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MORPHOTECTONIC ANALYSIS OF THE CHEL RIVER BASIN, NORTHERN WEST BENGAL, INDIA

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Abstract: Morphotectonic investigation by the use of geomorphic indices serves as a tool of identification in regions with active tectonic warp. Landforms in active deformation area are produced from relations of tectonic and surficial processes. One of the most significant landforms in ground is rivers that are extremely responsive to tectonic movements mainly uplift and tilting. Accordingly based on investigation of the rivers and interrelated drainage networks by the use of geomorphic indices we will be capable to achieve valuable information about tectonic record of the study area. In this study, find out of tectonic activities by utilize of geomorphic indices is surveyed in Chel River basin. In order to determine tectonic movement of Chel river basin area five different morphometric indices including Mountain Front Sinuosity (Smf), Valley Floor Width To Height Ratio (Vf), Stream Length Gradient Index (Sl), Hypsometric Curve And Integral (HI), Drainage Basin Asymmetry are applied to study area. According to generated results SL values changes between Smf value is According to generated outcome; the most active mountain fronts faults of the study area. Vf values range between in the area. Deep and narrow valleys show low Vf values <1.0, these valleys can be classified as "V" shaped valleys and Vf values between 1 and 1,5 are indicate moderately active regions and Vf values greater than 1,0 can be classified as "U" shaped valleys. According to generated outcome, in the study area the HI value is 0.669. High values of the hypsometric integral specify deep incision and rugged relief. Intermediate low values of the integral are related with more evenly dissected drainage basins. Asymmetry factor extensively greater than 50 suggesting tectonic tilt.

Keywords - *Lanforms, the Chel river,Geomorphic indices, Morphotectonic warp.*

I. Introduction

Morphotectonic is the study of landforms created by tectonic processes. The quantitative dimensions of landforms are consummate on the base of result of geomorphic indices by the use of topography maps, satellite images and field works. In order to evaluate comparative degree of tectonic activity in the study area the results of several indices are generally combined. Investigation of landforms is known as an important tool in tectonic investigations interrelated to several thousands to two million years ago. In young orogens, rapid sedimentation can cover young structures, in these cases geomorphic indices are most valuable for the type of processes that compose of landforms mainly investigation of drainage pattern and rivers can help out to the recognition of the position of active structures [1]. One of the most significant landforms on the ground is rivers that are extremely responsive to tectonic movements. Morphometric data joint with seismic and geomorphic data appear to be an important tool in formative relation levels of tectonic activity and in given that data for seismic hazard assessment. The study of active tectonic effects in the Chel River basin is able to reveal a lot of tectonic ambiguities and identify surficial warp pattern and active structures in the study area. The to seek of this study is to differentiate the geomorphic signals of different segments of the Chel River sprouting under diverse ranges of uplift and tilting rates. The relevance of the mainly widely – known geomorphic indices in the Chel River basin enabled us to correlate active tectonics with erosional processes in the broad area. Presents study the domino effect of investigations on the Chel River basin by the use of geomorphic indices.

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

II. Materials and methods

Geomorphic assessment of active tectonics by the use of geomorphic indices depends on the rock resistance, climatic variations and tectonic processes. The geomorphic indices associated with drainage networks are the stream gradient index [8], the valley floor width to valley height ratio [6][7]. The mountain front sinuosity [2]. The morphometric parameters were computed using equation of different researchers as presented in Table 1.

A. Table-1: Equation adopted for computation of morphometric parameters.

Sl no.	Morphometric parameters	Equation	Reference
1	Mountain front sinuosity	Smf = Lmf/Ls	Bull and McFadden, 1977
2	The ratio of the width of valley floor to valley height	Vf = 2Vf/[(Eld – Esc) + (Erd – Esc)]	Bull, 1977a,1978
3	The stream length gradient index	SL = (ΔH/ΔL) L	Hack, 1973
4	Hypsometric Curve and Integral	HI = $(E_{mean} - E_{min})/(E_{max} - E_{min})$	Strahler, 1952
5	The asymmetry factor	AF = 100 (Ar / At)	Burbank and Anderson 2001

III. Location of Study Area

The Chel river basin is a sub - basin of the mighty Tista which is situated in Derjiling & Jalpaiguri districts of West Bengal. Total area of the river system is about 804 km².Which is extended from 26°35′N to 27°08′N latitudes confining between 88°37′E to 88°50′E longitudes. The main headstream of the Chel, the daling chhu, rises on the southern slope of the daling hill, little east of Lava in Darjiling district. While the river the Chel merges into the Tista near Basusuba village at Mal police station of Jalpaiguri district.

