CHAPTER – I

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 acting on them. Landforms are the end products of endogenic and exogenic forces. The consequent effect of vertical and horizontal movements are seen in the form of joints, faults, folds, thrusts, ruptures and lineaments in regional as well as local level, along which energy is releasing. 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 physiography, 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 PHYSIOGRAPHY

The study area about 35kms in length and 24kms 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 parts of the study area is composed of unconsolidated material, derived from the Himalayas and brought down by the rivers originated from these hills. The average surface elevations along the N-S direction are respectively 350m and 30m above mean sea level (Fig.–1.1). The general slope of the area (0°54' to 22°58') is north-east to south-west directions.

Studying the cross-sections, it is visualised that there are a number of break-in-slopes and variation in slopes at different heights indicate the area under

PHYSIOGRAPHY OF THE STUDY AREA

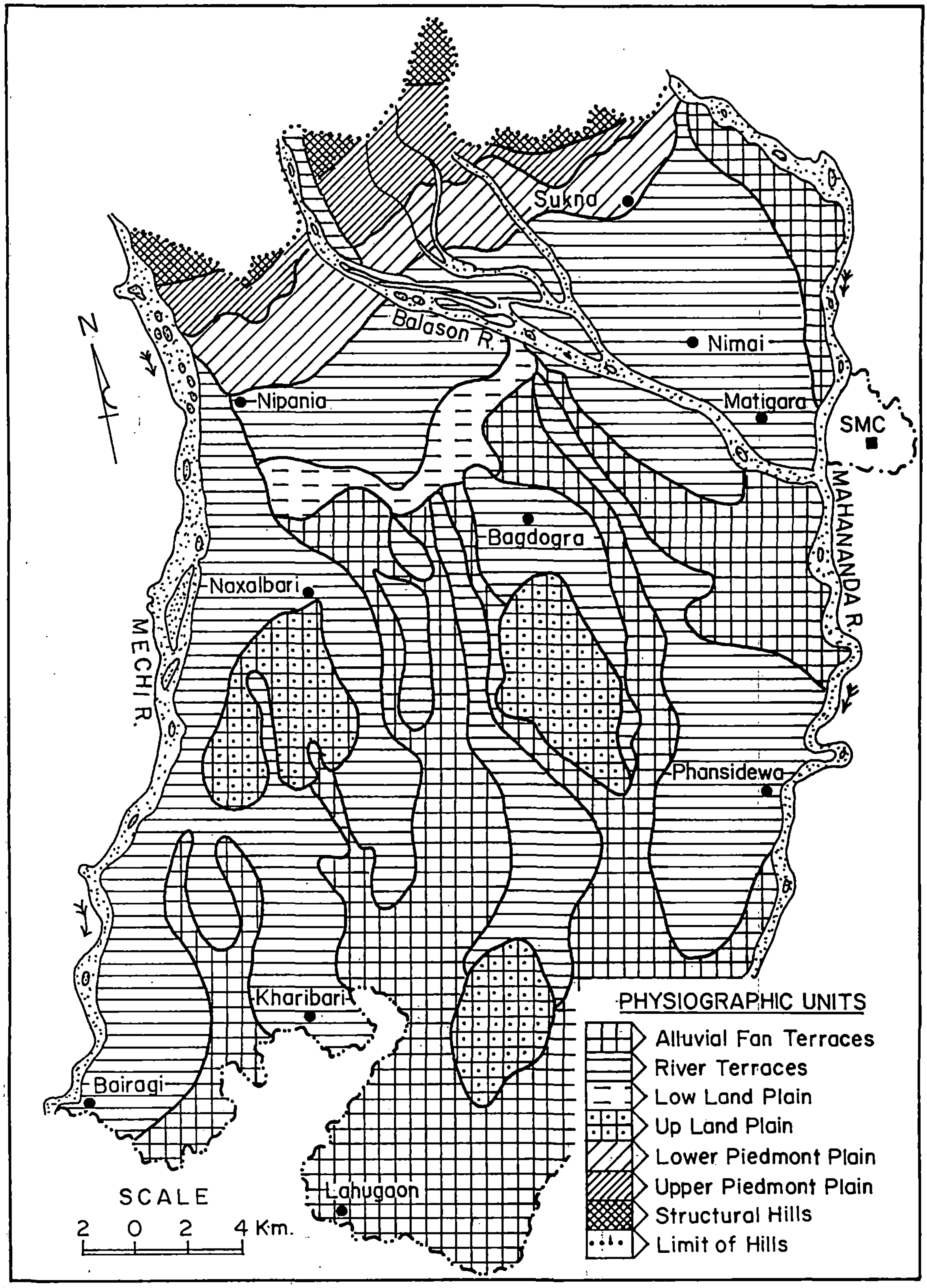


Fig. 1·1

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 (Fig.-1.1).

a) Structural Hills :

A small northern portion of the study area which is a part of Siwaliks formation 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 m above mean sea level. Headward 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 hills is highly forested. The ravenous part of this hill comprises of grit stone, gritly sandstone, conglomerates, boulders, sandstones, clays cemented by arenaceous materials which are more or less compact and coherent.

b) Piedmont Plains :

Long sloppy lands from the hills to the plain which is known as piedmont plains are originated from materials of the Siwalik as well as the Lesser Himalayas. On the basis of contour height, slope and composition of constituent materials, the piedmont plain has been divided into two parts – (i) lower piedmont plain and (ii) upper piedmont plain. It shares a very large part of the study area.

i) Upper piedmont plain : This plain is a depression part of the Lesser Himalayas and is filled with unassorted boulders, cobbles, pebbles, gravels, sands, silts and clays. Its general height ranges from 200 – 260 m from north to south facing.

ii) Lower piedmont plain : This plain is filled with unconsolidated materials like loose sands, gravels, silts and clays. The average height of this plain ranges from 120–200 m and having a moderate to gentle slope toward 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 m to 120 m above mean sea level. The entire plain is highly cultivated with irrigated water. It is composed of sands, silts, clays and somewhat alteration of gravels & pebble beds. This micro-division has been further classified into two categories.

i) Plains : The plain is composed of the alluvium brought down by the Mahananda, Balason and the Mechi rivers and their confluence. The alluvium consists of river borne materials viz. sands, silts and clays with lenticular intercalation of gravels. It also contains some impure beds of peat the product of drifted vegetation. This zone consists of a few conspicuous topographical features. The general slope is from north to south. A number of shallow local depressions forming swamps and lakes are scattered in the plain. Physiographically, the area could be divided into—(a) the upland plains of older alluvium and (b) the low land plains of newer alluvium.

