Chapter – II

GEOGRAPHICAL SET UP OF STUDY AREA

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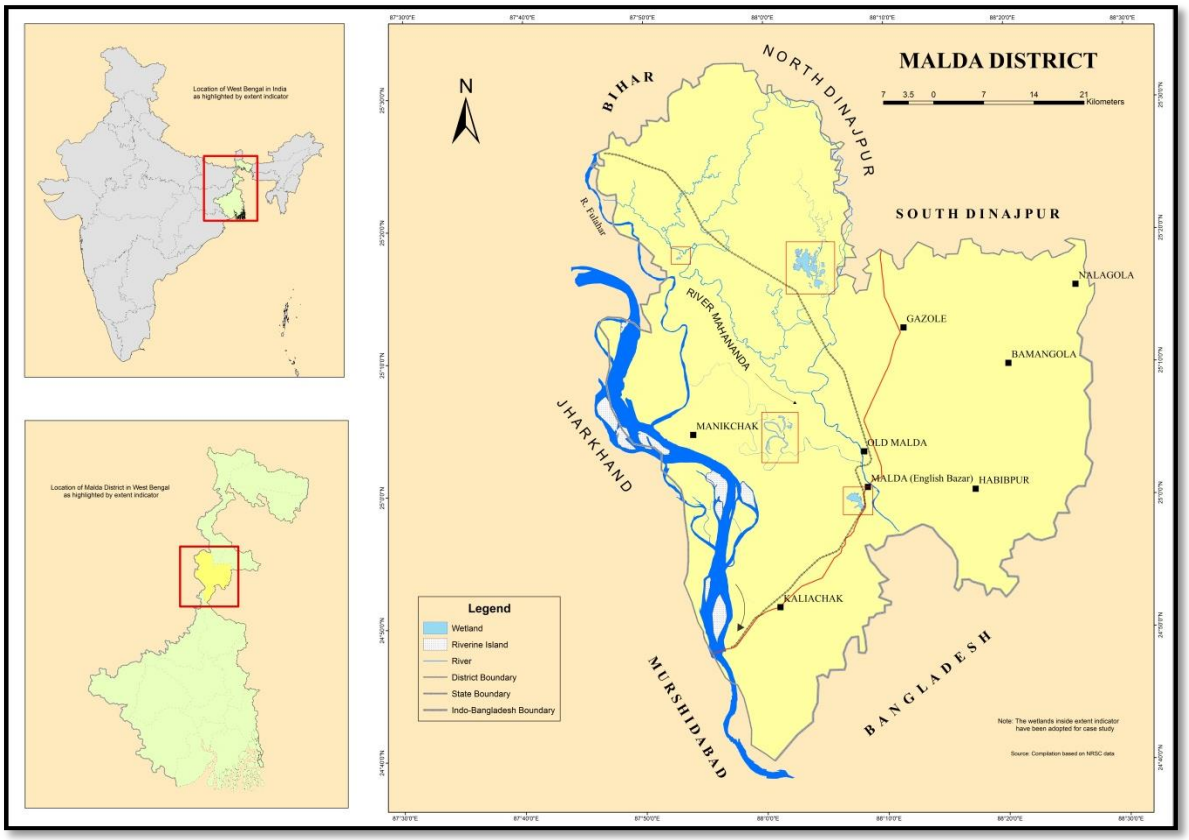
2.1 Introduction:

Malda district comprises 3,733 sq. km, and is located within 24˚40´20˝ N to 25˚32´08˝ N latitudes and 87˚45´50˝ E to 88˚28´10˝ E longitudes *(Map 2.1)*. The district is situated keeping Jharkhand in the west, Bangladesh in the east, and Murshidabad district in the south, whereas the river Ganga delineates its western boundary and the northern part shares the boundary with neighbouring district of North Dinajpur. Along with the seasonal inundation, the entire district is susceptible to the seasonal submergences. Manikchak- Gopalpur (east of river Ganga) belt is an active zone of channel migration. This belt experience frequent flood incidents as well as are associated with number of abandoned loops which are further traversed in an erratic manner by the river Kalindri. Study of satellite images of 1998, 2001, 2002, and 2003 reveal evidences of eastward channel migration as well as areal inundations. Such situation can be understood through the morphological re-arrangement of older meander scrolls.

Further territorial adjustments to the borders of Malda district had been occurred during the partition of India in 1947, when the Radcliffe award assigned several portions from its easternmost thanas to East Pakistan. The district has been reconstructed and subdivided into 10 police stations and 2 subdivisions: a) Sadar comprises it's headquarter at English Bazar and b) Chanchal with headquarter at Chanchal. There are 15 CD (Community Development) blocks in the district namely Gazole, Bamangola, Habibpur, Old Malda, English Bazar, Manikchak, Kaliachak 1, 2 and 3, Harischandrapur 1and 2, Ratua 1 and 2, Chanchal 1 and 2. Malda district comprises total number of 29 urban centers, which are subdivided into 2 Municipality towns (Old Malda and English Bazar) and 27 Census towns.

The main urban area of Malda district is the English Bazar municipality which receives the status of town after the independence of India in 1951 with a population of 35,161 persons. The population size has reached to 205,521 persons in 2011. According to census 2011, the district ranks 11th and 9 th position in terms of population size 3,988,845 and population densities of 1,069 inhabitants per sq. km respectively in the state of West Bengal. The population growth rate over the decade 2001-2011 has been recorded 21.5% (*District Census Handbook, 2011*). However, as per 2011 census, the population of Malda is overwhelmingly rural of about 86.42 % and the urban population is 13.58 %. Thus, the

burden of demographic pressure on the rural economy of this district is much heavier and the pace of urbanization is very slow. The district still continues to be a key region in the modern state of West Bengal, which connects more developed districts, located in southern part to economically backward districts, which form the northern West Bengal. Malda represents a place of great antiquity, which was once the cradle of state and society within Bengal.



Map 2.1: *Location Map of Malda District*

2.2 Geology:

From the very outset, Malda district is a flat terrain, which is crisscrossed with the rivers as well as depicts a geological history of alluvial formation. Broadly the district is a part of Bengal basin located on the western part of the alluvium filled gap between the shields of Rajmahal in the west and Garo-Lusai-Massif of the Meghalaya plateau in the east. In the north is the alluvial fan surface of the Himalayan foothills, the piedmont alluvial plain, which is formed by the streams descending from the mountains (*Gazetteers of West Bengal, Malda, 1969*).

Bengal Basin being in the Bengal delta is located within the mio-geosyncline area *(Chakraborty, 1970)*. The fluvio-glacial deposits in the foothill of the Himalayan valleys; the

