CHAPTER II
ENVIRONMENTAL SETTING OF THE STUDY AREA

The name Darjeeling comes from the Tibetan words, Dorje (thunderbolt) and Ling (place or land), meaning the land of the thunderbolt. In 1935, Darjeeling was annexed by the East India Company from Sikkim. Prior to that Darjeeling formed a part of Sikkim and for a brief period of Nepal.

2.1 LOCATION:

Darjeeling district is the northernmost district of west Bengal. It is located on the lap of the eastern Himalayas of India and lies between 27°13’ N to 26°27’N Latitude and 88°53’E to 87°59’E Longitude. The district comprises of four subdivisions namely, Darjeeling Sadar, Kalimpong, Kurseong and Siliguri. Siliguri Subdivision is mainly characterized by the tarai and the foothills of the district. The total geographical area of Darjeeling district is 3,149 sq.kms. The Terai is only 91 meters high above the sea level. The area is bounded by the Sikkim Himalaya in the north, the Bhutan Himalaya in the east and Nepal Himalaya in the west. The southern foothill belt is demarcated by a highly dissipated platform of terrace deposits extending along the east west axis. The exquisite scenic grandeur and invigorating climate in the area have earned the title of "Queen of the Hill Stations" (Chakraborti, P.K 1989.).
LOCATION OF THE STUDY AREA
2.2 RELIEF AND TOPOGRAPHY:

The Darjeeling hill area is formed of comparatively recent rock structure that has a direct bearing on landslides. The Hill areas of Darjeeling District are located within the lesser and Sub-Himalayan belts of the Eastern Himalayas. The area is bounded by the Sikkim Himalaya in the north, the Bhutan Himalaya in the east and Nepal Himalaya in the west. The southern foothill belt is demarcated by a highly dissipated platform of terrace deposits extending along the east west axis. The inner belt is defined by a ridgeline stretching from the Darjeeling Hill to the west and Kalimpong Hill to the east, overlooking the southerly flowing Tista valley in between. Prominent rivulets contributing to the Rammam - Rangit basin, dissipate the northern slope of Darjeeling Hills.

The Kalimpong Hill is rather rugged in topography and is dissipated by radically descending gullies and streams that contribute to the Tista and Jaldhaka River system.

The Darjeeling Hill area represents a unique geo-environmental perception. The area of study is primarily composed of erosional landforms produced by southerly flowing streams, which have exposed a full cross section of different tectonic units. The form units are, however approximately the same throughout the hill area, having more or less
uniform lithology, structure, climate, soil and vegetative covers. According to Mallet (1875), Audent (1935) the tectonic units are found to be in the reverse order of stratigraphic superimposition, and is represented by Siwalik and Gondwana systems. Towards the inner Himalayas, the thrusted sheets of Daling and Darjeeling group of crystalline rocks succeed these. The contact between different groups of rocks is represented by thrusts, dipping at high angles towards north. A brief description of various formations of the Darjeeling Himalaya is given here under

**Raised Terraces:** A recent or sub recent formation from a fringe along the hills, especially at the confluences of the rivers. These terraces are composed of gravels, pebbles and boulders mixed with sand and clay. The formation is semi-consolidated, stratified along with the evidences of upheaval at places. This type of high-level terraces is also called the Terai. A 40 m high terrace is found in the Tista valley at Kalijhora.

**Siwalik:** The Siwalik system in the Darjeeling hill areas is comprised of mudstones, sandstones, shale and conglomerates along with the bands of shale and lignite. In the Hill Cart Road and along the Tista River a few stretches of good exposures of Siwalik are found. The general strike of these rocks is NNE-SSW to NW-SE with dips varying between 30° to 60°.
**Damuda Series:** Just after Siwalik, coarse-grained hard sandstone, quartzites, carbonaceous shale and slates belong to Damuda series are found. The Damuda series of Darjeeling hill areas is equivalent to the Gondwanas of Indian peninsular region. The maximum width of the Damuda is about 2.5 km along the Tista valley. The maximum thickness is about 1000m. The general strike of the bed is from ENE to WSW, with a varying dip of 40º to 90º. In this belt coal seams of about 3 meters are found near Tindharia region, Lish and Gish Rivers.

