

### 3. STUDY AREA

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India, the seventh largest landmass in the world comprises a total area of 3,287,263 sq. km. Geographically India is positioned on Indian plate in the southern part of Asia. The landmass of India diversifies 3,214 km from north to south and 2,933 km from east to west. In the north, India is bounded by Himalayan mountain range, while southern landmass was bounded by Indian Ocean. In the west and southwest there lies Arabian Sea and Lakshadweep Sea respectively, while eastern region is surrounded by Bay of Bengal. India forms International Boundaries with seven countries *viz.* China, Bhutan, Nepal, Bangladesh, Myanmar, Afghanistan and Pakistan. India enjoys four diversified seasonal variation throughout the year *viz.* two month winter season (January–February), three month summer season (March–May), long lasting monsoon (rainy) season of four month (June–September) and post-monsoon period or pre-winter period of three month (October–December). Ganga is the major river basin of India originating from Western Himalayas in the state of Uttarakhand and empties into the Bay of Bengal. The Ganga–Brahmaputra system covers majority of northern, central and eastern part of India, while the Deccan Plateau encircles the southern part. Six types of diversified vegetation covers the entire land mass of India and maintains the ecosystem of the country *viz.* tidal or mangrove forests and semi-desert and desert vegetations, mountain forests, dry deciduous forests, deciduous or monsoon type of forests, and tropical evergreen rain forests.

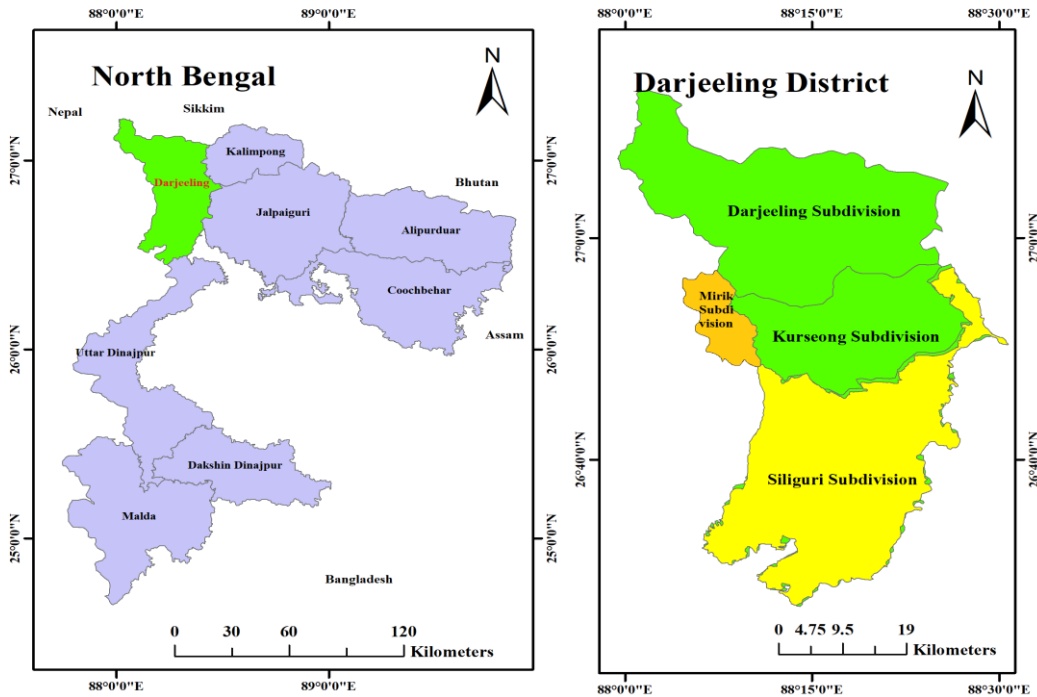
The diverse north–south and east–west extension of India is divided in to 28 states and 8 union territories. The state of West Bengal is the 13<sup>th</sup> largest state in terms of area covering an area of 88,752 sq. km. West Bengal occupies ~2.70% of National area and is considered as home to Royal Bengal Tiger. West Bengal is located in the eastern part of India and is globally recognized as eastern bottleneck of India encircled by Himalayas in the north to Bay of Bengal in the south. The remaining landmass is covered by plains and plateaus. West Bengal is delimited by three international countries *viz.* Bhutan in the North East (~183 km), Nepal in the North West (~100 km) and Bangladesh to the East (2216.70 km). West Bengal shares state boundaries with five Indian states *viz.* Sikkim (north), Assam (north east), Jharkhand and Bihar (west), and Orissa (south west). The entire area of West Bengal can be

