CHAPTER-II

PHYSICAL BACKGROUND OF THE DOOARS REGION

2.0. INTRODUCTION:

The Dooars or Duars are the flood plains and foothills of the eastern Himalayas in North-East India around Bhutan. Dooars means door in Assamese, Nepali, Maithili, Bhojpuri, Magahi and Bengali languages, and the region forms the gateway to Bhutan from India. There were 18 passages or gateways through which the Bhutanese people can communicate with the people living in the plains. This region is divided by the Sankosh River into the Eastern and the Western Dooars, consisting of an area of 8,800 Sq. km (3,400 sq. miles) as a whole. The Western Dooars is known as the Bengal Dooars and the Eastern Dooars as the Assam Dooars. Both were ceded by Bhutan to the British at the end of the Bhutan War (1864–65). The Eastern Dooars, in western Assam state, comprises a level plain intersected by numerous rivers and only slightly populated. The Western Dooars lies in northern West Bengal state and is a portion of the Terai, a lowland belt linking the Himalayas and the plains region. The Western Dooars is an important centre of the tea industry. The name Dooars ("Duars") is derived from the several passes that lead from the region into the Lesser Himalayas.

The Dooars region (Western Dooars) lies between 26°25'N to 27° N latitude and 88°30' E to 89°53' E longitude and covering an area about 5111.53 Sq. Km.[1] To the north of Dooars stand the East Himalayas as a natural backdrop, on the west by the Terai region, on the east by Assam and towards south it's a vast plain land with low river basin extends farther up to Bangladesh. The principal town in fact the only place in the district of sufficient size to be called a town is Jalpaiguri, situated on the west or right bank of the Tista River in 26°32'N latitude and 88°43' E longitude. The name Jalpaiguri is derived from jalpai, an olive tree, and guri, a place; it means, therefore, the place of the olive trees, of which there used at one time to be many in the town. Sir W.W. Hunter, in his Statistical account of Jalpaiguri, gives the following description of the Western Dooars: ' The Bhutan Dooars, the tract which was annexed at the close of the war 1864-65, is a flat, level strip of country, averaging about 22 moles in width, running along the foot of the Bhutan hills…'[2].

2.1. GEOMORPHOLOGICAL SET UP:

The Dooars region is bounded in the North by the hill ranges of the Himalayan and the South by the piedmont plains, which gradually grade into the alluvial plains further south. This region exhibits a diversity sediment and soil colour. This feature has been fan deposit in this

tectonically affected composing the piedmont plain in the area are of apparently fluvial origin. Huge size of the boulder deposition this region display later fluvial activity which is seen in the terraces and later deposits besides a plethora of distributary channels. Rill and gully erosion over a long period of time has produced an undulating surface in these ancient deposits. The Northern part consists mainly of pebble to quartzite overlain by finer deposit. Later fluvial deposits ranging mainly from cobble to clay size material over lay the area. In alluvial plains leaves, back swamps, ox- bow lakes etc. represent the usual landscape features comprising mainly the more recent flood plains but ancient flood plains surfaces may, perhaps be coeval with the uplifted Barind landform.

2.2. GEOLOGICAL SET UP:

West Bengal is divided into three distinct physiographic units. One is the extra-peninsular region, another is the peninsular mass of the southwest and third physiographic unit namely the alluvial and deltaic plains of south and east. The extra- peninsular region covers the mountainous tract of the Eastern Himalayas, the northern part of Darjeeling and Jalpaiguri districts. The extreme northern part of Dooars region is underlain by crystalline metamorphism of the Himalayan range. Recent Quaternary geological study by Geological Survey of India has brought out several features, which indicates tectonic activity in the Duars area of North Bengal, which is located in the fore deep region of India. The Buxa – Jainti hills are composed of a series of beds known as the Buxa series which consists of variegated slates, quartzite's and dolomites, and are fringed on the south by low hills of upper tertiary strata. Except the Buxa hills this region is covered by alluvial deposits which consists of coarse gravels near the hills, sandy clay and sand along the course of the rivers and sandy loam is confined further south. Between the Tista and Jaldhaka, the region is covered by the patch of black clay which followed southwards by a wide zone of piedmont deposits called the 'Bhabar' and the 'Terai', which have been merged with the southern alluvial plains. This zone consists of unconsolidated materials of varying sizes brought down by the turbulent hill streams like Raidak, Tista, Torsa etc. Subsurface geology of this region as revealed from bore hole logs indicate the predominance of very coarse material, mainly boulders up to an average depth of 65 meter. Below this, granular zone consisting of thick layers of gravel, pebbles, boulders and fine to coarse sand with varying proportion of clay.

A thin layer of Gondwana sand stones and shale's with anthracite coal beds intervenes between the Tertiary and the Buxa series. Northern part of Buxa series at 3 -5 km (2-3 miles) wide band of series lies which composed of phyllites, schist's and quartzites, known as the Dalling series. All these formations have a general east west strike and dips are generally north wards. The Buxa series and the Dalling series are generally considered to be of pre Gondwana age. The Tertiary series are not developed in the foothills region for a length about 64 km (40 miles) especially to the west of the hills. The Buxa and Dalling series again exposed in the western part of Jaldhaka River and extends westwards along the northern fringe of this region up to Reti River, a tributary of Khanabari River which flows between the Dhupguri and Falakata block.

Limestone occurs in considerable quantities in the Buxa hills and masses of calcareous tufa are found along their base. Copper are occurs in greenish slate with quartos layers to the west of Buxa and mine used to be worked by Nepalese at Chunabati about 3 km away. Copper ores are also found about 4.6 km north of Samsing Tea Garden, close to the boundary between the Jalpaiguri and Darjeeling districts. Building stone of good quality can be procured in the Buxa hills [3].

The geological milieu in this region represents the sub-Himalayas or the foothill zone consist almost entirely of the Siwaliks and typical formation of Quaternary and recent sediments. The upper part of this region mainly consists of Siwalik and older Quaternary formation, which are dominated by thick boulder and conglomerate horizons. The lower portion occurs as a fluvial terrace deposit. The recent sediments mainly represent thick pile of fluvial, unconsolidated sediments. The various faulting occur in this region. The time of faulting ranges from Pliocene to Recent with some of the structures assumed to be seismically active. The tectonic activity has played the pivotal role in creating the elevations and depression has had both a direct and indirect effect on the erosion and depositional aspect and drainage networks in the region, which persist even today.

2.3. RELIEF:

The physiographic features of the Dooars region are full of diversity. The Tista River demarcates the western part and the Sankosh River demarcates the eastern part of Dooars region. The district is almost not a flat country rather there are mountainous areas in the north. The blocks like Nagrakata, Mal, Kalchini and Matiali are consisting with moderate

