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Assessment of Flood Hazard Zone Using Remote Sensing & GIS – A Case Study of Subarnarekha River Basin

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Abstract: ***Flood is the natural hazards on the Earth surface; it is a relatively high flow of water that overtops the natural and artificial banks in any of the reaches of a stream. When banks are overtopped, water spreads over flood plain and generally causes problem for inhabitants, crops and vegetation. We can't control the flood hazard but if we awarded about this deserter we can protect and save the people life, property and other resources. The development of modern technology GIS is a powerful tool for identify the flood risks zone for planning and management against this natural hazard. Subarnarekha river basin is one of the major river basin in east India. Using satellite (Landsat-7 ETM+ & DEM) image, other related base map (River basin, Geology, Soil & Top sheet) and district wise rainfall data the flood hazard map were prepare in the GIS environment help of Arc GIS software. The weighted overlay analysis method used to prepared final flood hazard map using suitable feature class weighted values. The final flood hazard map divide into five categories Very high, High, Moderate, Low and Very Low. The major findings of this study; downstream part of Subarnarekha river basin is high to very high flood hazard risk fall in Baleswar and Mayurbhanj district in Orissa, East Singbhum and West Singbhum district in Jharkhand and West Medinipur District in West Bengal the part of Baleswar district is totally under of High flood hazard risk zone. In this study helps to concern the authorities to formulated their development strategies according to the available risk to the area.***

Keywords: Flood Hazard, Landsat-7 ETM+, DEM, River Basin, Remote Sensing, GIS, Weighted Overlay

1. Introduction

The flood is the natural hazard occurred by natural cause like heavy rainfall and other than the urbanization and de forestation. More than half the world's population lives in Asia, which is approximately one-fifth of the earth's land area. As natural disasters increase in both intensity and severity around the world, the Asian region continues to suffer a disproportionate number of hazard events and related losses in lives, infrastructure, stability, and economic progress (Arambepola. N.M.S.I et al, 2009 and Uddin. K, et al 2013). Flood hazard comprises many aspects which include structural and erosion damage, contamination of food and water, disruption of socio economic activity including transport and communication, as well as loss of life and property (Hewitt. K et al, 1971. Muhammad. I, et al 2013). Less developed places that are affected by climatic hazards face great challenges to future development. While improving development levels in the developing world has proved to be difficult in general (Collier, 2007; UNDP, 1990 to 2014; World Bank, 2002), extreme climatic events impose an additional constraint on development in such places (Adger, N.W, et al, 2003, 2006; Kates R.W, 2000; Kates R.W, et al 2007; Takeuchi, K et al, 2011; Tian. Q, et al, 2015). There has been a long tradition of geographic research on natural hazards (Montz. E, 2011). Geographic approaches to natural hazard research have evolved from focusing on understanding the geophysical environment to integrative studies that Examine both social and geophysical environments (Burton. I, et al, 1978 and 1993; White. F, 1945). Advanced technological tools, such as GIS and spatial analysis, have also facilitated natural hazard research and proved to be useful for quantifying vulnerability, resilience, and adaptive capacity which have emerged as core concepts in climate variability/change research (Belmonte. C, et al, 2011; Ho. T, et al, 2011; Frazier. G, et al, 2013; Malcomb. W, et al, 2014; Santos. A, et al, 2014; Silva. A, et al, 2015; Varis. O, et al, 2014). The production of a good map of flood risk zones involve using a tool with a broad range of functions capable of manipulating both spatial and attribute data. In this regard, the efficacy of the Geographic Information Systems (GIS) can be relied upon (Ayeni. B, 1998; Clement. A, 2013). In this study were integrated with analysis the satellite data and others data using Arc GIS software and finalize the flood risk zone for save the human life and protect the resources against flood.

2. Study Area

The study area Subarnarekha River is the part of East India, the river origin on piska near Ranchi district of Jharkhand. The Subarnarekha River flowing on the three states (Jharkhand, West Bengal & Orissa), under of seven districts (Ranchi, East Singbhum, West Singbhum, West Medinipur, Mayurbhanj & Baleswar) of India and finally meets in the Bay of Bengal. The study area **(Figure-1)** Subarnarekha river basin covers 20610 sq km on the Earth surface.

