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Research Article

Demarcation Of Flood Hazard Prone Areas In Coimbatore District Using Remote Sensing And Gis

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Abstract

With increasing rate of urbanization and industrialization, there is considerable elevation in the life style and economic conditions of the people of the city, Coimbatore. In contrary to that, natural disasters are increasing day-by-day, particularly flood, due to drainage congestion, a result of urbanization. The recent Chennai flood (2015) is an example. Coimbatore is about to experience a huge development in infrastructures, being selected as one among the cities to be developed as a smart city in India. On the other hand, the unpredictable climatic changes make natural disasters erratic. Hence it is unavoidable to get the preventive measures ready to meet the effects of disasters. In this mini project, an attempt has been made to predict the flood hazard prone areas in Coimbatore district using the advancements of technology, remote sensing and Geographical Information System (GIS) as the key tools.

The data required such as precipitation data, land use-land cover pattern, Digital Elevation Model (DEM), micro watershed, drainage density are acquired from Indian Meteorological Department, Global Land Cover Facility (GLCF) (LANDSAT Enhanced Thematic Mapper Plus (ETM+)), SRTM (Shuttle Radar Topography Mission) DEM respectively and created as thematic maps/ layers with the help of GIS Software. The method used to classify the categories of flood hazard prone areas is weighted overlay analysis. The thematic maps are given weights and created as separate weighted maps. The weighted maps are overlaid and ranked to divide the Coimbatore district into four regions of flood hazard prone areas namely, extreme, high, moderate and low.

Thus, the end result is the demarcated map of flood hazard prone areas in Coimbatore district categorized into four classes with a reasonable accuracy in accordance with historic flood records. This map, in future study, can be used as a base map for flood risk analysis and to estimate the loss of life and property prior to the disaster. Further, this map serves as a basis to foresee the areas prone to flooding and thus mitigation efforts can be adopted in advance.

Keywords: Flood hazard map, GIS, Remote sensing

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1 Introduction

A natural disaster is a major adverse event resulting from natural processes of the earth. Examples include Floods, Hurricanes, Tornadoes, Volcanic eruptions, Earthquakes, Tsunamis and other geologic processes. A natural disaster can cause loss of life or property damage and typically leaves some economic damage in its wake. The severity of which depends on the affected populations resilience or ability to recover and also on the infrastructure available.

Among the natural disasters, hydrological disasters are more destructive. India is most adversely affected by floods. It is a violent, sudden and destructive change either in quality of earth's water or land below the surface or in atmosphere.

A flood is a body of water that covers land which is normally dry. Floods are common natural disasters that can affect millions of people around the world. They destroy houses and buildings, and carry soil away from valuable farming land. Floods can also contaminate drinking water and lead to diseases. They are often caused by rivers, but overflowing lakes and seas can also cause flooding.

Flooding has always been a part human history. Many ancient civilizations developed along waterways and rivers because people needed water for their fields. Floods are not always destructive natural events. Before the Aswan High Dam was built yearly floods in Egypt brought along nutrients and made the land around the Nile very fertile. Every year floods during the monsoon season in Bangladesh not only deposit fertile soil but also kill thousands of people and leave millions homeless.

Floods are also caused by humans. Trees and plants normally help absorb too much water. When forests are cut or burned down, water from rainfall flows down barren land and produces mudslides. Too much water pressure on dams can lead to cracks in the concrete or even cause a dam to break completely.

This study insists on the use of technological sources such as Remote sensing (RS) and Geographical Information System (GIS) where RS is used for the acquisition of the required data and information and GIS is used for storing, manipulating, analyzing and processing the data, thus resulting in the Flood Hazard Zone Map.

2 Study Area

2.1 Explanation of Study Area

The Coimbatore City is Manchester of South India. It is metropolitan and Industrial city which is also referred as Kovai in Indian state of Tamil Nadu. The Coimbatore city is largest city after Madras and 16th biggest urban cluster in India. The Coimbatore Municipal Corporation is administrated the Coimbatore City. It is famous and vigorous development in the textile industries in Tamil Nadu. The study area map is shown in fig.2.1.

2.2 Geography

The latitude and longitude of the study area is 11°1′6″N and 76°58′21″E in south India at 411m above mean sea level at the banks of the Noyyal River, in southwestern Tamil Nadu. The total study area of Coimbatore city is 642.12 Km^2. As per the Bureau of Indian standards, the study area falls underneath the magnificence III/IV Seismic sector, having skilled an earthquake of value 6.0 on the Richter scale.

