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Spatial Distribution of Knick Points and Associated Waterfalls of the Drainage Basin of Tambraparni River and Neighbouring River Basins

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ABSTRACT: *This paper deals with a part of the author's research work dealing with the geomorphometry and geomorphology of the Tambraparni River basin of Kanyakumari District of southern Tamil Nadu, which is located at the state's border with Kerala on the western flank of Sahyadri Range. A careful study of the precise geographic locations of the major knick points of the long profiles of the master stream of the drainage basin of Tambraparni River (of Tamil Nadu) and those of the Neyyar River and Karamana River (both of Thiruvananthapuram District of the neighbouring state of Kerala) brought to light the fact that these do not exhibit a random spatial distribution but significantly exhibit linear arrangements. These knick points are manifested in the field in the form of waterfalls, rapids and cascades. Geological data available for of the three river basins does not afford indication of any lithological nor structural influence for the observable distribution pattern of the knick points, except in the case of a few knick points of Tambraparni drainage basin.*

KEYWORDS*: Geomorphology, River basin, Knick points, Long profile, Distribution pattern*

I. INTRODUCTION

A knick point is a geomorphological feature denoting a location of a river or channel where there is a sharp change in channel slope (such as a waterfall or lake). The 'classic' definition of the term knick point is that it is a discrete, steep reach which creates a local convexity in the generally concave up equilibrium channel profile. The term is used morphologically to describe an abrupt change in river gradient (Whipple and Tucker, 1999). In that sense, knick points can be considered as landforms that can range from high gradient rapids to waterfalls. These minor features associated with fluvial landforms provided early evidences of the dynamic response of bedrock rivers (Gilbert, 1896; Penck, 1924 and Davis, 1932). These still continue to offer compelling evidence for disequilibrium conditions in field, experimental and theoretical studies in geomorphology. However, fundamental questions regarding their origin, mobility and form still remain debated and unanswered.

Knick points are formed by tectonic events and eustatic changes of sea level. For example, uplift along a fault over which a river is flowing will often result in an unusually steep reach along a channel, creating a knick zone. Glaciation resulting in a hanging valley often forms prime spots for the development of knick points. Where there is lithological variation of the country rocks over which a stream channel develops (such as a shale formation occurring amongst a succession of igneous rock units, channel incision will be more in the region of softer rock formation than in the other rocks. This kind of lithological variation offering differential resistance to fluvial erosion can also result in the development of knick points. As observed for many major waterfalls, knick points are not geographically stationary features but these migrate upstream due to bedrock erosion leaving in their wake deep channels and in the case of a river that has reached its maturity initially results in abandoned floodplains, which subsequently become stream terraces. Retreats of knick point have been reported and studied by geomorphologists in regions affected by postglacial isostatic response and associated sea-level drop (such as in Scandinavia). Where a landscape is affected by a negative change of base level (due to tectonic uplift, isostatic rebound or eustatic lowering of sea level due to initiation of glacial epochs), the streams gain more potential energy and these display a tendency to deepen their channels. The deepening processes commence from the lowest reach affected by base level changes (from the stream mouth) and a new long profile will be formed in course of time.Where the pre-existing long profile intersects the new long profile, at a lower level (relative to the pre-existed one), the site will be marked by a knick point, generally in the form of a waterfall or a knick zone expressed in the form of a series of rapids and or cascades. Theoretically, the fluvial processes tend to work the knick points out of its system by either erosion (in the case of waterfalls) or deposition (in the case of lakes) in order for the river to retain its smooth concave graded profile.

II. GEOGRAPHICAL AND GEOLOGICAL SETTING

The Tambraparni River, in Kanyakumari district, locally known as Kuzhithuraiar, is the only major west flowing river in the southern Tamil Nadu (all others being east flowing and draining into the Bay of Bengal). The Tambraparni River Basin (TRB) which is located in the south-west of Indian peninsula and occupying the western flank of the Sahyadri Ranges (8˚10'58"N to 8˚34'39"N: 77˚05'47"E to77˚29'31"E) is composed of the basins of Kodayar, Paraliar and Kuzhithuraiar and draining an area of 867.52 sq. km (Figure-1). A terrain with a number of lofty hills forming the south-eastern extension of broader mountain range forming the crestal zone of the Western Ghats forms the drainage divide of the Tambraparni basin, separating it from the Neyyar basin of the state Kerala. The crestal zone of the Sahyadri ranges, forming the northern portion of the basin, constitutes the drainage separating TRB from Manimuttar basin, while the eastern boundary of TRB separates the basin from the adjacent watershed region of Palayar basin. Geologically, the basin can be broadly subdivided into two types of terrains, namely sedimentary terrain and hard rock terrain. Sedimentary rocks, referable to Tertiary and Quaternary ages of Phanerozoic age cover about 15 percent of the area of the basin and are found restricted along the coastal tract and adjoining lowland zone of the basin whereas, Crystalline rocks of Archaean to late Proterozoic age occupy the major portion of TRB. The major rock types exposed in the hard rock terrain are those of granulitic and gneissic metamorphic rocks referable to charnockite and khondalite groups, garnetiferous quartzo-feldspathic gneiss and, garnet- biotite gneiss.

