CHAPTER TWO

PHYSICAL BASIS OF SADIYA REGION

2.1 THE SADIYA REGION

The Sadiya Region (Fig. 2.1(c)) sometimes known as the Rukmini Plain (Borthakur, 1968) is located on the northern bank of the Lohit-Brahmaputra river alignment in the eastern extremity of Assam. It has been an integral part of Assam since pre-historic times. From administrative as well as study points of view, this Sadiya Region comprises the whole of the Sadiya Sub-division of the present Tinsukia District. Before 1979, it was a part of the former Dibrugarh District which was at times a Sub-division of the then Lakhimpur District of Assam, India. Since time immemorial, the region has been found as a land of unique historical and geographical identities. It comprises a plain area just at the foot of a part of the Eastern Himalaya in Arunachal Pradesh. The plain is not far away from the Namcha-Barwa Peak on the said Eastern Himalaya. Many parts of the Sadiya Region have remained untrodden since pre-historic or historic times. The region is still very backward and much neglected. It has been transportationally almost detached even from other parts of the Tinsukia District. The main means of communication to the other parts of Assam is only the waterway across the Lohit river.

The Sadiya Region is located latitudinally within 27°44'N and 27°57'N and longitudinally within 95°28'E and 95°54'E covering an area of 790 km². This region, in the olden days, was the legendary kingdom called the Bidarva of the pre-historic king, Vishmaka. After his reign, the region had gone subsequently to the hands of the Bodos, the Chutiyas, the Ahoms, and the British. During the period of the British rule, it was made a political unit called the Sadiya Frontier Tract and after India's Independence it was made an integral part of the Lakhimpur District in 1951. And finally it became an administrative sub-division of the Tinsukia District.

The location of the region has been conspicuously significant due to presence of a giant confluence of the three mighty
rivers, viz. the Lohit, the Dibang and Dihang. This confluence which is perhaps the biggest in India, supplies waters to make the origin and flow of the mighty river Brahmaputra. The three mighty rivers creating more or less dendritic valleys in the hills and plains converge into this region. The combination of these dendritic valleys in the easternmost part of the Brahmaputra valley gives the shape of bowl-shaped river plain.

The western, southern and south-western parts of the Sadiya Region are marked partly by perennial rivers and partly by dry-river beds (at the time of winter season). Therefore, it is a region under the regime of turbulent river flows. Free to activate channel-shifting and bank erosion without any check. Disastrous floods of both flash and spilling types have been recurrent in this riverine tract.

As mentioned earlier, the location of the Sadiya Region is on the foot of the hills and mountains that exist mostly in its three sides having a great opening by plains only towards the west.

The name 'Sadiya Region' follows the name of the Sadiya Town which was completely eaten up by fluvial agents like the Dibang and the Lohit rivers during 1952-53. The term Sadiya bears historical meaning and uses. The term further carries the history of human occupancy in the region. The etymology of the word 'Sadiya' seems to be controversial as a group of historians along with some of the general public demand that the use of the word has come from the burial place of the dead body (sa in Assamese) of the son of the king of Bidarva. The king's son was buried at the present Sadiya. Again some think it to be originated from the name of the Goddess Sati-Sadhani (Neog, 1986) of the Chutiyas. But according to philologists like Bishnu Rabha (1982), the word Sadiya is actually derived from a Bodo word called Chudiya. The Chutias, representing a branch of the Bodo families used to live in the Sadiya Region. In Bodo language, ji, di and ti mean water and the chu means sacred. The word chuti means the river of sacred water and the people living on the bank of the chu-ti are known as the Chutiya. Therefore, the region where the Chutiyas used to
live in was also known as chutiya, chujiya or chudiya. The Sadiya has now become the corrupted form of chudiya. This analysis is acceptable, because the Bodos were the original inhabitants of this region. The king, Vishmaka who ruled over the Sadiya Region in the pre-historic time, is also thought to belong to this group of people.

2.2 PHYSIOGRAPHY

The 'Sadiya Region' is a plain consisting of river channel beds, shoals and river islands, point bars, floodplains composed of old and new alluvium and piedmont plains. The plain is much flatter in the zone of confluence of the giant rivers. The region has perceptible slopes towards the hill margin. The gradient of the region ranges from 0.6 m per km in the confluence zone to 2.25 m per km in the piedmont zone. The region has been characterised by fluvio-geomorphologically significant material base, processes and problems of the three main river basins and, therefore, the morphology of the region has been modified by the combined effect of these rivers on geologic and surficial materials, geomorphic processes and human interference.

Physiographically, the region comprises plain with occasional lowlying pockets along the river valleys and the piedmont areas characterised by differential relative relief (Fig. 2.2) and dissection pattern (Fig. 2.3). The average elevation of the Sadiya Region is 134 m above the mean sea level sloping down towards the Dibrugarh Town. Where the elevation above the mean sea level is 104 m. The region has an average gradient of 20 cm per km along the Sadiya - Dibrugarh alignment. The contour variation (Fig. 2.4) within the region ranges from 180 m in the extreme northeast corner to 120 m at the confluence towards the extreme southwest portion. The slope or gradient of the region along the north - south direction (Fig. 2.5a) is relatively high in comparison to that along the west - east direction (Fig. 2.5b).

2.2.1 Physiographic Divisions

Based on the pattern of surface morphology as revealed by topographical sheets of one inch to a mile scale, satellite imagery
FIG. 2 '50.

