 in the study area. On the other hand, the parameters such as population density, literacy and non-workers determine the socio – economic characteristics of the study area. Literacy rate is very low in Lahorighat and Bhuragaon circle and highest literacy is found in Morigaon circle. Population density is high in Lahorighat, Mikirbheta and Bhuragaon circle in comparison to the other circles. According to 2011 census non workers population is high in Lahorighat, Mikirbheta and Bhuragaon circle and rest others are low.

Table1: Pairwise comparison matrix

Sl No	Factor	Rainfall	slope	Elevation	LULC	NDVI	Population density	Literacy level	Non workers
1	Rainfall	1	3	4	5	5	2	4	4
2	Slope	1/3	1	2	3	3	1/2	3	3
3	Elevation	1/4	1/2	1	3	3	1/2	2	2
4	LULC	1/5	1/3	1/3	1	2	1/3	2	2
5	NDVI	1/5	1/3	1/3	1/2	1	1/3	2	2
6	Population Density	1/2	2	2	3	3	1	3	4
7	Literacy level	1/4	1/3	1/3	1/2	1/2	1/3	1	2
8	Non workers	1/4	1/3	1/3	1/2	1/2	1/4	1/2	1

Table 2: Normalized pairwise comparison metrics

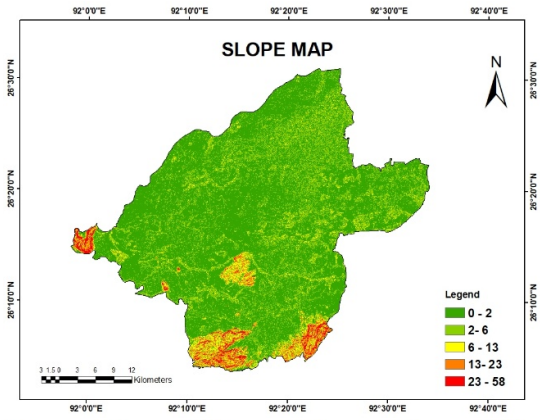
Sl No	Factor	Rainfall	slope	Elevation	LULC	NDVI	Population density	Literacy level	Non workers
1	Rainfall	1	3	4	5	5	2	4	4
2	Slope	1/3	1	2	3	3	1/2	3	3
3	Elevation	1/4	1/2	1	3	3	1/2	2	2
4	LULC	1/5	1/3	1/3	1	2	1/3	2	2
5	NDVI	1/5	1/3	1/3	1/2	1	1/3	2	2
6	Population Density	1/2	2	2	3	3	1	3	4
7	Literacy level	1/4	1/3	1/3	1/2	1/2	1/3	1	2
8	Non workers	1/4	1/3	1/3	1/2	1/2	1/4	1/2	1
		2.983	7.833	10.333	16.5	18	5.25	17.5	20

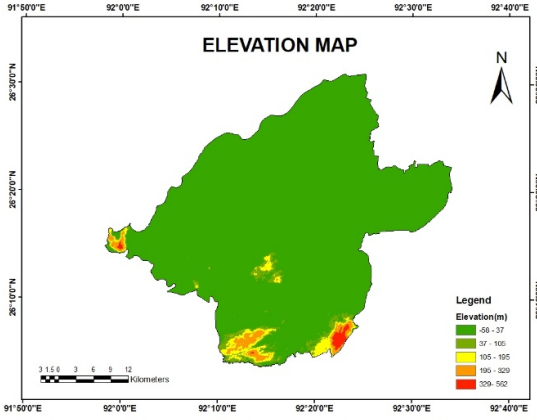
Table: Normalized pairwise comparison metrics

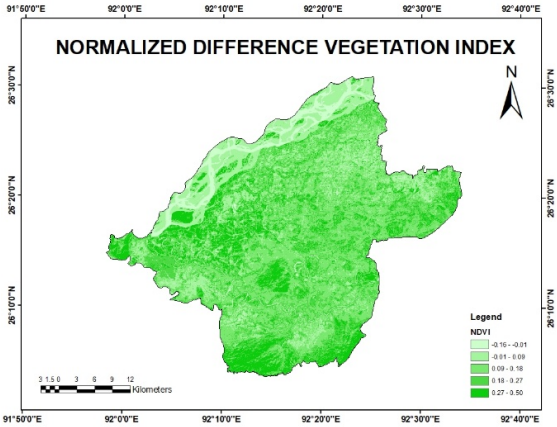
Sl No	Factor	Rainfall	slope	Elevation	LULC	NDVI	Population density	Literacy level	Non workers	SUM	CW	SUM/CW	CW %
1	Rainfall	.335	0.382	0.387	0.303	0.277	0.380	0.228	0.2	2.492	0.311	8.012	31.19
2	Slope	.111	0.127	0.193	0.181	0.166	0.095	0.171	0.15	1.194	0.149	8.013	14.98
3	Elevation	0.083	0.063	0.096	0.181	0.166	0.095	0.114	0.1	0.898	0.112	8.018	11.31
4	LULC	0.067	0.042	0.032	0.060	0.111	0.063	0.114	0.1	0.589	0.073	8.068	7.39
5	NDVI	0.067	0.042	0.032	0.030	0.055	0.063	0.114	0.1	0.503	0.062	8.112	6.28
6	Population Density	0.167	0.255	0.193	0.181	0.166	0.190	0.171	0.2	1.523	0.190	8.016	19.04
7	Literacy level	0.083	0.042	0.032	0.030	0.027	0.063	0.057	0.1	0.434	0.054	8.037	5.48
8	Non workers	0.083	0.042	0.032	0.030	0.027	0.047	0.028	0.05	0.339	0.0423	8.014	4.33
													100

