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Watershed Delineation of Rivers in Karaikal District using Remote Sensing and GIS Technique

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Abstract*: Water carry nutrients to areas all around the earth. They play a most important part in the water cycle, acting as drainage channels for surface water. Rivers provide good habitat and food for many of the earth's organisms. The purpose of this study is to delineate the watersheds basin in the Karaikal district from Bhuvan and United States Geological Survey (USGS) website. Digital Elevation Model is the main data source for extracting hydrology data in ArcGIS. Model Builder was the key for creation of Flow Accumulation, Stream segment, pour point and contour has been prepared using surface tool in ArcGIS software. Watershed delineation map is obtained by integration of Flow Accumulation, Stream segment and Pour point. Watershed analysis provides catchment boundaries but also hydrological parameters useful for management programs.

Keywords* : Digital Elevation Model, Land use and Landcover, Model Builder, Flow Accumulation, Stream segment, Geographic Information System.

I. INTRODUCTION

A. GENERAL

Watersheds are natural distribution and movement, where water flows in a definite path. Watersheds can be defined based on many parameters like geology, geomorphology, land use, soils, etc [18]. Watershed should be properly managed through scientific planning to prevent loss of top soil and water that result in low productivity to prevent land from deterioration to mitigate flood hazard in the downstream reaches to prevent gully formation even at low rainfall events etc. Analysis of large watersheds is quite difficult and time consuming. Remote Sensing data provides a speed and accurate to analyze large watersheds by virtue of synoptic and repetitive coverage. This study aims at delineation of watersheds by considering e.g. land use/ land cover, , elevation and slope in watershed of rivers of Karaikal district by integration of Remote Sensing and GIS.

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S. Sriram, B.E (Civil) degree in St. Joseph's College of Engineering, OMR, Chennai-6000119 future use and when drought strikes us, we think for storage of water[13].

B. NEED FOR STUDY

- Water is the foremost thing for all living being to survive in this world. The main source of water is from rainfall. We are not storing the water for
- Watershed is an area of land where all of water i.e. under it the drains off of it goes in to the same place.
- So, aim of this is to show the importance of watershed management using Geospatial techniques. Here we analyze the slope, contour and behavior of stream segments, drainage direction, flow accumulation etc.

C. OBJECTIVE

- To create a Land use and land cover map of karaikal district.
- To create a model builder for stream segmentation of karaikal district.
- To determine the stream length of Karaikal district.
- To delineate the watershed boundary of karaikal district.

II. STUDY AREA

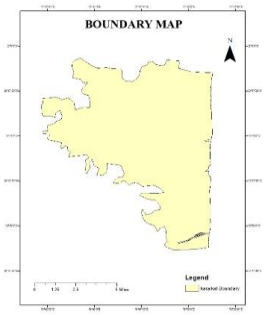


Figure 2.1 Boundary Map of Karaikal district

Karaikal is shown in the Fig 2.1 is one of the districts of the south Indian. The latitude and coordinates of karaikal is 10.932 N 79.831 E^{o}. The average rainfall of Karaikal district is 12600mm. The average temperature of Karaikal is 30 ˚C. Karaikal is famous for Temples. From the branch of cavery river water flows from Karnataka, then it emptying into the Bay of Bengal. The major river in Karaikal is arasalar river. Karaikal is located 9m above from the mean sea level. So the temperature is cold with partial showers during the months of November and December The main branches of Kaveri below Grand Anicut are the Kodamurutti, Arasalar, Virsolanar and the vikramanar. Although Arasalar and its branches spread through karaikal, the water of kodamurutti and virasolanar also meet the irrigation needs the region. Forming part of the fertile Cauvery delta region is completely covered by the distributaries of cauvery.

Karaikal is situated on the east cost of India, near Latitude 11N in the deltaic region of the Cauveri, experiences tropical maritime type of climate with a small range of temperature and moderate rainfall. Karaikal has an annual average rainfall of about 126cm. 68 Percent of which occurs during October and December.