divided into eight geographical zones viz. the Ganga Delta, Sundarbans, Coastal plains, Western plateau and high lands, Rarh region, North Bengal plains, Terai and Dooars, and Darjeeling-Kalimpong Himalayan. The state of west Bengal was further divided in to 23 districts, out of which 8 districts viz. Cooch Behar, Alipurduar, Kalimpong, Darjeeling, Jalpaiguri, Malda, Uttar Dinajpur and Dakshin Dinajpur lies north of river Ganga, while remaining 15 districts viz. North 24 Parganas, South 24 Parganas, Hooghly, Howrah, Kolkata, West Midnapore, East Midnapore, Jhargram, Purulia, Murshidabad, Nadia, Bankura, Paschim Bardhaman, Purba Bardhaman and Birbhum lies south of river Ganga.

The Darjeeling-Kalimpong Himalayan is the hilly area located in the north-western frontier of the state of West Bengal. This region comes under the Eastern Himalaya range. The entire Darjeeling-Kalimpong Himalayan region is separated by river Teesta in to two parts viz. hills to the east of Teesta and the hills to the west of Teesta. To the west of Teesta positioned the Singalila range and the Darjeeling-Kurseong range. The Singalila range encircles Singalila National Park and forms western frontier of the province separating Nepal from West Bengal. The four highest peaks in this region are Falut, Sandakfu, Tonglu and Sabargram having altitude of 3595 m, 3630, 3036 and 3543 m respectively. Sandakfu measures to be the highest point of the ridge of West Bengal. In the Darjeeling-Kurseong range notable peaks are Senchal and Tiger Hill. To the east of Teesta lies the Chola range and within this range lies the Kalimpong district of West Bengal.

Two districts of West Bengal are situated in the Darjeeling-Kalimpong Himalayan region viz. Darjeeling district consisting of four sub-divisions viz. Siliguri, Mirik, Kurseong and Darjeeling Sadar (Fig. 5), and Kalimpong district encompassing Kalimpong Municipality and three community development blocks namely Gorubathan, Kalimpong I, and Kalimpong II. Darjeeling district is situated in the foothills of the Himalayas in the Eastern India. It covers an area of 2,092.5 sq. km, occupying ~2.35% total area of West Bengal with Darjeeling being its district headquarters. The district extends its periphery by 29 km from north to south and 26 km from east to west. Geographically the district of Darjeeling can be divided into two sections viz. the hills and the plains. The entire sub-division of Darjeeling Sadar, Kurseong and Mirik falls under the hilly region while Siliguri subdivision constitutes the plane (uniform landmass). Streams of river Mechi, Balason,

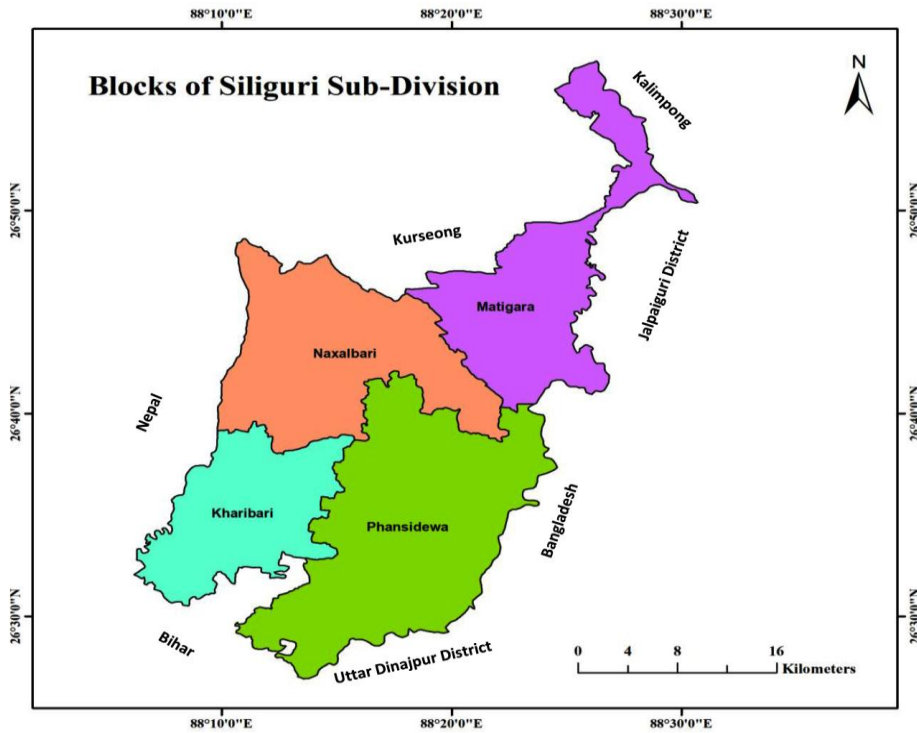
Mahananda and Teesta are distributed throughout Darjeeling district and represent the major drainage system of this district (Paul et al. 2009). Due to the existence of altitudinal variation the district of Darjeeling exhibits variability in climatic factors between hills and plains. Darjeeling is located ~2074 m above sea level and receives average annual rainfall of 3558 mm.