IV. Results and disscusion

***4.1 Mountain front Sinuosity*:**

Mountain front are major fault bounded topographic escarpments with measurable relief of exceeding are contour interval of 40m. Mountain frontal sinuosity index (smf) shows the balance between erosional forces that tend to cut the embayment into a mountain front and tectonic forces that tend to produce a straight mountain front coincident with an active range bounding fault. It can be presented as the ratio between (Lmf) the length of the mountain front along its base at the distinct break in slope and (Ls) the straight line length of the whole mountain front: it can be calculated using following formula –

$$Smf = Lmf /Ls. \quad (1)$$
$$= 26.387/17.28$$
$$= 1.52$$

[Where, Lmf is the length of the edge of the mountain piedmont junction, Ls is overall length of the mountain front] The mountain front shows dendritic to sub dendritic drainge pattern with characteristic deeply incised v-shaped valleys triangular along differing to segment of the mountain front[2](Figure 2).

Table 2 Showing Mountain front sinuosity of the chel River basin.

Mountain front Sinuosity	Value
Most active mountain front	1.0-1.6
Less active mountain front	1.6-3.0
Inactive mountain front	<3.0

4.2 Valley Floor Width to Height Ratio (Vf)

This Ratio is based on the examination that areas undergoing swift uplift are noticeable by incised streams, with narrow valley floors and v-shaped valley profiles. The index is defined as:

$$Vf = 2Vw/ [(Eld - Esc) + (Erd - Esc)] \quad (2)$$

Where, Vf= Valley Floor Width To Height Ratio.
Vw= width of the valley floor.
Eld and Erd = elevations of the left and right hand valley divides as you look down stream.
Esc= Elevation of the stream channel or valley floor.

The river valley floor width to height ratio (Vf) in the River Chel river basin varies from 0.23to 0.4. High values of Vf communicate to wide, flat valley floors, and low values communicate to actively uplifting v-shaped valleys. Association of the floor width of a valley to the height provides an index signifying whether stream is actively down cutting or mainly eroding laterally into the adjacent hill slopes. In the present study Vf ratios ranges between in the area deep and narrow valleys show low Vf values <1.0 this valleys can be classified as “V” shaped valleys and Vf values between 1 and 1. 5 are indicates moderately active regions and Vf values greater than 1, 0 can be classified as "U" shaped valleys these areas subject to major lateral erosion due to right lateral movement.