III. MATERIALS AND METHODS

Table 1: Sources of Data

Sl.no	Satellite	Source	Date	Resolution			
				Spatial	Spectral	Radiometric	Temporal (Revisit)
1	Cartosat 1	Bhuvan	15/04/2015	2.5 m	0.5 –0.85 µm	10 bits sensitivity	5 days
2	Landsat 8 (ETM)	USGS	22/07/2015	30 m	0.433 – 1.39 µm	12 bits sensitivity	16 days

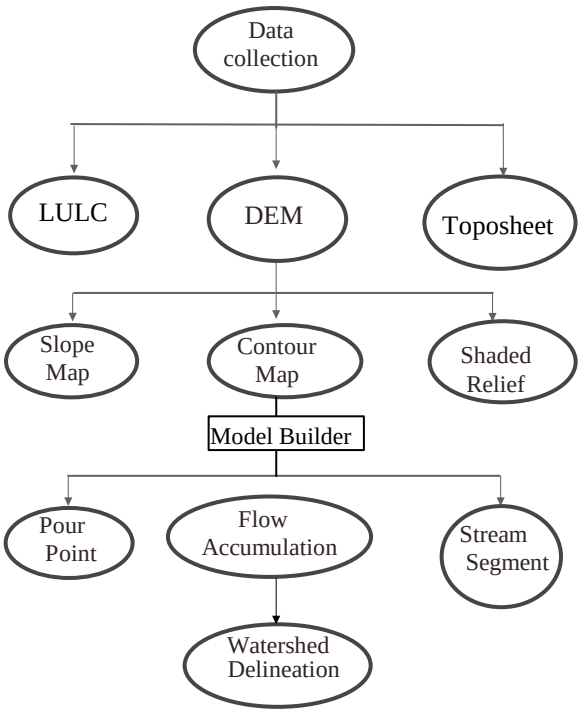
Cartosat 1

Cartosat 1 is the first Indian Remote Sensing Satellite capable of providing in orbit stereo images. The images were used for Cartographic applications meeting the global requirements. The spatial resolution of CARTOSAT 1 is 2.5m (can distinguish a small car)**.** Cartosat 1 provided stereo pairs required for generating Digital Elevation Models, Ortho Image products.

Landsat 8

Landsat 8 is an American Earth Observation satellite. The operator of Landsat was USGS. The spatial resolution of LANDSAT is 30m. This satellite orbits the Earth in a sun synchronous, near polar orbit at an altitude of 705 km and circle the earth every 99 minutes. It has a 16-days repeat cycles. Landsat 8 consists of nine spectral band including a pan band. The scene size is 185 km x 180 km.

IV. METHODS



V. RESULTS AND DISCUSSIONS

4.1 Land use Landcover Classification Analysis

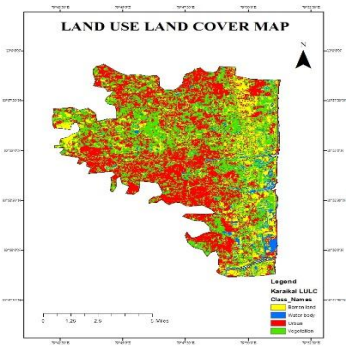


Figure 4.1. Land use Land cover Map

Land use and landcover map is shown in the Fig 4.1 was done by following process, the data are collected from the Landsat 8 and processed in ArcGIS. The visible band (red, blue, green) are composite and obtaining multi spectral image, then unsupervised and integrating them and obtaining the Land use land cover image. The total area of Karaikal was 30 Km^2. According to analysis of Land use Landcover Classification. It was further classified into four groups Barren land, Vegetation, Waterbody and Urban. From the data that have been collected from the Landsat-8 have been analysed. The study area is classified into different category namely Barren land, Vegetation, Waterbody and Urban. Generally refers to the categorization or classification of human activities and natural elements on the landscape within a specific time frame based. Majority of the area have been covered by the urban area.

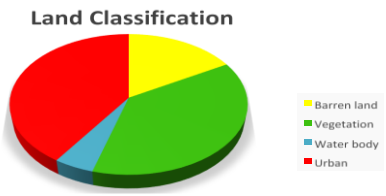


Figure4.2.

