Chapter IV

STUDY AREA

North Bengal University is situated at the lap of the Eastern Himalaya, commonly referred as Terai, and full of greeneries. Up to the middle of the last century the entire area was forest-clad with interspersed small human settlements. With the extension of communication systems through this area, mainly roads and rails, outsiders entered the area and large human settlements started appearing at the costly expense of natural green-wealth of this entire region. Now most of the natural tracts of vegetation are highly degraded and just counting their days to die.

However, even today some areas are forest-covered and it is difficult to keep track on the occurrence of each and every species inhabiting there. Pollen trapping sometimes assist to trace the presence of a species in the region. But for that a basic pollen catalogue is essential. That was not available for the Terai-Dooars region. Present work is an attempt to fill-up that gap.

4.1. Geography

The sub-Himalayan part of West Bengal is popularly known as *Terai* and *Dooars* that falls under the IUCN recognized '*Himalaya Biodiversity Hotspot*' (Conservation International, 2013). This region is not marked by any natural features. Generally the westernpart of the river Teesta touching the feet of the Himalayas is referred as Terai and Dooars is referred to the foothill region located on the eastern side of Teesta. Politically, Terai region constitutethe rolling plains part of Darjeeling District. On the other hand, whole Jalpaiguri district and a part of Alipurduar District are falling within Dooars (Das *et al.* 2010; Roy *et al.* 2009).The northern side of Terai-Dooars frontier is bounded by Darjeeling hills, Sikkim and Bhutan; east by Assam; Bangladesh, North Dinajpur District of West Bengal and Purnea District of Bihar is on south; and Nepal is in the west (Figure 4.1).

'Terai', meaning'moist land', is a belt of marshy grassland, savannas and forests that stretches about 38 km southwards in the foothills of the Himalayas (Chowdhury 2015). The ample presence of springs and wetlands in this area justify the coining of the name.

'Dooars' means 'door' in both Assamese and Bengali languages and form the gateway to Bhutan and also the entire North-east India.The beauty of the region lies not only in its tea gardens but also in the dense forests that make up the countryside, beautiful flowers of orchids and other epiphytic plants, innumerable small and large rivers and streams, huts of the local traditional people and the associated rich fauna. The area is spanning over 130 km, starts from the eastern bank of the river *Teesta* in Jalpaiguri district to the western bank of the river *Sankosh* in the Alipurduar district (Chowdhury 2015).

