CHAPTER-II

Physical background of the study area

2.1 Introduction

The physical formation of the study area is basically depends on its geologic structure, the controlling factor of landform evolution. The subsequent physical formations of this study area are influenced by different geomorphic processes, each of which has developed its individually accumulated landform characteristics. The present study area has hills, foothills and undulating which are found in a horizontal cross-section. The study area, thus, evoked a great combination of climate and elevation. In this chapter, the present researcher attempted to explore the physical set up of the study area with its nature and extent of variations in landform characteristics.

2.2 Methodology

This part is mostly based on the available topographical maps prepared by the Survey of India and the available published literatures about this region's geology, topography, drainage, soils, climate, natural vegetation, and landusepattern. The maps have been generated with the help of Arc-GIS 10.5 platform in collaboration with satellite imageries on the basis of available secondary data.

2.3. Geology

The geological structure of this area is very unique in terms of structural configuration as the Himalayan mountain fronts are contributing the major essence in form of sediments. There are three important formations extended in N-S direction under this geology of the study area. The Table 2.1 and Figure 2.1 below provide a broad as well as compact perceptionabout the formations of different geological periods and their approximate coverage percentage of study area under study. From this table 2.1 the outline of geology of diverse units and sequences, the evolutionary styles of the study area emerge out distinctly. The geological structure of this area also depicts the alluvium dominance on the study area the main thing by which the alluvium fans are made of.

Sl. No.	Geological Structure	Geological Period	Nature of Formations	Types of Rock
a)	Alluvium	Recent (Holocene) Pleistocene	Sub-aerial formations (soil, alluvial, colluvial) Raised Terraces	sand, gravel, pebble, etc. and soil covering the rocks sandy, clay, gravel, pebble etc.
Himalaya Front Tectonic Line (HFTL)				
b)	Lower Siwalik	Miocene	Sedimentary in origin.	Micaceous Sandstones (grey in colour), Conglomerates & Silts with bands of limestones.

Table 2.1 The geological structure of the study area
(Source: Based on Mallet, 1874; Gansser, 1966; Pawde and Saha, 1982)

a. Miocene

The Lower Siwalik rock formation had taken place during the geological period of Miocene. Along the Whole length of the outer most hills of the Himalaya from Indus to Brahmaputra the newer Tertiaries had occurred in a large scale which is known as Siwalik system (Bhattacharya, 1993). The lower Siwalik is also a part of Siwalik system occurs along the foothill zones dipping between 30°- 60° towards N-NE. From the lithological perspective it can be observed that the Siwaliks are principally formed with the debris washed out and carried by the different streams originating from the core of the central Himalaya. The top surface of this formation are generally pebbly and comprises of rounded pebbles of quartz either randomly orientation or are aligned parallel to the bedding plane (Tamang, 2013). This part of formation is occupying about 18% of the area under study.

b. Pleistocene

The southern part of the study area comprises of Pleistocene & Sub-recent alluvial deposits with gravels and coarse sand by the numerous rivers coming down to the debouching plain and forming several alluvial fans. These alluvial fans, the main focus of the present research are finally merged and formed the piedmont plain of Terai. The places covered by this plain under the study are, Merechebong, Khaprail, Sevok, MechiBasti, Naxalbarietc& same tea gardens Simulbari,LongviewPatinbarietc. The major portion of the study area is composed of Alluvium formations with Sedimentary rock type covering approx. 82% of the total study area.