Fig 2.1 Boundary of the study area

2.3 Water Bodies

The Coimbatore City having good water resource facility. The Noyyal river is playing major role and past feature of Coimbatore city and the nearby districts of Tirupur and Erode of Tamil Nadu. The one of tributary of Cauvery is Noyyal river. The water source details of the Coimbatore are shown in Fig 2.2.

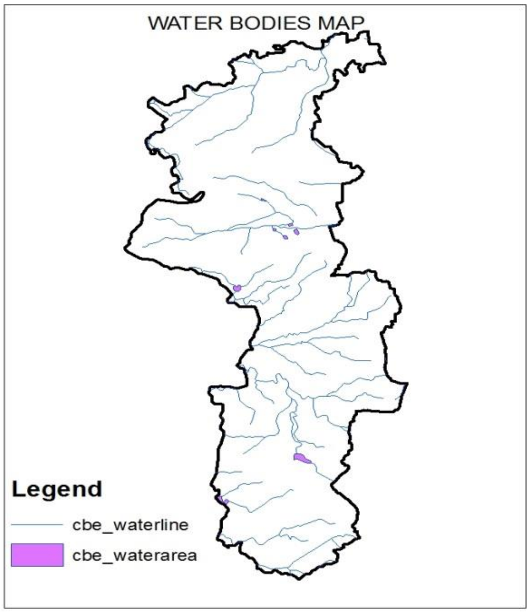

Fig 2.2 water bodies of the study area

2.4 Climate

The Coimbatore climate is always chill and cool due to presence of forests and near to the Western Ghats. Mostly, the maximum temperature between 34.9 °C to 29.2 °C. The month of June to august the city receives an amount of rainfall.

3 Methodology and Data

The overall methodology adopted for the delineation of flood hazard prone areas in Coimbatore district using Remote sensing and GIS is illustrated in the flow chart below (Fig. 3.1).

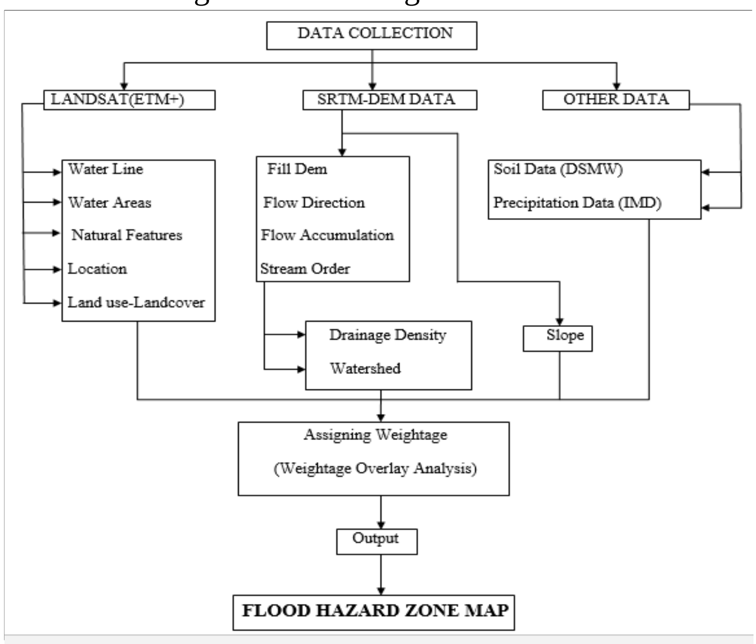

Fig. 3.1 Flow chart of Methodology

3.1 Data Collection

Data collection is the most important aspect for any research study. The collection of data is not an end in itself, but is essential for informed decision making. Data collection is a means of gathering facts, statistics and details from different sources.

The required satellite data are collected from open-source websites like Global Land Cover Facility (GLCF), United States Geological Survey (USGS), Bhuvan, Diva-GIS, Indian Water Portal, ESRI, NRSC etc., and satellites LANDSAT (ETM+). The data acquired for the process of flood hazard zonation are: DEM data, Water bodies, Land use-Land cover, Soil data and Precipitation.

3.2 SRTM-DEM Data

The Shuttle Radar Topography Mission (SRTM) is an international research effort that obtained Digital Elevation models (DEM). The elevation models are arranged into tiles, each covering one degree of latitude and one degree of longitude, named according to their south western corners. The resolution of the raw data is one arc-second (30m) but the raw data are restricted for the government use. For the rest of the world, only three arc-second (90 m) data are available.

