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Morphometric Characteristics Of Beki River Basin, Assam

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Abstract

Morphological analysis of a particular river shows the topographic situation and hydrological condition of the catchment area. Morphological parameters indicate the hazards like erosion, flood, channel shifting and other landform development. Therefore, the morphological analysis of a particular river is very useful for the future generation of geomorphologists, planners, administrators and other field scientists. The present paper is an attempt to analyse the morphological characteristics of the Beki river channel and its basin. Data based on primary like field visits, secondary like satellite images and landsat images incorporated with toposheets were meaningfully calculated with high accuracy. Here, we are going to discuss about relief characteristics, basin and channel profiles, basin shape, Elongation and circularity ratios and channel morphology. The relative relief fairly represents the variation of altitude. It is also concerned with the channel morphology- standard, hydraulic and topographic sinuosity indexes.

Keywords: morphology, beki river, relief, elongation ratio, circularity ratio.

Introduction:

Rivers are the dynamic entities and their characters vary over time and space in response to environmental controls. They usually drain over their basin delineated by well-defined boundaries. They can be analysed by a set of quantifiable basin characteristics. The characters and behaviours of the fluvial system at any particular location reflect the integrated effect of an upstream control, viz. climate, geology, physiography and land use. These basin controls in a coherent way determine the drainage regime and the quantity and type of sediment supplied. Assuming importance as a fundamental geomorphic unit (Chorley, 1969), a river basin has thus been considered as the favourable and effective unit for geomorphological studies. Such a unit-based study provides physical basis for a planning-oriented approach towards integrated management and development of land and water resources.

In addition to the study of magnitude, frequency of flows and the probability of both the low and high slope in a drainage basin also focus a great relevance with the significance of changing morphology of landforms. Flood genesis along with its hazard zonation and floodplain management have now received due attention of a host of field scientists towards exploring ways for sustainable human habitation, society and economy.

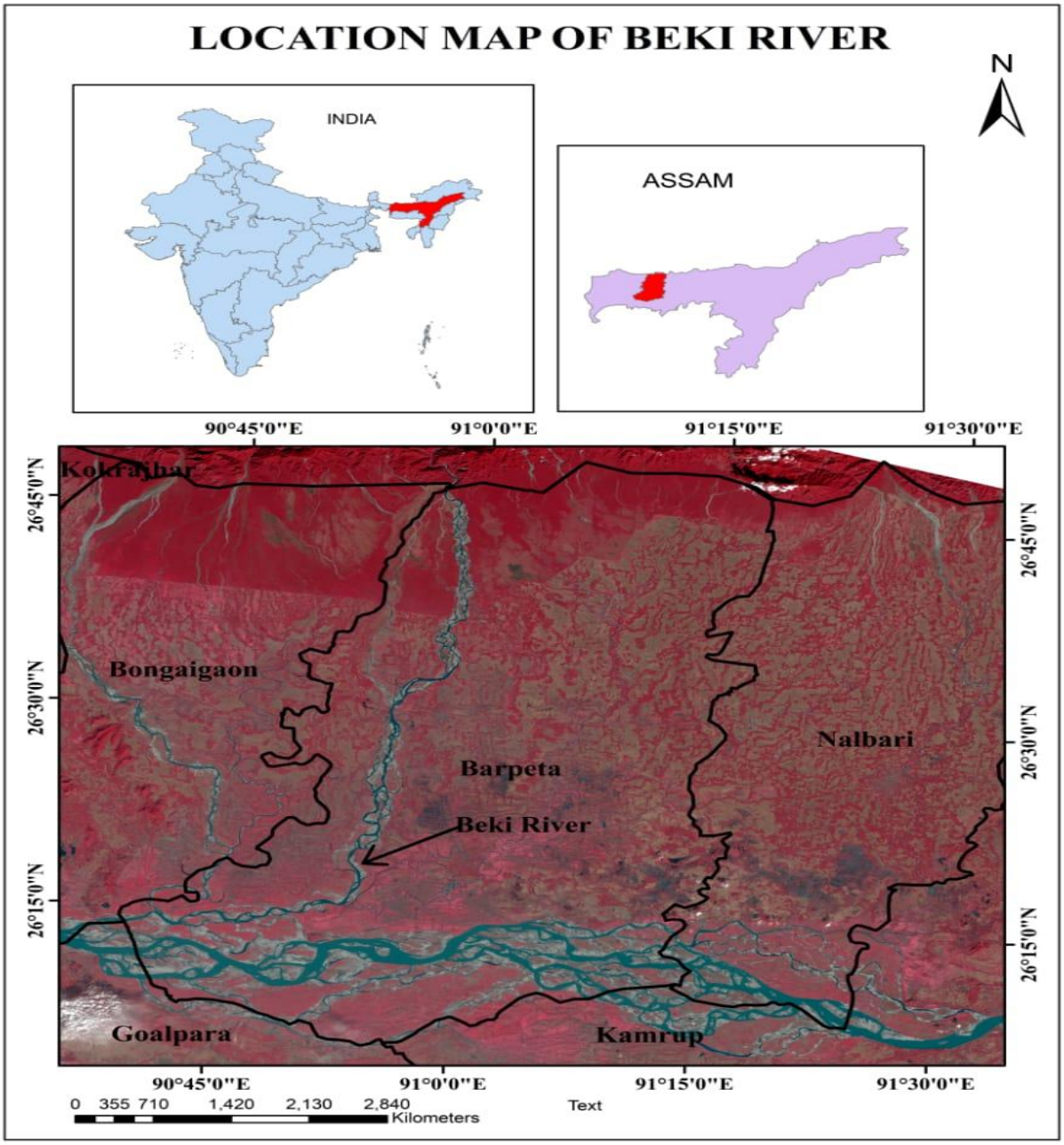
The river channels are in no way confined to symmetrical and definite tracks. They persistently shift their courses over the space through time. A river has its tendency to attain an equilibrium condition so as to adjust itself with varying fluvio-geomorphic as well as climatic condition. Morphological pattern of any drainage basin is a reflection of a number of dependent and independent factors involved in water and sediment discharges. Adjustment with channel gradient or slope, cross-section, width, depth, velocity etc. has been achieved by the channel as well as by the basin at specific location.