(a) *Upland plain* : - The upland plains of older alluvium, occupying a major part do not get inundated during the floods. It contains lumps, nodules and concretions all irregular in shape, composed of impure calcareous matter segregated through the agency of underground water. It is mainly composed of sands, silts and clays and is intensively cultivated.

(b) *Low land plain* : - It is located adjacent to the drainage lines and is subject to flooding during the rainy season in each year, when fresh silt and loam are deposited having light in colour. After the floods, the soil becomes moistures and winter cultivation do not require any irrigation.

ii) Terraces : The terraces are divided on the basis of levels and origins. Vertical bluff is seen distinctly at various places separating fan cut terraces from river terraces. The general height varies from 35 m to 60 m and the slope is very gentle and having southerly face. The entire plain is highly cultivated with the help of irrigation. Terraces may be further classified into two groups — (a) River terraces

DRAINAGE OF THE STUDY AREA

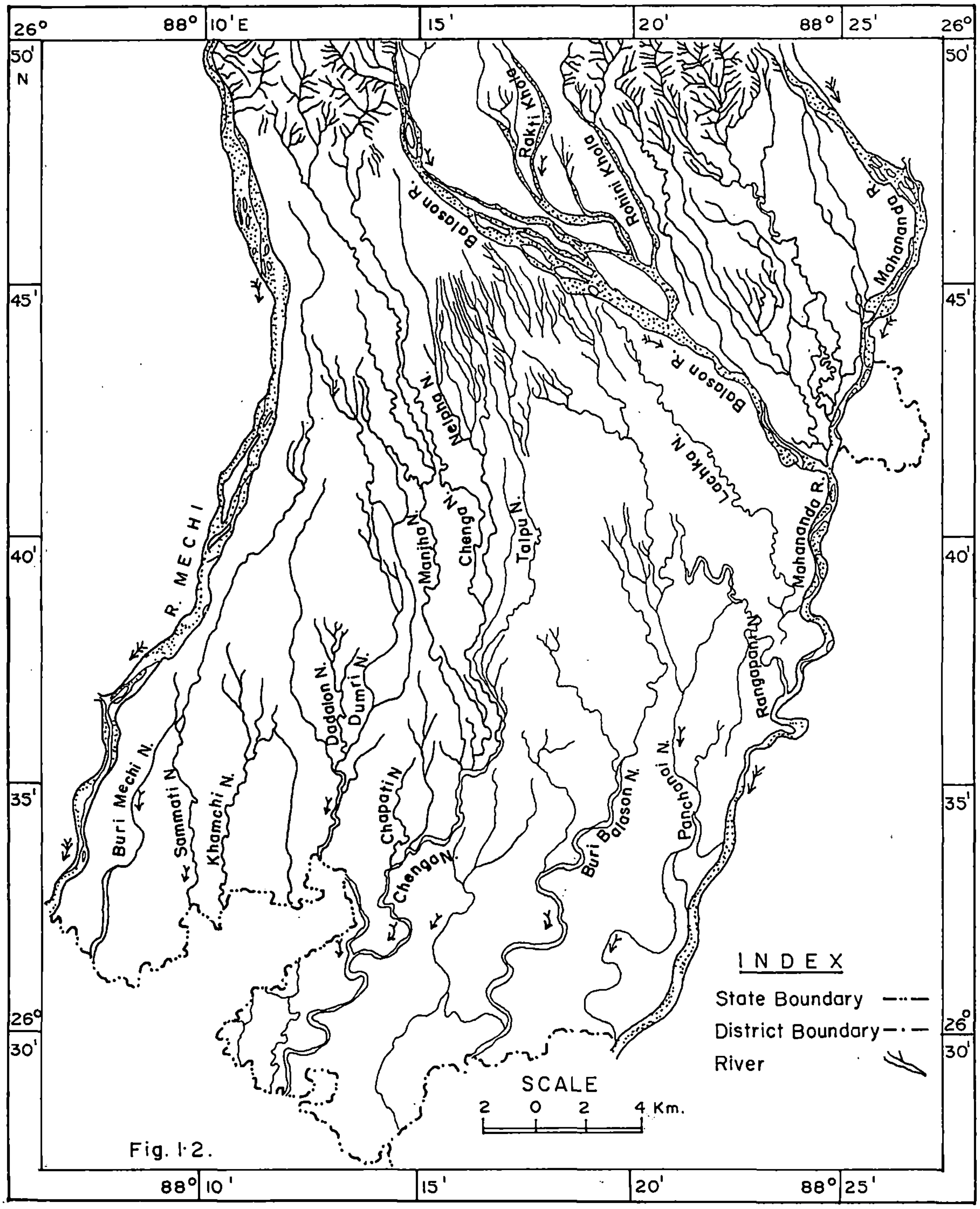


Fig. 1·2.

and (b) Alluvial fan terraces.

(a) *River terraces* : - River terraces are indicating 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 (Fig.–1.1). It is composed of pebbles, cobbles, sands, silts and clays is almost common. The vertical bluff between the terraces in the upper level is higher than that of the lower level. Due to high fertility, the river terraces are intensively cultivated with different types of crops and the multiple cropping is a possibility as most of the river terraces have high irrigation facility by channelising the river water. Wide terraces are found in both Mechi and Mahananda Rivers. The river terraces are horizontal and these are different from sub-recent fan terraces. The river terraces indicate non-cyclic deposition. High level river terraces of the Mechi river is composed of rounded and sub-angular boulders mixed in coarse matrix embeded in red clay.

(b) *Alluvial fan terraces* : - Geomorphologically, these were under intensive fluvial action. As a number of fluvial forms were developed. Alluvial fan terraces on both sides of the rivers have played an important role in formation and modification of landforms. Alluvial fan terraces are composed mainly by boulders and pebbles embedded by sand, silt and clay. The colour of fan materials on river cuttings are generally black and yellow which are clay materials.