SADIYA REGION
RELIEF BY N-S PROFILES

120 m

140 m

160 m

2 1 0  2 4 km

2 1 0  2 4 km

2 1 0  2 4 km

2 1 0  2 4 km
and hydrogeomorphological maps prepared by ARSAC and personal observations, the region may be divided into four distinct micro physiographic units (Fig. 2,5). They are (I) the Active Floodplain with river islands, (II) the Young Built-up Plain which may again be divided into three sub-units, viz. (a) the Young Built-up Plain in the east of the Kundil river, (b) the Young Built-up Plain in the west of the Kundil and (c) the Amarpur River Island of the Dibang, (III) the Old Built-up Alluvial Plain in the north and (IV) the Piedmont Plain in the north-east. In the Sadiya Region there is an area of about 246 km$^2$ accounting approximately for 31 per cent wherein there lie big river beds, beels and other stagnant water bodies which are supposed to merge with their neighbouring physiographic units. The small river channels of the Sadiya Region may also cover an area approximately of 9 per cent of the region's total area.

The following few paragraphs bring forth the characteristics of the physiographic units.

I. The Active Floodplain:

This unit lies just below or within the banks of rivers. The plains of low relief where floods are frequent, are included in this micro-physiographic unit. The chars and chaparais within the braided courses of the big rivers like Lohit, Dibang and Dihang are also included in this micro-physiographic unit. The small river islands, sand bars and point bars cover up some of the landforms of this micro-unit. The active floodplain covers parts of the Kundil river basin towards the north of the Lohit, parts of the lower Dibang basin including the lower part of the Amarpur island and the lower part of the Lohit river basin. Fluvio-geomorphologically, it is known as the 'flood-way' (Lee, 1972; Cooke and Doornkamp, 1974). This floodplain is composed of sand, gravel, silt and clay. Like other parts of the Sadiya plain, this active floodplain also has its slope falling down generally towards the confluence zone. However, the general trend of slope has locally been interrupted by the direction of channels. This plain is characterised by assemblages of meander cut-offs, swamps, beels, and levees. The active floodplain along the Kundil is spotted by beels like
SADIYA REGION
MICRO-PHYSIOGRAPHIC DIVISIONS

2 1 0 2 4 KM

DIVISIONS
ACTIVE FLOOD PLAIN
YOUNG BUILT UP PLAIN
OLD BUILT UP PLAIN
PIEDMONT PLAIN

BASED ON TOPOGRAPHICAL SHEETS, SATELLITE IMAGERY AND FIELD OBSERVATION.

FIG. 2.6
Gharpalia Beel, Dongor Beel, Anakuri Beel, Rajmao Beel and many small ones. These beels and swamps which are the breeding ground of local fishes, have now been in the slow process of transformation into agricultural land due to heavy siltation by floods and growth of aquatic vegetation. The width of the active floodplain along the Kundil is about 2 km on the average. The floodplain at the confluence zone, created by combined waters of Kundil, Lohit, Dibang and Ghurmar is the widest in the sub-division. The width here ranges up to 12 km (6 km on land). The active floodplain of the Amarpur island over which the floods of the Dibang and the Dutung (Gongo) pass is wide enough. The slope of the active floodplain is about 0.6 m per km on the average. But towards the Kundil, it is higher marked by 1.3 m per km. On the floodplain of the Sadiya Region, floods of both the flash and spill types caused by the Dihang and the Seserri also do occur. It has been observed that about half of the Amarpur island goes under active floodplain. The low water level of the Dutung is hardly found one metre below the top of the banks during rainy seasons.

The Lohit has a very active floodplain in the old Sadiya area as well as in the areas in and around Basagaon, Sunpura, Padumphula and Lakhimpuria. A good number of oxbow lakes, beels and swamps are seen within this plain. The beels located near the Lohit river are Lebang, Dolung, Deepong, Balai, Longswal, Dighali, Saru Labong (small Labong), etc. This plain has been characterised by some marshes having their origin due to meander-cut-offs or presence of paleo-channels. Frequent channel shifting associated with serious bank erosion has been the inherent characteristics of this zone. This tendency has gone up to a great height after the much disastrous earthquake of 1950. A large number of villages has already been washed away by the rivers and their floods during these years.

II. The Young Built-up Plain:

This young built-up plain is formed due to the continued alluviation by the rivers. The plain which is open and flat in nature, consists of the western part of the Kundil basin up to the Dibang river, the northern part of Amarpur island to the west
of the Dibang and the eastern part of the Kundil's active floodplain. The maximum elevation of this plain is 160 m, while the minimum one is 125 m above the mean sea level. The slope of the plain ranges between 2.25 m/km and 0.6 m/km. This plain extends up to the lower limit of the piedmont zone in the north-east and the old built-up plain in the northern part.

The young built-up plain has been characterised by a good number of small tributaries and distributaries. The tributaries are the Diphu, the Balijan, the Saru Balijan (small Balijan), the Ghurmara, etc. These rivers inundate some pockets on their banks during rainy seasons. This plain also has been characterised by some marshes having their origins at the old meander-cut-offs or the paleo-channels left by the persistent rivers.

The Young Built-up Plain, for conventional purposes may be divided into three sub-units. They are (a) the Young Built-up Plain in the east of the river Kundil, (b) the Young Built-up Plain in the west of the Kundil and (c) the Young Built-up Plain in the Amarpur island.

(a) The Young Built-up Plain in the east of the Kundil extends from the Kundil-Kalia-Deopani Reserve Forest on the piedmont plain to the active floodplain zone of the Kundil and the Lohit. This micro physiographic unit has been characterised by some beels, swamps and paleo-channels. Geophysical records show that this small area is very sensitive to tectonic activities, especially to earthquakes (Das, 1970).

