Chapter-2 About the Study Area

Introduction

This chapter tries to give a picture of the physical and socio-economic background of the Chel River Basin. The major objective of the present study is to analyze the historical channel planform dynamics of Chel River and since the factors governing such dynamism can be multi-faceted ranging from physical to human, it becomes imperative to give a systematic setup of such factors. Hence physiography, climate, drainage, geomorphology, geology, soil, LULC, natural vegetation, road and railway, demographic aspects, level of literacy, social structure, and work participation has been discussed herein at basin scale.

2.1 Physiography

The terrain in the Chel River basin ranges from highly undulating Eastern Himalayan surface in the north to gently rolling North Bengal alluvial plains in the south. The catchment area of the Chel basin above 300m is located on the flanks of Eastern Himalaya and in fact is an assemblage of numerous undulating hilly ridges and valleys heavily dissected by small streams and rivulets. The basin stretches from sub-tropical alluvial plains of Dooars with elevation of 100m near Kranti to almost temperate altitudinal zone in the northern extreme attaining elevation of 2450m at upper Westnar forest. The rise of elevation from south to north of the basin is gradual till Gorubathan but after Gorubathan northwards the surface elevation rises quickly. The basin rises northwards from Kranti (100m), Rajadanga (105m), Targhera Forest Beat Office (137m), Odlabari Bazar (155m), Rangamati T.G.(222m), Putharjhora T.G. (278m),Upper Fagu T.G. (524m), Pankhasari Khasmahal (138m), Samibiyong T.G. (1694m) and finally to Westnar Forest (2000-2450m). Physiographic divisions derived from SRTM DEM (30m spatial resolution) shows presence of high-altitude section in the north which falls under the relief zone of 1709- 2450m but the elevation quickly reduces to below 350m beginning from piedmont zone southwards for rest of the basin (Fig.2.1). The relief profiles drawn shows highest surface gradient of 0.57 in North-South direction, the medium surface gradient of 0.02 in the middle portion and presence of low surface

gradient of 0.015 in the lower part. The relief profiles also reveal two dominant surface gradient directions i.e. North to South and East to west (Fig.2.2). These two surface gradient directions have controlled the flow direction of drainage lines.

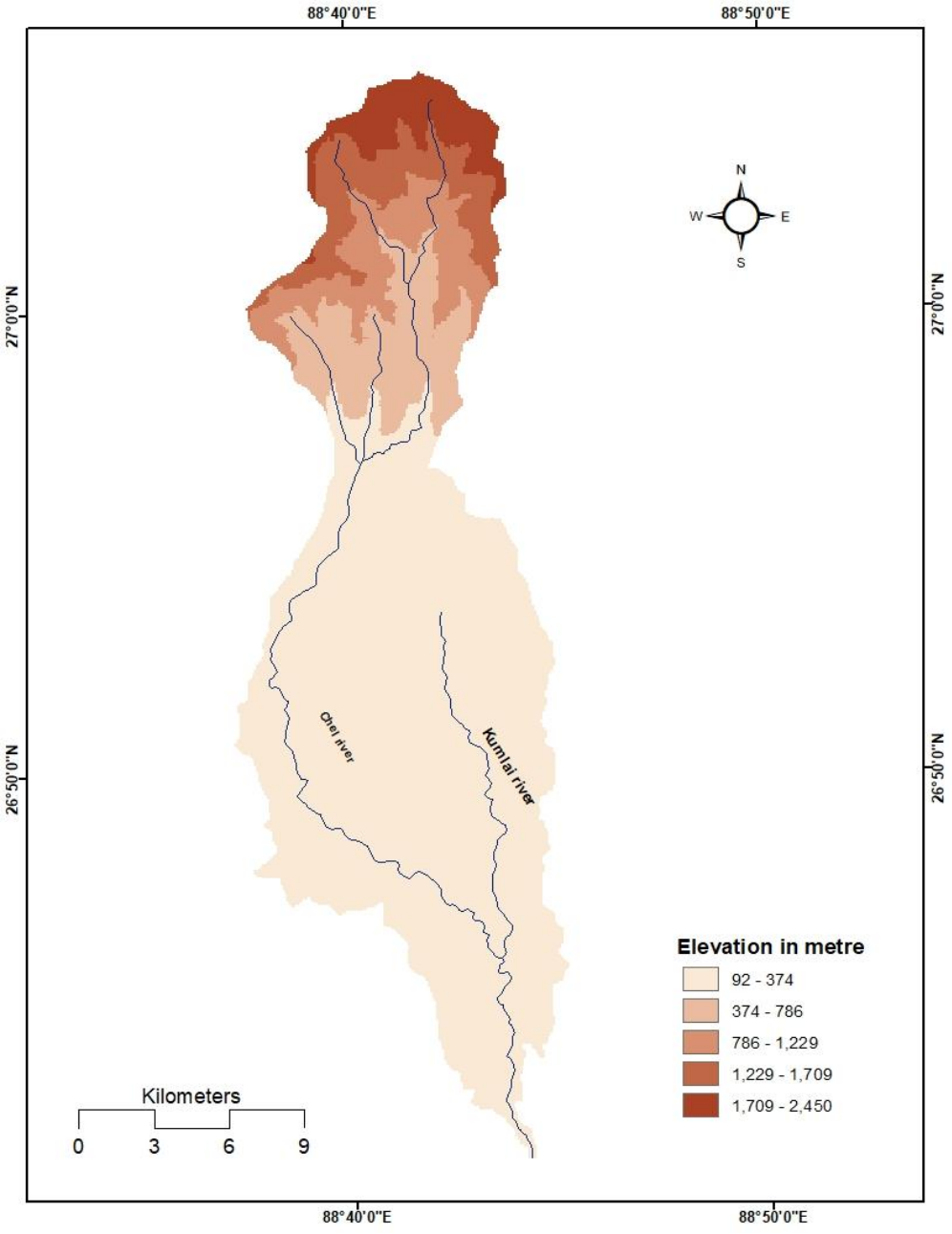

Figure 2.1 Surface elevation of the Chel River Basin.

