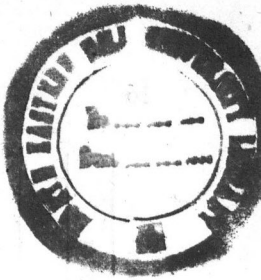

PHYSICAL SETTING OF GARO HILLS

P.G. MOMIN

Geological History

Garo Hills district, being a part of the Meghalaya Plateau, the geological history of which has to be explained in relation to the total structure of Meghalaya Plateau. The Garo Hills, a part of Meghalaya Plateau has indeed a checkered evolutionary history and is a fragment of the super-continent of Gondwana and contains within its bare face the marks of peneplanation which ranges from pre-combrian to recent periods. The higher parts of the plateau preserve remarks of Gondwana surface, while later cycles traced below them. The various rock types found in Garo Hills can be explained briefly as follows. The district of Garo Hills is occupied:

(a) Archean gnessic complex with acid and basic intusives,
(b) Lower Gondwans rocks,
(c) Cretaceous tertiary sediments. The general stratigraphic sequence of the formation is given below. (Table No. 1).

The geology of the Garo Hills is characterised by the presence of a wide variety of rock types that originated in various epochs of the earth is evolution, starting from the most ancient times upto the recent. The oldest known rocks comprise the "Archean Group" (about 3600 million years). This group is represented by hard massive rock like gnessic, granulites, begmatites, amphibiotites and blended ferruginous quartize which

TABLE 1

Geological Age	*Group Name*	*Formation Name*	*Rock Types*
1	2	3	4
1. Recent	Newer Alluvium (thickness not known)	Unclassified	Sand, silt and clay
2. —	Unconformity	—	—
3. Pleistoncene	Old Alluvium (thickness not known)	Unclassified	Sand, clay pebbles, gravels and boulders
4. —	Unconformity	—	—
5. Mio-Pliocene	Dupi Tila Group (1050 m)	Unclassified	Mottled clays, feldspathic, sandstone and conglomerate
6. —	Unconformity	—	—
7. Oligo-Mecene	Garo Group	1. Chengapara formation (700 m)	Sand, salstone clay, marl
		2. Baghmara formation (530 m)	Feldspathic limestone, pebbles, conglomeratic clay, selty clay
		3. Kopili formation (500 m)	Shals, limestone and marl
8. Eocene	Jaintia Group	1. Simsang formation (1150 m)	Silstone, sandstone, marl, alternation sand
		2. Shella formation (600 m)	Alternation of sandstone and limestone
9. Upper Cretaceous	Khasi Group	Mahadek formation (150 m)	Arkose (jlaucenitic)
10. —	Unconformity	—	—

1	2	3	3
11. Archean	–	Greissic complex	Biotite-greissic biotite hornblends gneissic, granitic, mimatite, micaschists, silliminite, quartz, amphibotite, pyroxite, gramitite

Source: Geological Survey of India, Shillong, Publication No. 30, Part IV, Meghalaya.

occupy about 60 per cent of the area in a northern part of the district. Over the Archean rest some localised patchy occurrences of semi-mentary rocks belonging to the Gondwana group (350 million years) and comprise pebb es bed, sandstone and carbonaceous shale with streaks and lenses of coal. They still remain as fossils in some places and once upon a time found abundantly in the neighbourhood of the shallow formation basis in which the Gondwana sediments were deposited (Map. No. 1).

The sediments of Tertiary age (65 m. years) occurs rather extensively around Shell, Siju, Adugiri, Baghmara, Rongara, and many other localities towards south. They derived their geologically accepted nomenclature from the type localities they occur in. The "Shella formation" consists of sandstone, lithomergic clay, shale, and some coal seems followed up by 'siju limestone' formation that locally contains potential reserve of suitable raw materials for cement. The 'Kopili formation' occuring near Adugiri includes then alternating bands of sandstone, shale, and fossiliferous limestone. Above the 'Kopilis', rests the 'Garo group' comprising silt-sandstone of 'Simsang formation', pebbles, conglomerate, mudstone and feldspathic-sandstone of 'Baghmara formation' and the rocks units of the 'Chengapara formation' represent by marl, silty clay and loose fine sand. All along the pings of the district except to the east as well as in the narrow river valleys occurs the alluvium-consolidated sand, clay and soil of the quarternary period.