1.2 DRAINAGE

The study area is drained by a number of rivers and rivulets (Fig.–1.2). The course of these rivers is generally from north to south conforming to the slope of the land surface and across the area from west to east. The area has two types of drainage system–one has its origin in the hills beyond the study area and the other originating in piedmont plains through seepage and whose prominence is generally determined by the water table fluctuations. All the rivers have large catchment area in the hills with their tributaries originating from the higher Sub-Himalayan Mountains in the north. After cutting down the ridges and mountain ranges, they debauch into the plains of terai carrying huge load of sediments in suspension and traction (Jana, 1996). The rivers are convergent in the hills whereas they are divergent in the piedmont plains. Most of the bed-loads in the form of clastic are deposited in the foothills as fan deposits. Coalescence of such fan deposits of various rivers gave rise to the vast piedmont plains of terai (Banerjee, 1980). Overall drainage pattern of the rivers is braided type due to heavy load of sediments on the river beds. As the river passes through high gradient in upper catchment, so runoff during rainy season in the upper reaches of the rivers is rapid and violent. Soil erosion and landslide problems are quite serious in the hill slopes due to high velocity of accumulated water. The riverbed siltation and consequent rise of the bed level in the lower reaches pose a real threat to the inhabitants of the flood plains of the southern part of the study area. On the contrary, the rivers and rivulets become dry during winter season resulting in scarcity of water in the southern part of the principal river basins. Three major rivers are Mahananda, Balason and Mechi.

a) Mahananda : The eastern boundary of the study area known as the Mahananda River, finally which flows into the Ganges. The source of the Mahananda River is the mountain of Mahaldiram, to the east of Kurseong. 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 Nawabganj District.

b) Balason : The Balason originates near Ghoom-Simana ridge and its valley of west Kurseong is larger than that of the Mahananda, although it does not receive heavy rainfall. After entering into the Terai, it divides into two streams – old and new Balason of which new Balason joins the Mahananda just below Siliguri.

c) Mechi : On the extreme west of the study area is the Mechi river, part of district boundary with Nepal, whose chief tributary comes from Nepal and brings down much detritus into the Mechi.

The drainage system of the study area have a profound effect on forming of lithologic status. But the climate of the region controls drainage. So it is very

GANGARAM TEA ESTATE (1998)

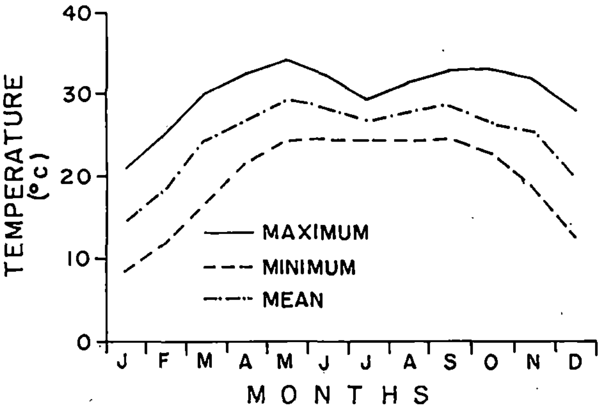


Fig. 1·3 (a) : TEMPERATURE CURVE

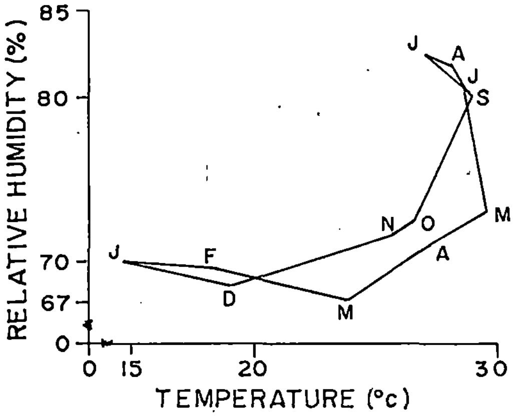


Fig. 1·3 (d) : RELATIONSHIP BETWEEN RAINFALL AND EVAPORATION

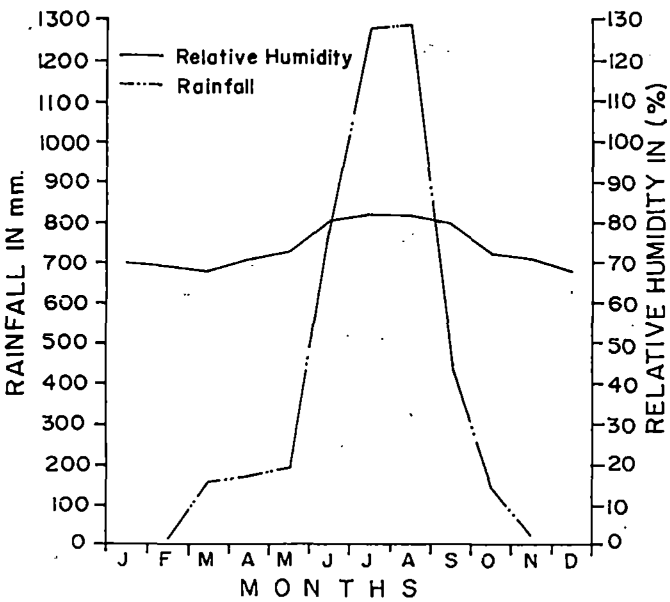


Fig. 1·3(b) : RELATIONSHIP BETWEEN RAINFALL AND RELATIVE HUMIDITY

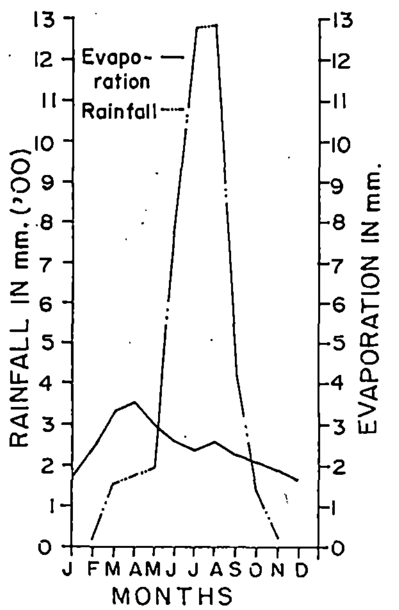


Fig. 1·3(c): RELATIONSHIP BETWEEN TEMPERATURE AND RELATIVE HUMIDITY important to study of climate in the area.

