

APPLICATION OF GEO-SPATIAL TECHNOLOGY FOR THE ANALYSIS OF LINEAR ASPECTS OF THE SAPTLINGI BASIN

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ABSTRACT

Linear aspect of the basin is related to the channel pattern of the drainage network wherein the topological characteristics of the stream segment in terms of open links of the network system are analyzed. For the present research work, Saptlingi Basin of the Sangmeshwar Taluka of the Ratnagiri district is selected as a study region. The main objective of the present research work is to analyze the linear aspects of the Saptlingi basin by using the ASTER GDEM data and Arc-GIS software. The study reveals that due to physical distinctiveness the study region has distinct type linear aspects.

Key Words: Remote Sensing, Geographical Information System, ASTER-GDEM

INTRODUCTION:

The study of physical aspects of the earth surface is the core of the spatial science (*Singh, Savindra, 1998*), like geography. The study of morphometry of drainage basin is an important aspect of geomorphology. The study of Morphometric analysis of the drainage basin is being conducted by the traditional way. However, in recent decades, the development in the field of geo-spatial technology, has took place that shifted the nature of research methodology of the subject. Linear aspect is one of the important aspects of the drainage morphometry. Linear aspect of the basin is related to the channel pattern of the drainage network wherein the topological characteristics of the stream segment in terms of open links of the network system are analyzed (*Singh, Savindra, 2003*). The drainage network which consists of all of the segments of streams of a particular river, is reduced to the level of graph, where stream junctions act as point and stream, which connect the point, become links or line wherein

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the number of all segments are counted, their hierarchical orders are measured and their different interrelationships are studied.

The nature of flow paths in terms of sinuosity is equally important in the study of linear aspect of the drainage basin. The linear aspect includes the discussion and analysis of stream order, bifurcation ratio, stream length, length ratio, sinuosity index.

THE STUDY REGION:

For the present research, Saptlingi basin of the Sangmeshwar talukais selected as a study region. The Saptlingi basin is located in the central part of the Sangmeshwar Taluka. The Bay basin to the south and Shastri basin to the north bound to the study region.

The Saptlingi River originates near Harpude and it merge with the River Bav near Musalmanvadi. The latitudinal extent of the Saptlingi Basin is 17°4'48.92" north to 17°5'42.11" north and longitudinal extent is 73°27'29.63" east to 73°39'14.42" east. The total length of the river is 22.48 km. and it covers an area about 67.69 sq. km (Fig. 1). Thirty-four villages are situated in the Saptlingi Basin. The Devrukh is an important town located on the bank of Saptlingi River.

The altitude of the study region is ranges between 7meter and 324 meters from Mean Sea Level (MSL). The east-west length of the study region is 18.94 km while north-south width is 5.085 km, in an average. According to 2001 census, the population of the study region is 44631 persons.





Fig. 1

AIMS AND OBJECTIVES:

The present research work is related to the application of Geo-Spatial technology for the analysis of morphometry of the the Saptlingi basin. The main objective of the present research is to study the linear aspects of the Basin Morphometry in the study region.

<u>RESEARCH METHODOLOGY</u>:

METHODS OF DATA COLLECTION:

The present research work is based on both primary as well as secondary data. The primary data is collected through intensive fieldwork in the study region. For that purpose, GARMIN'S Oregon 550 GPS is used. The tracking of the Saptlingi river is done with the help of GARMIN'S Oregon 550 GPS. It is also used for verification of remotely sensed data.

The Remote Sensing data is the main source of secondary data. The Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) remotely sensed data of 1.5 arc-second resolution, is downloaded from the internet through Global Mapper 13.2 GIS software, to meet the objectives of the study.

Methods of Data Analysis:

The shape-file of the Sangmeshwar Taluka is geo-referenced in Arc GIS 9.3 software, which has been used for the downloading of the ASTER-GDEM data from internet. The UTM projection and WGS 1984 datum has used during the geo-referencing.