The morphological characteristics associated with channel over time and space is seen to develop mainly due to climate and man-induced effects. The Beki river in no exception to the above conditions. The problem arising out of frequent damage of embankment along the river, especially at Narayanguri, in the upper part of the river, recurrent flood evenly in the lower part and bank erosion at Chafakamar village and other places, for example, have been considered as serial annual events. With this in mind the present problem "Morphological Characteristics of Beki River and its basin, Assam" is undertaken for the study. Hence an attempt is made here to examine mainly the channel morphology of the Beki river.

Study area:

The Manas River is one of the north bank tributaries of the Brahmaputra river. The Beki or Mora Manas originates at the debouching point of the Manas at Mathanguri at an altitude of 97m approximately. It is the easternmost channel of the present Manas network. It flows in a southerly direction by the side of Narainkuri, Chafakamar, Chengla, Jaipur, Goraimarigaon, Karakura, Kadang, Majidbhita and meet the Brahmaputra near Baghbar at an altitudinal level of nearly 30m. The channel distance of the Beki river is 90 km whereas the actual river distance is 69 km.

The area under investigation is covered by the survey of India toposheets numbering 78J/14, 78J/15 and78J/16. It lies latitudinally from $26^{0}14^{/}$N and $26^{0}46^{/}$N and longitudinally from $91^{0}0^{/}$E and $91^{0}55^{/}$E.



Significance of the Study:

The area under study has remained unexplored in the field of channel morphology. Hence the study has been a great significant one in the applied geomorphology of the basin. The major task lies with understanding and indentifying the morpholgical characteristics of the Beki channel and its basin related to fluvio-geomorphology. The study will, therefore, be helpful to the future generation of geomorphologists, planners, administrators and other field scientists.

Objectives:

The main objectives of the study are as follows -

1. To examine the physical basis of the Beki river channel.
2. To study the morphological characteristics of the Beki river channel and its basin.

Methods of Study and data Base:

Pre-Field Stage:

In this stage the researcher has consulted the existing literature in libraries and different websites (e.g. Shodhganga, , Google Scholar, Jstor etc.) in respect of journals, e-journals, books, Ph. D, M. Phil Dissertations, monographs, personal experience with a view to develop a broad theoretical framework of the work.