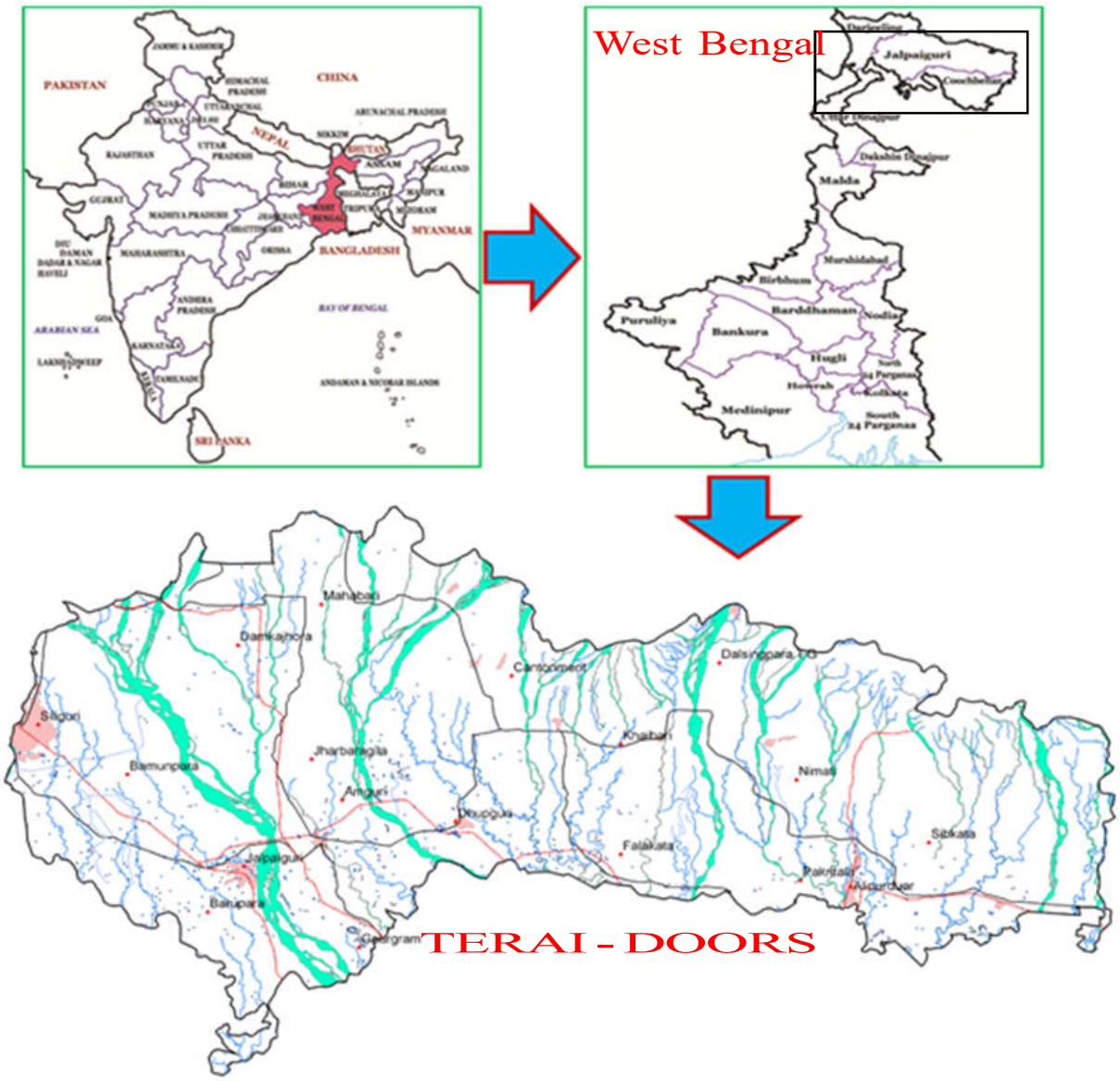

Figure 4.1: Map showing the location of Terai and Dooars regions of West Bengal - the study area [*source*: www.jalpaiguri.gov.in]

The slope of the land is gentle, from north to south andthe altitude ranges generally from 80 to 100 m AMSL. The entire region is made up of sand and pebbles laid down by the Himalayan Rivers like the *Teesta, Raidak, Jaldhaka, Sankosh* and several other small rivulets (Ghosh 2006). Due to repeated shifting of the courses of these rivers numerous ox-bow lakes were also formed in the entire area and became the natural habitat for rare flora and fauna (Biswas 2015).

Dooars is specially noted for housing several *in situ*protected areas for biodiversity conservation like Gorumara National Park, Buxa National Park, Jaldapara National

Park, Chapramari Wildlife Sanctuary, Buxa Tiger Reserve, Buxa National Park, Baikunthapur Reserve Forests, Sursuti Reserve Forest etc. And, on the other hand, Mahananda Wildlife Sanctuary is situated in Terai.

4.2. Location

Geographically, the location of Terai region is 25° 57" to 26° 36" N latitudes 89° 54" to 88° 47" E longitudes andfor Dooars it is 26° 16" to 27° 0" N latitudes and 88° 4" to 89° 53" E longitudes (Roy *et al.* 2009; Das *et al*. 2010).

4.3. Geology

The geological milieu of Terai and Dooars represents the sub-Himalayas or the foothill zone consist almost entirely of the Siwaliks and typical formation of Quaternary and recent sediments (Banerjee *et al*. 2003). Almost everywhere the soil is derived from underlying rocks. The depth of the soil varies from 0 – 100 cm in different regions, with texture varying from fine sandy, loamy to sandy with moderate organic matter and low Phosphate, Potassium, and micronutrient contents (State Forest Report 2006 – 2007). The pH of the soil of this region is acidic due to heavy rainfalland that ranges between pH 5.6 to 6.5 in some parts and major portion showing highly acidic soil with pH below 5.5 (Kadir 2001). The soil, which are deposited layers after layer is brought down by the numerous river systems from the Himalayan hills from about 3048 m or even above (Das 2015). The soil is basically consists of sands of different grades, stones, boulders in some areas along with humus of decomposed and semi-decomposed substances.

