CHAPTER II

A. PHYSICAL BACKGROUND OF THE STUDY REGION

Location

The Brahmaputra Valley lies between 25°31' 45" north and 28° north latitudes, and 89°41' east and 96°02' east longitudes (Fig. 2.1). The valley is a well-demarcated physical unit within the girdle formed by the Eastern Himalayas, Patkai and Naga Hills and the Garo-Khasi-Jaintia and Karbi Hills.

The valley represents a narrow plain, extending from near the syntaxial bend of the Eastern Himalayas, westward to beyond Dhubri on the border of Bangladesh. The valley covers an area of about 56,339 sq.km. and has an east-west extension of about 720 km and an average width of 80 km. Although spatially a compact unit, it has clear regional subdivisions, and is divided into seven administrative districts of Goalpara, Kamrup, Darrang, Nowgong, Sibsagar, Dibrugarh and Lakhimpur.

Physiography

The Assam Valley has been built mostly by the aggradational work of the Brahmaputra and its tributaries. It is almost a flat, level plain with very gentle slope from its north-east corner at Sadiya to Dhubri in the west. The general altitude of the valley ranges from 130 metres above
In the east to 28 metres above sea level in the west with a fall of about 14 cm per km.

The gradient is, however, not smooth throughout. It varies from section to section of the valley with the occurrence of extreme flat patches hindering quick drainage. Sadiya at the northeast of the plain has an elevation of 130 metres above sea level (a.s.l.), while Dibrugarh 100 km downstream has an elevation of 106 metres a.s.l., Dikhowmukh located 74 km farther downstream has an altitude of 92 metres, Dhansirimukh 86 km west of it, is 73.5 metres a.s.l., Gauhati 195 km west of Dhansirimukh, has an altitude of 51 metres a.s.l., and Dhubri located 186 km west of Gauhati is at 28 metres a.s.l.

Physically the valley is well demarcated from the hills, for the latter rise abruptly from 150 metres contour. The flatness of it is interrupted from the west of the Majuli island by a number of hillocks that lie seated on either bank of the river. These isolated hillocks represent the outliers of the Meghalaya Plateau. Often such hillocks project up to the bank of the Brahmaputra from south and extends underground to its northern side, rendering constrictions to its channel. This is an important factor contributing towards water logging in the immediate up stream part of the river especially during the rainy season.
The northern margin of the valley is characterised by an abrupt rise to the Eastern Himalayas. Its southern margin on the other hand rises gradually to the Nagaland in the east, Karbi Plateau in the middle and the Meghalaya Plateau in the west.

The two banks of the Brahmaputra plain present different forms of physiographic characteristics. (Fig. 2.2)

In the northern bank the 'Bhabar Zone' lying along the Eastern Himalayan foothills is a fairly high ground, formed as a result of the coalescence of alluvial cones. It is a zone of unassorted detritus where the water of a large number of small tributaries running down from the Himalayas debouch abruptly to the main valley and form a series of alluvial fans which join and obstruct the courses of the tributaries themselves near the foot-hills. As a result, the tributaries branch out in different channels till they form permanent courses farther down-stream in almost a southerly direction. The 'Tarai Zone' immediately south of the 'Bhabar zone' is a flat and narrow belt where water seeps out from the latter. This zone has tall grass and damp ground. It is fairly wide in north Goalpara and north Kamrup plains, but tapers down in Darrang and Lakhimpur districts.
Immediately south of the Tarai Zone, at about equal distances from the Brahmaputra to the south and the hills to the north, lies a strip of high ground or the 'Highland Zone' from east to west, which is not only the most densely populated area but also supports the rich rice fields. Through this zone runs the roads and railways.

In this zone we find patches of higher grounds of older alluvium especially around the area east of Jia Bharali. These project southwards from the piedmont zone along the interfluves of the tributaries, occasionally up to the bank of the Brahmaputra. These are on the average 2 to 3 metres above the flood plain and constitute favourable sites for tea plantation. Such patches of older alluvium are to be found up to Brahmajan in Helem Thana of Darrang district. East of Darrang i.e. in Lakhimpur the built up middle plain is very narrow as the Luhit - Kherkatia and their tributaries together form an extensive low-lying flood-plain. In Dhemaji subdivision the flood-plain reaches as far north as the foot of the hills.

South of the highland zone lies the wide and active 'Flood Plain Zone' of the Brahmaputra. This occurs on both the banks of the Brahmaputra except where the ground rises to the occasional monadnocks and incipient levees. This zone is swampy and contains numerous ox-bow lakes. It is fairly wide
in the Dhemaji subdivision of Lakhimpur district and Barpeta subdivision of Kamrup in the north bank. The flood-plain is extensive from Saikhowaghat to Dibrugarh, as also from the confluence of the Burhi Dihing to Neemati including the mauzas of Pani Dihing and Nitaipukhuri of Sibsagar subdivision. To the west it extends over Majuli to the Gelabil and Rangamati Grants of Dergaon Thana, and almost the whole part of northern Bokakhat Thana including the Kaziranga National Wildlife Sanctuary. In Nowgong the active flood-plain includes the Ladkhowa Grant, Dhing, Laharighat and Morigaon Thanass. In Kamrup the low-lying area in the south bank includes Palasbari, Chaygaon and Boko. In Goalpara district the thanas of Lakhimpur and south Salmara fall within the active flood-plain.

South of the Flood Plain Zone we have the plains of the south bank which is again narrow. It is only in Dibrugarh and Sibsagar districts that the plain is relatively large. Elsewhere it is literally confined to a narrow strip on either side of the 'South Trunk Road' or the National Highways No. 31 and 37. This narrow strip of land is, however, of immense human significance with high density of population and fairly intensive cultivation of rice, tea and vegetables. It is in this part, as in its counterpart in the north bank, that the density of population has been increasing at a much higher rate than in other parts of the plain.
As in the north bank, here also a patch of high ground with reddish old alluvium is found in Golaghat subdivision. The undulations and high mounds borne out of the old alluvium, are invariably occupied by tea gardens in the area between Dergaon and Jakhalabhandha.

