CHAPTER – I

PHYSICAL BACKGROUND OF THE STUDY AREA

INTRODUCTION

Geomorphology plays a significant role to understand the relationship between exogenic and endogenic forces that have shaped the landforms. The topography reflects the magnitude, intensity, frequency, and duration of endogenic forces acting on them. Landforms are the end products of exogenic and endogenic forces. So landforms are the topographic expression on the earth's surface and their evolution is associated with such forces and the lithology. As a preliminary to the investigation of the stratigraphical or the geological history of the area concern; it is more or less imperative to take note of the background of the study area especially in respect of relief, drainage, climate, soil, vegetation and other features as these are usually an expression of its subsurface structures or the structures that lie concealed beneath the soil (Mehdirath, 1967).

1.1 A BRIEF DESCRIPTION OF THE AREA

The monotonous flat plains of North Bengal merge gradually into the rising series of serrated peaks of the mighty Himalayas through the Terai, a gently sloping land, partly covered by river-borne deposits and partly by rocks of regions farther north. The hills of the Darjiling district encroach right upon the Terai. The high hill and the flat gently sloping plains of the Terai are separated by a series of earthen terraces of Pleistocene and Post –Pleistocene age-one rising higher than the other, thus forming a series of somewhat flat-topped cliffs overlooking the plains. These terraces finally merge into the base of the hills at an elevation of 500 to 700 m. Innumerable streams having their sources far in the high hills descend through deep precipitous gorges, only to appear in the foothills below as sluggish rivers with wide and shallow beds, forming semi-circular alluvial fans at the debouchure. Most of these rivers remain dry during the cold weather, but carrying of tremendous rush of silt- laden water during the monsoon and floods are not uncommon.

1.2 GEOLOGY

Stratigraphically and petrographically, the whole region shows features of unusual variation. The first group of rocks to be met with while going northward from the plains of newer alluvial deposits are the Siwaliks (Nahun Series), made up of hard and highly felspathic and slightly micaceous sandstones pebbles of quartz and schist. Along the entire base of this Siwalik zone there occurs a continuous belt of stratified and unstratified deposits of gravels, boulders, sands and clay thus forming a sort of transition between the hills and the plains.

The Tertiaries, occurring to the north of the Nahun Series, are represented by an east-west running belt extending from the Mechi to the Lehti River, and after a conspicuous absence for over 64 Km reappears near the Buxa hills. The Siwaliks are separated by a continuous thrust-fault from a narrow east-west running belt of the Gondwanas (Permo-Carboniferous). This belt gives place to the Dalings in the north and east of the Diana River. The Daling series gives place to a younger formation of the Buxas farther east. The Dalings intrude far inside the plains of Bengal by a series of spurs and promontories, through the Siwalik. (Fig 1.1)

GEOLOGICAL MAP OF DARJEELING DISTRICT
(Adapted from Mallet)

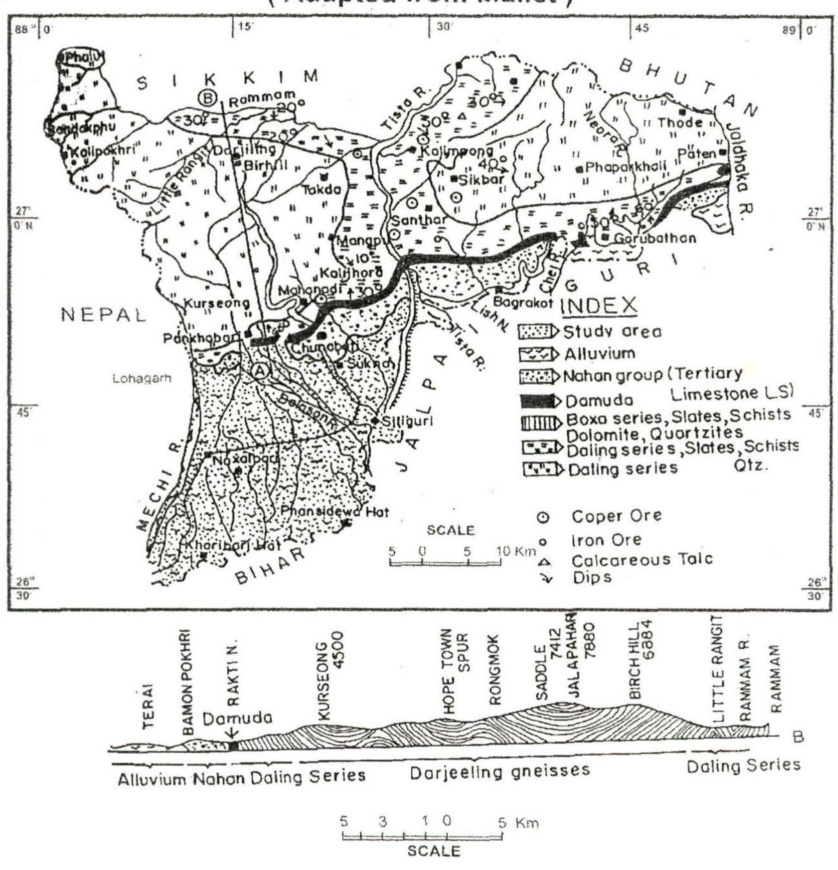

Fig. 1.1

In the Terai, the Pleistocene earthen plateau and terraces form the ideal place for tea cultivation if production and quality of tea are taken together. The unconsolidated nature of the sediments of the Post- Tertiary terraces allows excellent drainage, a more complete root development of the bush and a comparative stability of the soil due to the less abrupt slope of the region. Cost of tea production is low and quality is moderate. These gardens are most economically situated in the tea producing districts of West Bengal.

Table1.1 Geological Sequence of Darjiling District

Age	Formations	Litho logy
Recent	Sub-aerial formations or Recent Alluvia	Sand, silt & clay
Pleistocene and Sub-Recent	Alluvial deposits or Drift Formations	Older alluvium boulder bed, and other sands and gravels.
Miocene to Pliocene	Siwalik	Unconformity upper Tertiary, Sandstone, Mudstone, Shale and Pebble beds within bands of Limestone & Lignite.
Permo-Carboniferous	Lower-Gondwana	Main Boundary fault Fine to medium grained quartzitic Sandstones, interbedded within slate beds, carbonaceous shales and thin seams of flaky coal
	Buxa Series	Thrust Fault Slate, Schist, Quartzite and dolomite as a narrow band .
	Daling Series	Thrust Fault Slate, Phyllite, Mica Schist of different grades of metamorphism.
	Darjiling Series	Thrust Fault Fine grained augen and branded gneiss often granitiferous.

