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Digital Elevation Model (DEM) for cauavery river basin in Salem district, Tamilnadu, India using spatial technology

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ABSTRACT

The present study area (Cauvery river basin) lies between 77° 43' 54'' E to 79° 35' 55'' E longititude and Latitude 10° 10' 0'' N to 11° 10' 6'' N. The basin area is demarcated from the survey of Indian topographical map No.58 I/2 (1:50,000,1972) and it covers the area about 3397 sqkms. Morphometric analysis and their relative parameters have been quantitatively carried out for the Cauvery basin, Salem district, Tamilnadu, India. Digital elevation model (DEM) is used to determine the features of drainage networks and slope of drainage network and to determine the characteristics of basins. The foregoing analysis clearly indicates some relations among the various attributes of the morphometric aspects of the basin helps to understand their role in sculpturing the surface of the region.

Introduction

The American hydraulic engineer and hydrologist Robert E. Horton was the first to establish a quantitative methods for analyzing drainage networks (Eze and Abua 2002, and Thorne 2006). Horton (1945) felt that the main stem stream should be of the highest order. He defined a first - order stream as one receiving no tributaries. That is, a headwater stream with no tributaries. A second - order is formed by the junction of two – first – order streams and can receive other first – order tributaries. A third – order stream is formed by the junction of two streams of like order forms a stream of next higher order, which can receive tributaries of any order lower than it own.

A drainage basin, with all its elements and attributes, can be described as an open system with a permanently exchange of matter and energy with the surroundings. The evolution of any drainage basin is the result of interactions among the flows of matter and energy and the resistance of the topographical surface. The amounts of matter and energy act upon the variables defining the characteristics of a river basin. Some of these characteristics can be quantified by morphometric studies (Zăvoianu, 1985).

Morphometric analyses are conducted using information extracted from maps, aerial photography and/or satellite imageries, and information obtained from ground as well. This information about areas, perimeters, lengths, slope gradients, and land cover can be calculated directly or through of the application of formulas and indexes (Tucci, 1997).

Measuring of parameters as drainage density provides useful numerical information about landscape dissection and runoff potential. For instance, in a highly permeable landscape, with small potential for runoff, drainage densities are normally less than 1 km km-2. For highly dissected surfaces, drainage densities of over 500 km km-2 were reported (Zăvoianu, 1985). Detailed investigations of the main processes related to spatial variations of the density showed that a number of factors, as the climate, topography, soil infiltration capacity, vegetation, and geology, collectively influence the drainage density (Zăvoianu, 1985; Pidwirny, 2000).

Study Area

Salem is an interior district of Tamil Nadu in India with an area of 8634.23 Km^2 (Fig.1) and is bounded by Dharmapuri district on the North, Coimbatore on the West, South Arcot on the northeast and Tiruchirapalli on the South and South-West. The district lying between latitudes N 11°00' and 12°00 and longitudes E 77°40' and 78°50'. The major source for groundwater in the study area is rainfall during monsoonal season. The average 10 years annual rainfall is about 759.03 mm.

Salem district is underlain entirely by Archaean Crystalline formations with Recent alluvial and Colluvial deposits of limited areal extents along the courses of major rivers and foothills respectively. Weathered and fractured crystalline rocks and the Recent Colluvial deposits constitute the important aquifer systems in the district. Colluvial deposits represent the porous formations in the district. These deposits comprise boulders, cobbles, gravels, sands and silts and are seen in the foothills of all the major hill ranges. The thickness of these aquifers ranges from a few meters to as much as 25 m. Ground water occurs under phreatic conditions and is developed by means of dug wells. They are important from ground water development point of view in the hilly terrain.

The soils of Salem District can be assorted into the main types viz., Red Calcareous, Red non-calcareous, brown soil calcareous, Red collurial careareous, Red collurial non calcreous, Black soils, Alluvial calcareous, Brown soil non calcareous.

The District has a hot tropical climate with temperature ranging from 18.9° C (Minimum) to 37.9° C (Maximum) and the relative humidity is high at 79% with an average ranging from 80% to 90%.

Yercaud situated 1,515 metres high in the Shevaroy Hills, in salem district, Tamil Nadu, Yercaud is quiet little hill station on the Eastern Ghats is the only one of its kind in northern Tamil

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Nadu. While the rest of this region is generally dry, Yercaud presents a welcome contrast with its cool climate where temperature never rises above 30^0C.

Granite Gneiss, Charnockite, Granites and other associates represent the hard consolidated crystalline rocks. Ground water occurs under phreatic conditions in the weathered mantle and under semi-confined conditions in the fractured zones. These rocks are devoid of primary porosity but are rendered porous and permeable with the development of secondary openings by fracturing and their interconnection. The thickness of weathered zone in the district ranges from <1m to more than 25 m. The depth of the dug wells tapping weathered residuum ranged from 10 to 38 m bgl.

