

# Flood Risk Mapping of Korapuzha River Basin using GIS

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**ABSTRACT:** In recent years humans have endured increasing number of natural disasters, of which flood is the greatest and most common throughout the world. Flood plains are thickly populated because of their economic significance. The present study area Korapuzha river basin, Kozhikode, Kerala presents a challenge in terms of repeated flash flood hazard in some parts. The present study aims to prepare flood hazard zone map of Korapuzha river basin based on Multi Criteria Evaluation method using, Arc GIS tools. The hazard map thus prepared will show the total areas subjected to the hazards, as very low, low, moderate, high, and very high hazard zones. By preparing the hazard zone map, we can propose measures to reduce the risk of these hazards in Korapuzha river basin.

**KEYWORDS:** Flood hazard Risk zone map, Multi Criteria Assessment, GIS, Weighted Overlay Analysis.

## I. INTRODUCTION

Flood, a major natural disaster, affects many parts of the world including developed countries. Due to this natural disaster, billions of dollars in infrastructure and property damages and hundreds of human lives are lost each year. These hazards and losses can be prevented and reduced by providing reliable information to the public about the flood risk through flood inundation maps. Flood inundation maps are very essential for municipal planning, emergency action plans, flood insurance rates, and ecological studies.

Geographic Information Systems (GIS) are successfully used to visualize the extent of flooding and also to analyze the flood maps to produce flood damage estimation maps and flood risk map. The GIS must be used together with a hydraulic method to estimate flood profile with a given return period.

## II. RELATED WORK

Vishnu et al discussed water level measured from satellite imagery and DEM for the region indicate that low lying areas in the coastal plains.

Rincon et al assessed the flood risk mapping based on GIS and multi criteria analysis is a tool for estimating area prone to flood risk and help water resources planners and decision makers to focus on specific areas.

Ajin et al discussed flood hazard map from ArcGIS and ERDAS imagine software tool, help to identify flood prone area, which will assist in appropriate planning of development works.

## III. METHODOLOGY

We selected the area Korapuzha river basin, which comprises parts of Kozhikode district and is covering an area of 643 km<sup>2</sup>. The area lies in between north latitudes 11°32'45'' and 11°15'12'' and East longitudes 75°36'45'' and 75°56'24''. The study area has 40.94 sq.km long seashores.

The present study was conducted using Multi criteria evaluation method. A personal geo database was created in Arc Catalog and dataset was created for the Study area with the spatial reference of GCS\_WGS\_1984. Important places, Road, Streams, Water body and Soil were digitized using ArcGIS tools. The thematic maps of Rainfall distribution, slope, drainage density, soil type and land use land cover were prepared using ArcGIS software by assigning weightage

for each class. After digitizing and plotting the maps, the rank of each factor was given on the basis of its estimated significance in causing flooding. The data layers have been integrated in GIS environment by Weighted Overlay Analysis using Raster calculator.

