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FLOOD MAPPING OF CHALAKUDY BLOCK USING GIS

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ABSTRACT

Flood is a natural disaster which occurred in Kerala in consecutive 3 years of time. During the months of July and August the monsoon strengthens and rivers overflow. Two days of torrential rain had filled all upstream dams on Chalakudy river on August 15, 2018. As the flood gates of four dams (Thoonakadavu, Upper Sholayar, Lower Sholayar, Neerar Dam in Tamil Nadu) water came gushing to Peringalkuthu dam which started overflowing at 4.30am on August 16. All the streams, low-lying areas and agricultural fields in the river's proximity was flooded. All the towns and villages within 5 km of the river were flooded except the slightly high hill tops. It was the worst flood in Chalakudy in nearly a century. The Indian government had declared it a Level 3 Calamity, or "calamity of a severe nature". In this paper ArcGIS is used to map the flood hazard regions of the Chalakudy block. The thematic maps used are land use, soil map, slope, drainage and rainfall. The hazard map thus prepared shows the places which are more susceptible to flood. Weighted overlay analysis is used for overlaying the maps. From the map it is seen that downstream side of Chalakudy river is more susceptible to flood like Panchayats of Koratty, Kadukutty, Meloor, Kodassery, Pariyaram and some parts of Athirappily.

KEYWORDS: GIS, Weighted overlay analysis, Thematic maps.

1. INTRODUCTION

1.1 General

In this paper we are aiming to create a flood vulnerability map of Chalakudy block which was prone to flood during the frequent years. The procedure of project includes collection of rainfall, land use land cover, soil map from the Government officials an lope map, drainage map, land use land cover map, soil map, rainfall map etc.

1.2. Weighted overlay analysis

A weighted raster overlay service helps you identify locations based on your criteria and answer geographic questions. You can build these services from your vector and raster data using tools from the ArcGIS platform. Weighted overlay services are based on raster layers, you may have to convert existing vector data to raster data.

1.3. Study area

Chalakudy is a municipal town situated on the banks of Chalakudy River in Thrissur District of the Kerala State in India. The block covering an area of 522 sq kms divided into 6 panchayaths. Kadukutty, Meloor, Pariyaram, Kodassery, Koratty, Athirappily are the panchayaths situated in Chalakudy block. Chalakudy is a Midland region. The Chalakudy river flows through the southern part of the town. Chalakudy is at a distance of 35 km from Thrissur. Chalakudy river is the fifth largest river in Kerala with length of 144 km. The river basin is bounded by the Karuvannur sub-basin on the north and the Periyar sub-basin on the south. The total drainage area of the river is 1704 sq.km and out of this 1404 sq.km lies in Kerala and the rest 300 sq.km in Tamil Nadu.

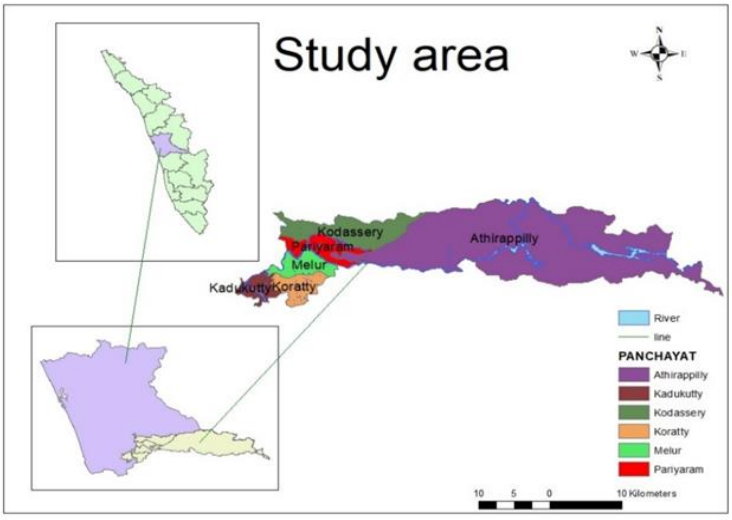

Fig. 1: Location map of study area.

2. METHODOLOGY

Methodology of flood hazard map preparation includes extraction of DEM to preparation of thematic maps such as slope map, drainage map, land use land cover map, soil map, rainfall map etc.