1.3 RELIEF

Relief is an important factor for tea cultivation. In order to conserve water and prevent erosion of soil, land management is essential. The necessity of certain planning is accepted by all tea estates but opinions are different regarding the value of terraces.

The study area about 35 kms in length and 24 kms in width is a monoclinal structure more or less parallel to the foothill of the Lesser Himalayas in the north. As the area guided by the high hills of the Lesser Himalayas in the north and gentle alluvium in the south, so the major part of the study area is composed of unconsolidated materials, derived from the Himalayas and brought down by the rivers originated from these hills. The average surface elevations along the north-south direction are respectively 350m and 300m above mean sea level. The general slope of the area (0°54'22" to 22°58') is northeast to southwest directions.

Studying the cross-section, it is visualized that there are a number of break in slopes and variation in slopes at different heights, indicate the area under tectonic activities. On the basis of slopes, contours and cross-sections, nature of erosion, composition of materials and drainage characteristics, the study-area is divided into three micro-divisions.

A. Structural Hills

B. Piedmont Plains

C. Terai Plains

A. Structural Hills: A small northern portion of the study area which is a part of Siwalik formations are forming hogbacks and cuestas having high relief of rugged profile with some structurally controlled drainage. The general height of the Siwaliks is more than 260 meter above mean sea level. Head ward erosion by the rivers in the Siwalik, scarp face and moderately steep slope in the higher part of the hills are significant features in the study area. The dip direction is toward the south-west and parallel to the topographical slope. As a result, flat topography has been formed in the lower part of the hill and the higher part is highly dissected by the streams and rivers. The structural hill is highly forested. (Fig 1.2)

B. Piedmont Plains: Long sloppy lands from the hills to the plains known as Piedmont plains originated from materials of the Siwalik as well as the Lesser Himalayas. The Piedmont plain has been divided into 2 parts-

a. Upper Piedmont Plain and

b. Lower Piedmont Plain.

a. Upper Piedmont Plain: This plain is a depression part of the Lesser Himalayas and is filled with unsorted boulders, cobbles, pebbles, gravel, sand, silt and clay. Its general height ranges from 200-260 meter from north to south.

b. Lower Piedmont Plain: This plain is filled with unconsolidated materials like loose sand, gravel, silt and clay. The average height of this plain ranges from 120-200 meter having a moderate to gentle slope towards the southward direction.

c. Terai Plains: It is located south of the Piedmont Plain with a gentle southerly slope. The junction of the Terai Plain and the Piedmont Plain is well marked by the presence of a spring line from where originate a number of springs. This plain covers a large part of the study area. The general height ranges from 40 to 120 meter above mean sea level.

PHYSIOGRAPHY OF THE STUDY AREA

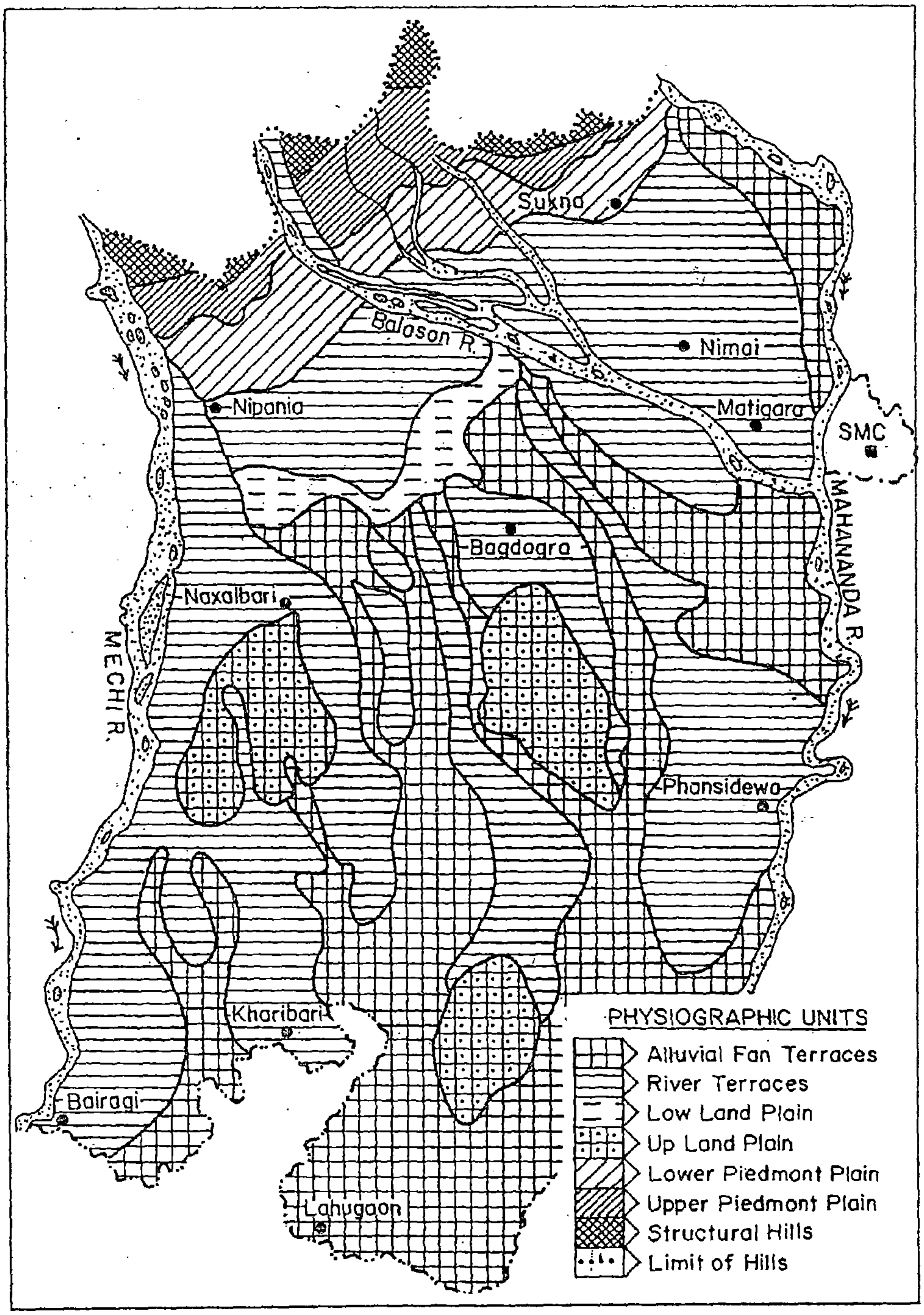

Fig. 1.2

I. Plains: The plain is composed of the alluvium brought down by the Mahananda, Balason and the Mechi rivers and their confluence. This zone consists of a few conspicuous topographical features. The general slope is from north to south. Physiographically, the area can be divided into- (I) the upland plains of older alluvium and (II) the lowland plains of newer alluvium.