1.3 CLIMATE

The climate is pronounced the continental characters i.e., extreme summer heat alternate with extreme winter and it plays an important role in deformation of rocks and underlying strata. It is noted that rainfall controls the drainage pattern and density in an area. 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 are 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 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 extends upto October. Rainfall, temperature, humidity and evaporation are most important elements of climate and these are very much prominent in the study area giving micro-climatic variations. Some of the parameters of the special weather phenomena of the study area, as recorded in Terai Meteorological Observatory located at Gangaram Tea Estate Compound in Phansidewa Police Station (P. S.) is shown in Table 1.1.

a) Temperature :

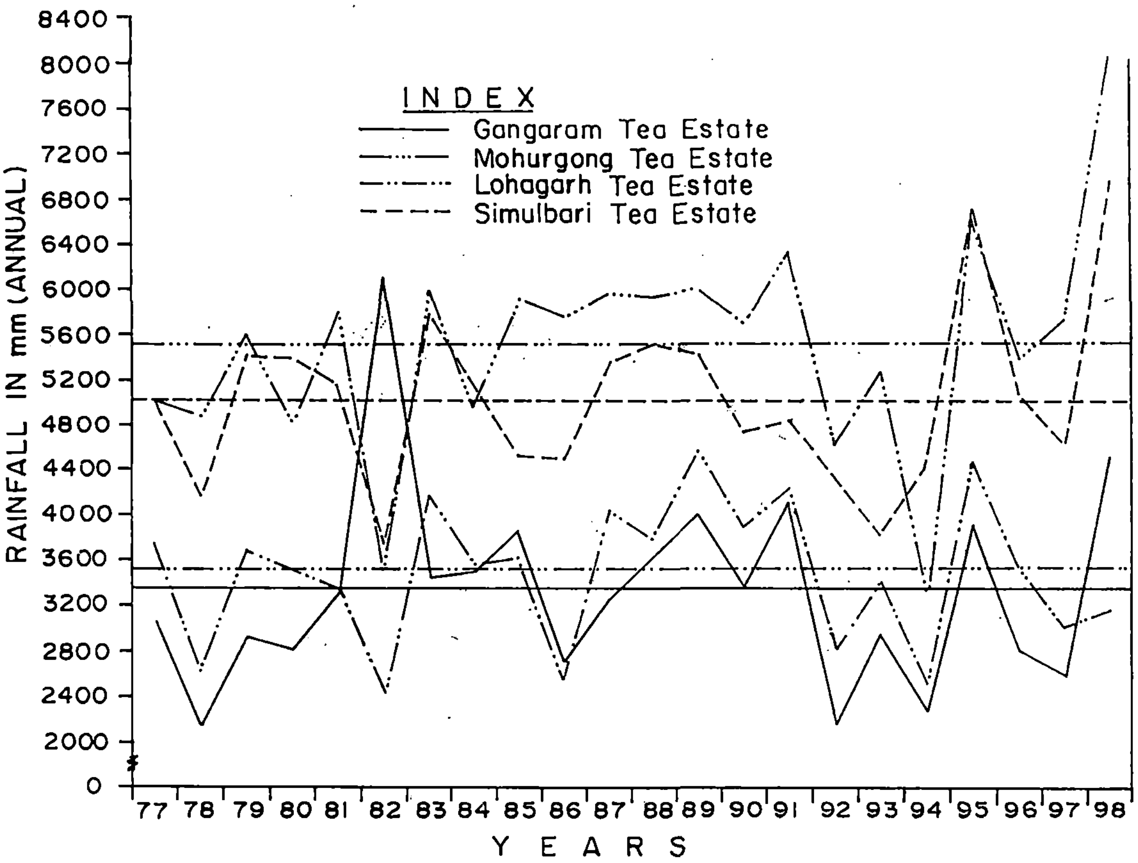
The hottest month in the year 1998 was May and the coldest month was January (Table–1.1). But generally hottest months are May and June. During these months, temperature occasionally rises upto 39°C. The coldest months are normally December and January. Lowest temperature in some years touches below 7°C. So high variation between the highest and lowest temperature is observed (Fig – 1.3.a). Mean daily maximum temperature rises continuously from January and attains a peak value in May. Then the temperature begins to fall and continues upto the month of July after which again a slight rise of temperature is noticed from July to August and September after which temperature decreases continuously till the minimum is reached in January. Increase of temperature

Table -1.1 : Meteorological data of Gangaram T. E., Phansidewa P.S. (1998)

Month	No. of Rainy days	Rainfall in mm	Average daily temperature° C			Average relative humidity in %	Evaporation total in mm	Vapour pressure in mm (Avg.)	Sunshine Brightness per day hr.	Wind velocity in km/hr/day
			Max	Min	Mean					
Jan	-	-	21.1	8.4	14.75	70.0	1.1	9.15	2.4	0.8
Feb	02	15.1	25.1	11.9	18.50	69.5	1.5	11.25	5.5	1.1
Mar	04	156.9	30.6	16.9	23.75	68.0	2.2	14.00	6.9	1.9
Apr	10	174.3	32.6	21.7	27.15	71.0	2.6	20.80	7.2	1.6
May	09	197.4	34.4	24.6	29.50	73.0	3.2	22.75	9.5	0.9
Jun	23	782.4	32.6	24.7	28.65	80.5	2.3	25.50	7.0	0.9
Jul	31	1284.2	29.4	24.5	26.95	82.5	1.0	23.80	1.7	0.4
Aug	28	1289.1	31.4	24.5	27.95	82.0	1.5	25.00	4.9	0.4
Sep	17	447.8	32.9	24.8	28.85	80.0	2.2	29.90	6.9	0.6
Oct	07	144.4	33.0	23.0	26.50	72.5	2.0	21.65	7.1	0.4
Nov	02	28.8	32.1	19.1	25.60	71.5	2.3	18.05	7.6	0.2
Dec	-	-	28.1	12.5	20.30	68.5	2.1	9.85	7.3	0.2