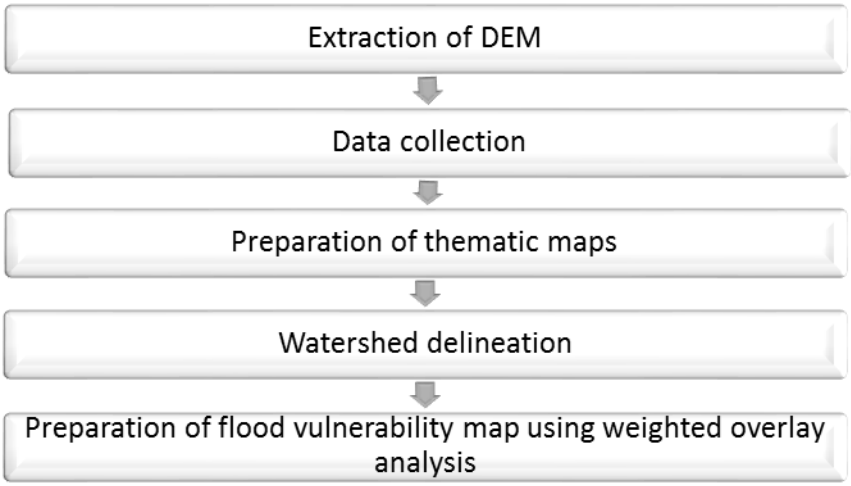

Fig. 2: Methodology.

3. THEMATIC MAPS

3.1. Elevation

A Digital Elevation Model (DEM) is a representation of the bare ground (bare earth) topographic surface of the Earth excluding trees, buildings, and any other surface objects.

3.2. Flow direction

Flow direction calculates the direction water will flow using the slope from neighboring cells.

3.3. Flow Accumulation

The Flow Accumulation tool calculates accumulated flow as the accumulated weight of all cells flowing into each downslope cell in the output raster. If no weight raster is provided, a weight of 1 is applied to each cell, and the value of cells in the output raster is the number of cells that flow into each cell. Cells with a high flow accumulation are areas of concentrated flow and may be used to identify stream channels.

3.4. Slope map

Larger the slope, the lower the flood risk. A slope map is a topographic map showing changes in elevation on a highly detailed level. Topographical maps plot lines through points of constant elevation: the closer the lines on the map, the steeper the landform.

3.5. Watershed delineation

Watershed delineation is the process of identifying the boundary of a watershed, also referred to as a catchment, drainage basin, or river basin. The usual steps for hydrologic conditioning of a DEM are:

1. Project DEM to coordinate systems WGS 84 UTM 43N
2. Fill sinks.
3. Calculate flow direction.
4. Calculate flow accumulation.

3.6. Drainage map

In geomorphology, drainage systems, also known as river systems, are the patterns formed by the streams, rivers, and lakes in a particular drainage basin. They are governed by the topography of land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land.

3.7. Drainage density map

Drainage density is an inverse function of infiltration. The less the infiltration of rainfall, which conversely tends to be concentrated in surface run-off. Higher the drainage density, the denser the stream network, the surface flow accumulates to the nearest stream very quickly.

3.8. Soil map

Soil map was classified on the basis of infiltration capacity. On the basis of infiltration capacity, the soil types found in the basin include; highly infiltrated, moderately infiltrated, and less infiltrated.

3.9. Land use/ land cover map

The land use management of the area is also one of the primary concerns because this is one factor which not only reflects the current use of the land, pattern and type of its use but also the importance of its use in relation to the living population and its relationship with the existing development.

4. RESULT AND DISCUSSIONS

4.1. Thematic layers

4.1.1. Drainage density

Drainage density in the present study area is classified into four classes. Drainage density is an inverse function of infiltration. The less the infiltration of rainfall, which conversely tends to be concentrated in surface run-off. Higher the drainage density, the denser the stream network, the surface flow accumulates to the nearest stream very quickly. Hence higher weights are assigned to class with poor drainage density and lower weights are assigned to class with adequate drainage density.