II. Terraces: The general height varies from 35 to 60 meter and the slope is very gentle having southerly face. Terraces may be further classified into two groups:-

i. River Terraces: River terraces indicate different levels of older flood or low land plains that have undergone repeated upliftment due to changes in long physical, climatic and tectonic conditions. Terraces at different levels are quite prominent in the Mahananda, Balason and Mechi rivers.

ii. Alluvial Fan Terraces: Geomorphologic ally, these were under intensive fluvial action as a result number of fluvial fans were developed.

1.3.1 RELIEF ASSESSMENT

The relief is the study of the vertical elevation of the landscape of an area. Some of the concepts relating to relief pertain to the range in altitude (Smith, 1935), depth of dissection (Dury, 1966), difference in altitude between a 'Stream Surface' and 'Summit Surface' (Evans, 1972) and some such measures. The most important source of the relief assessment is the contour map, the closer the contour interval the greater the micro details of relief. In reality some of the attributes of relief, are closely co-related with the slope and a gainful exercise of the slope of the study area is explained here.

1.3.2 SLOPE ANALYSIS

In an areal study of slope analysis, the slope aspect is of crucial importance as some of the interesting phenomena of slope evolution are controlled by it, such as the insolation, rainfall, wind and other climatic elements. The slope profile shows the nature of gradient of ground surface along a particular line, depicting the nature of slope of the surface.

On the basis of the above mentioned method, (Wentworth, 1930) a Slope Zone Map of the Terai area of the Mechi-Mahananda interfluves shows that the area can be broadly sub-divided into 6 zones having 5° intervals of which the minimum slope is 0° and maximum slope is recorded 23° at Panighatta.(Fig 1.3)

SLOPE- ZONE 1: Very steep slope (above 20°), found in north western corner of the Mechi-Mahananda and are at Belgachi, Udiarip, Kadma, Panighatta villages.

SLOPE- ZONE 2: Steep slope (15°-20°) found in the northern and north-eastern part of the study area and at Bara Chenga, Nipania, Mir Jangal, Bir Sing, and Dhemal villages of Naxalbari P.S and Sukna Forest and Mohurgang Gulma Tea Garden of Matigara P.S.

SLOPE ZONE

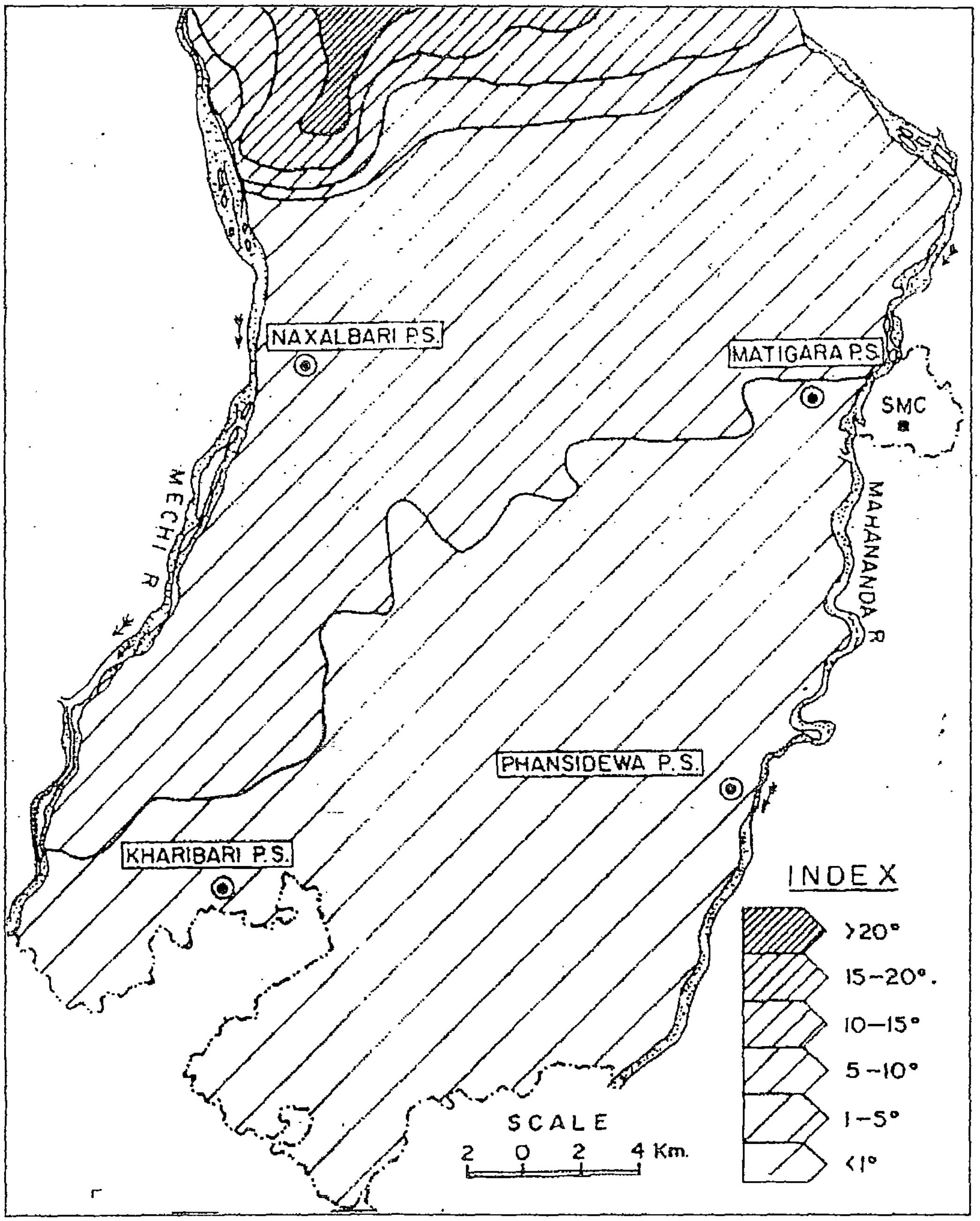

Fig 1.3

SLOPE ZONE 3: Moderate slope (10°-15°) found in the northern part of the Mahananda River at Omi and Bara Bhita of Naxalbari P.S and Patan, Champta and Panchanai villages of Matigara P.S.