Land classification

we can infer that the Maximum area have been covered by the urban and the Minimum area have been covered by the water body from the Fig 4.2. The various Percentage of area that have been covered are explained below.

The highest percentage of area that have been covered is urban area is of 40.51% of total area and Vegetation covers area of about 37.82% of total area and barren land cover area of 16.63% of total area and waterbody covers area of about 4.988% of total area[18].

4.2 Toposheet

Figure 4.3. Toposheet of Karaikal District

Toposheet is shown in the Fig 4.3 of the Karaikal District have been downloaded from the Survey of India. Have been used for the further classification. Toposheet of the karaikal District have been used to identify and the location of roadways, railways, boundary of karaikal District and the location of river flow in the district[18].

4.3 Digital Elevation Model (DEM) Analysis

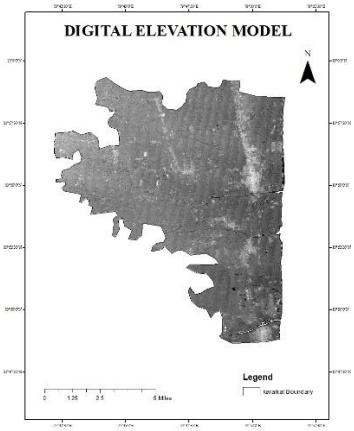


Figure 4.4. Digital Elevation Model

Digital Elevation Model (DEM) is shown in the Fig 4.4 data have been used for further classification of Slope Map, Contour Map and Shaded Relief Map[13], Digital Elevation model of the karaikal District have been downloaded from the Bhuvan by selecting the required tiles from the map and then downloading the image, then it was used in ArcGIS software and they have as in and they have used for further.

4.4 Slope Map

Slope Map of Karaikal has shown in the Fig 4.5 have collected Dem data have been processed in the ArcGIS software. Slope Map have been analysed by using the Dem data that have been collected and we identified that the slope has a degree of 89.999° [11]. Slope Map have been used for evaluating the various ground features of a basin and to prepare different thematic map, the Slope Map analysis is important. In the present study, the Slope Map has been prepared on 1:50,000 scale. The value that have represented in the Fig 4.5 says that the karaikal District has gently slope.

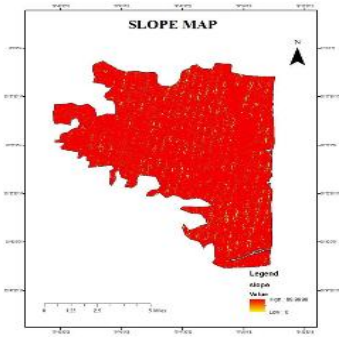


Figure 4.5. Slope Map

4.5 Contour Map

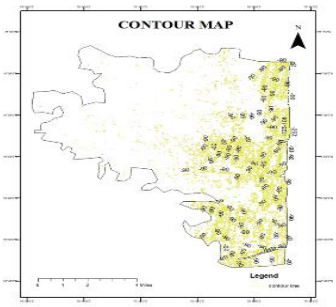


Figure 4.6. Contour Map

Contour lines is a line on a map joining points of equal height above or below sea level. And are used to illustrate topography, or relief, on a map. They show the level of ground above Mean sea level in either feet or meters and can be drawn at any desired intervals. As we infer from contour map from Fig 4.6 that the RL value ranges from -90 to -252. The Maximum area in the Karaikal District have been covered by the RL value -90 and the Minimum area in the Karaikal District have been covered by the RL value of -252[11].

4.6 Shaded relief map

Shaded relief Map of Karaikal shown in the Fig 4.7. Shaded relief maps provides a three dimensional configurations of a terrain on map by the uses of graded shadows. It is usually used in combination of contour. Areas that are flat or have few features are smooth on the map, whereas areas with steep slopes and mountains appear rougher[11].