Field-Stage:

The toposheets of years 1952, 1972, and 1912-13 has been acquired which are calibrated with available satellite images. Satellite images and Landsat images have been acquired from USGS website for various years. Secondary related to rainfall, temperature, water level, discharge, runoff at certain stations has been collected from the Water Resource Department and office of the Manas Tiger Project, office at Barpeta Road, Gabardhana Block Office (Barpeta Road) and Statistical Handbook of Assam. The Head office of the Water Resources department at Chandmari, Guwahati has been visited to collect the same. Atlases along with necessary maps for the purpose published by NATMO has been collected. Morphological changes of the main trunk have been carried out with the help of manual extraction of the drainage network from the available toposheets of various years.

Post Field Stage:

During this stage, the data collected from both primary and secondary sources has been processed and analysed using meaningful software and statistical techniques. Necessary maps, graphs, charts, tables have also been prepared with the help of appropriate cartographic techniques to clear the exposition of the problem of the area. The measurement of morphometric parameters such as Relative Relief, Elongation Ratio (Re), The Longitudinal Profile, Circularity Ratio, Standard Sinuosity, Hydraulic Sinuosity, Topographic Sinuosity has been computed using pre-existing mathematical equations.

Review of the Relevant Works:

A review of some of the existing works pertaining to the line of study is being presented here. The present trend shows that geomorphological and morphometrical

studies relating to environmental and human area in different parts of the world have became the subject matters of fluvial geomorphology.

Among many works so far available in theoretical as well as applied geomophological fields, notable ones go to the publication of geographical monographs by the University of Chicago under the initiative of G. F. White and his fellow students from 1945 onwards. Some of the works worth-mentioning here are of Jervis (1926), Schumm (1956), Wolman and Miller (1964), Harvey (1965). Chorley (1969) applied morphometric indices to analyse the development of erosional topography. He perceived relationships between the morphometric indice such as channel length, drainage basin area. Coleman (1969), worked on channel processes and sedimentation of Brahmaputra river. Strahler (1971), Smith (1972) and Gregory (1977) contributed valuable works especially on morphological works. Mangelsdorf et al., (1990) in their book discussed 'River Morphology' has elaborated the interplay of flowing rivers and their immediate environment. Any changes in the flow dynamics induced by anthropogenic or any naturally occurring processes brings subtle changes in flow regime and sediment transport calibre of a particular river system.