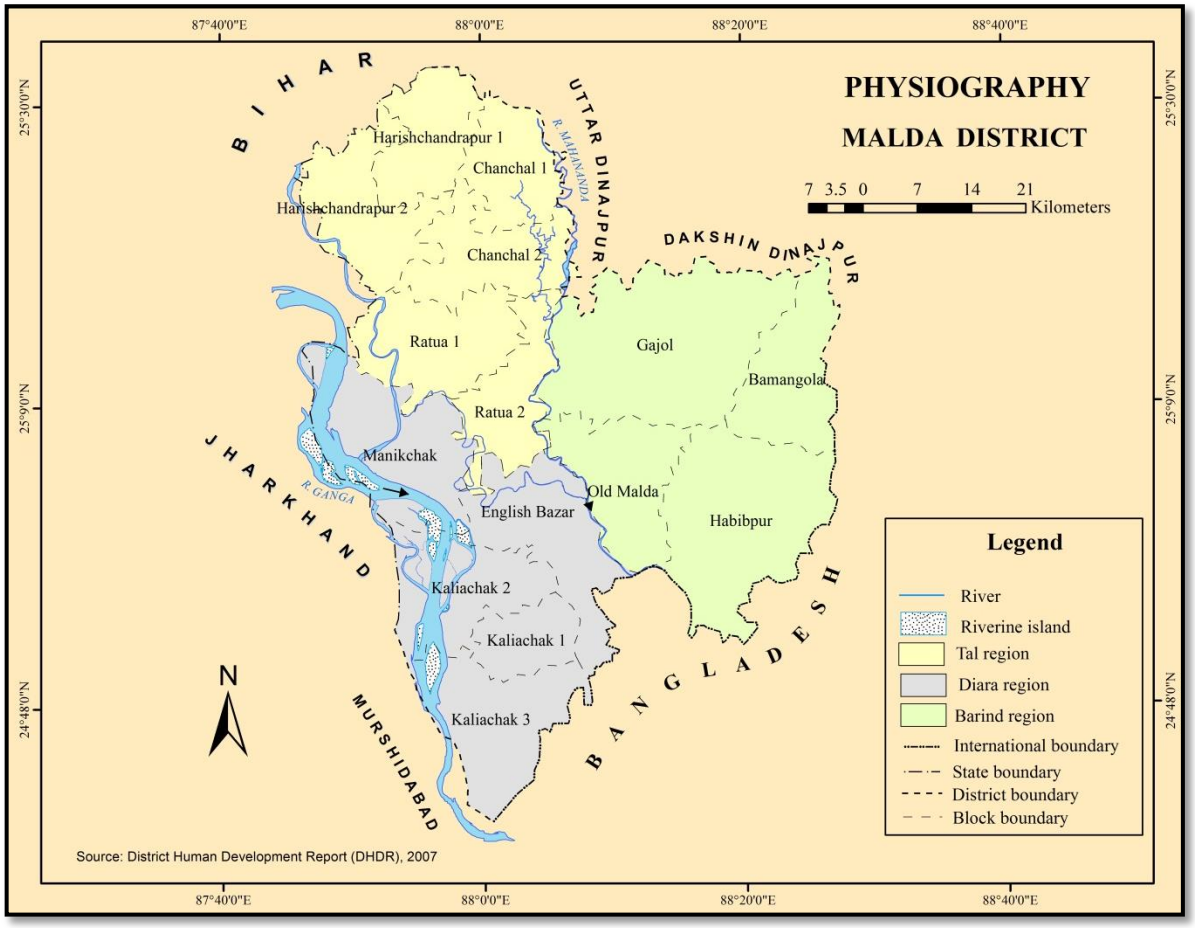
elevated and crescent shaped ferallitic-lateritic materials along *Rarh* and *Barind* has shaped the complex genesis of final frame of Bengal basin. On the other hand, the Rajmahal volcanoes (during Jurassic-early Cretaceous) are the most recent evidences of lithological aggradations. Actually this area is associated with a part of the Deccan shield and is the contiguous part of the north-eastern promontory of the Deccan shield. As per the structural geology, it is separated by the alluvium of the Bengal plains and is linked with the exposures of Archaean land surface in the Meghalaya-Assam. The eastern margin of the Deccan shield is characterized by lateritic terraces of various ages as well as separates the ancient Archaean formations from very recent coastal alluviums.

2.3 Topography:

The general slope of the district is from north to south. There are no hills in this district, unless a few elevated tracts are found on the east of the Mahananda River. The highest elevation of the district above sea level is 39.7 m at Pandua, Gazole in Mahananda–Tangan river basin. Elevations ranging between 30.0 m to 39.0 m (above m.s.l.) are found in the police stations of Bamangola and Habibpur in the Tangan–Punarbhava river basin. The other places of the district fall within the elevations between 23.5 m to 38.0 m. It is a triangular shaped region, through which a number of rivers flow from north to south and the slope is gentle as is proved by the meandering courses taken by the rivers, which are flowing through the district.

The physiographic make-up of the district is obviously an outcome of the gradual infilling of the North Bengal basin. Changeable geomorphic associations, has been accelerated by the oscillation of the mighty river Ganga, and results into the spatial deformations in the physiographic make-up. Physiographically, the district is divided into three well identified parts, namely, ***Tal*** (in the north and north-west), ***Diara*** (in south and south-west) and ***Barind*** (in the east) *(Map 2.2)*. The river Mahananda flowing from north to south, bisects the district into eastern and western regions. Geographically the land to the east of the Mahananda is called the *Barind*, which covers 1331.29 sq. km (35.66 %) of district *(DHDR Malda, 2007)*. *Barind* is associated with remarkable characteristic feature of relatively high and undulating land (successive mounds and depressions). The region is composed of the red clay soil of older and unconsolidated alluvium and is considered to have been developed during Pleistocene age. The soil has developed through the accumulation of sesquioxides, which has remained unaffected subsequently by inundations and renewed silting. Organic residues in this soil are highly decomposed, and leading to non-acidic soil

with 6.8 pH level and 0.54 % organic carbon content. As a consequence, overall soil fertility remains at modest level under non irrigated condition. Moreover, the hummocky terrain in the *Barind* region promotes a fair amount of runoff and the hard, impervious clayey soils, which permits little percolation.



Map 2.2: *Physiography of Malda District*

The eastern alluvium formation can readily be distinguished from the west of river Mahananda, which is further divided into two well defined parts by the river Kalindri, which is flowing from river Ganga towards east. In north of Kalindri, there is distinguishing natural feature named *Tal* land, with an area coverage of 1160.44 sq. km (31.08 %) in Malda *(DHDR Malda, 2007). Tal* land is featured with full of large and small depressions, which floods deeply as the rivers rise and drains by meandering streams into swamps or into river Kalindri. *Tal* region is strewn with the innumerable marshes and ox-bow lakes and remains submerged under considerable depths of water especially during the monsoon months. South of the Kalindri lies the most fertile and populous portion of the district. The most striking natural feature of this part is *Diara*, which is located in the transitional zone between *Barind* upland

and marshy *Tal* land, and contains 1161.51 sq. km (31.11%) of Malda district *(DHDR Malda, 2007).* The region is formed due to the combined action of deposition by two rivers namely Mahananda and Ganga and probably in the Pleistocene-Holocene epoch under the Quaternary period. The word *Diara* actually means low river banks, whereas the Karara means the high bank. By extension, these terms are commonly used to indicate land below and above flood level, respectively in the later alluvium. It has been evident with the finding of the marshy red older alluvium in this region which is locally called *karkach* and also known *chama mati* meaning thereby light and shallow layer of silts i.e., older alluvium of the river Ganga. Later the river Ganga has re-shaped with the uplift of the basement of the sub-Himalayan North Bengal basin. This low land is characterized with alluvium (consists of sandy clay and sands and fine silts) along the course of the river, which are embedded with clay in the flatter parts of this plain. This alluvium is typically dark, and loosely compacted with high water content and variable but appreciable quantities of organic material (*Gazetteers of West Bengal, Malda, 1969*). *Diara* is roughly estimated to be spread for eight to ten miles in width along the western and southern parts of the district. Its formation is the result of fluvial deposition by the river Ganga, the abandoned loops/off shoots of which can still be traced, starting from the present day course of the Bhagirathi River near Gour and extending westwards by successive stages of replenishment. This geographical entity is vulnerable to inundation during the rainy season but fortunate enough to have an excellent soil condition and irrigation facilities and is largely under the double cropping area.

2.4 Climate:

Malda district lies outside the tropics of Cancer, and is characterized by hot summer, profuse rains, and moisture in air throughout the year. The climate is significantly noteworthy because of its position and the strong effects of the south-western monsoon. Climate of Malda is dominated by three seasons i.e., hot, cold and rainy.

2.4.1 Seasons:

The hot weather begins with strong westerly winds from the month of March and continues till the middle of June. The days begin to be hot from the middle of February but night remains pleasant till the middle of April. The mean maximum temperature in April-May is about 35° C. The weather becomes oppressive during the month May to middle of September with high relative humidity ranging from 80% to 85%. Wind blows from the west during the mid-April when nor'westers sets in, sometimes in great fury. In May there are

strong winds from the west, hot and interrupted squalls, generally accompanied by thunderstorms and rains which often comes with hails of great magnitude and is popularly known as *'Kalbaishakhi'***,** which cause sharp drop in temperature.

Monsoon generally sets in the middle of June when the rainy seasons commence as well as continues till the end of September. The heaviest rain usually falls in July and August and sometime in even mid-June. The maximum rainfall sets in August amounting to 260 mm. Maximum rain generally occurs during the period from June to September. On an average, Malda experiences heavy showers of 76-80 numbers of rainy days. About 5-10 days experience burst of monsoon, associated with lightning.

