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Flood Hazard Zonation in Jiadhol River Basin of Assam

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Abstract: ***Jiadhol River is one of the most frequently flooded north bank tributaries of Brahmaputra. It has a basin area of 1094.93 sq kms, of which 38% lies in Arunachal Pradesh and 62% in Assam. There are many factors responsible for the intensification of floods in this basin. Flood management is very important in this river. Flood hazard zonation of the basin helps in proper management and adaptation of the floods in the basin. This paper aims to develop a simple method for flood hazard zonation of the basin by applying GIS. The method used here is multi-criteria weighed overlay analysis of GIS. This method includes many factors such as geomorphology, elevation, slope, drainage density, drainage network, flow accumulation, soil, groundwater table and land cover/land cover, lithology and also proximity to drainage, confluence, and embankment breaching point for flood hazard zonation. All factors are weighted according to their role in the occurrence of floods. Using the mentioned method, four hazard zones are derived, they are the severely flood-prone zone, moderately flood-prone zone, less flood-prone zone and flood free zones consisting 31% 18%, 15% and 36% of the basin respectively. Most of the upper basin comes under flood free zone except the river valleys. There are two distinct severely flood-prone zones in the lower part of the basin. The hazard zonation derived in the paper has been validated with the real-time flood data collected at the block level and is found relevant in identifying the severely flood-prone areas.***

1. Introduction

Flood is the most common hazard witness in the world today. The area effect by floods every year covers a large portion of the human inhabited area. These areas are also the most densely populated ones, and that is why flood hazards throughout the world are responsible for causing heavy damage to the humankind. These are the natural phenomenon associated with the floodplains of the world. Floods are unavoidable so we have to adapt to it and proper flood forecasting helps in better adaptation and management of floods. The scholars from different fields are continuously contributing lots of knowledge for improving the methods of forecasting flood as exactly as possible. India is a country in which large part of the country experiences the problem of flood every year. Flood hazard zonation is very significant in management and development of river basins (Jana, 1997). Its effectiveness increases by many folds with the use of more recent high-resolution multi-sensor satellite data (Prasad, et al., 2006), but due to lack of accessibility imageries with lower resolution are used. Singh, et al., (2013) has used Microwave Passive Remote Sensing (AMSR-R) in parts of Brahmaputra basin for monitoring floods. Jana (1997) used Survey of India toposheets of 1:50000 scale and IRS LISS-II for preparing flood hazard zones in North Bengal. Besides using the data from the satellite imageries, the basin morphometry, such as Digital Elevation Model, flow direction, flow accumulation and basin slope is also used in flood hazard mapping (Diakakis, 2011). Flood vulnerability multi-criteria analysis needed data on drainage density, surface runoff and slope map, agricultural loss, land use and land cover and these are given weightage on the basis of the relative importance of assigned to evaluation (Warghat et al., 2012). Among many other methods, the method based on multicriteria weightage overlap is becoming very common and easily viable method in hazard zonation. This method has been used by Lingadevaru and others (2015) for flood hazard zonation of Tungabhadra and Hagari sub-catchments. They used factors like land use, slope, soil, Lithology-Geomorphology, drainage density, the size of sub-watershed and rainfall distribution for flood zonation. This method is very convenient as it takes consideration of many factors that influence the occurrence of the flood. Carling (1986), has mentioned about the role of more specific factors such as Drainage length, width, maximum depth, mean depth, hydraulic radius, catchment area, and hydraulic slope in the occurrence of the flood. Flooding results from a complex mixture of geological, geomorphological, and hydrological conditions and can cause damage and disruption to people, organizations, industries, and the environment (Wu and Sidle, 1995; Glade, 1998). Others like Rodda (1969), states that the magnitude of the flood is determined by the basin area, basin shape, basin elevation, basin slope, drainage network, climatic factor, vegetation and land use.

Jiadhol River is a sub-tributary of the Brahmaputra causing severe floods damage in the Dhemaji district of Assam. The main objective of this paper is to prepare flood hazard zones of Jiadhol River basin with the help of multi-criteria weightage overlap method in ArcGIS software. The factors used in this method are geology, geomorphology, drainage density, flow accumulation, soil, groundwater table, Land-use and Land-cover.

2. Study Area

The Jiadhol River is one of the north bank sub-tributaries of the Brahmaputra River that empties into Charikoria River. The basin of the Jiadhol River extends from 27˚15′ N to 27˚45′ N latitudes and 94˚15′ E to 94˚40′ E longitudes, covering an area of 1191.62 sq km, of which 38% (446.6 sq km) lies in Arunachal Pradesh and 62% (746.6 sq km) in Assam. There are three main tributaries of Jiadhol in the hills Siri, Sido and Sika. The total length of the river along Siri is 186 km, out of which only 65 km is confined to the mountainous region remaining 121 km is in the plains.