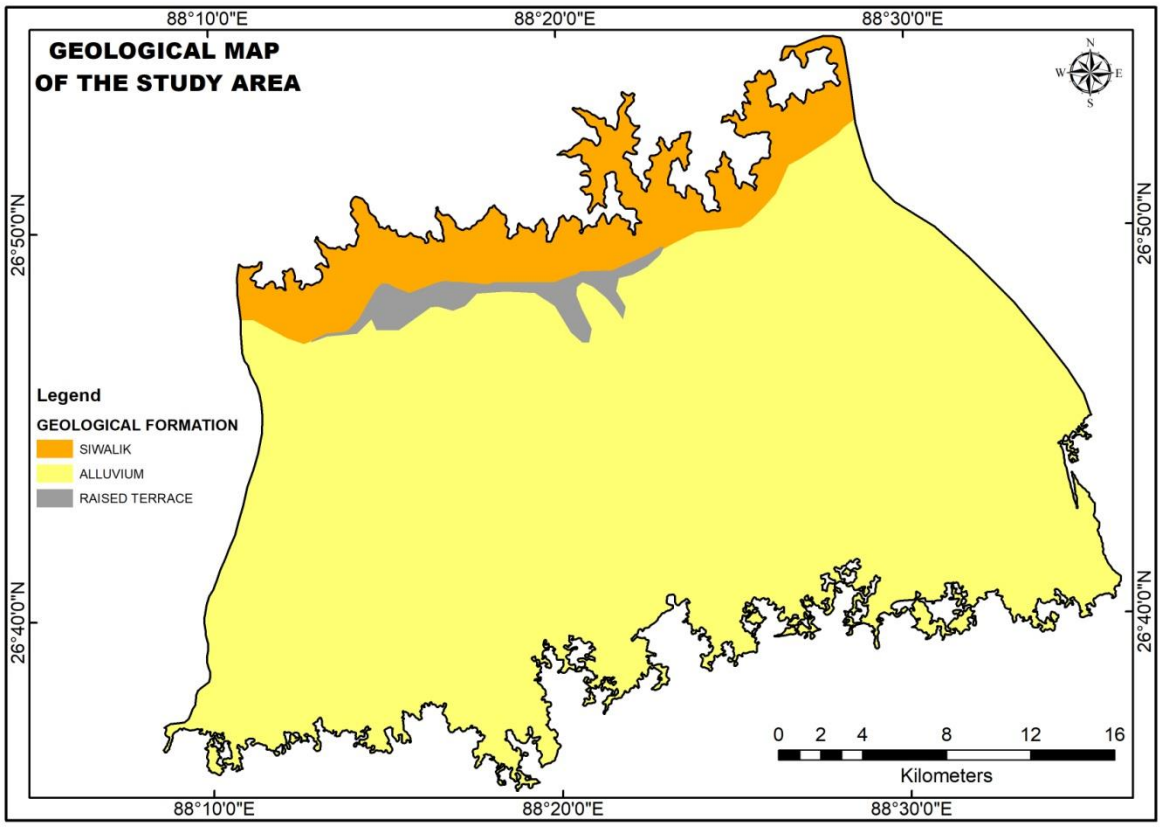

Figure 2.1: Geological map of the study area
(**Source:** Based on Mallet, 1874; Gansser, 1966; Pawde and Saha, 1982)

2.4. Topography

The entire study area reflects its heterogeneous topographic characteristics with a unique combination of plains, hills. The initial surface slope from north to south forces the rivers of this area to flow towards southward directions. The Terai (moist undulating land) traverses east-westward along the base of the Darjeeling Himalayas being drained by numerous rivers coming down from the Himalayan hills. From the relief map (Figure. 2.2) it can be viewed that the highest altitude of the study area is 510 m and the lowest is 75 m. Though, the general effective extension lies between the contour 400 m to 100 m, some patches of peaks are having the height of 500 m or more in the northern part and some depression patches of 75 m can be observed in the southern part of the study area. There are mentionable break of slopes were observed in the long-sectional profile (Figure.4.7) of the study area which creates the most favourable condition for the formation of alluvial fans in the study area. Some terraces are also observed having moderate to steep slope at the northern part of the study area and the southern part from the middle of the study area is monotonously flat with undulating patches.