3.3LANDSAT data

The Landsat satellite data is downloaded from GLCF open-source website with a resolution of Enhanced Thematic Mapper Plus (ETM+) sensor, 60 m. The other data obtained are water bodies, transportation network, natural features, land use-land cover etc.

3.4 Thematic Layer Preparation

1. Elevation map
2. Slope map
3. Aspect map
4. Contour map
5. Curvature map
6. Flow direction map
7. Flow accumulation map
8. Drainage density map
9. Micro-watershed delineation map
10. Land use land-cover map
11. Soil map
12. Precipitation map

3.5 Weighted overlay analysis

The method of weighted overlay analysis involves assigning weightage to the several factors considered in the flood hazard zonation, rainfall distribution, size of micro watershed, slope, drainage density, land use-land cover and soil type. The weights assigned for various factors and classes of each factor are given in table1. The equation used to find the Flood Hazard Index in this method is as follows:

FHI = (6* RD) +(5* SMW) + (4* S) +(3* DD) +(2* LULC) +(1*SO) ----- (1)

Where,

FHI is the Flood Hazard Index to be determined to categorize the zones.
RD is the classified Rainfall Distribution.
SMW is the classified Size of Micro Watershed.
S is the classified Slope.
DD is the classified Drainage Density.
LULC is the classified Land use and Land cover.
SO is the classified Soil type.

The final Flood Hazard Zone (FHZ) map is generated based on the assigned weightage in GIS Software. The weighted overlay analysis is carried out using “Raster calculator” tool under map algebra tool in the spatial analyst tools of the tool box. The output is a raster map showing five classes: very low, low, moderate, high and very high flood hazard zones.

4 Result and Discussion

4.1 Introduction

This part explains the results obtained and their significance. The main objective of the project is to determine the Flood Hazard Index (FHI) and ultimately the Flood Hazard Zone (FHZ) map using remotely sensed data and GIS software. The required thematic layers are prepared using GIS software. The factors determining flood hazard are assigned weights according to their sensitiveness to occurrence of the flood, given in Table 4.1. The classification of each factor is from Class 1 which implies that it causes highest Hazard of flood till class 4 which implies lowest hazard accordingly. The weighted layers of Rainfall distribution (RD), Size of micro watershed

(SMW), Slope(S), Drainage density (DD), Land use - land cover (LULC), Soil type (SO) are overlaid and the output is processed.

4.2Flood hazard zone map

The net probability of occurrence of flooding in each flood hazard zone is estimated from the total sum of the weight of each contributing factor considered. All the contributing factor maps were overlaid, in order to obtain the total sum of weight. The total weight for estimating the probability of flooding in a particular flood hazard zone = the sum of every contributing factor (Pramojanee, et al, 1997). The final output is the flood hazard zone map obtained by weighted overlay analysis by overlaying the 6 layers and by giving suitable ranks (6 being the highest; 1 the being lowest) to these contributing factors (Table 4.1) and the prepared map is shown in Fig. 4.3. The final map has five classes of hazard namely very high, high, moderate, low and very low: Class 5, 4, 3, 2 and 1 respectively.

Table 1. Weights for the factors determining FHI

Variables	**Weights**	**Classes**	**Range**
Rainfall distribution	6	4	594.6 to 1326.0
		3	1326.0 to 2056.4
		2	2056.4 to 2786.7
		1	2786.7 to 3716
Size of micro watershed	5	1	0 to 157
		2	157 to 357
		3	357 to 557
		4	>557
Slope	4	1	0 to 20
		2	20 to 40
		3	40 to 60
		4	>60
Drainage density	3	1	<1
		2	1 to 3
		3	3 to 5
		4	>5
Land use - land cover	2	1	Water body
		2	Vegetation
		3	Built up & urban land
		4	Forest
Soil type	1	1	Clay
		2	Black cotton soil
		3	Peat
		4	Red soil with clay
		5	Red soil