4.4. Topography

Topographically this area consists of low hill ridges and plains. The Terai stretches along the base of the hills, a low-lying strip shut in on the north by the giant outliers of the Himalayas. This tract belongs to the plains of West Bengal, and composed neither of the alluvium of the plains nor of the rock of the hills, but alternating bed of the sand, gravel and boulders which are brought down by the rivers from the mountains. The main ranges wind and zing-zag in all directions, giving off a number of long spurs on either flank. The Dow Hill ridge which is the longest, forms numerous spurs, rolling down to the plains of Darjeeling and Jalpaiguri districts. The horse shoe-shaped ridge is the longest of the all ridges and traverse along Sukhia, Simana, Mirik extending in south-eastern direction from the node finally descending down to Dudhiya where it joins the plains of the district and the neighbouring Nepal. The average altitude of Terai ranges from 90 m to130 m (Choudhury 2015). The valleys thus formed prevails great variety of climate and elevation. For the most part, they stretch from north to south, while the courses of the principal rivers are also in the same direction (Allen *et al*. 1906; Chattopadhyay & Das 1992).

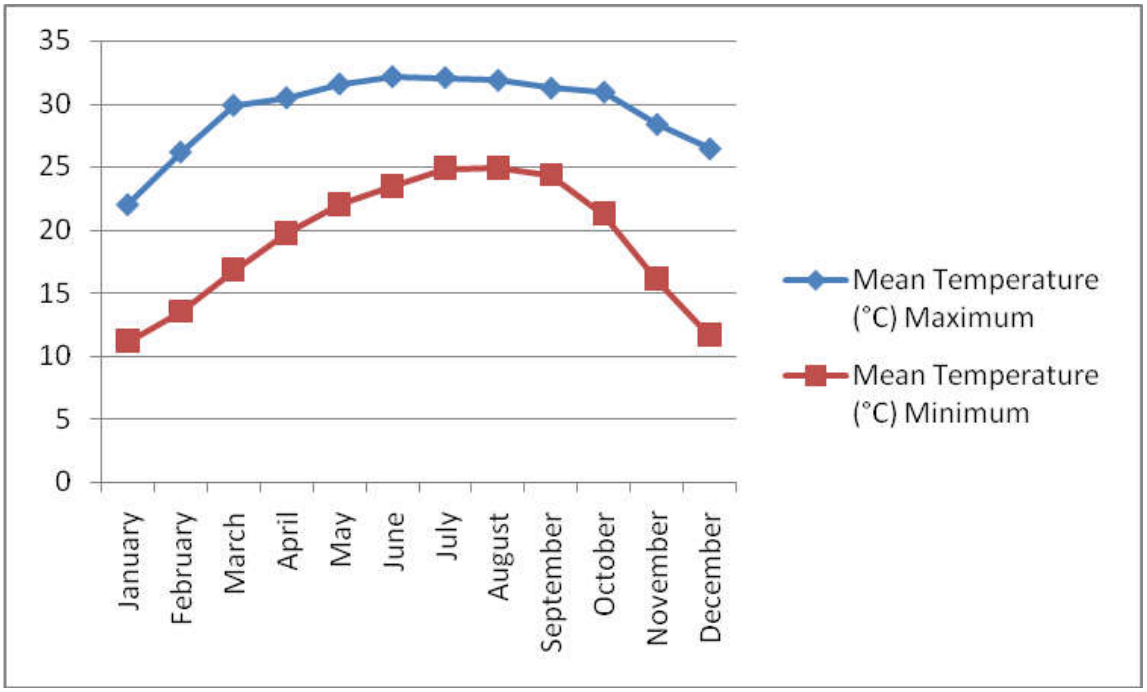

Figure 4.2: Graphical presentation of month wise mean maximum and minimum temperature during 2013 – 2018 in the Study Area [*Data source*: Department of Geography and Applied Geography, University of North Bengal]