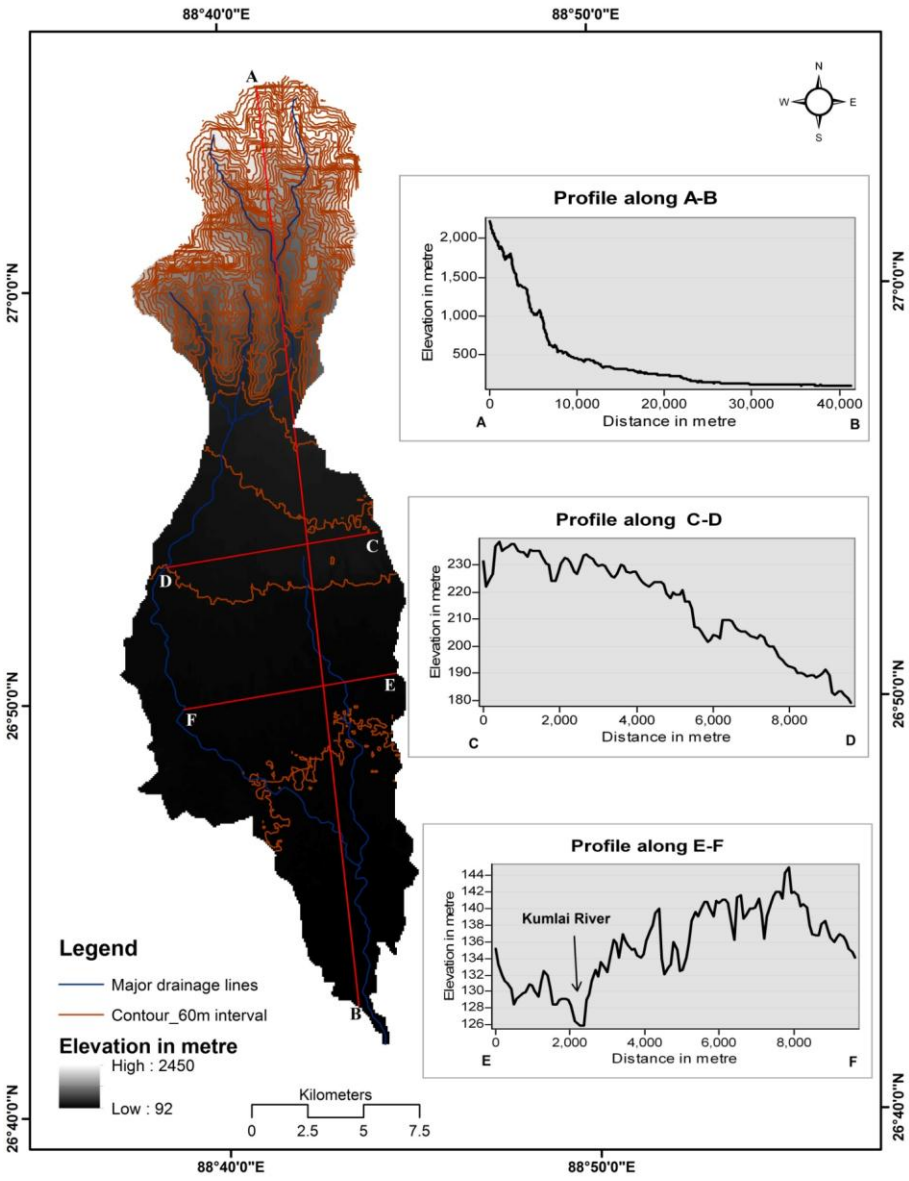

Figure 2.2 Gradient of land surface in Chel basin

2.2 Geomorphology

Broadly the Chel River basin can be divided into three geomorphic units, namely northern upper eastern Himalayan region, piedmont fan region in the middle and lower alluvial plain region in the south. The upper Himalayan region is the catchment of the basin and is characterised by presence of innumerable folded ridges and valleys which are disected heavily by numerous streams and rivuets. Few escarpments has developed over folded ridges at the northern edge of the basin most probably due to incresed vertical erosion induced by neotectonic upliftment of the basin. The piedmont surface covers

largest area of the basin and is characterised by huge aggradation of sediments due to break in slope. Therefore presence of large amount of unsorted boulders and gravels is ubiquitous. Lower portion of this region suffers from gully erosion by numerous plain origin streams. The lower alluvial plain region of the south is characterised by very gentle slope and presence of fine silt and clayey soil.The north central part of the region has developed into a badland topography due to gully erosion (Fig.2.3).Thus geomorphologically the basin comprises of the alluvial plain, piedmont surface, terrace surfaces, lesser Himalayan surfaces etc.

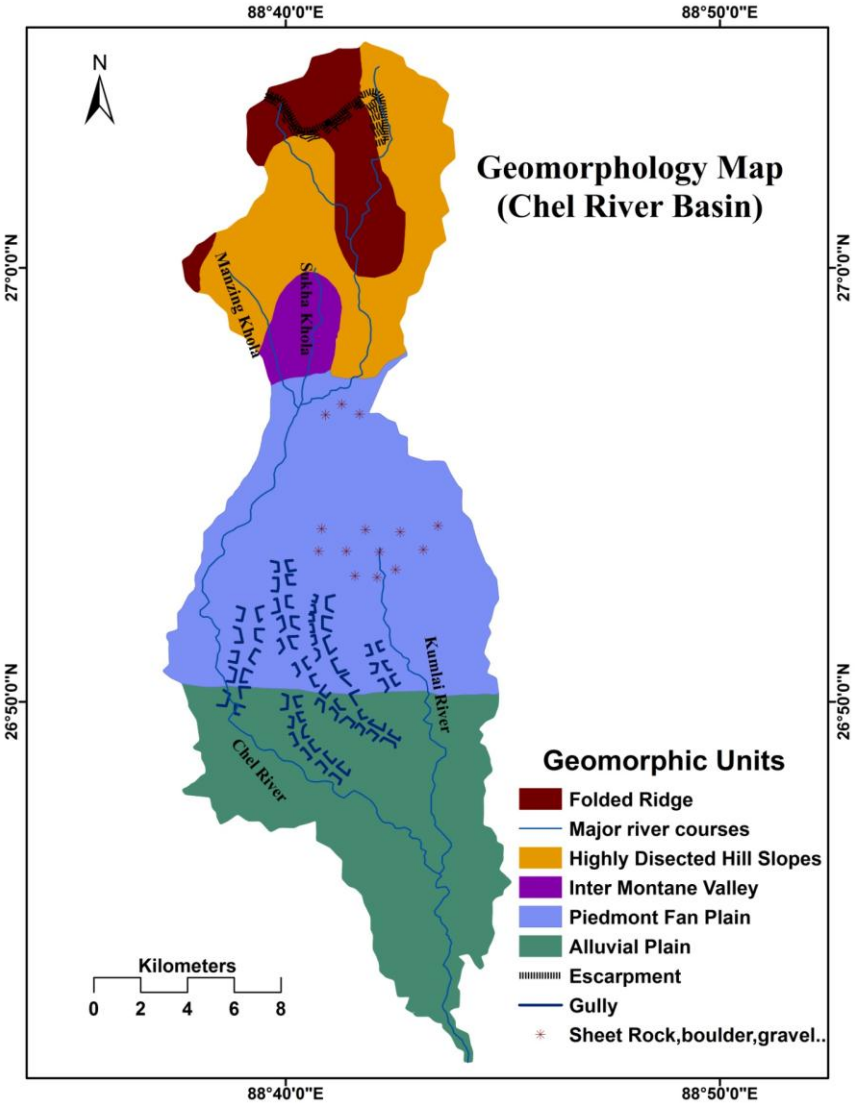

Figure 2.3 Geomorphology of Chel River Basin.

2.3 Climate

The basin experience tropical monsoonal type of climate. The annual total precipitation ranges between 250- 500 cm, 90% of which happens during four-five months of high-sun season (May-September) whereas very little precipitation happens during low-sun season. One or two months may remain rainless too during the low-sun season. Mean monthly temperature usually ranges between 18°C – 30°C. The highest temperatures are recorded during late spring just prior to the onset of monsoon (Fig.2.4).