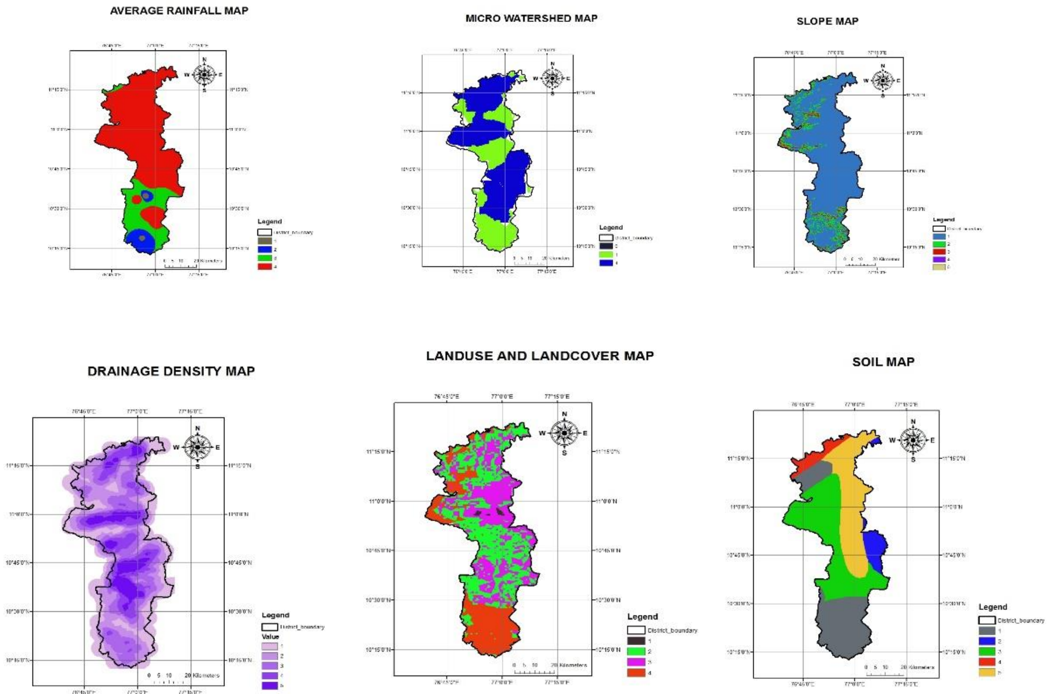

Fig. 4.1ReclassifiedThematic maps based on weights

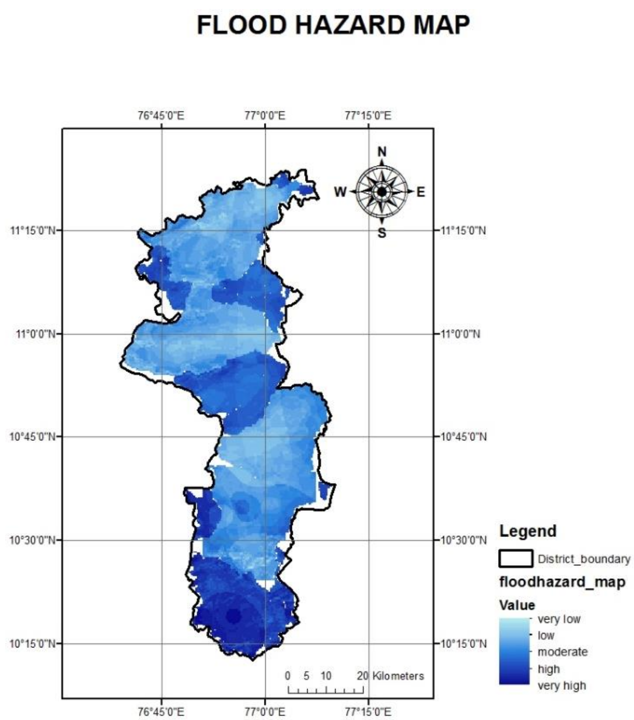

Fig 4.2 Flood Hazard Zone map

5 CONCLUSION

The parameters that contribute to flood like rainfall distribution, size of micro watershed, slope, drainage density, land use and land cover and soil type are successfully generated with the help of the data acquired from various sources listed before and Arc GIS software. This is the first step in FHZ map preparation. The weights are given as per the severity of the factors causing flood. The results obtained has 5 classes ranging from very low, low, moderate, high and very high (i.e.) class 1 to 5 respectively.

The flood hazard map is used to identify the remedial measurements for those particular places as well the development control rule should be implemented in future. The remote sensing and Geographical Information System are the best techniques to asses the flood hazard areas in economic as well as the time effective manner. The research results may be used for flood risk assessment in future for the same study area.

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