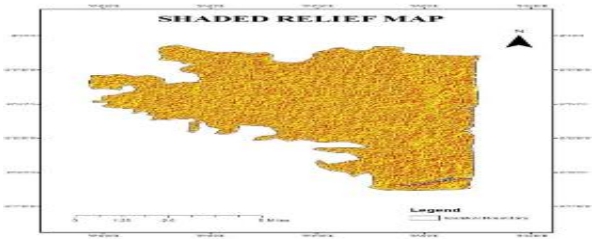


Figure 4.7. Shaded Relief Map

4.7 Model Builder analysis

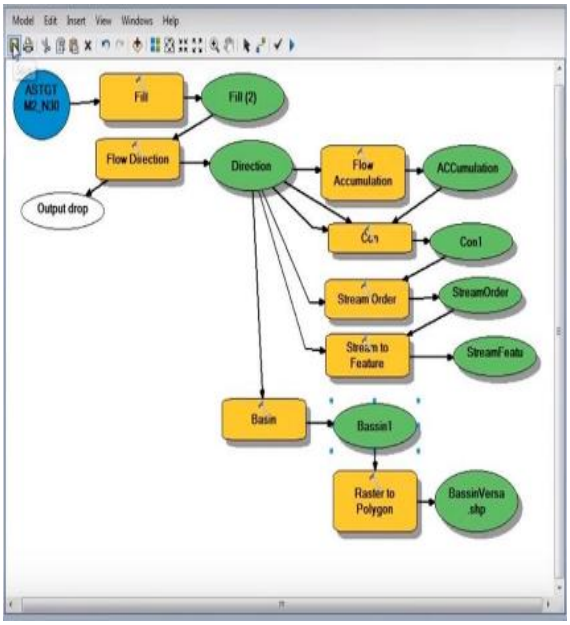


Figure 4.8. Model Builder

Model Builder Shown in the Fig 4.8 is an application you use to create, edit, and manage models. In this by giving input by using various tools in ARCGIS. We can easily get the output that we want such as watershed delineation map. And this is the time consuming. By using this algorithm we can delineation map of any particular area. Model Builder which is used to obtain the final process of Flow Accumulation and Stream segment[12].

4.8 Pour Point Analysis

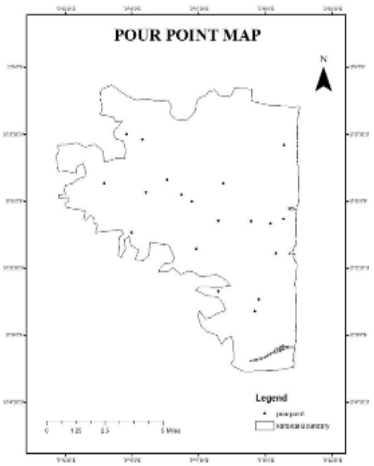


Figure 4.9. Pour Point Map

It is the point on the surface at which the water flows out of an area and it is point at which single stream segment divided into two or more branches. Pour point placement is an major step in the procedure of watershed delineation. A pour point is used to calculate the total contributing water flow to that given point. Pour point that have been Shown in the Fig 4.10 identified in karaikal district by using the contour map.

4.9 Flow Accumulation

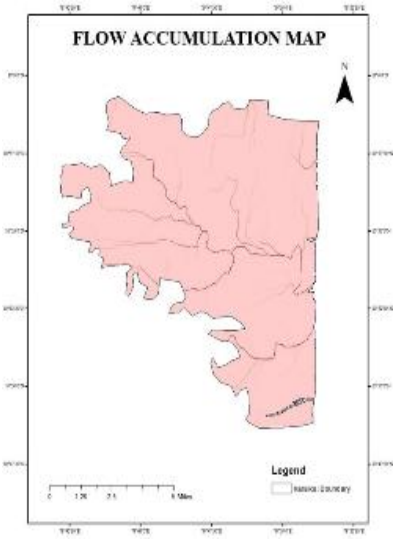


Figure 4.10. Flow accumulation

Flow accumulates tool calculates the accumulated flow from the slope data and use to determine the direction of the flow. Pour point analysis is done for determining the point and it is key for developig flow accumulation. Flow accumulation Map of the Karaikal shown in the Fig 4.10 have been processed from the Contour Map of Karaikal[13].