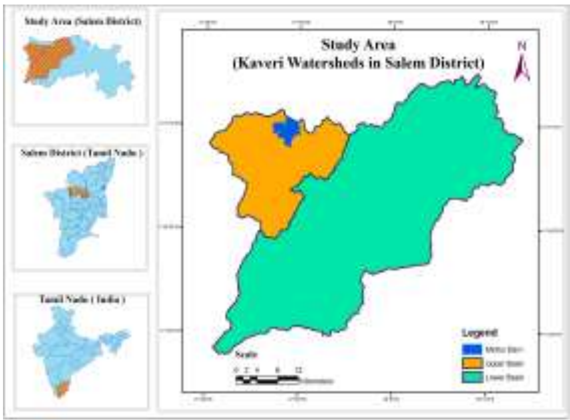

Figure 1. Study area

Methodology:

SRTM-WRS-2 Tiles image having, path 142 and row 53, GLCF acquired in 2000 is geo referenced to UTM map projection (Zone 43, North) and WGS84 ellipsoid, and used for the image analysis (Fig.2). Digital elevation models (DEM) used to identify the features of drainage networks, slope of drainage network and to determine characteristics of basin and sub-basin. DEM model is prepared using ERDAS imagine 9.1.

IV.ANALYSIS

i)Slope

Slope is analysed from the SRTM image is classified based on pixel values. The study area is extracted(cropped image) is itself can be identified the slope with its dark black to white which indicates slope of the study area from low to high(Fig.2)

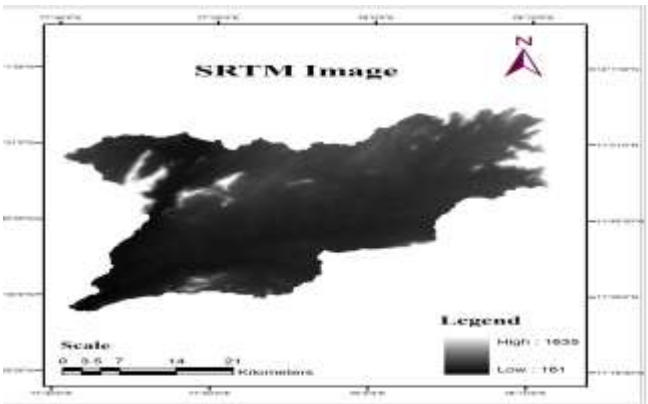

Fig 2. SRTM Image of the study area

The same SRTM image is used for good visual with three classification-high medium and low is given(Fig.3)

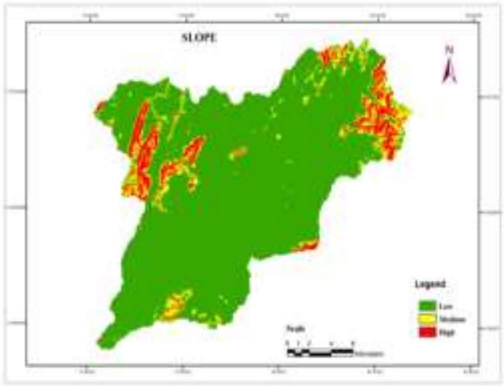

Fig 3. Slope of the study area.

Determination of drainage networks

Drainage networks are made from flow accumulation model. A lower limit value is determined considering the precision and size of the study on this model and according to the highest cell value obtained from flow accumulation model. All cells above this lower limit value are defined as a part of drainage network. When defining these drainage networks, all cells except for cells with zero value represent a part of the drainage network. By considering the water flow directions and flow accumulation model in the drainage network, main stream and side-branches are created. Water flow direction in flow accumulation model is from cell with lower values to those with higher values (Venkatachalam et. al.,2001). Drainage network map of the study area was drawn on this flow accumulation model (Fig. 4). This map shows existent stream paths and possible drainage network paths.