The 'Southern Foothill Zone', unlike the north bank one, does not have an extensive tarai region. In Dibrugarh and Sibsagar districts the foothill region is covered by high grounds and isolated hillocks which are occupied by tea gardens. Wherever tea plantations are absent the region is covered with dense forest. In the districts of Nowgong, Kamrup and Goalpara the foothill region is occupied by erosional platforms created by age-old erosion of the streams, alternated with 'beels' and swamps.

Drainage

Assam valley as a whole, is a riverine basin of the mighty Brahmaputra and its numerous tributaries. The Brahmaputra is principally constituted of three major tributaries viz. Dihang, Dibang and Luhit. The upper course of the river Brahmaputra lies in Tibet where it is known as the Tsangpo.

The valley has a structure comparable to a winnowing fan, being abutted by hills on three sides and open to the west. The river washes the basin from east to west. A large
number of tributaries from all sides traverse the high slopes of these hills with variable speed and load, and ultimately fall into the master river through a loose network of drainage channels over the plain. Some of these tributaries are really large and have extensive catchment areas and wide flood plains. The major north bank tributaries include Subansiri, Ranga Nadi, Dikrong, Buroi, Bargang, Jia Bharali, Jia Dhansiri, Barnadi, Pagladia, Manas, Champamati and Sonkosh. The main south bank tributaries are the Dihang, Luhit, Buri-Dihing, Disang, Dikhau, Jhanji, Dhansiri, Kapili, Digaru, Kulsi, Singra, Dudhnai, Krishnai and Jinjiram. (Fig. 2.3)

It has been mentioned earlier that the gradients of the valley, both along the east-west and north-south directions vary from section to section and hence the pattern of drainage also vary from area to area. Over the foot hill Bhabar zone, the tributaries become shallow and they tend to braid while in the tarai zone water percolates down and render the area perpetually moist and damp. It is over the built-up narrow central highlands that the tributaries have definite course. As the tributaries approach the Brahmaputra they tend to have a sub-parallel course because of the presence of levee on the immediate river bank. Thus the portion beyond the levee and built-up high land on either bank is turned into a marshy tract, in which the tributaries
very often lose their course. In the areas where the Brahmaputra plain is sufficiently wide this phenomenon of several tributaries losing their lower courses into the marshy tracts is common. In Dhemaji subdivision, Mangaldai, north Kamrup and north Goalpara plain in the north bank, and in the Pani Dihing and Gelabil areas of Sibsagar district, Dhing - Bhurbhandha area of Nowgong and in Jaleswar area of Goalpara district in the south bank have been turned into marshy tracts in this manner. These marshy tracts are not only unhygienic but also devoid of means of transport and communication. Such a situation has been further deteriorated by unplanned constructions of embankments, roads and divergent channels. The people in such areas have to live under extremely deporable condition especially during the rainy season for about eight months from April to November, in an ecology best suited for aquatic animals, insects and swamp birds. The rivers do open ultimately to the Brahmaputra, but through extremely tortuous lower course, for very often the water level of the Brahmaputra remains higher than that in the swamps.

Climate

The climate of the Brahmaputra Valley is characterized by hot and moist summer and cool and dry winter conditions with two transitional periods sandwiched between them.
The hot and moist weather season begins in early June and continues up to late September. This season is characterised by temperatures ranging between 28°C and 36°C, high humidity and cloudy sky. Though temperature tends to fall slightly towards the later part of the season, humidity increases because of copious rainfall occurring between June and September. About 65 per cent of the total annual rainfall is received during this season. The quantity of rainfall, however, varies from place to place on account of topographic factors, as can be seen from table 2.1. The north-western part of Goalpara district as well as the north-eastern parts of Dibrugarh and Lakhimpur districts are the areas of heavy annual rainfall with about 300 cms. The southern part of Nowgong district embracing the Lanka - Lumding area with an average annual rainfall of 109 cms., is the driest part of the State. The relatively low rainfall here is due to the rain-shadow effect of the Meghalaya Plateau (Fig.2.4).

High temperature accompanied by high humidity makes the atmosphere sultry and life trying, during this period. The people suffer from languor of mind and body, depression of spirit, and inability to undergo exertion during this season.

The dry cool winter season is confined to the months of December, January, and February, and is characterised by
Table 2.1
Monthly Number of Rainy Days During 1976

<table>
<thead>
<tr>
<th>STATION</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUN</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>TOTAL</th>
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<td>1</td>
<td>26</td>
<td>6</td>
<td>18</td>
<td>22</td>
<td>18</td>
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<td>7</td>
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<td>9</td>
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<td>18</td>
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<td>15</td>
<td>6</td>
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<td>1</td>
<td>12</td>
<td>10</td>
<td>11</td>
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<td>19</td>
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<td>15</td>
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<td>7. N.LAKHIMPUR</td>
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<td>8</td>
<td>14</td>
<td>21</td>
<td>25</td>
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</table>

Source - Meteorological Office, Borjhar, Gauhati.
Table 2.2.