Source : *Terai Meteorological Sub-station, Gangaram T. E., Phansidewa P.S., Siliguri, Darjiling*

Fig. 1·4: RAINFALL VARIATION IN SELECTED METEOROLOGICAL STATIONS (1977-98)



(daily) from January to May is attributed to the increase and rapid isolation of solar radiation, in summer season. The fall of temperature from May to June and July is obviously due to the break of general rains which decreases the temperature, so to make idea of solar radiation in June by seeing the temperature level will not be correct because the decrease of temperature from May to June is not due to decrease of solar radiation but due to break of general rains. This fact will more clear when a slight increase in temperature from July to August will be noticed (Fig–1.3.a). This increase is obviously due to the retreat of monsoon rains. The rapid decrease of temperature from October onward is due to the approach of cold season that is due to rapid decrease in isolation of solar radiation.

b) Rainfall :

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 which is summarised in Table–1.1, 1.2 and 1.3, show that the area receives fairly high annual rainfall. From the analysis of four meteorological stations within the study area from 1977-1998 reveals that the precipitation is adequate for the study area. The mean annual rainfall varies from 3339mm at Gangaram T.E. to 5508mm at Lohargarh (Table–1.2) indicating that the rainfall gradually increases in the area from south to north and shows a fluctuation of annual rainfall within the period (Fig.–1.4). The maximum rainfall in the area ranges from 5091 to 8048mm and minimum recorded rainfall ranges from 2143mm to 2757mm. The number of surplus and deficit years are equal, hence they balance each other. There is neither a number of excessive years with rainfall exceeding twice the mean and nor a number of years of rainfall less than half of the mean, hence no need to compensate for the balance of water. The annual rainfall in the 22 years span indicates that the area lies in highly rechargeable zone.

Inspite of the high annual rate of evaporation, the area is not dry because

Table – 1.2 : The salient features of the average rainfall records of the four rain gauge stations (mm).

DETAILS	STATIONS			
	Gangaram T. E. Meteorological sub-station.	Lohagarh T. E. Meteorological sub-station.	Mohurgong T. E. Meteorological sub-station.	Simulbari T. E. Meteorological 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	2703.30 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 half the mean	Nil	Nil	Nil	Nil

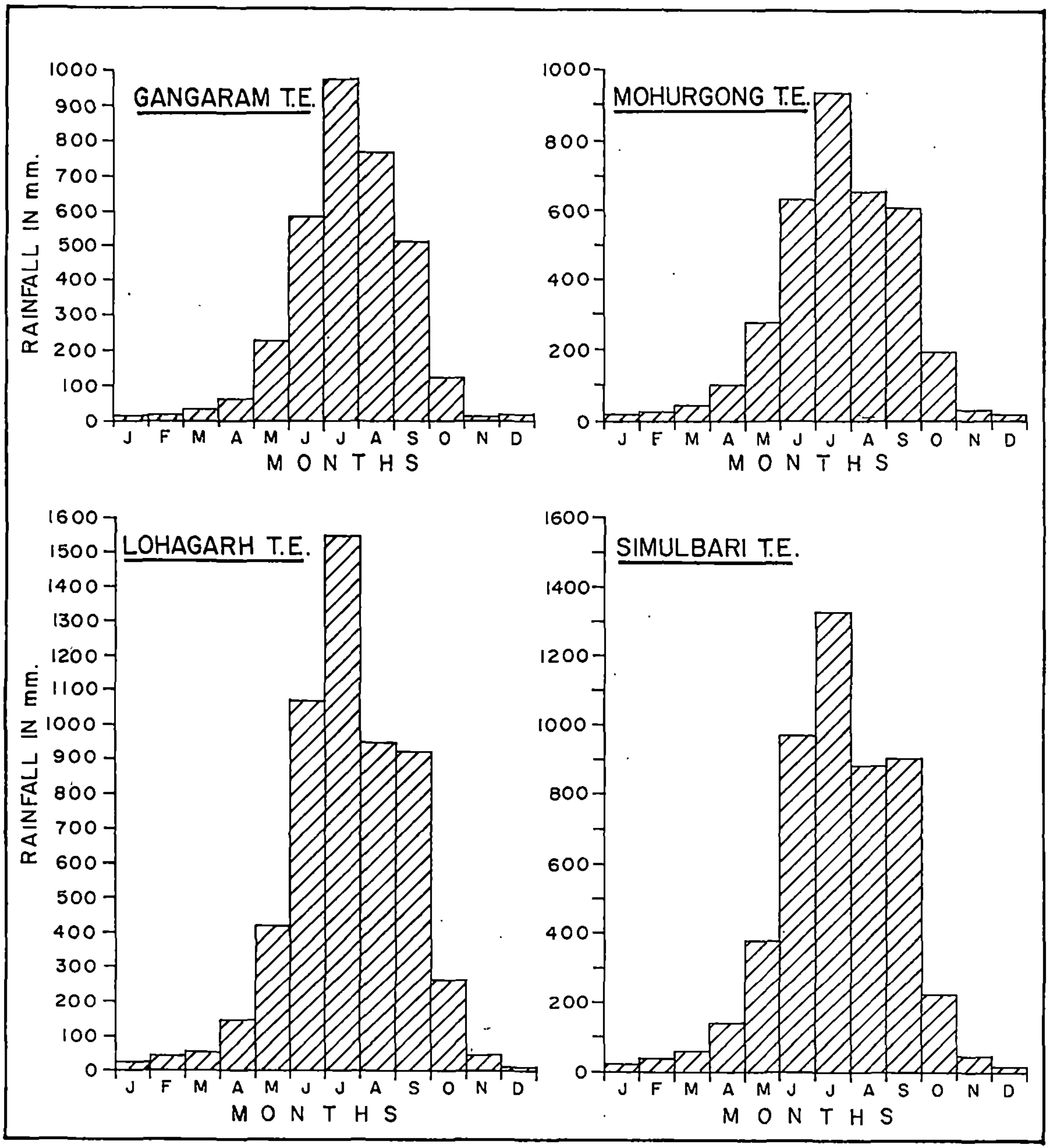


Fig. 1·5 : MONTHLY NORMAL RAINFALL(1998) OF FOUR RAINGAUGE STATIONS of the nature of precipitation during the four month period between June and September (Table –1.3). July is generally the wettest month. The rains start late in June and stop by the end of September or early October (Fig.–1.5). Number of rainy days is more in a month during June to September and there is a little rainfall in winter season also. But these winter rains are of great importance for agriculture and of less importance for ground water recharge and surface storage. During the high rains in the monsoon period, all the rivers are in spate and overflow occur frequently in the neighbouring areas and sometimes in the other countries of the rivers causing great damage to the lands and crops.