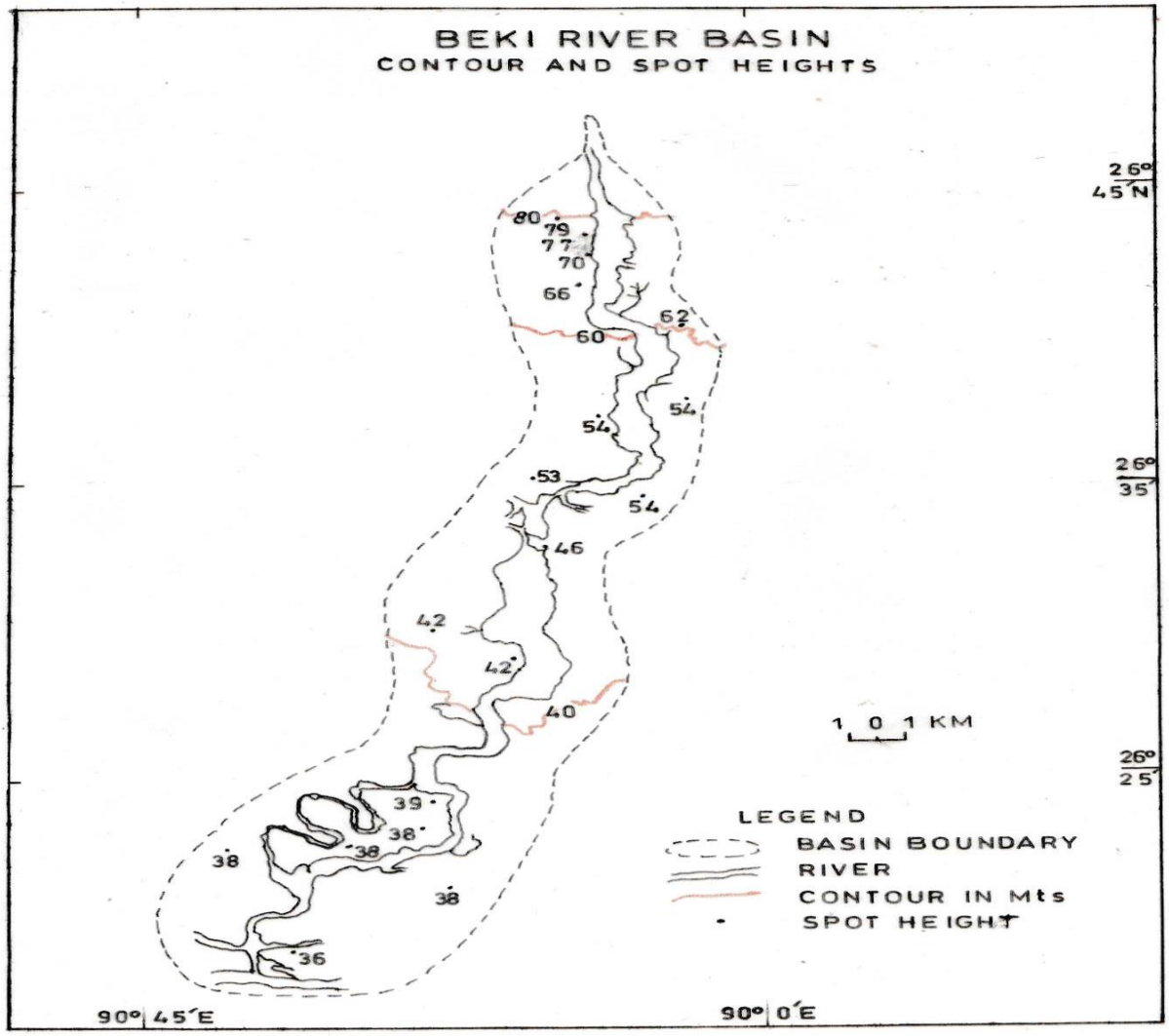
In India, many scholars have contributed works to the field of geomorphology and problems relating to flood. These works have been done mainly by Tanaskar (1969), Bhattacharya (1973), Sinha and Syatya Ram (1978), Gupta (1982), Das (1987), Goswami and Biswas (1988). Kale, V. S. and Karlekar, S. N. (1988), worked on the relief and drainage morphology where they came with the conclusion that in spite of geo-environmental conditions the fluvial systems reflect different basin and network characteristics. Agarwal (1998) in his study on drainage pattern of Naugarh area of Varanasi district used aerial data and the basin characteristics were studied and evaluated on the basis of morphological and its related parameters. . Singh et al., (2013) quantified various morphometric parameters in their study on Morar river basin.

A few works, namely of Goswami (1985), had been done on the river Brahmaputra. The other works namely of Bordoloi (1986) on channel migration of the Brahmaputra near Palashbari, Kamrup. Bora (1991) in his study on Jia Bharali river incorporated geomorphic analytical base, deciphered nature of bed and bank materials, sediment transport characteristics and the dynamics of channel change of the river. Barman (1998) has conveyed the use of morphometric parameters in his study on geomorphological characteristics of the Kamrup district. Bhattacharjee (2008) explored various fluvio-geomorphic aspects of Darrang district of Assam, made vital contributions in deciphering the drainage characteristics of seven river channels draining the parts of the district. Taher (1975), Barman (1982, 1984), Barman (1989), Singh (1988), Gogoi and Barman (1991), Goswami, Dutta and Kalita (1991), Kar and Goswami (1992-93), Roy & Bora (1994) etc. also deserve mentioning.

