Chapter – IV: Geomorphology
Chapter IV: GEOMORPHOLOGY

The earlier work, on some observation on the Quaternary formations of western Maharashtra, has been carried out by Carvinus G; Rajguru S.Net al. (1993).

In the present investigation, geomorphologic characteristics of Quaternary sediments from Godavari and Manjra River basin are studied to understand pediplain erosion, and gully erosion. A geomorphological map has been prepared to delineate various geomorphic units (Map. No. 8).

The area of present investigation has been studied by using map published by MRSA based on IRS. IB path 26 row 55c2A1 satellite imagery and toposheet (SIO) No. 56 E/4, 8, 56, F/5, 6, 9, 10 and 14 etc. of Nanded district for landform analysis with the objective to delineate various geomorphic units (Map No.8). These various geomorphic units are studied in the field and number of representative samples were collected and brought to the laboratory to study its physical and chemical characters of these units. (Table13).

Based upon the constituents and nature of erosion in the landforms, the study area is divided into following three geomorphic units.

2) Present floodplain (T0)
3) Older floodplain (T1)
4) Pediplain.

Well-developed erosional surfaces occur at 340m above MSL on Deccan Trap of Late Cretaceous to Early Eocene period. These surfaces owe their origin to Tertiary tectonic movements of epirogenic type and climatic changes (Dikshit, 1970)

The general slope of the alluvial plain is towards east. The section across the Godavari valley is drawn (Fig. 5. AA and BB), the section shows that there are three prominent geomorphic units viz. pediplain, terrace T1 and terrace T0. The break in slope profile, alluvial plain, floodplain T1 and pediplain, is prominent between.

Present floodplain:

These are places of deposition of sediments or primary storage of sediments in the river channel. Because of the low gradient and shortage of sediment supply, the Godavari channels are filled with soil and sand. At vary few places, gravels and pebble beds are deposited. Most of the point bar deposits are filled with silt (Sikarghat), Amdura.
The lower point bars are filled with gravel, sand & silt whereas over bank floodplains are filled with dark clay deposits. These gravels are of chert, quartz of different sizes and angular to subangular in nature. The overbank floodplain deposits are developed mainly due to supply of clay from the pediplain through gully erosion which are intersecting older floodplains. The soil of the overbank floodplains are shifted due to severe bank cutting. At some places like Shikarghat, the sand, silt is intercalated with clay beds, which indicates that the region has witnessed several phases of floods in the past.

The present flood plains, along river Manjra, are of cut and fill type and do not exceed 5 to 10m in thickness. The maximum lateral extent is not more than 2 km. There are two types of alluvial fill.

1) Calcinated yellowish brown silt associated with pebbly and sandy gravels.
2) Brownish less calcareous silt associated with sandy gravels.

Alluvium is not exposed always along the present flood plains. There are examples where Conglomerates are exposed along the present flood plains for example the exposure of Conglomerates along the left bank of the Godavari river around Thugaon, Gujari (Photo 9) & Asarjan.

The Conglomerate deposits are overlain by brownish sand and alluvium at the top (Photo 10) near Thugaon along the river bank of Godavari.

Lendi a tributary of Manjra, shows channel bar deposits of gravels, pebbles of unconsolidated, sub angular fragments of chert, quartz of different sizes. The river during floods cut off the Pleistocene deposits. These deposits are exposed at river Lendi near the Degloor. The fossil bones are recovered from these older channel deposits. The gravels, pebbles, which are angular in shape, represent less gradient of the stream which further indicates the less transportation. There is evidence for neotectonic activity in Patalganga tributary of Manjra (Badam, G.L. 1979). The old channel occurs at 8m. above the modern bed level. The stratified unconsolidated deposits of alluvial fill of channel bar deposits are exposed in the river Manjra at Tagyal, Sargoli and Yesgi along the banks of river Manjra. During floods, these older fills are cut off and deposits as present floods in the river Manjra. These gravels are of brownish colour and are overlain by thick deposits of brownish sand and silty clay.
Photo 9: Conglomerates exposed along the present flood Plain of Godavari River near Gujari

Photo 10: Conglomerate deposits (A) overlain by Brownish sand (B) & Alluvium (C) near Thugaon
The river Manjra, from Patoda (Beed district), flows in the SE direction for a distance of about 345 Km. and takes sinus turn for a distance of about 193 Km. and then flows due North. The sudden change in the direction of river Manjra probably has lowered the energy of transport and therefore it has deposited maximum sediments near its confluence before it meets the main stream Godavari.

