CHAPTER - 3
Study Area

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3.1. INTRODUCTION

The Northern part of the Indian State of West Bengal touching the feat of Eastern Himalaya is generally referred as Terai and Duars. The entire region is made up of sand, gravel and pebbles laid down by the Himalayan rivers like the Teesta, Torsa, Raidak, Jaldhaka, Sankosh and several other small rivulets. The river Teesta has divided the area into two parts, the western part is known as the Terai whereas the eastern part is known as the 'Duars' or 'Doors' (Ghosh 2006). The Terai means 'moist land' and *Duar* means 'door' in both Assamese and Bengali languages and form the gateway to Bhutan and to the North-eastern part of India.

The Terai and Duars are famous for the tea gardens, which were basically developed by the British and much extended after the British Raj left the country. The beauty of the region lies not only in its tea gardens but also in the dense jungles that make up the countryside. Famous wildlife sanctuaries and national park like Jaldapara National Park; Buxa National Park; Gorumara National Park; Chapramari Wildlife Reserve; Baikunthapur Reserve Forests and the Mahananda Wildlife Sanctuary are located in this region. The vegetation of Terai and Duars are very rich and covers all major groups of plants including several members of endemic and RET species (Chatterjee 1940; Das 1986; Kadir 2001; Ghosh & Das 2009). Also, this area is falling under biodiversity hotspot 'Himalaya' (Conservation International 2005). The wide diversity in habitat structure helped numerous plant species to settle in this area (Rai & Das 2008).

3.2. LOCATION AND BOUNDARY

Terai is located between 25° 57" to 26° 36" N latitude and 89° 54" to 88° 47" E longitude; whereas Duars is situated between 26° 16" to 27° 0" N latitude and 88° 4" to 89° 53" E longitude (Das *et al.* 2010; Roy *et al.* 2009). The Terai and Duars region politically constitute the plains of Darjeeling, whole of Jalpaiguri and Alipurduar District in West Bengal. This region is not marked by any natural features. However, its Northern frontier is bounded by Darjeeling hills and Bhutan; east by Assam; Bangladesh, North Dinajpur district of West Bengal and Kishanganj district of Bihar is on south; and in west is by Nepal. The slope of the land is gentle, from north to south. The altitude of this area ranges from 80 to 310 m. (Fig. 3.1 & Fig. 3.2).

3.3. DRAINAGE SYSTEM

Most of the rivers of Terai and Duars are eventually draining southwards. The most important river of Terai is the Tista, originated from the Zemu glacier of north Sikkim and finally flowing into the river Mahananda in Bangladesh (Ghosh 2006). Other important rivers of Terai include rain-fed rivers like Balason, Mahananda and Mechi (Kadir 2001). On the other hand, Torsa is the main river of Duars and other important ones are Jaldhaka, Diana, Karola, Murti, Raidak and Kaljani. It is running down from the Chumbi Valley in TAR (Tibet Autonomous Region of China), where it is known as Machu.