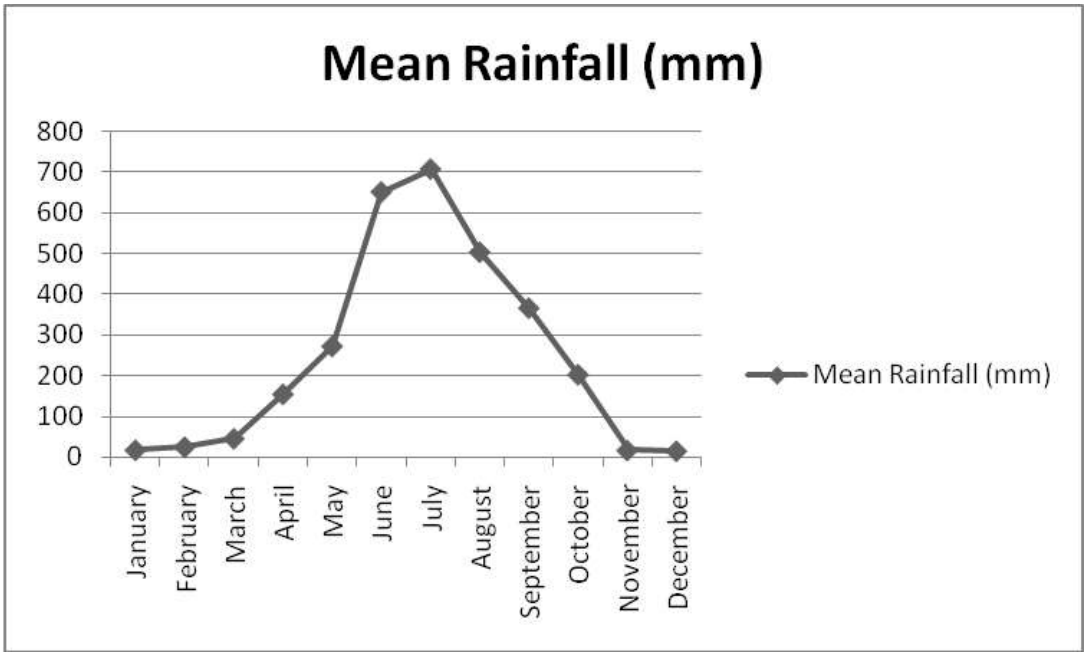

Figure 4.3 : Graphical presentation of month-wise mean rainfall during 2013 – 2018 in the Study Area [*Data source*: Department of Geography and Applied Geography, University of North Bengal]

4.5. Climate

The natural vegetation of an area is said to be dependent on its prevailing climate.'Climate' is generallydefined as the average status of weather over a long period prevailing over an area. Being situated at the feet of the Himalayas this region experiences somewhat pleasant climate, with no extremes of temperature both in summer and winter (Gurung 1911; Das 1986; Bhujel 1996; Kadir 2001). The cool wind blowing from the Himalayas provides relief to an otherwise hot and humid climate of the tropical–sub-tropical belt. Four climatic seasons, viz., Monsoon, Autumn, Winter and Summer can be recognized in theTerai-Dooars region.

4.5.1. *Temperature*

The most significant factor of climate is the temperature as Terai-Dooars area is basically located at the sub-tropical region and enjoys the shadows of Himalayas, it is relatively cooler than the other regions of West Bengal.The temperature fluctuates from a recorded highest of 37.5°C during summer to about 6°C in the winter. In December and January it is colder and 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. May to Septemberit is rather hot when there is monsoon rains (Figure 4.2) which helps to maintain a lower ambient temperature.

4.5.2. *Precipitation*

Although, precipitation is in the form of rainfall mainly, dense fog during the dry season quite often renders a zero-visibility condition. Condensation 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 herbaceous winter flora almost over the entire region.Rainfall mainly occurs due to thesouth-western monsoon wind. 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 (Gurung 1911; Kadir 2001). June to August are the months of heavy rainfall,extreme rainfall up to 200 mm per day has been recorded in the past (State Forest Report 2006 – 2007). The annual rainfall ranges from 2100 mm to 4000 mm in different years. The heavy rainfall occursduring the months of July and August (Figure 4.3). Water logging over wide areas in Dooars is a regular phenomenon for this entire area.

This area receives high annual precipitation and the average annual rainfall ranges from 313 – 335 cm. This high rainfall is restricted within a period from June to September.

4.5.3. *Relative Humidity*

The relative humidity refers to the average water content of the air. High Relative Humidity throughout the year is an important climatic characteristicof this region

which is responsible for the development and maintenance of such thick and dense vegetation.The highest Relative Humidity (RH) (85 – 95%) is observed during the months of May to September, i.e. during monsoon period (Figure no. 4.4). But, during the end of winter it is comparatively less, being around 60% in the morning and 45% in the afternoon. This refers to the driest period of the year.