The Archean bassment of Meghalaya a remnant of the north-easterly extension of the Indian Peninsula, remained a landmass experiencing earch movements leading to complete folding and fracturing of the ancient rock till Pre-cambrian times.[1] The sediments, later uplifted and folded, experienced low grade metamorphism as a result of granitic and basic/ultrabasic intrusions (e.g. Milliom granite and Khasi greenstone), The post Pracambrian land mass experienced peneplanation till Jurassic times resulting into the formation of a flat levelled surface preserved over the plateau till today. By the end of Jurassic, the southern margin of Khasi Hills experienced eruption of plateau besalts, the sylhet traps, along the southern

1. G.S.I. Pub. No. 30, Part IV, Meghalaya, pp. 79-80.

block subsided and the northern block upheaved. Towards Paleocine-Eocene times during the area attained a stable shelf condition and the calcareous formation of the Jaintia group deposited. The part of the Plateau covering the Khasi block was still experiencing upliftment of the northern block resulting into the deposition of only the oldest (Lower Sylhet) sandstone, limestone-beds over the plateau and the younger ones (middle, upper sylhet sandstone and limestone) along the southern frings of the plateau. The eastern Jaintia and Garo block respectively to the east and the west, remained land mass till mid-Eocene and experienced progressive downsinking later initiating the deposition of the coal bearing sandstone followed by limestone leed equivalent to the upper sylhet sandstone of Khasi Hills. Since then, the sedimentation continued uninterrupted over the submerged southern part of the Garo Hills and south eastern fringes of the Khasi-Jaintia Hills till the end of the oligocene when the Barail range to the south of the Jaintia Hills stood up as a landmass.

During Meocene, sedimentation continued uninterrupted over the southern and western part of Garo Hills and southern fringe of Khasi Hills, the Jaintia block becomes uplifted and remained a landmass. The major upliftment of the plateau as a whole started at the end of the Meocene resulting into the formation of the Khasi and Garo Hills. The pliocene (Dupitilla) sediments were deposited in these basins. The sub-recent older alluvial deposits along southern border of Khasi-Jaintia Hills, the southern and western part of the Garo Hills are fluviatile deposits along old river valleys.[1] On the basis of geological details and characteristics, the Garo Hills could be divided into the following sub-regions. (Fig. No 1 & Table No. 2).

(1) The old and new alluvial including small area of Gondwana rock type of the recent and Paleocene age. It includes the areas along the district border line from north-east to north-west, all the fertile river valleys and the plain areas. No minerals are found in this region Sand, silt, clay, pebble, gravel and bolder bed are the rocks found in these areas.

(2) Dupitilla, Chengapara group belongs to Meo-palsocene

1. G.S.I. Pub. No. 30, Part IV-A, p. 80, Meghalaya.

TABLE 2
GEOLOGICAL REGIONS OF GARO HILLS*

Sl. No.	*Name of the Geological Region*	*Geological period*	*Mineral found*	*Location*
1.	Old and New Alluvial with Gondwana	Recent and paletocene age	No minerals	
2.	Dupitilla and Chengapara formation	Meo, Paleocene and Oligocene age	Gypsum, mica feldspar, borryl	Garobadha, Anogiri and Mahenderganj
3.	Baghmara, Simsang Shella, Kopili formation	Oligecene and Eocene age	Coal, phosphate, limestone, oil, clay, iron mica	Darranggiri, Siju Arteka, Rongrenggiri Songsak, Darugiri, Rewak, Nongalbibra
4.	Granite	Archean age	No minerals	—
5.	Greissic complex	Archean age	Pyrite and Pyrrhotete	Jenglatgiri

*Based on G.S.I., Pub. No. 30, Meghalaya.

and Oligocene age. The area covered mainly south-west and southern boundary margin of the district. The rock types are clay, feldsper, conglomerate, sand, siltstone and marble. The important minerals are gypsum, mica, feldspar, beryl etc.

(3) Bagimara, simsang, shella, and Kopilli group of oligecene and eocene age are found in the south, central part to the south east and small pockets of north west, central and north west of the district. Coal, phosphate, limestone, oil, clay, iron, mica, feldspar, baryl etc., are the important minerals.

(4) Granite of Archean age are found only in the smaller area in the central, north-east border line to the Khasi Hills. The rocks are mostly porphyrite, and coarse-granite. No minerals are found in this group.

(5) Gneissic complex of Archean age covers the entire center, north eastern and north-western parts of the district. The rocks are mainly biotite, pyroxins, magnetite, and granulite. Pyrite and Pyrrhotete is the only mineral found in this area.

Economic geology

Garo Hills is rich in minerals wealth. It has a large reserve of minerals and when exploited for industrial purposes, it will contribute a lot to the development of the region as well as to the state and country. The potentiality of initiation or expansion of mineral-based industries in the district of Garo Hills mainly depend on the three principal mineral deposits. viz. Limestone, Coal and Clay.

Coal: Three Coal seams are known to occur around Nongalbibra 50 km. south of Darranggiri of which the middle one extend over an area of more than 50 sq. km. A reserve of 127 million tonnes of coal in this area. Thermal Power Station at Nongalbibra sustains its generation capacity of 5 M.W. from this coal and plan is approved to expand this capacity by 35 M.W. The possible reserve of coal in the district has however been estimated at 384 million tonnes. In the southern slope of the Tura range, two more seams of good quality coal have been located near Siju indicating a possible reserve of 125 million tonnes. Deposits at Balpakram area account for 107 m. tonnes of possible reserve coal.