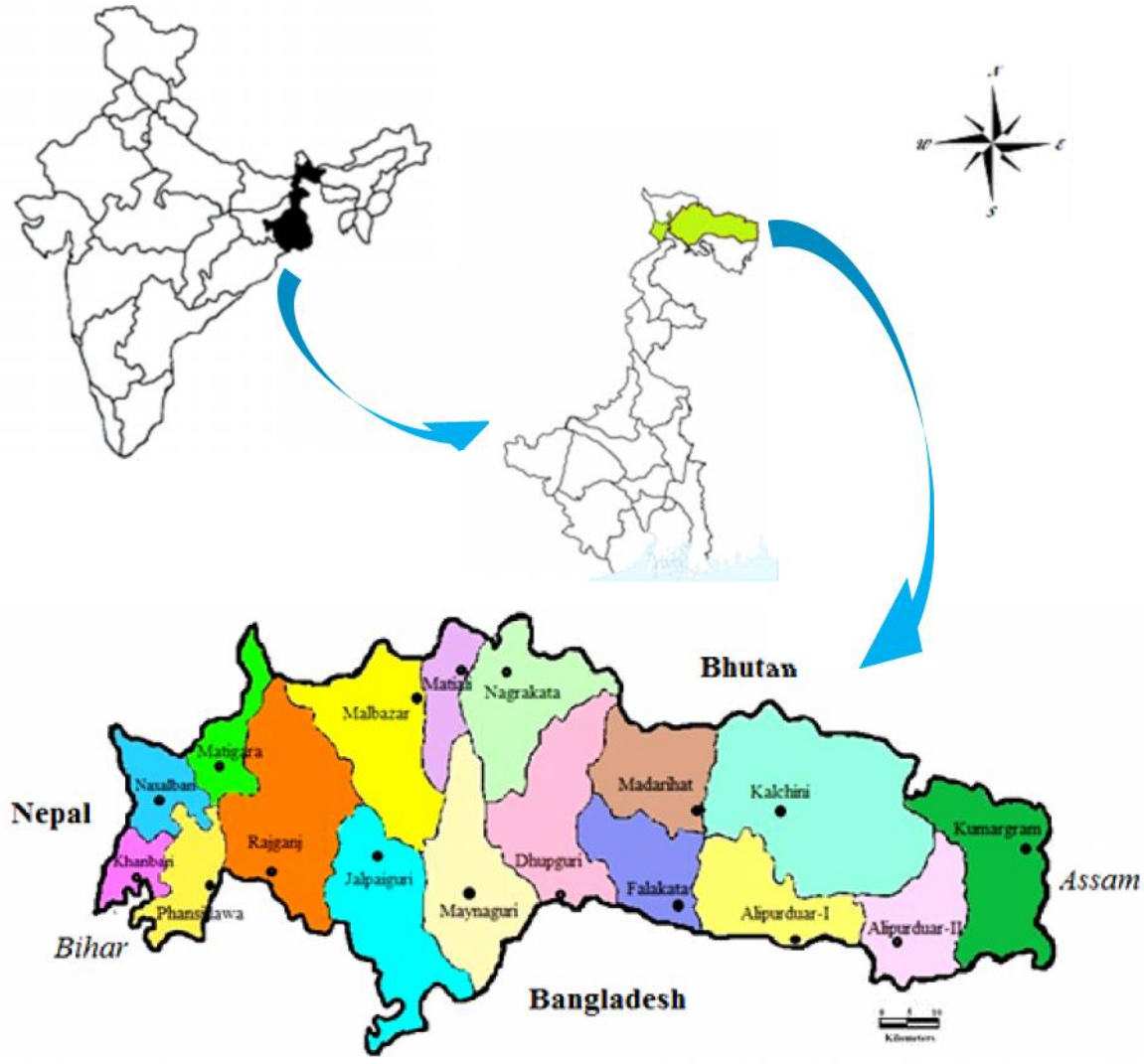

Fig 3.1. Block map of Terai & Duars

Figure 3.2. Protected areas of Terai & Duars

In addition, there are numerous small and considerable Jhoras or springs in Darjeeling hills. These springs are forming rivulets such as Magurmari, Lachka, Sanjoy etc. at the Sub-Himalayan Terai & Duars region. All these rivulets and their tributaries are rain-fed and remain almost dry in most of their portion when there is no rain in this area.

3.4. SOIL

The geological milieu in Terai and Duars represents the sub-Himalayan or the foothill zone consist almost entirely of the Siwaliks and typical formation of Quaternary and recent sediments (Banerjee *et al*. 2003). The soils are brought down by hill rivers like Tista, Torsa, Mahananda, Jaldhaka, etc. and their tributaries, bringing materials from a height of about 3048 m, and have deposited those layer by layer to form the soil of this area. The depth of the soil vary from 0 – 400 cm in different regions, with texture varying from fine sandy, rocky with moderate organic matter and low Phosphate, Potassium, and other micronutrient contents (State Forest Report 2006 – 2007). The pH of the soil of this region is acidic mainly due to heavy rainfall. The pH ranges between 5.6 to 6.5 in some parts and major portion showing highly acidic soil with pH below 5.5 (Kadir 2001).

3.5. CLIMATE

Climate is one of the basic rudiments in the natural environment. Vegetation of a region mainly depends on the prevailing climate of the area. It is generally defined as the average status of weather over long period. Four climatic seasons can be recognized in the Terai-Duars region and can be referred as Monsoon, Autumn, Winter and Summer. Being situated at the feet of the Himalayas this region experiences somewhat pleasant climate, with no extremes of temperature both in summer and winter (Kadir 2001; Das 1986; Bhujel 1996). The cool wind blowing from the Himalayas provides relief to an otherwise hot and humid climate of the tropical – sub-tropical belt.

3.5.1. Temperature

Temperature is the most significant factor of climate. As Terai-Duars lies in the shadows of Himalayas, it is relatively cooler than the central and southern regions of West Bengal. Temperature of this region varies from a recorded highest of 38°C during summer to about 6°C in the winter. The temperature usually starts increasing from the end of March, and days remain warm till the middle of October and then it falls rapidly throughout the region. In December and January it is colder and May to July it is rather hot when there is monsoon rains (Table 3.1) which helps to maintain a lower ambient temperature.

