Morphometric Analysis of Sonbhadra Sub-Watershed of Tawa Reservoir Catchment Area of Hoshangabad District, Madhya Pradesh using GIS Techniques

Chhapre Durgesh
Student
MVM College, Bhopal (M.P.)

Dr. V.L. Punvatkar
Department of Geology
Govt. MVM College, Bhopal (M.P.)

Dr. H.U. Usmani
Department of Geology
Govt. MVM College, Bhopal (M.P.)

Abstract
The study area covers 682.34 Km² in suke sub-watershed of Tawa reservoir catchment area of Hoshangabad, Bhopal (M.P.). The drainage network of suke sub-watershed and measurement of Linear, Aereal and Relief aspects of basin by digitized using remote sensing and GIS techniques. The drainage network shows that the terrain exhibits dendritic drainage pattern. Stream order ranges from one to sixth order. The drainage density in the area 1.73 km/km² belong to moderate category. Stream frequency in the area 2.40 and texture ratio 4.15 is range to belong moderate condition. The form factor indicate the sub watershed are less elongated in shape. The high value of circulatory ration the sub watershed is characterize by high to moderate relief and drainage system structurally controlled but the study area Rc is less than .50 indicating they are less elongated in shape.

Keywords: linear parameter, relief parameter, areal parameter, sonbhadra sub-watershed, GIS

I. INTRODUCTION
Development of a drainage system and the flowing pattern of a river over space and time are influenced by several variable such as geology, geomorphology of the area (The drainage basin is the fundamental landscape unit concerned with the correction and distribution of water and sediment, drainage basin. (Ritter, 1995). The transport of detached sediment from the watershed areas of multipurpose dam/reservoir, through the drainage network, gives rise to appreciable loss of soil fertility, rapid sedimentation of the reservoir and decrease in available water for irrigation in command area. Earlier morphometric analysis using remote sensing techniques has been well attempted by Srivastava and Mitra, 1995; Shrivastava, 1997; Nag, 1998; Agrawal, 1998 and all have arrived to the conclusion that remote sensing techniques has emerged as a powerful tool in the recent years. Development of drainage system and the flowing pattern of a river over space and time are influenced by several variable such as geology, geomorphology, structural components, soil and Vegetation of the area through which it flows. Geographical Information System (GIS) techniques have already been used for assessing various terrain and morphometric parameters of the drainage basin and watersheds as they provide a flexible environment and a powerful tool for the manipulation and analysis of the spatial information, particularly for the future identification and extraction of the information for better understanding (Vijith 2006). The fundamental unit of virtually all watershed and fluvial investigations is the drainage basin. An individual drainage basin* (a.k.a. catchment or watershed) is a finite area whose runoff is channeled through a single outlet. In its simplest form, a drainage basin is an area that funnels all runoff to the mouth of a stream. The hierarchical classification up to watershed based on level has been done which is given below-
- Region
- Basin
- Catchment
- Sub Catchment
- Watershed
- Sub-watershed.

A. Study Area:
The area of present study sub watershed is near the Tawa reservoir in Hoshangabad district in Madhya Pradesh and covers an area of 732.95 sq.Km. The area study falls on survey of India toposheet No.55j/2, 55j/3 & 55j/7. The area is well connected by
the road in the state capital Bhopal. Tawa reservoir forms the western boundary of satpuda National park and Bori wild life century.

B. **Morphometric Analysis:**

In the present study, the maps showing drainage details have been prepared from digital data of LISS IV Row 98 path 56C & 56D 23Nov 2011. These satellite images have been geo-referenced and merged using Image Processing software ERDAS IMAGINE and Suke Sub-Watershed associated drainage network were digitized using Arcgis 9.3 software. Morphometric analysis has been carried out of the following parameters:

![Drainage Map Of The Study Area](image)

**Fig. 1: Drainage Map of the Area**

1) Linear Aspect- Stream order (u), Stream Length (Lu), Mean Stream Length (Lsm), Bifurcation Ratio (Rb).
2) Areal Aspect- Drainage density (Dd), Stream frequency (Fs), Drainage Texture (T), Form factor (Rf), Circulatory Ratio (Rc), Elongation Ratio (Re) Length of overland flow (Lof), Constant channel Maintenance (C).
3) Relief Aspect – Basin Relief (H), Relief Ratio (Rh), Ruggedness’ number (HD).

C. **Linear Aspect**

Computation of the linear aspects such as stream order, stream length, Mean stream length, Bifurcation ratio for various stream orders and length ration are described below-

1) **Stream Order (μ)** –
   The smallest permanent streams are called “1st order”. Two 1st order stream joins to form a larger, 2nd order streams; two 2nd order stream join to form third order, and so on. Strahler (1964)

2) **Stream Length (Lu)** -
   The average length of stream of each of the different orders in a drainage basin tends closely to approximate a direct geometric ratio. (Horton 1945)

3) **Mean Stream Length (Lsm)** –
   Mean Stream length is a dimensional property revealing the characteristic size of components of a drainage network and its contributing watershed surfaces (Strahler, 1964).