Cold season starts from early November and continues till the end of February with mid-December to mid-January, being the coldest period. January is the coldest month in Malda amounting to 10°-12° C as average minimum temperature. In cold season on account of passages of eastern winds of western disturbances across northern India, Malda experiences unusually cold spell though for short periods. During the cold spell the minimum temperature goes down to 4° to 5° C. Winter days are bright and the air becomes crispy and clear. During cold season the district experiences very little rainfall with the exception of light showers (< 2 mm) at the end of December and a thunder shower in February. Occasional appearance of fog is also experienced in winter.

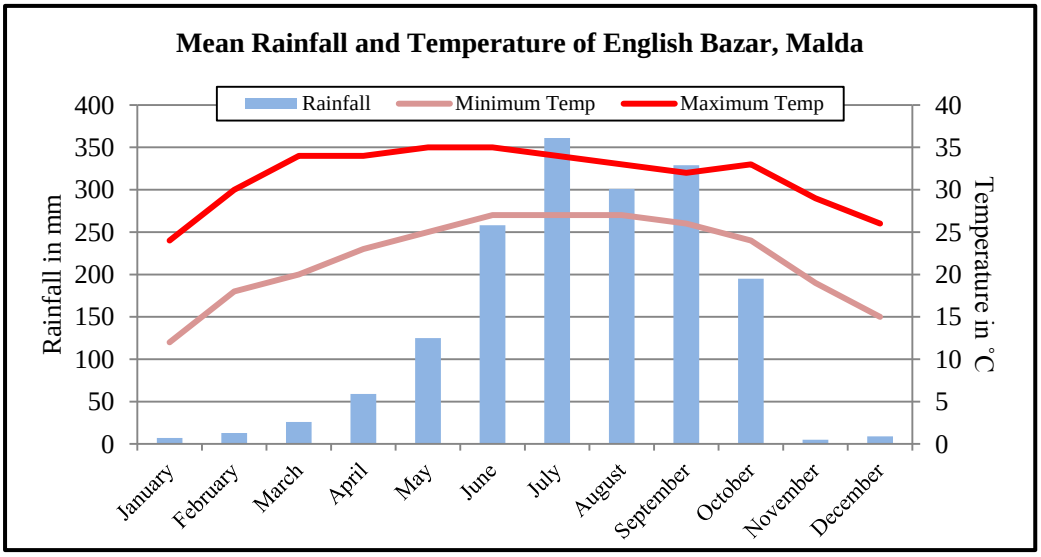


Figure 2.1: *Mean monthly temperature and rainfall of English Bazar, Malda*

2.4.2 Rainfall:

The mean annual rainfall of English Bazar is about 1500.0 mm, 75% of which fall during the monsoon months (June to September). July and August are the months, with

heaviest rainfall contributing 300-360 mm followed by September (329 mm) and June (258 mm). On contrary, months from November to January are devoid of rainfall and records only 5-9 mm. Furthermore, Malda district is also mentionable for its high intensity rainstorms. Long term monthly rainfall pattern of district has been tabulated in table 2.1 and diagrammatically represented in figure 2.1.

Table 2.1 Mean monthly meteorological record of Malda district

Month	Mean Temperature °C			Humidity (%)		Rainfall (mm)	Rainy-days	Wind velocity (Km/hour)
	Max	Min	Mean	08.30	17.30			
January	24	12	18	97	52	7	1	2.5
February	30	18	24	94	42	13	1	3.0
March	34	20	27	86	36	26	2	4.6
April	34	23	28.5	84	44	59	3	6.3
May	35	25	30	87	52	125	6	7.1
June	35	27	31	92	69	258	13	7.4
July	34	27	30.5	95	81	361	16	6.5
August	33	27	30	94	81	301	14	6.2
September	32	26	29	93	83	329	12	5.0
October	33	24	28.5	90	66	195	6	3.2
November	29	19	24	94	56	5	1	2.4
December	26	15	20.5	93	55	9	-	2.4
	31.58	21.92	26.75	91.58	59.75	140.66	71.9	4.7

Source: *IMD, Govt. of India*

2.4.3 Temperature:

January is the coldest month with the mean daily minimum and maximum temperatures recorded to be 12° C and 24° C respectively *(Figure 2.1)*. During January and February, night temperature normally drops to a couple of degrees above the freezing point and frost occurs for 1-2 days in a year. Such condition with cold spells often occurs in the wake of western disturbances. The lowest ever recorded temperature was 3.0° C in 1905. Temperatures begin to rise by the beginning of March. June is the hottest months with a range of mean minimum and mean maximum temperature of 27° C to 35° C. The highest ever temperature was recorded to be 41° C, recorded in 1997. The heat during the summer is oppressive as the moisture content in the air is high. With the arrival of monsoon in mid-June the day temperature decreases by 2° or 3° C but the night temperature continues to rise (*Gazetteers of*

West Bengal, Malda, 1969). Therefore, the temperature remains extortionate and the fluctuation of day and night temperature has been recorded only 6° to 7° C (*Figure 2.1*) (*Table 2.1*). With the withdrawal of the south-west monsoon by about first week of October, both day and night temperatures drop steadily and the weather gradually becomes cooler to cold.

2.4.4 Humidity:

Atmosphere is highly humid throughout the year in this district except the period between Decembers to middle of February. Afternoons are generally less (70-75%) humid during cold and spring season while, during monsoon months humidity is found to be high (80-88%) throughout the day. Month of July records the highest relative humidity both in the morning (08:30 am) and in the afternoon (17:30) amounting to 95% and 81% respectively (*Figure 2.2*). March is the driest month when the mean humidity has been recorded to be within 50% to 65% during 08:30 and 17:30 hours respectively.

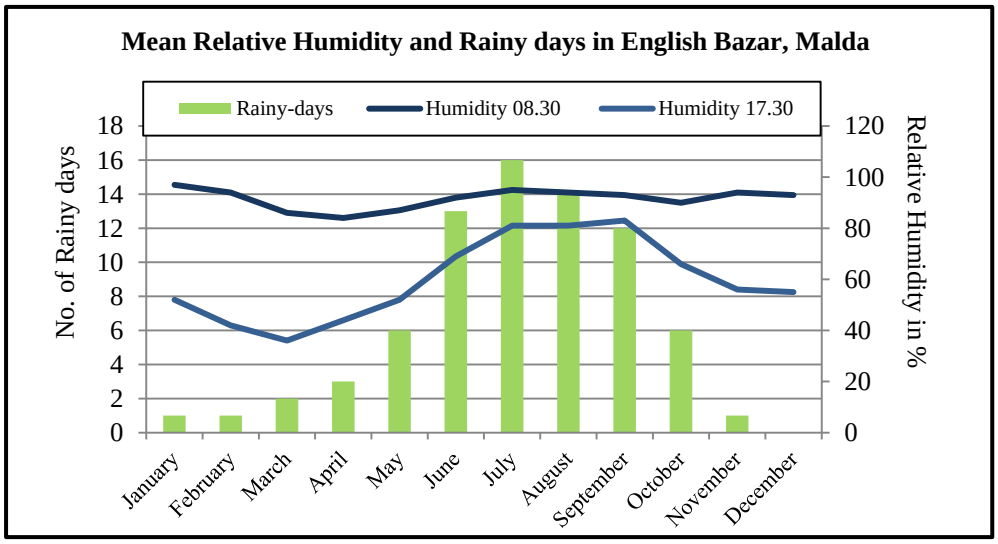


Figure 2.2: *Mean monthly relative humidity and rainy days in English Bazar, Malda*

2.4.5 Cloudiness:

In the monsoon month sky remains heavily clouded to overcast. During July and August on an average 12 days remain overcast. From October to April, the sky generally remains clear or partially clouded. Cloudiness begins to increase from May onwards.