3.5.2. Precipitation

According to Sahni (1981) this factor is conducive for abundant vegetation. Rainfall of the area usually starts around the middle of April with the arrival of Nor' Westers or locally called 'Kalbaisakhi' and continues till the end of October (Kadir 2001). Rainfall mainly occurs due to south-western monsoon wind. June, July and August are the months of heavy rainfall. A large difference of rainfall can be examined in the climate of this region. The annual rainfall ranges from 2100 mm to 4000 mm in different years. The heavy rainfall occurs in the months of July and August (Table 3.2); extreme rainfall up to 200 mm per day has been recorded in the past (State Forest Report 2006 – 2007). Sometimes water logging occurs in some places of Duars.

Table 3.1. Month wise mean maximum and minimum temperature during 2008 – 2013 in the Study Area (*Source*: Department of Geography and Applied Geography, University of North Bengal)

Month	Mean Temperature (°C)	
	Maximum	Minimum
January	22.03	11.14
February	26.18	13.49
March	29.88	16.82
April	30.47	19.72
May	31.57	22.02
June	32.14	23.48
July	32.07	24.87
August	31.85	24.93
September	31.24	24.35
October	30.92	21.27
November	28.37	16.11
December	26.44	11.64

Table 3.2. Month-wise mean rainfall during 2008 – 2013 in the Study Area (*Source*: Department of Geography and Applied Geography, University of North Bengal)

Month	Mean Rainfall (mm)
January	16.82
February	24.34
March	44.87
April	154.29
May	272.43
June	652.23
July	708.38
August	504.02
September	366.17
October	202.60
November	16.07
December	14.22

However, the formation of dense fog especially during the winter months is a character almost for the entire region. The formation, sometimes, become so dense that it produce a zero-visibility condition. Dissolving of fog also add a good amount of moisture to the upper layers of soil that becomes much helpful for the occurrence and survival of a rich winter flora almost over the entire region.

Another character of the region of recurrence of flood over wide regions in different parts of the region, which affects in both way, bad and good. While some terrestrial vegetation are degraded in one hand, it also form temporary wetland hosting large number of ephemeral plant species and maintain perennial wetlands.

3.5.3. Relative Humidity

An important climatic characteristic of this region for the development of abundant vegetation in this region is the maintenance of higher Relative Humidity throughout the year. May to September, i.e. the period of heavy rainfall, is damp and humid with relative humidity ranging from 85 – 95%

(Table 3.3). But, during the end of winter it is comparatively less, being around 60 % in the morning and 45 % in the afternoon.

Table 3.3. Month-wise mean maximum and minimum relative humidity during 2008 – 2013 in the Study Area (*Source*: Department of Geography and Applied Geography, University of North Bengal)

Month	Relative Humidity	
	Morning	Evening
January	93.40	72.81
February	91.72	67.72
March	88.22	64.60
April	88.90	73.24
May	89.34	75.72
June	93.64	82.11
July	92.40	83.98
August	91.94	80.12
September	92.30	81.23
October	91.17	77.68
November	90.79	72.15
December	92.32	69.56

3.6. VEGETATION

Due to suitable climatic factors and soil characters, the Terai-Duars region represents one of the richest botanical regions in India. So, several plant surveyors both from India as well as from distant countries (Gamble 1878; Hooker 1886; Prain 1903; Brandis 1906; Cowan & Cowan 1929; Champion & Seth 1968; Sikdar 1984; Banerjee 1993) have frequently studied the vegetation of this region. Among them, Gamble (1878) has classified the vegetation of Terai and Duars into four types, Sal forest, Khair and Sissu forest, Savannah forest and Mixed plains forest.

According to Champion & Seth (1968) Vegetation of this region is mainly Northern Tropical Semi-Evergreen and North-Indian Tropical Moist Deciduous forest type, which is further classified into four sub types: Wet Sal forest, Riverine forest, Dry mixed forest and Wet mixed forest

3.6.1. Wet Sal forest

Wet Sal vegetations are mostly tropical forests. *Shorea robusta* Gaertner is the dominant species of this vegetation. Additional associates of these kinds of forests include *Duabanga grandiflora* (DC.) Walpers, *Lagerstroemia parviflora* Roxburgh, *Litsea salicifolia* (Roxburgh *ex* Nees) Hooker *f.*, *Sterculia villosa* Roxburgh, *Terminalia bellirica* (Gaertner) Roxburgh, *Schima wallichii* Choisy etc. Besides those, some shrubby species like *Asparagus racemosus* Willdenow, *Clerodendrum infortunatum* Linnaeus, *Phlogacanthus thyrsiflorus* Nees, *Coffea benghalensis* Heyne *ex* Schultesetc. and few grasses like *Centotheca lappacea* (Linnaeus) Desvaux, *Microstegium ciliatum* (Trinius) A. Camus etc. are quite common.