Data Base and Methodology

The thematic maps of all the flood causative and intensifying factors, such as geomorphology, elevation, slope, drainage density, drainage network, flow accumulation, soil, ground water table and land cover/land are prepared with the help of data collected from secondary sources, toposheets and Satellite imageries. Data on lithology/geology was collected from the publications of Geological Survey of India. Flood inundation data of different areas are collected from the Office of Circle officers and mapped in GIS. Beside these factors proximity to drainage, confluence and embankment breaching point has a significant role to play in the occurrence of flood in an area. So, proximity buffers are made at GIS along with the main drainage, confluences and also along the embankment breaching points. Flood hazard zonation of Jiadhol River Basin is done by weighted overlap method in Arc GIS 9.3. Weights are given to all the selected parameters based on the degree of influence in the occurrence of flood in the basin (Table 1: Weightage of the Parameters). After preparing the Hazard Zonation Map of the study are, the location of severely flood-prone areas on the zonation map will be further validated with the real-time flood data collected at Block Development Offices.

Flood hazard zonation

Flood hazard zonation of Jiadhol River Basin is done by weighted overlap method in Arc GIS 9.3. The prepared flood hazard map of the Jiadhol River basin has four hazard zones (Fig. 2). The darkest color represents the most severely flood-prone zone it is comprised of 30.37 percentage of the total area of the basin. The moderately flood-prone zone comprises of the one tone lighter color, it covers 17.23 percentage of the total basin area. The two-tone lighter color represents the less flood-prone zone and it comprises 16.19 percentage of total area. The lightest color represents the flood free zone, it claims 36.21 percentage of the total area of the basin. It has been found that there are two distinct severely flood-prone areas in the basin one towards the center of the basin and other lies southward. The annual flood data collected from Block Development Office, Dhemaji, confirms that the central area is flooded for the major portion of the year.

3. Conclusion

Two distinct realms of severely flood prone areas towards the eastern side of the basin are visible in the studied area. The first one occupies the central portion whereas the second one covers the southernmost part of the basin. The Jiadhol river floods are limited to central part of the basin. Flood in the southernmost regions is attributed to the rise of water level in the master river, the Brahmaputra. Severely flood prone areas comprise of areas experiencing annual inundation, this area chronically flood-prone. The moderately flood prone areas comprise of the area connecting the two severely flood prone areas and its adjoining areas. Less flood prone areas cover the Piedmont area of the basin and the valleys of the three main tributaries in the hilly catchment of the basin. The hazard zonation map derived in this paper has a very significant role to play in flood management in the Jiadhol river basin.

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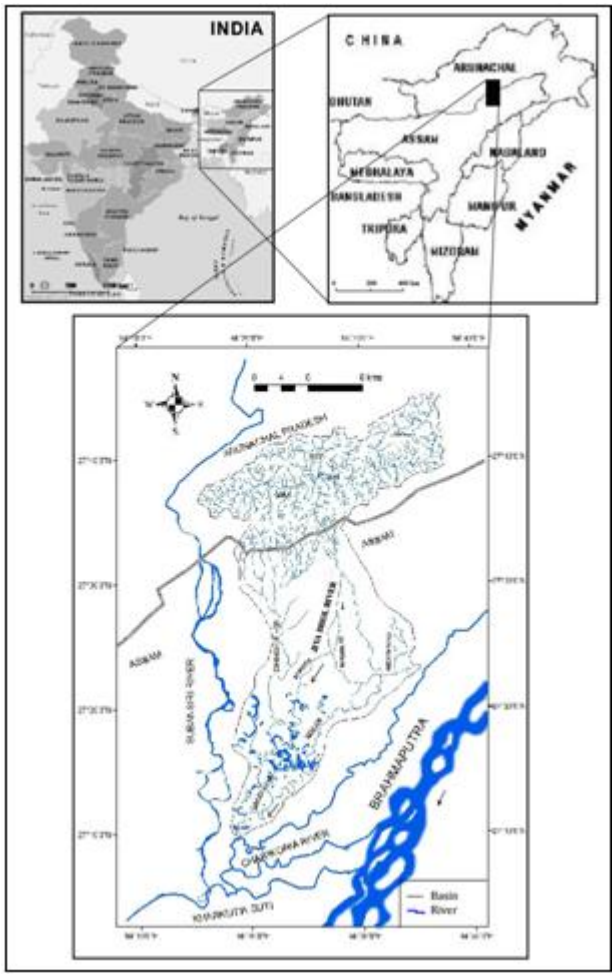

Figure 1: Jiadhol River Basin

Table 1: Weightage of the parameters

Parameter	Weightage	Sub sets	Weight	Role in occurrence of flood
Elevation (in m)	15	below 100	3	severe flood
		100-200	2	moderate flood
		200-300	1	less flood
		300-above	0	flood free
Slope (in Percentage)	10	0-2	3	severe flood
		2-4	2	moderate flood
		4-7	1	less flood
		above 7	0	flood free
Drainage density (streams per km^2)	2	3-2	3	severe flood
		2-1	2	moderate flood
		1-0	1	less flood
		0	0	flood free
Flow Accumulation	10	Yes	1	flood prone
		No	0	flood free
Geomorphic Units	10	Wetland, sand deposits	3	severe flood
		Flood plain, valley	2	moderate flood
		Alluvial plain, pediment	1	less flood
		High hills, foothills	0	flood free
Soil type	5	Histosols, sand	3	severe flood
		Entisols	2	moderate flood
		Alfisols	1	less flood
		Ultisols, Mollisole	0	flood free
Ground water table (in mbgl)	5	Less than 87	3	severe flood
		87-96	2	moderate flood
		96-108	1	less flood
		More than 108	0	flood free
Proximity to drainage (in m)	5	Less than 500	3	severe flood
		500-1000	2	moderate flood
		1000-2000	1	less flood