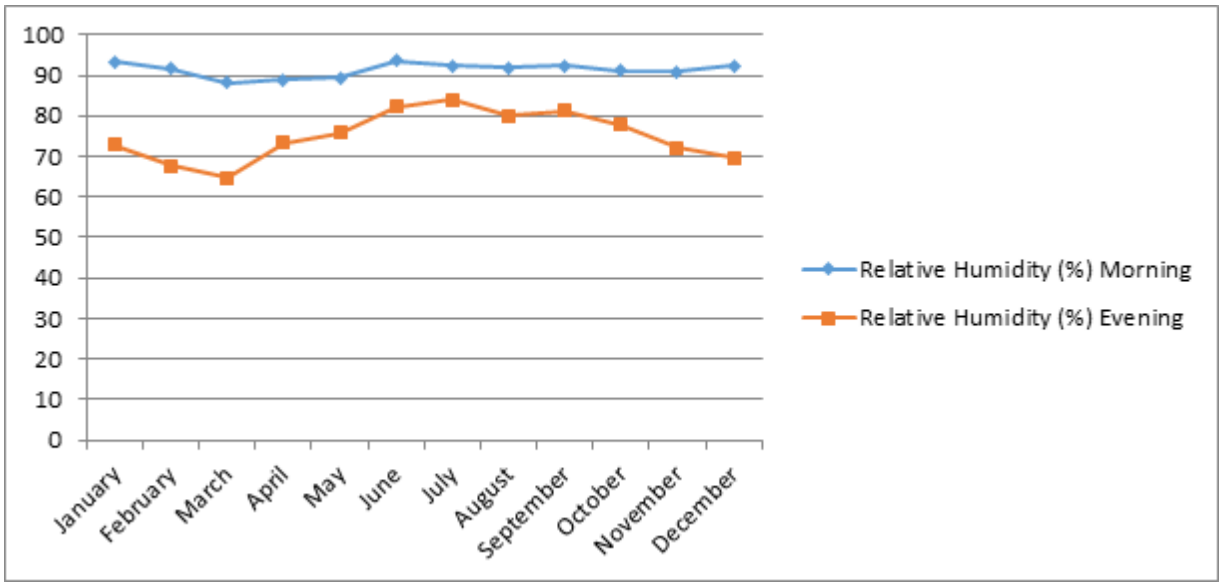

Figure 4.4: Graphical presentation of Month-wise mean maximum and minimum Relative Humidity during 2013 – 2018 in the Study Area [*Data source*: Department of Geography and Applied Geography, University of North Bengal]

4.5.4. Season of the Year

Five climatic seasons of the year can be recognized within the region, namely Summer, Monsoon, Autumn, Winter and Spring (Table 4.1). Being situated at the feet of the Himalayas the region experiences a somewhat pleasant climate, with no extremes of temperature both during summer and winter (Gurung 1911; Das 1986; Bhujel 1996; Kadir 2001).

Table 4.1. Climatic seasons of the year in Terai - Dooars region of sub-Himalayan West Bengal

Season	Months
Summer	April to Mid-June
Monsoon	Mid-June to Mid-September
Autumn	Mid-September to Mid-November
Winter	Mid-November to February
Spring	March

Temperature in this region does not exceed beyond 40° C. The temperature usually starts increasing from the month of May and the days remain warm till the middle of October and then the temperature falls rapidly throughout the region. An important characteristic of this region is the relative humidity, which is generally very high, maintains at 70 – 90 % throughout the year.

4.6. Drainage System

The entire area is slowly sloping towards the south. So, the natural water channels, temporary and permanent streams and rivers of different sizes, coming out from the Himalayas and then running from north to south direction (Figure 4.5). Among the numerous rivers and rivulets that intersect this area, *Teesta* is the most important one that originated from the *Zemu* glacier in North Sikkim (Ghosh 2006; Sarkar 2008). Most of the rivers of Terai and Dooars have originated in the Himalayas and eventually drains out from north-east to south-west. The other important rivers of Terai are *Balason, Mahananda, Mechi, Karatoa, Sahu* and *Panga* (Gurung 1911; Kadir 2001; Choudhury 2015). On the other hand *Torsa, Jaldhaka, Karala, Diana, Leesh, Ghish, Chel, Murti, Neora* and *Kaljani* are the major rivers of Dooars (Allen *et al*. 1906; Gurung 1911). Though they remain tame, shallow and nearly dry during summer, but they become furious and overflow during rainy season, sometimes causing flood over the wide areas.Majority of these rivers are rain-fed as those are originating from run-down water from the hill surfaces. In addition to the rivers, there are innumerable streams and nallahs those remain active only during rains.