SLOPE ZONE 4: Low steep slope (5°-10°) found in the northern part of the study area at Mahasing, Atal, Deomani of Naxalbari P.S and Kalabari, Dhakuria and Nimai villages of Matigara P.S.

SLOPE ZONE 5: Very low steep slope (1°- 5°) have been identified in the middle part of the study area at Bhim Ram, Mudir Jangal, Sat Bhaia and Dhakna villages of Naxalbari P.S, Matigara Hat, Dhakni Kata, Ujanu villages of Matigara P.S, Jiban Sing, Shyam Dhan and Bhulka of Kharibari P.S and Ambari, Motani and Liusi Pukuri villages of Phansidewa P.S.

SLOPE ZONE 6: Flat to gentle slopes (less than 1°) most extensive slope zone have been identified along the middle part and most of the southern part of the study area.

Thus it has been found that most of the northern part of the study area is characterized by steep to moderately steep slopes which is the indicator of youthful stage and the middle and southern part of the investigated area are characterized by low to flat slopes, which is the indicator of mature stage.

1.4 DRAINAGE

One of the distinct characteristics of the major rivers of North Bengal is that they undergo drainage inversion from converging drainage in the hills to divergent system in the plains. Most of the channels, otherwise dry during the lean period, drain considerable volume of water during the monsoon months. The changes in the gradient of their long profiles too are significant. Most of the rivers are full to the brim during the peak season in the lower reaches. Catchment areas of these rivers are mostly large. All the rivers of North Bengal plains are international in the sense that they flow through India and Bangladesh in the lower reaches and through Nepal, Bhutan in the upper courses. The rivers are flowing in a braided channel. The rivers of North Bengal can be divided into two systems, namely Mahananda system and Tista system. All the rivers are originating from snow clad mountains, and they are perennial in nature.

Rivers dominate the topography of the Terai. The courses may be divided into three sections:(a) hill section, where the rivers confine their waters within deep gorges or defiles and the course of the river is more or less fixed; (b) the course of the river between its debouchure from the hills to the plains, where semi-circular fans are formed by the deposition of the boulders, and the coarser soil particles. Water percolates through these rocky beds only to appear again a few miles further south; and (c) the swampy region formed by the reappearance of the streams. This region is generally covered by dense jungle.

From west to east, the most important rivers to be met with are the Mechi, which forms the boundary between Nepal and the Darjiling district, the Balasan, the Mahananda and the Tista. The Tista, flows for a short distance through the Terai, receives no tributaries from the area. It flows into the Brahmaputra and the Baikuntapur Jungle Mahal, therefore forms the watershed

DRAINAGE OF THE STUDY AREA

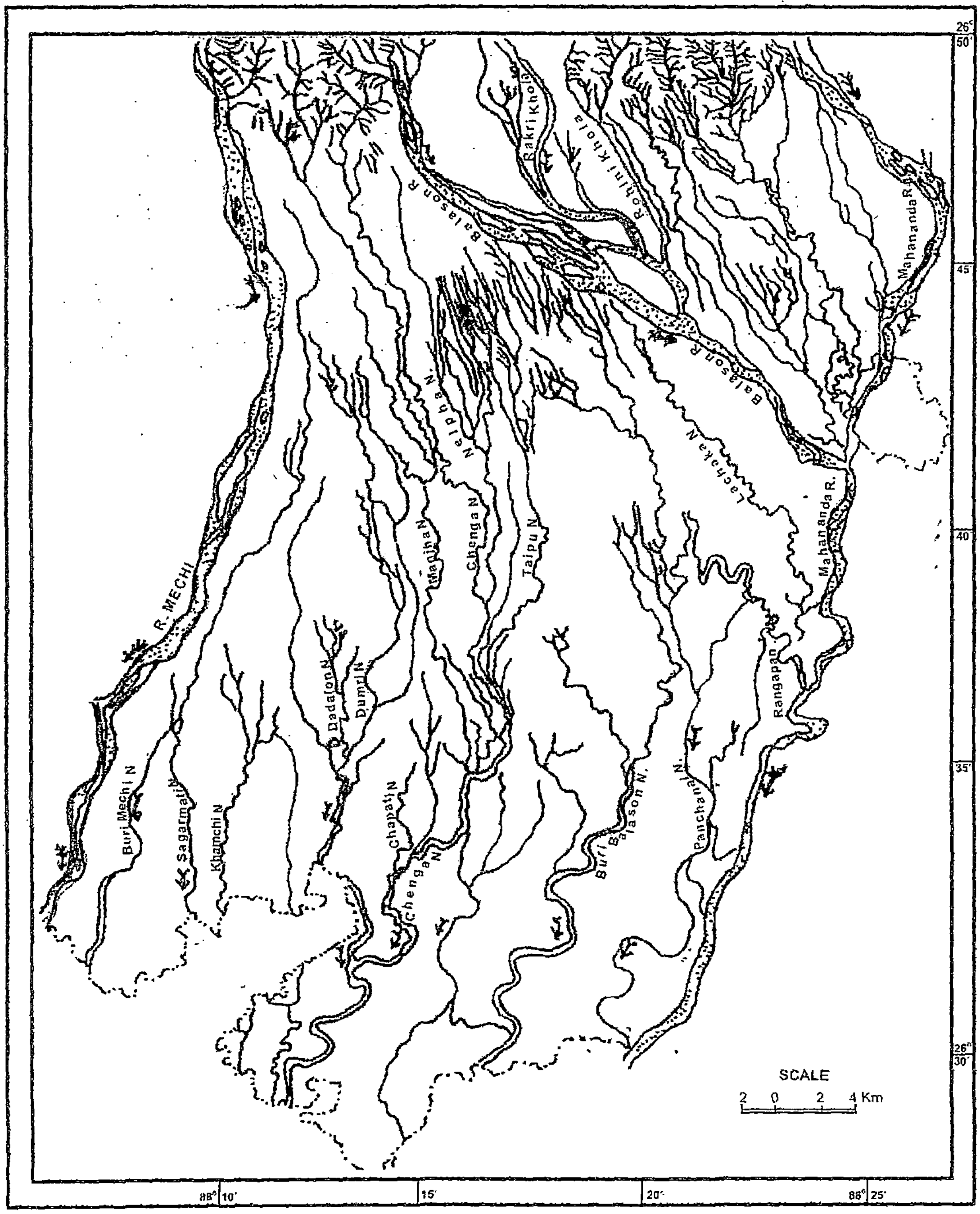

Fig. 1.4

in the Terai, between the Ganges and the Brahmaputra (Fig-1.4). The Terai is the westerly plains district in north- east India where tea is grown. Here the tea gardens are concentrated between the Mechi, the old Balasan and the Mahananda rivers.