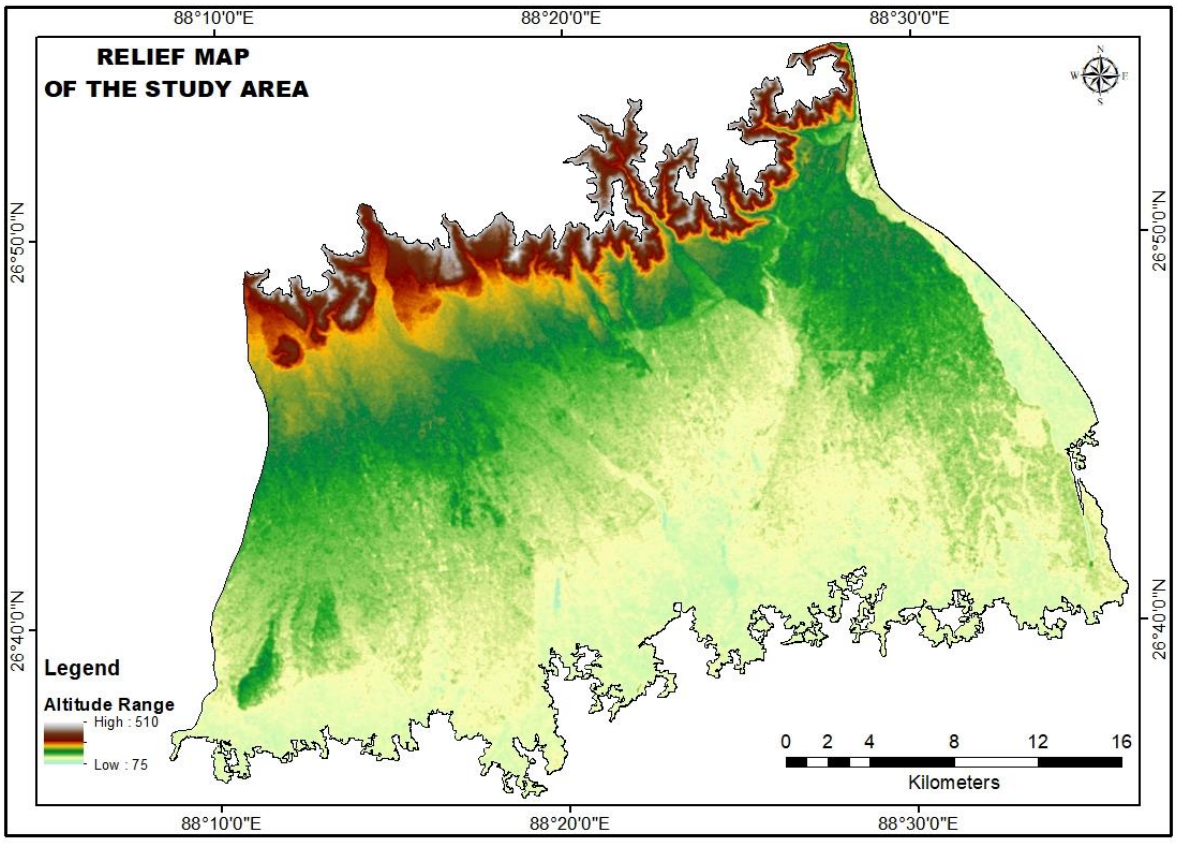

Figure 2.2: Relief Map of the study area

2.5. Drainage

The study area is blessed with rivers and most of them are perennial. The Tista, the Mahananda, the Balasan, theRakti, theRohini and the Mechi are the major streams flowing through the study area along with their tributaries. The pattern of the drainage of the study area is mostly dendritic. These rivers are flowing from north to south direction maintaining the initial slope of the surface of the study area. All the major rivers are originated from the Himalayas and flowing a long way from different mountainous tracts and thus carrying a huge load of diversified sediments which are finally deposited on the alluvial fans followed by break of slope. In the northern part or at the apex of the alluvial fans of the study area the rivers are moderately narrow and showing vertical erosional features due to slope whereas the braided pattern of rivers are observed in the middle and lower fart of the study area with lateral erosional features. Flash floods, stream bank erosion etc. are the natural characteristics of the rivers of the present area of study. The drainage map (Figure. 2.3) can give a glimpse of the drainage types and patterns of the study area.