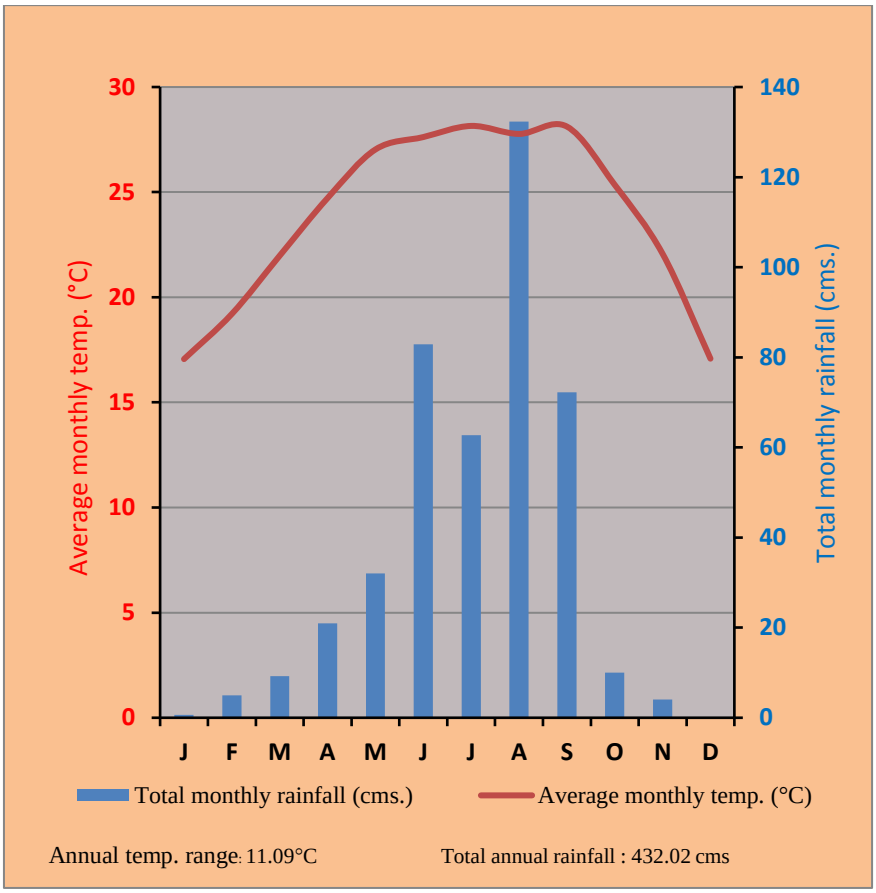

Figure 2.4 Climograph of Rangamutee Tea Garden, 2015 on the piedmont of Chel River representing typical Tropical monsoonal (Am) type of climate according to Koppen's Climate classification system experienced in the basin.

2.4 Drainage

The catchment area of the Chel basin is dissected by numerous rivulets and jhoras originating from different hill ridges and crests of different elevation which flows down to join and form small streams or Khola. Two similar rivulets, namely Kali and Sel merge to form Chel River at an elevation of 540m in the forest valleys of Sakam Reserve Forest. Flowing southwards Chel River is joined by two major right bank tributaries, namely Manzing Khola and Sukha Khola at piedmont near Putharjhora Tea Garden at an elevation of 264m. Further downstream Kumlai River joins Chel River as a major left bank tributary at the alluvial plain reach near Rajadanga at an elevation of 109m. Thus with a total length of 58.23 kms, Chel is a rain fed river which originates in the Sakam Reserve Forest and flowing southwards it flows via Ambiok, Gorubathan,Odlabari, Rajadanga and finally merges with Neora River near Kranti at an elevation of 92m . The combined flow of Chel and Neora River is called Dharala River which flows for 13kms and then merges with mighty Teesta River at an elevation of 89m about 8kms upstream of Teesta Bridge, Domohani, Jalpaiguri. Altogether the drainage network displays a typical dendritic drainage pattern in the Chel river basin (Fig.2.5).

Apart from these major streams, the Chel River is fed by many small seasonal streams, many of which become prominent enough to acquire the shape of streams only during the rainy seasons. Unlike two other left bank tributaries of Teesta namely, Lish and Gish, river Chel is the third major left bank tributary which flows almost parallel to the Teesta for a considerable length downstream from mountain front through the piedmont and alluvial plain stretch of Sub-Himalayan West Bengal (inset image of Fig. 4.1.1).

2.5 Geology

In general, geologically, Darjeeling Himalaya is made up of sequence of over thrusts pushed southwards (Froehlich and Starkel, 1993). The North-South geological section shows presence of Darjeeling gneisses, Daling phylittes and quartzites, Damuda shales separated by the Main Boundary Fault, the Tertiary molassic deposits of Siwaliks and, again another thrust namely Himalayan Frontal Tectonic Line, Quaternary deposits of boulders and alluvium to the extreme south. The highest point at Tiger Hill attains an

elevation of 2590 m (Fig.2.7). Among all, the Siwalik belt is very narrow in occurrence (0-5km) and is totally absent in some stretches forming bays (Fig.2.6).

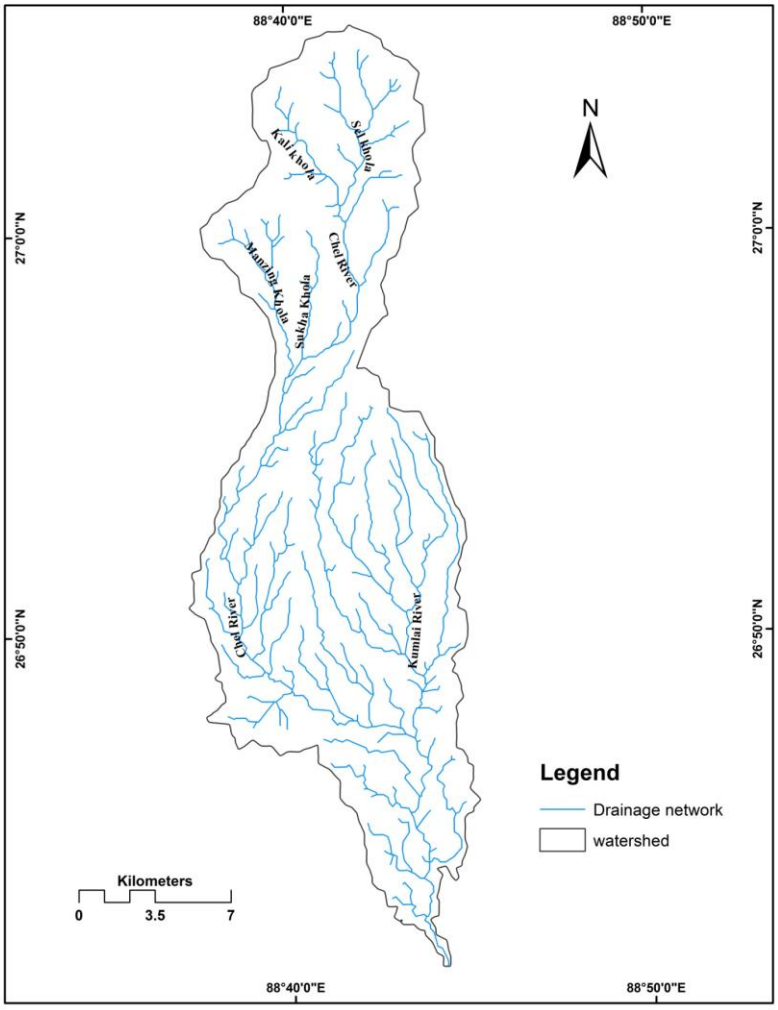

Figure 2.5 Drainage network of the Chel River Basin.

Nakata, 1972 has called these bays as re-entrants, along which the Ganga-Brahmaputra lowland enters north into the mountain fronts. In the case of Chel River basin, it is worth noticeable that there is total absence of Siwalik belt as well as Damuda series belt. Thus, within this gap the Quaternary sediment deposits of North- Bengal plains penetrate much northward up to mountain front almost near Gorubathan surface (Fig.2.6).

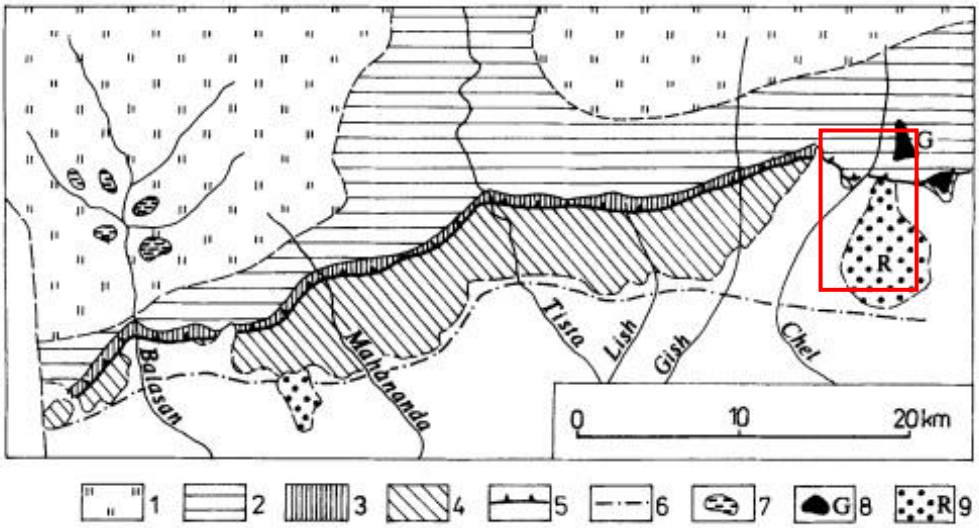

Figure 2.6 Geology and high erosional and accumulation levels, based on Heim and Gansser (1939), Nakata (1972) and Froehlich and Starkel (1993). 1. Darjeeling Gneiss; 2. Daling Phyllites and Slates; 3.Damuda Series; 4. Siwalik Series; 5. Main Boundary Fault; 6. Himalaya Front Tectonic Line; 7. Ambootia Surface; 8. Gorubatahan Surface; 9. Rangamati Surface. Chel basin demarcated by red rectangle.(Source- Froehlich and Starkel, 1993.pp-286).