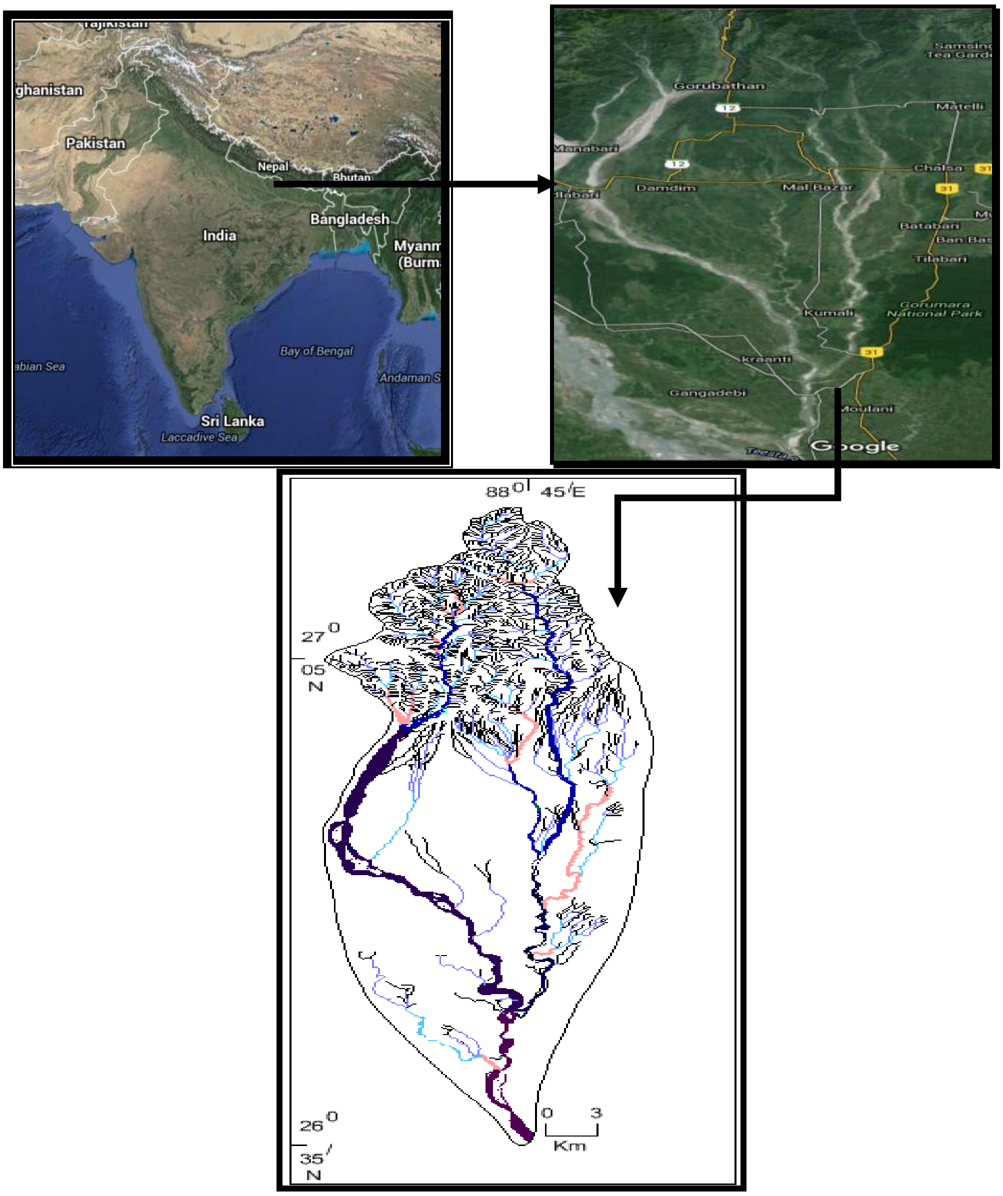

Figure: 1 Location map of the study area.