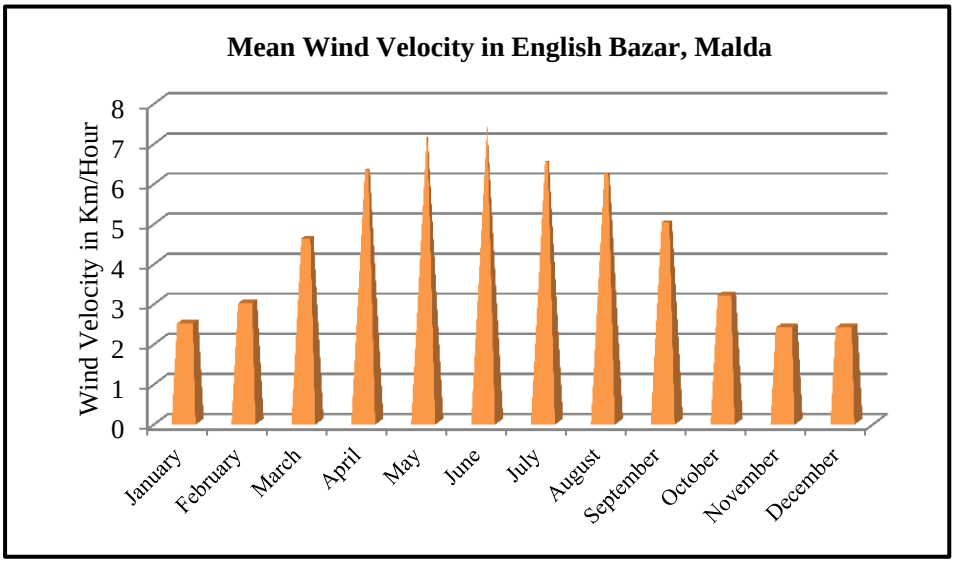


Figure 2.3: *Mean monthly wind velocity in English Bazar, Malda*

2.4.6 Wind:

Wind is generally light, except for a short spell of thunderstorms during the period between months of March to May. Mean monthly wind velocity of Malda district is shown in figure 2.3. Some of the cyclones and depressions that originate from the Bay of Bengal during south-west monsoon and post-monsoon seasons move in a northerly direction and affect the district and its neighborhood as well as causes widespread heavy rain and high wind. Thunderstorms during the months of April and May generally occur in afternoons, which are occasionally associated with squall and hail. Fog occurs in the winter months.

2.5 Drainage:

The rivers of Malda district are mostly of Himalayan and sub Himalayan origin and flow generally in southerly direction. The district is drained by major rivers namely the Ganga, the Kalindri, the Mahananda, the Tangan and the Fulahar *(Map 2.3)*. There are also other rivers like Punarbhava, Brahmani, Pagla, Buri Ganga, Chota Bhagirathi, Behula, Jalangi, Baromasia etc. situated in the district.

2.5.1 The Ganga:

The river Ganga runs through the blocks of Manikchak, Kalichak 2 and 3 and forms the south-western boundary of Malda district. The river touches the Sakrigali ghat opposite to Sahibganj of Bihar. Being obstructed by the Rajmahal massifs, it takes a southward sweep turn and follows the Garo-Rajmahal Gap of Bengal Basin as well as enters in the district at Gaduri of Bhutni char (Manikchak) under *Diara* region with a length of about 15 miles (24.2 km) (*Gazetteers of West Bengal, Malda, 1969*). Further downstream, it meets with the river

Kalindri, though now the opening has been dried up as the river has receded to the west. Hamilton, understood that the lower part of the Kalindri between this junction and the town of English Bazar as a zigzag branch course of the Ganga. About 3 km below Rajmahal, the Ganga throws off a small stream named Chota Bhagirathi, which is also presumably an old bed of Ganga. It runs first to the east and later to a southerly direction, bordering for about 20 km of the ruins of the famous Gaur dynasty. Possibly during 1700 A.D. onwards the Ganga had changed its course and shifted towards its present course.

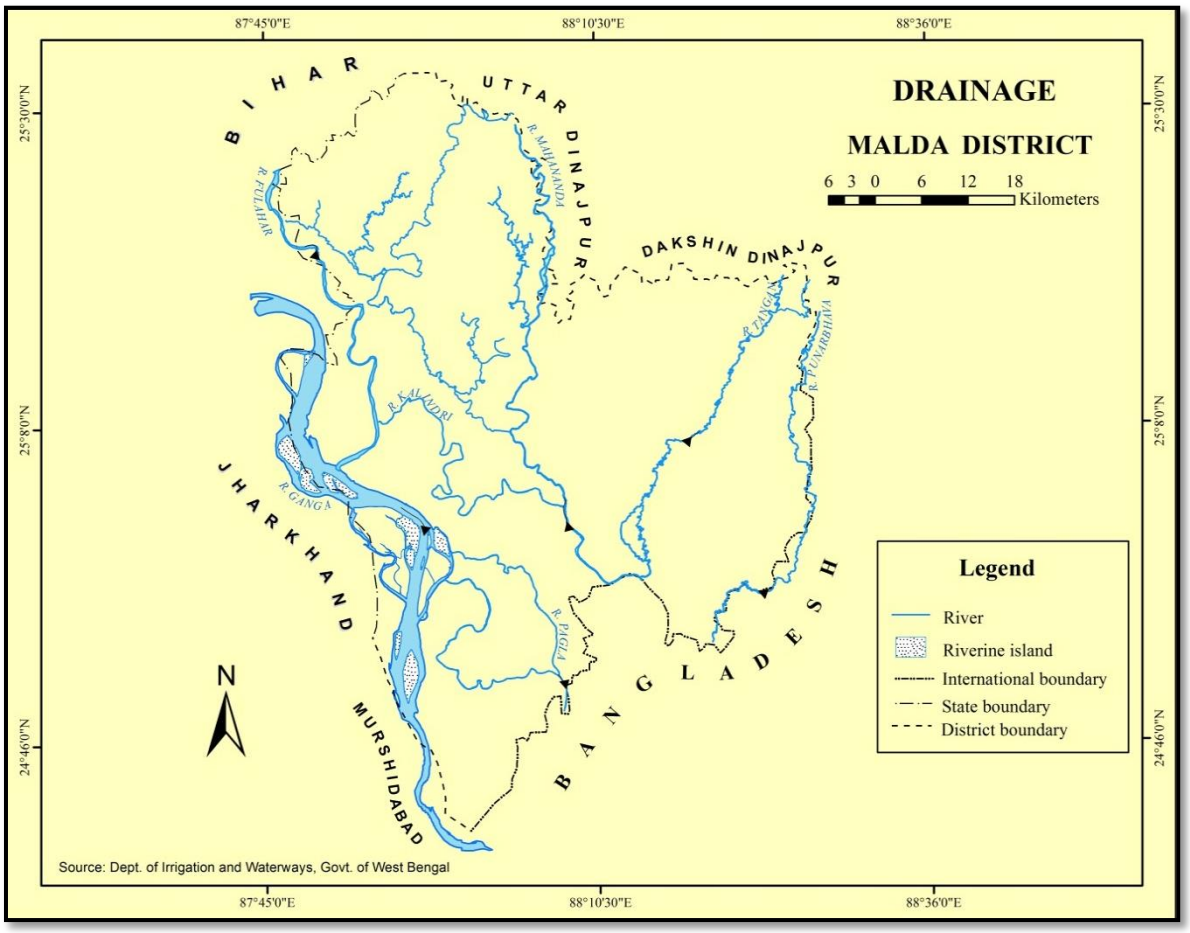
2.5.2 The Mahananda:

The Mahananda is a trans-boundary river, flows through the Indian states of West Bengal, Bihar and Bangladesh. The river rises in the lower slopes of the Himalayas from Mahaldhiram hill near Kurseong at an elevation of 2100 m and flowing southwards. It enters in Malda district from the extreme north-west corner. It then flows eastwards, approximately along the district boundary through Kharba, where it turns south and flows more or less straight through the central part of the district, covering the blocks of Gajole, Old Malda and English Bazar. It receives the water of Kalindri on its right bank, and from Tangan and the Punarbhava on the left before it falls into the Ganges at Godagari near Nawabganj district in Bangladesh. The total length of Mahananda River is 55 miles (88.6 km) in Malda district (*Gazetteers of West Bengal, Malda, 1969*). Being conjugated with river Kalindri, it suddenly widens to about 200-600 m and it acts as boundary line between the physiographic divisions of *Tal* and *Barind*. During the last century, changes have taken place in its course, but between the dates of Rennel's map it was flowing through the present Mara Mahananda along the western boundary of Kharba police station. At the North of old Malda, the river becomes narrower and shallower, as it is above the junction with the Kalindri.