		More than 2000	0	flood free
Proximity to confluence (in m)	3	Less than 500	3	severe flood
		500-1000	2	moderate flood
		More than 1000	1	less flood
Proximity to embankment breaching point (in m)	10	Less than 500	3	severe flood
		500-1000	2	moderate flood
		1000-2000	1	less flood
		More than 2000	0	flood free
Land use/Land Cover	10	Wetlands and waste	3	severe flood
		Cultivated land	2	moderate flood
		Residential areas	1	less flood
		Forest	0	flood free
Inundation interval (in years)	15	1	3	severe flood
		2	2	moderate flood
		3	1	less flood
		4	0	flood free

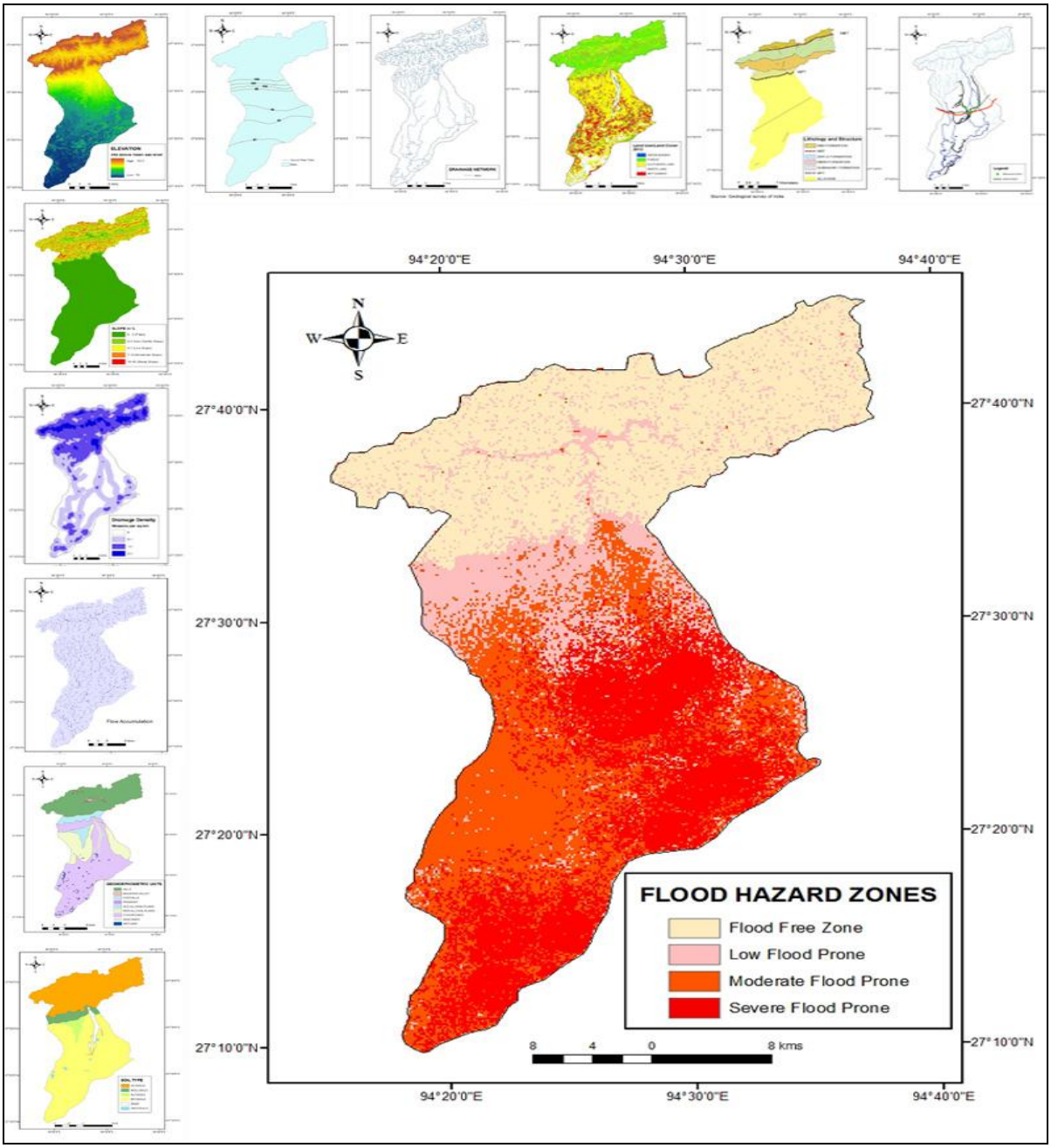

Figure 2: Flood Hazard Zonation of the Jiya Dhol River Basin