Limestone: A 100 metre thick Limestone band skirts along the southern slope of the Tura range of which the upper 75 m. constitutes of massive good quality, limestone suitable for the manufacture of cement. This forms undoubtedly the largest deposit of limestone in the district. Besides some smaller deposits are scattered over other areas. The important locations are Darrang Era-Aning deposits, Siju Arteka deposits, Tura deposits, and around Rongrenggiri, Dapsi and Darugiri of poor quality. (Fig. No. 2).

Clay: Deposits of lithomergic clay around Tura, Khera, Nongalbibra, and a few other localities account for a possible reserve of about 35 million tonnes. About 20,000 tonnes more of Lithomergic and bauxitic clay occur near Chandmari (Tura). Encouraged by this potential reserve, a pottery industry has sprung up at Mendipathar. Possibility exists for further development of this industry. The main deposits of clay are found at Tura and surrounding areas, Rongchugiri Rajabala road, Rongram Rongchugiri road, Rongchugiri Khera deposits, Songsak and Darugiri deposits etc. (Fig. No. 2)

Occurrence of minerals of little or unknown economic importance, mention can be made of glass, sand, and various kinds of road metals and building stones. The sandstones occuring around Siju, Tura, and Nongalbira contains sand that may be suitable for use in the manufacture of bottleglass. Occurrence of a few sizeable deposits of feldsper in the Archean metamorphites, suitable for insulator and ceramic industry, minor occurrence of gypsum in the shales of "Garo group" and mineral fertilizers (Phosphatic nodules) in the basal part of (Kopilli formation) are already known. The compect massive Archean gneissic and other comparatively harder rocks occuring widely in the district can be profitably used as building stones and road metals. The table No. 3 summarises the mineral types and their impacts.

Physiography

Physiorgaphically, Garo Hills a part of Meghalaya, represent a remnant of an ancient plateau of Pre-Cambrian peninsular shield, block uplifted to its present height of Nokrek (1515 m.), the highest spot over the district. The kernel of the

plateau is the Archean gneisses and schists are covered over the district.[1] The plateau standing as a watershed between the Surma valley of Bangladesh on the south and the Brahmaputra valley on the north, is dissected by several river and a network of their tributaries and lateral streams. The western part of Meghalaya, i.e. the Garo Hills is an extensively dissected tract with an average elevation of 600 m. or less (Fig. No. 3). The Nokrek peak situated 15 km. north east of Tura down on the Tura range has the highest elevation (1515 m.) or (4652 ft.) among other several peaks. Moheskola Adugiri range divides the Khasi and Garo Hills of the plateau separately. The most important physiographic features of Garo Hills are the Tura range and the Simsang Valley. Tura range runs almost through the central parts of the district, west to east extending from Tura town to Siju, a distance of 50 km. The Hills in the north of the Tura range including Arbella hills running parallel to Tura range are low but gradually decreases in height until they reach the later in the south.[2] Kailas hill, east of the Simsang is 3,375 ft. and the Balpakram on the border of the Khasi hills is 2831 ft. above the sea level. The rest of the district consists of a tumbled mass of hills, whose general tendency is to run north and south. The Kailas hills, which is called Chitmany by Garos, stands out an abrupt hog-back mass, which towers above most of the hills in the vicinity. It thus appears to be higher than it really is, and it is probably on this account that it is regarded as by the Garos as the "Home of the Spirit of the Dead".[3]

1. G.S I. Pub. No. 3, Part IV, "Physiography", pp. 72.

2. Sing, R.L., India: A Regional Geography, Meghalaya Mikir Region, p. 690.

3. Pakinthain, E., District Census Hand Book, Garo Hills, 1961, p. 2, "Mountain system".

Note: Balpakram is the end of the hill of Tura range border to Khasi Hills near Mohishola and Pindenggru hill. One of the very remarkable topography of Balpakram hill is the lime stone cave at Siju called "Dobak-Kol" by the Garos. Stalagmite and Stalagtites are found hanging on the roof and the fioor of the cave and no one has explored the end of the cave so far. The underground water so called "Chignap" by the Garos are found near Dapsi Toligiri which runs 3½ miles underground and raise up to the surface again. There are many beautiful landscape, vegetation, waterfalls, canons, gorges—in the district like Chibok dare, Renang dare, Mokma dare. (Dare means waterfall).