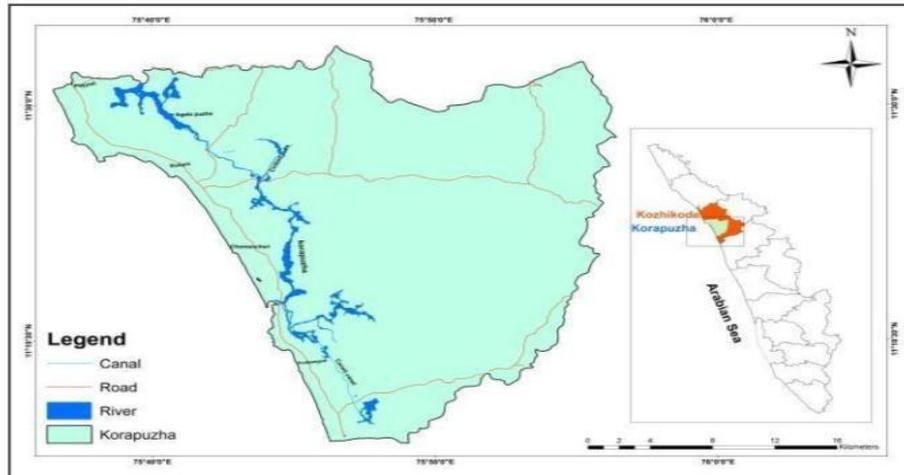


Fig.1 Korapuzha river basin

#### IV. EXPERIMENTAL RESULTS

##### A. Drainage Density

Drainage is an important ecosystem controlling the hazards as its densities denote the nature of the soil and its geotechnical properties. Drainage density is an inverse function of infiltration. The less the infiltration of rainfall, which conversely tends to be concentrated in surface runoff. High drainage density values are favourable for runoff, and hence indicate low flood chance. A watershed with adequate drainage should have a drainage density  $\geq 5$  whilst the moderate and the poor ones have drainage density classes 1-5 and  $< 1$  respectively. Higher weights are assigned to poor drainage density area and lower weights were assigned to areas with adequate drainage. The weighted drainage density map was created by assigning weights (Table 1) to each class using ArcGIS spatial analyst tools- Density. The prepared drainage density map is shown in Fig.2

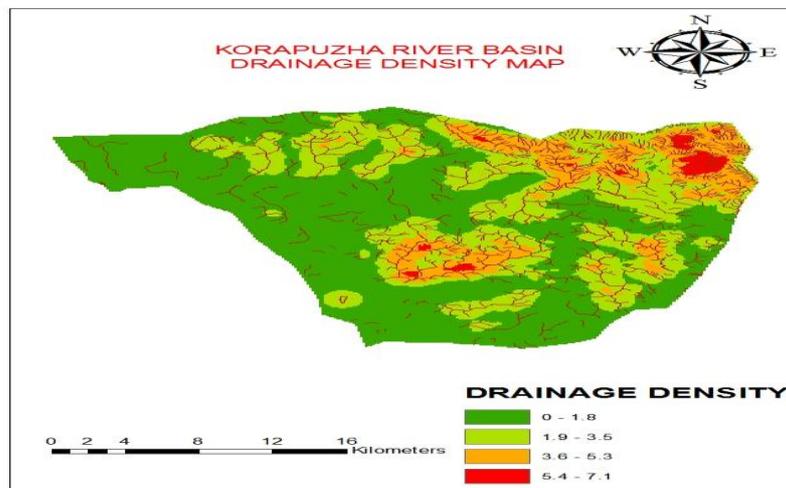


Fig.2 Drainage Density Map ( $\text{km}/\text{km}^2$ )

Table 1: Drainage weighted table

| Class | Drainage Density (km/km <sup>2</sup> ) | Weight |
|-------|--|--------|
| 1     | >5                                     | 2      |
| 2     | 3 - 5                                  | 4      |
| 3     | 1 - 3                                  | 6      |
| 4     | <1                                     | 8      |

**B. Land Use Land Cover(LU/LC)**

Land use classes of the Korapuzha river basin include: Built Up, Agricultural, Forest, wet land, waste land, beach and Water Body. Land use types were grouped into different categories, weight is assigned to each class based on the water storage of land and the runoff, the highest water storage land is given as higher as shown in (Table. 2). The prepared land use map is shown in Fig 3.

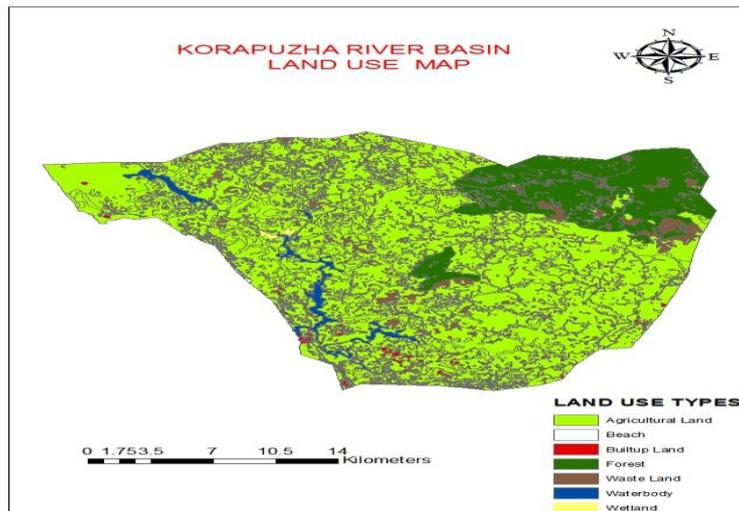


Fig.3 Land use Map

Table 2: Land use weighted Table

| Class | Land Use Type     | Weight |
|-------|-------------------|--------|
| 1     | Water Body        | 8      |
| 2     | Wet land          | 6      |
| 3     | Agricultural land | 4      |
| 4     | Waste land        | 3      |
| 5     | Forest            | 2      |