Photo 1.1: Drainage

A. The Mahananda River: The eastern boundary of the study area is the Mahananda River, which originates at Mahaldiram in the Darjiling district at an altitude of 2060m. Its catchment area receives a high amount of rainfall in monsoon. After debouching the hills, the Mahananda flows south as far as Siliguri, where it changes its direction to south west and forms the boundary between the study area and Jalpaiguri district and finally it enters into Bangladesh through Chapai Nawabgunj district. The river finally flows into the Ganges. There are a number of tributaries namely, Trinai, Ronchondi and Dauk.

B. The Balason River: The Balason rises from Lepchajagat Peak on the Ghum Simana saddle and flows south almost parallel to the 88° 15' E meridian till it reaches the plains at an altitude of 300 m and then turns south east where its valley is larger than that of the Mahananda. On entering the plains it is divided into two branches one called Old Balason and the other is New Balason which joins the Mahananda just below Siliguri. There are a number of terraces in the foothills of the mountain. The volume of water that flows through the new channel is considerable. There are many tributaries of the river. Among these Pulungdung Khola, Rangbang Nala, Manjjwa Jhora, Dudhia Jhora, and the Chenga are to be mentioned.

C. The Mechi River: It forms the boundary between India and Nepal and it rises at an elevation of 1905m south of the west facing Rangbang spur of the Singalila range and flows through deep gorge throughout the hilly course. It descends into Bhabar tract where its bed suddenly widens. The Mechi flows past Lohagarh tea garden (Photo1.1). The left bank tributary of Mechi is Kiyang Khola and joins at an altitude of 635m, the Ashli Jhora and the Mana Jhora. It changes its course several times due to floods and other tectonic activities. The old and new Mechi are several km apart but flow in same direction. The river is important from the point of view of irrigation.

1.5 CLIMATE

The tea plants can grow in the region where climate is hot and humid and the soil is acidic, but it is only in the presence of suitable climatic conditions which lead to high yields that it can flourish as an economically viable crop (Barua 1989). From the point of view of climate, tea is essentially a crop of the tropical region but grows well in sub-tropical region too.

The study area enjoys a humid sub-tropical monsoon climate which indicates the seasonal rhythms. Three distinct seasons viz winter or post monsoon, summer or pre-monsoon and rainy or monsoon is well identified in the area. The winter which is severe lasts from November to February. Succeeding the winter, the dry hot spell continues till the onset of the monsoon i.e. in the first week of June. During the summer hot winds are common in the area. The rainy season which begins from first week of June when the monsoon sets in and extends up to October.

Climate determines the type of tea to be grown in a particular place and it also affects crop yield, crop distribution and quality period (Biswas 1979). Therefore, various factors that affect climate of a place are rainfall, temperature, relative humidity, wind, altitude and day-length (T.R.A 1992).

1. Rainfall: Basically tea is a plant of the tropical region, where the rainfall is high. For the optimum growth of tea there seems to be no upper limit to the amount of rainfall. As tea is known to grow well even in places where annual rainfall is of 508cm. However, Eden (1976) estimated the lower limit to be 127cm provided other climatic conditions exert mitigating circumstances.

Harler (1956) estimated this to be 114cm (approx) if the temperature is not high. Eden (1976) also observed that if the average monthly rainfall falls below 5cm over a period of several months, crop production suffers severely. In the study area, this often happens during the cold weather period as a result of which early season crop suffers. Total annual rainfall has little value impact on the tea production. It is the rainfall distribution that matters. More and evenly distributed rainfall is desirable for sustained uniformly high yield throughout the season. Unevenly distributed rainfall causes drought problems in the cold- weather and drainage problems in the monsoon. Heavy rainfall may cause pollination and may cause localized water logging. Rainfall makes soil moist and induces vegetative growth.

Table 1.2 Rainfall records of the four rain gauge stations

DETAILS	STATIONS			
	Gangaram T.E. Meterological Sub - Station	**Lohagarh T. E. Meterological Sub - Station**	**Mohurgong T. E. Meterological Sub – Station**	**Simulbari T. E. Meterological Sub – Station**
Year of Records	**1977 – 1998**	**1977 – 1998**	**1977 – 1998**	**1977 – 1998**
Average annual rainfall	3339.36	5508.32	3489.74	4997.31
Max annual rainfall & Year	6095.50 1982	8047.90 1998	5091.10 1984	7115.30 1984
Excess over mean rainfall	2756.14	3736.00	1594.92	2393.54
Min annual rainfall & Year	2142.60 1978	270.30 1977	2450.20 1982	2757.30 1981
Deficit from mean rainfall	1196.76	1608.60	1045.98	1964.46
No. of Years with rainfall exceeding over mean annual rainfall	10	13	12	12
No. of Years with rainfall less than mean annual rainfall	12	09	10	10
No. of Years with rainfall exceeding twice the mean	Nil	Nil	Nil	Nil
No. of Years with rainfall less than mean annual rainfall	Nil	Nil	Nil	Nil