4) **Bifurcation Ratio (Rb)** –
   The bifurcation ratio is the ratio of the number of the stream segments of given order ‘Nu’ to the number of streams in the next higher order (Nu+1). Horton (1945) considered the bifurcation ratio as index of relief and dissertation.
D. Areal Aspect
The aerial aspects for the entire watershed determined using the method as suggested by Schumm, (1956).

1) Drainage Density (Dd) –
Drainage density has long been recognized as topographic characteristic of fundamental significance.

2) Stream frequency (Fs) –
Drainage frequency may be directly related to the lithological characteristics. The number of stream segments per unit area is termed Stream Frequency or Channel Frequency or Drainage Frequency (Fs) Horton (1945).

3) Drainage Texture (T) –
Drainage texture (Rt) is one of the important concept of geomorphology which means that the relative spacing of drainage lines.

4) Form Factor (Rf) –
According to Horton (1932), Form factor (Rf) may be defined, as the ratio of basin area to square of basin length.

5) Circulatory Ratio (Rc) –
The circularity ratio is a similar measure as elongation ratio, originally defined by Miller (1953), as the ratio of the area of the basin to the area of the circle having same circumference as the basin perimeter.

6) Elongation Ratio (Re) –
According to Schumm (1965, p. 612), 'elongation ratio is defined as the ratio of diameter of a circle of the same area as the basin to the maximum basin length.

7) Length of Overland Flow (Lg) –
The term length of overland is used to describe the length of flow of water over the ground before it becomes concentrated in definite stream channels. Horton (1945) expressed it as equal to half of the reciprocal of Drainage Density (Dd).

8) Constant channel Maintenance (C) –
This parameter indicates the requirement of units of watershed surface to bear one unit of channel length. Schumm (1956) has used the inverse of the drainage density having the dimension of length as a property termed constant of channel maintenance.

E. Geology of the Area-
The geological formation exposed in the study area ranging from Paleoproterozoic to Quaternary. The rock formation are comprises of Mahakoshal group, Vindhyan group, Gondwana group, Deccan trap, Satpura group and alluvium.

F. Geomorphology of the Area-
Geomorphic characteristic is differing for different provinces depending upon the lithological structure. They are mostly formed due to denudational, depositional and tectonic activities. On the basis of interpretation of remotely sensed data, top sheets and field check, it is clean that area comprises of Pedi plain, Pediment and Plains of River basin.
II. RESULT & DISCUSSION

Horton (1945) to realize that certain linear parameter of the basin are proportionately related to the stream order and that these could be expressed as basic relationship of the drainage composition. Various linear aspect that have been determined and the result have been tabulated in (table 1), which includes stream order, stream number, stream length, bifurcation ratio and stream length ratio.

<table>
<thead>
<tr>
<th>Table – 1</th>
<th>Linear Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSD</td>
<td>Stream Order</td>
</tr>
<tr>
<td>SONBHADRA</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>II</td>
</tr>
<tr>
<td></td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>VI</td>
</tr>
</tbody>
</table>

Lu: Stream length of order 'U' (km)
Nu: Total number of stream segment
Lsm: Mean stream length

<table>
<thead>
<tr>
<th>Table -2</th>
<th>Aerial Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>Result</td>
</tr>
<tr>
<td>Drainage density (Dd)</td>
<td>1.73</td>
</tr>
<tr>
<td>Stream frequency (Fs)</td>
<td>2.4</td>
</tr>
<tr>
<td>Texture Ratio(Rt)</td>
<td>4.15</td>
</tr>
<tr>
<td>Form factor (Rf)</td>
<td>1.24</td>
</tr>
<tr>
<td>Circulatory Ratio (Rc)</td>
<td>0.11</td>
</tr>
<tr>
<td>Elongation Ratio (Re)</td>
<td>1.25</td>
</tr>
<tr>
<td>Length of overland flow (LoF)</td>
<td>0.68</td>
</tr>
<tr>
<td>Constant channel Maintenance(C)</td>
<td>0.57</td>
</tr>
</tbody>
</table>
Table -3

<table>
<thead>
<tr>
<th>Relief Parameter</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin Relief (H),</td>
<td>870</td>
</tr>
<tr>
<td>Relief Ratio (Rh),</td>
<td>0.006</td>
</tr>
<tr>
<td>Ruggedness’ number (HD).</td>
<td>0.150</td>
</tr>
</tbody>
</table>

The stream order in Sonbhadra sub watershed has gone up to VI order and the total stream length of stream segment is maximum in the first order stream and it decrease as the stream order increase, sonbhadra sub watershed indicates stream is flowing from higher altitude to lower altitude in a varied lithological and the slope is moderately steep slope. The Lsm indicates the size and surface of drainage basin. (Table - 1) The drainage density in the area 1.73km/km.2 belong to moderate category. Stream frequency in the area 2.40 and texture ratio 4.15 is range to belong moderate condition. The form factor indicate the sub watershed are elongated in shape. The high value of circulatory ratio the sub watershed is characterize by high to moderate relief and drainage system structurally controlled but the study area Rc is less than .50 indicating they are less elongated in shape (Table - 2). The relief ratio increases with decreases drainage area and size of sub watershed. Extremely high values of ruggedness numbers show (Table - 3) the steeper and long slope of the basin.

REFERENCES