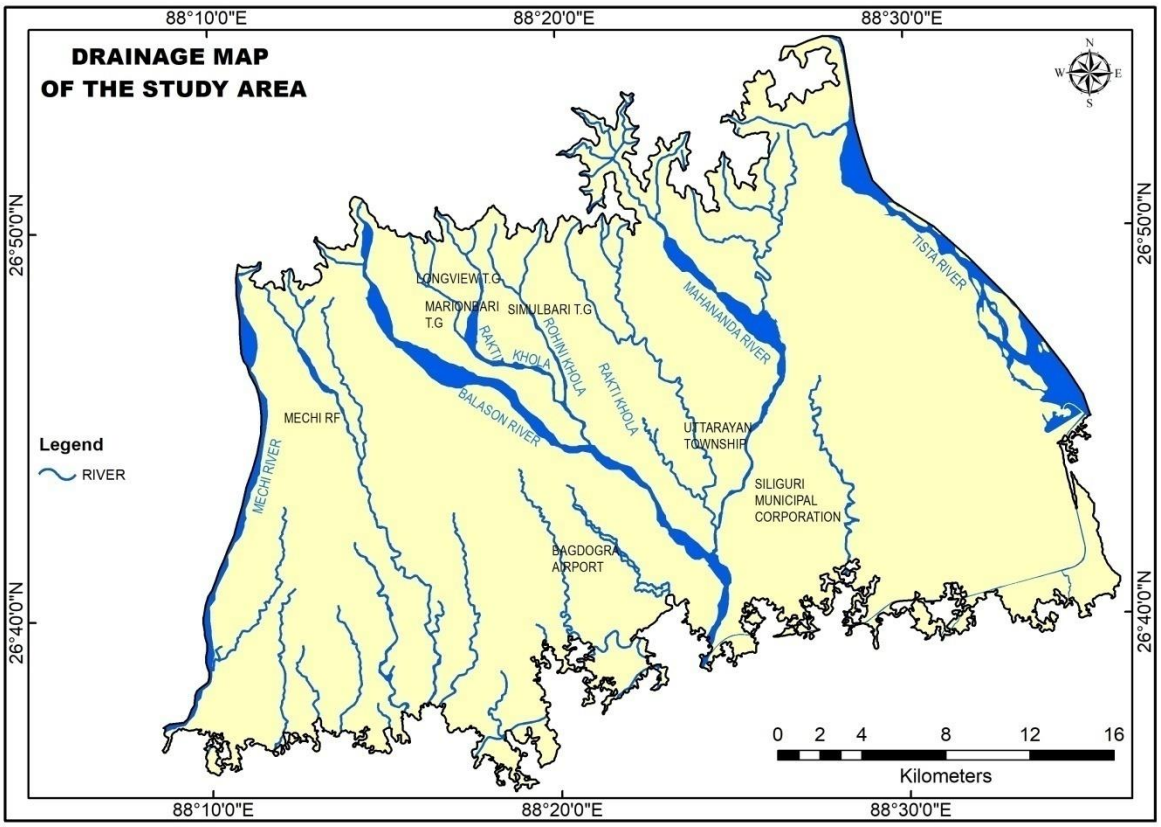

Figure 2.3: Drainage map of the study area

2.6. Soil

To study the characteristics of soil of the study area, a number of soil samples from different pits covering the whole study area were collected(Figure.4.12), tested in laboratories andanalysed the result (Table.4.4). The result of the analysis speaks about the mechanical &chemical properties of soil with the degree of pedogenesis of the whole study area. The detailed test report of some of the soil profiles are given in the appendix I.

It is found that the northern portion of the study area that is above the 200 mt. contour line up to an altitude of 350 mt. approximately the development of soil has become mare distinct with markedly leached horizon having moderately fine texture varying from sandy clay loam to sandy clay as seen in different soil profiles. But from above 350 mt. up to 400 mt. approximately (approximately as because there are some patched of 500 mt. are present) the soil of this region are comparatively less developed because of relatively higher slope, coarseness in alluvial deposits due to stream action and mass wasting.