Average Monthly Humidity in Percentage, 1976

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<th>JUL</th>
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<th>NOV</th>
<th>DEC</th>
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<td>82</td>
</tr>
<tr>
<td>3. TEZPUR</td>
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<td>94</td>
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<tr>
<td>5. JORHAT</td>
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<td>85</td>
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<td>86</td>
<td>79</td>
</tr>
<tr>
<td>6. DIBRUGARH</td>
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<td>72</td>
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<tr>
<td>7. N. LAKHIMPUR</td>
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<td>85</td>
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</table>

Source - Meteorological Office, Borjhar, Gauhati.
cool weather and frequent morning fog. The average temperature during this season is between 15°-20°C and rainfall is very low not exceeding 11.4 cm. However, this cool, fair and pleasant weather is interrupted casually by showers associated with western disturbances, which lower the temperature and bring cold spells. There is a regional micro-climatic variation within the valley in that the eastern districts of Dibrugarh, Sibsagar and Lakhimpur have a lower average temperature than the rest. Even in the summer, the temperature in the former drops down perceptibly following a heavy shower (Fig. 2.5). This is a marked feature of the localities throughout the state and may be said to exercise a great influence on the general climate, especially with respect of their location, with reference to the prevailing winds. The influence is more remarkable in the lower, than in the upper portion of the valley, which is mainly attributable to the obstruction the wind receives from the vicinity of the great ranges of hills, for this must prevent the dispersion of the noxious exhalations engendered in the low marshy grounds, and extensive dense forests, abounding in their vicinity and give rise to those fevers which are regarded so dangerous and intractable .... The southern side of the upper portion of the valley though more open to the prevailing winds, is exceedingly moist and damp; which
BRAHMAPUTRA VALLEY
SHOWING
AVERAGE MAXIMUM AND MINIMUM TEMPERATURE
AND RELATIVE HUMIDITY
(1967-76)

INDEX:

Fig. 2.5
may be attributed to the winds wafting the exhalations arising from the river and marshes in its vicinity to the adjacent hills, where they are frequently known to rest for several successive days .... From the frequent occurrence of high table lands on the northern side of the valley, with less jungle and marshy ground, that side has the advantage of a free circulation of air, and in consequence, is not productive of the diseases prevalent on the opposite side. Notwithstanding fevers contacted in the neighbourhood of the jungles are frequently of a malignant nature .......

(Barua 1933)¹.

The two transitional periods, between the two broad seasonal divisions mentioned above are the pre-winter or post monsoon period and the post-winter or pre-monsoon period. The pre-winter period consists of the months of October and November. It is a transitional period with both temperature and rainfall falling gradually and clouds beginning to disappear from the sky that frequently remained overcast so long. The rainfall during this period does not exceed 15.2 cm in the valley and rainy days are fewer.

Lakhimpur and Sibsagar districts in the eastern part of the

valley, experience longer rainy or cloudy days but the average rainfall per rainy day rarely exceeds 2 cm. This is the season for growing green vegetables and oil seeds on soils that still remain moist after long summer rains, but with prevailing dry atmosphere.

The post winter or pre-monsoon period starts in late February (with the beginning of the Indian month of Falgoon) and continues up to early June (end of the Indian month of Jaistha). This is a transitional period in the climate, and the one that exercises great influence upon the health of the inhabitants, especially strangers. The season is marked by the stillness of the lower stratum of the atmosphere in most parts of the valley.

According to Robinson², 'The remarkable varied period between relatively dry winter and wet summer, is characterised by a rapid rise in temperature from March'. 'Poxes' (basanta), conjunctivitis and many other diseases follow the dust-storms that blow in February and March, especially in Lower Assam along the neighbouring areas of the Brahmaputra, and the hot and dry spells of April and May is the time for diarrhoea, dysentery and cholera.

² Ibid.
As the season advances, the amount and frequency of rainfall increase due to frequent thunder-showers with hail storms in the afternoon. These thunder-showers are called Nor'westers, locally known as 'Bardoichila'. The average temperature of this season is 23°C and rainfall is 51.8 cm.

**Climate and Health**

As to the climate of Assam and its effect upon the general health of the inhabitants, different opinions are found. According to one section, its climate is equal to that of the healthiest provinces in India and according to the other, its climate bears close resemblance to that of Arakan. But their assertions cannot be taken for granted, because the climate of the State is determined by different factors in different localities. Hence, the climate and its effect upon the general health of the inhabitants at different places and at different times, differ from each other. The prevailing winds, carrying dusts and rainfall and nearness to the hills, forests and low marshy lands are mainly responsible for the ill effect upon the health of the inhabitants of the State. The commencement and cessation of the rains are considered to be the most unhealthy periods of the year, because along with it comes certain diseases such as typhoid and cholera (Fig. 2.6) illustration based on Appendix A, table 1. The strangers, who came from other parts of India, habituated to a comparatively dry climate, cannot easily adjust themselves with the
SEASONAL DISTRIBUTION SHOWING
PERCENTAGE OF OCCURRENCE
TO TOTAL INCIDENCE
(1975)

Fig. 2.6
damp and humid climate of the rainy season here. For instance, those who unfortunately came to Assam with Mirjumla, in the second half of the 17th Century, during the rainy season, to invade Assam, had to suffer much from fever and dysentery and a large number of them had to die of these diseases. The noted writer Shihabuddin and the contemporary French traveller Bernice and given vivid descriptions of the hardships met with by Mirjumla and his soldiers in the summer season here.

To sum up, the direct effects of unfavourable climates are greatly increased by indirect effects such as diet. In a general way, the more stimulating the climate, the more favourable is its type of diet. Thus we see, that in a climate like ours, the inhabitants consume more of bananas, yams, peanuts, rice and sometimes corn. Hence the amount of fruit intake besides bananas is usually small. The diet is bulky but lacks in proteins. The inhabitants are badly nourished, and this is a cause of inefficiency.

Evidently, all these conditions along with the thermodynamic influence of orography have developed a climatic distinctiveness for the Assam Valley, different from the normal Cwg or humid meso-thermal of the Ganga Plain as envisaged by Koppen, and, as such, the climate of this region may be classified as 'Cwb' or humid meso-thermal...
Brahmaputra valley type.  