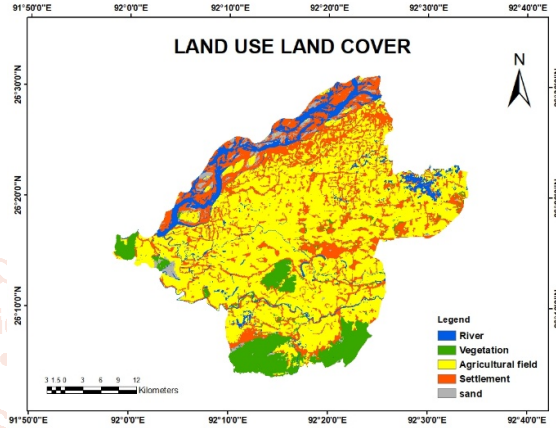
Source: Calculated by the researcher

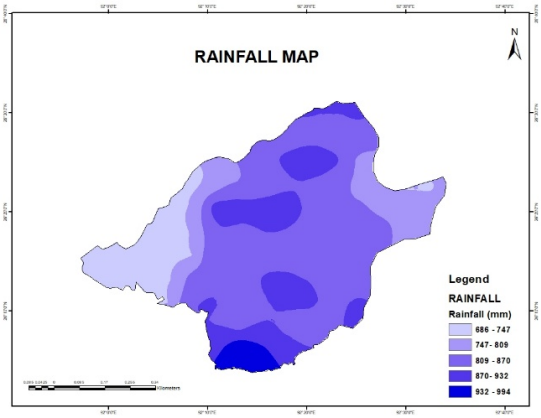
C.I (Consistency Index)
= 0.00517
C.R = CI/RI
= 0.0036

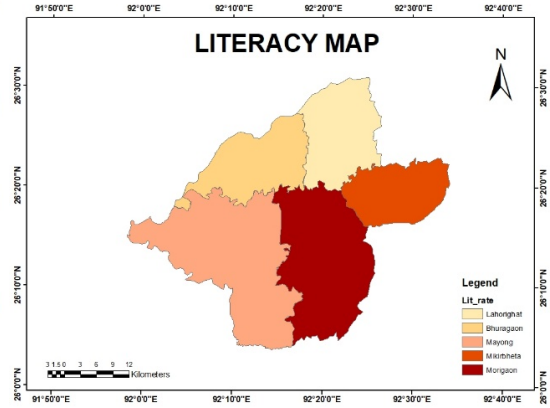

SLOPE MAP
N
Legend
0 - 2
2- 6
6 - 13
13- 23
23 - 58
Kilometers

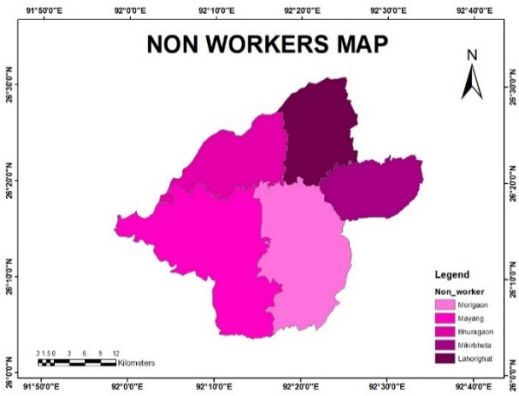

ELEVATION MAP
N
Legend
Elevation(m)
-58 - 37
37 - 105
105 - 195
195 - 329
329- 592
Kilometers