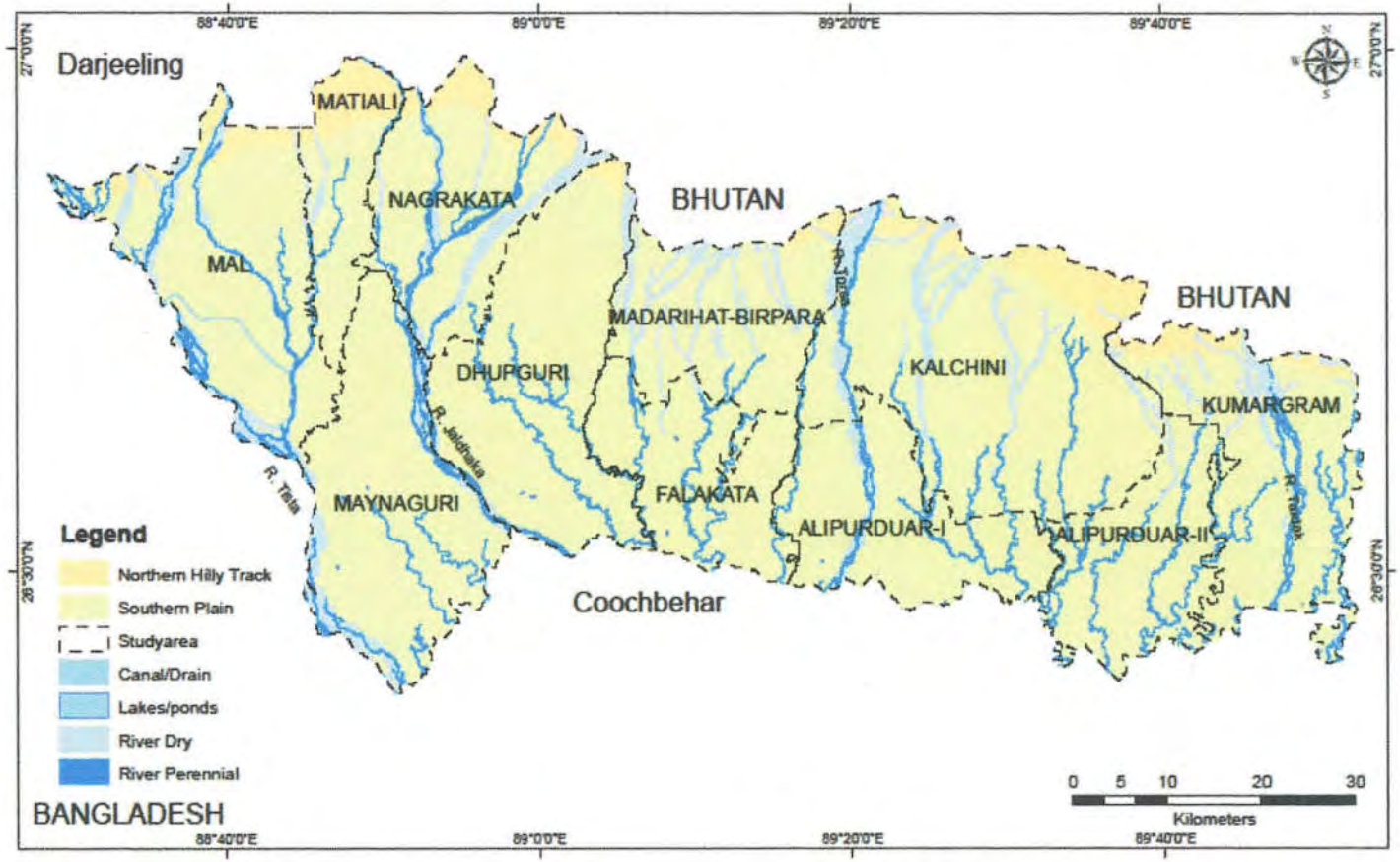
relief. The land is sloping from north and north-west to south. So, tea plantation is mostly found in hilly and sloping areas. Thus the tea plantation mainly developed on the sloping land due to the fact that the stagnant water severely affected the growth of tea bushes. The sloping topography of the Dooars region is very idle for the growth of tea plantation. On the basis of physiographic characteristics and relief the whole region can be divided into two physiographic units. This are-

(a) The Northern hilly tract:

The only mountainous tract in the Dooars region is the part of the Bhutan range in the immediate neighborhood of the frontier outpost of Buxa. The boundary between Indian and Bhutan territory is the Sinchula (also called Tchinchula) range. The one of its highest peaks, called Chhota Sinchula, which has an altitude of about 1736 meter. The Buxa Duar hills are dense and extensive tracts of Sal and other tree forests, the whole being interspersed by numerous rivers and small streams. The Sinchula range has an elevation varying from 1219 meter to a little over 1829 meter, the highest peak Renigango being 1896 meter above sea level. The hills run generally in long even ridges, here and there the summits bristle up into creeks of from 61 meter (200 feet) to 91 meter (300 feet) [4]. The military station of Buxa is built on an outlying spur of this range on hills of heights from 506 to 749 meter. Buxa Duar is one of the principal passes into Bhutan and a hill road leads direct from it to Muricham in Bhutan. A rough section from north to south resembles it as a gigantic staircase running step by step down from the lofty Himalaya to southern plains.

(b) The southern plain:

It is wavy and alluvial plain lying at the foot of the Himalayas where slope gradually declines from north to south. This is the typical piedmont plain or the alluvial fan surface of the Himalayan foot hills. The general elevation of this region is over 76 meter. A major part of this plain is built up of debris washed down from the Himalayan slopes. The immense loads of materials carried down by the streams are heaped up as soon as the streams descend to the plain. Erosion and deposition is repeated here in every year. A general southerly slope of 35 to 55 cm per km with a pronounced title to the east is the characteristics feature of the landscape where the rivers come down from the hills; huge semicircular fans are formed by the deposition of boulders and coarser soil particles. These along with many braided streams have built this board alluvial plain. The general appearance of this region is flat, sloping gently southwards, as is shown by the trend of the rivers.



Map Number - 2.1 Physiographic map of Dooars region

2.4. DRAINAGE:

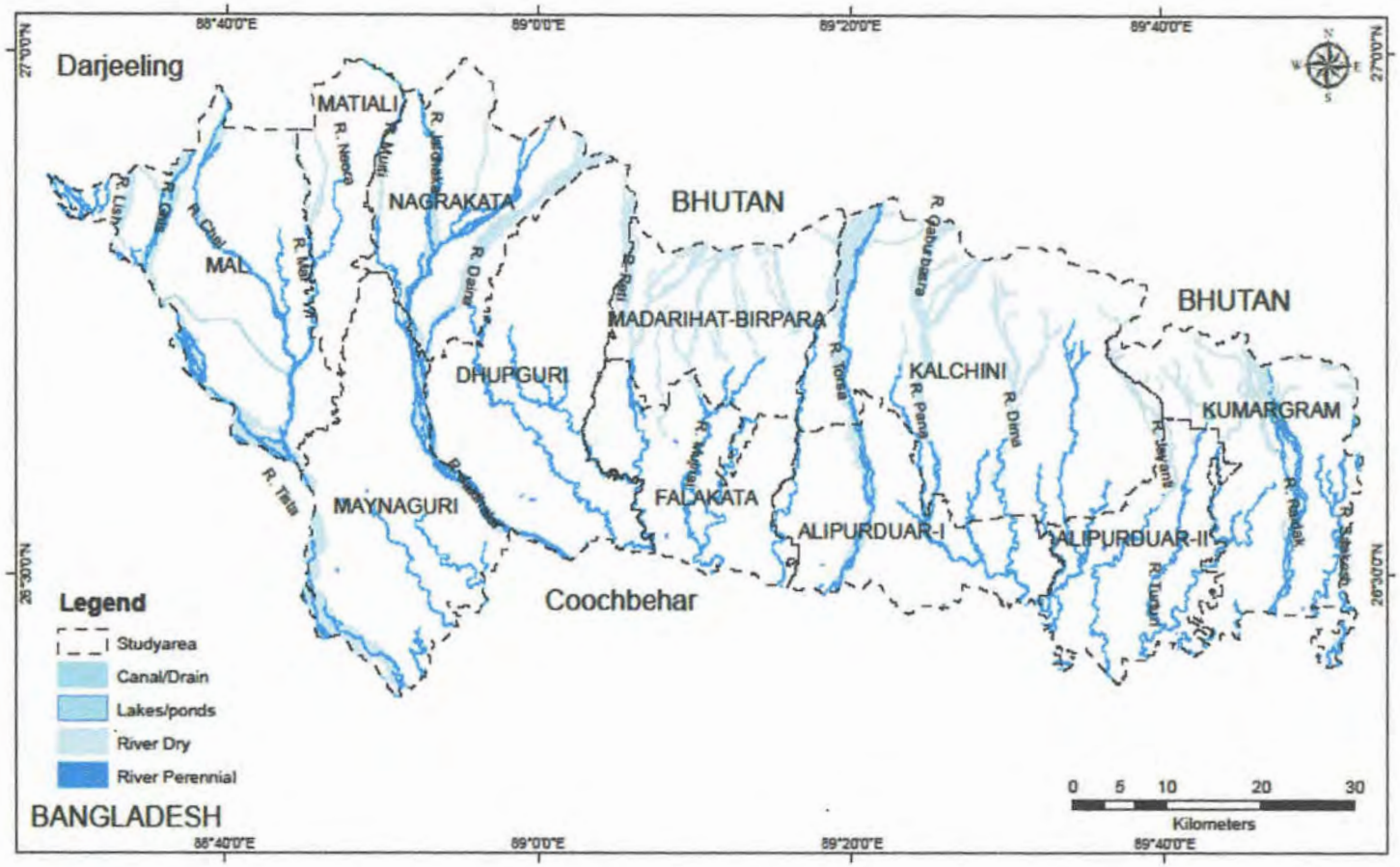
The Dooars region is well drained by a number of rivers and rivulets of various magnitudes. Besides its rivers the region abounds in numerous ponds and swamps. Most of the rivers flow from north to south, and as they debouch suddenly from the hills on to the plains, and rise and fall with great rapidity, frequently changing their courses, they often do much damage. The rivers of this region originate from the northern Himalaya and are snow fed. So, during the winter these do not dry up. Near the hills they are full of boulders, lowered down they are sandy; their banks are ill defined and as they bring down quantities of silt and debris from the hills. Due to this sudden flattening of slope rivers are not capable to carry the debris which flow through from hills and deposit the detritus in different region as per their specific gravity, like boulders, pebbles, singles, course sand, fine sand, silt and finer silt particles, that formation is called alluvial fan. For this reason height of the riverbed increase, river siltation increases which causes shifting and changing of river course. The principal rivers in this region from west to east are the Tista, Jaldhaka, Duduya, Mujnai, Torsa, Kaljani, Raidhak and Sankosh.

