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Morphology of the Lower Umiew River Valley in the Southern Meghalaya Plateau

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Abstract: ***Rivers and the valley systems they form are some of the most prominent and interesting features in the earth's surface. A product of fluvial erosion, river valleys are one of the most ubiquitous features of the landscape. Lying between 91°57' E to 91°76' E longitudes and 25°18' to 25°43' latitudes, the Lower Umiew River Valley is an important geomorphic feature located along the Southern Slopes of the East Khasi Hills District of the Meghalaya plateau. This region, characterised by hilly terrain and rugged topography is well known for receiving some of the heaviest rainfall in the world. The present study aims at giving a comprehensive description of the morphological features of the Lower Umiam River Valley and to analyse the impact that the long term heavy rainfall has on the valleys. It also aims to understand how the lithologic variations affect the width and depth of the valley. The approach of the study is mostly based on map works derived from topographic sheets as well as Digital Elevation Models (DEM) generated through ARCGIS. Basic calculations of the width and depth are done using suitable formulas. The results show that the valleys of the Lower Umiew River are broadened or enlarged V - shaped valleys, with steep valley slopes, narrow valley floors with interlocking spurs and high elevational relief. The valleys comprises of constrained reaches made up of mainly colluvial deposits, influenced by the heavy rainfall in the region.***

Keywords: river valleys, morphology, Lower Umiew River

1. Introduction

A trough through which the stream channel meanders, valley are some of the most prominent and interesting features in the earth's surface. It is a natural trench on the earth's surface that slopes down to a stream, lake or the ocean. Valleys are carved by running water or glaciers, excavated along a weak lithologic zone, or are structural in origin e. g. rift valley. Hence, valleys can be formed by both erosion and tectonic forces. However, valleys formed by geomorphic forces (erosion) are most common. River valleys are the most common types of valleys. A product of fluvial erosion, river valleys are some of the most ubiquitous features on the earth's surface. The Lower Umiew River Valley is a very prominent river valley located in the Meghalaya Plateau in North East India. It is drained by the Umiew River.

Data Base and Methods

The data for the study is mostly based on both primary and secondary sources. The secondary sources include various books, journals, published as well as unpublished thesis and internet sources. Primary sources comprises of Digital Elevation Map (DEM) of the valley. From the DEM, the contour of the valley was derived at an interval of 20 metre. Cross profiles of selected sections were taken, from which variables such as valley width, valley depth; valley floor width, valley floor width - valley height ratio and the width - depth ratio were obtained. The necessary calculations were undertaken using the values of the variables obtained through basic formula. The rainfall data is obtained through rain gauges installed at the stations.

The necessary calculations were undertaken using the values of the variables obtained through the following basic formulations:

a) Valley width (V_w) = Crest of one valley to the surface of the corresponding valley at the same altitude.
b) Valley depth (V_d) = Perpendicular depth from the crest.
c) Valley floor width (V_{fw}) = the lowest values available for the valley floor derived from ArcMap (Excel sheet)
d) Valley floor width - valley height ratio (V_f) = V_{fw} / [(E_{ld} - E_{sc}) + (E_{rd} - E_{sc}) / 2], where,

V_{fw} – Valley floor width

E_{ld} – Elevation of the left valley divide (looking downstream)

E_{rd} – Elevation of the right valley divide (looking downstream)

E_{sc} – Elevation of the valley floor

a. Width - depth ratio (w/d) = Valley width/Valley depth

2. Study Area

The Lower Umiew River Valley is situated along the southern slopes of the East Khasi Hills District of the Meghalaya Plateau. The river valley is a part of the Umiew Catchment covering an area of 493. k sq km, encompassing two typical landforms of the southern Meghalaya Plateau: deep canyons and hilly plateau. This valley is drained by the Umiew or the Umiam River, which originates from the Shillong peak in the East Khasi Hills at an altitude of 1, 912m above sea level. The Umiew River is one of the major south flowing rivers that stretch for about 400km till it finally enters Bangladesh at Shella. The river is characterised by strong altitudinal gradients, varying between 60m above sea level and 1, 965m above sea level which results in a large variation in meteorological, hydrological and ecological conditions over short distances. The Lower Umiew River Valley is located in a region which has the distinction of being one of the rainiest places in the world as well as being one of the most tectonically active. An important geological feature in the area is the presence of the Dawki Fault, which separates the Meghalaya Plateau from the Sylhet Trough.