c) Humidity :

The Figs.1.3.b & c show 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 air of study area. 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 value in January. The increase of relative humidity in post-monsoon season is partly due to rapid decrease of temperature and partly due to the winter rainfalls associated with western disturbances.

d) Evaporation :

It has been observed that the evaporation is very high during April–June and maximum in the month of May i.e., immediately after the winter season. The relationship between the relative humidity in percent and evaporation in mm reveals (Fig.-1.3d) that there is a inverse correlation between them. During low humidity, evaporation is high and vice-versa. Evaporation is also high during high temperature so there is a positive relationship between them. Maximum

Table – 1.3 : Normal monthly and annual rainfall in mm of four rain gauge station (1977-98)

Meteorological Station → Months ↓	Gangaram Tea Estate	Lohagarh Tea Estate	Mohurgong Tea Estate	Simulbari Tea Estate	Average rainfall of the four stations
January	13.10	24.30	15.30	23.21	**18.98**
February	13.49	46.59	24.31	37.80	**30.55**
March	32.73	53.65	40.05	58.15	**46.15**
April	59.74	148.73	98.72	140.31	**111.88**
May	227.23	422.93	274.73	376.44	**325.33**
June	585.33	1067.31	645.28	971.14	**817.27**
July	974.36	1546.77	945.91	1324.50	**1197.89**
August	768.85	948.14	658.62	884.21	**814.96**
September	510.17	923.45	624.66	903.00	**704.32**
October	123.93	263.68	188.02	224.08	**199.93**
November	15.10	48.79	24.56	41.97	**32.61**
December	15.31	13.87	13.74	12.54	**13.87**
Annual	**3339.34**	**5508.21**	**3553.90**	**4997.35**	**4353.17**

evaporation is in the month of highest temperature i.e., in May. But there is a poor relationship between rainfall and evaporation as well as relative humidity in the study area. High excess runoff (total rainfall – evaporation) is noticed during rainy season and draught condition is occurred immediately before and after rainy season.

1.4 SOILS

Climate directly or indirectly controls the formation of soils which is the end product of parent rocks. Structure, texture and other properties of soil depend on the parent materials, vegetation cover and presence of humus. Soils usually have quite good correlation with the physiographic condition of an area. The northern part of the study area is dominated by soils originated from the Siwalik formation. On the contrary, the northern part of the area is controlled by the soil originated from the piedmont surface materials. Soils are erodible and well developed in the lower reaches i.e., terraces are generally associated with soils of fluvial origin deposited through braided channel and are usually very flat and cultivated, whereas, the upper terraces have deep soils of fine loamy textures.

The soils of the study area are divided into two broad groups : (a) Forest soils and (b) Terai soils. The forest soils in the hills are brown while those in the terai are deep black and grey black. The colour becomes lighter down the profiles with decreasing organic content. The fertility of the smaller portion of the hilly area is very high but the yield of crops is very low due to their small depth which at places may be only a few centimeters. This type of soil is mainly siliceous and aluminous with free quartz and sand. It is usually poor in lime, iron oxide and nitrogen but fairly rich in potash. Some areas being quite rich in potassium derived from muscovite and feldspar present in the gneiss. The pedozolic soil in the hilly areas are suitable for cultivation of tea.

The yields of crops in terai soil are high because of high presence of nitrogen and phosphate. Due to severe leaching by rain water and present of good amounts of organic matter, these soils are acidic and pH 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. Another problem of the terai soil is the water-logging which leads to stagnation of excessive moisture at the root-zone of the crop reducing their yield. On the other hand, the drainage of this surplus water is likely to deplete the soils of their nutrients. A balanced system of conservation of soil fertility should, therefore, be evolved, so that along with the removal of the detrimental factors of acidity and water-logging, which displaces oxygen from the root surface, the present fertility may be kept intact.

1.5 VEGETATION

Vegetation depends on climate and soils, hence, there is a good relationship between soil and vegetation in an area. In the study area, the vegetation is very high and is highly associated with the nature of slopes. The area of steep slopes in the north and north-west side i.e., in Sukna, Panighata etc. places are thickly vegetated by Simul, mixed Sal-Khair, Siris, Sissoo and large and healthy bamboo forest. The area of moderate to gentle slope are more conspicuous smaller trees, the wild banana is the most abundant, its crown of very beautiful foliage contrasting with the smaller-leaved plants amongst which it nestles; next comes a screw-pine with a straight stem and a tuft of leaves, each 3 or 3.5m long, waving on all sides. In the southern part of the study area having gentle slope where soils can easily be rooted compare to the area of steep slopes. Gentle slope and high fertility are the major factors for dense vegetation in the low land of terai area. Most of the area are vegetated by the abundant bamboo bushes, its dense tufts of culms, 30 m and upwards high. Twenty or thirty species of fern are luxuriant and handsome. Handsome number of Neem tree are also observed in the lower terraces as well as upper terraces. Weeds and grasses are thickly vegetated in the plains of the terai area.