2.5.3 The Kalindri:

The river Kalindri is simply an offshoot of the eastern branch of Ganga, but actually it is a branch of the river Mahananda, and renamed as Fulahar. Bypassing through the district of Purnea, it enters in Malda district near Mihaghat, from where it is known as River Kalindri. It took off about 3 km north-west of Ratua and following a winding course in south easterly direction through the blocks of Harishchandrapur 2, Ratua 1, 2, Manikchak and Old Malda and ultimately debouches into the Mahananda at Nimasari (the northern boundary of English Bazar municipality) after traversing through an irregular course. It empties itself into the river Mahananda during rainy months but in dry seasons it looks like discontinuous pool of water. The total length is 53 miles (85.33 km) in Malda district (*Gazetteers of West Bengal, Malda,*

1969). In the north, it receives its tributaries like the Kali kosi, Kankhor, Kosa and Baromasia, four small streams which drain the entire *Tal* area. The bank is high and steep, where erosion has taken place with resulting into red clay or sandy soil. The river is navigable in the rainy seasons and fordable in hot weather. During dry season the reach between Ratua and Chandipur becomes almost dry and is worth to even foot crossing. Between Mirjadpur and Araidanga the channel retains some water. But the Milki-Amriti reach is again remains dry.



Map 2.3: *Drainage map of Malda District*

2.5.4 The Fulahar:

The river Fulahar extends itself for about 100 km since its take-off from old Mahananda or Mara Mahananda near Bagjob. Actually the river has been traversed through Purnea of Bihar and near Miaghat of Harischandrapur. The confluence of Fulahar and Ganga is now at Narayanpur of Manikchak block. At the beginning of this century the river used to follow through the abandoned channel of Kalindri and emptied itself into Kalindri. The river system between Mihaghat and Shankartola has been named as Fulahar–Kalindri system.

Teljana, Kankhar, Baromasia, Kush, Kalkosh etc. are the main tributaries of Kalindri, which contribute to river Fulahar.

2.5.5 The Tangan:

River Tangan is an important tributary of Mahananda. The source area of the river has been destructed by the natural calamities. Being originated from Jalpaiguri district, it has passed through Panbari of Bangladesh as well as crossing Thakurgaon and Pirganj area. The river has again entered to Hemtabad of North Dinajpur district and then flows downstream over the plains of Banshihari and Gangarampur of South Dinajpur district. It has entered into Malda district at the boundary of Bamangola and Gazole police stations. The length of this river in the district is nearly 40 miles (64.4 km) (*Gazetteers of West Bengal, Malda, 1969*). The paleo-channels of the Tangan had been found for more than the miles named Mara Tangan in the Gazole block, whereas the Chunakkhai nala of Old Malda block is the abandoned cut off of the Tangan. Floods in Tangan River are associated with the floods in the Mahananda.

2.5.6 The Punarbhava:

River Punarbhava is the important off shoot of Teesta and the other two are Karotoya and Atreyee. These three make the form of Teesta meaning thereby three streams i.e., *'trisrota'* and Punarbhava is the southern/western most off stream from Teesta, with a length of about 40 miles (64.4 km). The Punarbhava forms the boundary for a few miles between Tapan in West Dinajpur and the police station of Bamangola in Malda district (*Gazetteers of West Bengal, Malda, 1969*). The river contains steep banks; particularly where it passes through the *Barind* formation. Floods in this river is also associated with the Mahananda, and during 1787 at the time of the great avulsion of the Teesta, the river Punarbhava started to be suffering from regular flow of water.

2.5.7 The Pagla:

Few miles downstream of Gaur, one of the eastern distributaries of mighty Ganga has been originated and designated as river Pagla. The river Chota Bhagirathi has been embodied with Pagla and performs an annular or semi-circular drainage pattern. During the period of 2003 flood, the watershed between Pagla and Ganga has totally been obliterated as well as has been captured by the grasps of river Ganga.

2.6 Soil:

In Malda district, there is variability in the soil morphology and its physical and chemical properties, which depends upon the geomorphic situations, moisture regime and degree of profile development. The district is enriched with alluvial Soil. North-east of the district is occupied by older alluvium soil and the south-west by deep to very deep newer alluvial soil, which is comparatively more fertile. Alluvium association of soil has an immature profile. Chemical and morphological observations show that one or two sandy layers are often found in the profiles examined. These soils are rich in calcium. Free calcium carbonate occurs over most of the area either in the surface soil or within 2 to 3 ft. in the profile.

2.6.1 Taxonomic Classification of Soils of Malda District:

The first modern classification of soil of West Bengal was initiated during the middle of twentieth century by the rapid reconnaissance survey based on 9.6 km grid system with the launching of Stwarart Scheme by the Department of Agriculture, Government of West Bengal in collaboration with I.C.A.R. *(National Commission on Agriculture, 1976)*. National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) in co-operation with the Department of Agriculture, Government of West Bengal has published Soil Map of West Bengal in four sheets in 1991. This is perhaps the most comprehensive and descriptive map of West Bengal's soil. The present discussion has mostly been based on the above mentioned study. The following table 2.2 and map 2.4 represent the major Taxonomic Order, Sub-order, and Great Groups which have been identified in Malda district. **Two** taxonomic soil Orders, **four** Sub-orders, **four** Great groups and **six** Sub-Groups have so far been identified.

2.6.1.1 Entisols:

These soils have little or no evidence of pedologic profile development either due to short duration or receiving of new deposits of alluvial at frequent interval from the higher tracts *(Sarkar, 1996)*. The only evidence of pedogenic alteration in these soils is a small accumulation of organic matter in the upper 30 cm of soil profile. Entisols may have an ochric or anthropic epipedon. A few that are sands have an albic horizon. The Entisols of Malda district have mostly ustic soil moisture and temperature regime. The order Entisols comprises an area of 1167.8 sq. km or 31.3% of the total geographical area of Malda district (*Map 2.4*). Two Sub-orders: Fluvents and Orthents have so far been identified in the district.

2.6.1.1.1 Fluvents:

These are mostly light brownish to reddish soils that are formed in recent water-deposited sediments mainly on flood plains. The Fluvents are flooded frequently unless dams or levees protect them. Stratification of the materials is normal. Most alluvial sediments came from eroding soils or stream-banks and contain an appreciable amount of organic carbon that is mainly in clay fraction. Strata of clayey or loamy materials commonly have more organic carbon than overlying more sandy strata. Thus, the percentage of organic carbon decreases irregularly with depth if the materials are stratified. The Fluvents of Malda district have been identified as Ustifluvents.

Table 2.2 Major Taxonomic Orders, Sub-order and Great Groups of Soil in Malda District