4.10 Stream Segment Map

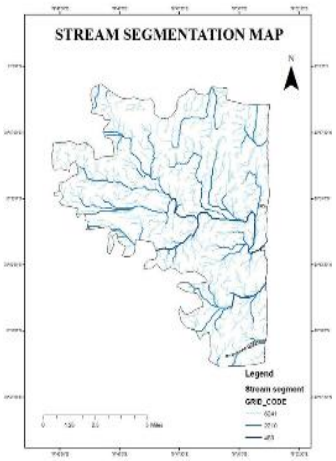


Figure 4.11. Stream Segmentation Map

Stream Segmentation Map of the Karaikal District shown in the Fig 4.11 is a total number of stream segments per stream order. Stream number to be contingent upon the factors such as geology, soil type, slope, vegetation and rainfall. The presence of more number streams in a watershed indicates large runoff conditions. Hence from stream segmentation map of karaikal it has found that the district has higher number of streams.

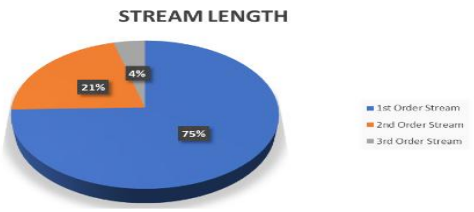


Figure 4.12. Stream Length

As we infer that the 3rd order stream flows the maximum length in the karaikal of 420341.5m of overall 75% of the area. And the 2nd Order Stream flows the Length of 119680.5 of overall 21% of the area. And the 1st Order Stream flows length of 23410.5 of overall 4% of the area which is shown in the Fig 4.12[17].

4.11 Watershed Delineation

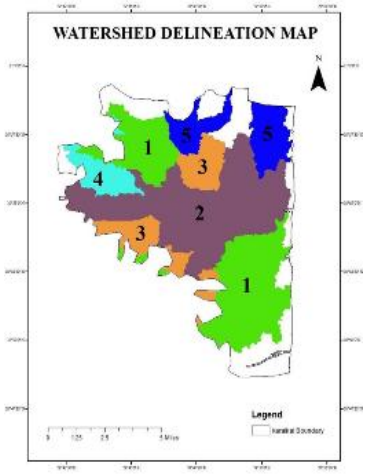


Figure 4.13. Watershed Delineation Map

Watershed delineation map Fig 5.13 is obtained by integration of Flow Accumulation**,** Stream segment and Pour point. After processing done by ArcGIS, the Watershed delineation of karaikal is divided into five segment of catchment areas. A Watershed that describes an area of land that contains a common set of water flowing body that all drains into a single larger body of water a lake or an ocean.

Table 4.14. Classification of segments and Towns

Segments	Town
1	Tr.Pattinam, Nedungadu
2	Thirunallur, Karaikal
3	Neravy
4	Thirunallur
5	Kottucherry, Nedungadu

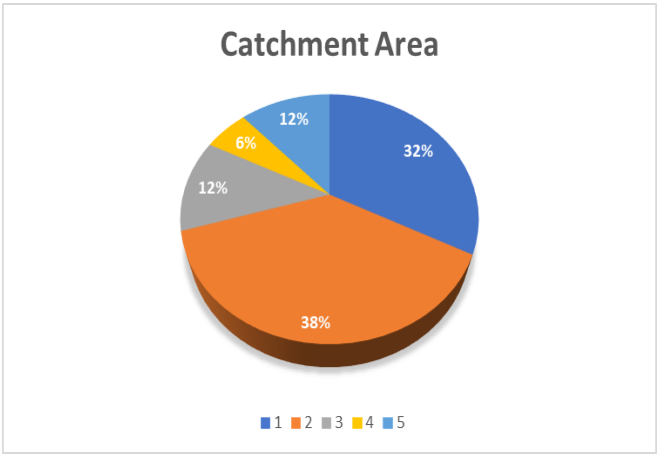


Figure 4.15. Catchment Area

As we infer from the Table 1 and the Fig 4.14, the Tr.Pattinam and Nedungadu have occupied 32% of the catchment area. Thirunallur and Karaikal have occupied 38% of the Catchment area. Neravy have occupied the 12% Catchment area. Some part of Thirunallur occupied 6% of Catchment area. Kottucherry and Nedungadu have occupied 12% of the catchment area in Karaikal District[14].