**Daling Series:** This series is comprised of chlorite shales, phyllites and schist associated with quartzite, which rest over Damuda series. Well-developed form of Damuda series is found along the Tista River and the stretches along the Tindharia –Paglajhora on the Hill Cart Road. The rocks are occasionally traversed by quartz and feldspar veins. The most important feature of this series is increasing metamorphism upwards, where slates form the lowest bed.

**Darjeeling Gneiss:** In the higher reaches of the Darjeeling hill areas, the Dalings gradually grade into the more metamorphosed rocks, which is known as Darjeeling Gneiss. The dips of the rocks are irregular and vary in between 40º – 70º. Darjeeling gneisses are highly foliated due to metamorphism. There are two prominent sets of joints in the Darjeeling
gneiss, one running roughly NW-SE and the other NNW-SSE. The general
direction of the hill spurs is in accordance with the joint directions.

2.3 DRAINAGE:

River Teesta is the master stream in the area while the
Rammam and Rangit are the two important tributaries of the Teesta. The
Teesta, like many other great rivers of Northern India, rises on the further
side of the Himalayas and bursts through the mountain barrier. After
draining Sikkim, the Teesta forms the boundary between that state and the
Darjeeling district for some distance, till it receives the waters of the Great
Rangit. It then runs into the south, and, threading its way through the
mountains, debouches on the plains through a gorge known as the Sivok
Gola Pass. After a short course through the Darjeeling Tarai, it passes into
the Jalpaiguri district at its north-western corner, and eventually falls into the
Brahmaputra River. Its principal tributaries are the Rangpo and the Rilli on
its left bank and the Great Rangit, the rayeng, and the Sivok on its right.

The Great Rangit, the chief affluent of the Tista, enters
Darjeeling district from the west and forms party of the northern boundary,
flowing from west to east till it joins the Tista. Its affluent, above the point
of junction with the Tista, are the Rangnu, the Little Rangit, and the
Ramman, which successively fall into its southern bank.
The Ramman, one of the tributaries of the Great Rangit takes its rise under the Phalut peak in the Singalila range, which forms the western boundary of the district. It first touches on Darjeeling in the extreme north-west of the district, and then flowing from west to east forms the boundary between Darjeeling and Sikkim until it falls into the Great Rangit. The principal tributaries of the Ramman within the district are the Rathu and Siri rivers flowing northwards; empty themselves into the Ramman on its right bank.

The Little Rangit takes its rise under the Tanglu Mountain in the Singhalila range in the borders of Nepal, and flows generally in a north-easterly direction till it falls into the Great Rangit on its southern bank.

The Mahanadi has its source near Mahaldiram to the east of Kurseong. After leaving the hills it flows in a southerly direction as far as Siliguri, where it changes its course a little to the west and forms the boundary line between the Tarai and Jalpaiguri as far as Phansidewa in the extreme south-east of the district. After leaving Darjeeling, the Mahanadi passes through Purnea and Malda, and finally falls into the Ganges within the Rajshahi district.

The Balason River takes its rise at Llepcha Jagat a few miles to the south-west of the station of Darjeeling. It flows a southerly course till it
enters the tarai, when it divides into two streams. One, called the New Balasan, branches off and joins the Mahanadi on its right bank just below Siliguri; the other, the Old Balasan, continues its southward course till passing out of the Tarai, it also joins the Mahanadi in Purnea. The principal tributaries of the Balasan in the hills are the Rinchington on the left and the Rangbang on the right bank; and in the plains the Rakti and Rohini, both of which join it on its left bank.