Tista River was originally a river of Ganga basin as per history. The Tista River originates from the Pauhangri glacier in Sikkim. The name Tista has been derived from the Sanskrit word 'Trisrota' meaning three flows such as Atrai, Karotoa and Tista. It means a trifurcated channel which drains the piedmont zone and later became three separate rivers of North Bengal. The total length of the river is about 440 km from its source at the Pauhungri glacier in north eastern Sikkim to the point of confluence at the chilmari area in Bangladesh. After its origin in the glacier, it flows through a magnificent gorge known as the Sivok Gola pass. It then traverses the Darjeeling Terai and enters Jalpaiguri district at its North West corner and flows in a south easterly direction. For some distance from this point its bed is stony and it contains little water during the dry season while the swiftness of its current and the numerous rapids render it useless for navigation during the rains. It is a wild river in the Darjeeling hills where its valley is filled with dense forest, but its drainage area in the mountains is quite small. It has no tributaries of any importance on the right or west bank. On the left bank, the principal tributaries are Lish, the Ghish, Rajini, Chel, Neora and the Dharla rivers. The Dharla is formed by the confluence of the Chel, Mal and the Neora rivers and brings down a considerable volume of water. The Tista forms the boundary of the Western Dooars, dividing it from the permanently settled portion of the district which formerly belongs to Rangpur.

The Tista is a large river which runs almost parallel to the Ganges for nearly 241 km. During the dry season, the water of the Tista runs into those of the Ganges by two distinct channels, situated about 32 km from each other, and a third channel at the same time discharges itself into the Meghna; but during the season of the floods, the Ganges runs into the Tista whose outlet is then confined to the channel that communicates with the Meghna.

In 1787, due to heavy flood and devastating earthquake Tista shifted its course to Bhramaputra basin [5]. After the flood of 1950's it is observed that a huge quantity of water of river Tista is flowing through Buri Tista and falling into the Yamuna in Bangladesh. This course tends to develop further with the course of time. To prevent this Jalpaiguri town protective embankment had to extend up to Jharsing Swar near Haldibari in Coochbehar district. During the flood of 1968, a thick sheet of water (about 3.5 m to 4 m thick) inundated a large tract of land includings towns of Jalpaiguri, Maynaguri, Domohani, Mekhliganj etc. casing untold misearies of the people and the river opens a new course through Upalchand Forest near Kathalbari tea garden in Mal block. It devastated huge quantity of forest area and took its course again to its main course. A big chunk of Upalchand Forest was washed out in this case.

The ***Jaldhaka River***, 186 km long, with drainage of 3960 sq. km, rises in the Bhutan hills and drains the eastern slopes of the Rishi-la Mountain in the Darjeeling district, of which it forms the boundary. After entering Jalpaiguri, it flows in a southerly direction until it approaches the boundary of the district, where it takes a sweep to the east and enters Koch Bihar territory. It joins the Torsa in the Rangpur district and the combined rivers under the name of the Dharla flow into the Tista.its principal tributaries within the Dooars region are the Murti, a considerable stream, flowing from the Dalincot mountains in Darjeeling; and the Diana which rises in the Bhutan hills and falls into it on its east bank in pargana moraghat, opposite Naothoa Hat. The Diana is particularly troublesome river, frequently changing its course and doing much damage to roads and cultivation. Since the flood of 1954, river Jaldhaka was shifting towards East near Tandu Tea Garden in Nagrakata block. The river devastated nearly 10 sq. km. of forest area and almost 50% of the Tandu Tea Garden. To prevent the tendency of avulsion of Jaldhaka to river Bamni, an embankment has been constructed. In the late 90's another shifting took place. Jaldhaka, by breaching the left bank embankment avulsed into river Doikhowa and ruined a huge area of Northwestern part of Dhupguri block.



Map Number-2.2 Drainage map of Dooars region

During 1956, river Diana avulsed through a rivulet Jhumur and Rangati just south of Kalabari Tea Garden, devastating about a 100 sq. km area. Due to this original course of river Jhumur was abandoned and it is now a tributary of river Rangati. By constructing embankment at Kalabari, the course of Diana was thrown back to its own. But this river has a tendency to avulse to river Rangati.

The ***Duduya River*** is formed by the combined waters of the Gairkata, Nanai, Angrabasha and other small streams, all of which rise in the north west of the Dooars. It flows in a south westerly direction and enter the Koch Bihar at Dakalikoba Hat. Its principal tributaries are the Kalua or Rehti, Barabank, Dam-Dima and Tasati which rise in the Bhutan hills or the north of the Dooars and join it on its east or left bank.

The ***Mujnai River*** takes its rise near Hantapara from the southern slope of the Bhutan water shed and flows south through the Western Dooars receiving a current from the Torsa via Bura Torsa on its left and the Birpati on its right before it enters this region by the west and north-west in between Soulmari and Singjani. Formerly this river known as the Mansai, was the main river in this area until the Jaldhaka usurped its channel and reduced this river to the position of a left bank tributary. The oldest river flowing through this channel was the Mansai.

The ***Torsa River***, 358 km long takes its rise in the Tibetan Highland terrain along the western margin of Chomolhari glacier. Following through the gorges of the Chumbi valley of Tibet, where it is known as the Machu, its headwater channel reaches the mountain side slopes of Phari-Dzong, and flows through Bhutan where it receives the name Amo Chu after travesing about 113 km from the source [6]. It enters British territory by the Bala Duar and flows south through the Western Duars, separating the Falakata and Alipurduar-I block. The river enters Koch Bihar from the north between Latabari in Mathabhanga and Bakshibos-Putimari in Koch Bihar and flows nearly south with a few tortuous bends up to the north of Barabhita. Here the streams bifurcates and one branch goes eastwards under the name Torsa and the other stream goes southwards under the name Dharla. The only tributary of the Torsa is the Ghargharia which comes from the north-west. This River is formed by the combination of two small streams outside the district of the Western Duars. River Torsa bifurcates itself near about a 1.5 km down of the road bridge near Suhasini Tea Garden (Hasimara) into two branches namely- i) Sil Torsa- the eastern branch ii) Char Torsa , the western one. During

1950's due to sudden flood the Sil Torsa course developed severely and washed out the road bridge on NH-31 over Sil Torsa and widened its width in double. During 1954 , on the other hand the Torsa river developed the Char Torsa course and wash out the bridge over Char Torsa on NH-31 and widen the course about 1 km.