VI. CONCLUSION

The watershed delineation was created with the help of various maps based on the derived methodology. The initial step in delineating watershed is to found the area of inland water source which is 4.98% of total area of Karaikal district that is obtained from Land use and Land cover map. From the slope map which is created using DEM data, the direction of water flow in Karaikal district can be found. The contour map was created to define the elevations in Karaikal district. The Process of Model builder analysis is created manually to accumulate the flow and stream segment of the district. By using Stream segment map, the length of minor distributary is found to be 420341.1 m, the major distributary is found to be 119680.5 m and the main stream is found to be 23410.5 m.

The watershed delineation map of Karaikal district is created by using the stream segment map and the delineation is divided into 5 segments as follows : Tr.Pattinam and Nedungadu have occupied 32% , Thirunallur and Karaikal have occupied 38% , Neravy have occupied the 12%, Thirunallur occupied 6% , Kottucherry and Nedungadu have occupied 12% of the total catchment area in Karaikal District. By using GIS and Remote Sensing watershed Delineation have been done fast, accurate and economic.

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REFERENCES

1 Basavarajappa, Pushpavathi H T " Applications of Remote Sensing and GIS on Geology and Geomorphological Landform of Kollegal Taluk, Karnataka, South India ".
2 Bingner R L, "Runoff Simulated from Goodwin Creek Watershed using SWAT".
3 Comair G F, McKinney D C, Seigel D " Hydrology of the Jordan River Basin of Watershed Delineation, precipitation and Evapotranspiration"
4 Daffi R E, Ahuchaogu I I, " Delineation of Watershed and Stream network using ILWIS 3.7.1"
5]David G, Tarboton "A new method for the determination of flow directions and upslope areas in grid digital elevation models "
6 Erin E Peterson, David M Theobald Jay M Ver Hoef , "Geostatical Modelling on stream network based on hydrologic distance and stream flow"
7 Qi C, Grunwald S "GIS based Hydrological Modeling in the Sandusky Watershed using SWAT"
8 Jaswindar Singh, Vernon knapp H "Hydrological modelling of the Iroquois river Watershed using SWAT"
9 Kaviya B, Om Kumar, "Watershed Delineation using GIS in Selaiyur Area"

10 Mengistu B Defersha, Assefa M Melesse "Watershed scale application of WEPP and EROSION 3D models for Mara river Basin, Kenya "
11 Nagaraju D, Siddaraju K, Shivaswamy, "Delineation and characterization of Geomorphological features studies of Muguru Addahalla Watershed, Mysore, India."
12 Nahida Hameed Hamza Alqaysi, Mushtaq Abdulameer Alwan, "Delineation of the Watersheds Basin in the konya city and modelling by GIS".
13 Patil C B, Mohite B M, Yadav S A "Watershed Management by SWAT analysis with Q-GIS software".
14 Prabhu P, Baskaran R "Drainage Morphometry of Upper Vaigai river sub basin, Western Ghats using Remote Sensing and GIS".
15 Rasheed, Saleem Abed, "Watershed delineating in GIS environment".
16 Sharma S K, Nema R K , "Assessing Vulnerability to Soil erosion of a Watershed of Narmada basin using Remote sensing and GIS ".
17 Tiwari J, Sharma S K "Land use and Land cover Mapping based on Normalized Difference vegetation index using Remote Sensing and GIS in Banjar river Watershed of Narmada basin".
18 Viswanathan K E, Manikandan M "Watershed Delineation for Varahanadhi Basin using opensource Geospatial Technology.

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