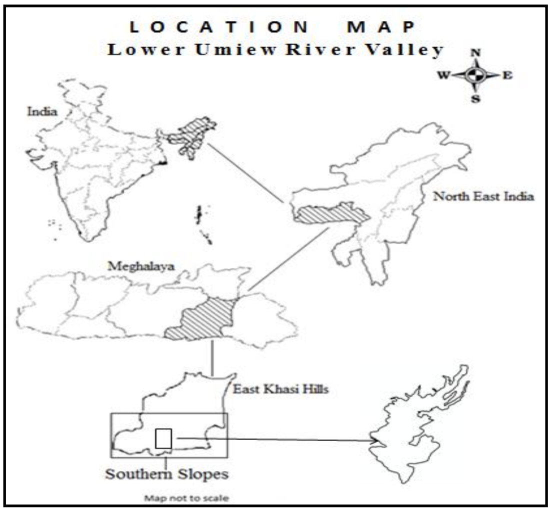


Figure 1: Location of the Lower Umiew River Valley

Morphological Characteristics of the Lower Umiew River Valley

The south facing escarpment of the Meghalaya Plateau, where the Lower Umiew Valley is situated, is dissected into several spurs by a system of valleys cut into the basement of the metamorphic and igneous rocks. Most of these valleys have been incised by head - ward erosion, exploiting the lines of the NE - SW faults and joints common in the region. Reminiscent of canyons and deep gorges, the valleys in this region are up to around 800 – 1000 m deep approximately.