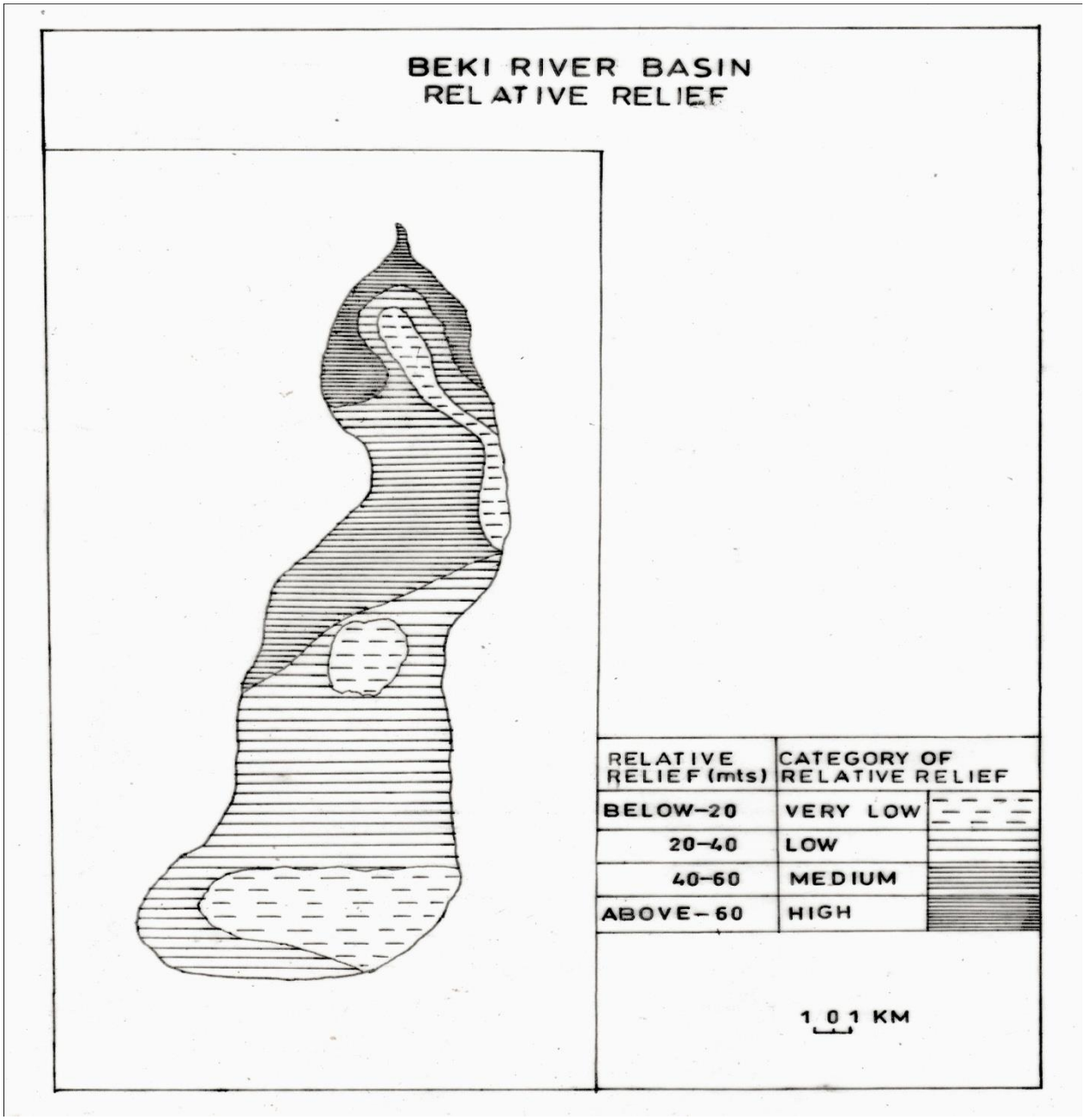
As the study area is large in terms of spatial extent it is not possible to study the entire area thoroughly within a limited time. The work is designed in the following steps -

Relative Relief:

The term relative relief indicates the actual variation of height per unit area with respect to its local base level.



The relative relief of the basin is determined in order to have a view of the whole basin which yields various factorial impacts in controlling the morphometric characteristics of landform. Following the G.H. Smith's technique of Relative Relief (1935),1:50,000 topographical maps of the basin have been divided into grid square 5 square km the whole area under study. As the major portion of the study area is plain, the contour interval is interpolated at 20m interval. The difference of the highest and lower elevation of each grid has been marked and on isopleth map has been prepared and analysed and interpreted.