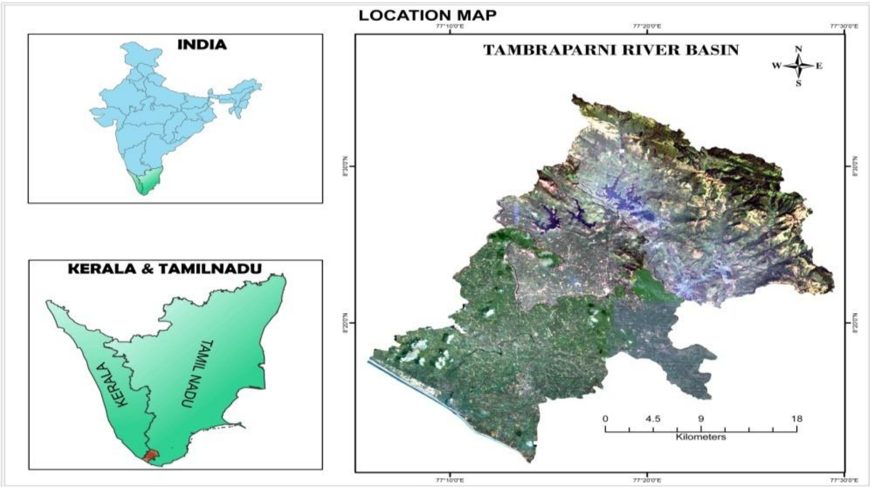

Fig: 1

III. OBJECTIVE AND METHODOLOGY

The main objective of the present paper is the detection of major knick points within the stream net of TRB as well as in the neighbouring river basins located on the western flank of Sahyadri Range and to highlight their spatial distribution on a regional scale. The entire basin of TRB has been captured from the latest available Survey of India topographic sheets of 1:25,000 scale and delineated with the of ArcGIS-9.3 software. Prominent fluvial geomorphologic features (waterfalls, rapids and cascades) were recognized primary through the study of the topographic maps covering the basin and further detailed and useful information about these features were gathered though a series of field trips carried out during the course of the present study. Studies were also extended outside the boundary of the basin, for the confirmation of possible regional alignment of knick points of the neighbouring basins and subsequent field checking and substantiation.

IV. RESULTS AND DISCUSSION

Significance of the location and spatial distribution of waterfalls in TRB: There are a total number of 5 waterfalls found distributed in the basin of Tambraparni River. It has also been noted that among these, one is located within the lowland zone, another in the midland as well as in highland zone and the remaining two occur within the zone of foothills.A careful field study of the location of the famous waterfall at Triparappu, located at 50m amsl, indicated that its location is controlled by an abrupt lithological change of the country rocks over which the Kodayar River flows. The incision of the river channel is probably facilitated by the border line separating the zone of khondalite from that of the adjoining garnet-biotite gneiss. Within this stretch, measuring about 825m linear zone, the river channel follows the trend of the northwest to southeast running boundary between the two rock types, and the waterfall at Triparappu is presently located where the stream channel encounters the lithological boundary. Entrapment of drainage channels along a linear zone forming the boundary of two adjacent rock types is generally a function of preferential weathering and erosion along zones of rock weakness. In the midland zone, the location of a 5 m waterfall occurring at the south of Kodayar Kiltangal is also influenced by an abrupt lithological change across the course of Kodayar River, as in the case of the waterfall at Triparappu. This waterfall is located where the channel enters a region of khondalite from that of charnockite, which favoured the site of the fall. This waterfall is located at an elevation of 220m amsl.The 10m waterfall situated at the north of Kodayar Kiltangal and a 25m waterfall occurring at the Masipatti River, both falling within the foothill zone, has no apparent structural or lithological control favouring their locations.The most prominent waterfall of TRB and which has also the distinction as the highest one in the TRB, characterized by a freefall of 60m occurs where the Chambakkal Ar traverses the northwestern extremity of a steep 300m scarp (having a northwest to southeast trend) of 1.25 km length. Unlike in the case of other waterfalls of TRB mentioned earlier, this waterfall is genetically related with the associated macro-scale geomorphological feature or landform.

Regional distribution of knick points of TRB and associated drainage basins: The geomorphological study of TRB revealed that there is a remarkable pattern in the spatial distribution of waterfalls associated with the drainage net of the Tambraparani river system. A map showing the location and spatial distribution of waterfalls in TRB and adjacent river basins is provided in Figure- 2. In the present study, when the geographic locations of the waterfalls associated with the neighbouring basins of Neyyar River and those of the Karamana River (located further northwest) and Palayar River (located southeast) are also considered along with waterfalls of TRB, it was discovered that these are found aligned along a set of two imaginary parallel straight lines (as shown in the Figure- 2).