The ***Kaljani River*** is formed by the combined waters of the Alaikuri and Dima, which first take the name of Kaljani after their junction at Alipurduar of Jalpaiguri district. It enters Koch Bihar by the north of Kholta. Almost at the point of its entry into the district it receives on the right bank a small, the Gidari, which takes its rise in the Western Duars [7]. The Kaljani proper has no tributaries of any importance on its right or west bank but on the left or east bank it receives the waters of the Nonai, Cheko and Gadadhar. The Alaikuri, which supplies the greatest portion of the water to the Kaljani, is a fairly large river, which rises in the Bhutan hills and after a southerly and south-easterly course through the Western Duars, joins the Dima at Alipurduar. Its principal tributaries on the west or right bank are the Gabur Basra, Buri Basra and Bania rivers and on the east or left bank, the Nimtijhora and Paror. The Dima is also a stream of some size rising in the lower Bhutan hills near Buxa and flowing south to its confluence with the Alaikuri. In recent years the Kaljani has been cutting away its bank on the Alipurduar side, and threatening the civil station. Some spurs were constructed by the PWD in the hope of turning the stream but this have been entirely washed away.

There are two rivers of the same name Raidhak and the other Raidhak flows east of this Raidhak. Both rivers flow for some distance almost parallel. The ***Western Raidhak River*** originates in the Bhutan hills where it is known as Chin Chu. It flows southward between the borders of Buxa and Bhalka Dooars but in 1905 the river came down in high flood and deserted its former bed which lies to the east of the Raidhak Tea Garden; it swept across country and poured its water into several small streams to the west of its former course, one of which the Dhaulajhora, is now the main stream and runs to the west of the Raidhak Tea Garden. South-east of Nararthali, this river bifurcates into two streams and the western stream enters Koch Bihar at Dorko while the Eastern stream enters at the west of Khagribari where it is known as Rangbarsuti and both the stream again united at Salbari.

The ***Eastern Raidhak River*** also comes down from the Bhutan hills and enters the district in between the Khagribari and Rampur and after a course of about 16 km; it falls into the great Gadadhar to the south of Jaldhoa. The Raidhak after its union with the Rangbarsuti in Salbari

flows south east through Dhaldabari and Nagarkhana. The main current of the Raidhak is now flowing through the Dipa which was originally a branch of the Raidhak in Bara Salmari, about 1 km west of the confluence of the Rangbarsuti. The Dipa flowed for 8 km south-east and joined the united currents of Dhersi-Lohagir, another branch of the Raidhak issuing forth from Dorko, upto Dhalpal this river is known as Dhersi while from Andaran Fulbari this river is called as Lohagir.

Sankosh River rising in the Himalayan ranges in the border areas of Bhutan and Tibet, the Sankosh drains the area between Kula Kangri South peak and Chomo Lhari. It flows by Punakha where it is about 370 m wide but narrows down further below to flow through a gorge. In the plains, the right bank of the Sankosh River demarcates the boundary of the Dooars region and before the partition it marked the boundary between the provinces of Bengal and Assam and flows through the districts of Kokrajhar, Dhubri and Koch Bihar. Its principal tributary on its right or west bank is the Glentani. Both the Raidhak and Sankosh flows into the Brahmaputra. The drainage area of the Sankosh is moderately large.

2.5. CLIMATIC CONDITION:

Dooars region is part of monsoon climate zone of South-Eastern Asia. The seasons of this region follow generally the course of those of other regions in the plains but owing to its proximity to the hills, the rainfall is much heavier and the temperature is rarely excessive. The climate of this part is characterized by a hot and oppressive summer season, plentiful rain and moisture in the air while during temperatures drops rapidly. Towards the close of March, increasing thermic recordings indicate the advent of summer. May is the hottest month of this region with average maximum temperature of about 32°C whereas January is coldest with 11°C. Highest ever recorded maximum and minimum temperature are 40°C and 2°C. The harshness of the weather comes as a barrier to mobility both for the residents as well as visitors. The mounting heat and the intense barometric lows culminate into monsoonal outbursts. The average annual humidity in the district is of 82%. The annual average rainfall is 3160 mm. December is the driest month with average rainfall 0.2 mm and July is wettest with 809.3 mm. With the onset of monsoons the surface is full streamlets that eventually drain into perennial rivers, causing them to overspill and occasional floods. Number of rainy days is 0 to 1 during November to February and 24 days during July. Thunderstorms are common weather phenomenon during May.

2.5.1. *Rainfall:*

The heaviest rainfall in the Dooars region is at the foot of the hills [8]. The district head quarter occupies an intermediate rainfall though the fall is much less in the north of western Dooars. Rainfall occurs in almost every month of the year; it is lightest in the cold weather months, rather more heavy in March and increases considerably in July. The month of May is considered a rainy month and precipitation is often very heavy. From June to September rainfall is general; the monsoon current flows northwards and is deflected towards the west in Northern Bengal so that the prevailing direction of the wind at Dooars during the rains is east or south east. The average annual humidity in the district is of 82%. The table (Table Number-2.1) shows the average seasonal rainfall and number of rainy days during 2008-2012 of Dooars region of Jalpaiguri district.

Table Number-2.1

Seasonal rainfall and number of rainy days of Dooars region of Jalpaiguri district

Main season	Normal rainfall in (mm)	Normal rainy days (number)
SW monsoon (June-September)	1626.36	66
NE Monsoon(October-December)	63.75	9
Winter (January- February)	173.99	12
Summer (March-May)	1012.19	30
Annual	2876.29	117

Source: Hydromet Division, India Meteorological Department, Jalpaiguri.

2.5.2. *Temperature:*

Temperature is rarely excessive in the Dooars region. It is lowest in January with 11°C; by April the mean temperature rises and after that it gradually increases till it reaches its highest point in July and August. The mean maximum temperature occurs in May and the mean minimum is lowest in January. In Buxa area the climatic condition is quite different. The rainfall is heavier and even in the hottest weather fans are not used and blankets are often necessary at night. The tea garden area to the north of this region is generally cooler than the western part of the Tista River. The table (Table Number- 2.2) shows the month-wise average relative humidity, rainfall and maximum and minimum temperature of the Dooars region from 2009 to 2013:

Table Number -2.2

Month-wise average relative humidity, rainfall and maximum and minimum temperature of the Dooars region from 2009 to 2013

Year 2009

Month	Relative Humidity (%)		Rainfall (mm)	Temperature (°c)	
	8:30 am	5:30 pm		Minimum	Maximum
January	90	78	0	12.8	23.1
February	81	65	0	14.1	27.5
March	65	52	50.8	17.2	31.1
April	72	63	78.74	21.7	32.1
May	78	69	248.92	22.4	32.5
June	84	72	444.5	24.4	33.6
July	85	78	551.18	25.1	33.0
August	89	81	444.5	24.7	32.1
September	81	76	99.06	24.4	33.8
October	80	76	264.16	20.9	31.8
November	82	76	0	16.0	28.4
December	92	81	0	12.5	24.1

Year 2010

Month	Relative Humidity (%)		Rainfall (mm)	Temperature (°c)	
	8:30 am	5:30 pm		Minimum	Maximum
January	93	76	0	9.2	22.3
February	81	63	0	12.8	26.6
March	68	56	0	19.1	31.5
April	78	69	48.26	22.5	32.3
May	79	71	368.3	22.9	32.5
June	86	77	332.74	24.2	31.6
July	90	78	723.9	25.1	32.5
August	89	83	424.18	25.4	32.2
September	89	84	548.64	24.2	32.1
October	81	77	76.2	21.9	31.6
November	82	75	15.24	17.7	28.6
December	82	75	0	12.2	25.0

Year 2011

Month	Relative Humidity (%)		Rainfall (mm)	Temperature (°c)	
	8:30 am	5:30 pm		Minimum	Maximum
January	91	78	2.54	9.4	20.8
February	81	63	5.08	13.5	26.8
March	75	58	10.16	17.0	29.9
April	76	68	139.7	19.7	31.8
May	81	73	388.62	22.2	32.3
June	84	73	386.08	24.1	33.4

July	90	79	596.9	24.1	31.9
August	85	77	480.06	24.3	33.0
September	83	79	533.4	23.5	33.0
October	77	74	15.24	21.2	32.8
November	81	74	12.7	16.5	28.2
December	87	79	5.08	12.8	24.3