The relative relief map of the Beki river basin reveals that there is variation in local relief. The minimum relief in the tune of less than 20m lies on the valley areas, while the maximum local relief (above 60m) is seen on upper part of the basin.

Table 1. Relative Relief of the Beki Basin

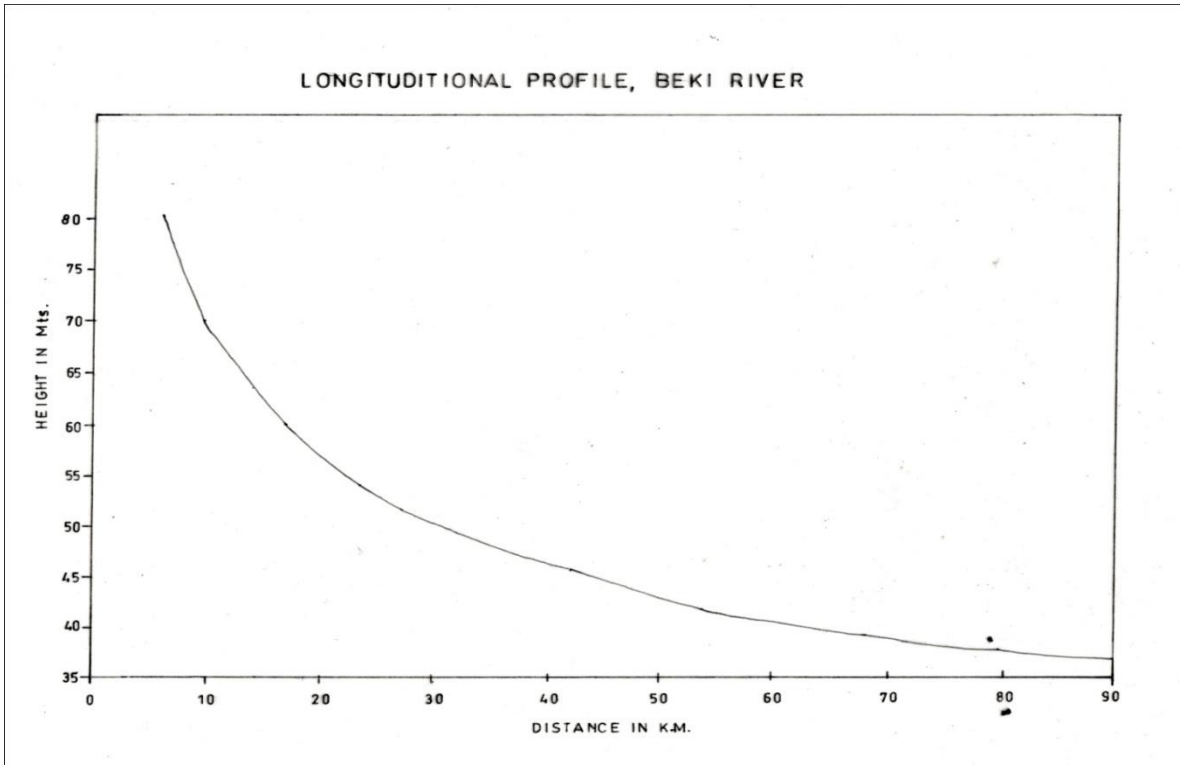
Relative Relief	Categories of Relative Relief
Below 20	Low

20-40	Medium low
40-60	Medium
Above 60	High

Profile Analysis:

The Longitudinal Profile:

The longitudinal profile of a river represents channel gradient of the river from its source to month. Each river uses to develop such a longitudinal course (profile) that it may be able to transport the bed-load downstream. The longitudinal profile of the Beki River follows a smooth path which is concave in nature with very low gradient up to the river Brahmaputra. The patterns give an idea of the dynamic equilibrium associated with the river itself and its basin too.



Basin Shape:

3.21 Elongation Ratio:

According to Schumm's (1956) the shape of any drainage basin can be expressed by elongation ratio that is the ratio between the diameter of a circle with same area as of the basin and the length of the basin.