**Soil**

The soils of Assam are made of detritus laid down by the Brahmaputra and its tributaries. These alluvial soils contain sand and silt with a high quantity of humus. In the fringes of the valley particularly in Kamrup, and Nowgong districts, there are limited areas with lateritic soil along the border of the Meghalaya Plateau. (Fig. 2.7). Barring the narrow Bhabar and Tarai areas, the soils of the valley are of two genetic types - new alluvium and old alluvium. New alluvial soils are mostly found in the river banks and are subject to annual floods and renewal. This soil is often neutral, with a pH value of 5.5. In texture they vary from sandy to clayey loam. The percentages of nitrogen and organic matter are adequate for agricultural purposes and are particularly high in lowlying areas. They are suitable for the cultivation of rice, jute, pulses, mustard, potatoe and vegetables.

The old alluvium is distributed in a scattered manner in the interfluvues and has built up higher ground in the north as well as on the south bank areas of Assam especially

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HE IV ALLUVIUM
OLD ALLUVIUM (act die)
LATERITE
SOILS OF SUBMONTANE TRACT

SOIL TYPES
NEW ALLUVIUM
OLD ALLUVIUM (acidic)
LATERITE
SOILS OF SUBMONTANE TRACT
HILL SOILS (mostly red loams and lateritic soils)

BY COURTESY OF DR. M. M. DAS.
along the foot hills. Such soils are reddish in colour and heavier than common new alluvial soil. The soils are more acidic and vary in texture from sandy to clayey loam with high to low content of nitrogen. The pH value is 4.2 to 5.5. The acidic character of these soils makes them very suitable for tea plantation, particularly in the Upper Assam Valley. These are also suitable for sugarcane, fruits, rice and vegetables, but not for pulses and mustard.

The soils of the upper part of the Brahmaputra Valley are rich in phosphoric content but that of the lower part are considerably poor in it. The percentages of both nitrogen and organic matter are sufficiently high especially in the low lying soils where putrification is common. Heavy clayey soils of the low lands with high percentage of nitrogen, prevent percolation of standing water. Organic matters, especially of vegetal origin, get poorly decomposed under the conditions of stagnant water and emit methane and allied gases fouling the immediate layer of the atmosphere. The sandy loams lying in the flood plains of the Brahmaputra and its tributaries are, however, good for rice and jute cultivation.

The lateritic soils which occupy small areas along the fringe of the valley are highly leached soils, poor in
plant nutrients and are generally of limited agricultural value. The soils in the northern foot hills, particularly in Goalpara, Kamrup and parts of Darrang districts are coarse alluvium formed by the debris deposited by the streams debouching onto the flat plain. Just south of this zone lies the tarai tract with peaty soils that remain perpetually saturated with moisture and supports tall grass as in the riverine tracts of the Brahmaputra and her tributaries.

Soil and water play a very important role in the diffusion of diseases, and are potent elements in the promotion of the life cycle of human parasites. The hookworm (Ancylostoma duodenale) disease is related to the texture of the soil, for the hookworm larvae grows in sandy soil and does not grow in clayey soil. Along the river banks, where moisture and temperature are congenial for the development of hookworm, the inhabitants of villages along river banks are more frequently infected with hookworm than inland dwellers. Conversely, the type of soil that favours the development of the hookworm eggs, is hostile to roundworm (Ascaris lumbricoides)\(^5\). Hence inverse proportion of infestation by both worms in males and females is found in places where usually men work in the fields and women stay around the house. However, in certain places

where women work in the fields and men go to sell the produce, it is the women who bear the brunt of hookworm infestation and men get the roundworm.

Natural Vegetation

A long rainy season accompanied by high rainfall and temperature, relatively low evaporation and damp and fertile soils favour a luxuriant growth of natural vegetation of all descriptions in the Brahmaputra valley.

The natural vegetation in the valley is predominantly of four types, viz. tropical evergreen, moist deciduous, grasses and marshes.

The tropical evergreen forests generally occur on the piedmont (Bhabar) zone adjoining the Himalayan foot hills as also the eastern and southern foot hills of Arunachal and Nagaland bordering Dibrugarh and Sibsagar districts. They present the typical three-storied appearance of tropical forest and contain the various species of trees like Nahar (Mesua ferrea), Makai (Shorea assamica), Hollong (Dipterocarpus macrocarpus), Titasopa (Michelia champaca), etc. Apart from the Himalayan foot hill region of Assam, these forests are found in the easternmost part of the valley, particularly in Dibrugarh and Sibsagar districts with an imposing, dense, luxuriant growth, a characteristic vegetation of high rainfall regions. The Hollong (Dipterocarpus
macrocarpus), and the Makai (Shorea assamica) provide raw materials for plywood mills in the upper Assam valley.

Other notable trees mixed in Nahar-Hollong forests are Amari (Terminalia tomentosa), Sam (Artocarpus chappasa), Jutuli (Altingeza excelsa), Borgach (Ficus benghalensis), Gamari (Gmelina robusta), Kadam (Anthocephalus cadamba) and Hollock (Terminalia myriocapa). They thrive in swampy areas, mainly in Darrang district along its northern fringe bordering the Bhutan foot hills. Khair (Acacia catechu) and Sisso (Dalbergia sissoo) often pure and sometimes mixed, are found to thrive well in the overflooded tracts by the side of the rivers located just at the foot hills.

In the north bank of the Brahmaputra the extreme eastern part is covered by another species of evergreen type, known as Sia-Nahor (Mesua ferrea), which comprises about 70 per cent of the trees in that area. The semi-evergreen forests are more widespread in the valley than others, though species within them vary from one locality to the other. These occur predominantly in the districts of Goalpara, Kamrup, Darrang and Sibsagar especially in the vicinity of streams and moist areas and in the tarai region. These forests are not as dense as the evergreen ones.