Due to the loose nature of soil that can be easily washed away, during monsoon shifting of the courses of different rivers is very common. This lead to the formation of numerous ox-bow lakes of different shapes and sizes. Important one may be the Rasik Beel in the Coochbehar District (Sarkar 2008). It is an important wetland and is home to wide range of flora and fauna (Biswas 2015).

4.7. Vegetation Type

The presence of various types of floristic elements, fauna and microbes makes the vegetation of Terai and Dooars very rich (Allen *et al*. 1906; Chatterjee1940; Kadir 2001; Ghosh & Das 2005, 2009). Also, this area falls under the IUCN recognized "Himalaya Biodiversity Hotspot" (Conservation International 2013). The wide diversity in habitat structure and climatic conditions helped numerous plant species to settle in this area (Rai & Das 2008).

The vegetation of Terai–Dooars area being contiguous with the Darjeeling part of the East Himalayan forests is quite rich in biodiversity and harbours numerous rare and threatened species of plants (Das *et al.* 2010a, b) (Figure 4.6). The forests are mostly mixed-deciduous type and other prominent vegetation includes riverine scrubs and forests, herblands, shrubby-scrubs, savannah type tall grasslands etc.

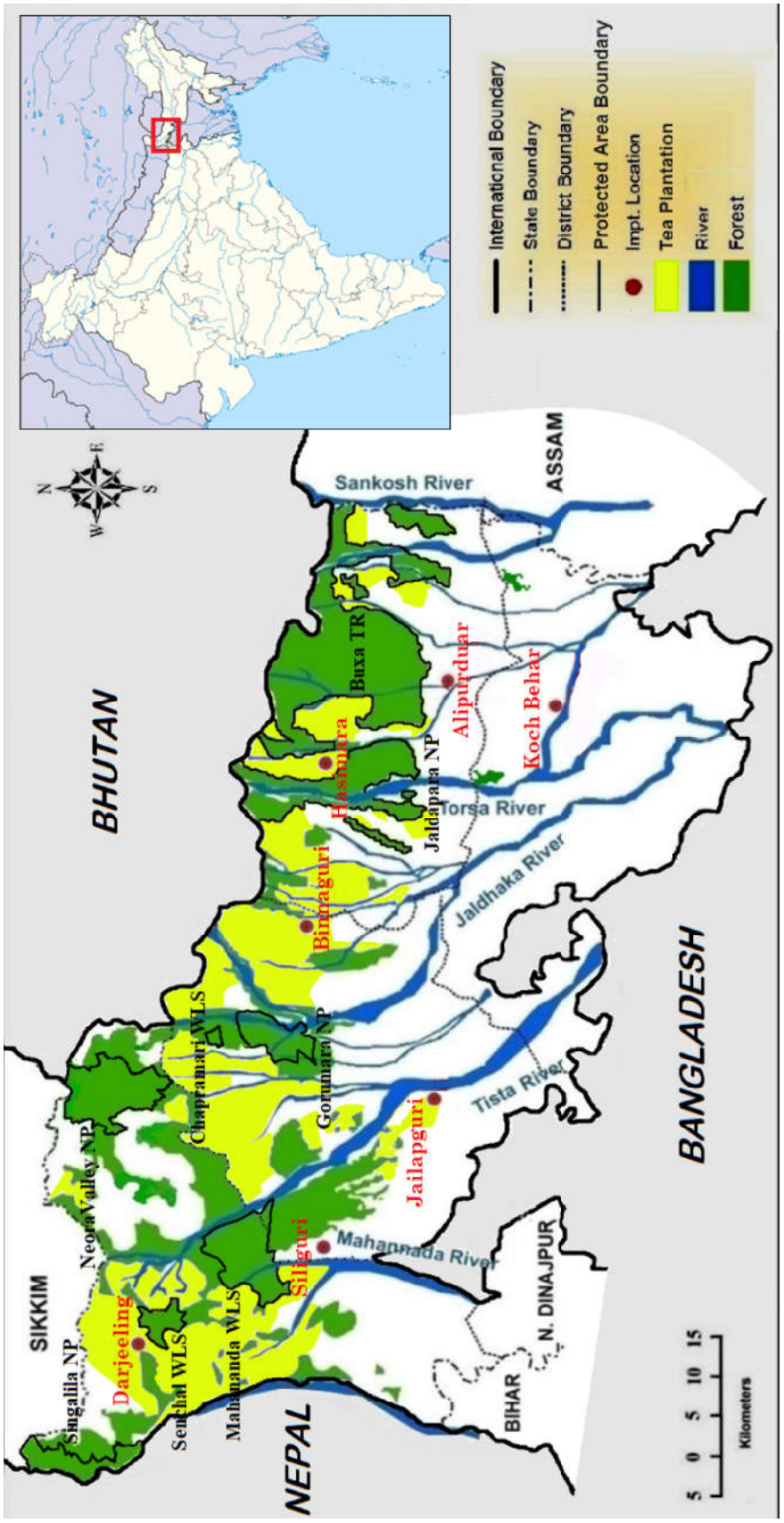

Figure 4.5. Drainage map of Darjeeling-Hills, Terai and Dooars region of West Bengal

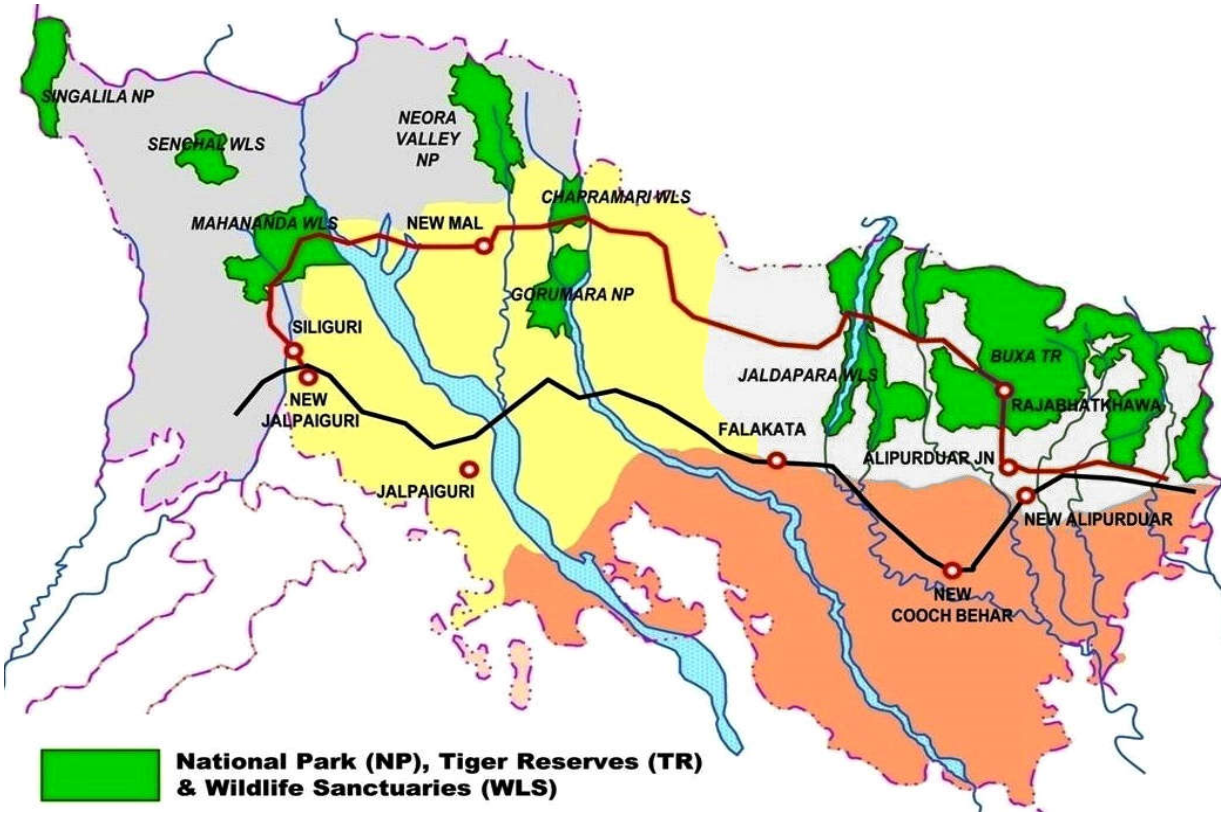

Figure 4.6. Protected Areas (in IUCN guideline) in Terai-Dooars and Darjeeling-hills region of West Bengal.