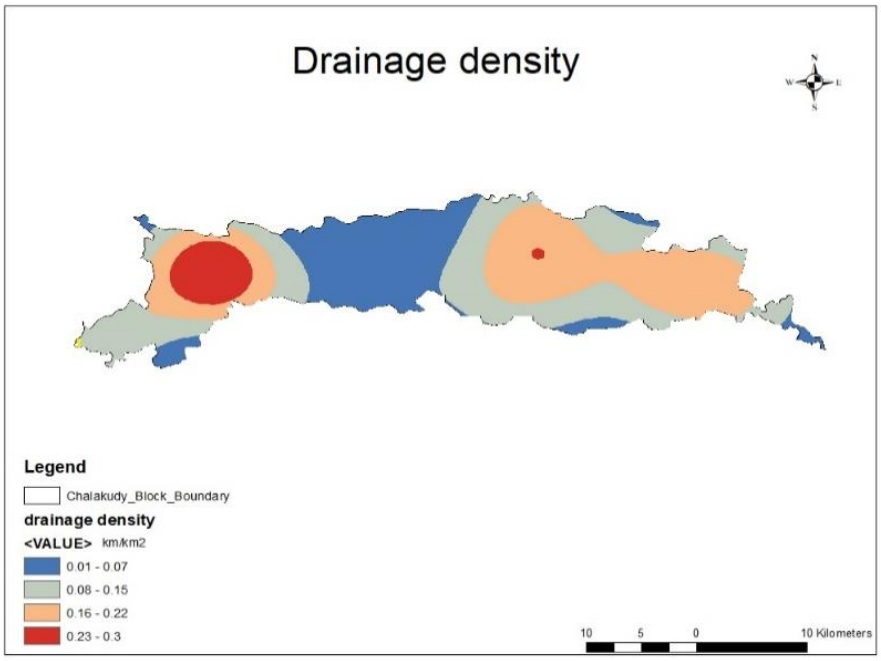

Fig 3: Drainage density map.

4.1.2. Land use/ land cover

Land use classes in the area include: Built Up, Mixed Vegetation, Forest, Plantations, and Water Body. Highest weight of 8 is assigned to water body and lowest weight of 2 is assigned to forest. In our study area Kadukutty, Meloor, Koratty, Pariyaram, Kodassery are covered in agricultural land. There are few built up land and wetlands here. Quarries are also present in these areas. Quarries increase the chance of flood and landslide. Athirapilly panchayath is mostly covered with forest. So, the chance of flood there will be minimum. The Chalakudy river and its tributaries are flowing through Chalakudy block which is one of the main reasons of flood.

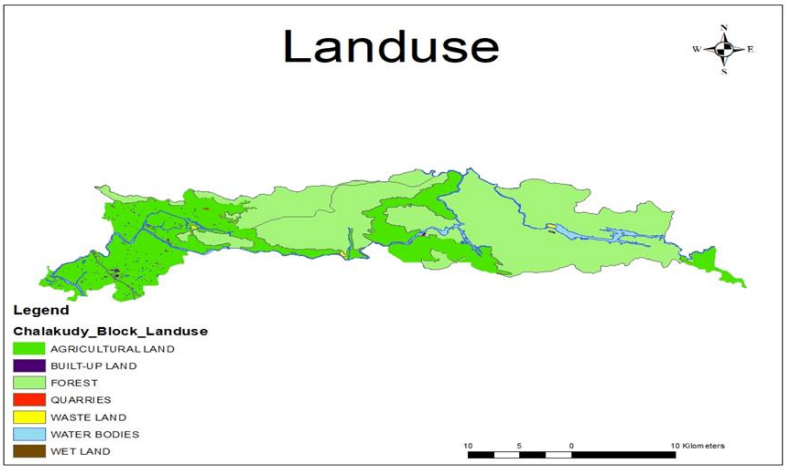

Fig 4: Land use map.

Table 1: Land use classification.

Land use pattern	Weightage
Forest	2
Built-up land	3
Waste land	4
Quarries and wetland	5
Agricultural land	6
Waterbodies	8

4.1.3. Soil map

According to FAO there is clayey soil in Chalakudy. But the composition of clay is different in different soils. By the composition of clay and other constituents the soil in Chalakudy is divided into three (table 2). The soil types in an area are 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 infiltration capacity. The clay content in the soil will reduce the infiltration. So the soil is classified in to three according to the clay content in it.