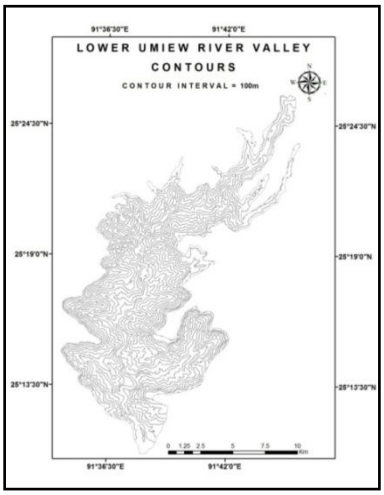


Figure 5: Contour map of the Lower Umiew River Valley

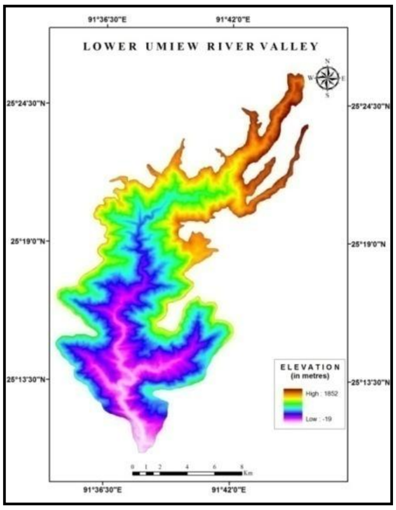


Figure 4: DEM of the Lower Umiew River Valley

Cross Sections of the Lower Umiew River Valley

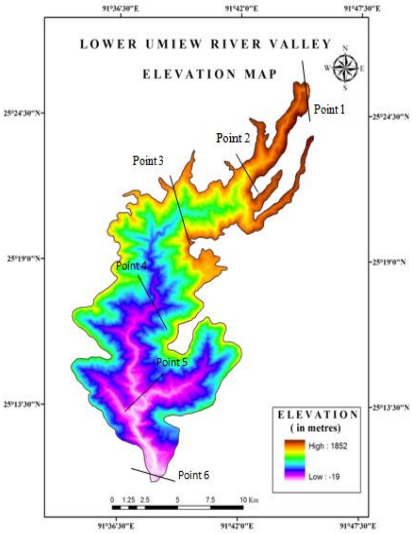
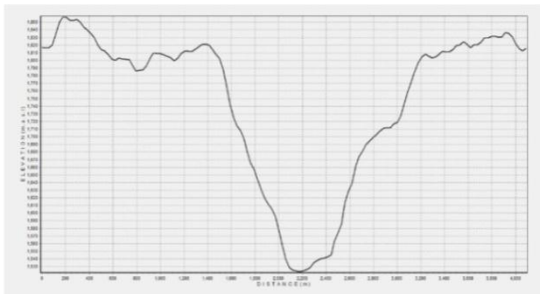
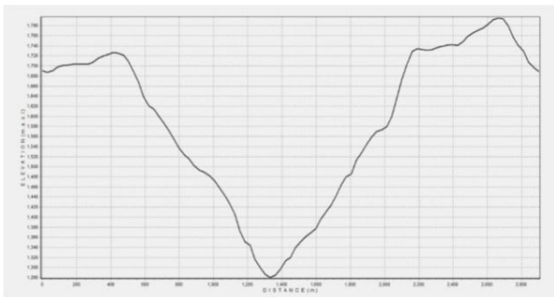


Figure 7: Cross sections of the river valley



1.1: Cross section at point 1



1.2: Cross section at point 2

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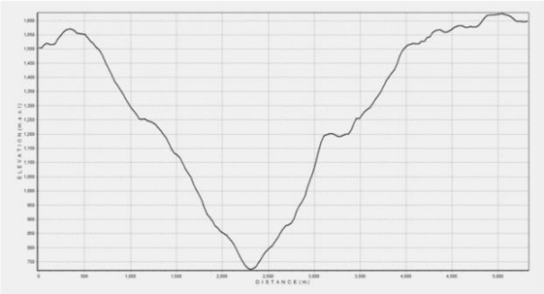
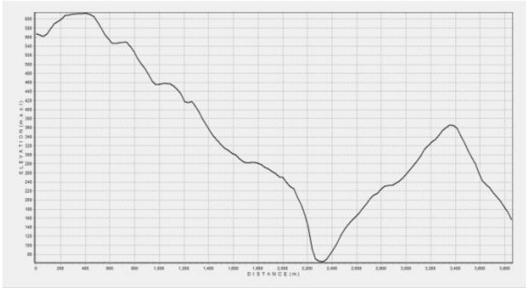
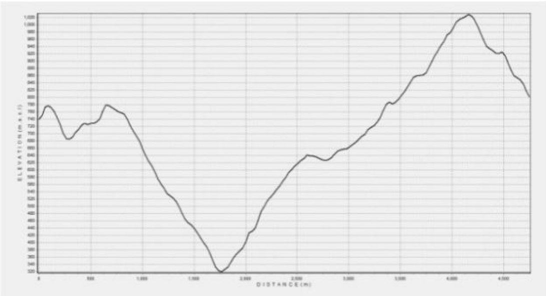


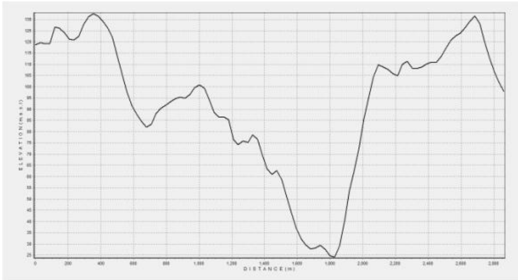
1.3: Cross section at point 3



1.5: Cross section at point 5



1.4: Cross section at point 4



1.6: Cross section at point 6

Table 3: Cross sections of the Lower Umiew River Valley

Lower Umiew River Valley					
Cross Section No	Valley Width (W) (m)	Valley Depth (D) (m)	Width - Depth Ratio (W/D)	Valley Floor Width (V_{fw}) (m)	Valley Floor Width - Height Ratio (V_f)
1	1764.29 m	291.72 m	6.05	45.80 m	0.16
2	1744.84 m	450.57 m	3.87	31.59 m	0.07
3	4140.25 m	873.66 m	4.74	31.56 m	0.04
4	2711.06 m	583.59 m	4.64	32.48 m	0.06
5	1969.37 m	425.71 m	4.63	33.42 m	0.08
6	1058.58 m	81.90 m	12.94	30.51 m	0.37
Total	13388.39 m	2707.15 m	36.87	205.36 m	0.78
Average	2231.4 m	451.2 m	6.1	34.2 m	0.1