(b) The Young Built-up Plain in the west of the Kundil active floodplain zone is having slightly higher elevation than that of the young built-up plain in the east. This portion is not tectonically much sensitive as previous one. The earthquake of 1950 did not affect much in this zone. This part has been regularly washed by Ghurmara and Disoi rivers. It has comparatively small number of beels, swamps and marshes than that of eastern counterpart. High floods visit this area occasionally. People who have migrated from the active floodplain or from some other parts of the state, come to settle down here.
(c) The Young Built-up Plain of Amarpur consisting of a part of the Amarpur river island lies to the north of the active floodplain zone of the island. The island has a gradually falling slope towards the south. After 1950, the Gongo river (a branch of the Dibang), now locally known as the Dutung uses to flow through the middle part of the island. A paleochannel of the Gongo river is marked by cut-off above the present lower course of the Sesseri which today meets the Dihang (Fig. 2.7). However, the old channel gets flooded during every rainy season. It has some beels and swamps which owe their origins to river cut-offs or paleo-channels. Floods of high and medium intensities frequently inundate the southern part of the sub-zone.

III. The Old Built-up Plain:

The Old Built-up Plain which is intermediate between the young built-up plain and the piedmont zone has been characterised by patches of small high grounds scattered all over the plain. There are also terraces on it. This plain in the Sadiya Region extends from the western border of the Kundil-Kalia-Deopani Reserve Forest to the eastern bank of the Dibang. The old built-up plain is formed of old alluvium having high proportions of acidic and phosphoric contents. The plain is interspersed by a number of big and small streams running from north to south. But this part of the Sadiya Region rarely goes to floods. A part of this plain has been under forest cover called the Sadiya Station Reserve Forest (North Block).

IV. The Piedmont Plain:

This micro physiographic unit exists on the extreme north-eastern corner of the Sadiya Sub-division. This is actually a small extension of a wide piedmont below the Arunachal Himalaya. The small piedmont in Assam has been regularly washed by the Kundil-Kalia (the upper portion of the Kundil is known as the Kalia) and the Balijan having their origins in the Eastern Himalaya. This plain which is composed of unconsolidated and unassorted river-borne materials like boulders, pebbles, cobbles, gravels, sand and silt conforms to the characteristics of a bhabar zone below the Himalaya. The plain has been marked by intermittent
channels and alluvial fans and cones. During rainy days, the waters of the Kundil-Kalia and Balijan get linked with Hajo, Digaru and Paya rivers aligned outside the Sadiya Sub division in the east. A large number of springs locally known as bhumuks (Goswami, 1978) is also present in the lower limit of this bhabar zone. At times during high to moderate floods, the Hajo river uses to flow frequently over the Kundil-Kalia river. This process of overtaking by the Hajo river has now been found to get retarded within last ten or fifteen years and this river is now flowing through the Balijan river where the upper portion of the latter is in the process of drying up and merging up with the Kundil-Kalia river.

2.3 DRAINAGE CHARACTERISTICS

The Sadiya Region is a region of too many rivers - big and small (Figs 2.4). The region has been washed away by three major rivers, viz. the Dibang, the Lohit and the Dihang. Of these, the Dihang and the Lohit are having their origins at some Tibetan glaciers. All these three rivers combinedly form a great confluence with the Brahmaputra in the Sadiya region. The rivers receive water partly from snowmelt and partly from rainfall. All these three major rivers have very large basins (Figs. 2.7 and 2.8) characterised geomorphologically by very complex channels and landform assemblages. The fluvial geomorphology of the Sadiya Region is mostly guided by the basin morphology and surface unstability of Dihang, Dibang and Lohit drainage systems. The Sadiya Region has about 20 significant rivers. The region is not only influenced by the rivers of the region itself, but also by some ones outside the region. The Lohit and Dibang fall in the first group, while the second group includes the rivers like Dihang and many others.

The Lohit - The Lohit (Fig. 2.7) has its origin at the Yako Peak (29°30' N, 97°15'E; 6614 m above the sea level) near the Shugden (Gômpa) Glacier located in the south-eastern part of the Tibetan Plateau. The river is known as the Zayul-chu or the Cha-yi-Le-Ho in Tibet (China). Crossing over hills, mountains and passes in China and Burma, the river enters into the Indian territory at
THE TSANGPO-DIHANG DRAINAGE SYSTEM

GANGA CATCHMENT
SONKOSH CATCHMENT
MANAS CATCHMENT
SUBANSIRI CATCHMENT
DIBANG CATCHMENT
R BRAMHAPUTRA

--- BASIN BOUNDARY
--- RIVERS

FIG. 28
a point about 15 km below Rima. At Rima, the Zayul Chhu (about 100 km long) is met by the Rong-To-Chhu (> 100 km) having its source in a glacier on the Nimboat Gomra Tirap Phasi Range (6190 m). The combined waters of the above two major rivers take the name of Krawnoon before entering into India. This new stream is joined by another stream called the Chelum Susning coming from the Indo-Burma border. Thus many streams, small and big oozing from China, Burma and Arunachal Pradesh, meet to constitute the master stream Lohit (Fig. 2.7). Actually the downstream part of the river Hayuliang from Tezu (Arunachal Pradesh) downwards has been known as the Lohit. This Lohit passes near the Indian mythologically famous Parshuram Kunda or the Brahma Kunda. From this Brahma Kunda, the river becomes braided at downstream with a breadth of about 2 km on the average. Taking many tributaries this Lohit becomes wide for about 6 km near Tezu.

Then it joins with the Digaru, Tengapani, Paya rivers at downstream and enters into Sadiya Sub-division at Sunpura. At the entrance of the river to the Sadiya Sub-division of Assam, the Lohit is joined by the Balijan at Sunpura. The Lohit embraces the Noa-Dihing from the left and the Kundil from the right. It further takes the Dibang in the west. The Lohit here is locally known and often recorded as the Brahmaputra.

The catchment area of the Lohit is calculated to be 28,280 km² by the Brahmaputra Board of the Government of India. As per Goswami's (1985) calculation, it is only 22,077 km². About the half (14,680 km²) of the catchment area of this giant river falls within India. The Lohit contributes about 9.5 per cent of the total water discharge of the Brahmaputra at Pandu near Guwahati. The absolute relief of the Lohit basin varies from 5200 m to 120 m. The gradient of the basin and the river channel is very high. The valley descends by a vertical height of 152 m within 14.5 km in Miju inhabited area.