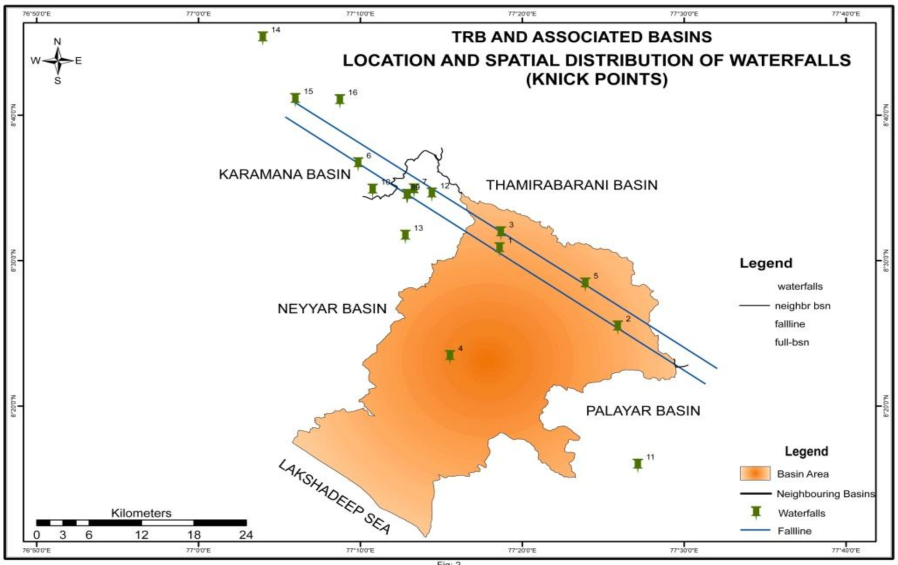

Fig: 2

Moreover, the trend of these lines is also more or less parallel to the western coast. In geomorphologic literature, the term ‘fall line’ is applied for the imaginary line or the narrow zone connecting the waterfalls on several successive and near-parallel rivers. However, in the present context, the geomorphologic setting required by the definition is not fully satisfied; and therefore, the term fall line is not preferred and used. The exact geographic coordinates of waterfalls of the TRB and those of the adjacent Neyyar Basin and Karamana Basin forming two sets of linear alignment are listed in table-IA and table-IB.

Table I(A)
Geographic Coordinates of Waterfalls (Set A)

Sl. No.	River Basin	Location Number in Map	Latitude	Longitude
1	Karamana River Basin	15	8°40'59"N	77°05'00"E
2	Neyyar River Basin	12	8°34"44"N	77°14'22"E
3	Tambraparni River Basin	05	8°31'56"N	77°18'35"E
4	Tambraparni River Basin	02	8°28'25"N	77°23'49"E

Table I(B)
Geographic Coordinates of Waterfalls (Set B)

Sl. No.	River Basin	Location Number in Map	Latitude	Longitude
1	Karamana River Basin	06	8°36'33"N	77°09'51"E
2	Neyyar River Basin	08	8°34'25"N	77°12'54"E
3	Tambraparni River Basin	01	8°30'44"N	77°18'28"E
4	Tambraparni River Basin	02	8°25'24"N	77°25'49"E

Therefore, it seems that the spatial distribution of waterfalls within TRB and in the neighboring basins should not be considered as a mere coincidence as a local feature, but forms a part of a regional feature having genetic relationship with the associated regional geological structure and this inference do not in any way contradict the observations made with regard to the local (geological /geomorphological) set up of the waterfalls already noted in earlier paragraphs in this section. The spatial pattern of the distribution of waterfalls identified within the basin in the present study indicated that it is a part of a geomorphological phenomenon of a regional scale and therefore deserves special attention and explanation.

V. CONCLUSION

A more detailed study of the knick points of the Tambraparni River system brought to light the remarkable nature in the spatial distribution of waterfalls. When the geographic locations of the waterfalls associated with the neighbouring basins of Neyyar River and those of the Karamana River and Palayar River are also considered along with those of Tambraparni River, it was discovered that these are found aligned along a set of two imaginary parallel straight lines. The noteworthy spatial pattern exhibited by the distribution of waterfalls identified within the basin in the present study indicated that it is a part of a geomorphological phenomenon of a regional scale extending beyond the boundary of the basin. However, the geological data available for of the three river basins does not afford indication of any lithological nor structural influence for the observable distribution pattern of the knick points, except in the case of a few knick points of Tambraparni drainage basin.

REFERENCES

[1]. Davis, W.M., 1932; Piedmont benchlands and Primarumpfe. Geological Society of America Bulletin, Vol. 43, pp. 399–440.
[2]. Gilbert, G.K., 1896; Niagara Falls and their history, National Geographic Society' The Physiography of the United States, The American Book Co., New York, pp. 203–236.
[2]. Penck W., 1924; Morphological Analysis of Landforms, English translation (1953) by H. Czech and K. C. Boswell, London, Macmillan.
[4]. Whipple, K.X. and Tucker, G.E, 1999; Dynamics of steam-power river in incision model: Implications for height limits of mountain ranges, landscape response timescale and research needs, Jour. Of Geophysical Research, Vol. 104, pp. 17.661- 17.674, doi: 10.1029/1999JB900120