TABLE 3

MAJOR MINERALS & MINERAL BASED INDUSTRIES IN GARO HILLS*

Sl. No.	*Deposit*	*Reserve*	*Quality*	*Industry/Plan*
1.	*Coal*			
	(a) West Darranggiri	127 m tonnes	Low ash	The 5 M.W. Thermal Power Station at Norgalbibra is already commissioned. Proposed further increase of capacity to 40 M.W. under study
	(b) Siju coal field	125 m tonnes	Low sulphur	—
	(c) Rongrenggiri	—	—	—
	(d) Balpakram Pindenggru coal field	38 m tonnes	—	—
2.	*Limestone*			
	(a) Darrang-Era-Aning	47 m tonnes	Cement grade	Suitable for cement and lime burning industry
	(b) Siju	165 m tonnes	Cement and chemical grade	Suitable for cement and lime burning industry
	(c) Tura	—	Poor grade	—
3.	*Clay*			
	(a) Tura area	0.76 m tonnes	Lithomergic clay/pottery refractory	Used in Mendipathar Pottery works
	(b) Tura Rongram	0.7 m tonnes	Ceramic grade	Suitable for ceramic industry
	(c) Rongchugiri	0.7 m tonnes		
	(d) Rongchugiri	3.0 m tonnes		

(e) Songsak Daruggiri area	0.85 m tonnes	Ceramic grade	Suitable for ceramic industry
(f) Nongalbibra area	3.5 m tonnes		

*Based on: Know your district, Garo Hills, Meghalaya, G.S.I., Shillong, 125 year Celebration booklet.

From the point of view of physical features the district of Garo Hills can be decided into following three regions:

1. The Northern Sub-montane region.
2. The Central main plateau region.
3. The Southern hill slope region.

1. The northern sub-montane region forms a continuation of the central plateau till it merges with the plains of Assam. But unlike southern hill slopes, which are generally steep and abrupt in certain places, it gently slopes downwards till it merges with the valley of Assam.

2. The central plateau region is the highest part situated between 900 m. and 1800 m. elevation (M.S.L.). It is a dividing line of catchment area or watershed for rivers and streams traversing to the north and southern direction of the district.

3. The southern hill slope region begins where the central plateau ends at about 900 m. elevation and streaches downward up to the plains of Bangladesh. In some places the slopes are steep.

River Basins: Most of the rivers of the district originate from the Tura and Arbella range, the central and heart of the district and the water dividing line or watershed falls through the centre from West till it touches Khasi Hills in the east. Therefore, the water divides or the drainage basin of the district can be divided distinctly into two zones:

1. The northern river basin zone.
2. The southern river basin zone.

The northern river basin zone can be demarcated into eleven sub river basins. The largest basin is the Damring river and its tributaries and there are second six largest sub-basins, like Didram, Manda, Galwang, Ringgi, Didak and Diti. The rest of the rivers have only smaller basins (Fig. No. 4). In the southern river basins, simsang is the largest out of the total 14 rivers. The other second and third larger rivers basins are Ganol, Bugi, Darang and Bandra and the rest are smaller rivers and streams only.

Drainage Pattern: The drainage pattern in the region represents a most spectacular feature revealing extraordinary straight courses of the rivers and streams, evidently along joints and faults. The magnificient gorges scooped out by the rivers in the southern part of the district, are the result of massive headward erosion by anticedent streams, along the joints of the sedimentary rock over the block, experiencing relatively greater uplift. Watershed in Garo Hills, the consequent streams are mostly controlled by the structures—faults and monoclines in the sedimentary rocks. The northern part of the district of the plateau, devoid of many sedimentary cover, is marked by long incisive valleys formed due to headward erosion along the joints in the gneissic rocks and granites. The drainage system of the district is divided directly by the central upland zone which acts as the water-shed from which the rivers flow down to the south, the Surma valley of Bengladesh and to the north, the Brahmaputra valley of Assam. Only the southern flowing river i.e. Simsang at Nangalbibra 5 M.W. Thermal hydro power generating centre are being developed. With the establishment of Bangladesh, it may be possible in future to consider many of the rivers from generation of electricity (Fig. No. 4). The rivers in Garo Hills district are not navigable. There is no change of the course of the river, the bank of the river usually covered with the thick forest on both sides and the stream flows through deep gorges, and they are usually steep. The important five rivers which are navigable within the district for short distance are the Damring, Ganol, Bugi, Dareng and Simsang.

1. *Damring:* It is originated from Arbella range and passes through the villages of Rangagiri, Tapa, and Thira where it enters Goalpara district of Assam. It is navigable during the cold season by making a raft only.

2. *Ganol:* This river rises from Tura range and it flows west of Garo Hills. This river is known as Kalu by the non-Garos. During rainy season only it is navigable to a distance of ten miles and is dangerous due to the blockage in the river beds.

3. *Bugi:* This river also rises from the Tura range and it flows to the south through the villages of Anal, Ruga, Monapaur Ramrangpara, Jamdamgiri and Buddpara, ultimately it falls into the old bed of Brahmaputra in Mymensing district of Bangladesh.

4. *Dareng*: This is one of the main rivers of Garo Hills which flows in a winding course. It is originated from the southern part of Tura range and it flows to Bangladesh.