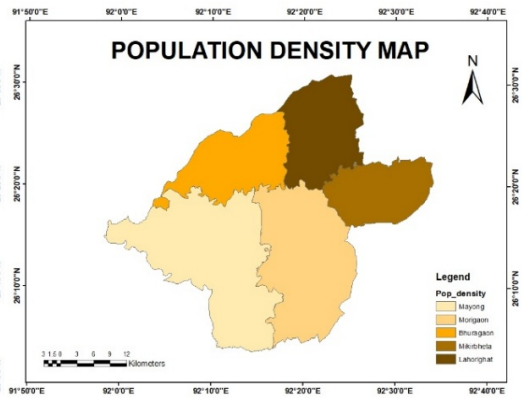

NORMALIZED DIFFERENCE VEGETATION INDEX
N
Legend
NDVI
-0.16 - -0.01
-0.01 - 0.09
0.09 - 0.18
0.18 - 0.27
0.27 - 0.50
Kilometers

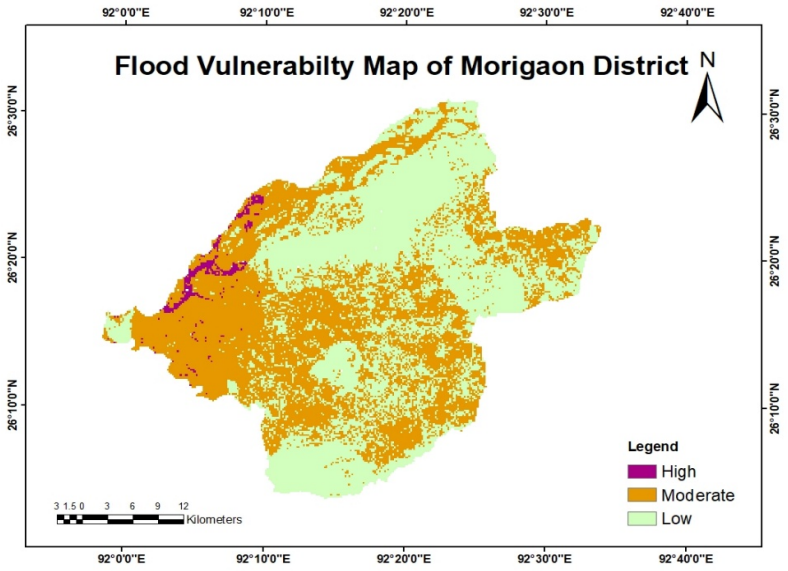

LAND USE LAND COVER
N
Legend
River
Vegetation
Agricultural field
Settlement
sand
Kilometers


RAINFALL MAP
N
Legend
RAINFALL
Rainfall (mm)
686 - 747
747- 809
809 - 870
870- 932
932 - 994


LITERACY MAP
N
Legend
Lit_rate
Lahorighat
Bhuragaon
Mayong
Mikirbhela
Morigaon
Kilometers


NON WORKERS MAP
N
Legend
Non_worker
Morigaon
Mayang
Bhuragaon
Mikirbhela
Lahorighat
Kilometers


POPULATION DENSITY MAP
N
Legend
Pop_density
Mayong
Morigaon
Bhuragaon
Mikirbhela
Lahorighat
Kilometers



Major findings of the study

- Flood vulnerability mapping is the most important nonstructural management techniques as it helps to identify areas susceptible to flooding, supports risk assessment, guides land use planning enhances disaster preparedness as well as minimizes the potential loss of life, property etc.
- Morigaon district is highly flooding prone zone and every year people faced flood as well as socio-economic damage and losses to properties. Low elevation, gentle slope etc. are the main factors of occurrence of flood in this area.
- Lahorighat, Bhuragaon circle is highly affected by flood and river bank erosion, Mayong circle and rest of the other areas also moderately affected by flood. The present study reveals that the flood vulnerability is high in Bhuragaon circle, some parts of Lahorighat and Mayong circle is also moderately vulnerable.
- Flood hazard, flood vulnerability mapping can reduce damages in some extent. In the present study flood vulnerability map is the resulting output incorporated with both physical and social factors which depicts different flood vulnerability areas of the district.

CONCLUSION

Flooding is a major cause of concern in today's world. Flood has been a chronic disaster in Morigaon district. The area is recurrently affected by floods due to excessive discharge in the river Brahmaputra and its tributaries. This research focused on the assessment of flood hazard as well as vulnerable areas of the study area. The present research identifies the area most in danger from flooding and highly vulnerable areas which may aid in implementing a management and monitoring strategy for the affected areas. The study area can only be improved by implementing an effective flood risk planning, adopting flood protection (structural and non-structural) strategies, implementing regulations to restrict residential development in flood prone regions, enhancing the availability of flood shelters and healthcare facilities, adopting sustainable strategies for managing floodplains and increasing public awareness for mitigating flood hazards.

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