The Dibang or the Sikkang - The drainage system of the Dibang or the Sikkang conforms to dendritic pattern and covers the whole of the area of the Dibang Valley District of Arunachal Pradesh. The Dimasa Kacharis here call the river Shanqi.
The river originates as the Adzon river near the south-eastern side of the Kangri Pass (29°55'N, 95°25'E) located on the Sub-Himalayan region. The elevation of the source of this river is 5455 m. The river after being fed by as many as six major tributaries enters the plain near the Ashun Pani and flows through the plains taking a good number of streams with it. The Dibang coming down to the plain flows towards south as a braided river. The river bifurcates itself into the Gango and the Dibang to cover up a river island called the Amarpur island downwards in the western part of the Sadiya Sub-division. After flowing downwards for more than 15 km, they separately meet the Lohit. At present, one part of the Dibang uses to flow through the lower course of the Ghurmara river on whose bank the present ferryghat exists. The Ghurmara and the Kakor chaparis are located in this part.

According to the Central Water Commission of Government of India, the drainage area of the Dibang is 12,120 km² with a total channel length of 200 km majority of which fall in the hills. The river flows through deep gorges in the mountain belts.

The Kundil - The Kundil is the main river that flows midway of the mainland of the Sadiya Region. The river originates at the Tethaliang Peak (3295 m) in the western part of the Mishimi Hills of the Lohit Valley District of Arunachal Pradesh. The river enters into Assam crossing the north-eastern boundary of the Sadiya Sub-division. A river called the Balijan also runs parallelly very near to the Kundil. During rainy season, the Balijan meets frequently the Kundil. This portion of the Kundil is known as the Kaliapani river. After flowing for about 10 km downstream, the Kundil receives the Kapau river on its right side. After embracing few tributaries downward such as Jiya river having its origin in Arunachal hills, the river Kundil ultimately meets the Lohit at Kundil Bazar. The mouth of the Kundil has been under frequent erosion by the Lohit and, therefore, there occur changes of geographical scene from time to time. On its way to the Lohit, the Kundil takes the
Diphu river on its left bank at the Eight Mile point where presently a bridge is constructed on the Kundil. As the Diphu river is now blocked for the construction of the bridge, the river Diphu is tending to flow to the Kundil creating a new channel. The Kundil has a catchment area of 1178 km².

Other Rivers - Other rivers that contribute water to the Sadiya Region are the Balijan, the Disoi, the Ghurmara, the Saru (Small) Balijan etc. The Balijan river marking the eastern boundary of the Sadiya Sub-division of Assam oozes from a peak (3295 m) on the western part of the Mishimi Hills. The river flowed directly towards south and emptied into the Lohit at Sunpura few years back. But today the upper course of the river is captured by the Kundil, and the Hajo river which had previously flowed through the Paya river now uses to flow through this lower course of the Balijan. The river is of frequently shifting nature. At times the Balijan was flowing westward in its lower course parallel to the Lohit, but this westward flowing part is today captured by the northward shifting Lohit. This captured part is still called the Balijan by the local people. The Saru Balijan originating from the Diphu river used in the past to flow parallel to the Lohit as an anabranching river to meet the Kundil which is also now partly merging with the northward shifting Lohit. While capturing the Diphu river in its upper course by the Kundil, the former turns to lose its bigness. Similarly, the Saru (small) Balijan also lost its original identity. The Ghurmara river originating from the west of Roing at times used to flow as a tributary to the Dibang. The river was captured by the Lohit due to its northward shifting. The extreme lower course of the Ghurmara now is captured by an off-shoot channel of the Dibang very recently. The Ghurmara river creates floods due to either the waters from the Dibang or backwaters from both Dibang and Lohit rivers.

The above mentioned rivers have their direct impact on the geomorphology, hydrology and geography of the region. However, there are some rivers outside the region having indirect impact on this region. Of these worthmentioning rivers,
the Tsang-po-Dihang-Brahmaputra (Fig. 2.4), the Noa-Dihing and the Sesseri are notable.

The Dihang is the name given to the part of the Brahmaputra river in Arunachal Pradesh of India. It is the lower part of the Tsang-po which may be termed as the Tsang-Po-Dihang-Brahmaputra. The Tsang-Po which originates from the southeastern part of the Manas-Sarovar lying at an elevation of 5300m in Tibet contributes a huge amount of snowmelt and rain water as well as sediments to the whole Brahmaputra Valley including the Sadiya Region. The Dihang is fed by a large number of tributary streams like Siyom, Yang-Sang-Chhu, Yamne, Sesseri, etc. The gradient of the river falls from 3657 m to 300 m within a length of 250 km. However, for greater part of the region along the river, the gradient ranges from 157 m to 310 m per km (Sharma, 1992). The lower portion has a gradient of only 5 m per km.

The Tsang-Po-Dihang has a total catchment area of 3,05,000 km², out of which a measure of 12,000 km² falls within India. The river Dihang bifurcates into three at a place near Ranaghat slightly above Pasighat thereby creating extensive river islands known Kobo chapari and Lali chapari.

The Sesseri river originates from Damroh in the western part of the Dibang valley District of Arunachal Pradesh. It has a length of 80 km and tributaries like the Bou, the Ewado, the Sissu, the Egadi Karang, etc.