The Arc-GIS 9.3 software is used for the analysis of data. In the Spatial Analyst Tool, the hydrology tool is used for the processing of ASTER-GDEM data. The following tree diagram depicts the research methodology involved in the research.

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STREAM ORDERING:

Stream ordering refers to the determination of the hierarchical position of a stream within a drainage basin. A river basin consists of its several branches having different position in the basin area, they have their own Morphometric characteristics, and therefore, it becomes necessary to locate the position of a segment in the basin, so that the hierarchical organization of stream segments is visualized.

'Stream order is defined as a measure of the position of a stream in the hierarchy of tributaries' (L. B. Leopold, M. G. Wolman and J.P. Miller, 1969). Gravelius made

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first attempt in 1914 to determine the orders of stream network wherein he attempted to trace the stream from the outlet to the source like an explorer.

Here an attempt is made to analyze the stream order of the Saptlingi Basin by using Strahler's method of Stream ordering. It is observed that in the study region, stream orders are up to fifth level. Fig. 2 depicts the stream ordering in the study region and table III provide information related to stream order and length of the stream.

<u>BIFURCATION RATIO</u>:

Bifurcation ratio (R_b) which is related to the branching pattern of the drainage network, is defined as a ratio of the number of stream of a given order $(N\mu)$ to the number of streams of the next higher order $(N\mu+1)$ and is expressed in terms of the following equation-



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| | Bifurcation Ratio | | | | | |
|---|--------------------------|--------|------------|------------------|--|--|
| | Sr. | Stream | Number | Bifurcation | | |
| | No. | order | of streams | ratio | | |
| 0 | | (μ) | (Nµ) | (R _{b)} | | |
| 1 | 1 | 1 | 293 | 3.90 | | |
| | 2 | 2 | 75 | 6.25 | | |
| 4 | 3 | 3 | 12 | 4 | | |
| | 4 | 4 | 3 | 3 | | |
| | 5 | 5 | 1 | - | | |

Table I The Saptlingi River Basin

Source: Attribute Data

The mean bifurcation ratio of the study region is 4.28. It is observed that the bifurcation ratio of the Saptalingi Basin is 3.90 for the first order. The Bifurcation ratio for the second, third and fourth order is 6.25, 4 and 3 respectively (table 3.1). The Bifurcation ratio of the Saptlingi Basin is controlled by the Physiography, drainage density, stream entrance angles, lithological characteristics, basin shapes and basin area. Initially, the bifurcation ratio from first order to second order is increased and after that, it decreased. It is also observed that the number of streams decreasing with increasing stream order.

LAW OF STREAM NUMBERS:

The law of stream numbers relates to the definite relationship between the orders of the basins and stream numbers. R. E. Horton's law of stream numbers states (1945) 'that the number of stream segments of successively lower orders in a given basin tend of form a geometric series beginning with the single segment of the highest order and increasing according to constant bifurcation ratio'.

In the present research work, the following equation given by R. E. Horton's is used

 $N\mu = R_b^{(k-\mu)}$

Where,

 $N\mu$ = number of stream segment of a given order

 $R_{b=}$ constant bifurcation ratio

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$\mu = basin \ order$

k = highest order of the basin

Table II

The Saptlingi River Basin

Law of Stream Numbers

| | | S. | Hypothetical No. | Actual No. of | Actual | Constant |
|----|------|----------|-------------------|--|---|--|
| | Sr | Stream | of Streams in the | Streams in the | Bifurcation | Bifurcation |
| | No | order | respective Stream | respective | ratio | ratio |
| | 110. | (μ) | order | Stream order | (R ₁) * | (R1) ** |
| | 1 | 2 | (Nµ) ** | (Nµ)* | (1(0) | |
| 52 | 1 | D 1 | 256 | 293 | 3.90 | 4 |
| | 2 | 2 | 64 | 75 | 6.25 | 46 |
| | .3 | 3 | 16 | 12 | 4 | 40 |
| | 45 | 4 | 4 | 3 | 3 | 45 |
| | 5 | 5 | 1 | 1 | - | 4 5 |
| | | ate A ** | · D · | Annual section of the | and an and the state of the second second | The second secon |