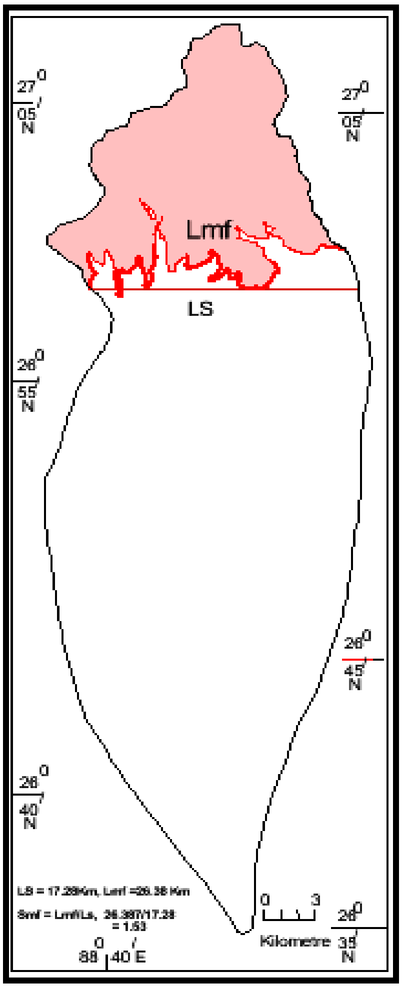

Figure: 2

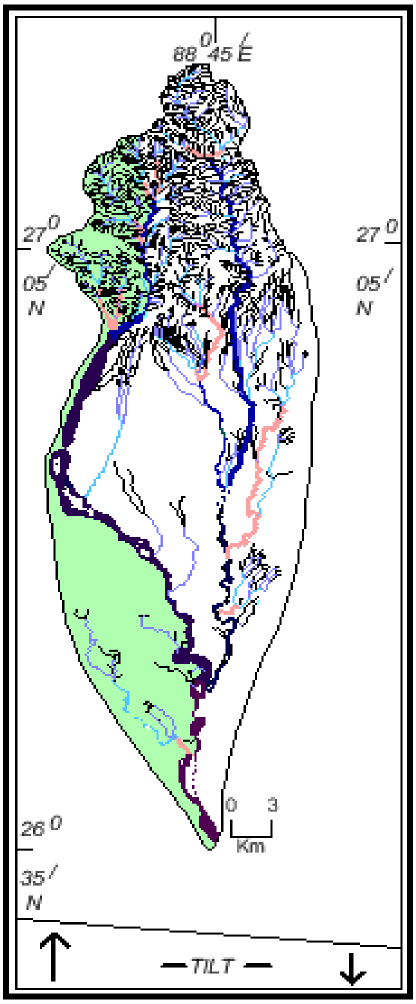

Figure: 3

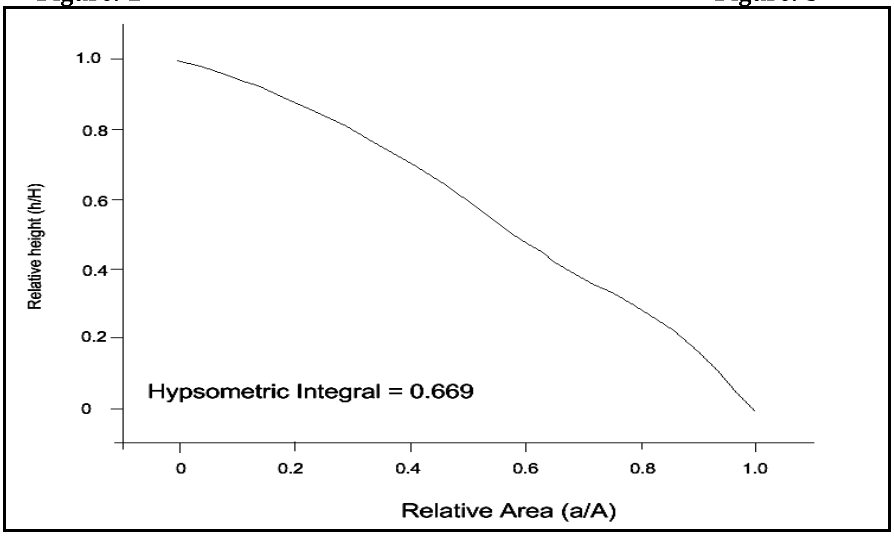

Figure: 4 Hypsometric Integral of the Chel River Basin

4.3 Stream Length-Gradient Index (SL)

The SL index is a helpful tool for the quantitative classification of stream gradient conditions and the evaluation of relationship between approaching tectonic activity, rock resistance, topography, and length of the stream. It is calculated using the following equation:

$$SL = (\Delta H / \Delta L)\ L \quad (3)$$

[Where SL is the Stream Length-Gradient Index, L is the total channel length from the midpoint of the reach where the index is calculated upstream to the highest point on the channel, and $\Delta H/\Delta L$ is the channel slope or

gradient of the reach, where ΔH represents the change in elevation for a particular channel of the reach with respect to ΔL that symbolizes the length of the reach].
The computation of the SL index is characteristically achieved by obtaining the significant parameters from topographic maps. The stream gradient index (SL) for this river evenly varies extensively from 33.57 to 1105.59, whereas segment-wise channel slope ranges from 0.0912° to 21.313°. The full stream length within the hilly territory is roughly 15.98 km, while the elevation difference between the catchment apex and the downstream endpoint within the same territory is roughly 2000 m. Symbol 'K' as 'gradient index (topographic)' for the whole river profile under study and for the River Chel within the same terrain it turns out to be 1352 [3]. Theses study apprehended to facilitate the gradient index ratio 'SL/K' is a helpful substitute for topographic relief difference and in the case of the River Chel in the hilly terrain it is 0.359–2.356. The indecisiveness of SL/K is comparatively insufficient in case of the studied section of the river.

