

A Study of Drainage Characteristics of Punpun River Basin – A Tributary of the Ganga River

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Abstract

The Punpun river basin presents some unique drainage characteristics which the present study tries to analyse using quantitative methods. After describing the overall particularity of this drainage basin between the Son in the west and the Phalgu river in the east, the study looks at the drainage network of the tributaries. Some anomalies in the course of the Morar are discussed. It then examines both the drainage frequency and the drainage density which both show regional differences from south to north. The paper further describes the drainage pattern observed within the Punpun basin.

Characteristics of the Punpun River Basin

The Punpun river is a right bank tributary of the Ganga river. The Punpun river basin occupies areas in the states of Jharkhand and Bihar in India. It has spread in two geographical regions in the country namely – the Chotanagpur Plateau and the Middle Ganga plain. It covers an area of 6482 sq. km. The drainage characteristics have been analysed with the help of the topographical sheets No. 72 C, 72 D and 72 G. Field work and survey have helped in supporting the results.

Almost all over the world run-off water is the dominant agency of geomorphic processes and more so in humid regions like India. Rivers are often guided by structure and morphogenetic processes operating in the region. Consequently, the study of drainage characteristics is an important aspect in the analysis of terrain.

The Punpun river basin experiences the maximum effect of running water in the monsoon season. However on account of the seasonal character of rainfall, rivers of this region suffer from a lack of perennial supply of water, hence during winter they are reduced to tiny rivulets over wide sandy beds. The whole tract is drained by the Punpun and its tributaries most of which come from the hills of the southern uplands region of the basin (Fig. 1). Punpun river emerges at 24° 30'48"N Latitude and 84° 8'E Longitude, 2 km north to the Jharna hill (442 m) on the northern tip of Palamau district in Jharkhand state. Flowing in a SW-NE direction, parallel to River Son in its western side, it joins the Ganga at 25° 31'16"N latitude and 85° 17'E longitude near Fatuha district, Bihar. River Morhar and River Jamuna are the main tributaries of Punpun river which flow in the northward direction to the east of River Punpun (Fig.2). The river basin forms an inter-

* The basin extends from 84° 7' E, to 85° 16' E, longitude and from 24° 30'07"N to 25° 16'27"N latitude.