5, *Simsang:* This is the largest river in the district. It is originated from Tura range as it flows eastward and bend southward till it emerges on the plains of Pargana Susang of Mysemsing. It is navigable for short distance only due to the rocky and rapid falls—throughout the river courses. It passes through the villages of Simsanggiri, Dobakkol, Rongbinggiri, Siju, Rewak, and Baghmara. The important tributaries are namely Rongkai, Rompa, and Chibok. During the preparation period this river is the best for transport system for exchange of necessary materials.

Physiographic Regions

On the basis of elevation the Garo Hills can be divided into five physiographic regions: (Fig. No. 3)

1. Above 1351 m.
2. 901—1350 m.
3. 301—900 m.
4. 151—300 m.
5. Below 150 m.

1. The first region, above 1351 m. are more or less innermost and heart of the district surrounding Nokrek peak which is the highest peak (1515 m.) in the district. This area is regarded as 'Wilderness'.

2. The second region, lies in three pockets, i.e. a part of Nokrek, Chitmang and Balpakram hills. This area is completely absent, of human settlements. The only thick forests with various types of trees which are standing for number of years can be found.

3. The third region, lies between 301-900 m. high, is the central part of the district from which the Simsang and Ganol rivers have originated. Simsang rivers flow to east and southern direction and the Ganol flows to the north-western direction. This area has only a few human settlements, mainly because of poor accessibility.

4. The fourth region, lies between 151 to 300 m. high included inner part of the district touching the Khasi Hills in the east and north-eastern part. This portion is the catchment area of all the important rivers and streams. The area is hilly and is covered with thick forests. It is thinly populated and economically weak.

5. The fifth region, which is below 150 m. high includes all the fertile plain and river valleys starting from Ildek river in the north-eastern most along the district boundary to the north and north west touching Goalpara district of Assam and south, south-western part of the district bordering to Bangladesh right upto the Moheskola area. Nearly half of the district falls in this region which is more populated and economically more developed part of the district. The valuable sal and teak forest are covered by the hill slopes.

Weather and Climate

The weather and climatic conditions of Garo Hills are primarily a part of broader conditions obtained in North-East India with the exception of the impact of local physiographic conditions. The climatic condition range from sub-tropical to semi-temperate at the higher elevation. The district experienced at certain seasons of the year fairly high temperature. November to February are the only cold months in the year. Though the heavy rainfall in summer month keeps down the temperature, it renders the atmosphere exceedingly steamy and oppressive. Southern part of Garo Hills lies on the rain belt and receive the high percepitation. There are three seasons:

1. The cold season
2. The warm season
3. The rainy season.

1. The cold season starts from November to February. When the temperature is comparatively low it receives very little or no rainfall during this period which are originated from the North East monsoon. The temperature (mean) of Garo Hills is ranging from 17°C to 21°C in November to January, station at Tura, and the rainfall is almost 2 mm to

17 mm as recorded for the last 30 years (1931-1960). (Table No. 4).

2. The warm season is from the month of March to May and it merges with the monsoon rainy season. The temperature remains as high as 24°C to 26°C in average and the dryness prevails all over the area.

3. The rainy season starts from June to October. The south west monsoon brings rain in the region. The rainy season commences and breaks at slightly different times in different parts of the region but end of the May is the normal time in all the places. The mean temperature goes in between 24°C to 26°C and 200 mm to 700 mm is the average rainfall as recorde at Tura station for last 30 years (Table (No. 4).

The seasonal (temporal) and spatial variation of temperature and rainfall of Garo Hills, as recorded in the South western part i.e, the adjoining areas of Tura and Dhubri receives the highest temperature i.e., 27°C to 28°C in the month of August. The coldest month is January with 17°C as its temperature. In the central and eastern part of the district the temperature falls in between 9°C to 11°C in December and January and the highest is 21°C as recorded in surrounding areas like Shillong and Cherapunjee stations. The North and North-Eastern parts of the district is quite warm as temperature goes up to 28°C as recorded in the adjoining areas of Gauhati. The amount of rainfall in the Western part of the district is below 2 mm is the lowest (Tura and Dhubri) in the month of December and 600 mm to 700 mm in the highest in June to August months. The Central and eastern part receives 4 to 6 mm of rainfall is the lowest in December and 500 to 2921 mm is the highest rainfall in June as recorded in the surrounding areas of Cherrapunjee and Shillong stations. In the northern part of the district adjoining areas of Goalpara and Kamrup district of Assam, 300 mm is the highest rainfall as it receives in July.

