CHAPTER 3

GEOMORPHOLOGY
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Drainage basin has recently come to occupy a prime position in geomorphic studies as the various attributes can be successfully measured, quantified and analysed to distinguish regional variations. The main object of the present study has been to find out the stages in geomorphic evaluation of Sonbarsa river basin and its important terrain features, with the help of different morphometric attributes.

Morphometry may be defined as the measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimension of its landforms (Clarke 1966).

3.1 DRAINAGE CHARACTERISTICS: An understanding of both drainage characteristics and fluvial processes is essential to comprehend the development of landscape in an area. This is particularly true in the tropics where the fluvial processes are predominant.

The drainage map of the Sonbarsa river basin was prepared on an overlay, using topographic maps (fig.-3.1). The Sonbarsa and its tributaries, i.e., Karela nala, Patewa nala, and Lomti nala form the network of drainage of the Sonbarsa catchment area. The Sonbarsa is the most significant stream of the catchment area.

The drainage basin of the Sonbarsa river trending E-W, is elongated and arcuate in shape. It is wider in central region and tapering towards both ends and possesses a zigzag periphery.

The Sonbarsa which is a consequent stream originates from boundary of Chilpi series rocks, near village Karela and flows initially towards east over shales, spreading with tributaries in sandstone / sandstone shale intercalations and again follows east and north east directions over limestone.
The average drainage pattern of the basin is dendritic which has developed over the rocks of uniform resistance. The development of such a dendritic pattern in the Sonbarsa river catchment is obviously due to the presence of massive rocks of Rajput group of Chhattisgarh basin. A typical dendritic pattern is observed on limestone and massive sandstones. Parallel pattern is usually found where there is pronounced slope or structural control, which leads to regular spacing of parallel or near parallel streams in the basin.

The higher order streams form sub-parallel type drainage pattern while the lower order forms dendritic to sub dendritic pattern. The valleys are wider, shallow and clearly spaced. The presence of dendritic pattern indicates nearly horizontal strata with uniform lithology, while the parallel pattern reveals uniform regional slope and structural control. In most of the cases the trends of the streamlets are sympathetic with those of the major sets of joints.

3.2 MORPHOMETRY OF THE SONBARSARiver BASIN: Terrain evaluation survey involves multidimensional approaches for assessing the properties of physical environment (Townsend 1981, 10). The physical attributes of terrain are the complementary aspects of economic values. Morphometric analysis is considered as one of the most popular technique in this context (Strahler 1952, Dury 1967), which helped to prepare morphometric taxonomy of landscape.

The landforms are the relief features of the earth's surface and the measures and analysis of landforms is the geomorphometry (Strahler, 1952). Among the sculpturing agents, fluvial processes are the most common. The most important element of fluvial system of its basin landscape is the stream channel system, which develops in relation to hydraulic, geomorphologic and erodibility characteristics of their channels. The stream channel system can be measured and grouped under three broad heads of linear, aerial and relief properties of the drainage basin.

Three morphometric properties of the sample drainage basin (i.e. Sonbarsa river basin) have been measured, grouped and analyzed to establish their interrelationship under the present fluvial system.
The purpose of the present study is to summarize and define the character of drainage basin developed over distinct terrain and lithology.

The linear properties portray the branching system of drainage lines in a drainage basin regardless of their width. The channel system of different magnitude of the drainage basin has been subdivided into hierarchical order after Strahler and Horton's (1945) law of stream number (Fig. 3.2).

The quantitative geomorphic methods provide means of measuring size and form properties of a drainage basin. The standard techniques of morphometric analysis were developed by Horton (1945) and modified by Strahler (1954). The study is primarily based on published and derivative data. For the analysis of drainage characteristics and relief, intensive use has been made of topographical sheets (R/F 1:50,000). The checking method and other conventional methods were adopted to check the critical points.

The various drainage parameters calculated and grouped under (A) Drainage network (B) Basin geometry (C) Measurement of intensity of dissection and (D) Relief aspects are described.

3.2 (A) DRAINAGE NETWORK: This includes stream order, stream number, stream length and bifurcation ratio.