The Mechi takes its rise under the Rangbang spur in the Singalila range in the Nepal frontier, and flowing from north to south marks the western boundary of the district from its source. After it enters the Tarai, it divides into two branches near the lower Mechi forest, and eventually joins the Mahanadi in the Purnea district.

The Jaldhaka, called in the upper part of its course the Di-chhu, marks the eastern boundary of the district, which it separates from Bhutan and from the Western Duars in the Jalpaifuri district. It runs a straight course from north to south, its principal tributaries being the Paralangchhu, Rangchhu and Machhu, which flow into it on its right bank. Besides, numerous rain fed rivulets in the hills become the most dominating factor of environmental control during rainy season.
2.4 SOILS:

The soils of Darjeeling Hill area have developed depending upon the underlying geological structure. But, in general the soils have been developed by both fluvial action and lithological disintegration. The soils that have developed in the Kalimpong area are predominantly reddish in color. Occasional dark soils are found due to extensive existence of phyllitic and schists. Soils in the highlands stretching from the west to the east of the district along most of the interfluvial areas are mainly mixed sandy loam and loamy, while those on the southern slopes of Mirik and Kurseong are mainly clayey loam and reddish in color. Sandy soils are mainly found in the east of the river Tista. All the soils are definitely acidic in nature with the tendency to increase slightly in depth in most cases indicating the lacking of bases from surface and accumulation in the lower horizons. The weathering of lateritic type is the substantial mechanism in the transformation of the substratum. The variable thickness of the regolith and soils depend on the rate of weathering and gradient of the longitudinal slope profiles and intensity / gravity of mass movements. The basic soil types are yellow soils, red brown soils and brown forest soils. Red and yellow soils have developed on gneiss while brown on schists and shales. Coarse pale yellow to red
brown soils are found on the Siwaliks while clayey dark soils are developed on Daling series.

The character of the bedrock is reflected only in the grain size composition of the soil. On the Darjeeling gneiss, very coarse-grained (50% -80%) particles are found. In Damuda and Daling series percentage of sandy and coarse particles in the soils are high. On the Siwaliks, silty – clay fraction is higher. The chemical content of the soil over Darjeeling gneiss is characterized by a high proportion of potassium derived from feldspar and muscovite mica. This soil is poor in lime, magnesium, iron oxides, phosphorous and nitrogen. Therefore lime is used in the tea plantation areas.

2.5 CLIMATE:

The amount of rainfall plays a very important role in causing instability of slopes. A very high intensity of rainfall within a short span of time is not uncommon in Darjeeling hill areas. It is found in the old records; that this natural phenomenon has occurred about 42 times during the period from 1891 to 1975 (Chatterjee 1982).

The isohyets, maps prepared on the basis of average annual rainfall during last 25 years in 3 subdivisions in Darjeeling hill areas, shows that the value increases from west to east, a maximum concentration of landslides fall between 210cm and 410cm of Isohyets.
Besides seasonality, another climatic feature in the Darjeeling hills is created by orographic factor; causing the vertical zonation of temperature and decline of precipitation. Thus the mountain front is exposed to heavy rainfall, especially the middle parts of the southern hills. The mean annual temperature fluctuate from 24ºC in the plains and drops below 12ºC on the ridge. During summer month the temperature reaches 16ºC-17ºC on the ridge and during winter drops at 5ºC-6ºC. There is no distinct relation between total rainfall and altitude. The southern slopes of the ridges get much higher (4000-5000mm) precipitation than the leeward sides (2000-2500mm). The next main ridge with Tiger Hill gets 3000mm while to the north the Great Rangit valley receives about 2000mm of rainfall. The annual total rainfall in Darjeeling town fluctuates between 1870-3690mm.

