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Response of alluvial river to active faulting example form Peninsular India

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***Abstract*-Alluvial rivers are highly sensitive to vertical adjustments along the faults that located across the river channels. The present study identified a pattern change of an alluvial river from the East coast of India, an oldest continental boundary in the Indian landmass. The study identified the structures responsible for the pattern change and the style of movement that caused the forced meandering. These structures are oriented along the NW-SE direction which is considered as favourable for movement in the present tectonic regime.**

I. Introduction

The east coast is the oldest continental boundary in Indian landmass (120 Ma since separation form Gondwana). The rocks in this region are highly weathered with laterite cover. The NW-SE trending Gundalakama fault is the prominent seismogenic structure that generated significant seismicity. During the routine geological investigation the authors came across the anomalous meandering path of Manneru river which is flowing along a gentle slope and having sharp turn. This lead us to a curiosity to understand the nature and reason for the pattern and whether it have any relation with active tectonism.

Geomorphic evaluation is a possible method for the analysis of alluvial river dynamics for identification of active faults [1]. The present study carried out under the presumption that even the smallest changes in topography affect the sinuosity of low gradient rivers [2]. In the present study also the attempt has been made to find the style of ongoing tectonic activity in the study area, along the east coast of India, by analysing the fluvial morphology of NE-SW trending Manneru River.

II. Study Area

The area comprises metamorphic rock of Archean age overlined by Gondwana sedimentary rock, laterite and alluvium. The marine, fluvio marine and fluvial deposits are of quaternary age (Pleistocene – Holocene) with small outcrops of laterite of Pleistocene age observed in the coastal tract [3]. This area is broadly falling under Seismic zone III of seismic zonation map of India, Moderate damage corresponding to intensity VII of MM scale [4], and has also experienced couple of micro earthquakes in the recent past.

Upputeru is the tributary of the major river Manneru which is debouching into bay of Bengal. In general both the rivers flows along SW to NE and at Sanampudi it takes a right angled turn towards south east along a straight course and finally debouches into the Bay of Bengal. Although Upputeru and Mannar rivers show meandering as it is flowing through very gentle slope, the straight segments between meanders are the anomalies in this terrain.

III. Methodology

In the present study ASTER DEM is utilized for extracting the tributaries/ drainages. The same has been validated by extracting the drainage pattern from 1:50000 scale toposheets. Delineation of the lineament is carried out by using the Landsat 7 and Liss IV data. The major course of the river is segmented for different reaches based on change in style of course and sharp turn. River sinuosity index (SI) is calculated carried out as per the formula given in Table 1. Further the lineaments are identified as faults based on the field observations.

Table 1: Formula used for calculating the River Sinuosity

Indices	Formula	Remarks
River Sinuosity (SI)	SI =Curved Length of Drainage Segment/ Straight Length of Drainage Segment	[5]

IV. Analaysis

A. Lineaments and drainage

There are three prominent lineaments identified in the area. The NE-SW lineament ‘L1’ follows the course of the Upputheru and Manneru rivers (Fig. 1). There are two NW-SE trending lineaments, namely L2 and L3, influencing the course of NE trending rivers of the area. Two drainages, both named Upputeru, are joining at Pedapavani. After the confluence the Upputeru river further flow towards NE to join Manneru river near Manchavaram, where the lineament L2 is also crossing the river (Fig. 1). A small river named Elikeru which is flowing in the eastern side of the river is also

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influenced by the L2 lineament and takes a right angled turn towards right to debouch into Bay of Bengal. It should be noted that some studies in peninsular India identified NW-SE trends as one of the favourable orientation for faults for reactivation in the present tectonic regime [6].

Both Upputeru and Manneru rivers are flowing through gentle slope and show strong meandering. However, after their confluence, the river goes through relatively straight path before forming another meander. The river takes a sharp turn towards SE along L3 lineament and follows a straight course to enter into Bay of Bengal.