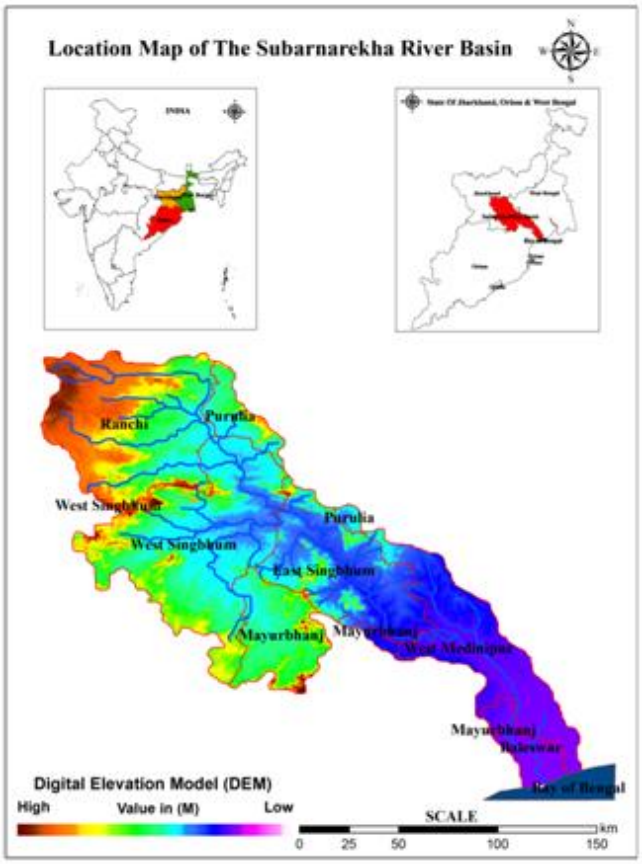

Figure 1: Location Map of the Study Area

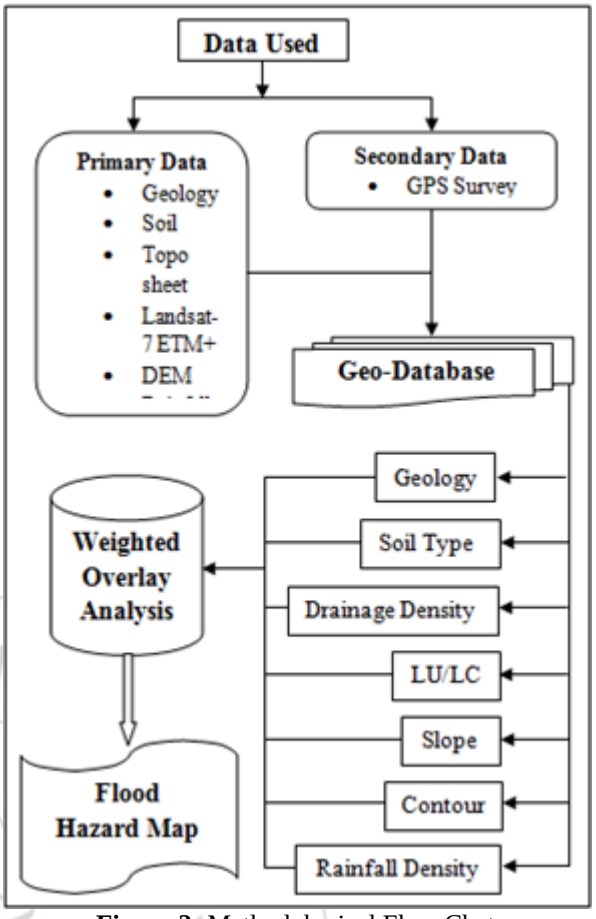

Figure 2: Methodological Flow Chat

3. Data & Software Used

The study was based on the both primary and secondary data collected from different government office. The different software used for creating the final map, details of data & software used is in **(Table-1).**

Table 1: Data & Software Used

Areas	Type of Data & Software	Data Source & Software Version
Data Used	Top sheets	SOI
	Geology	GSI
	Soil	NBSS
	Landsat-7 ETM+	GLCF
	DEM	Bhuvan
	Rainfall	IMD
Software Used	Arc GIS	10.1
	ERDAS	9.0
	Microsoft Office	2007

4. Methodology

The flood hazard analysis ware computed using multi criteria evaluation (MCE). To run MCE, the selected flood causative factors such as geology, soil type, elevation, slope, drainage density, land use, and rain fall were developed and weighted. The weighted overlay technique was computed in Arc GIS 10.1 Model Builder to generate flood hazard map using suitable class weighted value. Details of methodological flow chat in **(Figure-2).**