3.2 (A) 1 Stream Order: After a careful analysis and consideration of the methods suggested by earlier workers, Strahler's (1952) ordering system has been adopted. The stream order analysis leads to conclude that Sonbarsa river is Vth order stream.
Table 3.1 (A) GEOMORPHIC PARAMETERS

<table>
<thead>
<tr>
<th>Order No. of Stream</th>
<th>Bifurcation Ratio (Rb)</th>
<th>Mean Stream Rb</th>
<th>Mean Stream Length (km)</th>
<th>Mean Stream Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>318</td>
<td>4.4</td>
<td>276</td>
<td>0.86</td>
</tr>
<tr>
<td>2</td>
<td>72</td>
<td>4.5</td>
<td>4.72</td>
<td>129.95</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>8</td>
<td>66.5</td>
<td>4.15</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
<td>83.65</td>
<td>41.82</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td></td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>409</strong></td>
<td></td>
<td><strong>561.1</strong></td>
<td><strong>1.33</strong></td>
</tr>
</tbody>
</table>

Table 3.1(B) GEOMORPHIC PARAMETERS OF THE BASIN

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Basin Geometry</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Area (sq. km)</td>
<td>411</td>
</tr>
<tr>
<td>2.</td>
<td>Length (km)</td>
<td>45.25</td>
</tr>
<tr>
<td>3.</td>
<td>Average width (km)</td>
<td>16.75</td>
</tr>
<tr>
<td>4.</td>
<td>Perimeter (km)</td>
<td>112.7</td>
</tr>
<tr>
<td></td>
<td><strong>Basin Shape</strong></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Form Factor</td>
<td>0.20</td>
</tr>
<tr>
<td>6.</td>
<td>Circularity Ratio</td>
<td>0.40</td>
</tr>
<tr>
<td>7.</td>
<td>Elongation Ratio</td>
<td>1.50</td>
</tr>
<tr>
<td>8.</td>
<td>Lemniscate's Ratio</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td><strong>Intensity of Dissection</strong></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Drainage Density (km/sq. km)</td>
<td>1.36</td>
</tr>
<tr>
<td>10.</td>
<td>Length of Overland Flow</td>
<td>0.36</td>
</tr>
<tr>
<td>11.</td>
<td>Constant of Channel Maintenance</td>
<td>1.52</td>
</tr>
<tr>
<td>12.</td>
<td>Stream Frequency (Channels / sq. km)</td>
<td>0.99</td>
</tr>
<tr>
<td>13.</td>
<td>Infiltration number</td>
<td>1.34</td>
</tr>
</tbody>
</table>
FIG. 3.2 HORTON ANALYSIS

REGRESSION COEFF. (b) FOR BASIN 0.65
BIFUR. RATIO (Rb) = 4.46

Fig. 3.2.a.

Fig. 3.2.b.

Fig. 3.2 (c) ORDER (STREAM)
Table 3.2 STREAM ORDER DISTRIBUTION OF THE BASIN

<table>
<thead>
<tr>
<th>Order</th>
<th>Area Covered (sq. km.)</th>
<th>% of area (Approx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>226.05</td>
<td>55</td>
</tr>
<tr>
<td>II.</td>
<td>115.08</td>
<td>28</td>
</tr>
<tr>
<td>III.</td>
<td>65.76</td>
<td>16</td>
</tr>
<tr>
<td>IV.</td>
<td>34.93</td>
<td>8.5</td>
</tr>
<tr>
<td>V.</td>
<td>4.38</td>
<td>3.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>411.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The first order stream facilitate run-off to drainage system and the second and third order streams constitute a zone of recharge whereas the fourth order streams play an important role for the storage for the entire drainage system (Maggirware 1990). The trunk stream through which the entire discharge of water and sediments passes is therefore the stream segment of the highest order. The trunk stream of the investigated basin is Vth order.

3.2. (A) 2 Stream Length: The total and mean length of streams of different hierarchical orders are of great importance in the study of drainage network. Total stream length is the result of either the greater number of stream segment or the presence of longer segment.

The total length of all streams of the Sonbarsa river basin is 561.1 km. It is observed that the total stream length decreases with increasing in the stream order. The mean stream length of successive higher order except for the I and II order varies significantly because of fewer number of streams with respect to their longer stream lengths. It is believed that the increase in the average length of IV & V order streams may be due to their development in the plain (Table - 3.1 A) (Fig 3.2b).
According to Horton's law (1945) of stream lengths, the mean length of streams of each of the successive orders of a basin tend to approximately a direct geometric proportion sequence. It is clear from the Table (3.1A) that the length of the streams varies with the stream order in a manner, which suggests a geometrical progression. The same relationship is also confirmed from the linear trend by logarithmic plot of the data (Fig. 3.2c).