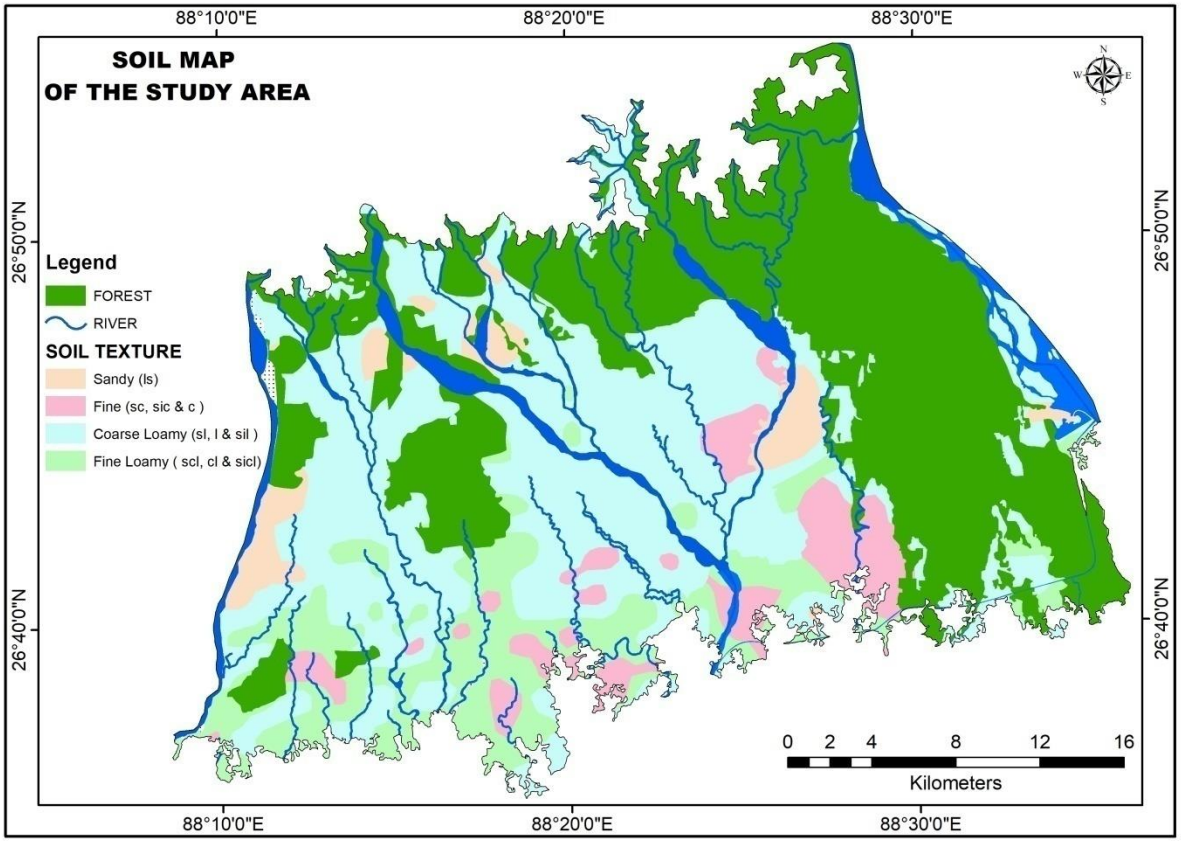

Figure 2.4 Soil map of the study area.
(Source: Field survey and NBSS&LUP)

The middle part of the study area along 200 m contour comprises with soils, relatively coarse textured varying between sandy loams to loamy sand. Though, in some patches over the study area, the top soils are composed of comparatively finer texture in comparison with the subsurface soil.The lower or southern portion of the study area ranging contours from 100 mt. up to 200 mt. is belonging to gently sloping surface with comparatively finer soil texture like loam to clay loam than the soil just above it.

2.7. Climate

As the study area is consisted of the hill, foothill & plain topography the overall climatic characteristics of this area is interestingly diversified and related with altitude. To understanding the climate as a whole of the study area three sub-segments are given below.

2.7.1. Seasons of the study area

The present study area experiences four main seasons with altitudinal dissimilarities. The major seasons are:

i. Summer season (May to September)
ii. Autumn season (October to November)
iii. Winter season (December to February)
iv. Spring season (March to April)

The upper portion experiences extended rainy days throughout summer seasonwith continuous rainfall. The winter is generally cold with rare rainfall. The middle and lower part of the study area which is also known as the southern lowlands having semi long humid summer with mild winter (Tamang,2013). The whole study area experiences pleasant autumn and spring season.

2.7.2. Temperature:

From the collected data (Table no. 2.2) from the different part of the study area it can be said that the temperature distribution of all over the months of the lower part of the study area is higher than that of upper part or the semi-hill area. The mean annual temperature of the whole study area is about 23.54°C. The northern uplands are having a mean annual temperature of 17.17°C whereas in the southern parts it is recorded 24.70°C. In summer season, the mean temperature ranges between 16°C to 21°C in the upland and 23°C to 29°C in the lowlands. In winter, cold temperature ranging between 5°C to 12°C can be observed in the northern part of the study area, while, the southern part is having temperature between 13°C to 20°C.

