



## Morphotectonic analysis of Sonai River Basin, Assam, NE India

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### ABSTRACT

The Sonai River Basin comprises a major part of the Barak river basin in the Barak Valley and is located south of Barak River, North East India. The study area has been investigated for geomorphic signatures of active tectonics using Geographical information system (GIS). Most commonly used geomorphic indices for morphotectonic analysis, viz. basin elongation ratio (Re), transverse topographic symmetry (T), asymmetric factor (AF), valley floor width to valley height ratio (Vf), mountain front sinuosity (Smf) have been used. The values of (Re), (T), and (AF) indicate that Sonai river is a tectonically active basin. The values of (Vf) and (Smf) suggest lesser activity but still reflecting the evidences of tectonically active structures in the area.

**KEYWORDS:** Morphotectonic analysis, Sonai River Basin, Geomorphic indices

### INTRODUCTION

The subject of tectonic geomorphology deals with (i) the impact of tectonic base level fall on the processes and morphologies of fluvial systems and (ii) assessment of the relative degrees of tectonic activity of mountain fronts, or other structural elements, during the Quaternary Period (Bull and McFadden, 1977). Analysis of active structures can be done by using morphotectonic indices, which are sensitive to rock resistance, climatic changes and tectonic processes resulting into landscape evolution. Remote sensing plays a significant role in providing spatial information needed for computation of these indices. Many workers have carried out morphotectonic analysis using remote sensing and GIS techniques.

Most commonly used indices for morphotectonic analysis, viz. basin elongation ratio (Re), transverse topographic symmetry (T), asymmetric factor (AF), valley floor width to valley height ratio (Vf), mountain front sinuosity (S<sub>mf</sub>) have been used to identify the evidences of active structures in the area. (Sarma et.al 2011).

### STUDY AREA

The Sonai River is a major southbank tributary of the Barak River. The Sonai River basin undertaken for study comprises a major part of the Barak Valley, a part of North Cachar Hills of Assam and a part of the states of Mizoram. The area undertaken for morphotectonic analysis of drainage basin is bounded within the north latitudes from 23° 25' 33" to 24° 44' 18" and east longitude 92° 41' 11" to 92° 56' 59" (Fig-1) and covers an area of about 2875 km<sup>2</sup>.

The Survey of India (Sol) topographic maps covering the area are 83 D: 10-16, 83 H: 2- 4 and 84 A: 9-15

### DATA BASE AND METHODOLOGY

- The drainage lines are reproduced from Sol topographic maps of 1:50,000 scale.
- All these reproduced drainage maps are transformed to digital image, which are geometrically rectified to facilitate their comparison and georeferenced to Geographical map projection, and Datum Modified Everest using Arc-GIS software 9.2.
- All the reproduced maps are mosaiced to create a complete map.
- Drainage lines for the area specific to each toposheet are digitized for Sonai River basin.

### REGIONAL GEOLOGIC SETTING

The Tripura, Cachar (south) and Mizoram region is situated in the north-eastern part of India between latitudes 22° N and 25° N longitudes 91° 10' E and 93° 30' E approximately. Except for a part of its northern border which is flanked by Assam and Manipur states of India, this region is surrounded by the territories of Bangladesh and Myanmar. The geomorphology of the region is typified by a succession of hill ranges and valleys of meridional and submeridional trends. The general elevation of the region increases to the east towards the Chin hills of Myanmar. The hill ranges mainly comprise compact and resistant older rock units exposed in the anticlinal crests,

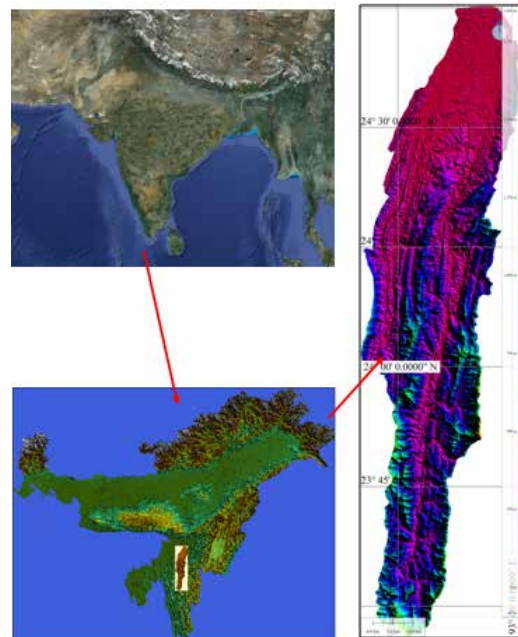


Fig 1: Location map of the study area

Morphotectonic Parameters	Formulae	References	Values, Inferences	Range in Study Area
Basin Elongation Ratio (Re)	$Re = (2\sqrt{A}/\sqrt{\pi})/L$ , A=Basin area, L=Basin Length	Bull & Mc Fadden (1977)	Re<0.50, Tectonically Active Re=0.50-0.75, Slightly Active Re>0.75, Inactive settings	0.415
Drainage Basin Asymmetry: Topographic Symmetry Factor (T)	$T = Da/Dd$ , Where Da=Distance from midline of drainage basin to midline of active channel and Dd = Distance from basin midline to basin divide.	Cox (1994)	T=0, Symmetric Basin T>0, Asymmetric Basin	0.05-0.7
Asymmetry Factor (AF)	$AF = 100(Ar/At)$ , where Ar = Right hand side area of drainage looking downstream and At = Total area of drainage Basin		AF=50, Stable Setting Environment AF>50, Suggest Tilt	265