3.2 **(A) 3 Stream Number**: There is a progressive decrease in number of streams as the numerical value of stream order increases in the basin (Table 3.2). The number of first order streams is much more in the area, which indicates that the basin is in a developing condition, and this is mainly due to the presence of easily erodible shale and sandstone (intercalated with shale). While the number of streams of higher order is less mainly because these are confined to hard and compact limestone and their existence is structurally controlled.

Horton (1945) stated that there is a close relationship between the number of streams and the length of streams of each order when compared with order value. The trend line plot between stream order and log of number of streams tends to follow closely an inverse geometric series and satisfies the first law of stream number (Fig. 3.2C)

3.2 **(A) 4 Bifurcation Ratio (Rb)**: The bifurcation ratio (Horton, 1932) shows the degree of integration prevailing between streams of various orders in a drainage basin. The bifurcation ratio for the Sonbarsa river basin ranges from 2 to 8 with an average of 4.72 (Table -3.1 A).

Average value of bifurcation ratio was calculated by determining the slope of fitted regression of logarithm of number of streams (ordinate) and order (abscissa) as given by Maxwell (1953). From the figure, the bifurcation ratio is estimated to be 4.46, which means that on an average there are nearly 4.5 times channel streams of any given order as against next higher order. The mean bifurcation ratio (4.72) and the Rb derived through regression coefficient (4.46) is nearly same, indicating almost uniform development of drainage network.
Chow (1964) stated that the drainage pattern of watershed having the bifurcation ratio ranging between 3 to 5 are not much influenced by geological structures. Therefore, on the basis of average bifurcation ratio of 4.72 for the Sonbarsa river system, it is concluded that the present river system is not affected by geological structures, which is also confirmed by horizontal nature of beds.

3.2 (B) BASIN GEOMETRY: It is an important factor which influences recharge and discharge of groundwater. This includes basin area, length, width, and perimeter and basin shape.

Depending upon the order and the length of the streams, the area of the Sonbarsa river basin is calculated as 411 sq. km.

3.2 (B) 1 Basin Length (Maximum elongation): It is measured along the main stream from the catchment outlet to the remotest point on the catchment boundary. The basin length, thus, measured 45.25 km. Whereas, the width of the basin (maximum elongation perpendicular to the boundary of the basin) is 16.75 km. The perimeter of the basin is found to be 112.7 km. The basin is developed parallel to major drainage axis.

3.2 (B) 2 Basin Shape: For determining the shape of the basin, Form Factor (Horton, 1932), Circularity Ratio (Miller, 1952), Elongation Ratio (Schumnn, 1968) and Lemniscate Ratio (Chorley et al 1957) were determined. Form Index indicates the shape of the drainage basin.

3.2 (B) 2.1 Form Factor (F): Form factor expresses the shape of the basin, its profile and channel dimension. Horton (1932) used this term to express the ratio of the basin to its axial length, where axial length is the horizontal distance along the longest basin dimension parallel to main drainage line. It is expressed as:

\[ F = \frac{A}{Lb^2} \]

Where \( A \) = Basin area

\( Lb \) = Basin length
As per Horton, the form factor less than 0.19 shows elongated shape of the basin while the value greater than 0.53 indicates circular shape. For the Sonbarsa river, the value is 0.20 (Table 3.1 B) (very close to 0.19), which conforms to the elongated shape of the basin (Fig. 3.1).

The low form factor value (0.20) also indicates that the basin receives less intensive rainfall over its entire area and thus having fewer tendencies towards floods.

3.2 (B) 2.2 Circularity Ratio (Rc) : Miller (1952) has expressed the drainage basin shape in terms of circularity ratio (RC). This compares the area of the watershed to the area of the circle having the same perimeter.

\[ Rc = \frac{4 \times A}{P^2} \]

Where \( A \) = Area of the basin
\( P \) = Perimeter of the basin

The low values (less than one) i.e. 0.40 (Table 3.1 B) for the Sonbarsa river basin also suggest its elongated shape.