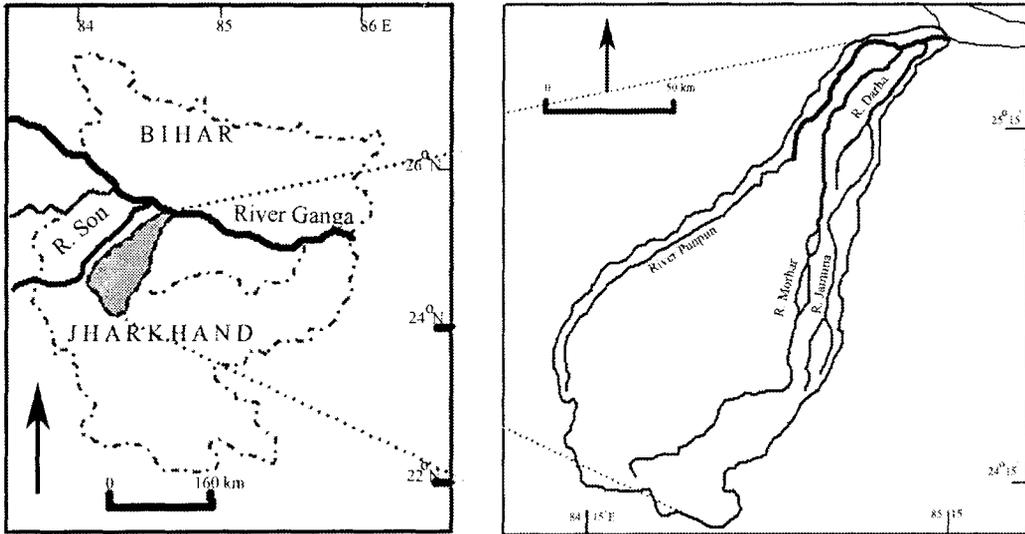


Fig. 1: Location Map of Punpun River Basin

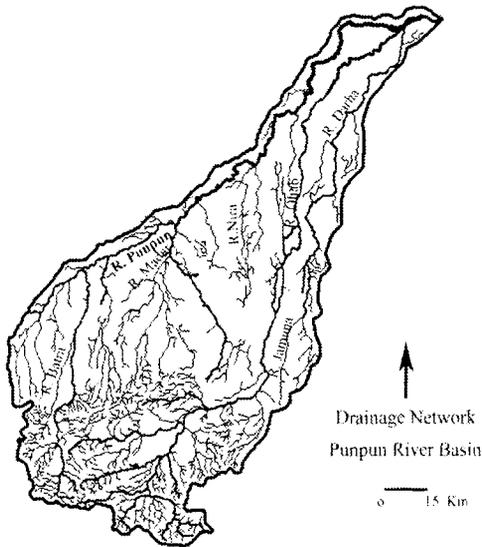


Fig. 2: Punpun River

mediate basin between the River Son in the west and River Palgu in the east both rivers flow in almost SW-NE direction. After leaving the highlands of the southern uplands, the Punpun flows almost in the northeastern direction for its entire course. The river

receives many tributaries from south along its course. Some of them are River Patane, River Adri, River Ballari, River Nira, River Sinane, River Chandal, River Morhar and River Jamuna (the last one is called River Darha in its lower course). One of the most notable features about River Punpun is that all its important tributaries (mainly the third and higher order streams) flow on its the eastern side. River Punpun itself flows very close to the western boundary of the basin in close proximity to river Son. Hence does not have the opportunity to develop tributaries on its western side.

The geomorphic characteristics of the Punpun River Basin may be just described as:

1. The SW-NE course of the Punpun river reflects a structural SW-NE alignment, parallel to the structural alignment of the neighbouring Son river in the west.
2. The Punpun flows on the western outer margin of the basin, while the Morhar flows in the central part of the basin.

3. The Punpun, however, qualifies as the main river of the basin by the greater width of its bed and water discharge. The width of Morhar and Darha is reduced to the size of rivulets towards the confluence with the Punpun.
4. But for the source region, the Punpun shows a meandering course.
5. The absence of any tributaries on the western side or left bank of the river with the exception of a few gullies due to the nearness of Son river.
6. A sharp bend towards the east, close to the mouth of Punpun river. In this section the Punpun flows from west to east and receives its major tributaries Morhar and Darha. This sharp turn before joining the Ganga also is observed in the case of Son and Phalgu river, the latter flows over a long distance parallel to the Ganga.
7. In their lower courses the major tributaries of Punpun too adopt a SW-NE direction which is also characteristic of the adjoining rivers towards the east, like the Phalgu.

The drainage pattern in the basin is dendritic in nature but becomes parallel in the lower course of the main tributaries. The total length of the master stream of the basin is 220 km and the total catchment area is 6482 sq km. The height of the Punpun basin ranges between 610 m on the southern boundary and 28 m near the confluence with the Ganga.

Drainage Network of Tributaries and Sub-Tributaries

The Punpun River basin is drained by a number of rivers, streams and rivulets which

jointly make the density of drainage network in the southern and central uplands. Most of them follow the SW-NE direction for their flow which is a common feature of the rivers of the study area with only a few exceptions.

River Morhar and Jamuna are the most important tributaries to the Punpun. The drainage network of Morhar is well developed and dense in its upper course. The Morhar rises in the Dumaria Upland on the eastern boundary of Palamu district from an altitudinal zone of 300-375 m. In its source region, Morhar is known as Chokti river and many small streams join from the surrounding area such as Urur, Anauna, Surhar, Kolhubar and Kasumahi. They represent the ideal dendritic drainage pattern. All these tributaries originate in and flow through the southern uplands of the Punpun basin. Streams such as Urur, Amauna, Kusumahi and Ghari are right bank tributaries of Morhar river in the southern and central part of the basin.

The course of the Morhar in the northern central region of the basin is quite intriguing. First, the river splits several times forming larger island between the two branches, and then the two arms join again. In one case the eastern distributary, called as Budha, joins the main stream after covering the distance of about 7 km. At Bajatpur the river divides forming river Dhab from the left branch. The Dhab flows first north and then bends towards the east parallel to the Punpun river. Further north the Morhar again bifurcates. The left branch retains the name Morhar while the right branch is called Darha, later join the Jamuna. These bifercations of the Morhar are the result of change in slope from the upland to the plain and the reduction in

discharge forcing the river to deposit material that it cannot transport. There is no important sub-tributary joining River Morhar in its lower course before meeting the Punpun after covering a distance of 408 km.