3.6.2. Riverine forest

The Riverine forests are found in small patches in the elevated river-beds and in the lands raised after shifting of rivers. The vegetation remain occupied by grasses and perennial plants mostly shrubs and

climbers. Main grass species of these forests are *Phragmites karka* (Retzius) Trinius *ex* Steudel, *Saccharum arundinaceum* Retzius, *Saccharum spontaneum* Linnaeus, *Themeda villosa* (Lamarck) A. Camus etc. Whereas *Buddleja asiatica* Loureiro, *Clerodendrum japonicum* (Thunburgh) Sweet, *Clerodendrum infortunatum* Linnaeus etc. are dominating shrubs of such vegetation. Some common species of trees like *Acacia lenticularis* Bentham, *Albizia lebbeck* (Linnaeus) Bentham, *Bischofia javanica* Blume, *Bombax ceiba* Linnaeus with *Acacia catechu* (Linnaeus *f.*) Willdenow and *Dalbergia sissoo* A.P. de Candolle occur as distinct patches in these forests.

3.6.3. Dry mixed forest

Though the annual precipitation is high and with prevailing high atmospheric humidity for most of the period, the dominance of deciduous species of trees is quite prominent in these foothill vegetation formations. This type of vegetation is characterized by the presence of deciduous trees like *Artocarpus lacucha* Buchanan-Hamilton, *Bombax ceiba* Linnaeus, *Cryptocarya amygdalina* Nees, *Gmelina arborea* Roxburgh, *Lagerstroemia parviflora* Roxburgh, *Litsea glutinosa* (Loureiro) C.B. Robinson, *Litsea salicifolia* (Roxburgh *ex* Nees) Hooker *f.*, *Sterculia villosa* Roxburgh, *Wrightia arborea* (Dennstedt) Mabberley, etc. The undergrowth flora includes *Eragrostis unioloides* (Retzius) Nees *ex* Steudel, *Lepidagathis incurve* Buchanan-Hamilton *ex* D. Don, *Lygodium flexuosum* (Linnaeus) Swartz, *Solanum indicum* Linnaeus, *Urena lobata* Linnaeus, etc.

3.6.4. Wet mixed forest

Just opposite of the Dry Mixed Forests, the Wet Mixed Forest is dominated by evergreen and semi-evergreen trees along with a very low frequency of deciduous trees. In addition a large number of shrubs, climbers and herbs are inhabitants in this type of forested vegetation. This zone is also rich in epiphytes and stem-parasites. The major trees of these forests include *Actinodaphne obovata* (Nees) Blume, *Castanopsis tribuloides* (Smith) A. DC., *Cinnamomum bejolghota* (Buchanan–Hamilton) Sweet, *Cryptocarya amygdalina* Nees, *Knema erratica* (Hooker *f.* & Thomson) Sinclair, *Litsea glutinosa* (Loureiro) C.B. Robinson, *Litsea monopetala* (Roxburgh) Persoon, *Machilus duthiei* King, *Mesua ferrea* Linnaeus, *Terminalia myriocarpa* Heurck & Mueller, *Syzygium cumini* (Linnaeus) Skeels etc. This type of forest is characterized by the presence of a good number of climbers (some of those are liana) such as *Argyreia roxburghii* (Wallich) Arnott *ex* Choisy, *Bauhinia vahlii* Wight & Arnott, *Mikania micrantha* Kunth, *Tetrastigma planicaule* (Hooker *f.*) Gagnepain, *Thunbergia grandiflora* (Roxburgh *ex* Rottler) Roxburgh, *Tinospora sinensis* (Loureiro) Merrill, etc. The ground cover vegetation is also very rich, which include annual and perennial herbs, root parasites, saprophytes etc. like *Ageratum conyzoides* (Linnaeus) Linnaeus, *Blumea balsamifera* (Linnaeus) A.P. de Candolle, *Commelina benghalensis* Linnaeus, *Oxalis corniculata* Linnaeus, *Urena lobata* Linnaeus, *Triumfetta rhomboidea* Jacquin, etc.

3.7. LAUREL HABITAT

Laurels are mostly terrestrial plants and its different species, mainly shrubs and trees, occur both inside and outside the forested vegetation. Quite often Laurels grow in completely open condition or in grasslands. Savannah type of grasslands are common in the Duars and some species of Lauraceae found to raise their umbrella like top portions over such grasses.