Garo Hills district being a part of Meghalaya plateau, and a rainest place of the world, it receives high amount of rainfall (Fig. No. 4). It is quite sufficient to the need of the people during the cultivation period. But the soil is as such, the water level is very deep, the rain water does not remain underground for longer time. As a result of this, the water deficiency is

TABLE 4(a)

AVERAGE ANNUAL RAINFALL AND TEMPERATURE, 1931-60

Months	BHUBRI Temperature Max. 0c	Min. 0c	Mean 0c	Rainfall (m.m.)	TURA Temperature Max. 0c	Min. 0c	Mean 0c	Kainfall (9 m.m.)
January	22.9	11.8	17.3	11.2	23.6	12.3	17.9	11.9
February	25.3	1.2	19.7	19.2	26.4	14.9	20.6	7.5
March	30.1	18.1	24.1	45.3	29.9	18.7	24.3	72.1
April	31.6	21.5	26.5	154.2	32.5	22.1	27.3	131.1
May	29.9	23.0	26.4	418.5	31.0	22.9	26.9	402.2
June	29.8	24.6	27.2	644.3	29.3	22.7	26.0	708.7
July	29.6	25.8	27.7	447.7	28.9	23.2	26.5	709.2
August	30.7	26.0	28.3	305.3	29.3	23.3	26.8	558.6
September	30.7	24.7	27.7	331.4	29.5	22.7	26.1	461.5
October	29.1	23.0	26.0	135.1	28.9	20.3	24.6	249.7
November	26.3	17.8	22.0	11.8	26.5	16.3	24.6	17.7
December	23.7	14.3	19.0	1.2	24.7	13.5	19.1	1.2

there during the dry period of March and April before the rain starts. The clearance of jungles for jhuming is also greatly affect the rainfall and rain bearing wind direction and obstraction during the winter months. The district receives North-East monsoon in winter and South East monsoon in summer. On the basis of the rainfall variation, the district of Garo Hills may roughly be identified into two climatic sub regions:

1. The northern part low rainfall region, and
2. The central and southern heavy rainfall region.

The northern part of Garo Hills, the adjoining areas of the Goalpara and Kamrup districts of Assam falls under the rain-shadow area after the Tura range in the central part. It receives lesser amount of rainfall than southern part as recorded as 300 mm only at Gauhati station in the month of July. The main vegetations are the teak, sal, and bamboo forest, and the main cultivation is jhuming in the hills and the wet cultivation in the plain areas. Paddy, jute, mustard seeds, betel nut and betel leaves, bananas and tobacco are the main crops.

The central and southern part of the district bordering to Bangladesh, receives heavy rainfall above 700 mm as recorded at the stations like Tura and Dhubri in the June-July months. Sal, Teak, and the jungle mixed with bamboos are the main vegetation. The main agricultural crops are paddy, wheat, oranges pinapple, betel nut etc.. The seasonal and monthly average amount of water discharged data are not available as the rivers and streams of Garo Hills fall under the restricted international boundary (India and Banglanesh). Therefore, the analysis of the water surplus and water defficiency of the region is not possible to find out properly out of the rainfall and temperature data only.

Vegetation cover and Forest Wealth

The district of Garo Hills is rich in forest[1] resources. The

1. The forest in Garo Hills are divided for administrative purposes as "State Forest" under the administrative control of the Forest Deptt. of the state and the forest under the administrative control of the Forest Deptt. of the Garo Hills District Council.

TABLE 4(b)

AVERAGE ANNUAL RAINFALL AND TEMPERATURE, 1931-60

Months	SHILLONG Temperature Max. 0c	Min. 0c	Mean 0c	Rainfall (m.m.)	CHERRAPUNJEE Temperature Max. 0c	Min. 0c	Mean 0c	Rainfall (m.m.)
January	15.5	3.6	9.5	15.2	15.8	7.6	11.7	19.8
February	17.1	6.4	11.7	28.5	16.9	10.5	13.7	37.3
March	21.5	10.5	16.0	59.4	20.5	12.9	16.7	178.9
April	23.8	14.1	18.9	136.4	22.0	15.1	18.5	605.2
May	23.7	15.5	24.6	325.4	22.1	16.3	19.2	1705.1
June	23.7	17.4	20.5	544.6	22.9	17.3	20.1	2921.5
July	24.1	18.1	21.1	396.9	22.2	18.4	20.3	2456.7
August	24.1	17.8	20.9	334.6	22.5	18.4	20.5	1827.5
September	23.6	16.6	20.1	314.9	22.9	18.1	20.5	1167.7
October	21.8	12.9	17.3	220.2	22.4	15.9	19.1	447.4
November	18.9	7.7	13.3	34.9	19.7	11.9	15.8	46.7
December	16.4	4.5	10.4	6.3	17.0	8.8	12.9	4.9

hilly areas of the district are covered with dense evergreen forest. The total areas under forest in the district is 4,66,498 hectares according to census 1971.[1] The important varieties of timber available in the district are teak, sal, bansum, bogipoma, gonsoroi, holu, ajhar, koroi, jamuk, seda, jharul, gogra, titachapa, jatipoma, khokom, buati, bamboo etc.