In respect of landslide hazards, the duration of rainfall is very important. Long duration along with heavy down pour may cause deeper infiltration and overland flow, which ultimately may result into the occurrence of landslides on weaker slopes. The records show some of the long continued down pours. Amongst them the most remembered ones are in 1787, 1789, 1827 (493 mm in one day) and in June 1950 (965 mm). The last such rainfall recorded during 1968 (2nd and 5th Oct - about 1780 mm).
Thereafter, 358 mm in Oct 1973, 382 mm in June 1983, 457 mm in September 1986 and 350mm in 1990 were recorded.

2.6 NATURAL VEGETATION:

The principal economy of Darjeeling Hill Area depends on tea production, horticulture, agriculture and forestry. The major portions of the forests are today found at elevations of 2000 mts and above. The area located in between 1000-2000mts is cleared either for tea plantation or cultivation.

The five major forest types according to altitudinal variation found in Darjeeling Hill Areas are:

<table>
<thead>
<tr>
<th>Forest Type</th>
<th>Altitude Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical moist deciduous forest</td>
<td>300-1000 mts</td>
</tr>
<tr>
<td>Tropical evergreen lower montane forest</td>
<td>1000-2000 mts</td>
</tr>
<tr>
<td>Tropical evergreen upper montane forest</td>
<td>2000-3000 mts</td>
</tr>
<tr>
<td>Temperate forest</td>
<td>3000-3500 mts</td>
</tr>
<tr>
<td>Sub temperate forest</td>
<td>Above 3500 mts.</td>
</tr>
</tbody>
</table>

About 30% of the forest covers found in the lower hills are deciduous. Evergreen forest constitutes only about 6% of the total forest coverage.
Shora robusta remains the most prominent species of Tropical moist deciduous forest along with heavy undergrowth. In the slopes on southern portion of the Tista and the Great Rangit valley and in the Goke forests, this type of species is found. These species cannot thrive in areas of lower precipitation.

Tropical lower montane evergreen forests are found on steep higher slopes, where drainage condition is good; Dhupi (Cryptomaria Japonica) is a known variety. The impact of man on this variety is very conspicuous.

Tropical upper montane evergreen forests are found in the areas where high humidity along with dense fogs and less sunlight is available. Undergrowth is dense and contains Nettles, Raspberries, Ferns and bamboos. On the steep ridges, Rhododendrons and bamboos are abundant. Prior to 1863 very little attention was paid to the conservation and afforestation programmes. Darjeeling district had 11,000 hectare of Reserve Forest up to 1879. But, after independence due to rapid urbanization, the upper belt of the forest was taken for commercial use. Much of the natural forests in the Senchal, Ghum-Simana and Takdah ranges have been converted. Some patches of natural forests are still found in Reshop, Bara.
Senchal, Lopchu, Rongbong and Durbin Gram Panchayats. On the difficult terrains, still a few natural forest patches are found.

The analysis of the deforested areas indicates that landslides are most common in these tracts. Therefore, the areas with intense deforestation may be superimposed on the landslides affected area map in support of this hypothesis.

The analysis of the deforested areas indicates that landslides are most common in these tracts.

a) The forest area within the tea garden areas.

b) The forest area along the principle thorough fares including NH55.

c) The forest area at the fringe of the urban centers/settlement.

The hill areas of Darjeeling District is divided into 3 forest divisions, viz, – Darjeeling, Kurseong and Kalimpong. The growing pressure of population during the last two decades has left clear marks on the forest resources of the region. Marked declines in forest cover were observed in Takdah-Ghoom-Simana- area of Darjeeling Sadar, Sukhna, Pankhabari regions of Kurseong, and Chel, Jaldhaka catchments of Kalimpong division.
REFERENCES


Basu, P., 1979: Soil erosion & landslides on Darjeeling Himalayas. Geographical Review of India


Hofer, T., 1993: Himalayan deforestation, changing river discharge, and increasing floods: myth or reality? Mountain Research and Development.


Starkel, L., 1993: The effects of deforestation on slopes and channel evolution in the tectonically active Darjeeling Himalaya. Earth Surface Processes and Landforms.