GRAPHICAL REPRESENTATION SHOWING RAINFALL AT THE FOUR STATIONS

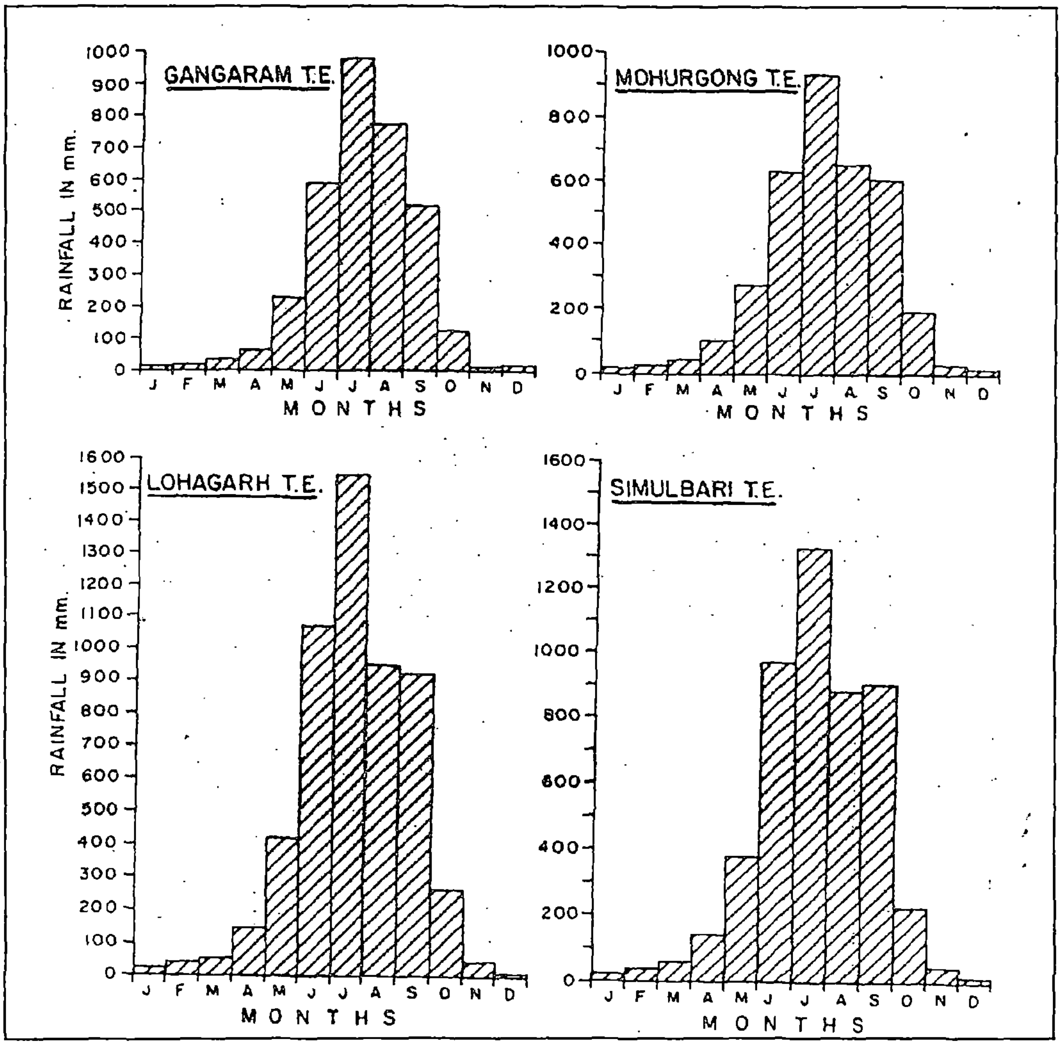

Fig 1.5

The Terai region receives most of its rainfall from the south-west monsoon during June to September. Except for the winter both summer and rainy seasons are quite oppressive. From the rainfall data it is clear that the area receives fairly high annual rainfall. From the analysis of four meteorological stations within the study area from 1997-1998 it has been revealed that the precipitation is adequate for the study area (Table 1.1). The mean annual rainfall varies from 3,339 mm at Gangaram Tea Estate to 5,508 mm at Lohagarh, (Fig-1.5) indicating that the rainfall gradually increases in the area from south to north and shows a fluctuation of annual rainfall within the period. The maximum rainfall in the area ranges from 5,091 to 8,048 mm and minimum recorded rainfall ranges from 2,143 mm to 2,757 mm.

2. Temperature: Temperature affects tea production by influencing the rate of photosynthesis and by controlling growth and dormancy. It may be mentioned that temperature above 30°C and below 13°C are harmful for the growth of tea bush. Like any other plant, growth of tea is subject to the influence of a number of environmental factors of which temperature is one. Favourable temperature conditions alone cannot ensure its satisfactory growth unless other environmental factors remain congenial.

SHOWING THE MAXIMUM AND MINIMUM TEMPERATURE RECORDED

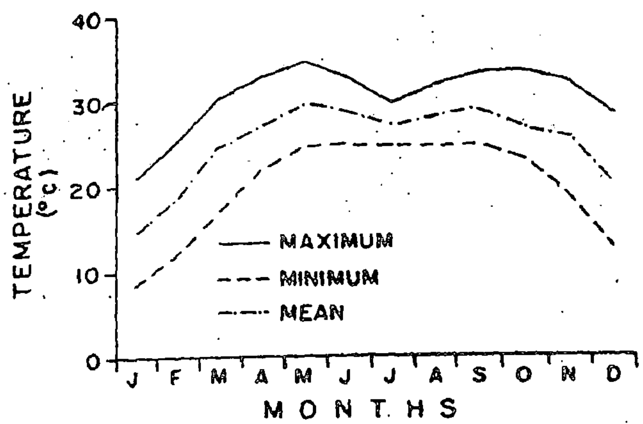

Fig 1.6

Generally the hottest months are May and June. During these months, temperature occasionally raises up to 39° C. The coldest months are normally December and January. Lowest temperature in some years touches below 7°C. So high variation between the, highest and lowest temperature is observed. Mean daily maximum temperature rises continuously from January and attains a peak value in May (Fig-1.6). Then temperature begins to fall and continues up to the month of July after which again a slight rise of temperature is noticed from July to September after which temperature decreases continuously till the minimum is reached in January.

3. Day Length: Sunlight is another factor for quality of tea. It may be mentioned that more than 50 percent intensity of light is harmful for tea. Length of the day plays an important part in the growth of tea plants. There is a positive correlation between day length and yield. The length should be 9.4- 15 hrs. Stagnation of growth occurs if day lengths are shorter than 11 hrs.

In low illumination, day length may be more than 13 hrs. Winter dormancy is more due to shorter day lengths.

4. Humidity: Tea requires a humid climate for its growth. It is found that in north- east India mean relative humidity drops below 60 percent even during the driest part of the year. In March although in the early afternoon hours, it may sometimes fall as low as 30 percent.