River Jamuna, which becomes River Darha in its lower course, rises near the south-eastern boundary of the basin. Only one tributary joins the river Darha or Jamuna namely Karwara.

The Punpun river basin experiences the maximum effect of running water in the monsoon season. However on account of the seasonal character of the rainfall, the rivers of this region suffer from a lack of perennial supply of water, hence during winter they are reduced to tiny rivulets over wide sandy beds. The tributaries of river Punpun in the central and the northern regions of the basin are swollen and turbulent during the rainy season but become fordable within a few weeks after the rain. For the rest of the year they are almost dry and reduced to tiny streams

Punpun River Basin: Drainage Frequency

According to Horton (1932) the drainage frequency is defined as the total number of stream segments per unit area. The occurrence of stream segments depends on the lithology, the structure of rocks, vegetation cover, nature and quantum of rainfall and infiltration capacity of the soil. It is an index of the various stages in landscape evolution.

The drainage frequency obtained for square grids with unit area of 51 sq. km. Table 1 record drainage frequency and Fig. 2 displays the areal distribution of drainage frequency in the basin.

Distribution of Drainage Frequency

Table No. 1 shows the distribution of drainage frequency in Punpun river basin which reveals that only 7.73% of its area exhibits a good drainage frequency cover that ranges from high to very high categories of the present classification.

1. **Poor drainage frequency (less than 0.112/sq.km):** This category is covering 40.10% (2599.28 sq.km.) area of the Punpun basin. The entire northern portion, eastern part and a small western portion of the basin are covered by this category. The northern portion of the low drainage frequency area are drained by the rivers Darha, Morhar, Dhab and Punpun, while in the eastern portion again the middle course of Morhar and the upper course of the river Jamuna are found. In the western central region there are the upper course of Punpun and middle course of rivers Batra and Patane.
2. **Moderate drainage frequency (0.112-0.224/sq.km):** It covers 1560.86 sq.km. or 24.08% area of the basin. Most of the central part of the basin is occupied by this category of drainage frequency and is drained by the rivers Adri, Patane, Teakri, Keshar, Jharhi, Medar, Dhab etc. There are many small areas of moderate drainage frequency through out the basin (fig. 2).
3. **Moderately high drainage frequency (0.224-0.336/sq.km):** The vast southern upland region is covered by this class of drainage frequency which amounts for 28.09% (1820.79 sq.km.) of the basin area. This area is fed by the upper and middle courses of river Batra, Patane, Subhar, Chotki, Morhar, Amauna, Kusumahi and others.

4. **High drainage frequency (0.336-0.446/sq.km):** This class of drainage frequency occupies 6% or 388.94 sq km of the Punpun river basin. Small areas of this class of drainage frequency are confined over the southern uplands in four different regions drained by the upper streams of Kolhubar, Surhar, Amauna, Ghari and Morhar.

5. **Very high drainage frequency (over 0.448/sq.km):** This category of drainage frequency covers only 1.73% or 112.13 sq km of the area in the Punpun river basin. Confined in the south-eastern uplands, there are four patches (Fig. 2) of very high drainage frequency. They are drained by the upper streams of Kolhubar, Morhar and Ghari.

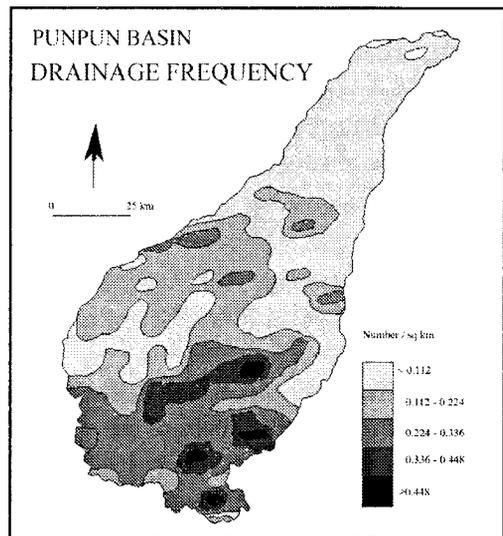


Fig. 3: Drainage Frequency

From the uplands in the south to the alluvial plain, high to moderately high (34.9%), moderate (24.8%) and poor drainage frequencies (40.10%) follow each other. As the more or less W-E running uplands do not form a continuous chain but are interrupted by some W-E flowing tributaries, isolated hills are observed, which show high to very high drainage frequency. It should be noted here that the youthful, mature and old relief of the basin match with areas of

poor, moderate and high drainage frequencies. The development of stream segments in the Punpun basin is more or less affected by rainfall conditions as well as the geologic and tectonic attributes of the terrain.