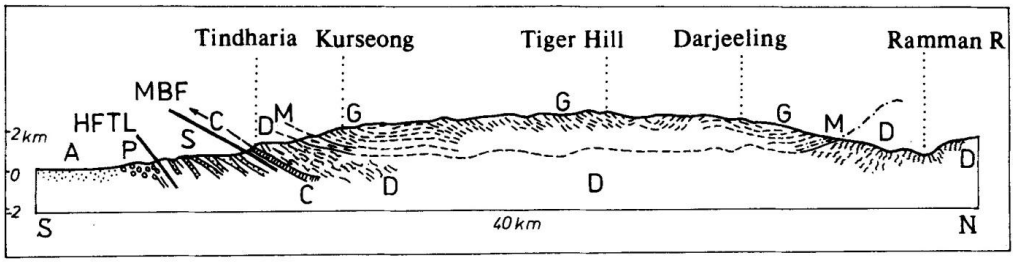

Figure 2.7 Geological section of Darjeeling Himalaya in North- South direction, after Heim and Gansser (1939). A,Holocene alluvium; P, Pleistocene Boulders; S, Siwaliks; C, Damuda Series; D,Daling phyllites and slates; M, Mica schists; G, Darjeeling gneisses; MBF and HFTL, two main fault lines.(Source- Froehlich and Starkel, 1993.pp-286).

Chel basin falls under the Gorubathan Recess in the Darjeeling Frontal Himalaya (Fig.2.9). The Himalayan Mountain front is sinuous in map view. Recesses are the Himalayan front convex-to-the hinterland expressions. Opposite to Recesses are the Salients, defined as Himalayan fronts expressions convex-to-the foreland. In fact,

Salients and recesses are the characteristic features associated with sinuosity of the Himalayan front in map-view (Marshak, 2004; Mukul, 2010).

The absence of Siwalik and Damuda series makes Gorubathan recess unique in the Eastern Himalayan belt as the North- South width of the Himalayan arc is minimal here (Heim and Gansser, 1939; Srivastava et al., 2017). The North-South aerial distance between the foreland (27.0947° N, 88.8744° E) and the Tibetian Plateau in the Yadong-Gulu Rift (27.6781° N, 89.1175° E) is merely ~ 70 km here (Srivastava et al., 2017). Nakata, 1989 had identified all the faults in the Gorubathan Recess. Over the years contemporary geologists (Mukul, 2000; Matin and Mukul, 2010; Kundu et al. 2011, 2012; Kundu, 2013; Srivastava et al., 2017) have re-interpreted the existing faults on the basis of well constrained field observations and contemporary fold-and-thrust theory.

Gorubathan-Jiti and Matiali faults were identified as the Main Boundary thrust (MBT) by Nakata (1989). Based on occurrence of Daling over Gondwana series which is characteristic of Ramgarh Trust (RT) in the neighboring Dharan Salient West of Gish Transverse Fault (GTF), it was subsequently revised as Ramgarh Thrust (RT) (Matin and Mukul, 2010). Thus, in the Gorubathan Recess, Gorubathan-Jiti fault is interpreted as the RT and it defines the Himalayan Mountain Front (Srivastava et al., 2017). The Matiali fault formed due to reactivation and bifurcation of the Gorubathan fault and thus identified as MBT (Nakata, 1989). However, Srivastava et al., 2017 have interpreted Matiali fault as a footwall rejoining splay (e.g., Boyer and Elliot, 1982) of RT at the present erosion- level due to exhibition of branch points with RT and geometry of Matiali fault in plan-view (Fig. 2.10). Nakata (1989) interpreted the Chalsa fault as MFT. However, Gondwana rocks are observed in the footwall overlaid by Dalings in the hanging wall, in the Chel river section, west of the branch point (B) of the Matiali fault with RT (Fig.2.8 &2.10). Srivastava et al., 2017 argues that since Chalsa fault is the next observed fault south of RT, it should carry Gondwana rocks in the hanging wall. Further, since the MBT carries Gondwana rocks in its hanging wall in the frontal Dharan Salient (Mukul,2000), the Chalsa fault is the MBT rather than MFT in the Gorubathan recess.

Nakata, 1989 had identified Baradighi fault to the south of the MBT. This blind Baradighi fault has been interpreted as MFT in Gorubathan recess in correlation with the imbricate fan or schuppen zone structure that repeats the Siwalik section (Kundu et al., 2011,2012; Kundu,2013) south of MBT in the neighboring Dharan salient. However, Srivastava et al., 2017 states that there is need of more detailed information from sub—surface logs and data to establish the above interpretation of structural geometry of Gorubathan recess more definitively especially south of Chalsa fault trace as because there is only one topographic high at Bharadighi which is the lone indicator of deformation in the footwall of Chalsa fault (MBT). Thus, in the light of present knowledge, recent works and understanding about the Gorubathan recess it can be said that within Chel river basin Ramgarh Thrust which is locally called Gorubathan-Jiti fault marks the mountain front. Since chel basin forms the western portion of the Gorubathan recess, there seems no presence of MBT and HFT. This seems reasonable from the point of view of absence of any topographic highs south of RT within the Chel basin.

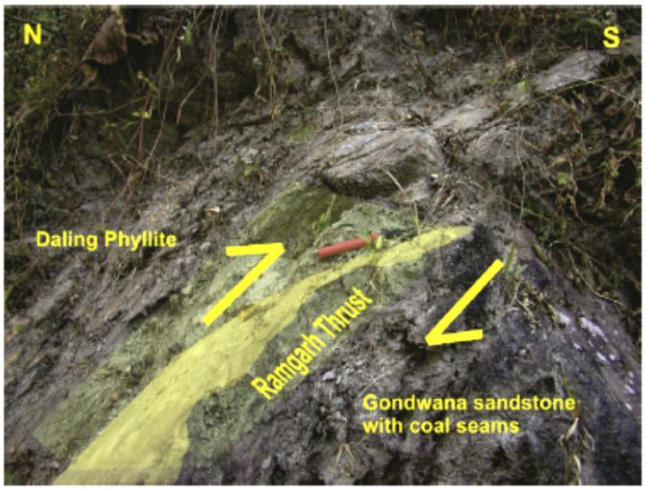

Figure 2.8 Exposed Ramgarh thrust (RT) in Gorubathan town carrying Daling phyllites over Gondwana sandstones at the base of the T4 deformed terrace (Yellow shaded area is exposed fault surface). Source- Srivastava et al., 2017.pp-9.