2.7.3. Rainfall:

From the Figure3.3 based on Table no.2.2, it can be said that from April to October for both upper and lower regions of the area under study, the mean monthly distribution of rainfall is getting a sharp rise, but from October up to March the sharp decrease of the monthly rainfall can be experienced. The Southwest monsoon winds which contribute about 85% of the total annual precipitation is the main controlling factor of the rainfall over this whole study area. Form the collected data it is seen that the heavy rain months are mainly June, July and August with the average rain fall 550.63mm, 668.87mm, 572.15mm respectively. December is the month of lowest rainfall both in the upper and lower part of the study area. The average number of rainy days in the plains is 103 days and 128 days in the upper segment of the study area.

Months	Upper Fan Region		Middle Fan Region		Lower Fan Region		Whole Study area	
	Rainfall (mm)	Temp (°C)	Rainfall (mm)	Temp (°C)	Rainfall (mm)	Temp (°C)	Rainfall (mm)	Temp (°C)
January	23.625	10.53	8.25	14.23	13.925	17.26	15.27	14.01
February	27.58	12.09	11.05	18.1	17.245	19.6	18.63	16.60
March	58.88	15.56	24.95	21.3	37.59	23.45	40.47	20.10
April	89.09	18.62	112.65	23.7	101.38	26.27	101.04	22.86
May	255.46	19.5	268.11	25.3	235.1	27.6	252.89	24.13
June	667.765	20.72	563.435	27.5	420.68	29.19	550.63	25.80
July	842.395	21.71	681.44	26.4	482.76	28.12	668.87	25.41
August	695.025	21.88	621.725	26.84	399.69	28.81	572.15	25.84
September	421.32	19.94	639.605	25.6	345.575	27.35	468.83	24.30
October	149.415	18.36	124.35	24.6	135.81	26.65	136.53	23.20
November	29.31	15.23	81.8	21.3	23.125	23.02	44.75	19.85
December	16.95	11.92	6.57	17.9	4.7	19.11	9.41	16.31
Annual Mean	**273.068**	**17.172**	**261.9946**	**22.73083**	**184.798**	**24.703**	**239.954**	**21.535**

Table 1.2 Rainfall and Temperature of the study area
(Source: Tea Gardens record collected in 2014-2017)

Hence, from the above findings we can draw following conclusions concerning the climatic characteristics of all segment of the area under study

1. The characteristics of rainfall and temperature are considerably different in the upper and lower part of the study area.
2. Comparatively heavy rainfall in the upper part of the study area contributing high amount of water in the different streams and channels through runoff resulting heavy sediment loads in form of surface erosion.
3. The climate the plain part of the study area bear a resemblance to Koppen's Am (Tropical Rain-forest climate) type of climate since the average temperature of all the

months (21.54 °C) remains high above l8°C. Also, the annual rainfall of this part is also amply high being 3276.82 mm. it seems like Koppen's 'A' climate. Hence, the climate of the plain portion of the Basin under study can be termed as Tropical rainy type (Bhattacharya, 1993).

4. It is also found that from mid of October to mid of March the whole study area is experiencing the below average temperature.

2.8. Natural Vegetation

At the beginning of the 19th century the Terai region were well covered with tropical forests of densely growing Sal (*Shorearobusta*), Segun (*Tectonagrandis*), or sturdy sheesham(*Dalbarghiasisso*).(Basu&Sarkar, pp-328). Other than this the study area also have some species like, Champak (*MicheliaChampaca*), Almond (*TerminaliaMyriocarpa*),Gokul (*Ailanthus grandis*)etc with valuable commercial timbers. It is observed during field survey and analyzing remote sensing data that mainly the upper segment has the major forest cover with tea gardens than middle and lower. For example Sevok, Upper Rohini, marchebong, Mechibastietc. areas are mostly forest covered than middle areas like Sukna, Khaprail, Samalbong etc. and lower fan areas like 2.5 miles, Matigara, Bagdogra etc. But, unfortunately deforestation in different ways making slopes of the upper apex areas vulnerable resulting loss of soils from the slop due to which rivers are getting more sediment load which are finally deposited at the foothills.