4.4 Hypsometric Curve and Integral (HI)

The hypsometric curve of a catchment represents the relative area below (or above) a given altitude [4]. It describes the distributions of elevations across an area of land, from one drainage basin to entire planet. It is a powerful tool to differentiate between tectonically active and inactive areas [5]. The shape of the hypsometric curves — and the HI values— provide valuable information not only on the erosional stage of the basin, but also on the tectonic, climatic, and lithological factors controlling it. The simple way to characterize the shape of hypsometric curve for a given drainage basin is to calculate its hypsometric integral. The integral is defined as the area under the hypsometric curve [4] [5]. One way to calculate the integral for a given curve is as follows.

$$HI = (E_{mean} - E_{min})/(E_{max} - E_{min}) \qquad (4)$$

[Where E_{mean} = Mean elevation, E_{max} = Maximum elevation, E_{min} = Minimum elevation]
Where as hypsometric integral (HI) value is 0.669. High values of the hypsometric integral designate that most of the topography is high relative to the mean, such as a smooth upland surface cut by deeply incised streams. Intermediate low values of the integral are associated with more evenly dissected drainage basins. In the study area the HI values changes between 0.106 and 0.787. High values of the hypsometric integral indicate deep incision and rugged relief. Intermediate low values of the integral an connected with more evenly dissected drainage basin (Figure4).

4.5 Asymmetry factors

Asymmetry factor (Af) is a morphometric indices for measuring the degree of asymmetry in a drainage basin. Asymmetry factor characterize drainage basin asymmetry and helps in formative the broad tilt of the basin landscape irrelative of whether the tilt was due to local or regional tectonic deformation, Stream pattern can reveal that deformation [5]. Drainage system analysis provides preeminent tools to infer the long-term evolution of the landscape [1]. One of the simple forms of deformations is tilting which can be caused by flexure or warping of an area of the earth's surface. Slanting can cause a Stream network to because asymmetrical, with more are on one side of the drainage basin on the other. The Af factor above or below 50 may result from basin tilting, resulting either from active tectonics or lithologic structurally controlled differential erosion. Aft value of > 50% indicates that the basin area has tilted towards the downstream left side. Whereas, Af value of < 50% indicates that the basin has tilted towards the downstream right side. The asymmetry factor (Af) was developed to identify tectonic tilting transverse to flow at drainage-basin or larger scales as:

$$\text{Asymmetry Factor:} \quad (Af) = 100\ (Ar/At) \qquad (5)$$

[Where, Ar = Area of the right (facing downstream) of the trunk stream At = Total area of the drainage basin]
For Chel river basin the Af value of 32.58% and negative differential value of Af-50, suggest that the basin has tilted towards the downstream left side (figure 3)

V. Conclusions

According to generated outcome, the Chel basin generally influenced by neotectonic activities. The outcome of the practical indices: Smf values is 1.52 computed for mountain fronts show that the most active mountain fronts related with active faults of the area. SL indices changes between 0.359–2.356 denotations of that tectonically influence of the area by neotectonic activities. The river valley floor width to height ratio Vf in the River Chel on north of the MFT Ridge Crest ranges from 0.23 to 0.25 and 0.29 to 0.4 on the southern scarp face. In the study area deep and narrow valleys show low Vf values <1.0 this valleys can be classified as "V" shaped valleys and Vf values between 1 and 1.5 are indicate moderately active regions and Vf values greater than 1,0 can be classified as "U" shaped valleys. In the study area HI value is 0.669. High values of the hypsometric integral indicate that most of the topography is high relative to the mean, such as a smooth upland surface cut by deeply incised streams. Intermediate low values of the integral are associated with more evenly dissected drainage basins. Asymmetry factor significantly greater than 50 suggesting tectonic tilt.

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