**C. Soil type**

The soil types in an area is important as they control the amount of water that can infiltrate into the soil, and hence the amount of water which becomes flow. Soil map was classified on the basis of Texture of soil. On the basis of texture, the soil types found in the basin include; Alluvium, Laterite, Hill soil and Coastal Alluvium. The weighted soil map was prepared by assigning weights to each soil classes based on the texture and infiltration capacity. Lower infiltration type soil has given the highest weightage as shown in (Table 3). The prepared soil map is shown in Fig.4

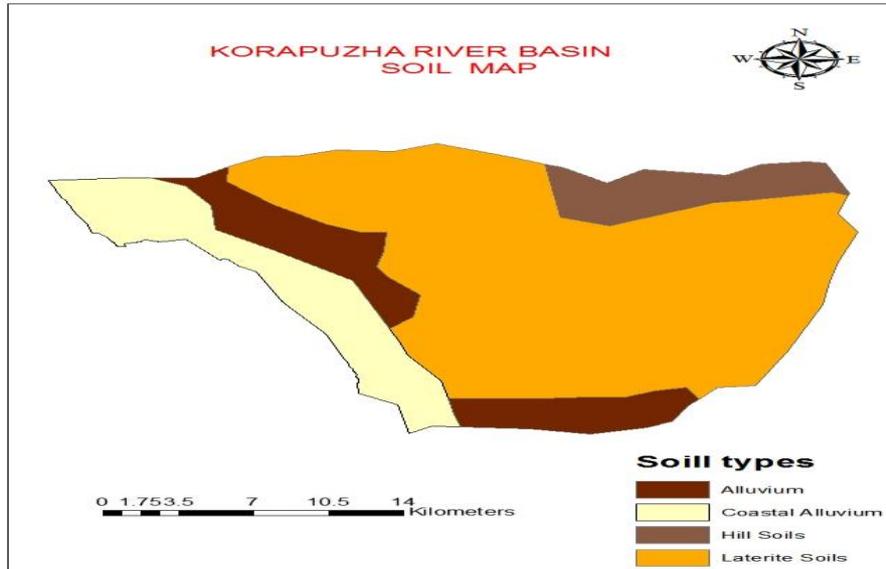


Fig.4 Soil Type Map

Table 3: soil weighted table

| Class | Soil Type       | Weight |
|-------|-----------------|--------|
| 1     | Alluvium        | 8      |
| 2     | Laterite        | 6      |
| 3     | Hill            | 4      |
| 4     | Costal alluvium | 2      |

**D. Rain fall intensity**

Heavy rainfall is one of the major causes of floods. Floods are associated with extremes rainfall, any water that cannot immediately seep into the ground flows down slope as runoff. The rainfall distributions data was collected and map was prepared by using IDW Tool in ArcGIS. The prepared rainfall distribution map is shown in Fig.5. The weighted rainfall map was prepared by using ArcGIS spatial analyst tool shown in (Table 4). The weightage is given as highest weight for higher intensity value and lower weightage for low intensity value as per the runoff and the capacity to convey water.