5. Result & Discussion

5.1 Geology

Geologically the area covers by granite, gneiss, metamorphic, gravel, alluvium etc. iron ore presents in Dalma hill region situated in middle part of the study area. Northan part of the study area presents in granite, gneiss cover by Dhalhun mountain range this area is less affected by flood hazard. The middle part of the study mixing of various geological feature and lower part of the study cover by recent alluvial its more than effective flood hazard according to others geological features. The geology of the study area is in **(Figure-3).**

Figure 3: Geology Map of Subarnarekha River Basin

5.2 Soil Type

Soil drainage is one of important factor for water movement in the soil. Soil type is very important in soil drainage, others factors are soil texture, structure and physical condition of surface and sub-surface soil layer. In the study area Subarnarekha river basin loamy, fine loamy, course loamy, sandy, gravelly, alluvial, clay, alkaline etc soil type are presents. In all the soils type sandy, clay, fine loamy all are more effective to soil erosion due to loose in texture. In flood porn area presents in loosing soils given the highest scale of flood hazard rating. The soil map of the study area is included in **(Figure-4).**

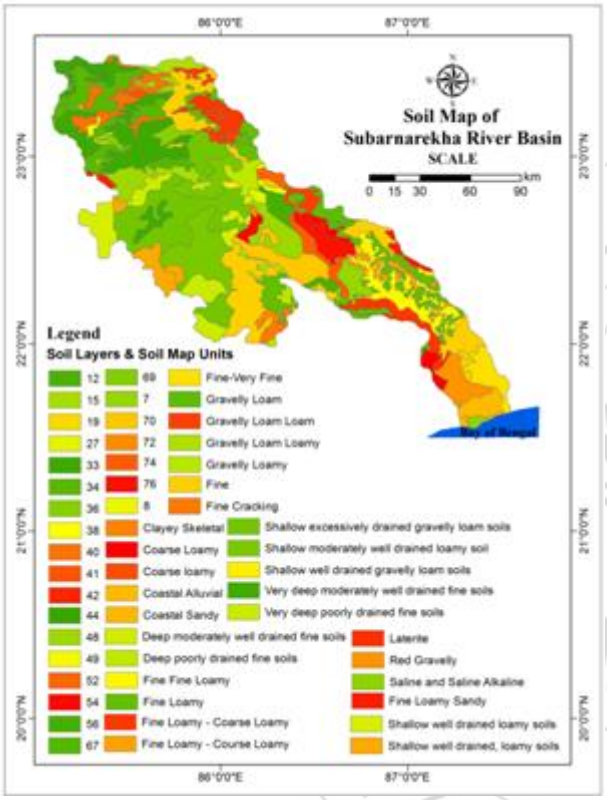

Figure 4: Soil Map of Subarnarekha River Basin

5.3 Drainage

Subarnarekha is the main river in the study area flowing from the north-west to south-east direction and finally meet in the Bay of Bengal at Baleswar district. The river basin covers 20610 sq km with its tributaries Ranu, Karkari, Kharkai and Sankh **(Figure-5).** The Subarnarekha river origin in piska near Ranchi district and flowing towards the Bay of Bengal, the upper and middle part of this river flowing under the hill mountain region lot of perennial and non-perennial drainage meet in this river it makes the high water volume in lower part area of Subarnarekha river basin. Available of high volume of water in rainy season it's occurred flood hazard and destroy the human life & other resources.

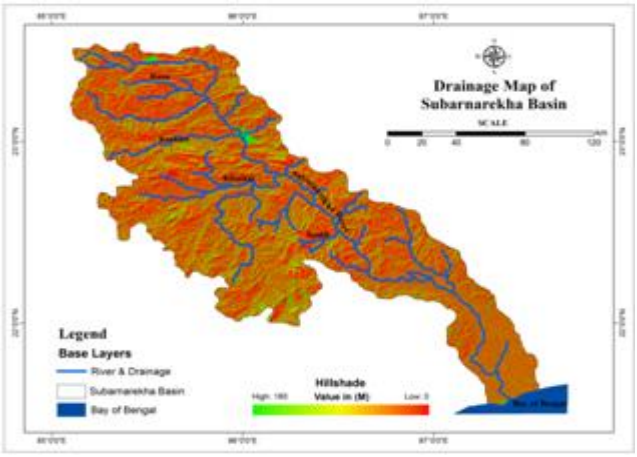

Figure 5: Drainage Map of the Study Area

5.4 Elevation and Contour

The north-western parts of the Subarnarekha river basin represent the highest elevation (180 m) and highest contour (600 m) the area under the high hill mountain region. South-eastern part of the basin represents low elevation and low contour value and the area under the low lying coastal zone **(Figure-6).** The Dalma mountain region presents in middle part of the study area. In the rainy season runoff water moves from the high elevation to low elevation and occur the flood hazard in low lying area. The 3D view of the study area is in **(Figure-7).**