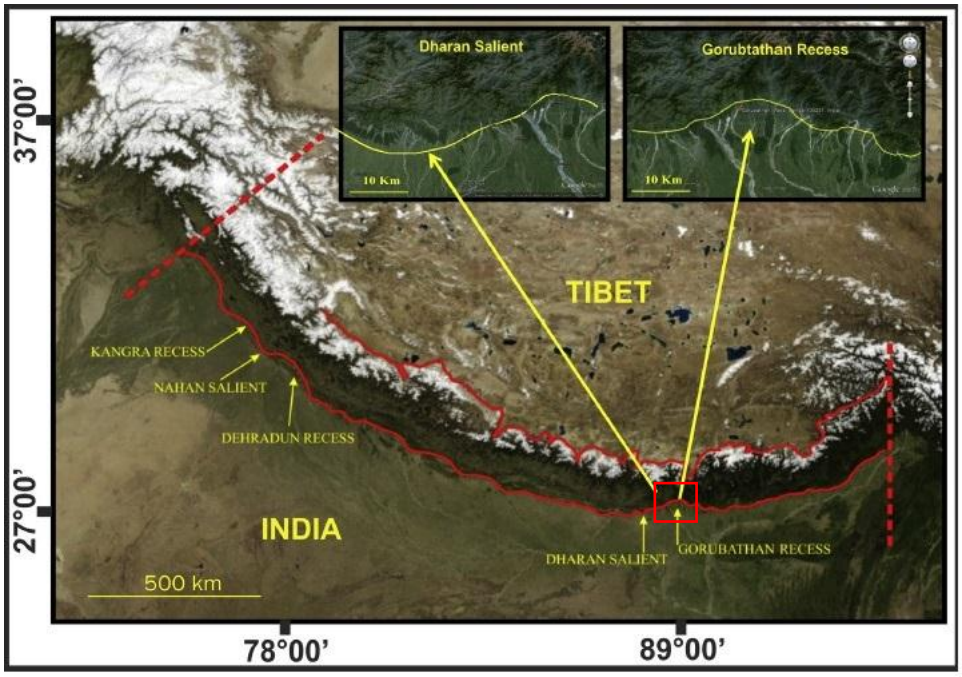

Figure 2.9 Map showing Sinuosity in the Himalayan arc expressed as convex-to-the-foreland salients and convex-to-the-hinterland recesses. Location of Chel River basin in Gorubathan Recess marked with red square (Source: Srivastava et al., 2017.pp-3).

The catchment area of the basin above the RT has an area of about 96.7 sq.km. The Chel River, having its origin in the Darjeeling Himalaya runs for 14.12 km length in its mountainous course and then descends down to north Bengal plains for rest of its length of 44.13 km to meet river Neora. The northern hilly catchment portion of Chel basin lies to the east of Lesser Himalayan Duplex (LHD) and Gish Transverse zone (GTZ), a sinistral strike-slip transverse fault, at the very proximity (Mukul et al. 2017). The northernmost part of the catchment drains Chungthang formation of Proterozoic age, followed by Lingtse Granite Gneiss of Proterozoic-II and Reyang formation of again Proterozoic age. Downstream, the river crosses over a narrow strip of Buxa formation of Proterozoic age again. Further downstream from near mountain front, remaining part of the basin is located on Quaternary sediments of Baikunthapur formation of the very recent Holocene epoch and Chalsa formation (middle to upper) of Pleistocene epoch (Fig. 4.5.13 & Table 4.5.1).

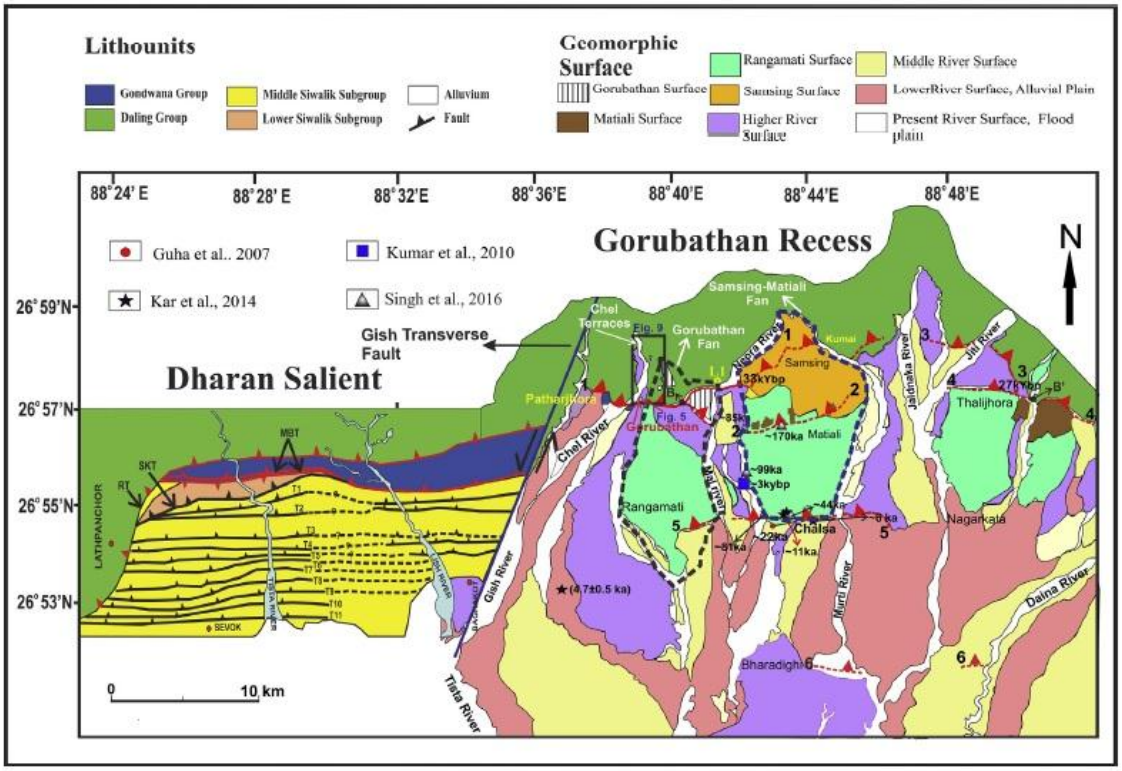

Figure 2.10 Geology of the frontal Darjiling Himalaya. Eleven imbricate thrusts in the footwall of the MBT were observed in the Dharan salient (Kundu, 2013). Deformed Quaternary alluvial fans were seen in the Gorubathan recess (dashed lines). Red lines show the major active faults in the area: 1. Gorubathan fault (RT); 2. Matiali fault (rejoining splay of RT); 3. Jiti fault (RT); 4. Thalijhora fault (rejoining splay of RT); 5. Chalsa fault (MBT); 6. Bharadighi fault (MFT?) (Modified after Nakata, 1989). B and B' shows two branch points of Matiali fault with Gorubathan fault (RT). (Source- Srivastava et al., 2017 pp-4)

2.6 Soil

The major part of the Chel basin is covered with very deep fine loamy soil (Fig. 2.11). It occurs on very gently sloping lower piedmont plain and covers the middle portion of the basin. It is characterized by poor draining capacity (Fluventic Dytrochrepts and Fluventic Eutrochepts). In terms of areal coverage, next follows very deep, poorly drained, coarse loamy soils (Typic Haplaquents and Typic Fluvaquents) which occurs on level to nearly level lower piedmont plain with loamy surface and covers the southern part of the basin. The hilly portion of the basin is covered with Moderately shallow, well drained, gravelly loamy soils (Loamy- skeletal, Typic Udorthents) between the elevation range of 400-800 meters (approx). It occurs on steep sided slopes with gravelly loamy

surface and is characterized by moderate erosion and moderate rockiness. Then follows, moderately shallow, excessively drained coarse loamy soils (Typic Udorthents Loamy skeletal, Typic Dystrochrepts) occurring on steep side slopes above 800 meters (approx) characterized by gravelly loamy surface, severe erosion and strong rockiness. A small patch (1.16 % of basin area) of Shallow, excessively drained, gravelly loamy soils (Lithic Udorthents.) is found in the northern most corner of the basin. It generally occurs on very steep side slopes and characterized with gravelly loamy surface and is generally associated with severely eroded rocky outcrops (Fig.2.11 & Table 2.1).