B. River Sinuosity (SI)

As mentioned earlier the river has been divided into 10 segments to compare the sinuosity. The main trunk of the Manneru river is divided into six segments (Fig.1) where the main Upputeru river is divided into three for the calculation. The data shows that the manner river show highly anomalous (SI=1.61) in the third segment(Table 2). The subsequent segment (segment 4), however show a low anomaly (SI =1.25). The high value repeated in the downstream (segment 5; SI = 1.61) before it takes a sharp turn. The sinuosity value is the lowest one (1.08) in this segment (segment 6) which is debauching into Bay of Bengal. Similarly, Upputheru river show relatively low meandering values except for the segment (segment 9) joining Manneru river (SI =1.37).

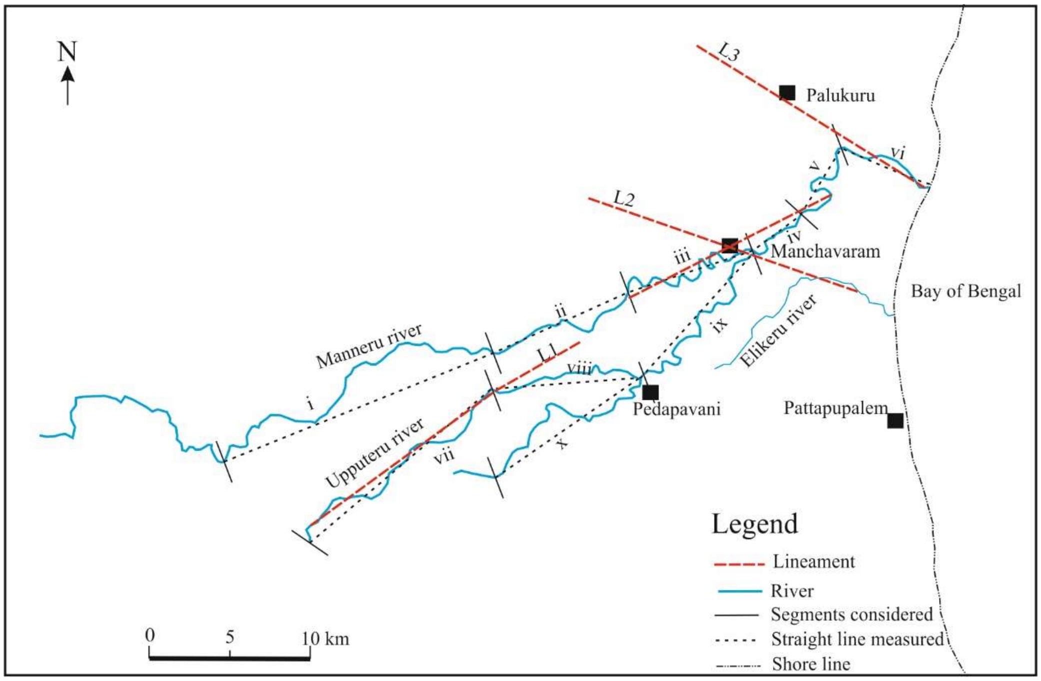

Figure 1: Anomalous pattern of Manneru and Upputeru Rivers

Table 2: River sinuosity calculated

Segment no	SI value
i	1.252
ii	1.163
iii	1.615
iv	1.250
v	1.610
vi	1.087
vii	1.202
viii	1.190
ix	1.370
x	1.330

C. Field Observations

During the search for the reasons of river pattern anomaly, faults exhibiting brittle deformations are observed along both the NW-SE trending lineaments. Along L2 the fault is traced across a second order drainage parallel to Manneru river (Fig 2). Brittle faulting is also observed at several locations along the lineament L3 (Fig.3). The faults show reverse movement and are oriented along the lineaments. Significantly both these structures are dipping towards Northeast.

Figure 2: Fault observed along L2

V. CONCLUSION

Over the years change in river pattern is often identified as adjustment along faults. The present study evaluated the sinuosity pattern and identified the causative structures as NW-SE trending faults. The reverse movement of the faults that run across the direction of the river apparently obstructs the downstream flow and forced the river to form meander in the upstream side. This also lead a straight course in the downstream side. For the lineament 2 the river appears to be failed to cut across the lineament and flows along it along a straight course. The present study could be a template for understanding influence of active faults on alluvial rivers in similar conditions.

Figure 3: Fault observed along L3

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