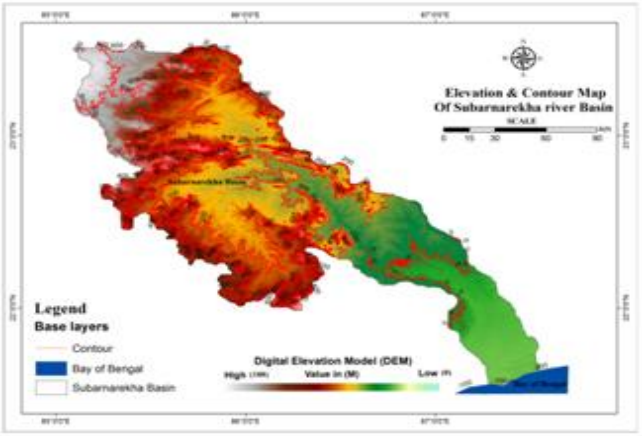

Figure 6: Elevation & Contour Map of the Study Area

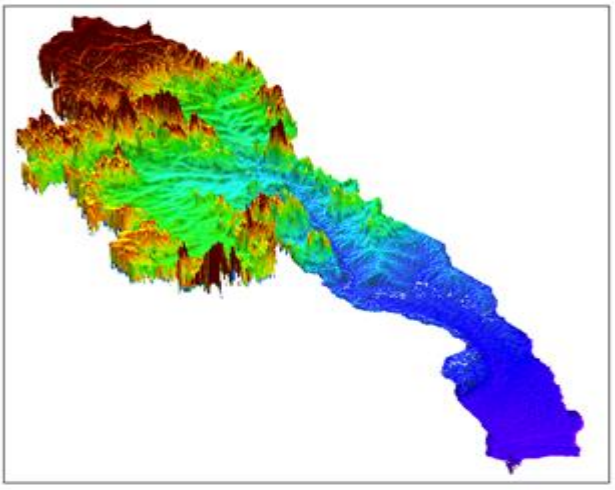

Figure 7: 3D View of the Subarnarekha River Basin

5.5 Slope

Slope identifies maximum rate of change in value from each cell to its neighbors or a measure of change in surface value over distance, expressed in degrees or as a percentage. The lower the slope value indicates the flatter terrain. The higher the slope value or degree of slope indicates presents of hill or mountain. North, middle and southern part of the study is indicate higher the slope and southern coastal area, middle part and some part of north site is indicate presents of low slope **(Figure-8).** Slope and flood hazard are in inverse relation higher the slope less affected the flood hazard and lower the slope higher affected the flood hazard.

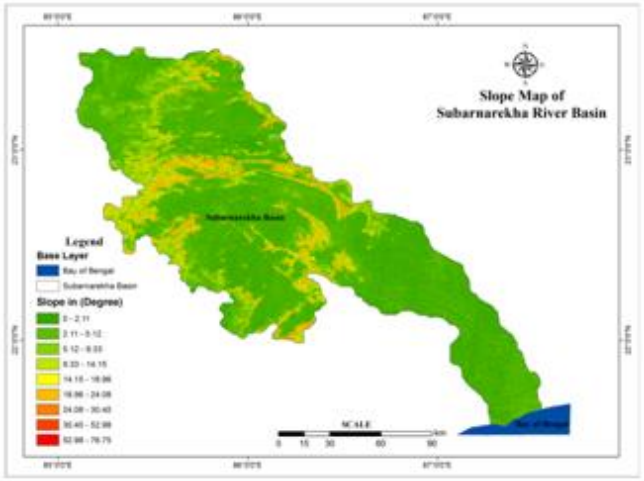

Figure 8: Slope Map of the Study Area

5.6 Land Use / Land Cover

The LU/LC map prepare by using Landsat-7 ETM+ data help of ERDAS software. The supervised classification method was applied to creating LU/LC of the study area. The LU/LC divide into eight different class; agriculture land, fallow land, forest, vegetation, sand, river, settlement, inland water body and fallow land. The Hill mountain region covers by forest, the agriculture land presents of river side area, discrete type of vegetation presents in all around the study area, river sand mainly found in Subarnarekha river bank, inland water body found in northan, southern and eastern part of the study, scatter settlement presents in the study area but northan portion of the study area found high settlement density and fallow land presents in foot hill area and all around the study area **(Figure-9).** Due to flood hazard agriculture land, settlement is highly affected and also affected the other resources but forest land is less affected and its controls and protected the flood hazard.