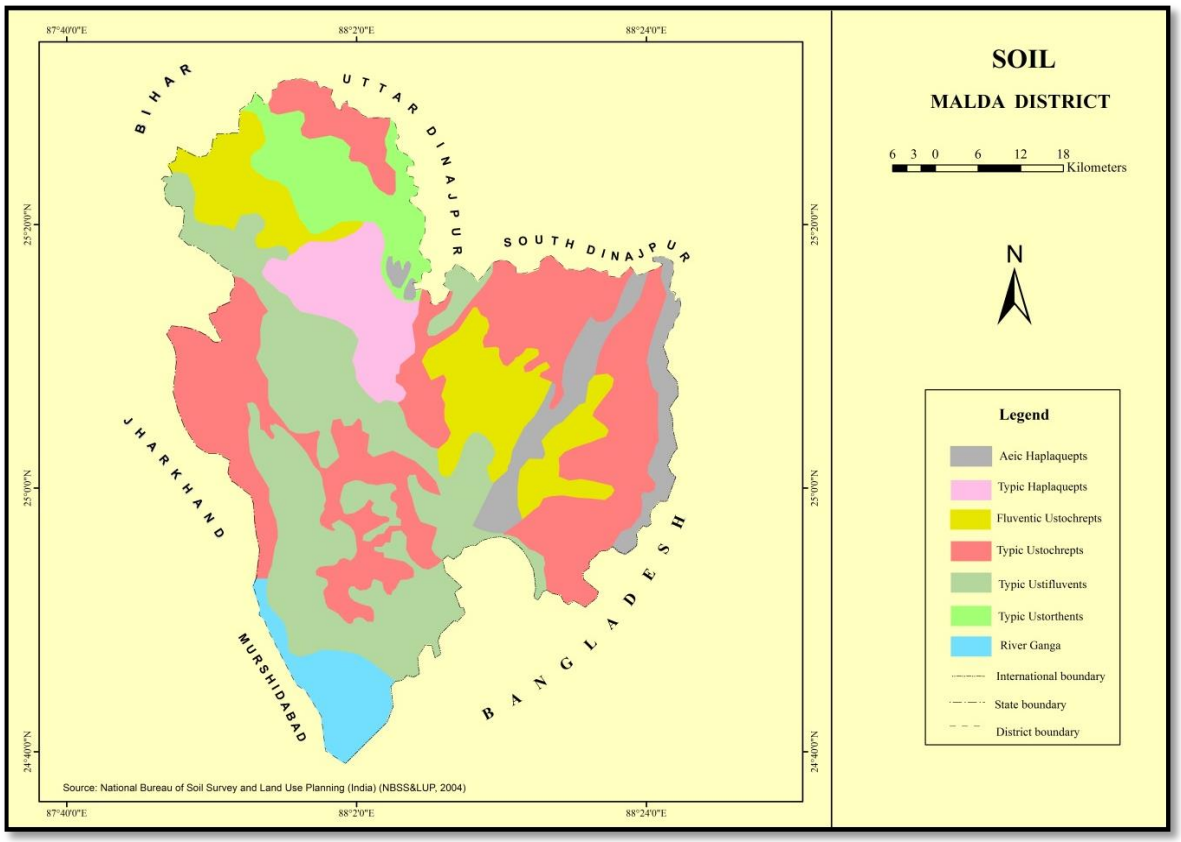
Orders	Sub-Orders	Great Groups	Sub-Groups	Area (sq. km.)	Area (%)
Entisols	Fluvents	Ustifluvents	Typic Ustifluvents	919.3	24.6
	Orthents	Ustorthents	Typic Ustorthents	248.5	6.7
Inceptisols	Aquepts	Haplaquepts	Aeic Haplaquepts	217.9	5.8
			Typic Haplaquepts	230.6	6.2
	Ochrepts	Ustochrepts	Typic Ustochrepts	1661.3	44.5
			Fluventic Ustochrepts	455.4	12.2

2.6.1.1.1.1 Ustifluvents:

These are the Fluvents that have an ustic soil moisture and isomesic to isothermic soil temperature regime. These soils are found on flood plains and are found flooded regularly during monsoon. The soils are previously known as alluvial soils and occupy 919.3 sq. km or 24.6% of the total geographical area of Malda district. The Ustifluvents are best developed in recent alluvial materials of Mahananda flood plain. They are very deep, well drained, dark yellowish brown coloured, moderately fine textured and neutral in reaction. **A** horizon is often underlain by layer of sandy deposit i.e. **C** horizon. Abundant mica particles are present throughout the soil profile. Within the subgroups of Entisols, Ustifluvents have higher soil organic carbon stock than other subgroups *(NBSS & LUP, 2004)*.

2.6.1.1.2 Orthents:

These are primarily Entisols on recent erosional surfaces, where the former soil has completely or partially been removed or so truncated that the diagnostic horizons for all other orders are absent. The great groups have been identified in as Ustorthents.



Map 2.4: *Soil map of Malda District*

2.6.1.1.2.1. Ustorthents:

These are the Orthents that have ustic soil moisture and thermic to isomesic soil temperature regime. The Ustorthents commonly occur in very recently exposed regolith, mostly in soft sedimentary deposits. Ustorthents occupy 248.5 sq. km or 6.7% of the total geographical area of Malda district. These soils are best represented by the *Amra series*, which develops on granite or gneissic parent rocks and has moderately to very steep slope. These are shallow to very shallow well-drained soils and have brown and dark brown colour, slightly acidic in reaction and have gravelly clay loamy **A** horizon over stones and pebbly **C** horizon.

2.6.1.2 Inceptisols:

These soils occur mostly in the plain and also in the lower topographic situation in a hydromorphic (aquic moisture regime) environment in West Bengal *(NBSS & LUP, 2004).* Inceptisols have altered horizons that have lost bases or iron and aluminum but retain some weather able minerals, they do not have an illuvial horizon enriched either with silicate clay that contains aluminum or with an amorphous mixture of aluminum and organic carbon. The common diagnostic horizons may have an umbic or ochric epipedon, a cambic horizon, a

fragipan and a duripan. Inceptisols develop mainly in the fine textured parent materials. These are the most common soils in Malda district covering 68.7% (2565.2 sq. km) of total geographical area of the district as well as mostly utilized for paddy cultivation. Two Sub-orders have so far been identified: Aquepts and Ochrepts.

2.6.1.2.1 Aquepts:

These are the wet Inceptisols. Their natural drainage is poor or very poor and if they have not been artificially drained, ground water stands close to the surface at some time during each year but not at all seasons. They mostly have grey to black surface horizon and mottled grey subsurface horizon. Most Aquepts are found in younger deposits i.e., in depressions, very flat plains, or flood plains. Most of them have cambic horizon, and some have fragipan. Aquepts of Malda district have been identified to be Haplaquepts Great group.

2.6.1.2.1.1 Haplaquepts:

These are sodic soils and have shallow ground water level and have a season in which capillary rise and evapo-transpiration bring sodium or other salts to or near the surface. The Haplaquepts normally are grey and mottled from the surface down ward or from a depth near the surface. Nearly, all these soils are level and are in Holocene alluvium. The vegetation, generally are hedges and salt-tolerant grasses and shrubs, but some of them have partially drained and are now irrigated for crops. Two Sub-Groups have so far been identified in Malda district (i) Aeic Haplaquepts and (ii) Typic Haplaquepts. Aeic Haplaquepts occupies an area of 217.9 sq. km. (5.8%) and are mostly identified in Gajole, Bamangola, Habibpur and Old Malda blocks of Malda district. Typic Haplaquents occupies 230.6 sq. km. or 6.2% area of the district and are identified in Chanchal 2 and Ratua 2. These soils are very deep, imperfectly drained and have light brownish grey to olive grey in colour, slight acidic in reaction, sandy loam to loamy **A** horizon, light grey, loamy **C** horizon. The cation exchange capacity is 8 to 16 m.e. /100gm of soil.

2.6.1.2.2 Ochrepts:

Ochrepts are of light colour, brownish, more or less freely drained Inceptisols. They have been formed on undulating or sloping ground of late Pleistocene or Holocene age. Ochrepts have an ochric epipedon and a cambic horizon. Ustorchrepts as the only Great group of Sub-order Ochrepts has so far been identified in Malda district.