Factors affecting vegetation cover

The vegetation cover of the district is complex, rich and variegated. But continuous onslaughts by man, clearance, heavy exploitation and maltreatment by burning and overgrazing have destroyed many forests and replaced by barren land. The retreating or destruction of forest in the district are taking place in faster rate than before due to the following factors:

1. *Jhuming:* In many parts of the district, the forest are cutting down for the cultivation purposes. The local primitive people, since the time immemorial, depend on jhum cultivation. All the vegetation are cutting down in the cold season, dried them for sometimes and set them fire during the dry months (March/April). The jhummia families changing their cultivation land every year. The denudation and degeneration of the forest cover of the district has already led to serious problem of soil erosion all over the hilly areas.

2. *Lumbering:* The forests of the district are now of importance mainly for their yield and good timber, such as the taek, and sal timbers. The demand for timber is increasing and year by year reducing the forest areas by the extensive exploitation of trees. The steadily increasing use of wood resulting from an expanding population and a severe strain on the forest resources of the district. Not only that lumbering is also one of the important and primary occupation of the people who depend on cutting, collecting, and setting forest product, like cane, broom, lac, gum, thatching grass, fruits and roots etc.

3. *Pasturing*: Overgrazing of domestic animals in a factor

1. The Techno-Economic Survey of Garo Hills District, Govt. of Meghalaya, 1975 on "Forest Resources" p. 54, Rural Industrial Project Garo Hills.

TABLE 4(c)

AVERAGE ANNUAL RAINFALL AND TEMPERATURE 1931-60

Months	GAUHATI Temperature Max. 0c	Min. 0c	Mean 0c	Rainfall (m.m.)	SILCHAR Temperature Max. 0c	Min. 0c	Mean 0c	Rainfall (m.m.)
January	24.8	11.0	17.5	11.4	25.5	11.7	18.6	14.6
February	26.3	12.8	19.5	18.3	27.1	13.6	20.3	44.7
March	30.2	16.5	23.4	53.4	30.4	17.5	28.9	97.0
April	31.6	20.3	27.1	125.9	31.5	0.8	26.1	312.5
May	31.0	22.7	26.8	273.6	31.2	22.8	27.0	493.3
June	31.5	24.7	28.1	293.4	31.3	24.6	27.9	605.2
July	32.1	25.8	28.9	301.5	31.8	25.1	28.2	546.5
August	32.2	25.8	29.0	263.0	31.2	24.5	27.8	475.3
September	32.1	25.2	28.6	190.1	31.8	24.7	28.2	378.4
October	30.5	22.0	27.2	90.1	31.1	27.7	26.9	207.0
November	27.7	16.9	22.3	11.5	29.2	17.6	23.4	44.0
December	24.9	12.5	18.7	5.0	26.5	13.3	20.1	6.9

for deforestation, in Garo Hills. The local graziers such as the milkman, Nepalese are mostly keeping their domestic animals moving one place to another in search of good grazing land. Along with the destruction of forest by jhum cultivation, the overgrazing of animals create more destruction of forest and cause soil erosion. The simple classification of Garo Hills vegetation fall under the Tropical west evergreen forest. By and large, the forest of Garo Hills can be sub-divided into the following:

1. Evergreen forest mixed with bamboo
2. Sal Forest
3. Reserve Forest

1. The evergreen forest mixed with bamboo can be found in the district for about 60 per cent of the total district areas. This forest included mixture of all tropical vegetation like bamboo, reed, cane, broom, thatching grass, tall-grass and different varieties of trees both in the plain and the hilly areas. The mixed forest mostly paid eastern part of the district.

2. *Sal forest:* The area under their type of forest will be about 25 per cent of the total district area. The sal forest, it does not mean that the sal trees are only grown but there are some other species also. But those areas are dominantly occupied and grown by sal trees as the soil is favourable for their growth. The sal growing areas are mostly occupied in the north-eastern and south-eastern parts of the district.

3. *Reserve Forest:* The reserve forest of the district occupied almost 10 per cent of the district total area. This reserve forest is controlled by the state Government and it includes all the classed forests, i.e., unclassed forest, and the protected forest. But the unclassed forests are under the control of District. There are 16 different reserved forests in Garo Hills and are given in Table No. 5 with area in sq. km.