Year 2012

Month	Relative Humidity (%)		Rainfall (mm)	Temperature (^{o}c)	
	8:30 am	5:30 pm		Minimum	Maximum
January	90	79	5.08	10.7	21.4
February	82	66	2.54	12.8	25.8
March	63	49	7.62	16.8	30.0
April	75	65	170.18	21.0	31.6
May	76	66	177.8	23.0	33.8
June	90	81	675.64	24.2	31.5
July	90	82	739.14	25.0	31.5
August	84	76	279.4	25.2	33.5
September	87	81	327.66	24.1	32.0
October	78	74	139.7	20.3	31.4
November	76	71	0	14.7	28.8
December	91	80	0	11.8	23.4

Year 2013

Month	Relative Humidity (%)		Rainfall (mm)	Temperature (^{o}c)	
	8:30 am	5:30 pm		Minimum	Maximum
January	90	76	0	8.2	22.3
February	79	63	12.7	13.9	27.8
March	70	55	10.16	19.0	31.5
April	69	61	96.52	21.7	32.1
May	83	72	182.88	23.8	31.9
June	85	79	576.58	25.9	33.5
July	89	80	927.1	26.1	32.5
August	88	79	556.26	25.7	32.6
September	83	78	281.94	25.3	33.3
October	82	79	226.06	22.4	30.2
November	74	73	17.78	16.4	29.3
December	85	76	0	13.9	24.4

Source: India Meteorological Department, Jalpaiguri

The table (Table Number-2.3) shows the rainfall data of some tea gardens of Dooars region from 2009 to 2013:

Table Number-2.3

Rainfall data of Kumargram, Mathura, Atiabari, Nagrakata, Damdim and Bagrakote tea gardens from 2009 to 2013

Station: Kumargram Tea Garden (Rainfall in mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2009	2.5	0.0	22.8	180.3	365.7	165.1	828.0	541.0	332.7	27.9	0.0	2.5
2010	0.0	0.0	129.5	439.4	398.7	807.7	767.0	881.3	434.3	43.1	5.0	0.0
2011	0.0	7.6	96.5	116.8	160.0	546.1	1016	614.6	370.8	35.5	0.0	7.6
2012	2.5	12.7	2.5	104.1	292.1	156.2	1038.8	381.0	429.2	96.5	0.0	0.0
2013	0.0	0.0	0.0	187.9	424.1	594.3	1003.3	363.2	657.8	182.8	0.0	0.0

Source: Kumargram Tea Garden, Kumargram

Station: Mathura Tea Garden (Rainfall in mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2009	0.0	0.0	53.3	88.9	284.4	589.2	678.1	779.7	142.2	215.9	0.0	0.0
2010	0.0	0.0	71.1	299.7	363.2	645.1	723.9	640.0	327.6	43.1	0.0	0.0
2011	0.0	12.7	104.1	119.3	203.2	292.1	833.1	571.5	355.6	15.2	2.5	0.0
2012	2.5	2.54	2.5	142.2	365.7	1145.5	1010.9	449.5	551.1	152.4	0.0	0.0
2013	0.0	12.7	2.5	177.8	309.8	444.5	965.2	419.1	436.8	0.0	0.0	0.0

Source: Mathura Tea Garden, Alipurduar

Station: Atiabari Tea Garden (Rainfall in mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2009	0.0	20.3	124.4	111.	586.7	762	922.0	165.1	271.7	0.0	0.0	0.0
2010	5.0	81.2	337.8	355.6	927.1	1239.5	685.8	551.1	63.5	2.54	0.0	5.08
2011	12.7	30.4	190.5	144.7	563.8	723.9	360.6	355.6	711.2	0.0	0.0	12.7
2012	2.5	2.5	137.1	210.8	868.6	1102.3	408.9	447.0	106.6	0.0	0.0	2.5
2013	10.1	17.7	106.6	279.4	617.2	962.6	515.6	566.4	106.6	0.0	0.0	10.1

Source: Atiabari Tea Garden, Kalchini

Station: Nagrakata Tea Garden (Rainfall in mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2009	0.0	0.0	7.6	195.5	144.7	647.7	469.9	665.4	383.5	236.2	2.5	0.0
2010	0.0	5.0	60.9	106.6	312.4	767.0	878.8	881.3	449.5	93.9	7.6	0.0
2011	2.5	7.6	33.0	127.0	248.9	673.1	970.2	342.9	436.8	43.1	5.0	0.0
2012	5.0	2.5	5.0	127.0	208.2	734.0	1000.7	467.3	670.5	33.0	0.0	0.0
2013	5.0	12.7	17.7	60.9	228.6	515.6	924.5	535.9	276.8	144.7	2.5	0.0

Source: Nagrakata Tea Garden, Nagrakata

Station: Damdim Tea Garden (Rainfall in mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2009	0.0	0.0	7.6	20.3	185.4	551.1	657.8	873.7	266.7	312.4	12.7	2.5
2010	0.0	12.7	17.7	81.2	375.9	693.4	1028.7	802.6	622.3	177.8	15.2	0.0
2011	10.1	10.1	58.4	144.7	264.1	589.2	845.8	462.2	447.0	101.6	7.62	0.0
2012	5.0	0.0	2.5	109.2	175.2	581.6	995.6	335.2	589.2	50.8	0.0	0.0
2013	5.0	7.6	25.4	93.9	358.1	652.7	904.2	386.0	325.1	185.4	38.1	7.6

Source: Damdim Tea Garden, Damdim

Station: Bagrakote Tea Garden (Rainfall in mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2009	0.0	2.5	0.0	294.6	307.3	391.1	929.6	749.3	309.8	279.4	0.0	0.0
2010	0.0	5.0	2.5	78.7	441.9	716.2	990.6	855.9	434.3	190.5	17.7	0.0
2011	15.2	10.1	119.3	147.3	325.1	581.6	965.2	609.6	706.1	55.8	0.0	15.2
2012	0.0	2.5	0.0	66.0	157.4	469.9	1117.6	734.0	754.3	20.32	0.0	0.0
2013	7.6	17.7	22.8	27.9	383.5	568.9	914.4	505.4	439.4	254.0	35.5	7.6

Source: Bagrakote Tea Garden, Bagrakote

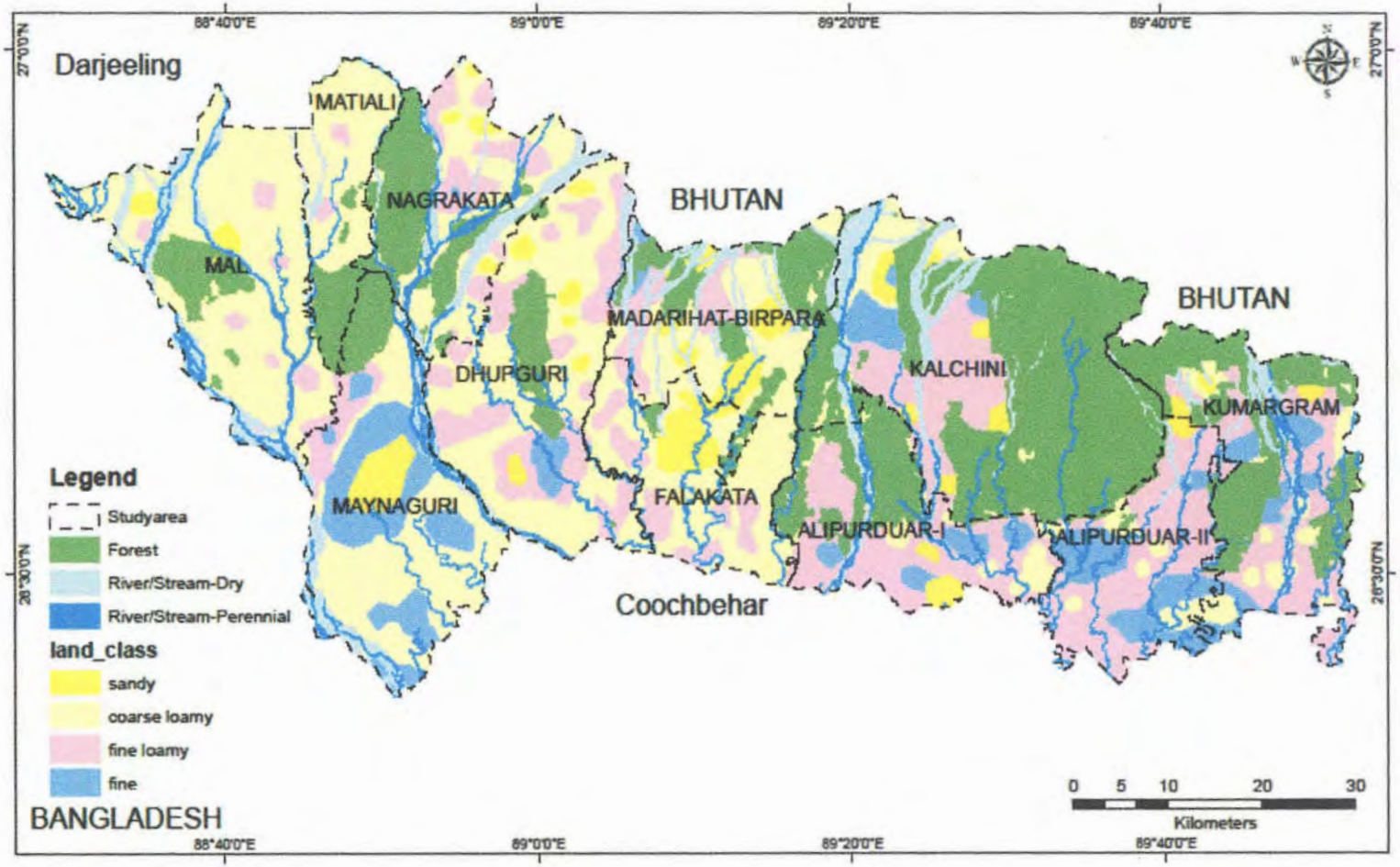
2.6. HYDROLOGICAL CHARACTERISTICS:

Hydrological condition at a particular point is guided by topography, geology, and rainfall (Annual rainfall 3160 mm) of the region. Under uniformly excellent water aquifer condition groundwater simulates topography. Most of the aquifer is semi-confined and unconfined in this belt (prevalence of sand to boulder size material). The groundwater table coincides with the surface water, so many rivers originates from the groundwater in this region. In monsoon period ground water level upper than surface water, this causes more danger for contamination. Hydrological characteristics also have changed from last decade. Ground water level and water quality of the region varies from pre to post monsoon period due to recharge of rainfall.

Ground and surface water quality monitoring is the process of regular study of parameters related to ground and surface water. It helps determining the quality trend and hence the threshold values for the restoration of water quality to its normal. Different factors those affect the water quality are physical, chemical and socio- economic parameters of the area. The water quality is differing in circumference of tea garden belts than other area of the district. Water resources are at the heart of sustainable development in Dooars region. Water of sufficient quantity and quality is an essential resource for agriculture, industry and tourism, but also for everyday life in cities and villages. But water resources are deplete and degrade due to the use of huge amount chemicals in tea garden belts for better production which contaminates ground water through percolation and rivers and other water bodies through surface run-off. The contamination of surface water and groundwater pollution can result from the large-scale application of fertilizers, pesticides and agrochemicals in tea garden area. Unwanted elements and others excess elements easily leach out though high permeable and porosity soil, which are easily contaminated with ground water[9].

2.7. SOIL:

The soil of this region is alluvial in nature and has a light texture and defined as sandy loam to loamy sand which highly permeable porosity. The geological point of view soils are mainly the products of weathering of fluvial clastics. In fact soil is a substance or thing of upper part of the earth's surface which is formed as a result of natural evolution and complex interaction of rocks, organisms, climate, relief and man. This region is entirely covered with alluvium with hard rocks exposed along the northern border. The soil has low water holding capacity, characterized by low fertility with low nitrogen and potash medium phosphate



Map Number-2.3 Soil map of Dooars region

contents. Leaching of salts under heavy rainfall condition increases the acidity in the soil. Pedagogically the deposits can be grouped into five unit based on soil formation, colour of topsoil and composition of soil, quaternary terrace deposits. The first one has no soil cover which is the present day flood plain, the second unit consists of enormous well developed coarse to fine sand size grading southward away from the foot hills, to silt and clay. The third and fourth unit ranges from boulder to sand size fraction, which is developed highly porous and permeable soil. The last unit mainly made up of boulder of various sizes, with little or no matrix.

Due to natural and man-made hazards, erosion of top soil is a major problem of Dooars region. Erosion of soil mainly occurred due to human interference. In the name of so called development, for constructing roads in hilly region, detonators are often used for blasting stones or part of hills, which causes loosening and cracking of stones and ultimately causes severe landslide and sleeps. Unscientific spreading of human habitation is also a big factor for soil erosion. To meet the demand of greater population in the hills of Dooars, terrace cultivation of paddy with the help of flow irrigation is adopted. This process washed out the cementing material, which bonds the stone. It is experienced that hill flow irrigation project areas are often followed by severe sleeps. Adding to this unscientific dolomite mining in Bhutan and neighboring Sub-Himalayan hills causes erosion of soil in heavy amount. It is true, that due to some natural process soil erosion occurs but interference of human activities increases its margin heavily. Due to the erosion of top soil in tea gardens areas the soil nutrients are eventually decreased which adversely affects the growth of tea bushes. Besides, the erosion also leads to the washing out of the chemical and fertilizers that are used in the tea gardens mixed with the nearer river water through surface run-off. So, it is high time necessary steps should be taken before any calamity can take place.

2.8. FOREST AND NATURAL VEGETATION:

The forests of Dooars region can be broadly classified as Tropical moist deciduous forest. A major part of this region is covered by forests. The numerous hamlets are surrounded by thickets of trees and shrubs, partly planted and partly of spontaneous growth, in which mango, jack, pipal and tamarind trees frequently occur; bamboos thrive luxuriantly and the numerous clumps of these form a conspicuous feature in the landscape and add greatly to its beauty. Even today this area remains one of the most prominent wildlife areas of the country

and bears the best Sal forest in India. The main forest cover comprises of semi moist deciduous vegetation. Apart from these high rise forests there are floodplains of rivers like Murti, Jaldhaka, and Torsa etc. covered with grasslands which nourishes a wide spectrum of wildlife. Forests like Gorumara, Chapramari, Jaldapara and Buxa are declared as sanctuaries and national park to protect wildlife.