3.2 (B) 2.3 Basin Elongation (Re) : Schum (1963) defined elongation ratio as the ratio of the diameter of a circle with the basin area to the maximum length parallel to the principal drainage line.

\[ Re = \frac{2R}{Lb} \]

Where \( R \) = Radius of circle
\( Lb \) = Basin length.

If the elongation ratio is around 0.57 then the basin is elongated, between 0.6 to 0.66 oval and 0.66 to 1.00 indicates circular shape. The low value 0.50 (Table - 3.1 B) of Re conforms the elongated shape of the Sonbarsa river basin.

3.2 (B) 2.4 Lemniscate's Ratio (K) : Chorley et al. (1957) have used the term lemniscate or pear shape, which defines precisely the shape of the basin; it is more consistent with empirical reality than an ideal circular shape for a basin.
Chorley suggested that if the K value is below 0.6 then the basin has circular in shape, if between 0.6 to 0.9 then oval and when greater than 0.9 elongated in shape. High values obtained for the Sonbarsa basin i.e. 1.24 (Table - 3.1 B), also conforms to the elongated shape of basin.

3.2 (C) MEASUREMENT OF INTENSITY OF DISSECTION: This includes drainage density, length of overland flow, constant of channel maintenance, stream frequency and infiltration number.

3.2 (C) 1 Drainage Density: Drainage density is inversely proportional to the base flow in the area, and is a measure of dissection of watershed. It is independent of order, having a bearing on the permeability of material. It depends upon the climate and physical properties of the watershed.

Drainage density is defined as total stream length per unit area. It has a great geomorphological significance because it is related to the dynamic nature of network of stream segments and area of basin (Savindra Singh, 1976). Drainage density may be viewed as an index, which links hydrological inputs and outputs, as the extent of network response precipitation inputs, yet it also governs run-off output (Gardiner, 1981). Various methods of computation and estimation of drainage density have been advanced. Horton (1945) formulated the following method for computation.

\[
Dd = \frac{EL}{AK}
\]

Where \( EL = \) Total length of all segments of all orders of streams of drainage basin

\( AK = \) Total basin area.

For the Sonbarsa river basin it is 1.36 km. / sq. km.

It may be argued that Horton's method of derivation of drainage density yields only one value for the whole basin and therefore this value does not give an idea of the spatial variation of drainage density in a drainage basin or a physiographic region. Singh (1978 b) developed an alternative grid method to overcome the limitations of Hortonian method of computation of drainage density. Following
Singh's (1978b) method of drainage density, (the total stream length per unit area, here the unit area in squares of one km x one km each,) computed value have been grouped into 3 drainage density (Dd) categories e.g. (i) Extremely low drainage density (DdL, 1-2 km/km²), (iii) Moderate drainage density (DdM, 2km-4km/km²), (iv) High drainage density (DdH, 4km/km² & above). The frequency distribution and spatial coverage of various drainage density categories have been presented in Table 3.3.

**Table - 3.3  SPATIAL DISTRIBUTION OF DRAINAGE DENSITY (DD)**

<table>
<thead>
<tr>
<th>Dd Categories (km/km²)</th>
<th>Area (km²)</th>
<th>% Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 (DdEL)</td>
<td>168</td>
<td>40.82</td>
</tr>
<tr>
<td>Extremely low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2 (DdL)</td>
<td>133</td>
<td>32.31</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-4 (DdM)</td>
<td>79</td>
<td>19.19</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 4 (DdM)</td>
<td>30</td>
<td>7.29</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Drainage density map of the Sonbarsa river basin (Fig. 3.3a and b) portrays spatial pattern of aerial coverage of different categories of drainage density. It is observed that the areas occupied by Chandi limestone, some parts of alluvial plains and broad elongated tracts are characterised by extremely low drainage density. Because of slope factor, moderate drainage density is occupied by shale / shale and sandstone intercalations, however, comparatively high drainage density is also observed at few places in the same lithology. This anomaly is most probably due to topographical variation.

So, the topography and rock types are the main factors, which control the drainage density distribution in the area. While the development of the stream
segments in the basin is more or less affected by rainfall and temperature conditions as well as geologic / tectonic attributes of the terrain.