**Older floodplain (T1)**

The older floodplain of Godavari river basin is gently sloping and has flat geomorphic surface of deposition. The Godavari River is in meandering stage. These older floodplains have surface elevation ranging between 340m to 370m above MSL. The low channel elevation has facilitated the transport of silt and clay rather than coarse sediment in the upper reaches of river Godavari. In the lower reaches of Godavari, where a tributary Manjra confluences with Godavari, huge sediment deposition is facilitated. This deposition is mainly because of the sediments supply from the Precambrian granites through which river Manjra is flowing. The soil of this zone is dark, brown clay type with high moisture retaining capacity. The Ph of the soil from this region is 7.9 with porosity of 36%.

During rainfall the older floodplain are eroded and form gully due to gully erosion. Because of low permeability and high water logging capacity of soil, soil from older floodplain (M Babar and Kaplay, 1999) is used for manufacturing of bricks, which is one of the raw materials for building construction in the region.

**Pediplains:**

The gently sloping part of the basin on either side of the river Godavari and Manjra is covered by a thick soil cover, which represents older flood plain. The soil of this unit is black, calcareous, moderately drained with high moisture retaining capacity.

Slow permeability of sub soils creates problems of salinity and water logging during rainy season due to injudicious management of canals irrigation (Bharambe et. al 1997) in soils of Maharashtra.

Few floods cause lot of erosion of the soil and it is transported to the river channel and deposited as present floodplains. The thickness of soil cover varies from 0.5 to 3 m in the region. Deep black soil in the region is one of the important factors to have good fertility of the soil.
Soil of the either bank of river Manjra is sandy loam and slightly saline in nature. This soil, at some places, rests on Precambrian granites.

The various basins (Map 9) are studied from the morphometric point of view. The details of which are given in the table below.
MAP - 8 Geomorphological map of part of Godavari river basin, Nanded District.
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Section No.</th>
<th>Texture</th>
<th>Coarse Sand</th>
<th>Fine Sand</th>
<th>Silt</th>
<th>Clay</th>
<th>% Pore space</th>
<th>% Water holding capacity</th>
<th>PH</th>
<th>Ca PPM</th>
<th>Mg PPM</th>
<th>Org. C %</th>
<th>P205 Kg/ha</th>
<th>K20Kg/ha</th>
<th>Na PPM</th>
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<td>Available K (Meq/l)</td>
<td>Available K (P.P.M.)</td>
<td>Available K2O (P.P.M.)</td>
<td>Available P (P.P.M.)</td>
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<td>Electrical Conductivity (Millisiemen)</td>
<td>pH</td>
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Table 13: Chemical Characteristics of Geomorphic Units From Godavari River Basin
INDEX

- Present Flood Plain
- Older Flood Plain
- Pediplain
- Vertisol (Black Clayey Soil)
- Grey Brown Silt
- Clay
- Sand
- Calcareous Silt

Fig. 5 Cross sections along the reference line (A-A, B-B etc.) as shown in map 8.
Map 9. Watershed basin of Manjra & Godavari Rivers
### Table 14: Morphometric Analysis of Godavari and Manjra river basin:

#### Penganga sub-basin (PN-1)

<table>
<thead>
<tr>
<th>Stream order.</th>
<th>I&lt;sup&gt;st&lt;/sup&gt;</th>
<th>II&lt;sup&gt;nd&lt;/sup&gt;</th>
<th>III&lt;sup&gt;rd&lt;/sup&gt;</th>
<th>IV&lt;sup&gt;th&lt;/sup&gt;</th>
<th>Total</th>
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P1 to P6 = Watershed Basin of Penganga River.