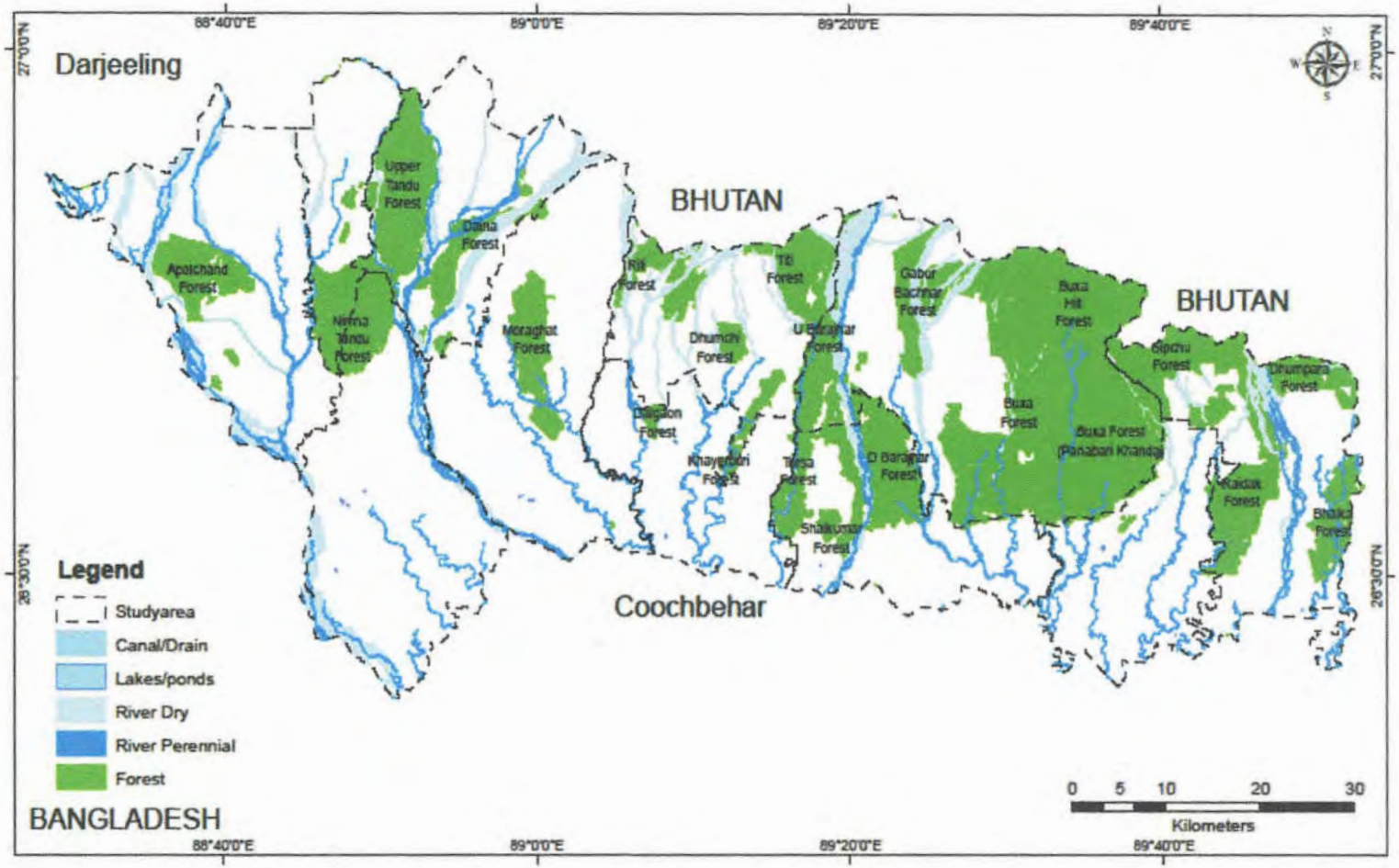
The forests of this region mainly extend from plains to Terai regions of Himalayas and are located in the flood plains of different main hill rivers and other medium and small rivers and rivulets which have created a pocket of grass land. Apart from national parks and sanctuaries a significant area of this region is covered by forest. Somewhere it has such a luxurious growth that even the sun light finds it difficult to kiss the land.

The forests of this region are predominately Sal with pockets of various other types- Evergreen Forest, Savannahs, Riverine forest and swamps. The Sal forests can be primarily classified as a) Mature Sal b) Scattered Sal c) Wet mixed and d) Dry Sal. Savannahs are found where a good quality of sand is present in the soil and are characterized by the presence of Kumbhi, Amla, Sidha, Tanki etc. Riverine forest is a deciduous forest and its main two species are Khair and Sissoo. At some places Odal and Sidha are found in good proportion. In many places lands surrounding the streams are swampy and bear a special type of vegetation. A vast population is directly or indirectly dependent on the forest of Dooars region. The forest of Dooars bears its significance in the international context for providing shelter and protection to various species of wildlife, included in the Red Data Book (RDB) and appendices of CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna).

The Dooars area covered mainly with dense and lofty forests. The swampy wet land helps to grow natural forest. But increasing population and requirements of food creates a vicious circle which leads to change the land use pattern of this region. Forests are also being damaged to establishing tea gardens. Mainly two types of cause are responsible for deforestation. This are-

1. Natural causes

Due to the shifting of river deforestation occurred here. Shifting of river Jaldhaka devastated nearly 50% of Tandu forest and Tandu Tea Garden. Shifting of river Diana, deforested the Western part of this river i.e., Diana forest. During 1960's shifting of river Torsa to Buri



Map Number-2.4 Vegetation map of Dooars region

Torsa caused huge damages to Chilapota forest. In the foothills region shifting and changing course of river Torsa damages a huge portion of Reti forest near Jaigaon.

2. *Man-made causes:*

On the other hand, manmade hazards also cause deforestation in this region. In the name of development and requirements of cultivable lands, huge forest area has damaged for this purpose. For example, the Baikunthapur forest which is now just a shadow of the past. Deforestation of huge area causes ecological imbalances in this region and changing weather condition is the result of this.

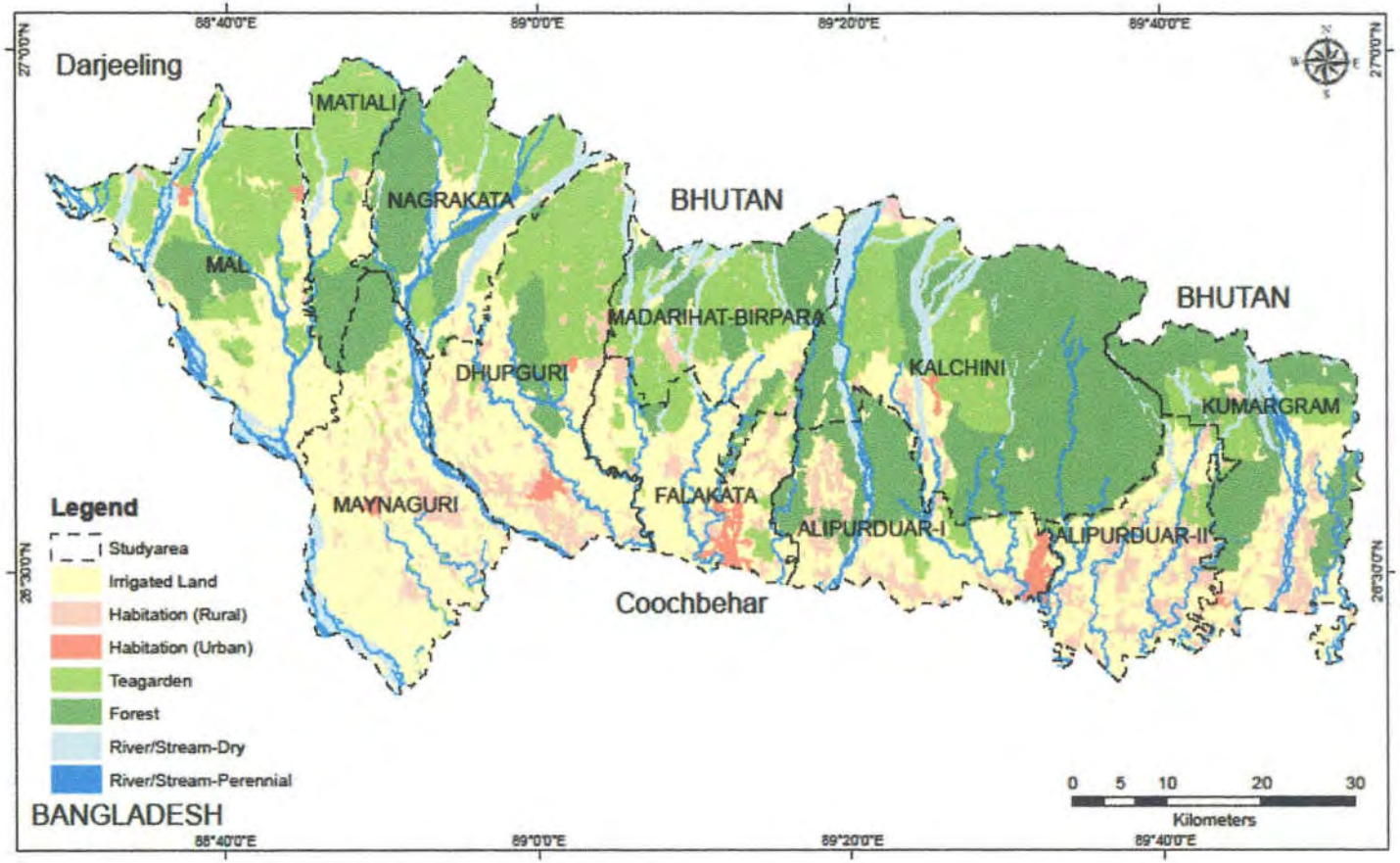
2.9. FAUNA:

The Dooars region has always been famous for its big game and though the heavy grass and reed jungle which is the favourite resort of wild animals is steadily diminishing owing to the extension of cultivation, the sanctuary afforded by the numerous forests will prevent game from being killed out. The forests of Dooars are home to many rare and endangered species of mammals and birds. The Indian One Horned Rhinocerous is found in both Gorumara National Park and Jaldapara Wildlife Sanctuary. Near extinct species like the Hispid Hare and Pygmy Hog have been reported from the Gorumara National Park. Bengal Florican an endangered bird had been photographed in Jaldapara wildlife sanctuary. Apart from this species like Tiger, Leopard, Asian Elephant, Gaur, Wild Boar, Sambar, Cheetal, Hog deer, Barking Deer are also found in the various forest tracts of this region. Among the larger carnivore tiger, leopard are commonly found at the jungle of different tea gardens of the western part of Dooars and they do much harm to the villagers especially tea garden workers by damaging their residential houses and their lives as well as by carrying off their cows, goats, pigs etc.