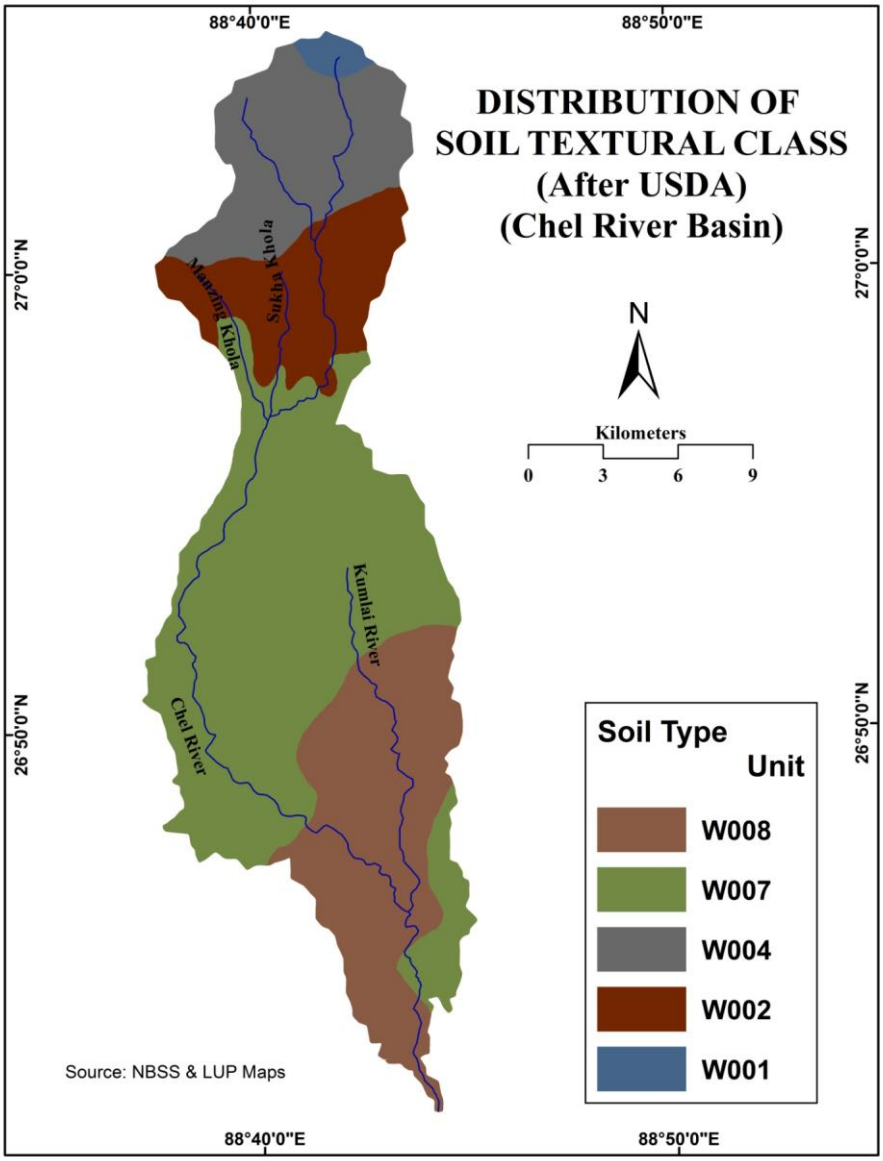

Figure 2.11 Distribution of soil types in the Chel River Basin.

Table 2.1 Table showing type, characteristics and areal coverage of different soil types in Chel River Basin (Source- adopted from NBSS & LUP Maps).

Map symbol	Description	Taxonomic Name	Area (sq.km.)	% age to basin area
W001	Shallow, excessively drained, gravelly loamy soils occurring on very steep side slopes with gravelly loamy surface and severely eroded, Associated with rocky outcrops	• Loamy skeletal, Lithic Udorthents.	3.72	1.16
W002	Moderately shallow, excessively drained coarse loamy soils occurring on steep side slopes with gravelly loamy surface, severe erosion and strong rockiness. Associated with moderately shallow, well drained, gravelly loamy surface and moderate erosion.	• Coarse loam, Typic Udorthents • Loamy skeletal, Typic Dystrochrepts	40.51	12.62
W004	Moderately shallow, well drained, gravelly loamy soils occurring on steep side slopes with gravelly loamy surface, moderate erosion and moderate rockiness	• Loamy- skeletal, Typic Udorthents	48.73	15.18
W007	Very deep, imperfectly drained, fine loamy soils occurring on very gently sloping lower piedmont plain with loamy surface and moderate erosion Associated with very deep, imperfectly drained, coarse loamy soils.	• Fine loamy, Fluventic Dytrochrepts. • Fine loamy, Fluventic Eutrochepts.	151.84	47.3
W008	Very deep, poorly drained, coarse loamy soils occurring on level to nearly level lower piedmont plain with loamy surface Associated with very deep, poorly drained, coarse loamy soils.	• Coarse loamy, Typic Haplaquents • Coarse loamy, Typic Fluvaquents.	76	23.7

2.7 Land Use Land Cover (LULC)

LULC map was generated based on Landsat 8 OLI/TIRS (Dec, 2017) image with 30m spatial resolution data in consultation with SOI topographical maps and Google Earth. The LULC classes produced show that the basin has a good percentage of area (35.76%) under forests followed by Tea Gardens (30.11%), 13.07% of croplands, 3.8% under sandy bars,0.92% under rivers and streams water and only 0.41% under settlement (Urban areas) (Fig.2.12).