The figures (1.7 & 1.8) showing relative humidity and temperature reveals that March is the month of least relative humidity and July is the month of maximum relative humidity. The rapid decrease of relative humidity from January to March is obviously due to rapid increase of air temperature, after which the relative humidity increases and reaches its maximum in July. This increase must be clearly attributed to the break of monsoon rains, which increases the moisture content of the area under study. The decrease of the amount of relative humidity from August to December is due to retreat of general rains. After December the relative humidity again increases and in the post-monsoon season, it reaches to its maximum in January.

SHOWING THE RELATIONSHIP BETWEEN TEMPERATURE, RAINFALL AND R.H

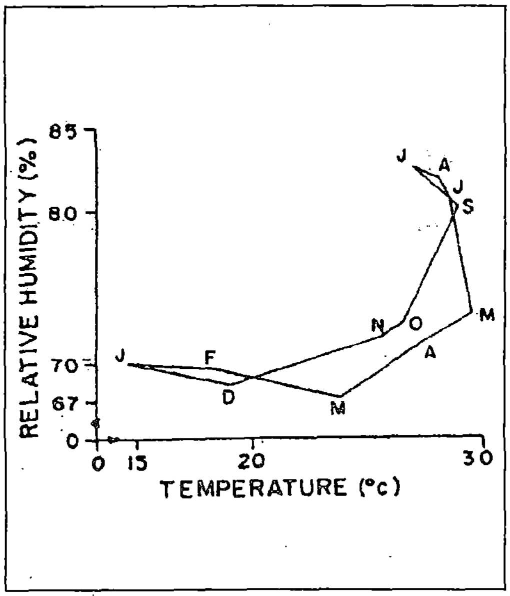

Fig 1.7

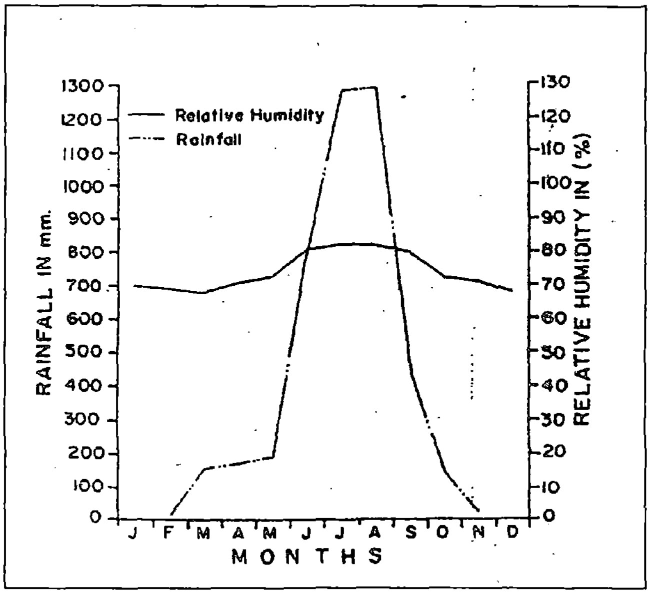

Fig 1.8

It may be mentioned that tea bushes cannot grow below a critical level of atmospheric humidity and that this level is not the same for all bushes. Since bushes are not adversely affected in an atmosphere fully saturated with water vapour, an upper limit of humidity does not seem to exist for the tea plant at any stage of its growth.

5. Hail: In north –east India spring showers are accompanied by hail until the middle of June. Hail storms are unpredictable but they are of a localized nature. Damage caused to tea bushes depends on the severity of the storm, its time of occurrence and state of growth of the tea bushes. Unprunned and light skiffed tea suffer less damage from hail than young tea bushes in the process of recovery from pruning. Presence of shade trees, afford some protection to tea bushes. Severe hail causes complete defoliation, breakage of young stems and striping of bark.

Bushes damaged by hail become more susceptible to attack by fungal diseases. Prophylactic spraying of fungicides immediately after hail and resting of bushes for the production of new leaf are the usual recommendations for section of hail damaged tea.

6. Wind: Wind may not be as important an ecological factor in the growth of plant as temperature, sunlight and rain but, the wind turbulence could be useful in reducing high leaf temperature (35°& above). Wind also helps in photosynthesis.

1.6 SOIL

Soil is the medium of plant growth of the entire depth of a profile. The top 30cm of the soil is most valuable for agriculture (Brady 1965).

1.6.1 Requirement of soil for Tea Plantation

Soil is one of the most important factors that determine the success of tea plantation. Tea has been known to grow well in widely different soils. For the optimum growth of the plant, soil should possess the following properties (TRA 1992).

(a) Good Depth.

(b) Good Physical Characteristics.

(c) Suitable Chemical Properties.

(d) Good Moisture Retention Capacity.

Soils intended for tea growing should have good depth and variability. Shallow and compacted sub-soils which limit root growth reduce top growth of the bushes. Tea grown in such soils is liable to suffer from drought in dry period and water logging during the wet monsoon months. The influence of soil depth on productivity of land can also be influenced by sub soil texture. In a deep coarse texture soil, bushes can suffer from drought and nutrient deficiency because of rapid and excessive leaching process. Shallow sub soil or medium soil or fine texture overlying hard impervious and compacted clayey sub soil can also be responsible for drought susceptibility and water logging.

A long duration crop like Tea has the advantage that it remains on the same piece of soil for many decades. By following the modern improved methods of husbandry, soil under a stand of tea can be left virtually undisturbed during the entire life span of the plantation. The tea bushes and shade trees continue to add organic litter to the soil (Barua D.N 1989).

Tea is grown only on soils from which free lime and calcium carbonate have been leached out to a very large extent. However, the leaching action does not spare other bases like potash and magnesium. These and other bases too are washed away along with lime and calcium carbonate. The resulting soil is much depleted in potassium, calcium, magnesium and other bases, all of which are essential for the growth of tea. Leaching from the soil continues all the time and further loss of minerals occur through their removal along with the harvested crop and the pruning, if these are allowed to be taken away. So in order to maintain the productivity of a tea field, the loss of essential minerals has to be replenished from outside sources.

1.6.2 Soils of the Study Area

The soils of the study area are divided into three broad groups:

1. Grey Sandy Loam (New Alluvium)
2. Yellow Sandy Loam (Mal Sands)
3. Red Earth (Red Bank Soils)

The Red Bank, Mal Sands, and the New Alluvium are formed on transported rock material. The Red Bank Soil is a transitional form of brown earth under a more humid monsoonal climate, where both the processes of laterization and podzolization are active, with the latter in the lead. The Yellow Sandy Soils on the other hand, are under a more immature stage of lateritic process than the Red Bank. The Mal Sands gradually pass on to the utterly undeveloped and young Grey Sandy Loam of the south.