Width - depth ratio: < 5.0 = Low
>5.0 = High
Valley Floor Width - Valley Height Ratio (Vf): <0.08 = Low
>0.08 = High

3. Results and Discussion

The Lower Umiew River Valley has an average width of about 2231.4 m, with the widest part being 4140.25 m and its narrowest 1058.58 m. The average depth of the valley is about 451.2 m, the deepest point being 873.66 m and the shallowest point at 81.90 m. The river valley has an average valley floor width of around 34.2 m, the widest at 45.80 m and the narrowest at 30.51 m. The valley has an average width - depth ratio of 6.1. The valley has low width to depth ration, ranging from 3.87 to 12.94. The valley floor width to height ratio (V_f) of the valley ranges between 0.04 to 0.37, with an average of about 0.1.

The widest and the deepest points of the valley are found along the middle section of the valley, whereas the narrowest and the shallowest point are found along the lower section of the valley. The upper section of the valley has the widest valley floor, while the rest of the valley floor is around 30 m to 33 m wide. The width - depth ratio of the valley is low, with an average of only 6.1. High width - depth ratio of >12 occurs only at the end of the valley at about 12.94, while most of the valleys have width - depth ratios between 3 to 6. The low width - depth ratio (<12) signify that the valleys are narrow and deep. The lower Umiew River Valley has an average valley floor width to height ratio (V_f) of only 0.1. The entire valley have V_f ratio of <1.0. These low V_f values indicates that the valley can be classified as a 'V - shaped' valley. Using the Rosgen (1996) classification, the valley can be classified as a Type I valley. These valleys are V - Shaped, confined and are often structurally controlled and associated with faults. Elevational relief is high and landforms are steep and highly dissected.

Valley materials vary from bedrock to residual soils occurring as colluvium, landslide debris, and other similar depositional materials. The stream types that are found in such valley are usually type Aa+, A and G.

4. Conclusion

The Lower Umiew River Valley is a predominantly V - shaped valley, with steep valley slopes and a narrow valley floor with interlocking spurs and also high elevational relief. It is characterised by deep gorges, incised river valleys, multiple interlocking spurs and numerous waterfalls. The valley floors comprise of constrained reaches made up of mainly colluvial deposits. Interlocking spurs, of various sizes are a prominent feature of the valley. The rugged topography and the mostly V - shaped valleys are suggestive of a rapid and fluvial induced incision along the Lower Umiew River Valley. Episodic uplift accompanied by prolonged weathering and erosion has likely resulted in the exhumation and exposure of basement rocks along some parts of the fault. The presence of a vast numbers of big and small waterfalls along the region is indicative of a youthful topography.

Located in a region receiving some of the heaviest precipitationin the world, the Lower Umiew River Valley is greatly affected the rainfall. The monsoon dominated erosional processes accounts for the rugged landscape often found along the region. The slopes along the valleys are densely dissected by the high orographic rainfall, and the valley floors are littered with large amounts of sandstone boulders, theresultof massive landslides and rock falls. The excessive rainfall also leads to heavy weathering and mass - wasting, thereby leading to a steepening of the valley sides. Gulley formation along the valley slopes are also a notable feature. Waterfalls are commonin the valley and along its slopes, which is especially torrential and numerous during the summer monsoon season. Furthermore, the heavy rainfall contributes to the widening of the valley through the process of rain - wash along the valley sides. Lateral erosion has resulted in the local over steepening of the valley sides. Intense erosion has possibly enhanced the widening of existing fractures and the formation of rounded hills in the region. Landslides and rock falls are a common occurrence.

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