Within the Government Reserved Forests of the district there are differant types of forests such as the alluvial sal forest, foothill and plateau sal, deciduous forests, evergreen forests, bamboo forest and plantation etc. The area under different types of forests in the reserved forest of Garo Hills are given in Table No. 6 along with their approximate area occupi

TABLE 5
AREA UNDER RESERVED FOREST, GARO HILLS

1. Darengiri Reserve Forest	10,356 sq. km.
2. Sangsak Reserve Forest	23,390 sq. km.
3. Dambo Reserve Forest	18,129 sq. km.
4. Rongrengiri Reserve Forest	36,259 sq. km.
5. Chima Bangsi Reserve Forest	23,309 sq. km.
6. Dima Reserve Forest	20,720 sq. km.
7. Rajasimala Reserve Forest	18,130 sq. km.
8. Ildek Reserve Forest	2,560 sq. km.
9. Dilma Reserve Forest	2,560 sq. km.
10. Angratoli Reserve Forest	30,043 sq. km.
11. Baghmara Reserve Forest	44,288 sq. km.
12. Siju Reserve Forest	5,180 sq. km.
13. Rewak Reserve Forest	6,473 sq. km.
14. Emangiri Reserve Forest	8,283 sq. km.
15. Dibru Hills Reserve Forest	15,022 sq. km.
16. Tura Peak (catchment area)	3,890 sq. km.
Total	2,68,516 sq. km.

Data Source: D.F.O., Garo Hills, Tura.

Almost entire district of Garo Hills need afforestration. Different types of vegetation can be grown in different parts of the district. A forestration will regulate the climatic condition, the stream flow and prevent the soil erosion. According to the emphasis given by the Government of Meghalaya, the schemes are being carried out for raising the forest plantation and forest development in different circles. Besides, promoting agricultural development in various parts of the district, forests will help to develop various industries in the surrounding region. The industries that are based on forest product include buildings, furnitures, agricultural implements and the sal timber of Garo Hills are famous for its good quality which are used in railways. Area under plantation of different trees in such reserved forests are given in Table No. 7.

TABLE 6

AREA UNDER DIFFERENT TYPES OF FOREST IN THE RESERVED FOREST OF GARO HILLS, 1975

(Area in Hectare)

Name of the reserve	*Total area*	*Alluvial sal*	*Foot Hill & plateau sal*	*Dicidious forest*	*Evergreen forest*	*Bamboo forest*	*Blank un-productive*	*Open pro-ductivə*	*Area under plantation, etc.*
Baghmara	4429.0	—	115.67	1667.39	—	84.51	153.66	1227.96	1169.81
Angratoli	3011.0	300.00	800.00	—	—	263.68	8.66	1251.00	389.52
Siju	518.0	—	125.00	20.00	—	30.00	60.00	279.00	—
Rewak	647.0	—	75.00	72.00	—	—	34.40	296.00	169.00
Emangiri	829.0	—	96.50	54.00	273.3	—	—	373.82	40.00
Dibhru Hill	1502.0	135.00	—	344.60	—	311.04	63.16	454.68	193.28
Dilma	259.0	50.00	—	134.00	—	5.04	8.28	44.32	17.40
Rajasimla	1813.0	—	455.00	180.00	—	152.00	56.39	1116.70	31.11
Ildek	259.0	70.00	—	36.00	—	38.00	22.00	36.00	38.00
Chimabangsi	2331.0	725.42	—	359.54	—	60.00	273.03	346.51	166.50
Dhima	2072.0	256.35	—	752.00	—	123.00	414.63	316.34	110.08
Rongrenggiri	3584.0	—	289.04	—	—	730.00	865.00	289.84	410.98
Songsak	2331.0	—	1226.64	36.00	—	155.00	249.88	230.00	9.28
Darugiri	1036.0	—	275.00	165.00	—	30.00	40.00	342.20	193.80
Dambu	1813.0	—	160.75	367.00	—	129.01	328.81	121.32	711.29

Data Source: Forest Marking Plan, Forest Deptt., Govt. of Meghalaya, Shillong, p. 25.

TABLE 7

AREA UNDER PLANTATION OF DIFFERENT SPECIES UNDER WORKING CIRCLE SCHEME: 1976, GARO HILLS

Name of the Reserve Forest	*Area allotted in Hectares*	*Special suitable for plantation*
1. Ildek	80.00	Teak, Kadam
2. Dilma	98.24	Teak, Gugra
3. Rajasimla	598.53	Teak, Kadam, Poma, Hollock, Bhalu
4. Bhima	831.82	Teak, Poma, Titasopa, Gugra, Kadam
5. Chima bangsi	444.64	Teak, Khokam, Kodam, Poma, Amari
6. Dambu	459.38	Teak, Kadam, Hollock
7. Darugiri	502.24	Teak, Kadam, Bhalu
8. Songsak	1087.24	Choice of the D.F.O.
9. Rongrenggiri	357.44	Teak, Titasopa, Bogipoma
10. Dibru Hill	712.42	Choice of the D.F.O.
11. Baghmara	2380.71	Teak, Poma, Bogipoma
12. Angratoli	1322.88	Teak, Poma, Titasopa
13. Rewak	1141.22	Choice of the D.F.O.
Total	9978.36	

Data Source: Forest Working Circle Plan. Forest Department, Government of Meghalaya, Shillong, pp. 112-113.