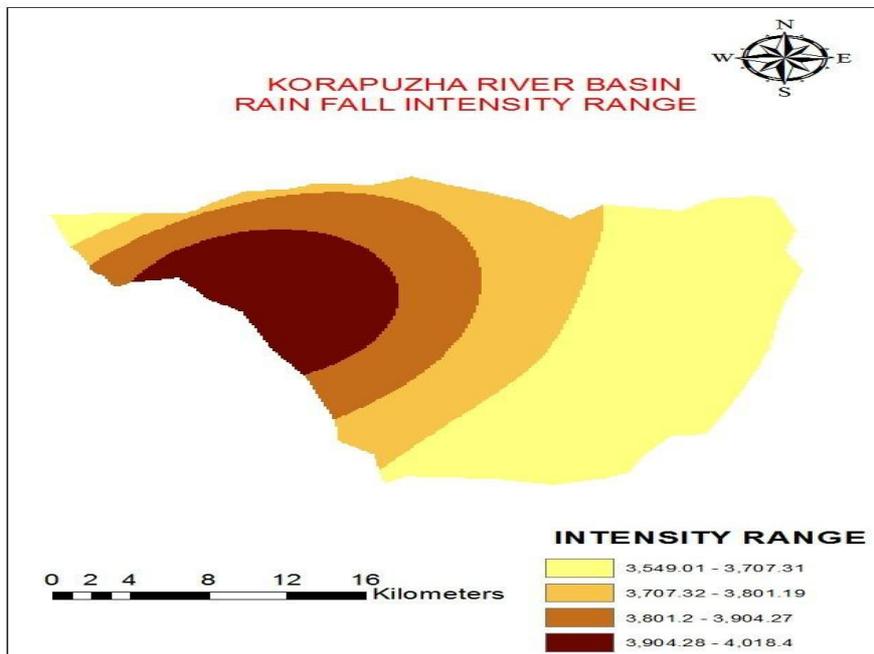


Fig.5 Rain fall intensity Map (mm)

Table 4: Rainfall weighted table

| Class | Average Annual Rainfall (mm) | Weight |
|-------|------------------------------|--------|
| 1     | 3549.01 – 3707.31            | 2      |
| 2     | 3707.32 - 3801.19            | 4      |
| 3     | 3801.2 - 3904.27             | 6      |
| 4     | 3904.28 – 4018.4             | 8      |

**E. Slope**

Slope has a dominant effect on the contribution of rainfall to stream flow. It controls the duration of overland flow, infiltration and subsurface flow. A smooth/flat surface that allows the water to flow quickly is not desirable and causes flooding, whereas a higher surface roughness can slow down the flood response and is desirable. Steeper slopes are more susceptible to surface runoff, while flat terrains are susceptible to water logging. Slope angle of watershed ranges from 0 to >70, weights are assigned as shown in (Table.5). Class having less value was assigned higher rank due to almost flat terrain while the class having maximum value was categorized as lower rank due to relatively high run-off. The prepared slope map shown in Fig.6

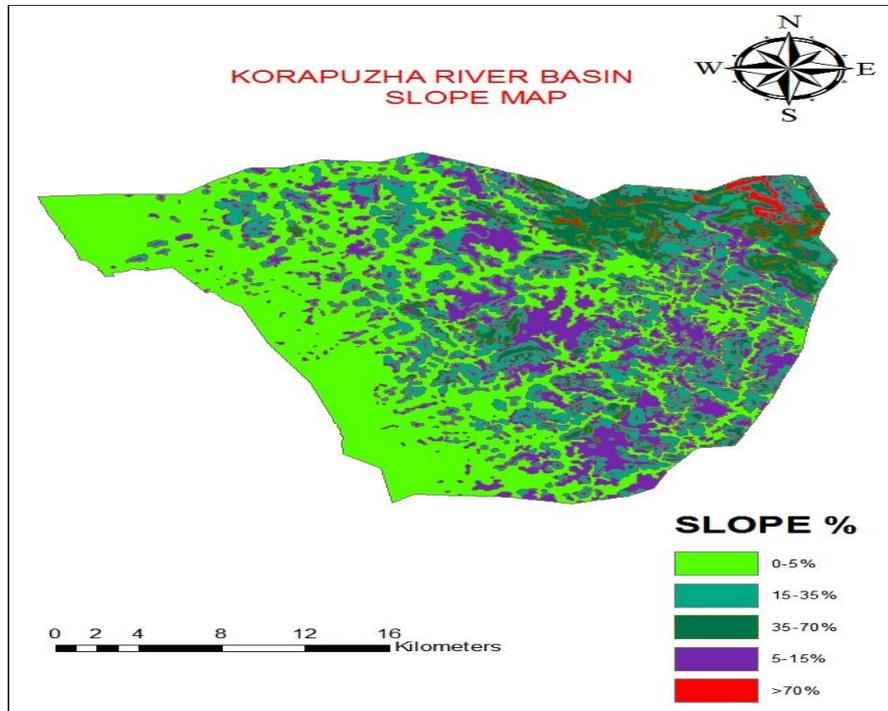


Fig.6 Slope map

Table 5: Slope weighted table

| Class | Slope (%) | Weight |
|-------|-----------|--------|
| 1     | 0 -5      | 8      |
| 2     | 5 – 15    | 6      |
| 3     | 15 – 35   | 4      |
| 4     | 35-70     | 3      |
| 5     | >70       | 2      |