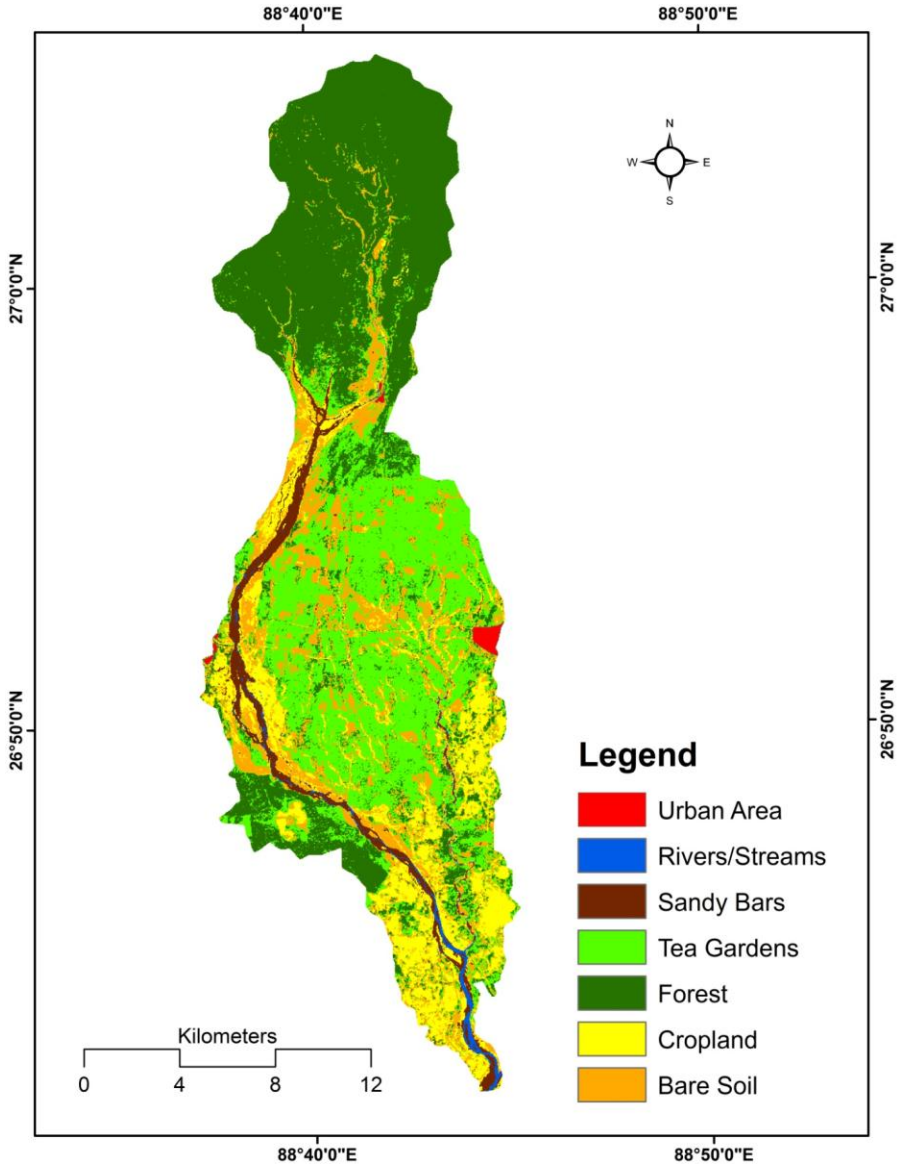

Figure 2.12 Land Use Land Cover map of Chel River Basin.

2.8 Natural vegetation

Chel basin possesses very good amount of area under natural vegetation (35.76%) which is much better than the national forest coverage percentage of 21.54. Noted researchers like Champion and Seth (1968), Banerjee (1964), Bhujel (1996), etc have studied and classified the natural vegetation of this region. Following their works and based on variation in elevation and major species composition, the forests of Chel basin can be categorized into following types-

1. Tropical Forest (Plains and low Hill Forest, upto 1000m) - This forest can be sub-categorised into semi-evergreen, moist and dry deciduous forests and comprises mainly broad leaved trees. Trees attain heights of 25 to 35 m and thus are distinctly above the dense herbaceous undergrowth below. The tree species are mixed but dominancy of *Shorea Robusta* (Sal trees) has been noticed during field surveys. Extensive Sal forests dominate the basin below 300m from near Gorubathan (Western edge of Sakam Reserve Forest) to Apalchand Tea Garden, below Odlabari which is a part of Apalchand Reserve Forest.

2. Sub-Tropical forest (Middle Hill Forest, 1000-1600m)- This forest type comprise both deciduous and evergreen forests. This zone covers Ambiok forest, Nim Khasmahal, and Phaparkheti areas of the basin. The dominant species includes Panisaj (*Terminalia myriocarpo*), Chilauni (*Nyssa sessiliflora*), *Siris* (*Albizzia spec*.) etc. Huge climbers and epiphytes occur along with deciduous trees in this forest.

3. Temperate Forest (Upper Hill Forest, 1600-2400m) - The vegetation is thick and comprises of medium sized evergreen trees. Pankhasari, Sambiyong and Westnar forest areas comes under this type of forest. Deciduous trees cover small portion of the areas. There is presence of mixed type of vegetation and major species are Katus (*Castanopis indica*), Phalado (*Erythrine indica*), Walnut (*Juglans regia*), Oaks (Querus), Laurels (Laurus nobilis) etc. Moses, Lichens and epiphytes grows vigorously over the branches of large trees. The ground is covered with vigorous growth of shrubs, herbs and ferns.

2.9 Road and Railway

Chel River Basin is well connected with neighboring districts and states with good road and railway network. Most importantly NH31C and NEFR Broad gauge railway line passes through its middle portion in east west direction (Fig.2.13). Further state highways and rural roads Criss cross the basin. Development of good transportation network facilitates in huge sediment mining activity in the basin (Sub-Chapter-4.6).

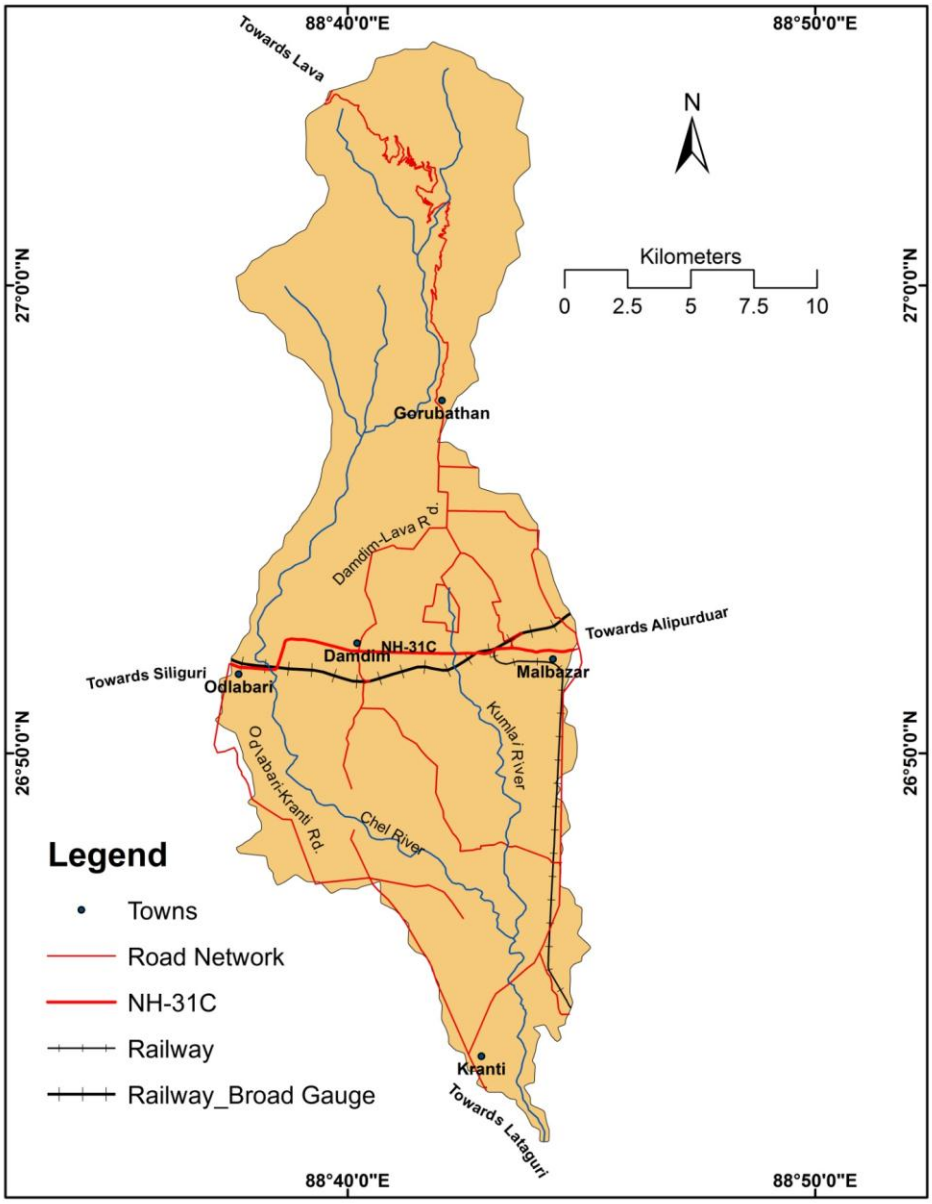

Figure 2.13 Transport network in the Chel River Basin.