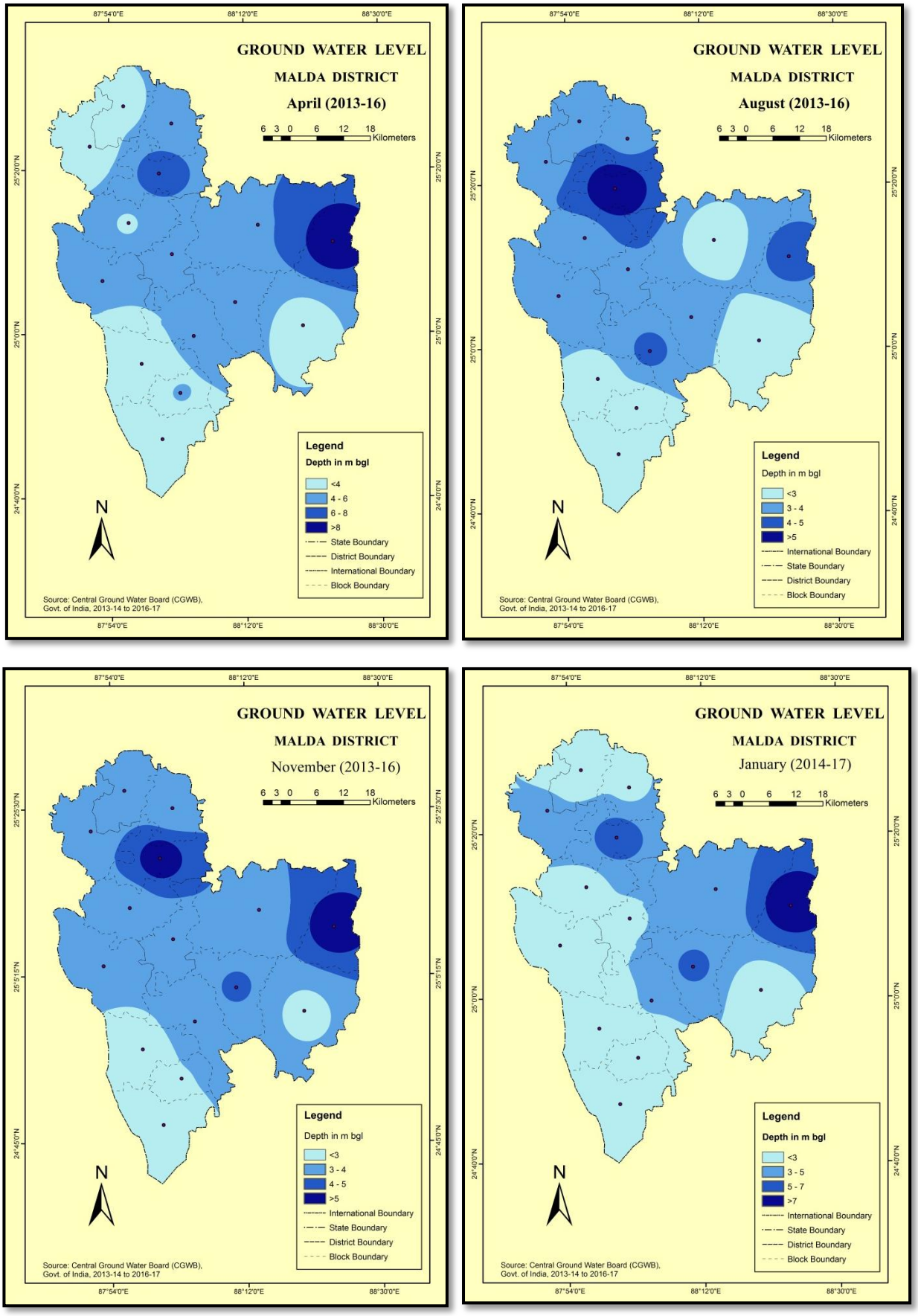
2.6.1.2.2.1 Ustorchrepts:

These are the reddish or brownish ochrepts, found in Holocene deposits. Ochrepts of ustic soil moisture regime (Ustorchrepts) are the most common soils found in Malda district covering an area of 2116.7 sq. km or 56.7% of the total geographical area of the district. These soils are developed on colluvial deposits and are very deep, imperfectly drained and have yellowish brown colour. The **A** horizon is slightly acidic in reaction and loamy in texture while the **B** horizon is characterised by yellowish brown in colour and neutral in reaction.

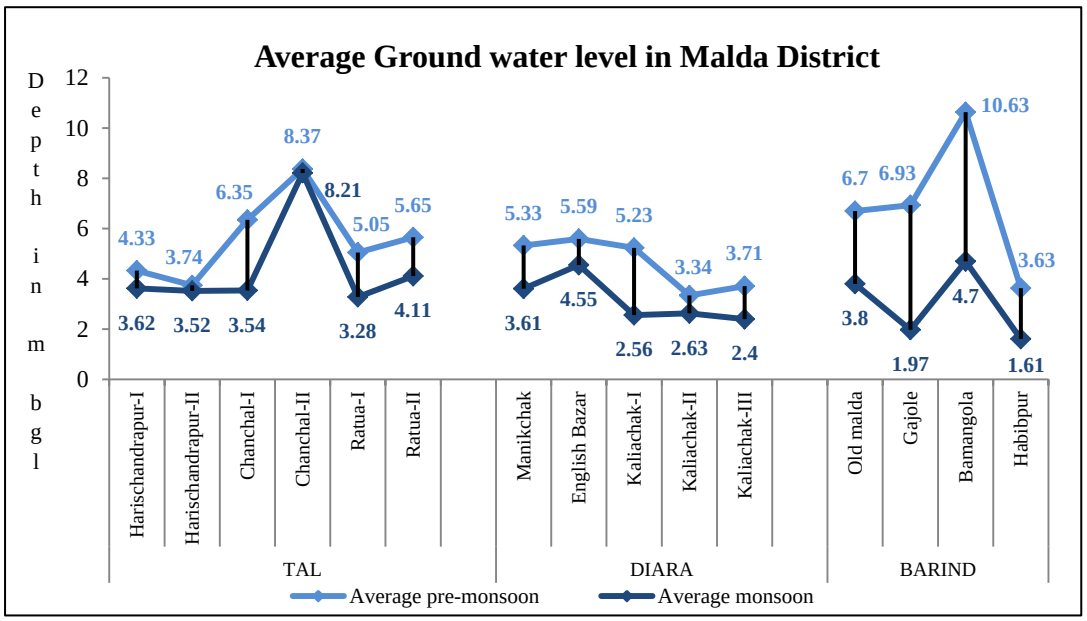
2.7 Ground water:

The ground water table is very effective and technically feasible alternatives for storing substantial quantity of monsoon run off. The geological formations of these sub-surface reservoirs may be considered as "warehouse" for storing water that come from the sources, which are located on the land surface (*CGWB, 2000*). There are several pockets in Malda district, where water table is either high or low, which is determined by the local slope, soil texture, and soil structure, rainfall and permeability factor. Within the three natural regions of district *Tal*, being centrally depressed region, as well as characterized by lack of gradient and consequent runoff, remains submerged under considerable depths of water especially during the monsoon rains.

Diara is a well-drained flat land. Thus the ground water level in both *Tal* and *Diara* is moderate to high throughout the year. *Barind* tract, being featured with hummocky and undulating terrain, suffer from low ground water table especially during pre-monsoon period. However, the ground water level of Malda district, covering four seasons namely pre-monsoon, monsoon, post-monsoon and winter, are displayed in map 2.5 *(Appendix-1)*. The ground water level (m bgl) between pre-monsoon, monsoon, post-monsoon and winter during 2013-17 has been shown *(Map 2.5)* in order to delineate the impact of rainfall and resultant ground water development on the ground water regime in district. The seasonal fluctuation in water level between pre-monsoon and monsoon is dominated by a rising pattern *(Figure 2.4)*. Normal rainfall in the mentioned year has resulted into rise in water level in almost each block in Malda district. The *Tal* region (Harischandrapur 1 & 2, Chanchal 1 & 2, Ratua 1 & 2) record an average water level ranging from 3 m to 8 m bgl throughout the year. With exception, Chanchal 1 and 2 record low to moderate water table throughout study period, which is attributed to lack of village level data. However, introduction of boro paddy cultivation in a large scale is another important factor for declining trend of water level.



Map 2.5: *Ground water levels (m bgl) in Malda District during 2013-17*



Source: *Central Ground Water Board, Ministry of Water Resources, Govt. of India, 2013–2017*

Figure 2.4: *Average ground water level during 2013-17 in Malda District*

Barind region (Old malda, Habibpur, Gajole, Bamangola) records much fluctuating water level with noticeable rise from average 4 m to 10 m bgl during 2013-17 study period. Bamangola block along with Gajole with highest elevation in district record a maximum rise in water level from pre-monsoon to monsoon *(Figure 2.4)*. *Diara* region (English Bazar, Kalichak 1, 2, 3 and Manikchak) exhibits a steady rise ranging from 2.5 to 5 m bgl from pre-monsoon to monsoon *(Appendix-I) (Figure 2.4)*.