Game birds used to abound in the Western Dooars but many species are getting scarce as the grass lands are being brought under cultivation. The red jungle fowl may be seen feeding in the early morning and at sunset on the edges of the forests.

2.10. LAND USE PATTERN:

The dramatic transformation of land use pattern of Dooars region has taken place during the second half of the last century. Huge migration vis-à-vis influx of population compelled the people to settle in the former water bodies, marshy lands, hilly forest, decayed water bodies and interior area of the district. So the land use pattern has also been changing from natural land to man-made or artificial structure. The land use pattern of the area is forest (28.75%),



Map Number-2.5 Land use map of Dooars region

tea garden (19.06%), cultivated and non-cultivated land (38.91%), and others (13.28%) (Water bodies, residential, hill etc.). The tea garden and hill area covered in the northern part of this region. Forest covers area scatter in whole district. Land use pattern changed dramatically from last decade that is the one of the major cause of environmental hazard of this region. The table (Table Number-2.4) shows the land use pattern of Dooars region.

Table Number-2.4

Land use pattern of Dooars region

Area under	Area in Sq. km.	Area in percentage
Tea	974.26	19.06
Forest	1469.56	28.75
Cultivable land	1978.67	38.71
Non-cultivable land	10.23	0.20
Others	678.81	13.28
Total	5111.53	100.00

Source: Official website of Jalpaiguri district.

2.11. TEA PLANTATION:

The bulk of Indian tea is produced in North Indian states of Assam and West Bengal along with the southern states of Tamil Nadu and Kerala. The West Bengal tea industry is the second largest in the country after Assam. There are around 330 tea gardens spread across the Dooars, Terai and Darjeeling hills, the majority of them being in the Dooars region. The foothills of the Himalayas covering the districts of Darjeeling and Jalpaiguri occupy a significant position in the tea map of India. The tea gardens of Dooars region lays in the northern part of West Bengal along the foothills of Himalayas. The Dooars consists of marshy land with densely forest cover. It represents a transitional belt of high plain between the Himalayas and the flat plain of North Bengal. Most of the soils in Dooars are old red, well-weathered, rich loamy, deep and acidic. Lying in the Himalayan foothills, Dooars has been rightly considered as the Gateway of the Bhutan, Sikkim and the entire North-East of India. It stretches from River Tista on the west to River Sankosh on the east over a span of 130 km by 40 km [10].

The tea growing areas situated in the Jalpaiguri district with an annexation of a small tea growing areas in Koch Bihar is popularly known as Dooars. The word Dooars has no political

implications but only has the geographical relevance. It can be divided into two regions namely Western Dooars which falls within the district of Jalpaiguri, formed in 1869 after the annexation of Bhutan Dooars in 1864-65 and another is Eastern Dooars comprising the portion of Assam annexed earlier. P. J. Griffiths recorded that Warren Hastings was first to presume and comprehend in 1774 that the East India Company would make money if tea could be cultivated in the plains (the Dooars) down the Bhutan hills. About tea cultivation in Dooars writes Grunings, "It was soon found that the soil and climate of the western Dooars was suitable to the growth of tea; Government offered land to investors on favourable terms and the industry developed rapidly". As per the district gazettes' and Gruning's report, the first tea garden was opened at Gazolduba in Western Dooars in 1874 [11].

This Gazolduba garden was later purchased by an Indian company viz. Friends Tea Company Limited. Jalpaiguri Tea Company Limited was established on 29th May 1879, the first Indian tea company with exclusively Indian shareholding and board of directors. The company acquired a plot of forest land Mogulkata in Banarhat from the government. The land for tea cultivation was prepared by clearing the forest. With the passage of time this small garden developed into big tea gardens. Success of this tea garden paved the way for the emergence of many more gardens in places like Bagrakote by Mr. North and Mr. S. Creswell, and at Fulbari by Mr. Pillans and Colonel Money within a short span of time. In order to encourage tea industry grants were offered to Fulbari, Bagrakot, Dalimkot and Rangatee tea gardens in 1876. During the period 1879-1927, 13 Indian tea companies were established in the Dooars area [12]. At present there are 156 tea gardens in the Dooars region due to the presence of old red soil, favourable climate, undulating topography, excessive labour, increasing demand etc.

2.12. CONCLUSION:

The Dooars region is located on the northern part of West Bengal along the foothills of the Himalayas. It represents a transitional belt of high plain.between the Himalayas and the flood plain of North Bengal. Dooars means door in Assamese, Nepali, Maithili, Bhojpuri, Magahi and Bengali languages, and the region forms the gateway to Bhutan from India. There were 18 passages or gateways through which the Bhutanese people can communicate with the people living in the plains. The Dooars region is bounded in the North by the hill ranges of the Himalayan and the South by the piedmont plains, which gradually grade into the alluvial plains further south. The geological milieu in this region represents the sub-Himalayas or the foothill zone consist almost entirely of the Siwaliks and typical formation of Quaternary and

recent sediments. The Tista River demarcates the western part and the Sankosh River demarcates the eastern part of Dooars region. The district is almost not a flat country rather there are mountainous areas in the north. The land is sloping from north and north-west to south. The principal rivers in this region from west to east are the Tista, Jaldhaka, Duduya, Mujnai, Torsa, Kaljani, Raidhak and Sankosh. The climate of this region is characterized by a hot and oppressive summer season, plentiful rain and moisture in the air while during temperatures drops rapidly. Most of the soils in Dooars are old red, well-weathered, rich loamy, deep and acidic. The Terai soils are deposited as a result of their movement through water erosion. The lower strata of stones and gravel of miscellaneous rocks had moved from the hill ranges. This region consists of marshy land with huge forest cover. The forests of Dooars are home to many rare and endangered species of mammals and birds. The tea garden covered in the northern part of this region and this plantation is the mainstay of economy of this region.

REFERENCES

1. *http: // jalpaiguri.gov.in*
2. *Grunning, John F., 'Eastern Bengal and Assam District Gazatteers: Jalpaiguri Gazetteer, The Pioneer Press, Allahabad, 1911, P.2.*
3. *Singh, R.L., 'India- A regional geography' UBS Publishers' Distributors Pvt. Ltd. New Delhi, 2008, p. 265.*
4. *Karmakar, M. 'A Geographical Outline of North Bengal', N.L.Publishers, Siliguri, 2011, p. 4.*
5. *Hunter, W.W., 'Statistical Account of Bengal' Vol-X, District of Darjeeling, Jalpaiguri and State of Koch Behar, Trubner and Co., London, 1876, p. 13.*
6. *Karmakar, M., op. cit., p. 23.*
7. *Ibid. p. 24.*
8. *Ibid. p. 38.*
9. *Banerjee, S.S., Podder, B.C., 'Environmental Hazard of Tea garden belt in Jalpaiguri District, West Bengal' retrieved at http://www.geospatialworld.net/paper/application/ ArticleView.aspx?aid=982 on 2.03.2012.*
10. *Mitra, D., 'Globalization and industrial relations in tea plantations' Abhijeet Publications, New Delhi, 2010, p. 7.*
11. *Dwibedi H.N., 'Production of tea in India with special reference to Dooars' K.P.Bagchi and Company, Calcutta, 1999, p. 21.*
12. *Debnath, S., 'The Dooars in historical transition' N.L.Publishers, Siliguri, 2010, p. 137.*