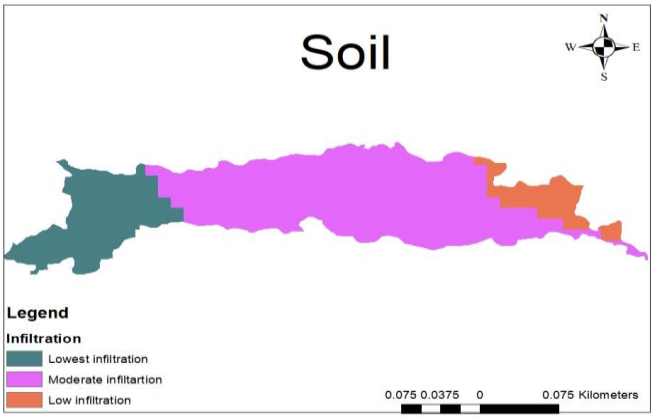

Fig 5: Soil map.

Table 2: Soil classification.

Infiltration Rate	Weightage
Moderate infiltration	6
Low infiltration	7
Lowest infiltration	8

4.1.4. Rain gauge stations and rainfall

The major rain gauge stations in the Chalakudy river basin are Vettilapara, Thunnakadavu, Parambikulam, Vynthala and Thumboormuzhi. The amount of runoff is related to the amount of rain a region experiences. The level of water in rivers or lakes rises due to heavy rain falls. When the level of water rises above the river banks or dams, the water starts overflowing, this causes floods.

Table 3: Raingauge stations in Chalakudy block.

Name of rain gauge station	Latitude	Longitude	Maintained By
Vettilapara	10.291	76.509	Hydrology Department
Thunnakadavu	10.436	76.777	Hydrology Department
Parambikulam	10.392	76.777	Hydrology Department
Vynthala	10.263	76.3	Hydrology Department
Thumburmozhi	10.297	76.452	Hydrology Department

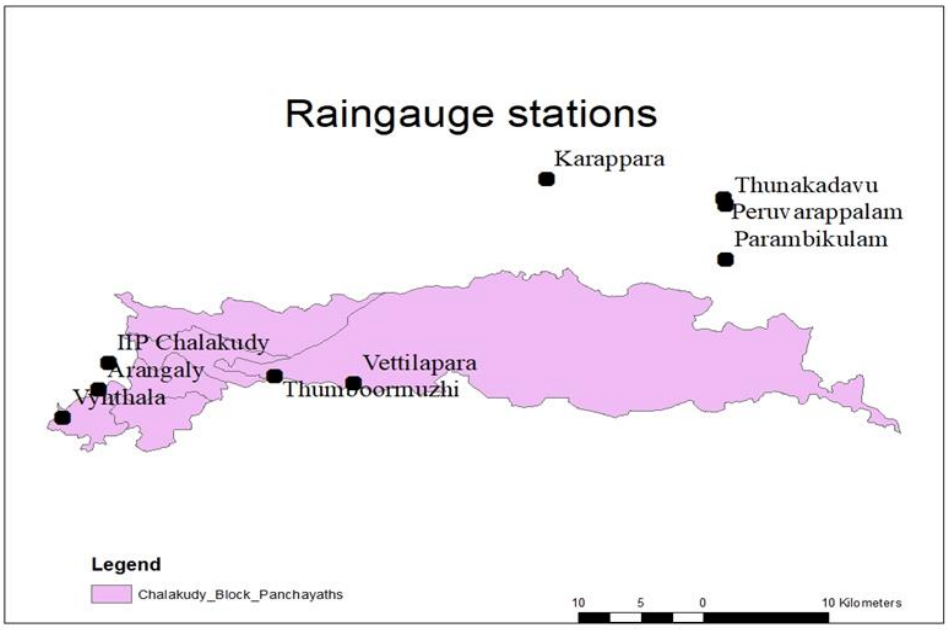

Fig 6: Rain gauge stations.

Rainfall intensity of the catchment area is found by interpolating the amount of rainfall in each rain gauge station using Inverse Distance Weighted Method. Places with higher intensity is give highest weightage.