Drainage Density: Punpun River Basin

Drainage density refers to the total stream lengths per unit area. These values have been grouped into five classes as depicted in Table No. 2 and Fig. 4.

Table No.1: Distribution of Drainage Frequency

Drainage Frequency (No./sq.km.)	Drainage Frequency Category	Area (sq.km.)	Area (%)
Below 0.112	Poor	2599.28	40.10
0.112-0.224	Moderate	1560.86	24.08
0.224-0.336	Moderately High	1820.79	28.09
0.336-0.448	High	388.94	6.0
Above 0.448	Very High	112.13	1.73
Total		6482	100

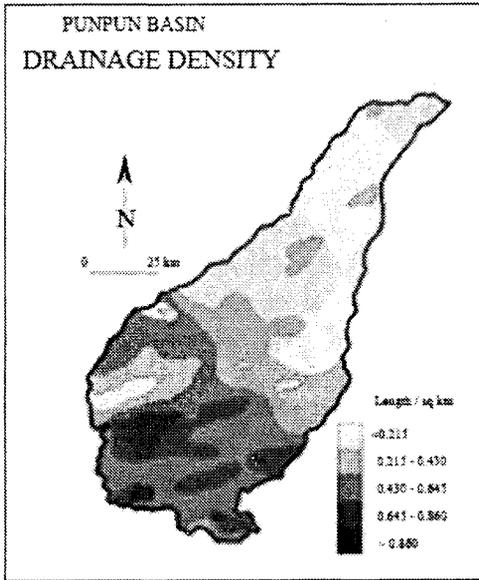


Fig. 4: Drainage Density

Distribution of Drainage Density

1. **Coarse drainage density (below 0.215 km/sq km):** The areas of coarse drainage density measure 42.07 % or 2726.97 sq km of the basin. The vast northern plain including some patches on the western boundary and others represent this category. The coarse drainage density is associated with the lower

courses of the rivers of the basin. Level land surface, less amount of rainfall and scanty natural vegetation are responsible for such drainage density in the Punpun basin.

2. **Moderately coarse density (0.215 – 0.431 km/sq km):** The transitional zone between the southern uplands and northern plain of the basin is occupied by moderately coarse drainage density. Some patches of this category are located in the north, south and western boundary of the basin. They cover 16.12% or 1044.83 sq km of the area of the basin.

3. **Moderate drainage density (0.431 – 0.645 km/sq km):** The areas of moderate drainage density occupy 2046.66 sq km or 32.11% of the Punpun basin. This drainage frequency is associated with the upper courses of many rivers of the southern upland. However, this zone is not uniform and is often interrupted by the presence of areas of finer or coarser drainage density.

4. **Moderately fine drainage density (0.645 – 0.860 km/sq km):** Areas of moderately fine drainage density are

Table No.2: Distribution of Drainage Density in Punpun River Basin

Drainage Frequency (No/sq. km)	Drainage Frequency Category	Area (sq. km)	Area (%)
Below 0.215	Coarse	2726.97	42.07
0.215-0.431	Moderately Coarse	1044.89	16.12
0.431- 0.645	Moderate Drainage Frequency	2046.66	32.11
0.645- 0.860	Moderately Fine	592.45	9.14
Above 0.860	Fine	36.29	0.56
Total		6482	100

confined only to the southern uplands in four different patches within the moderate drainage density regions. The largest patch is above the SW – NE hill range of the southern uplands. To the south of this larger area there are three small patches in a line stretching from SW to NE direction. Another small patch of this category is located in extreme south-eastern portion of the basin. Moderately fine drainage density accounts for 592.45 sq km or 9.14% of the total area of the Punpun basin.