The typically deciduous Sal (Shorea robusta) forests cover large areas in the districts of Goalpara, Kamrup,
Darrang and the western part of Nowgong district. The most important 'Sal' tract of the valley is in the Machpara area of Goalpara district covering above 205 km². These forests contain another associated species of Sal known as Makri-sal (Schima wallichai), an important plywood species of the lower Assam valley. Besides these, we have the Sal and Segun (Tectona grandis) belt along the southern foothills of Goalpara, Kamrup and Nowgong.

The moist deciduous riverine forests containing Khair (Acacia catechu), and Sisso (Dalbergia sissoo) occur mainly along the river banks from the Sankosh in the west through Goalpara and Kamrup to the eastern boundary of the dense tall grass.

Moist deciduous forests under the conditions of sandy soil or human interference give rise to mixed deciduous forests. Such forests occur mostly in the Lower Brahmaputra Valley. The main species of this group are Odal (Sterculia villosa), Simulu (Bombax malaboricum), Sidha (Laegerstromea parviflora), and Makri-Sal (Schima wallichai). The ground of these forests are covered by thatches, grass and reeds. Such forests are subjected to intense fire, so the few valuable species occurring with them are generally hollow at the base.
There is a type of riverine deciduous forest which occurs all over Assam in those alluvial tracts which are inundated by streams in the monsoon period. This type comprises mainly the Simulu (Bombax malabaricum), Koroi (Albizzia procera) and Kadam (Anhthocephalus cadamba). The riverine forests are open and hence we find extensive grasslands all along the riverine tracts. Son-kher (Imperata orundinacea), the best thatching grass in Assam, is found in these tracts of mixed tree and grasses.

The Savannah type of forest occurs in the well-drained higher areas adjoining the foot hills and near the settlement where human interference is common. It represents a transitional stage, whose further succession to the next-stage is limited by the intense fires that sweep through these areas almost annually. The species found in these areas are Atkuri (Wrightia tomentosa), Bogori (Zizyphus jujuba), and Gurol (Randia dumetorum), a kind of Imperata arundinacea found extensively in these areas. Lowland Savannah containing Ekara (Saccharum spontaneum) as the main grass is found on the banks of the rivers and streams which are flooded during the rains.

In addition to the above mentioned types of vegetation, the valley also supports many species, like Bamboo (Bambosa arundinacea) and Cane (Dendrocalamus strictus)
which are of considerable economic importance. Bamboo occurs throughout the valley, but is found more in Upper Assam. There are varieties of bamboo, among which Jati (Bambusa nutans), Bhaluka (Dendrocalamus longispathus), and Koteha (Bambusa arundinacea) are the most important. Canes occur in swampy areas all over the valley but they are found in plenty as large cane-brakes in the evergreen and semi-evergreen forests of Upper Assam and in the Darrang district.

There are important types of grass found all along the banks of the rivers, particularly in the riverine and savannah tracts of the valley. The grass and reeds are Kher (Imperata species), Ekara (Saccharum spontaneum) and Kahua (Saccharum munja). Water hyacinth (Icchornia) is seen wherever there is a low lying swampy area. Those, around which people stay, often make these a dumping ground for their garbage, thereby polluting the atmosphere and rendering surroundings unhygienic.

Moreover, herbs and grasses especially those growing on damp soil become the breeding ground of germs, worms, flies and insects. Such areas are particularly malarial. Furthermore, swamps and floating vegetation obstructing putrefaction, give out foul gases, and thereby making the air polluted. With such a surrounding one is apt to suffer from various diseases. Unplanned growth of trees under the
existing climatic conditions, in the residential compounds leading to continuous shade and dampness, makes matters even worse.

During the early summer months, an ailment known as Hay-fever or Hay-asthma is sure to occur in most persons, which is marked by excessive irritation of the nose and throat, and accompanied with violent sneezing and intense headache. This is due to the small particles found in the form of dust and those floating in the atmosphere which get into the human body and thereby causing such ailments. Such other pollen grains and small insects found in certain plants, when carried along with the wind do cause irritation of the nose and throat.

This is just one example of the various diseases caused due to vegetation, whether directly or indirectly.

B. THE ECONOMY

The State’s annual income during the year 1975-76 was 1327.2 crores at current prices and 479.9 crores at constant price (1948-49). The per capita income at current price in the same year was 814.4 rupees and 295.9 rupees at constant price. For the country as a whole, the national income at current price during the year 1975-76 was 603,000 million and Rs. 220,000 million at constant price. The per
capita income being 1005 rupees at current prices and 366 rupees at constant prices^.

The nonagricultural economic activities in 1974 including mining, small enterprises, and construction etc. contributed only 18 per cent to the State's total income, whereas agriculture and allied activities contributed 57 per cent as estimated at current prices^.

Land-Use and Agriculture

Agriculture is the mainstay of the economy of Assam. It is of basic importance to the region, not only because it provides most of the food requirements and gives employment to 66 per cent of the population, but also because it supplies raw materials such as tea and jute which constitute the backbone of the State's economy. Assam grows about 50 per cent of India's total tea and 15 per cent of the country's jute. Though agriculture is the main occupation and primary resourcebase of the region, the operations associated with it are still traditional and its modernisation is yet to take place. The predominance of human labour, draught by bullocks and almost singular use of wooden


7 All Figures used have been taken from 'Statistical Hand Book, Assam, 1974, Government of Assam.
ploughs are notable features of Assam's agriculture. Use of modern inputs like fertilizers, insecticides, agricultural machineries and high yielding varieties of crops is insignificant, and the average yield of crops per hectare is low as compared to other parts of India. Assam's cropping system is based on monoculture with double and multiple cropping having made only a little headway. Improved methods of agriculture are yet to be accepted by the farmers as normal practice. Furthermore a notable feature of the State is the small holdings of farms, which is best understood by the following:

Bhalla has classified the cultivating households in Haryana into the following five categories according to the size of their net operational holdings:

(i) Sub-marginal peasant households, each having a holding size of less than 2 hectares.