Source:

Attribute Data

** Singh, Savindra, 2001, p. 363





Source: Compiled by the researcher

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The analysis based on R. E. Horton's equation shows that the stream numbers of The Saptlingi Basin are more or less in geometric series. The fig. 3.2 depicts the compression between actual stream numbers observed in the study region and hypothetical stream numbers given by R. E. Horton. It is clear from the fig. 3.2 that the law of stream numbers is best fitted to the Saptlingi basin (table 3.2).

LENGTH RATIO AND LAW OF STREAM LENGTH:

The proportion of increase of mean length of stream segments of two successive basin order is defined as length ratio (R_L). In the present research work the following equation given by Singh, Savindrais used to calculate the length ratio (R_L).

| | 5 | | | Table | ш | | 5 | |
|----------------|--------------|---------------------------|---|---|---|---|--------------------------------------|-----------|
| 1 | U | The Saptlingi River Basin | | | | | | |
| Ê | Length Ratio | | | | | 5 | | |
| Navushi | Sr. No. | Stream order (µ) | Total No. of Streams in the respective Stream order (Nµ) | Total Length of the respective Stream order in km (Σ Lμ) | Cumulative length of the stream orders | Mean Length of the respective Stream order in km. | Length Ratio (R _L) | n Journal |
| | 1 | 1 | 293 | 120.11 | 120.11 | 0.40 | 0.67 | |
| | 23 | 2 | 75 | 42.08 | 162.19 | 0.56 | 1.30 | |
| | 3 | 3 | 12 | 26.06 | 188.25 | 2.17 | 1.85 | |
| | 4 | 4 | 3 | 5.46 | 193.71 | 1.82 | 2.21 | |
| | 5 | 5 | a'SV | 14.58 | 208.29 | 14.58 | 1.07 | |

Source: Attribute Data

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Where,

 R_L = Length Ratio.

 $L\mu$ = is the mean length of all stream segments given order.

 $\Sigma L\mu$ = is the sum of length of all stream segments of a given order.

 $N\mu$ = is the number of stream segments of a given order.



Source: Compiled by the researcher

The total stream length of the Saptlingi Basin is 208.29 km. Mean length of all the streams is 0.54 km. Table 3.3 and fig. 3.3 gives an idea about the law of stream length and length ratio. There is positive correlation between mean length of the streams and stream order. It means the mean length of the streams is increasing with increasing stream order. The length ratio of the study region is increasing with increasing stream order, except the stream of fifth order.

SINUOSITY INDEX:

The shape of the open link in term of geometric structure of drainage line involves the calculation of deviation of observed path (O_L) from the expected path- almost a

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straight line (E_L) of a river from the source to the mouth. For the calculation of sinuosity index, the following equation given by S. A. Schumm is used.

$$CS = \frac{O_L}{E_L}$$

Where,

CS = Channel sinuosity

 $O_L = Observed path of stream$

disciplinary Pess EL = Expected straight path of a stream

The sinuosity index of the Saptlingi River is 1.18. It is observed that the River Saptlingi has straight course. It is because of the geological and hydrological control, high degree slope, absolute and relative reliefs, and the short length of the river.

CONCLUSION:

Geo-Spatial Technology is an important tool for the analysis of the fluvial morphometry. It provides accurate and up-to-date spatial as well as non-spatial data, regarding the same.

The stream orders of the study region are up to fifth level. The mean bifurcation ratio of the study region is 4.28. The bifurcation ratio of the first, second, third and fourth order is 3.90, 6.25, 4 and 3 respectively. It is also proved that the law of stream numbers is best fitted to the study region. The length ratio of the study region is increasing with increasing stream order, except the stream of fifth order. The sinuosity index of the Saptlingi River is 1.18, it means the River Saptlingi has straight course.

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