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<th>III&lt;sup&gt;rd&lt;/sup&gt;</th>
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<th>III&lt;sup&gt;rd&lt;/sup&gt;</th>
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<th>II&lt;sup&gt;nd&lt;/sup&gt;</th>
<th>III&lt;sup&gt;rd&lt;/sup&gt;</th>
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### Penganga sub-basin (PN-6)

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<th>4&lt;sup&gt;th&lt;/sup&gt;</th>
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### Manar Sub-basin 1

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<th>4&lt;sup&gt;th&lt;/sup&gt;</th>
<th>Total</th>
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<td>72.25</td>
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### Table 15: Watershed characteristics of Lendi & Tiru River

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<th>2&lt;sup&gt;nd&lt;/sup&gt;</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt;</th>
<th>4&lt;sup&gt;th&lt;/sup&gt;</th>
<th>Total</th>
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<tr>
<td>No. of Streams</td>
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<td>25</td>
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GV, 110, GV-106, GV 103, GV-104, GV-113, 100, 102, GV, 111, GV112 are watershed basin of Godavari River. The characteristics of all these basins is given in the following table

**Table 16: Watershed characteristics of Godavari River (GV-110)**

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<th>Stream order.</th>
<th>I$^{th}$</th>
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**GV-106**

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**GV-103**

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<td>III&lt;sup&gt;rd&lt;/sup&gt;</td>
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<th>III&lt;sup&gt;rd&lt;/sup&gt;</th>
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<th>II&lt;sup&gt;nd&lt;/sup&gt;</th>
<th>III&lt;sup&gt;rd&lt;/sup&gt;</th>
<th>IV&lt;sup&gt;th&lt;/sup&gt;</th>
<th>Total</th>
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<td>2</td>
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### GV-III

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<th>IV&lt;sup&gt;th&lt;/sup&gt;</th>
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### GV-100-B

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<th>III&lt;sup&gt;rd&lt;/sup&gt;</th>
<th>IV&lt;sup&gt;th&lt;/sup&gt;</th>
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### Table 17: Watershed characteristics of Manjra river basin (MR 63)

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<th>I(^{st})</th>
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<th>III(^{rd})</th>
<th>IV(^{th})</th>
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<td>17.5</td>
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### MORPHOMETRIC ANALYSIS OF SUB BASINS

Morphometric analysis of 17 subbasins is carried out. Within each of these sub-basins measurable properties of different aspects are measured, computed and tabulated. The various aspects thus studied are linear aspect (determination of hierarchical orders of streams, computation of stream numbers, bifurcation ratios, measurement of stream length and length ratios) and area aspects (measurement of basin area, area ratio, basin shape, computation of stream frequency, drainage density and drainage texture.)

**Linear Aspects of the sub basin:** Linear aspects of the basin are related to the channel patterns of the drainage network wherein the topographical, characteristics of the
stream segments are analyzed in terms of open links of the network system. Following are
various linear aspects of the sub basins:

Stream order:

Out of the four available system of ordering the streams, because of its simplicity,
(Gravelius, 1914, Horton, 1945, Strahler, 1957 and Scheidegger, 1970), the system of
Strahler (1957) modified after Horton (1945), is followed. Accordingly, the smallest
unbranched stream segment is designated as the first Order stream the one formed by the
merging of two such first order segments i designated as the second order stream and so on &
so forth.

Stream number:

The number of the stream segments (N) present in each order are counted and tabulated.
The number of streams decrease as the stream order increases. Graphical representation of
these data yields a straight-line plot (Fig.6).