The Noa-Dihing, rising from the Patkai-Singpho Hills of northern Burma enters into India and ultimately meets the Lohit at a point east of Dholla Bazar. It has a catchment area of 3274 km² with 185 km length, but of which 120 km falls in the hills. It is a very turbulent river and brings heavy discharge of water to the Lohit. Like the Lohit and the Balijan, the above rivers are also changing their courses persistently. The drainage density (Fig. 2.9) or the drainage frequency (Fig. 2.10) of the Sadiya region bears a great parity with direction and location of major rivers. Both the drainage density and drainage frequencies are found to be highest near the confluence on the western part of the region.
2.4 GEOLOGIC AND GEOMORPHIC EVOLUTION OF THE REGION

As the Sadiya Region is an integral part of Assam below the syntaxial bend of the Eastern Himalaya, its geologic and geomorphic evolution is similar to that of India's north-eastern part. The evolution of this region is the result of diastrophic and surficial processes that occurred through geological ages of about 2000 million years (Geological Survey of India). The present physiographic configurations of Assam including that of the Sadiya Region is of very recent origin. Various organizations like the Oil and Natural Gas Commission of India, Geological Survey of India, Geology and Mining Department, Government of Assam have given some clues about the geological and geomorphological evolution of this part.

Geologically the Sadiya Region is formed mostly of recent alluvium deposited for long on the geotectonically developed Himalayan foredeep (Krishnan, 1982) or rift valley (Burrard, 1912) which rest on pre-cambrian rocks basement extended downward from the present Shillong Plateau having affinities to Deccan Plateau in terms of rocks composition and structure (Fig. 2.11). The present surficial conditions of the Sadiya Region like other parts of North-East India, have been the result of continued action by subaerial agents, intensified time to time by diastrophic agents. The landmass had existed since the Permo-Carboniferous times. Records say that 2000 million years ago, a large part of North-East India including the present area under the eastern Himalayan regime was covered by an extensive landmass. About 250 million years ago the processes of sedimentation and subsequent erosion on the areas at present occupied by the Arunachal Himalaya in the north of the Sadiya Region had their pronounced geologic and geomorphic impact on the Region. During the later part of the Eocene era i.e. 60 million years ago, the diastrophic movement on the neighbouring Shillong Plateau ceased as a result of which part of North-East India including the Sadiya Region came to a stable position. Thereafter, the Sadiya Region being characterised by shallow depression began to have sediment loads which continued up to the Late Tertiary Period. At the end of the Oligocene, the Upper Assam part got uplifted resulting in
GEO-TECTONICS OF EASTERN INDIA

Thrust

Southern: Main Boundary
Northern: Main Central

Cretaceous Flysch and ophiolite zone

Siwalik zone

Sub Himalayan zone

Central Himalayan zone

Tethys Himalayan zone

AFTER KRISHNAN (1943)

FIG. 211
the exposure of sedimentary beds formed earlier on the depressed areas. During the period of upliftment, there occurred erosion over a thickness of 4000 to 5000 metres of sediments (Murthy, 1968). About 20 million years ago, during the Middle Miocene times, the whole of present Upper Assam and the present Himalayas were under water wherein sedimentation occurred for long. After the Miocene was over, this depressed part got uplifted in a large scale, first slowly and then rapidly. The present Patkai range lying at a distance of about 150 km south-east of the Sadiya Region began to uplift developing some foldings. Thus in Upper Assam, movement of basement blocks continued resulting in partial interruption in sedimentation over the region.

During the Pliocene times (about 10 million years ago), the rapid upliftment of the Himalayas had resulted in the deposition of pebbles, cobbles, boulders and coarse sands on the foothills of the Himalayas including the piedmont zone of the Sadiya Region.

The Brahmaputra, the main fluvial agent in the region is thought to exist during Pleistocene and recent times. Its course history is in deep controversy. Some think it to be an antecedent river, the upper course of which tried to establish on altitudinally high mountainous areas by cutting channels, even in the midst of upliftment of the Himalayas. Some other think that the Tsang-po was a different river from the Brahmaputra, which used to flow from east to west and met the present Indus. Again some other opine that the river by the name Indo-Brahm (Pascoe, 1919) or the Siwalik river (Pilgrim, 1919) used to flow through a depression below the Himalayas only to meet the Arabian sea. The present Brahmaputra may be the eastern part of the said Siwalik river or the Indo-Brahm. During that period, the present Brahmaputra was a remnant of the foredeep (Krishnan, 1982, p.510) created below the Himalayas. This Brahmaputra started flowing to the Bay of Bengal in the east-west direction from the Brahmakurda (as already mentioned) located east of the Sadiya Region. However, in the later period the Dihang, a tributary to the Brahmaputra, captured the Tsang-po by its headward erosion over the Namicha Barwa Peak. After the headward erosion completed, the waters of
the Tsang-Po used to flow over the Brahmaputra (Bandyopadhyay, 1983).

There is a number of stories as regards the evolution and fluvial processes of the Brahmaputra. One of such stories derived from old religious script describes that the Dihang in the old days was known as the Syama or Chema or Chenglai. This river which oozes from Himalayan range met ultimately two lakes called the Diha-Darowa and the Dibangia. The lower course of the river was known as the Dihang-Dipang (meaning free to move). Another river oozing out of the Mishimi Hills used to flow to these above mentioned lakes by the name of Dibang. The story says that the Dihang captured the Tsang-Po as already discussed. Ultimately the westward flowing Lauhitya (presently the Brahmaputra) took away the waters from these two lakes and the Dihang and Dibang were bound to touch the Lauhitya.

Still another story says that the Tsang-po was flowing from west to east from the Great Lake called the Brahmakunda created due to collection of deep water yielded by three glaciers in the western part of Tibet. The east flowing Tsang-po river accumulated water like a sea on the northern foot of the Namcha Barwa Peak. One outlet from this sea spilled away towards India forming the Dihang river.

The topography of Sadiya Region has tremendously changed its surface morphology due to a series of minor upliftment and subsidence of land caused mainly by the earthquakes and fluvio-geomorphic processes during the last 100 years, especially after the 1897 great earthquake.

The geological history and development bear no less importance for Sadiya Region as Table 2.1 shows geological successions, stages, thickness of beds, etc. for the District of Lakhimpur (undivided) including the Sadiya Region.