Valley Floor to Valley Width Ratio (Vf)	$Vf = 2Vfw / (Eld - Esc) + (Erd - Esc) / l$ , where Vfw = Width of valley floor, Eld & Erd = Elevation of the left & right valley divides respectively and Esc = Elevation of valley floor	Bull & Mc Fadden (1977)	Low Values, Deep Valleys, Active Incision High Values, Broad Valleys	0.224-11.63
Mountain front sinuosity ( $S_{mf}$ )	$S_{mf} = L_{mf} / L_s$ where, $S_{mf}$ = mountain-front sinuosity, $L_{mf}$ = is the length of the mountain front and $L_s$ = chord length or straight line length.	Bull and McFadden (1977) Edward A.Keller and Nicholas Pinter,Active Tectonics,(1996)	$S_{mf} = 1.0 - 1.6$ , Most active mountain fronts those associated with active range bounding faults. $S_{mf} = 1.4 - 3.0$ ,Mountain fronts with lesser activity but still reflecting active tectonics $S_{mf} = 1.8$ to $>5$ , Inactive mountains	1.11- 3.23

Table1.1:Computed morphotectonic parameters with their values for the Sonai river basin

whereas the valleys are composed of younger and softer formations exposed in the synclinal troughs. The main drainage pattern of the area is of the "trellis" type.

**Valley Floor Width to Valley Height Ratio (Vf):**

The index (Vf) was proposed to identify the areas of tectonic quiescence and areas that have been recently uplifted (Rhea, 1993). This index quantifies the observation that V-shaped valleys are formed in more tectonically active areas, whereas U-shaped valleys are formed in less active settings. More tectonically active mountain fronts will have V-shaped

valleys and very low ratios because they will have steeply incised gorges with high relief and narrow valleys (Bull and McFadden, 1977).

A total of 10 channel cross-profiles were drawn for the Sonai river to calculate the Vf. (Figs. 3 and 4). The values of Vf for the Sonai River varies from 0.224 to 18.13 (Table 1.3 ). The Vf values between 0.224 to 1.75 indicates V shaped valley due to upliftment of the area (sections J-J' to F-F). But Vf values from 2.97 to 18.13 which infer slow rate of upliftment and formation of broad valley (sections E-E' to A-A'). So, in case of Sonai river values of Vf suggest that both rapid upliftment of area and high rate of incision and which also lead to development of broad valley.

**Mountain-front sinuosity**

Mountain front sinuosity is the ratio of the distance along the mountain front at the mountain front piedmont intersection over the straight line distance of the same mountain front (Bull and McFadden, 1977). Mountain front sinuosity is a balance between the tendency of uplift to maintain a fairly straight front that coincides with a tectonic structure and the work of streams that tend to erode irregularities into the front. (Bull and McFadden, 1977).

**Table 1.4. : Mountain front sinuosity index of Sonai basin**

SEGMENT	$L_{mf}$ (km)	$L_s$ (km)	$S_{mf}$ (km)	REMARK
1	80.67	30.71	2.62	Lesser activity but still reflecting active tectonics
2	16.969	15.239	1.11	
3	37.426	22.238	1.68	
4	66.046	20.397	3.23	
5	80.736	27.495	2.94	
6	46.59	22.533	2.07	
7	131.335	41.054	3.19	
8	94.471	43.954	2.15	
9	130.875	48.278	2.17	
Average	76.124	30.124	2.52	

Mountain front sinuosity of the Sonai river is measured in nine segments (Fig 5) and the results are given in Table 1.4. Mountain front sinuosity of the Sonai river lies between 1.11 to 3.23 which suggests lesser activity but still reflecting active tectonics.

**CONCLUSIONS**

Geomorphic indices computed using GIS are considered to be suitable for evaluating the effects of active tectonics over a large area. Seven geomorphic indices, viz. basin elongation ratio (Re), transverse topographic symmetry (T), asymmetric factor (AF), valley floor width to valley height ratio (Vf), mountain front sinuosity ( $S_{mf}$ ) have been used. The values of (Re), (T), and (AF) indicate that Sonai river is a tectonically active basin. The values of (Vf) and ( $S_{mf}$ ) suggest lesser activity but still reflecting the evidences of tectonically active structures in the area. This study further indicates that a systematic morphometric and morphotectonic approach may be used as a tool for outlining the regions of present day ground instability of the region.

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