Figure 9: Land Use / Land Cover Map of the Study Area

5.7 Rainfall

Rainfall is the main causative factor for flood hazard occurring, when high rainfall occur the flash flood or flood occur in lower part of river basin area or low lying area. In Subarnarekha river basin annual rainfall depth map creating in GIS environment, the map shows that the part of Ranchi, Purulia and West Medinipur district under of low rainfall area **(Table-2).** The East Singbhum, West Singbhum and Mayurbhanj district found in moderately rainfall and highly rainfall occur in Baleswar district **(Figure-10).** The high rainfall possibility of high flood hazard.

Table 2: District wise Annual Rainfall

Sl No	*District Name*	*Annual Rainfall 2014 in (mm)*
1	Ranchi	901
2	West Singbhum	1521
3	East Singbhum	1341.21
4	Mayurbhanj	1661.4
5	Baleswar	1803
6	West Medinipur	1187
7	Purulia	1026.7

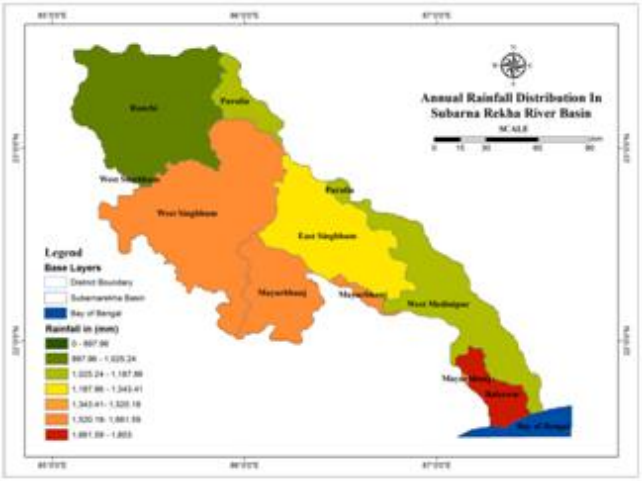

Figure 10: Rainfall Depth Map of the Study Area

5.8 Flood Hazard

Multi-Criteria Evaluation technique was used to prepare flood hazard map of the Subarnarekha river basin using GIS

technology. Flood hazard model was created using all primary and secondary data help of Arc GIS 10.1 model builder tool. The weighted overlay analysis method used to prepare flood hazard map using different class weighted value. The upper part of the Subarnarekha river fall in Ranchi district is indicate very low & low flood hazard, some part of Purulia, west & east Singbhum and Mayurbhanj district indicate low flood hazard. The moderate and high flood hazard zone indicates in part of Mayurbhanj, east and west Singbhum & west Medinipur district. The Baleswar district in Orissa, due to presents of low lying coastal area, high rainfall and high volume runoff water the area under the high flood hazard zone **(Figure-11).**

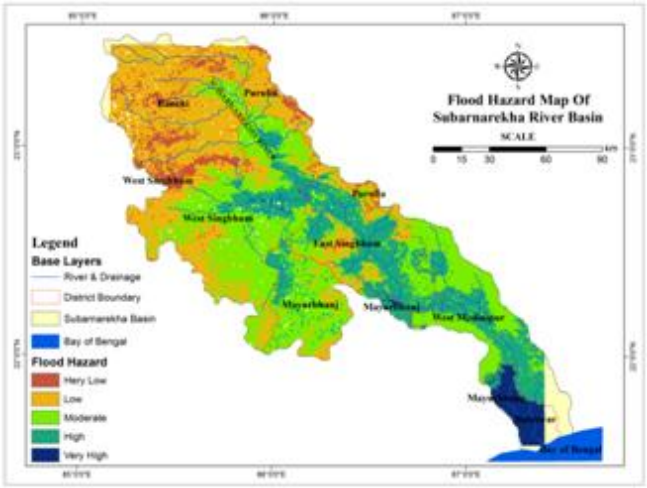

Figure 11: Flood Hazard Map of Subarnarekha River Basin

Conclusion

The present study was indicating cost effective way to flood hazard zone mapping in Subarnarekha river basin using GIS technology. The study was regulated flood hazard zoning in order to restriction the damage. The study was found agriculture land; settlement, vegetation and coastal ecosystem are more affected due to flood. The study is made for future planning and protects human & other resources help of local concern authority against the flood hazard.

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