This Transitional Zone, being composed of Red Loams (Red Bank) and Yellow Sandy Soils (Mal Sands), however constitutes the best Tea Soils of North Bengal. Both the soils are rich in organic matter and nitrogen, acidity is not too very high to affect production. But there are minor points of difference between them.

Tea gardens like Ashapur, Belgachi, Bijoynagar, Marapur, Ord Terai, Kamalpur, Merry View, Kiran Chandra, Naksalbari, Pahargoomiah, Bhojnarain, have sandy loam soil. Singhia Jhora, Phargoomiah, Naksalbari, Bijoynagar, Belgachi, Manjha, Chandmoni, Fulbari, Thanjhora, have clay loam Soil. Azamabad Tea Estate has Red Bank Soil.

The yield of crops in Terai is high because of high presence of nitrogen and phosphate. Due to severe leaching by rain water and presence of good amounts of organic matter, these soils are acidic and ranges between 5.0 and 6.2 and are poor in bases and available plant nutrients. The reserve of nitrogen, potash and phosphate are sufficient, but none of these is available to plant as they occur in an acid medium. The problem is, therefore, to neutralize the acidity without depleting the soil nutrients.

1.7 VEGETATION

Vegetation mainly depends on climate and soil hence there is a good relationship between soil and vegetation in an area. In the study area, there is thick cover of vegetation, which is highly associated with the nature of slopes. The area of steep slopes in the north and north-west side i.e. Sukna, Panighata etc places are thickly vegetated by simul, mixed sal, khair, siris, sissoo and large healthy bamboo forest. The area of moderate to gentle slopes are more conspicuous, smaller trees like the wild banana is most abundant, its crown of beautiful foliage contrasting with the smaller leaved plants amongst which it nestles. The screw-pine with a straight stem and tuft of leaves, each 3 or 3.5 m long is found in the southern part of the study area where slope is gentle and soils can easily be rooted compared to the area of steep slopes.

Gentle slopes and high fertility are the major factors for dense vegetation in the low land of Terai area. Most of the area is vegetated by the abundant bamboo bushes. Twenty to thirty species of fern are found in this region having abundant and luxuriant growth. A large number of neem trees are also observed in the lower terraces as well as upper terraces. Weeds and grasses are thickly vegetated in the plains of the study area.

1.8 POPULATION

The study area is a composition of several tribes of the country. There are 16 tribes out of which Santal and Oran are the most common tribes found in the tea gardens. Percentage of SC is less in the tea gardens. Labourers are mostly tribes. It is evident that only a few families are from general and OBC group. They are very negligible in percentage. Most of the office staff belongs to this group. The specialty of these tea gardens is that all these tribes and communities have lived together since time immemorial in peace, harmony and tranquility. Generally tea industry has more female population than male.

The rural population of the study area is 62% of the total population of 1991 Census and this high percentage is due to the dominantly agricultural economy of the area. The overall density of population in the study area comes to 735 persons /km² as against 446 in 1991 of Kharibari P.S. The rural and urban population densities are 446 and 12,713 respectively at Kharibari and Matigara block. The spatial patterning of density can be divided into three groups: (a) Low density: less than 500 persons/km² and is recorded in Naksalbari, Kharibari & Phansidewa blocks, (b) Moderate density: 500-700 persons/km² and is recorded in Newly formed P.S- Matigara block, (c) Very high density: more than 1000 person per sq kms is recorded in Siliguri Municipal Corporation.

CONCLUSION

The study area is a monoclinal structure, more or less parallel to the foothills of the Lesser Himalayas in the north. It extends for about 35kms in length and 24kms in width. The general slope of the area is northeast to southwest direction, ranges from 0° 54' to 22° 58'. Geomorphologic ally the area may be divided into 3 major units and a number of micro units. The major units are: a) the hilly structures, b) the Piedmont Plains, c) the Terai Plains. The hilly structures are observed in the northern part of the study area where Siwalik formations are forming hogbacks and cuestas having high relief of rugged profile with some structurally controlled drainage. Long slopping lands from the hills to the rivers, known as piedmont plains which originated from the materials of the Siwalik as well as the Lesser Himalayas. The Terai Plains occurs south of the Piedmont Plains with a gentle southerly slope. The junction of the Terai Plain and the Piedmont Plain is well marked by the presence of a spring line from where a number of springs originate and also separating the alluvial fans from the hills.

The area is drained by a number of rivers and rivulets. Among these Mahananda, Mechi, Balason are well known which originates from the Himalayas. Most of the rivers are shallow in depth but are highly torrential in rainy season. There is a general tendency of eastward migration of the drainage channels due to tectonic activities. In plains, the rivers have often shifted as much as 5kms during the last 50 years.

The climate of the study area has pronounced continental characters, i.e extreme summer heat and extreme winter months. In the north, snow clad mountain ranges and peaks of the Great Himalayas stand as a natural barrier and influences the precipitation and weather conditions in the investigated area. The average annual rainfall of 22 years is 3339mm with 133 rainy days. Summer is hot in the plains while it is cool in the hills. May- June is the hottest months and December-January is the coldest months. The atmosphere is humid with Relative Humidity ranging from 80 to 85% in rainy season while it is less humid in winter season ranging from 68 to 70%. The rate of evaporation is maximum in April-June and minimum in the month of January.

The soils of the study area vary from Podzol to Terai soils. The Podzol or forest soils in the hills are brown while those in the Terai are deep black and grey black. Due to severe leaching by rain and presence of good amounts of organic matter, the soils in the plain is very porous and acidic in nature with pH value ranging from 5.0 to 6.2. The water retaining capacity of this soil is very poor. The fertility status of the soil in respect of nitrogen, phosphate and potash are medium to low. The Podzol soil which is also acidic in nature with pH ranging from 4.5 to 5.5 is found in the hilly structures. This soil is suitable for cultivation of tea.

It is observed from study of the geology, relief, drainage, climate, soil, vegetation and population of the area that, they exert great influence upon the tea plantation of the area, which is the main industry of this region. So to study the different aspects of tea industry it is necessary for assessing their history with physical background of the study area and these have been discussed in the next chapter.