1.6 LAND RESOURCES

The important land resources of the study area are as follows :

a) **Land Utilization** : The total geographical area of the study area covers 206,388 hectare (ha) out of which net area sown in 1992-93 was 47,761 ha. The areas under forests and current fallow record gradually decrease, where as net sown area and area not available for cultivation register marginal increase upto 1990-91. Prior to independence, when population problem was not acute as it is at present, agricultural production was not a problematic dimension. However, with the famine of 1943 and independence 1947, the agricultural sector was given first priority resulting in the extension of cultivable lands through depletion of forests and marginal wastelands. Owing to adverse physical conditions obtaining the area of investigation namely steep slope, heavy rainfall and landslide etc., cultivation is carried on under the great difficulties and a considerable input of labour, chiefly manual.

b) Agriculture : Agricultural conditions of the study area are extremely diverse only because of its physical configurations. Agriculture is centre to the economy of the study area and represents the basic sector from which a major part of the economic growth must originate. So any perspective agricultural planning of the district necessarily involves an identification of the major issues and subsequently the constraints confronting them. The accelerating growth of population has had serious repercussions on her ecological balance.

In general, the study area is endowed with fertile soil, abundance of water resources and a very high ratio of cultivators to land. Inspite of these favourable attributes agricultural productivity is still very low with respect to other districts of the state. However, significant progress has been made in recent years. But only a fraction of the production potential in agriculture has been achieved, leaving scope for substantial increase in agricultural production. This is apparent from the fact, that at present, only a negligible area is under cultivable wastelands and about 30 percent under forests. Net sown area amounts 51 percent of the total study area of 43,202.49 ha (1995) and 20 percent of the total area occupies the tea gardens. So it is thus obvious that Intensive agriculture is the only alternative, in which irrigation act as a catalyst. Moreover, drought and floods are recurrent phenomena. Hence, irrigation is an integral part of water management, appears to be a fundamental pre-requisite in an agricultural economy that operates in consonance with monsoonic weather. It is also acts as a restorative measure in case of upland utilization of water resources by irrigations through the different methods–(a)

Canal & stream irrigation, (b) River-lift irrigation, (c) Shallow tubewell irrigation, (d) Deep tubewell irrigation, (e) Tanks & ponds irrigation, (f) Jhora & river irrigation and (g) Dugwell irrigation.

c) **Cropping Pattern** : The crop of the study area broadly fall into two groups — (a) the plantation crops like tea and cinchona and (b) non-plantation crop like rice, maize, potato, wheat, jute, vegetables, fruits etc. Rice is grown extensively in the plains, while maize, potatoes, fruits and some vegetables are grown in the upper reaches. Soils are fertile for the cultivation of a variety of crops and availability of good quality of water is sufficient except in the months of dry season. Raising of one crop a year is commonly practiced under rainfed condition. There are two main harvests in a year — (a) the Kharif and (b) the Rabi. The Kharif are sown in June to August and reaped from September to November. Whereas, the Rabi crops are sown in the month of October to November and reaped from February to April. In the study area, the rice, amongst the other crop, covers the major parts of the cultivated as well as irrigated area. Block-wise crop pattern and their geographical distribution are shown in the following Table-1.4.

d) **Fertilizer and Pesticides** : Due to rapid increase of population and continuous decreases of cultivable land and problems of different natural calamities, the farmers are trying to produce more crops for the fulfillment of the rising demands for the present requirements of the study area through a number of popular chemical fertilizers as well as pesticides. The more familiar and common chemical fertilizers among the farmers of the terai area are ammonium sulphate, Urea, calcium ammonium and ammonium phosphate. For the production of high yielding varieties of crops and the fillup of the present situation, there are more than 150 fertilizer depot-holders in the study area who handled more than 500–650 metric tons of fertilizers per year. In recent years, crop production measures have been introduced in the study area and the farmers are becoming familiar with the use of prophylactic materials like D.D.T. 60%, B.H.C. 12%, Aldrin 8%, Lime-sulphur solution, Folidole, Parathion, Endrin 20 E.C., etc. In 1992-93, 42626 ha of arable land was brought under plant production measures and about 275 metric tons of pesticides were spent on them. Besides this, in the tea plantation, for high yielding production, a huge amount of fertilizers as well as the pesticides are used.

Table - 1.4 : Block and Crop wise area distribution of the study area in 1990-91

Crop types & Areas	Matigara Block			Naxalbari Block			Kharibari Block			Phansidewa Block		
	Area Irrigated			Area Irrigated			Area Irrigated			Area Irrigated		
	Actual in ha.	Percent of GAI	Percent of GAS	Actual in ha.	Percent of GAI	Percent of GAS	Actual in ha.	Percent of GAI	Percent of GAS	Actual in ha.	Percent of GAI	Percent of GAS
Aman paddy	2833	75.55	86.42	4249	81.74	86.14	2938	96.80	70.69	4581	69.70	54.58
Aus paddy	1052	29.55	32.10	1578	30.36	32.00	1044	34.40	25.12	1845	28.08	21.99
Jute	186	5.27	5.68	243	4.67	4.92	1305	43.00	31.40	2550	38.79	30.38
Wheat	486	13.64	14.81	729	14.01	14.77	461	15.20	15.20	567	8.62	6.75
Vegetable	324	9.09	9.88	486	9.34	9.84	441	14.53	10.61	688	10.47	8.20
Pineapple	45	1.25	1.36	69	1.32	1.39	389	12.80	9.35	891	8.99	7.04
Potato	170	4.77	5.19	255	4.90	5.17	-	-	-	-	-	-
Ginger	0.41	.01	0.01	0.41	0.01	0.01	-	-	-	-	-	-
Others	-	-	-	-	-	-	81	2.67	1.95	142	2.16	1.69
Double cropped area	2509	-	-	2659	-	-	2469	-	-	4881	-	-
Gross area irrigated (GAI)	3561	-	-	5198	-	-	3035	-	-	6572	-	-
Gross area sown (GAS)	3278	-	-	4933	-	-	4156	-	-	8393	-	-
Total reported area	16108	-	-	20672	-	-	14408	-	-	31043	-	-

Source : *Annual Action Plan (1990-91) under IRDP of Siliguri Mahakuma Rural Development Agency, Siliguri, Darjiling, India.*

1.7 POPULATION AND CULTURE

A study of population of an area is of great significance since it has a direct bearing on the utilization of water resources in the area. The distribution of population of the study area is maximum with respect to the surrounding region, which was due to the fertility of its soil as also the widespread industrial and commercial activities in and around the Siliguri town. Keeping in view the supreme role of population in shaping the regional economy and its inevitable relationship with the water resources, it becomes necessary to study the various demographic elements in a spatio-temporal framework. In such a perspective, the important attributes of population distribution, growth or decadal variation and density per km^2 are shown in Table–1.5.