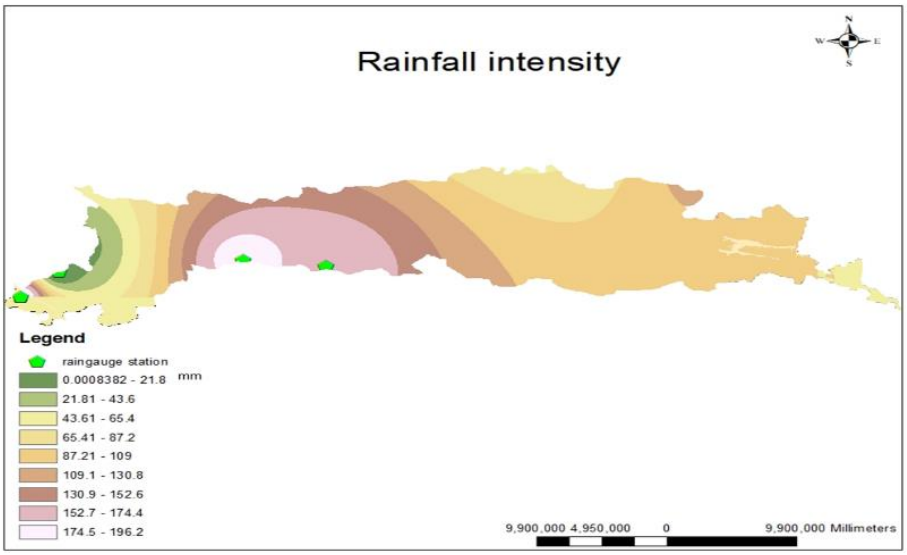

Fig 7: Rainfall intensity map.

4.1.5. Slope

Slope map derived from Digital Elevation Model gives the elevation difference of the terrain. From the map obtained it is found that places including Kadukutty, Koratty, Kodassery, Meloor, Pariyaram and a small portion of Athirapilly have less than 20-degree slope, which

will cause less runoff and more inundation. Athirapilly panchayat have more elevation differences.

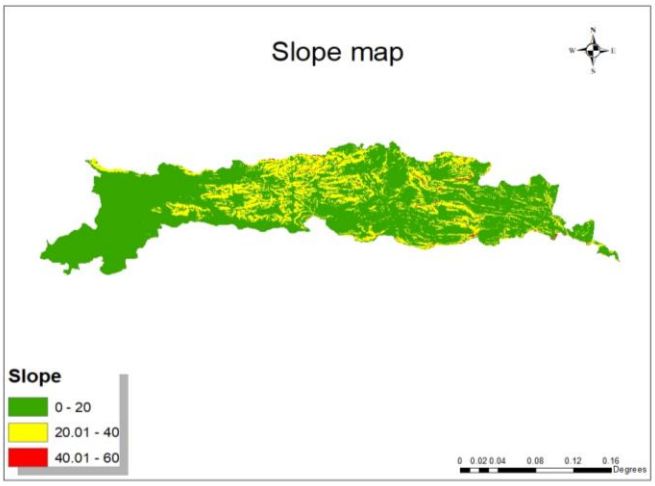

Fig. 8: Slope map.

Table 4: Slope classification.

Degree of slope	Weightage
0-20	8
20-40	6
40-60	4

4.2. Weighted overlay analysis

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. total weight for estimating the probability of flooding in a particular flood hazard zone is equal to the sum of every contributing factor. All of these processes, the compilation of contributing factor maps, the overlaying of all maps and the calculation of hazard areas were done by using Raster Calculator in ArcGIS Spatial Analyst tool.