2.10 Demographic Aspects

Chel River basin spreads over parts of Gorubathan and Malbazar blocks of Darjeeling and Jalpaiguri districts respectively of West Bengal. These two blocks have been considered to get an idea about the demographic aspects of the basin. The municipality of Malbazar and census town of Odlabari lies at the eastern and western edges of the basin boundary, therefore the demographic aspects of these two towns have not been included to avoid getting an inflated figure. According to the Census of India, 2011 Gorubathan block has a total population of 60663, of which 51.19% is males and 48.81% is females. Similarly, Malbazar block has a total population of 299556, of which 50.68% is males and 49.32% is females. Malbazar has a better sex ratio of 973 against 953 of Gorubathan. The average sex ratio of the two blocks is 963 which is far better than the national average sex ratio of 940 (Table 2.2). The decadal growth of population of Gorubathan during 1991-2001 was 17.03% whereas it was slightly lower 15.39% for Malbazar. While during 2001-2011 the decadal growth of population was slightly higher for Malbazar (12.87%) against 11.76% of Gorubathan. The average decadal growth registered during last two decades (1991-2011) was 14.12% (Table 2.3). Higher population growth in such a difficult terrain put more stress on the existing land, soil and water resources. This in turn increases slope instability and soil erosion.

Table-2.2 Demographic and socio-economic characteristics of the study area (Census, 2011)

Blocks	Population	Sex Ratio	Scheduled Caste (%)	Scheduled Tribe (%)	Literacy (%)	Male Literacy (%)	Female Literacy (%)	Working Population (%)	Working female out of the working population (%)	Main workers (%)
Gorubathan	60663	953	6.64	23.6	76.88	84.21	69.23	39.79	37.03	23.81
Malbazar	299556	973	26.84	34.5	57.67	56.72	43.28	37.94	31.63	27.94
Average		963	16.74	29.05	67.28	70.47	56.26	38.87	34.33	25.88

2.11 Level of Literacy

The level of literacy in the Chel Basin blocks is 67.28% with 70.47% male literacy and 56.26% female literacy (Table 2.2). All the values are lower than the national average figure of 74.04%. Comparatively Gorubathan fares better with 76.88% literacy rate against 57.67% literacy rate of Malbazar. Further Gorubathan also scores better in both male and female literacy rates of 84.21% and 69.23% respectively against 56.72% and 43.28% of Malbazar. People in general here have to follow a difficult lifestyle putting in intensive physical labor for making their ends meet. Attainment of basic education becomes secondary and thus gradually this leads to lacks of opportunities for attainment of social and cultural development.

Table- 2.3 Decadal growth of population in the study area (Census, 2011)

Blocks	Decadal Growth, 1991-2001 (%)	Decadal Growth, 2001-2011 (%)	Average (1991-2011) %
Gorubathan	17.03	11.76	14.1
Malbazar	15.39	12.87	14.13
Average	16.21	12.32	14.12

2.12 Social Structure

In the Chel basin blocks 16.74% scheduled castes and 29.05% scheduled tribe population to the total population resides. The percentage of both Scheduled Caste and Scheduled Tribe population is high in Malbazar. Gorubathan holds on 6.64% of Scheduled Caste population but it holds a significant percentage (23.6%) of Scheduled Tribe population (Table 2.2). Scheduled Caste and Scheduled tribe population are mostly engaged in informal menial works as daily wage earners in tea gardens, sediment mining, coal mining etc.

2.13 Work Participation

According to census 2011, 38.87% of the total population is the working population in the Chel basin blocks. Out of this figure, 25.88% are the main workers and rest 12.99% are the marginal workers.The percentage of working population in Gorubathan is 39.79% whereas it is 37.94% in Malbazar. Thus, there is not much difference in terms of work participation percentage between the blocks. But if we consider the female working population percentage to the total working population than it is significantly more in Gorubathan (37.03%) than in Malbazar (31.63%). The average female working population percentage is (34.33%) (Table 2.2).

Major Findings

- The Chel basin stretches from sub-tropical alluvial plains of Dooars with elevation of 100m near Kranti in the south to almost temperate altitudinal zone in the northern extreme attaining elevation of 2450m at upper Westnar forest. The rise of elevation from south to north of the basin is gradual till Gorubathan but after Gorubathan northwards the surface elevation rises quickly.
- Broadly the Chel River basin comprises of northern upper eastern Himalayan region, piedmont fan region in the middle and lower alluvial plain region in the south.
- With annual total rainfall range of 250-500cm and mean monthly temperature range of 18-30^{o}C, the Chel basin experience tropical monsoonal type of climate.
- The drainage network of Chel basin exhibits typical dendritic drainage pattarn. The Manzing khola and Sukha khola are the major right bank tributaries of Chel River whereas Kumlai River is the major left bank tributary.
- Chel basin falls under the Gorubathan Recess in the Darjeeling Frontal Himalaya. The absence of Siwalik and Damuda series makes Gorubathan recess unique in the Eastern Himalayan belt as the North- South width of the Himalayan arc is minimal here.

- The absence of Siwalik and Damuda Series has another important implication on the structural geology of the Gorubathan recess and makes it a unique region in the Darjiling frontal Himalaya as Ramgarh thrust, rather than the MFT, defines the mountain front here.
- Very deep fine loamy soil is the most dominant soil group which covers 47.3% of the total Chel basin area.
- The LULC classes shows that the basin has a good percentage of Forest area (35.76%) followed by Tea Gardens (30.11%), 13.07% of croplands, 3.8% under sandy bars,0.92% under rivers and streams water and only 0.41% under settlement (Urban areas).
- The Chel basin comprise of three types of forests, namely tropical forest (upto 100m), Sub-tropical forest (1000-1600m) and temperate forest (1600-2400m).
- Chel River Basin has good network of road and railway lines. NH31C and NEFR Broad gauge railway line passes through its middle portion in east west direction. Further state highways and rural roads criss cross the basin.
- The total population of Chel Basin area is 360219. Sex ratio of the area is 963 which is better than the national average of 940 and shows characteristics of an agrarian region. The decadal growth of population was 16.21% in 1991-2001 which decreased to 12.32% in 2001-2011. Average decadal growth of the area is 14.12% during 1991-2011.
- With a literacy rate of 67.28%, the Chel basin area lags behind the national literacy rate of 74.04%. The male literacy is 70.47% and female literacy is 56.26% in the study area.
- The study area has 16.74% scheduled caste and 29.05% Scheduled tribe population to the total population.
- In the study area 38.8% of the total population are the working population, of this 25.88% are the main workers whereas rest 12.99% are the marginal workers. The average female work participation is 34.33%.

Conclusion

With highly dissected northern hilly terrain having high altitudinal variation and gently rolling plains in the south, Chel River basin has a straddle like situation between the upper Eastern Himalayan hill surface and sub-Himalayan north Bengal plains. It falls under the unique western portion of Gorubathan recess of the himalayan arc wherein Ramgarh Thrust (Gorubathan-Jiti fault) defines the mountain front rather than the MFT. The basin is unique also in the sense that there is complete absence of Siwalik and Damuda series belt of rocks. The Chel River and its major tributaries namely Manzing and Sukha khola having originated in the higher reaches of Himalaya quickly loses much of surface gradient reaching Putharjhora (300m approx) at the tip of the piedmont within 10kms (approx) from their source. These situations coupled with intense and concentrated rainfall within the basin lays all favorable condition for copious amount of sediment aggradation in the piedmont zone. The aggradational zone of piedmont is growing downwards and also has penetrated to much interior upwards. In consistency the piedmont surface is composed of very deep fine loamy soil (W007) as the most dominant soil group which covers 47.3% of the total Chel basin area. This aggradation zone favours channel diversification and avulsion during high flow. The basin still has good forest coverage. But with less literacy and higher percentage of SC and ST population, the basin portrays social backwardness. Less than 40% work participation and higher percentage of marginal workers within and decadal population growth rate (1991-2011) of 14.12% futher implies higher exploitation of existing natural resources which is getting reflected by increse in areas under agriculture, settlement and sand and boulder river bed whereas a decease in area under forest and water bodies and river (Fig.4.6.10). A substantial size of population is engaged in low wage menial works which includes sediment mining on the aggradation zone of piedmont after Tea Garden and cultivation.