(ii) Marginal or small peasant households, each having a holding size between 2 and 4 hectares.

(iii) Intermediate peasant households with holding size between 4 and 8 hectares.

(iv) Big peasant households with holding size between 8 and 12 hectares and

(v) Very big peasant households with holdings size
of more than 12 hectares\textsuperscript{8}.

By the standard of the holding size fixed by Bhalla for Haryana, 80.82 per cent of the total operational holdings in Assam are submarginal, 14.04 per cent marginal, 4.79 per cent medium and only 0.35 per cent big. It may be mentioned here that about 16 per cent of the total rural households in Assam are landless\textsuperscript{9}, and the agricultural density is 5.34 hectares and physiological density being 5.87 hectares. It is, therefore, found that as large as 81 per cent of the total operational holdings have 43 per cent of the total operational area below the floor level of economic holding. Peasants belonging to this category have to live in abject poverty and perpetual debt.

A micro-level study on rural development and strategy for action with regard to four 'Gaon Panchayats' (a number of villages under a village council) of the State - Nischiratpur (Cachar district), Borpujia (Nowgong), Pub Tamulpur (Kamrup) and Panidihing (Sibsagar)\textsuperscript{10}, confirms the


microscopic sizes of operational holdings, and also a significant number of landless rural households. The report on Borpujia indicated a serious imbalance in the size and ownership structure of land holding. 67 percent of the cultivated land is held by only 29 percent of the households, while 14.5 percent of the households are landless. The per capita availability of operational land is only 0.12 hectare. 83 percent of the total population of the area lie below the poverty line. This report is representative of the rural areas of the whole State.

All this shows the absolute poverty the rural population lives in, and thus falls an easy prey to several diseases, due to malnutrition and sub-standard living conditions. The nutritional density for the valley is 6.37 hectares, and the caloric intake is below the required amount.

The proportion of cultivable land to the total geographical area of Assam is also relatively small (41.94 percent) as compared to that of Bihar, Uttar Pradesh, Punjab, Tamil Nadu and Andhra Pradesh, where the sown area to the total vary between 50-60 percent. Even in States like Madhya Pradesh, Orissa and Karnataka it is about 40 percent. The smaller proportions of sown area 2,141,289

11 R.N. Dubey, et.al., Economic Geography of India. (1968)
hectares (34 per cent) in the valley is due to the fact that out of the total of 63,17,265 hectares of land about 1,439,980 hectares (23 per cent) are not available for cultivation on account of hills, rocky surfaces, swamps, marshes, shifting river channels and flood affected low lands. Forests cover 1,743,743 hectares (28 per cent) of total land. The areas of fallow lands and cultivable wastes are 302,212 hectares (5 per cent) and 183,805 hectares (3 per cent) respectively. Another important feature to be noted is that the area cropped more than once is very negligible in the region. Of the total area sown only 5,08,779 hectares (24 per cent) are put to cultivation more than once. This means that about 76 per cent of the net sown area remain idle after one crop cultivation.

Rice, the most important of all the food grains grown in the valley, accounted for about 71 per cent of the total area under crops in 1970-71\(^{12}\). Wheat, which has come to be the next important food crop, is grown over a small area of only 21,000 hectares. The important commercial crops of the valley are tea, jute, oil seeds, and sugarcane.

\(^{12}\) All data relating to agriculture have been obtained from *Statistical Hand Book* (Assam, 1974). Percentage figures have been worked out by the author.
Tea is the principal commercial crop and was planted in 9 per cent of the net area sown in 1971. About 75 per cent of the region's tea comes from the districts of Dibrugarh, Sibsagar, Darrang, and Nowgong. In respect of area and production of tea, Dibrugarh district takes the leading position.

After tea, jute is the next important commercial crop occupying 7 per cent of the net area sown in 1970-71. Jute is mainly cultivated in the districts of Goalpara, Kamrup, Darrang and Nowgong. The largest jute growing area of the region lies in the Nowgong district.

Sugarcane is grown all over the valley mainly with significant concentration in the districts of Sibsagar, Kamrup and Darrang.

Besides crop cultivation, the region's agricultural economy is supported by animal husbandry, fishery and forestry. These three important adjuncts of agriculture contribute a sizable income to the States economy.

Minerals

Except petroleum, natural gas and coal no other important mineral has so far been discovered in the Brahmaputra valley. It is also known to contain some quantity of asbestos, corundum, fireclay, iron, and copper. But it is
only coal and petroleum that have been exploited on commercial scales. Coals of Gondawans formation are found along the foot hills of the Himalayas running in patches from Bhutan Duars to near Sadiya. The coal fields of Tertiary origin are concentrated in the south-eastern part of the valley. The major coal fields are Ledo - Makum, Jaipur - Dilli, and Nazira. The estimated reserves of workable coal Ledo - Makum and Jaipur - Dilli are 310,000,000 tonnes and 20,000,000 tonnes respectively. The coal of the region contains remarkably low ash but high sulphur. These are presently consumed by railways, iron and brass foundries, brick, kilns, inland water steamer services, tea gardens and other industries in addition to households. Assam's most important mineral of national significance is petroleum. The Dibrugarh district contributes by its oil and coal deposits, 90 per cent of the net income from mining in Assam. The oil fields are concentrated in and around Digboi, Naharkatiya, Hugrijan, Doom Dooms and Moran, of Dibrugarh district and Rudrasagar, Lakua, Geleky, Teek, and the areas between Jorhat and Golaghat in Sibsagar district.