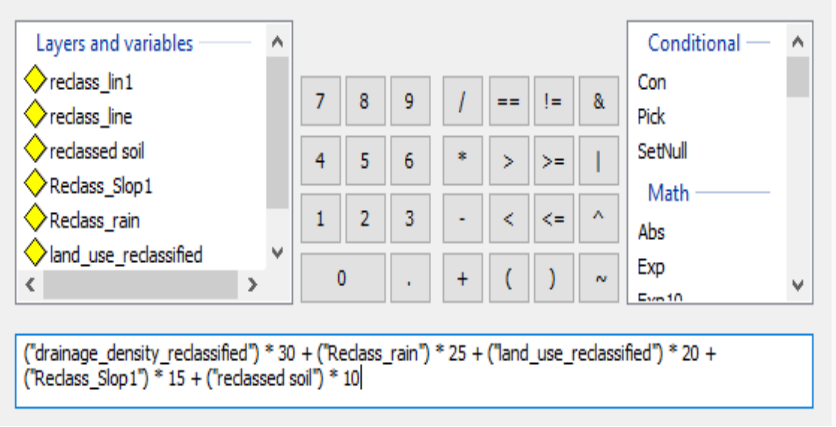

Fig 9: Raster calculator.

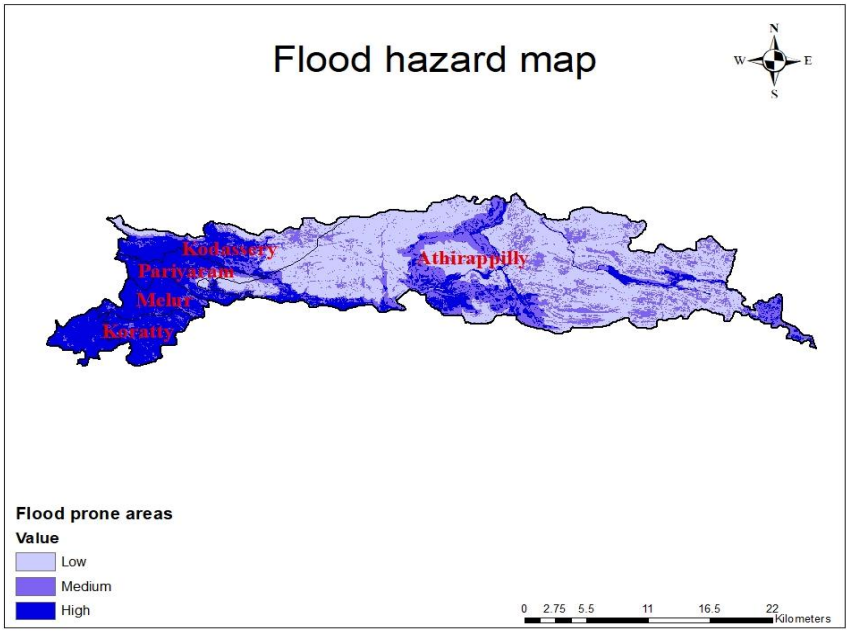

Fig 10: Flood Hazard map.

5. CONCLUSIONS

From the flood vulnerability map obtained by weighted overlay analysis it is found that Koratty, Kadukutty, Meloor, Pariyaram, Kodassery and a small part of Athirappily were affected by flood. Presence of waterbody and agricultural land mainly contribute to the flooding of that area. The forest area was least affected by flood because of high infiltration. Built up area was also present in flooded area. The places flooded were the downstream of Peringalkuthu dam which was opened due to heavy rain which in turn caused heavy flow of water.

6. FLOOD CONTROL MEASURES

Peringalkuthu dam is situated at the upstream of Athirapilly which has a reservoir capacity of 32MCM. Water from Upper Sholayar, Lower Sholayar and Idamalayar flow to Peringalkuthu. It can cause overflowing of dam. Increasing the capacity of Peringalkuthu dam and thus contain more water in the dam can be done to avoid overflow. A dam was proposed in Vazhachal which was not sanctioned due to the adverse effects to biodiversity. By sanctioning that dam some water can be flowed towards Vazhachal dam which will reduce the amount of water in Peringalkuthu dam and thus the impact of overflowing due to opening of dam can be reduced. A seven-meter canal is situated which flow from Vachumaram to Idamalayar which has a capacity of 1000MCM. Deepening the canal can

increase its capacity. Some water can be deviated towards this canal to reduce the amount of water flowing towards Peringalkuthu. Also, small scale watershed management techniques like rainwater harvesting, artificial recharge of ground water resource, check dams, dikes can be done. Also, river bank protection works, widening of riverbank and construction of water flow channel in water stagnant areas can reduce the impact of flood.

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