Plate 2.1 Glimpse of natural vegetation near the apex of alluvial fan.

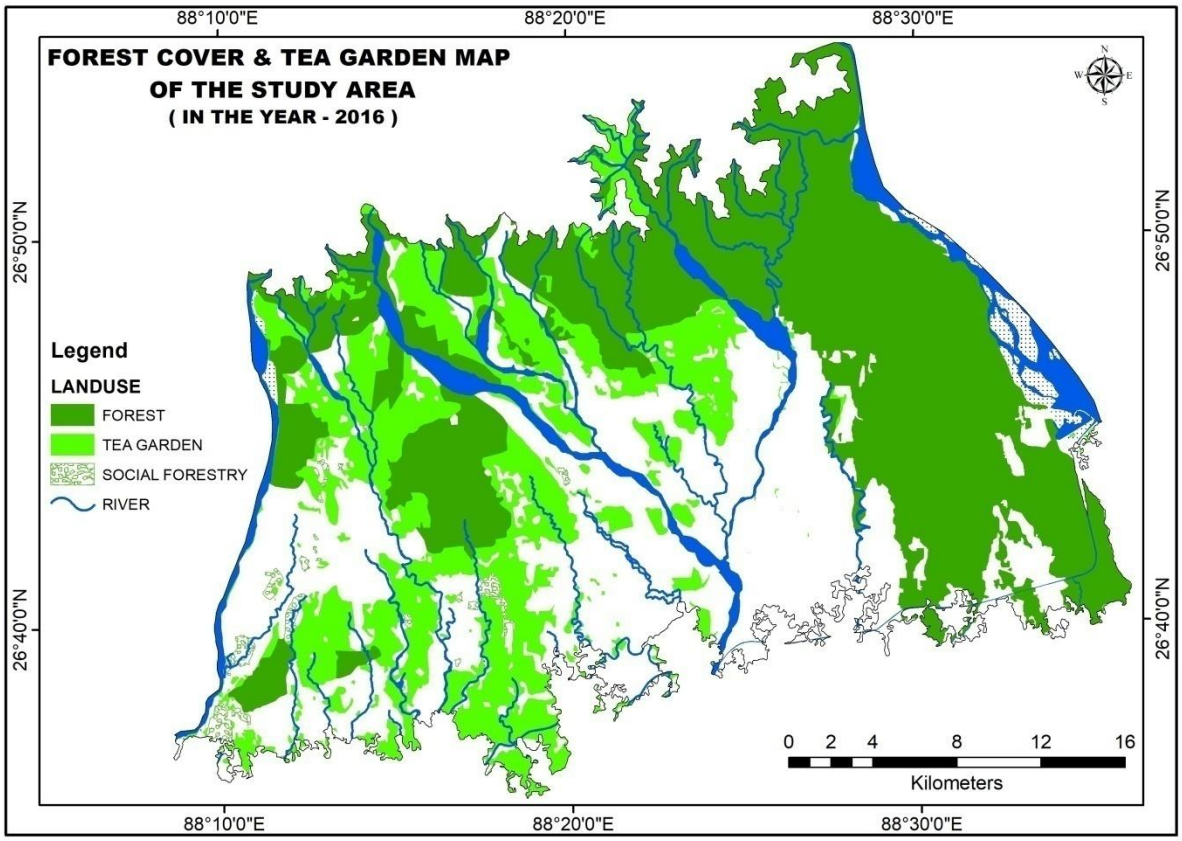

Figure 2.5 Natural vegetation cover and tea garden map of the study area.

(**Source:** Bhuvan Satellite image.)

Plate 2.2 Soil erosion/ Slope failure at Sevok on Shivakhola River

2.9. Conclusion

From the above discussion it can be concluded that the whole study areais geologically young and friable region with mostly consisted of sands, gravels & older alluvium. The whole area is unevenly composed of sandy, fine, coarse and fine loamy soils with a large intensity of average annual rainfall and temperature variations. Vegetation cover of the study area has rapidly decreased from high altitude to lower altitude which is from north to south.

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