3.2 (C) 2 Length of Overland Flow: The length of overland flow is also an important factor in measuring the texture. It is used to express the length of flow of water over the ground before it is carried away in main stream channel. It is largely affected by geological structure, lithology, rainfall intensity, infiltration rate, plant cover etc. The length of overland flow value of 0.36 for the Sonbarsa river basin reveals that the stream developing in shale or shaly sandstone region is shorter and the spacing of stream is narrower in comparison to streams on Chandi limestone.

3.2 (C) 3 Constant of Channel Maintenance: Schumm (1956) used the reciprocal of drainage density, which is expressed in sq. km/km. Since it represents the drainage area required to maintain one unit of channel length, hence it is a measure of watershed erodibility. The value 1.52 (Table 3.1B) expressing strong lithologic rocks with a surface of high permeability. It is observed that the low value belongs to shale/shale sandstone intercalations, while the high values are restricted for Chandi limestone. This analysis clearly reveals that the intricate channels that have developed in shaly region need lesser space to flow over than the channels in Chandi limestone.

3.2 (C) 4 Stream Frequency: Stream frequency denotes the number of stream segment per unit area (Horton 1945). It is defined as the ratio between the total number of channels cumulated for all orders within a basin to the basin area. The stream frequency influences both drainage density and configuration. It is an index of drainage texture of the catchment, and decreases with corresponding increase in the stream order.

Frequency distribution for Sonbarsa watershed (Fig. 3.4) shows that almost all parts of watershed area have the stream frequency in between 0 to 6, with an average of 0.99 channels/sq. km. (Table - 3.1 B), however, only 6.56% of the total area has the frequency greater than 6 (Table - 3.4). It also signifies that the area is least affected by vertical erosion.
3.2 (C) Infiltration Number: This is computed by multiplying the values of drainage density and stream frequency. Thus higher the value of (I), greater the permeability of the soil cover. The infiltration number for the Sonbarsa river is 1.3464 (average) which is much higher, suggestive of highly permeable soil cover. (Table-3.1 B)

3.2 (D) RELIEF ASPECTS: This includes basin relief and relief ratio. The total relief of the Sonbarsa basin is 355 m. The relief increases from east to west.

3.2 (D) 1. Basin relief: It is defined as the elevation difference between the highest and the lowest points of the basin (Strahler 1954). The computed value for the Sonbarsa is 80 m exhibiting nearly flat topography.

3.2 (D) 2. Relief Ratio: This is the ratio of the maximum basin relief to the horizontal distance along the longest dimension of the basin parallel to the principal line (Schum 1965). The relief ratio is 1.76 for the Sonbarsa river basin, which reveals that water flows almost over flat terrain.

3.3 GEOMORPHIC UNITS: The art of remote sensing possesses unique potentialities of vividly displaying the size, shape, patterns and spatial distribution of various aquifer systems, their signature of deformation and morphogenetic landforms. (Chaterji et al, 1983; Ramaswamy and Balkliwal 1983, Vats, 1985, Kumar and Singh 1993). The interpreted Geomorphological map is brought out by using FCCL-5 TM, band 432 path-row 143-45 frame-2, Roll-37 obtained on 22nd February, 1987 on 1:50,000 scale (Fig. 3.6). During the detailed hydrogeological investigations, the overlay of Sonbarsa river basin was superimposed over satellite imagery and on
the basis of tone, texture, size, shape, pattern and associated features the following geomorphic units have been delineated.

3.3.1 Pediplain: A portion of study area shows, a vast track of land having low relief and dark tone, which on ground truth studies has been observed to be pediplain. It is composed of sedimentary rocks, which includes mainly limestone and shaly limestone. Drainage is broad and well developed, and attains maturity.

3.3.2 Valley fills: The unconsolidated sediments of shale/shaly limestone, are deposited in northeastern and southwestern part of the basin. Because of its shaly nature, terrain exhibits widely spaced, shallow and stressed valley in western part. The eastern part of the terrain occupied by limestone, displays deep and narrow valleys. In imagery, it appears as linear tone. The valley fills constitute variant fraction of deposits like, pebbles, gravels, sand and silt. The alignment of vegetation, suggests the occurrence of groundwater at shallow depth.

3.3.3 Pediment: This appears to be purple brown in color on the FCC. The area is devoid of vegetation. The thick and massive outcrops of sandstone are spread out uniformly in this region. At places thin detritus of soil is developed over sandstone, otherwise these outcrops are naked. The region forms the significant run off zone for the Sonbarsa River.