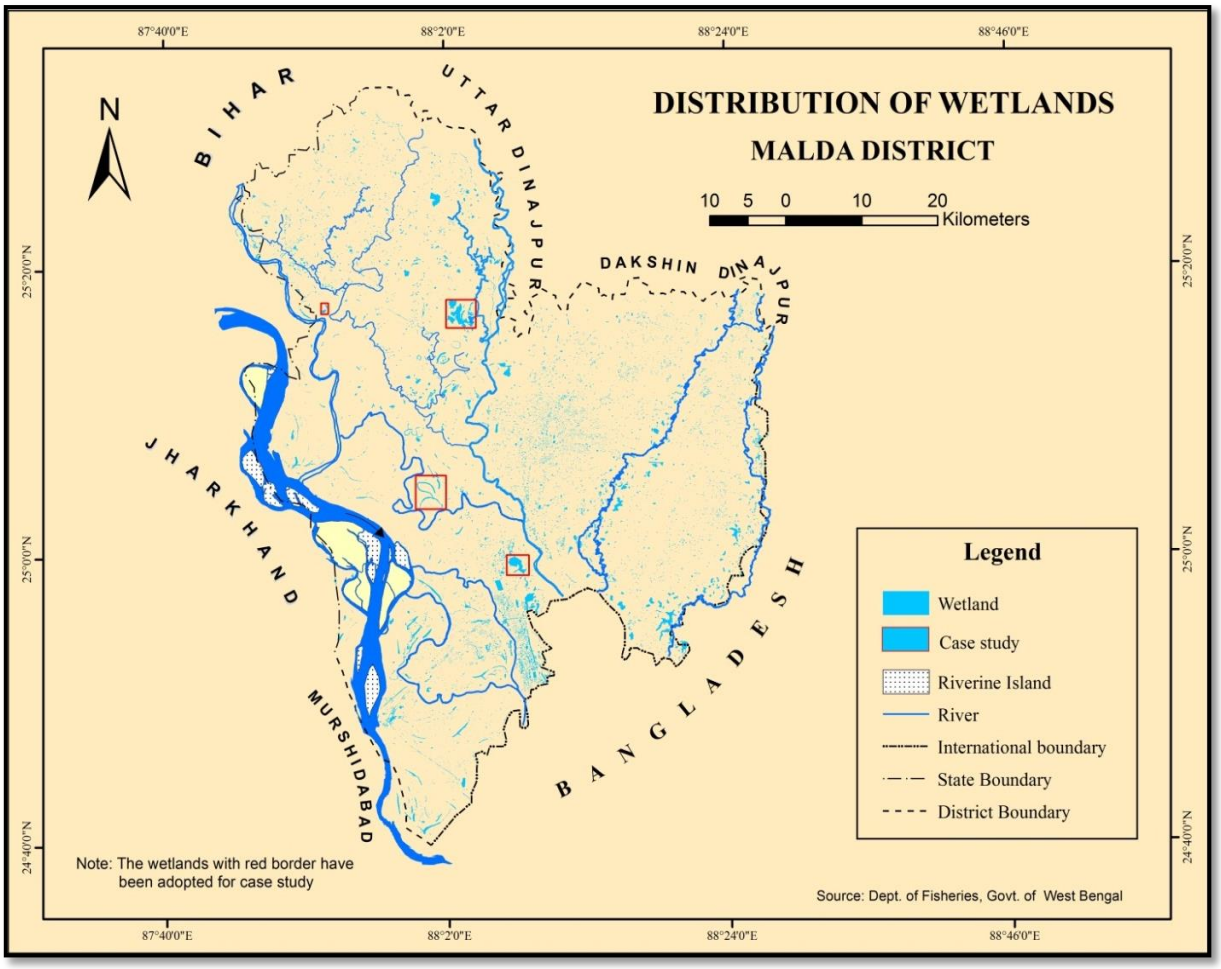
2.8 Natural Vegetation:

In Malda district, the area under forest is 20 sq. km which is only 0.54% of total area, containing 8 and 5 sq. km under reserve and protected forests respectively and 7 sq. km under un-classed state forest *(State Forest Report, Govt. of West Bengal, 2011-12)*. The largest protected forest is locally known as Kariali Forest, which still contents a remnant of the natural forest vegetation. Adina is another forested tract, which is close to English Bazar. Scattered small section under forest areas is located in Old Malda, Harishchandrapur and Gajole blocks. The most abundant vegetation is *Bambusa vulgaris* (Bamboo), *Ficus benghalensis* (Banyan), *Ficus religiosa* (Peepal), *Delonix regia* (Krisnachhura) and *Vachellia nilotica* (Babul). The forest comprising of natural species like *Shorea robusta* (Sal), *Barringtonia acutangula* (Hijol.), *Dalbargina sisso* (Sisso), *Bombax ceiba* (Cotton), *Azadirachta indica* (Neem), *Albizzia lebbeck* (Siris), *Neolamarckia cadamba* (Kadam),

Tamarindus indica (Tetool) etc. The Deciduous types of vegetation such as *Cocos nucifera* (Coconut), *Litchi chinensis* (Litchi), *Tectona grandis* (Sagwan/ Teak), *Toona ciliata* (Toon) etc. are also found in this district. Among the fruits grown in the district, Mangifera indica (mango) is the most famous. The mango orchards are distributed all over the district, especially in west of River Mahananda, with the exception of a strip along River Ganga. The existence of the following fruit species can still be noticed in the district such as *Artocarpus heterophyllus* (jack-fruit), *Phoenix dactylifera* (date-palm), *Annona reticulate* (custard apple), *Cucumis melo* (marsh melon), *Citrullus lanatus* (water melon) etc.

2.9 Wetland status:

Malda district represents a mature geomorphic process with strong evidences of complex hydrological activities in the form of recurring shifting of river channels, massive bank erosion along with often dereliction of rivers etc. The unique fluvio-geomorphic set-up facilitates the formation of natural inland wetlands like cut-off meanders, seasonal waterlogged areas, lakes, and marsh etc. The district is occupied by 562 wetlands (≥2.25 ha) according to IWMED *(Bhattacharya, et al., 2000)* and 502 wetlands (≥2.25 ha) according to Space Application Centre *(SAC, ISRO; 2010)*. The wetlands of this region are generally palustrine (floodplains, seasonal waterlogged, marsh), lacustrine (Lakes) and riverine types. All these wetlands are directly or indirectly connected with the different river systems namely Ganga, Mahananda, Kalindri, Tangan, Punarbhava and Pagla. In terms of the spatial extents of different wetland categories, inland natural wetlands in the form of riverine wetlands, waterlogged seasonal are mostly dominant followed by natural lakes/ ponds, marshy lands and man-made wetlands in Malda district. Moreover, a considerable portion of the district is occupied by cut-off meander/ ox-bow lakes. Out of the well identified physiographic regions, *Tal* tract, being full of large and small depressions, exhibits maximum number of wetlands, followed by *Barind* and *Diara* tracts. *Diara* region, which is a low bank of river, floods deeply. As a consequence, extensive and frequent flooding in this vulnerable geographical entity drastically expunges the possibility to identify the individual wetlands. On the other hand, in spite of promoting a fair amount of run-off, *Barind* tract of high and undulating terrain restrict widespread flooding. Therefore, the individual wetlands with their specific characteristics are easily identifiable (*Map 2.6)*.



Map 2.6: *Distribution of wetlands in Malda District*

2.10 Conclusion:

Malda district is crisscrossed with plentiful rivers, which are flowing through the well-defined physiographic divisions. The district is occupied by number of river linked wetlands, each with specific characteristics. Most of the wetlands throughout this district is treated as an efficient wealth as well as have great significance in terms of ecological and socio-economic benefits. Being highly productive and rich in biological diversity, these wetlands provide a vast range of ecosystem services i.e. food, fiber, waste assimilation and water purification, flood mitigation and recharging the ground water. Further, most of wetlands in Malda district are being used for paddy cultivation *(Bhattacharya, 2000)* and are potential to promote gainful self-employment and tourism activity for being a part of the cultural heritage.

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