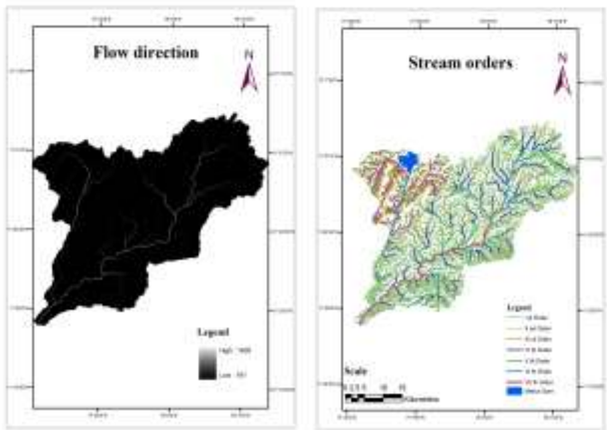

Fig 4. Flow direction and stream order of the study area

Stream orders

If the streams are idealized as single lines containing no lakes, islands, nor junctions of more than two streams at the same point, the resulting diagram is known in the geomorphic literature as a dendritic stream network. The sources are the points farthest upstream in a stream network, and the outlet is the point farthest downstream. The point at which two streams join is called a junction. An exterior link is a segment of stream network between a source and the first junction downstream. An interior link is a segment of stream network between first two successive junctions or between the outlet and the first junction upstream(Fig.5).

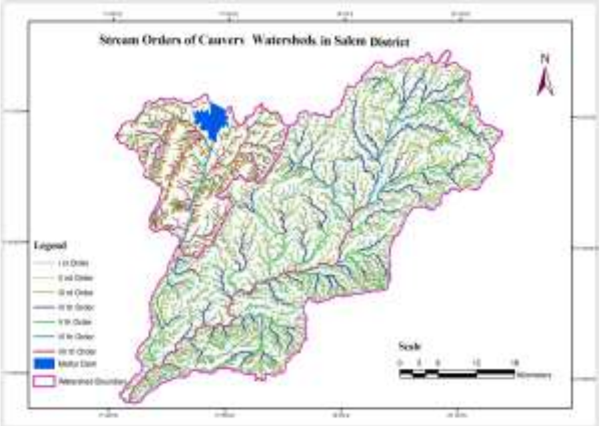

Fig 5. Stream orders of the study area

The following table shows the stream order found in the study are calculated based on the Strahler(1952) method.

Stream Order	Length (m)
I st order	2974354
II nd order	1344644
III rd order	738566
IV th order	374433
V th order	173752
VI th order	76708
VII th order	72646
Total Length	57,55,103

Digital elevation model (DEM) of study area

In this study, 1/50,000(1972,58 I/2)scaled topographic maps containing water accumulation basin were used.

Satellite remote sensing can provide operationally digital elevation models (DEM) through radar interferometer or stereoscopic optical satellite images and is further analyzed through Geographical Information System (GIS) technology to define watersheds, stream-networks and order.

Digital elevation models (DEM) are efficient and effective methods used to determine the features of drainage networks and like size, length, and slope of drainage network and to determine characteristics of basin and sub-basin (Garbrecht and Martz,1999). Moreover, the DEM many significant values like slope, direction, flow length and good visual effects for the common people too.

Elevation information of each contour was defined in geographic information system and according to these values, three-dimensional modelling of the field was gained at 10 mts elevated is given(Fig 5).The study field was much rugged with 3397 sqkms.

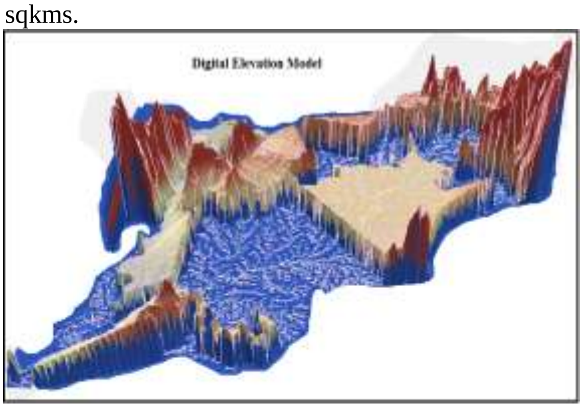

Fig 5. Digital Elevation Model of the study area

Conclusion

The quantitative analysis of morphometric parameters is found to be of immense utility in river basin evaluation, watershed prioritization for soil and water conservation, and natural resources management at micro level.

Flow direction of the study area were determined and accordingly flows were generally in northeast- south west direction according to seventh order and over all flow direction with 1670 sqkms.

The morphometric analysis carried out in the Cauvery river basin shows that the basin is having low relief of the terrain and elongated in shape. Drainage network of the basin exhibits as mainly dendritic type which indicates the homogeneity in texture and lack of structural control. In some parts of the basin, the dipping and jointing of the topography reveals parallel and radial pattern. The linear pattern of the graphical representation indicates the weathering erosional characteristics of the area under study. The morphometric parameters evaluated using GIS helped us to understand various terrain parameters such as nature of the bedrock, infiltration capacity, runoff, etc. Similar studies with high resolution satellite data help in better understanding the landforms and their processes and drainage pattern demarcations for basin area planning and management.

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