In addition, wide areas in Terai and Dooars are also covered with mono- or mixed-plantations using both local and exotic species (Das 2004; Das *et al*. 2010; Moktan & Das 2012; Saha *et al.* 2013; Shukla *et al.* 2013). Gamble (1878) classified the vegetation of Terai and Dooars into four types- (i) *Sal* forest, (ii) *Khair* and *Sissoo* forest, (iii) Savannah forest and (iv) Mixed plains forest (Cowan & Cowan 1929). According to Champion and Seth (1968) vegetation of this region is mainly Northern Tropical Semi-Evergreen and North-Indian Moist Deciduous forest types which is further classified into four sub-types, Wet *Sal* forest, Riverine forest, Dry mixed forest and Wet mixed forest. Wet *Sal* forests are mostly tropical forests. *Shorea robusta* is the most conspicuous species growing in Lower Siwalik "Dry" Terai and well drained loamy plains. The Riverine forests can be observed in small patches in elevated riverbeds.In land area raised after shifting of rivers the forests remain dominated by perennial plants, mostly shrubs and climbers. Though the annual precipitation is high and with prevelant high atmospheric humidity for most of the period, the dominance of deciduous species of trees is quite prominent in foothills which fabricate the Dry Mixed forest. Just reverse of the dry mixed forests, the Wet Mixed forest is dominated by evergreen and semi-evergreen trees along with a very large number of shrubs, climbers and herbs (Champion & Seth 1968; Bhujel 1996; Ghosh 2006).

4.8. Biodiversity Protected Areas:

From the biodiversity points of view, the study area is extremely important. This has been reflected in the recognition and establishment of a large number of Protected Areas following IUCN guidelines. Following is a list of such PAs established only in Terai and Dooars region (high altitude PAs are not included):

National Parks:

- Buxa National Park
- Gorumara National Park
- Jaldapara National Park

Wildlife Sanctuaries:

- Chapramari Wildlife Sanctuary
- Mahananda Wildlife Sanctuary
- Pakhi Bitan Wildlife Sanctuary
- Rasikbil Bird Sanctuary

Reserves:

- Buxa Tiger Reserve
- Chilapata Reserve Forest
- Eastern Dooars Elephant Reserve
- Sursuti Reserve Forest
- Sursuti MPCA; etc.

This is the direct indicator of the richness of the biodiversity of the study area. However, details of the floristic status of most of the PAs is not known, except Paul and Kumar (2012, 2014) for Mahananda Wildlife Sanctuary, Banerji (1993), Pandit *et al.* (2004), Ghosh and Das (2007), Ghosh *et al*. (2013, 2020) for Jaldapara National Park; Biswas (2015) and Biswas *et al.* (2013) on Rasikbil Bird Sanctuary; Saha (2018) and Saha *et al*. (2013, 2014) on Gorumara National Park; and Buxa Tiger Reserve (Sarkar 2014, Sarkar & Das 2012, 2014). Apart from these some small but important works were also published, as on Gossaihat Beel (Biswas *et al*. 2012; Chowdhury *et al.* 2014), Chilapata Reserve Forest (Shukla *et al.* 2014) and on Sursuti MPCA (Das *et al*. 2010; Biswas *et al.* 2020).

However, the anthropological activities in the region are too high and are mainly development related. Construction of very wide express high ways and rail-tracks even through the protected areas in addition to innumerable new settlements and extension of existing settlements, new township areas, industries, etc. are severely affecting the area's natural vegetation very fast.

Hence, it is not arduous to visualise that in near future the biodiversity of Terai-Dooars regions will be highly affected. Therefore, now it has become an important issue to understand and/or record the actual flora and vegetation of this region and to construct suitable devise to recognise them.

Pollen morphological data is among the most prime tools in taxonomy. So, it is now important to develop a pollen database for this region which will have significant uses in different allied areas of future research.