The Disang is the lowest series of the tertiary groups. They consist of sandstones and shales of varying texture and colour. The Naojan stage is composed of sandstone and shales of varying proportions and it is the lowest stage of the Barail series. The Barail stage forms the middle part of the Barail
### Geological Succession of Beds of Undivided Lakhimpur District

<table>
<thead>
<tr>
<th>Age</th>
<th>Series</th>
<th>Stages</th>
<th>Thickness (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent and Pleistocene</td>
<td>New and Old alluvium</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plio-Pleistocene</td>
<td>Dihing Series</td>
<td>Unconformity</td>
<td>300 m - 400 m</td>
</tr>
<tr>
<td>Mio-Pliocene</td>
<td>-</td>
<td>Unconformity</td>
<td>800 m</td>
</tr>
<tr>
<td>Miocene</td>
<td>Tipam Series</td>
<td>Girujan clay stage</td>
<td>400 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tipam clay stage</td>
<td>1400 m</td>
</tr>
<tr>
<td>Oligocene</td>
<td>Barail series</td>
<td>Tikak Parbat Stage</td>
<td>550 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boragolai Stage</td>
<td>2500 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naojan Stage</td>
<td>1000 m</td>
</tr>
<tr>
<td>Eocene</td>
<td>Disang Series</td>
<td>Unconformity</td>
<td>Obscured by</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fault</td>
<td></td>
</tr>
<tr>
<td>Pre-Cambrian</td>
<td>Granitic Rock Basement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

series is composed of sandstones and shales embedded with coal seams. The sandstone horizon here contains oil seepage and natural gases. The Tikāk Farbat stage is the uppermost part of the Bārail series and is composed of sandstones and shales having thick coal seams.

The Tipam sandstone stage is the lowest stage of the Tipam series comprising sandstones, clay, shale, quartz and fossils. Occasionally they contain thick layers of oil and natural gas deposits. The Girujan clay stage is the upper one and contains mottled clay, sandstones and fossil woods. The Namsang stage consists mainly of conglomerates, sandstones, lignite fossil wood and pebbles of various sizes. The Dihing series has alternate beds of pebbles, clays and sandstones.

2.5 SOILS

There have been no authentic studies on soils as regards their distribution, structure, chemical composition, etc. However, the soils of the Sadiya Region are broadly similar to those of Upper Assam. The uppermost soils of the region conform to elements of old and new alluvium.

The old alluvium is generally found in the upper stair of the floodplain up to the lower boundary of the piedmont zone at the foot of the hills in the northernmost part of the Sadiya Region. Here the soil is interspersed by deep river valleys. Generally the mounds above the floodplain characterised by more or less undulating surface and terrace consist of such soil. The old alluvium consists of alternate beds of pebbles, gravels or boulder with loose sand and clays. The new alluvium is generally found in the Young built-up plain as well as in the active floodplain (Fig. 2.2). Such type of soil consists of sand, silt and clay with varying proportions of vegetal remnants. It is generally composed of soils of different texture, which occur with ranges from 0.6 to 1.2 microns. It has a firm bottom of clay over which the soil rests (Borooah, 1985). In the Sadiya Region, it is composed of silt and loam with high percentage of sands. The thickness of this type of soil is greater in areas near the Lohit and the Brahmaputra.
The soil of the Sadiya Region varies from sandyloam to sand. The soil is fertile but poor in quality to preserve water. The sandy soil has also a substantial proportion of silts. The soil in the east of the Kundil is more or less clayey in character.

The acid content of the old alluvium is relatively high. The soils of this region have less soluble materials. The MgO percentage of the soil here is high. The pH values vary from 4.2 to 5.5 per cents with low quality of exchangeable calcium varying from 0.1 to 5 mg/100 gm (Borooah, 1985; Forest Department, 1988).

The new alluvium is less acidic. The pH values vary from 5.5 per cent to the range of slightly alkaline condition. These soils are rich in $P_O_4$, $K$ and $Ca(6.to.20$ mg/100 mg ) but the $N_2$ content is somewhat medium being only 0.1 per cent (Borooah, 1985).

The old alluvium is suitable for tea cultivation, but due to non-availability of extensive land and lack of communications, the commercial plantation of tea has not grown up till now though the first plantation was started in this region by the British.

The new alluvium with high percentage of nitrogen is suitable for rice cultivation, but due to drought or flood, paddy can not be grown in some years. The sandy and sandy-loam soils are suitable mostly for rabi crops and vegetables.

2.6 GROUND WATER CONDITIONS

The availability and potentialities of ground water in the Sadiya Region is not yet surveyed. Of course, attempts to survey the same has been made in recent times on some neighbouring areas. The Assam Remote-Sensing Application Centre (ARSAC), Guwahati had conducted some works on the assessment of ground water conditions in different districts of Assam as past as in 1989 while classifying landuse pattern of the whole of Assam. The Geological Survey of India (GSI), Central Ground Water Board, etc. have delineated hydrogeology of some parts of Assam on maps, based on their field studies. Ground water conditions of the lower parts of the Lohit valley in Arunachal Pradesh have been delineated into
three hydrogeological units, viz. the foothill zone, the piedmont zone and the alluvial plain zone (Patgiri, 1991). On the other hand, a study conducted by ARSAC based on satellite imagery has delineated three zones of ground water potentiality in Dibrugarh and Tinsukia districts as the floodplain, the younger alluvial plain and the piedmont plain (ARSAC, 1989). Based on these two studies, the geohydrological situation (Fig. 2.12) of the Sadiya Region is described for the active floodplain, the younger built-up plain, the old built-up and piedmont plain which well conform to the geomorphic divisions.