Bifurcation ratio (Rb):

Bifurcation ratio is related to the branching pattern of the drainage network. It is
expressed in terms of the following equation.

\[ \frac{N}{N+1} \]

Where \(N\) = Number of streams of a given order.
\(N+1\) = Number of streams of the next higher order.

The bifurcation ratios of three sub basins are given in Table 17.

In the present study the bifurcation ratios of 17 sub-basins range from 2.00 to 10.00.
Of all these basins the bifurcation ration of 11 sub-basins range from 2.00 to 5.00 (considered
up to 5.50) and for that of 6 sub-basins it is greater than 5.00 (i.e. > 5.50) (Table 17).
Bifurcation ratio of 5.00 indicates that there is apparently minimum structural control in
drainage development. Bifurcation ratio greater than 5 for the streams of 6 sub basin is an
exception to this. Such high bifurcation ration may be due to elongated shape of the sub­
basins or the structural control on the drainage development (Stralher, 1964, Zavoianu.
1985and Babar et. al. 2000).

Stream length and length ratio (RI):

The lengths of the various stream segments are measured with reference to stream
order and the total length as well as the mean stream length of each order is computed. The
mean stream lengths of the streams increase in direct proportion with the order. Fig 7 brings
out this exponential relation clearly. The total and mean lengths and the length ratios are given in table 17.

The relation of number of streams against stream order in each of the three sub basins (Fig.6) shows that the number of streams of a given order in each form, an inverse geometric sequence decreases systematically with increasing order and conforms the Horton’s (1945) law of stream numbers.

The values of mean stream length for the area are in direct geometric progression to stream order (Fig.7) and conforms to the Horton’s (1945) law of stream length.
Fig. 6. Semi-log plot of Stream Order Vs. Number of Streams of Sub-Basins.
Plot of Stream Order vs. Number of Streams
GV-101 (S)

Plot of Stream Order vs. Number of Streams
GV-113 (H)

Plot of Stream Order vs. Number of Streams
GV-111 (H)

Plot of Stream Order vs. Number of Streams
GV-112 (S)

Plot of Stream Order vs. Number of Streams
GV-103 (S)

Plot of Stream Order vs. Number of Streams
GV-104 (S)

Plot of Stream Order vs. Number of Streams
GV-110 (S)

Plot of Stream Order vs. Number of Streams
GV-106 (S)
Table 18: Bifurcation ratio & Length ratio of the sub-basins

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Fig. 7: Semi-log plot of Stream Order Vs. Mean Stream Length of Sub-Basins.
STUDY OF STRUCTURAL CONTROL OF THE RIVER CHANNELS

From the LANDSAT imageries and the lineament map of the region (Map 10) it is observed that the Godavari, Manjra Rivers follow the lineaments. The length of lineaments and directions are recorded in Table No 41.

The river Tiru follows a length of 42 Kms. Lineament during it’s course. It meets main stream Manjra, whereas river Manar, another tributary of Manjra, also follow a lineament of about 32 Kms in length.

The river Terna a tributary of Manjra also follows a lineament. There is intersection of two lineaments at the confluence of Manjra and Terna River (Map. 10).

The sudden change in the direction of river Manjra, after flowing to a distance of 354 Kms. in southeast direction, is an indication of its structural control. The river has turned N 40° W, which extends to a distance of around 602 Kms. up to the confluence of river Manjra with Godavari (Map. 10).

The study of the lineament, when superimposed on the geomorphology, suggests that the Penganga basin follows the lineament. Similarly, some of the basin from Godavari basin also follows lineaments (Map 11). This fact is well supported by the bifurcation ratio (which is more than 5)

Among the other structures studied vertical joints in the granitic exposure forms the prominent feature (Photo 11 ), which is exposed along the Lendi river near Degloor.

Photo 11: Vertical joints in granites near Degloor
Map. No. 11 Lineament superimposed on Geomorphology of the basins.

**Index**

- Lineament
- Road
- Village
- Quaternary
- Basalt
- Granite
- Dist. Boundary
Figure: Rose diagram of Lineament from Godavari basin.