Digboi, the pioneer oil field in the country, has been producing oil since 1890. The discovery of other oil

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fields mentioned above, has put Assam prominently in the oil map of Asia. Assam’s oil reserves are estimated to be sufficiently large and there is good prospect of more oil reserves being discovered in Upper Assam. Natural gas is another important resource associated with the petroleum deposits of the State which has initiated a series of industrial developments. It is notable that the natural gas is being utilized for producing electric power near Duliajan. In 1976 Assam produced 558,000 tonnes of coal, 4296,000 tonnes of crude oil and 848 million cubic metre of natural gas. The share of oil royalty in the State’s annual income was 19.33 crores in 1976.

Fire clay is another mineral which is to be found in association with the coal seams of Upper Assam. Recently bounded Magnetite - quartzite has also been discovered in Chandardina hill in Goalpara and near Hahin in Kamrup district along the Meghalaya border.

Minerals so far discussed above are industrially significant. There are certain other minerals, which are called trace elements found in phreatic water and which are required in micro-quantities for the human body. These

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minerals include calcium, phosphorus, iron, sodium, potassium, chlorine, magnesium, lead, etc. Lack of any one of them may lead to a particular deficiency disease.

In the Brahmaputra valley, higher calcium concentration in ground water between 45 and 108 parts per million (ppm) has been found around Digboi, Dibrugarh, and Tinsukia in Dibrugarh district, Bardowa - Jakhalabandha area in Nowgong district and Bansbari - Manikpur area in Goalpara district\(^\text{15}\). Where as in other wells calcium content generally varies from 10 to 35 ppm. Magnesium content of ground water in the valley, however, ranges between 1.4 ppm and 50 ppm, though majority of the wells show magnesium concentration of the order of 5 to 10 ppm. Sodium and potassium concentration in ground water is relatively less than 20 ppm and 10 ppm. Sulphate content of ground water is generally less than 30 ppm, though in Tinsukia it is relatively high (98 ppm) as against its chloride and bicarbonate contents of 39 ppm and 128 ppm respectively. Concentration of bicarbonate ions, as high as 250 ppm has been noticed in ground water around North Lakhimpur, Nalbari and Bongaigaon. In Nowgong district, bicarbonate content decreases towards the river from 250 to

There is generally a low concentration of iron content along the major recent river flood plains in the northern bank of the Brahmaputra river. However, relatively higher concentration of iron (2.0 to 13.0 ppm) is found around North Lakhimpur, Tezpur, Bongaigaon in almost continuous patches along the north bank. In the southern bank however, less iron content is found in the flood plains of Nowgong, Sibsagar and Dibrugarh districts (Fig. 2.9).

As stated earlier, lack of these minerals in the human body, may lead to a particular disease. As for example calcium is required for bone and teeth development, coagulation of blood and many other life process. Magnesium deficiency leads to neuro-muscular irritability - tetanic convulsions, tremor, etc. Lack in sodium chloride causes muscular cramps. Lack of iron leads to goitre. Lead which is used for a lot of things such as the manufacturing of water pipes and plastic paints, is also very poisonous at the same time. Lead poisoning which can happen due to swallowing of peeled out paints by children, inhalation of automobile gas, etc. has several negative effects on the body, and one of them is brain damage.

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16 J.E. Park, et.al., Textbook of Preventive and Social Medicine, 1976, Jabalpur.
BRAHMAPUTRA VALLEY
SHOWING
ISO BICARB CONTOURS OF GROUND WATER

SOURCE: Central Ground Water Board.
BRAHMAPUTRA VALLEY
CONTOURS SHOWING DISTRIBUTION
OF IRON IN GROUND WATER

CONTOUR OF IRON (Value in ppm)
ppm - PARTS PER MILLION

SOURCE: CENTRAL GROUND WATER BOARD
Thus we see that wine rale have both industrial and medical significance.

**Industries**

Though the valley appears to be industrially important in North-East India with its relative industrial advancement among the adjoining areas, it would rather appear to be a void on the industrial map of India, excepting however, its tea and petroleum industries. The region is potentially rich in the industrial raw materials, but their economic exploitation has been hindered by several factors such as its isolation from the rest of India due to transport and communication bottleneck, paucity of capital, limited local market, shortage of cheap labour, lack of entrepreneurship and non-availability of cheap power.

The industrial landscape of the region, except that of tea, is limited to small pockets around Gauhati and Dibrugarh.

Of all the industries tea processing and oil refining are most significant and these two groups of industries have made notable contribution to the economic development of the State. As specified above, tea processing alone contributes 28 per cent to the State's income from the industrial sector followed by small enterprises (26 per cent), mining (22 per cent), establishment (16 per cent), and construction, etc.
(8 per cent), Production of tea in 1977 was 291 million kgs., sugar 7.1 thousand tonne, jute 4.2 thousand tonne, petroleum refinery products 1214 thousand tonnes and plywood* 23.4 million sq.metre.17

Next to tea processing comes the food processing industries i.e. rice and flour mills, which are mostly concentrated in the Nowgong and Kamrup districts. There are 287 mills and 1699 persons employed. The two refineries employing 1602 workers is the third biggest industrial undertaking. The other notable industries of importance are two inorganer fertiliser factories employing 1761 persons, 6 cotton spinning and weaving factories (1174)18, 2 jute and mesta spinning and weaving factories (1227), 66 flour mills (530), and one sugar refining factory (408). Besides these there are 42 plywood and veneer mills (4707), 299 sawing and plaining mills (2728) and 4 match factories (1051).