For the Beki Basin, area of the basin 128.4 km^2 diameter of the circle with

$$R = \frac{\text{Same area as basin}}{\text{basin length}}$$

Thus, $$R=2\sqrt{\frac{A}{\pi L^2}}$$

$$= \frac{2}{\sqrt{\pi}}\sqrt{\frac{A}{L^2}}$$

$$= \frac{2}{\sqrt{3.1416}}\sqrt{\frac{128.4}{76^2}}$$

$$= 1.128 \text{ X } 0.149$$
$$= 0.2$$

The value of 'R' varies from 0 (highly elongated shape) to unity i.e. 1.0 (circular shape).

Thus, the value of R is 0.2 the basin is elongated shape.

Circularity Ratio:

Similar to elongation ratio, the measure of circularity ratio acts as a perimeter of basin morphometry. Miller (1953) used the measure which is the ratio of circumferences of a circle with same area, as the basin to basin perimeter. The value range around 1.

The Basin area 128.4 km^2

Circumference of the basin=4π x128.4 km^2

Perimeter (P) of the basin = 142 km

$$\text{Circularity ratio} = \frac{4\pi A}{P^2}$$

$$= \frac{4x\ 3.1416\ x\ 128.4}{142^2}$$

$$= \frac{5539.38}{20164}$$
$$= 0.27$$

This value shows that Beki basin tends to an elongated shape.

Channel Morphology:

Standard Sinuosity, Hydraulic Sinuosity, Topographic Sinuosity:

Table 2: Sinuosity Index of the River

Beki River	Standard Sinuosity Index	Hydraulic Sinuosity (in p.c.)	Topographic Sinuosity (in p.c.)
Overall Sinuosity	1.36	81.63	18.36
Sinuosity of Upper Reach	1.21	91.66	8.33
Sinuosity of Middle Reach	1.3	73.80	26.19
Sinuosity of Lower reach	1.46	84.12	15.87

The sinuosity pattern of the channel indicates the ratio of the channel length to valley length (Schumm, 1963). Through this index we can understand how far a channel deviates from its straight course. The channel is said to be meandered when its sinuosity index is more than 1.3 or 1.5 (according some authorities). Any valueless than 1.5 indicates the stream is straight. The Beki river from its entrance at Mathanguri to the mouth near Baghbar is of slightly meandering in nature. The nature of meandering reveals the nature of ruggedness of physiographic base over which the river flows. The sinuosity index of upper reach of Beki river less than 1.5 directing it to be straight, while the middle reach also having straight channel and the lower reach of the Beki river is slightly meandering in nature.

The complex sinuosity index is - Hydraulic Sinuosity Index (HDI) and Topographic Sinuosity Index (TSI). The important role of hydraulic index and topographic sinuosity index is to find out the relationship of topography and water (Muller). These are calculated in terms of percentage.

The hydraulic sinuosity index and topographic sinuosity index of the Beki river reveal that the whole of the river has more hydraulic force. This indicates that the channel is controlled mainly by water forces not by topography. The upper part of the Beki basin gets for more hydraulic control than the topographic control. Because, at the time of storm rainfall, the Beki river other rivers of Assam get full of flood water. Moreover the water along the channel passes over deadly flat plain. A very loose nature land surface over which the river flows is not having topographic control on the water passing over the channel in the basin. Similarly the middle and lower reach of the Beki river also get greater hydraulic control than the topographic control.

Conclusion:

Here we discussed about relief characteristics, basin and channel profiles and channel morphology. The relative relief fairly represents the variation of altitude. From the analysis we may say that the basin as a whole shows an uneven physiographic characteristics with varying relative relief. The northern part of the basin is bounded by the 80m contour. Similarly, the area of the basin as a whole shows the diversification in slope distribution. The longitudinal profile of the basin is smooth and concave in nature. This pattern gives an idea that the river has been in dynamic equilibrium. Here also analyse the basin shape. Elongation and circularity ratios are used to analyse the shape of the basin. From the analysis it is seen that the basin is mainly elongated in shape.

It is also concerned with the channel morphology- standard, hydraulic and topographic sinuosity indexes. The average standard sinuosity index of the Beki basin is 1.36 which prove, the channel is slightly meandering. The hydraulic and topographic sinuosity indexes reveal that the channel is mainly controlled by water force not by topographic one.

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