The active floodplain is partially recharged with shallow ground water table. The water table has the general slope towards the confluence zone as well as to its immediately associated major channels. The younger built-up plain has been recognised as a well-recharged zone having water table at relatively high depth ranging up to 76 metre below the surface. The piedmont plain which are formed of unconsolidated materials of varying sizes has, on the other hand, been characterized by very good recharge of ground water having potentialities for pumping by deep tube wells. The water table in this zone is found to vary between 76 and 110 m below the surface.

The study by Patgiri (1991) reveals that slope of the water tables in old alluvium and piedmont zones is steeper than that of the alluvial plain near the river channels. The quality of the ground water is good and suitable for drinking and irrigation purposes. The region has a vast ground water reserve which can be developed through open wells and tube wells both for domestic and agricultural purposes.

The depth of water table in most of the areas varies from 1.5 m to 15.36 m. The piedmont zone, according to Prasad and Phadtare (1978) has a thickness of 14 to 30 m of saturated layer and supposed to yield water at the rate of 30 to 60 m$^3$/hr for draw-down of 1 to 4.5 m. The shallow aquifer of the alluvial plain zone contains ground water under confined to semi-confined conditions. The depth of such shallow confined aquifer generally varies from 2 to 4 m below the land surface.
The seasonal fluctuations of water table in the piedmont plain and the old alluvium zones lie within 4 metre, while that in the alluvial plain is about 2 m. It can be assumed that the fluctuation range increases as the elevation of the region increases.

The quality of ground water in the region is found to conform to excellent and good categories of Wilcox classification *(1955)* for irrigation purposes in respects of pH values, electrical conductivity, presence of elements and compounds like carbonate, bi-carbonate, chlorides, calcium and magnesium and also in respect of hardness. The neutrality (pH values from 6.4 to 7.8), the hardness (soft to moderately hard), calcium and magnesium concentrations (5.2 to 5.9 ppm and 1.5 to 7.1 ppm respectively) of water in the Sadiya Region have all following WHO's category as revealed by its report *(1963)*, set limit to drinking water standard for the region *(Raghunath, 1982)*. During the pre-monsoon period, the water table in the alluvial fans in the piedmont zone lies between 4.5 m and 9.0 m below the surface. In the old alluvium it is within 1.5 m to 4 m, while areas in the active floodplain including the abandoned channel areas, it varies from 1.0 m to 2.5 m. The seasonal fluctuation is from 0.5 m to 2.5 m in vertical direction. The open well sinking to a depth of 6 m or more is likely to be perennial. The frequently occurred disastrous earthquake had played their roles in nature of existence of the water table in this region. A conversation with an elderly man of the region reveals that an earthquake that occurred few years before 1950 had raised the north-eastern and eastern part of Sadiya Region by 3.7 metres and again this part was lowered down to 2.5 m by the great earthquake of 1950. Thus fluctuation of depth of ground water table also simultaneously occurred. Definitely all these phenomena have their impact on land, hydrology, geomorphology and human occupation of the region.

2.7 EARTHQUAKES IN THE REGION

Earthquakes have been modifying the land and people of the region *(Figs 2.13a and b)*. The entire Himalayan mountain belt is one of the seismically weakest zones in the world. There are topographic evidences and historical records as well as present
Fig. 2-13 a

Source: Seismological Survey of India, Shillong
Fig. 2.13b

SEISMICITY IN INDIA AND ADJACENT COUNTRIES

250 0 250 500 750 Km.

- Liable to Severe Damage
- Moderate Damage
- Liability to Damage Slight or Nil
- Area of Moderate to Severe Damage in Past Earthquakes
scientific records as regards the frequency of earthquake occurrences. Two (of 1897 and 1950) of the five or six major earthquakes (in terms of intensities) of the world so far recorded had occurred in this zone. The records available in libraries as well as in nearby seismological centres at various places in North-east India reveal that four or five tremors occur in the region every year. However, a major earthquake occurs at an interval of about 10 years. The rarer earthquake has taken an interval of about 50 years. Since 16th century A.D. the remarkable earthquakes in North-East India had occurred during 1548, 1596, 1642, 1663, 1669, 1696, 1714, 1869, 1875, 1897 (Magnitude, $M = 8.7$), 1918, ($M = 7.6$), 1923, 1930 ($M = 7.1$) and 1950 ($M = 8.7$) (Gogoi and Barman, 1991). At the decreasing intensity and frequency of future earthquakes in India's North-East, it is added that frequency of earthquake occurrences has been decreasing since 1969 (Sharma, 1989) over the past frequencies. As a matter of fact one can draw that during the period from May one, 1834 to May one, 1835, there occurred as many as twelve earthquakes of low to high intensity within one year time (Oldham, 1883). Studies by seismic centres at various places in North-East India indicate that the frequency of earthquakes is not much more at present times (Sharma, 1989).

Assam was greatly affected by the great 1897 and 1950 earthquakes. The former had the epicentre at the Shillong Plateau, while the later had the same at Rima in the Lohit Valley District of Arunachal Pradesh. Rima is nearer to Sadiya Region. Due to location of the epicentre at the Himalayan mountain, the 1950 earthquake had its tremendous destructive effect on the whole area of Upper Assam. The fluvio-geomorphology was very badly affected and is yet to recover. Landslides occurred heavily within the mountain belt subsequent upon the great tremor.

Applying the magnitude-frequency relationship of Gutenberg and Richter and Extreme Value Method (Type I and III) of Gumbel on earthquake data available up to 1984, Sharma (1989) predicted that the occurrences of earthquakes of different intensities in the North East India may range between 6 and 8 of the Richter scale with a return period of 50 years. The study further reveals that the Himalayan region and the Indo-Burma border are having high risks of occurring high intensity earthquakes.
The pattern of earthquake occurrences during 1920 to 1988 in North East India may, however, be shown in Table 2.2 (Brahmaputra Board, 1987 and N.E.C., 1993).