3.3.4 Lateritic upland: It appears to be moss green in colour and is observed near the periphery of the basin the isolated patches of these laterites appear to form upland as evidenced by number of first order streams originating from it.

3.3.5 Lineament pattern: The lineament is a linear topographic feature of regional extent. It provides important clues for effective utilization of groundwater resources. In the study area, (Fig. 3.6) it reveals that there are two prominent sets of lineaments, one trending NE-SW & other strikes NW-SE. The lineament pattern exhibits tow fundamental characteristics of the basin: (I) streams along the traces with thick soil, (II) comparatively higher recharge in the wells along the lineament areas (Kareemuddin and Dharmayaj, 1979). The over all look leads to conclude that the development of stream course is appreciably controlled by the lineament system.
3.4 SLOPE ANALYSIS: Slope map of an area provides information regarding the
distribution of various slope elements. The slope elements in turn are controlled by
the climatomorphogenic resistance. Hence, an understanding of slope distribution is
essential, since slope map provides data for planning settlements, mechanization of
agriculture, afforestation, deforestation, planning of engineering structures,
morphoconservation practices, etc. The gradient reflects the control of surface
material and process, while in turn partially determining land use.

An Analysis of the slope, of the study area has been carried out following
Wentworth’s method. Calculation of average slope based on the analysis of contours
represented on Survey of India topographical sheet No. 64 G/3, 4, 7 7 C/15, on
1.50,000 scale. This has been supplemented with field observations. For analysis,
the contour map of the study area with an interval of 20 m has been divided into grids
of 1 km² each and thus the numbers of contours cutting have been counted along
each side of the grid. The average slope of the basin was calculated using
Wentworth’s (1930) formula, modified for metric system and which is expressed as
follows:

\[ \tan \theta = \frac{N \times l}{636.66} \]

Where, \( N \) = Number of contours
crossing a grid
\( l \) = Contour interval
636.66 = Constant

The inverse of tangent value gives the angular value of slope. The slope
values thus obtained for each square grid range from below 10 to slightly over 40.

These values have been classed into 3 slope categories, namely less than 2°,
2° to 4° and above 4° at a regular interval of 2°.
FIG. 3.5 SLOPE CATEGORY MAP OF SONBARS A RIVER BASIN.
FIG. 3.7 LAND USE/LAND COVER MAP OF SONBARSA RIVER BASIN
### Table – 3.5 : FREQUENCY DISTRIBUTION OF SLOPE VALUES

<table>
<thead>
<tr>
<th>Slope Categories (In degree)</th>
<th>Grid Frequency</th>
<th>Grid Frequency %</th>
<th>Cumulative Frequency %</th>
<th>Slope Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 2°</td>
<td>296</td>
<td>72.52</td>
<td>72.52</td>
<td>Level SL</td>
</tr>
<tr>
<td>2°-4°</td>
<td>106</td>
<td>25.97</td>
<td>98.45</td>
<td>Gentle SG</td>
</tr>
<tr>
<td>Above 4°</td>
<td>5</td>
<td>1.22</td>
<td>99.67</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

The critical analysis of slope categories map (Fig. 3.5) and corresponding Table –3.5 , reveals that more than 75% area of the basin possesses very low angle (0-2°), slope indicates flat nature of terrain, suitable for agriculture with very low drainage frequency. Gentle slope category covers about 25% of total area of the basin. This slope category is associated with lateritic upland and exhibits coarse drainage frequency and relatively low relief. Moderate slope is observed near village Deodongar, Karela, Singapur, Bhalucona, which is due to residual hills and lateritic upland areas.

#### 3.5 LAND USE/LAND COVER : The Knowledge of land use/land cover is important for planning and management activities concerned with surface of earth as it is related to human activities like, planning for agriculture, urban or industrial development. Land cover described the materials such as vegetation, rock and building, soil cover etc., that is present on the surface.

On the basis of colour, tone and texture of satellite imagery land use pattern (Fig. 3.7) Identified as buildup land, agriculture land, fallow land/crop land and fallow land with or without scrub, water body etc. It is observed that nearly 48.6% of the area is being utilised as agriculture land 3.2% as builtup land 3.6% water body 14.3% as fallow land and rest is with or without scrub (barren land). Thus, the major part of the study area primarily being utilised for agriculture purposes.