The textile industry is perhaps the least developed having only one jute mill at Silghat and one spun-silk mill

* Plywood - Includes commercial, decorative, black boards, flush doors and tea chest.


18 Figures within brackets show the number of registered workers employed in the factories in 1975, Statistical Hand Book, Assam, 1976.
at Jagiroad, both in Nowgong district. Though the region produces about one fourth of the total Indian jute, its manufacturing is yet to be developed. The bulk of jute from the valley, feeds the jute mills of West Bengal. The major centres of plywood industry are at Margherita, Mariani and Tinsukia - all in Upper Assam.

Industries nearing completion or projected during the last plan period include a petrochemical complex at Bongaigaon, a cement factory at Bokajan, two jute mills, five sugar mills, two paper and one paper pulp mill. This would raise the economy of the region.

There is lack of industrialization in the State, and agriculture is the main occupation of the inhabitants. In the densely populated rural areas, mechanization will be a solution, as that would increase employment of the landless or nearly landless rural population. Mechanization can be adopted, and progress in industrial development should be there, so that the unemployed population are gainfully absorbed.

Thus we see that lack of industrialization has led to restricted avenues of employment and poverty which in turn leads to high price of industrial products and non-availability of essential consumer goods including drugs, needed for various kind of diseases.
Due to the geographic location of the State, coupled with poor means of transport and communication, lack of industrialization, and slow pace of urbanization, development of trade and commerce is still unsatisfactory.

The colonial interests deterred a healthy growth of trade and commerce in Assam as most of its economic products were traded in Calcutta, the then commercial headquarters of the colonial interest of eastern India. All the tea produced in Assam was auctioned at Calcutta for foreign markets and Assam did not have a single tea auction centre for more than 150 years until 1972. Likewise, the raw jute produced in the State was sent to Calcutta to feed the jute mills located around the metropolis. Except the retail trade, the entire whole-sale trade of the State in all the essential commodities were controlled and handled by Calcutta market.

One very significant aspect of the commercial structure of Assam is that the entire trade and commerce, whether whole-sale or retail, is controlled by non-indigenous traders, especially the businessmen from Rajasthan. Consequently an insignificant portion of the profit from trade and commerce is left towards the capital formation in the State as most of it goes outside Assam.
Transport and Communication

Lack of adequate transport facilities in Assam is still one of the major impediments to the economic development of the entire North Eastern region. In the recent years the volume and importance of road transport have been increasing, but inland water transport is languishing.

A network of good road system is vitally important from the socio-economic point of view. However, the road development in Assam has special difficulties on account of the existence of numerous hill ranges of varying height, rivers and streams with their oft changing courses requiring considerable extent of bridging, circuiting of roads, etc.

There are 1,140 km of National Highways. The North Trunk Road runs almost parallel to the river Brahmaputra along the north bank, while the National Highway No.37 runs from Gauhati to Tinsukia along the south bank. The western part of the National Highway again traverses the State along the north bank from Gauhati to Dhubri. The National Highway is very important to the State as it passes through important industrial, commercial and administrative centres like Gauhati, Nowgong, Jorhat, Sibsagar, Dibrugarh and Tinsukia. The trunk road and the National Highway have many feeder roads spreading over the entire region. There are regular bus services run by the Assam Transport Corporation linking most places with each other. The rural areas surrounding
the urban centres are also served by daily bus services. Recently, Interstate truck services have also been introduced between Assam and other parts of India. Gauhati is the transport focus of the region not only by roads but by railway and airways as well. With the construction of the Brahmaputra bridge at Gauhati, transport between the two sides have become much easier.

The total Public Works Department road length in Assam increased from 9759 km\(^{19}\) in 1950-51 (including Meghalaya and Misoram) to 19840 km in 1975 and then to 20149 km in 1976.

Although the number and length of the roads in Assam have increased in recent years, the bulk of the rural population is still poorly served by roads. Most of the villages have only fair-weather roads, as can be seen from the total roads in Assam, 87 per cent of the roads are earth, 1 per cent gravel and 12 per cent metal.

At present the railways serve as the main communication system between Assam and rest of India. Except the negligible length of 105 km of broad gauge, up to New

Bongaigaon, the entire railways system in Assam is metre gauge. The two main railway lines run east-west along both the banks of the Brahmaputra and connect most of the major urban centres on either side. New towns like Bongaigaon, Rangiya, New Gauhati, Lumding, Mariani and Tinsukia have grown mainly due to the development of railways. Tea, jute, petroleum and petroleum products are the main commodities transported by the railways from Assam. Large areas in the region, however, are yet to be provided with railway service. The main railway line in the south bank of the Brahmaputra does not pass through the main towns like Nowgong, Jorhat, and Sibsagar and these towns are being connected with the main line by minor branch railway lines. It is worth mentioning that although the construction of railways in the region dates back to 1880's, its expansion has been very slow due to lack of industrial development and geographical condition mentioned above.

The railways still bear stamp of colonial economy having served only the tea and petroleum producing areas. The rural population are yet to get any substantial benefit from it.

The volume of traffic, both passenger and goods, is increasing rapidly to and from the region, as a result, the railways being metre gauge, are overburdened. Therefore, all
these call for the improvement of the railway system. Work is in progress for the construction of broad gauge line upto Gauhati.

The air transport in the region is fairly developed. The amount of air-borne traffic between the region and Calcutta is considerably high. The interstate air freighter services are important to the region in view of its isolated location and transport difficulties. There are five air ports operating within the State, viz. Barjhar (Gauhati), Saloni (Tezpur), Rowroish (Jorhat), Lilabari (North Lakhimpur), and Mohanbari (Dibrugarh), and all of them are linked with Calcutta by daily passenger-cum-freighter service.

Air service being extremely expensive is not accessible to common people in the State.