Table 2.2

North-East India

Magnitude and Occurrence of Earthquake,
(1920-88)

<table>
<thead>
<tr>
<th>Magnitude in Richter Scale</th>
<th>No. of occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 - 6</td>
<td></td>
</tr>
<tr>
<td>6 - 7</td>
<td>169</td>
</tr>
<tr>
<td>7 - 8</td>
<td>16</td>
</tr>
<tr>
<td>8 and above</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>464</td>
</tr>
</tbody>
</table>

Most part of the Sadiya Region are located on the isoseismal zone Χ (ten) of the Rossi-Forel scale equivalent to isoseismal zone IX (nine) of modified Marcalli earthquake intensity scale (Brahmaputra Board, 1987)

2.6 THE CLIMATIC BASE

The climate of Sadiya Region, like other parts of the Brahmaputra Valley conforms largely to sub-tropical monsoon type. However, there are local variations of climate from place to place. The Sadiya Region bounded in all the sides by mountains except the western one, experiences peculiar type of monsoon climate. The climate here is comparatively moist and damp than that of the other parts. Rainfall (Fig. 2.14) is always heavy because of obstruction of the moisture-laden S.W. monsoon by the lofty eastern Himalaya in this part. The average annual rainfall received by the Sadiya Region is about 275.9 cm spread at different intensities over 100 rainy days within a year. The maximum average temperature in the plain is 27.7°C. August is the hottest month having temperature record around 30.9°C, whereas the minimum average is 18.7°C.
FIG. 2-14

SADIYA AND ADJACENT REGION
DISTRIBUTION OF ANNUAL RAINFALL (cm.)

\[ 20 \quad 0 \quad 20 \quad 60 \text{ KM} \]

--- INTERNATIONAL BOUNDARY
--- SUB-BASIN

Based on rainfall distribution map by Brahmaputra Board.

FIG. 2-14
January is the month having temperature record of 6°-10°C. The humidity during summer ranges between 82 and 90 per cent. During the winter season, the relative humidity ranges around 72 per cent. The climate of the region like other areas of India has four clear-cut seasons, viz. (1) Pre-monsoon - March to May, (2) Monsoon - June to August, (3) Retreating monsoon - September to October and (4) winter - November to February.

The pre-monsoon period being characterised by hot and dry weather in the season's later part experiences trend of temperature rise from the month of March. During the season, the maximum temperature is about 28.3°C, while the minimum is about 20°C on the average. The westerly disturbances forming a common phenomenon to Assam, do occur in the Sadiya Region also in the early part of this season. The cyclonic Bordoichila accompanied by heavy thundershowers occurs during this season. The average rainfall during this season amounts to 30.3 cm.

Amongst all the seasons, the rainiest one is the monsoon season lasting for late June to late September. This season like other parts of N.E. India records about 85 per cent (or equivalent to 276 cm) of the total annual rainfall. July and August are the months with maximum rainfall. The mean temperature ranges around 27.5°C during these two months. Relative humidity rises to above 85 per cent. 'The monsoon has now become more erratic in respects of rainfall and temperature' was said to the researcher by an elderly local man at the time of field study.

Post or retreating monsoon period starts at the last week of September and extends up to November. This season is characterised by autumn temperature around 20°C with its high diurnal range, occasional rainfall amounting to about 30 cm, morning fog, moist and dry monsoon winds directing from north-east to south-west.

The winter season which runs for November to February experiences coldest weather of the year. Fog is a common phenomenon in the winter season. The average temperature is below 12°C. Occasional cold winds associated with the north-east monsoon often enter into the Sadiya Region due to movement of the
Northern continental Polar Airmass towards the south through China. The season is marked also by rarely occurred westerly disturbances. The number of average foggy days is 28, whereas the rainfall amounts to 11.8 cm on the average. During the winter, the Sadiya Region remains a bit more cold because of the proximity of hills and mountains in surrounding areas.

2.9 NATURAL VEGETATION

As a result of sufficient supply of water in land and air from monsoon rains, moderate temperature, the region has been favourable for the growth of luxuriant vegetation. The piedmont plain, old and young built-up plains and the swampy areas have been congenial grounds for a variety of woody trees and other natural vegetation in the region. All the vegetation may be classified into the groups like -

(1) the deciduous monsoon vegetation mixed with evergreen species in the north, especially in the reserve forest areas,

(2) the grassland in the river islands and char areas, and

(3) the riverine and swampy vegetation.

The first type of vegetation, though generally seen all over the region, presents an attracting picture especially from the reserve forest areas. There are five reserve forests (Fig. 2.15) in the Sadiya Region, viz. the Sadiya Station (North Block), the Sadiya Station (west Block), the Hollow Bananchal, the Kukuramara Bananchal and the Kundil-Kalia-Deopanâ Reserve Forest. The evergreen vegetation is particularly seen mixed with deciduous trees in the Kundil-Kalia-Deopani and Sadiya Station (North Block) reserve forests. These forests contain species like Makai (Shorea assamica), Nahar (Mesua ferra), Hollong (Dipterocarpus macrocarpas), Ajar (Lagerstroemia flos reginae), Hollock (Terminalia myriocarpas), Sam. (Artocarpus chaplasha), Poma (Cedrela toona), Uriam (Andracne trifoliata), Kadam (Nauclea cadamba), Gandhasarai (Camphorea glandulifera), etc. Hollong is a good timber tree growing often to more than 50 metres high. Makai is another source of good timber. The region supplies timber for domestic and commercial uses in other places also. These forests are also characterised by a second
storied growth marked by bamboo (Bambusa), cane, etc. These reserve forests are also marked by reeds (Phragmites) and thatching grass (Imperata) in the ground level. All the forest products are widely used by the local people for building huts and houses in addition to their uses in some other works.

The riverine areas, especially the river islands and char-lands are full of grasses, thatches, reeds and riverine trees like Simul, Uriam, Kadam, Plum, etc. The extensive coverage of grass and thatches over these areas facilitates the rearing of cattle and goats.