a) Population Distribution : The rural population of the study area is 62 percent of the total population of 1991 Census and this high percentage is due to the dominantly agricultural economy of the area. There are a total of three urban centres, with a city corporation under class-I town

b) Population Growth : The increase in population of different blocks of the study area is shown in Table–1.5 during the last one decade. The nature of the growth rate is continuously increasing. The causes of this growth rate of population are mainly due to high death rates, owing to epidemics and diseases only because of the Bangladesh-Pakistan and later India-Pakistan wars. But the rest of the periods record substantial growth of population, which may be the result of declining death rates due to improved medical facilities and improved standard of living due to increase in irrigation facilities and rural electrification, increase in agricultural production, educational development etc.

c) Population Density : The overall density of population in the study area comes to 735 persons / km^2 as against 446 in 1991 of Kharibari P.S. (Table – 1.5). The rural and urban population densities are 446 and 12713 respectively at Kharibari and Matigara block. The spatial patterning of density can be divided into three groups—(a) low density : less than 500 persons/ km^2 and is recorded in Naxalbari, Kharibari & Phansidewa blocks, (b) moderate density : 500–700 persons/ km^2 and is recorded in Newly formed Police Station–Matigara block,

Table – 1.5 : Block-wise population distribution, growth and density per km^2 of the study area.

Name of Police Station	Area in Km^2	POPULATION						Percentage of decadal variation (1981-1991)			Density persons per km^2 (1991)
		1981			1991						
		Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	
Siliguri	17.65	155445	1067	154378	223747	6797	216950	+43.94	+537.02	+40.53	12713
Matigara	151.86	77165	77165	-	84760	80057	4703	+9.84	+3.75	-	539
Naxalbari	206.70	81175	72467	8708	102537	90473	12064	+26.32	+24.85	+38.54	496
Kharibari	143.50	51646	51646	-	64012	64012	-	+23.94	+23.94	-	446
Phansidewa	312.40	107464	107464	-	140045	140045	-	+30.32	+30.32	-	448
Total	832.11	472895	309809	163086	615101	381384	233717	+134.4	+619.9	+79.07	-

Source : *District Census Handbook, Darjiling district, Census of India, 1991, Series-26, Part XII – B, West Bengal.*

(c) very high density : more than 1000 persons/ km^2, which is recorded in SMC, only because of Sub-divisional head quarters belonging block and all types of facilities are available here, according to census 1991.

The vernacular current in the study area is the dialect of Bengali and Hindi. Most of the area is controlled by the Bengali language people, except some location of the northern part of the study area. In the hills, the upper portion is covered by Nepalese language. The percentage of literacy is rather poor except in the Siliguri Municipal Corporation.

1.8 NATURAL RESOURCES AND INDUSTRIES

The study area and its surroundings contains a valuable mineral deposits mainly consist of coal, copper, iron, graphite, lime and construction materials. Except the construction materials, the exploration of which does not appear to be a very profitable proposition. Most of the hilly areas, lack of modern means of transport, because of which the mineral resources of the area have not yet been properly developed. Collieries in the study area raise coal by open cast quarries on outcrops of large and small lenticular seams occurring on the hill slopes or river valleys. The entire production is consumed by local brick manufacturers. Another interesting feature of the coal-fields of the area is the occurrence of natural coke, all these features are seen on the banks of the river Balason.

Iron ores are found within Siwalik sandstones at Lohargarh village having a band of a maximum thickness of about 40 m and iron content is as low as 30% and only because of this mine, the groundwater contains a huge percentage of iron ion. The study area does not possess high class building or ornamental stone but the ordinary varieties used for construction purposes by the public works departments and the forest departments in local as well as the whole country. The hilly parts in the area are moderately forested and the larger timbers have bamboo in plenty mixed with a fair amount of Khair, Ebony Sal and Neem. Wild lifes— Elephants, Rhinoceros, Yak, etc. in the wooded parts of the area are significant livestock as a natural resources.

Owing to the vantage location of Siliguri town in relation to the North Bengal districts as well as Bihar, Assam, Sikkim, Nepal, Bhutan and Bangladesh, its industrial and commercial growth since the partition of India in 1947 has been phenomenal and this trend is likely to be maintained in the future. Tea industry was firmly established in the area as a commercial enterprises in 1856 and now it is the 2nd largest area of India for tea exporting in the world. Due to its topographical behaviour, no remarkably large industries have been established in the area. But a number of moderate industries–Distillery factory, Cattle feed plant etc. are established in the area. The area is flourished by a number of registered and unregistered small scale industries – like rice, oil, flour, saw-mills, bakeries, plywood, furniture, cement clinker, cottage and other industries and some milk produced factory.

CONCLUSION

From the study of the foregoing chapter it can be concluded that the study area is mostly uneven in nature and physiographically it has been divided into three units–(a) Terai plains, (b) Piedmont plains and (c) Structural hills which are mainly drained by three perennial rivers viz. Mahananda, Balason and Mechi having different pattern and texture and the general tendency of migration of the drainage channels is eastward. The study area enjoys a humid subtropical monsoon climate which indicates a seasonal rhythms. The average annual rainfall is 4334 mm with 134 rainy days, which indicates that the area lies in highly rechargeable zone. The soils of the study area vary from sandy loam to podzol. The water retaining capacity of this soil is very poor. The study is partly covered by the dense forest and tea gardens and rest of the part covered by seasonal crops and vegetables. The irrigation practices in the area involve both from surface and groundwater sources for variable crop production. The artificial irrigation is done commonly by deep and shallow tube wells as well as the dug well methods. By proper use of chemical fertilizers and pesticides as also enhanced irrigation facilities the farmers are able to increase the yield rate of the agricultural products. The growth of population is one of the striking developments in the history of mankind but this growth in itself is greatly influenced by geomorphic changes. The density of population of study area ranges from 446 to 539 persons per km^2 (block wise) and Siliguri Municipal Corporation is about 12713 persons per km^2, according to Census 1991. The historical development of the study area of the Terai belt and its different phases of growth will help in better understanding of its geological setting which has been discussed in the next Chapter.