#### F. Flood risk zone

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. To obtain this total sum weight, all of contributing factor maps was overlaid. The flood hazard map was prepared by giving suitable ranks (5 being highest; 1 being lowest) to these contributing factors as shown in table 6. All of these processes, the compilation of contributing factor maps, the overlaying of all maps and the calculation of hazard areas were obtained by using weighted overlay in ArcGIS spatial Analyst tool and 5 risk zones of Korapuzha river basin was found, Very high risk zone, High risk zone, Moderate risk zone, Low risk zone and Very low risk zone based on this Study area as shown in Fig.7.

Table 6: Flood risk contribution table

| Sl. No. | Contributing Factors     | Rank |
|---------|--------------------------|------|
| 1       | Rainfall Distribution    | 5    |
| 2       | Slope                    | 4    |
| 3       | Drainage Density         | 3    |
| 4       | Land Use Land Cover type | 2    |
| 5       | Soil type                | 1    |

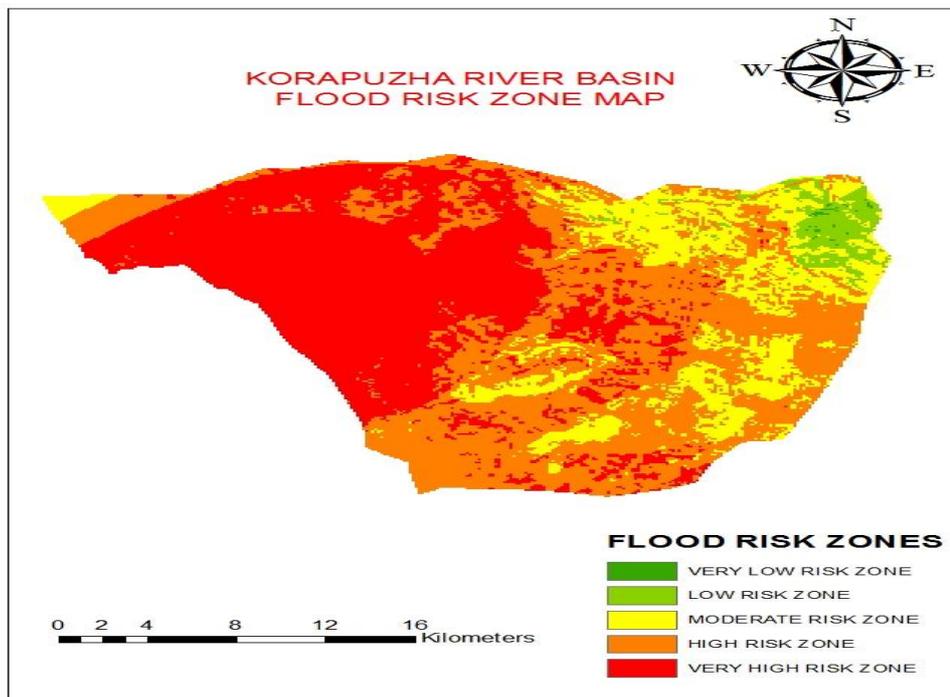


Fig.7 Flood risk zone map

### V. CONCLUSIONS

GIS techniques and analysis are valuable tools for various fields. This has been used for mapping, modelling and analysis of variety of applications in disaster management at various levels and scales. Floods are natural phenomena which cannot be prevented. However, human activity is contributing to an increase in the likelihood and adverse impacts of extreme flood events. Firstly, the scale and frequency of floods are likely to increase due to climate change, which will bring higher intensity of rainfall and rising sea levels as well as to inappropriate river management and construction in flood plains which reduces their capacity to absorb floodwaters.

In this study, an attempt has been made to prepare flood risk assessment map of Korapuzha river basin using ArcGIS. Using this map, flood prone areas of the study area can be identified easily, which will assist in preparing evacuation maps and helps to reduce the risk of floods. And also can be used as a tool in planning of development works. The present study shows a simple and cost effective way of using geographical information system for creating flood hazard map from the available data base.

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