5. ***Fine drainage density (above 0.86 km/sq km)***: Two tiny patches of the fine drainage density are located in south-eastern portion of the basin. The area under these patches is 36.29 sq km or 0.56% of the total basin. Rocky and sloping terrain is responsible for such drainage density in this part. This category is observed in the upper courses of river Amanuna and river Morhar.

From the source region to the mouth of the basin, the drainage density becomes coarser. However one can distinguish two different zones. The southern upland shows moderate to moderately fine drainage density. Though the area of moderate drainage density with 32.11% dominates, it is irregular and frequently interrupted by areas of mostly finer drainage frequency. This seems to reflect the changing character of the hilly relief and the rocks of the upland. About 58.19% of the area exhibits coarse and moderately coarse drainage density, where rivers mainly flow over younger and older alluvium. The spatial variations in the Punpun basin are related to precipitation effectiveness, vegetation and rock type.

Punpun River Basin – Drainage Pattern

The drainage pattern means the form or “geometrical forms” of the drainage systems and the spatial arrangements of streams in a particular locality or region. In other words drainage patterns refer to the particular plan or design which the courses collectively make. The location, number and flow directions of different streams of a particular region depend on the nature of slope, structural control, lithological characteristics, tectonic factors, climatic conditions, vegetal characteristics and geomorphic history of the drainage basin. The drainage pattern of any region is of great help in the interpretation of geomorphic features. Drainage patterns, according to Thornbury (1969), provide a more practical approach to an understanding of structural and lithological controls in landform evolution.

1. Dendritic Pattern

Dendritic or tree-shaped drainage pattern is the most common and widespread pattern to be found in the earth’s surface. The dendritic pattern is associated with the areas of homogenous lithologies, horizontal or very gently dipping strata, flat and rolling extensive topographic surface having extremely low relief.

The Punpun River Basin also enjoys the presence of dendritic pattern. Quiet well-developed dendritic pattern is observed in the southeastern and southern upland region. A small tributary of river Morhar – Kusumahi in the southeastern region of the basin presents an ideal case of dendritic drainage pattern. Other rivers which show this pattern are River Surhar, Amauna, Batra, Kolhunbar and Morhar in its upper course.

2. Radial (centrifugal) Drainage Pattern

Radial drainage patterns, also known as centrifugal patterns are formed by streams which diverge from a central higher ground, ending in all directions. It is obvious that dome structures, volcanic cones, batholiths and laccoliths, residual hills, small tablelands and isolated uplands favour the development of ideal radial patterns.

In the Punpun basin radial drainage pattern is not very common. It is observed only at one place in the basin, where the first order streams of River Adri, Keshar, Surhar and Patane flow in various directions from the hill range of 300 m height. This region is located on the northern boundary of the southern upland region of the Punpun river basin.

3. Parallel Drainage Pattern

Parallel drainage pattern is composed of numerous rivers which flow parallel to each other and follow the regional slope. This pattern is more frequently developed on uniformly sloping terrain. The main tributaries of Punpun such as rivers Patani, Morhar, Darha and Adri in their middle and lower courses form the parallel drainage pattern. In this way the northern and central parts of the basin exhibit these types of patterns.

Punpun River Basin: Occurrence of Floods

Normally the region is liable to scarcity of water when the rainfall is deficient or untimely. Sometimes due to high rainfall the rivers and streams are flooded, especially in the lower reaches of the river Punpun. Inundations are of short duration, local and cause little damage. Serious floods are rare in the central and southern part of the basin. However, some flooding is noted near the

confluence of river Punpun with the Ganga and along narrow stripes on both banks of the Punpun, whose middle and lower course are prone to seasonal flooding.

Conclusion

The Punpun river basin, sandwiched between the Son in the west and the Falgun basin in the east, has a varied relief caused by structural alignment of the main rivers, the lithology, crystalline rocks in the south, alluvial deposits in the north, and the rainfall regime. The different relief provinces, namely hills interrupted by valleys in the south and alluvial plain in the north are recognisable in the drainage pattern (dendritic in the south, parallel in the north), in the drainage frequency (high to moderately high in the south, poor in the north), and in the drainage density (moderate in the south but coarse in the north). In between the two areas some transitional zone emerges especially in the southwest with moderate drainage frequency and moderate coarse drainage frequency partly formed over older alluvium.

References

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