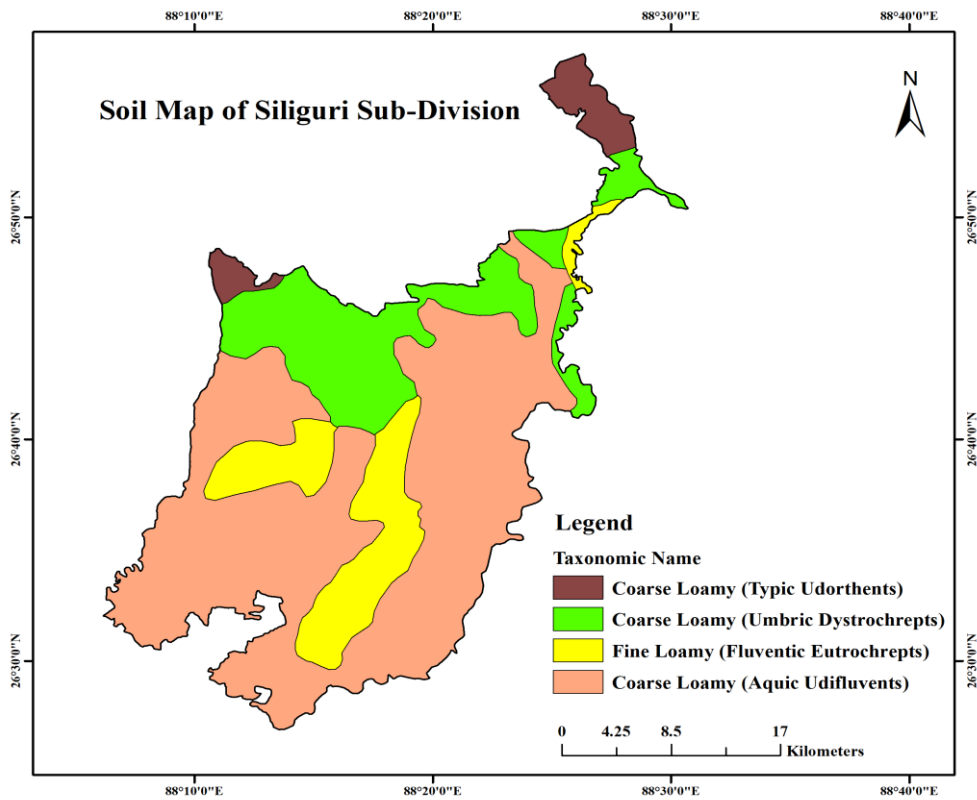
**Fig. 5:** Geographical map of North Bengal and Darjeeling district

Siliguri subdivision is located at the foot of Himalaya mountain range, in the plains of district Darjeeling along the side of river Mahananda. The Sub-Division is encircled by Sub-Himalayan ranges on the North; Bangladesh, Uttar Dinajpur and Bihar on the South; Jalpaiguri and Kalimpong district on the East and Nepal on the West. Geographically Siliguri sub-division is distributed over 837.45 sq. km and has a 19.32 km International border with Bangladesh. The Siliguri subdivision contains four community developmental blocks namely Matigara, Naxalbari, Phansidewa and Kharibari and one Municipal Corporation that covers the area of Siliguri town (Fig. 6).

The area of Siliguri sub-division is situated at ~122 m above sea level and is demarcated by the low hills of Himalayas in the north to alluvium plains in the south (Fig. 7). The major part of the sub-division area contains unconsolidated materials



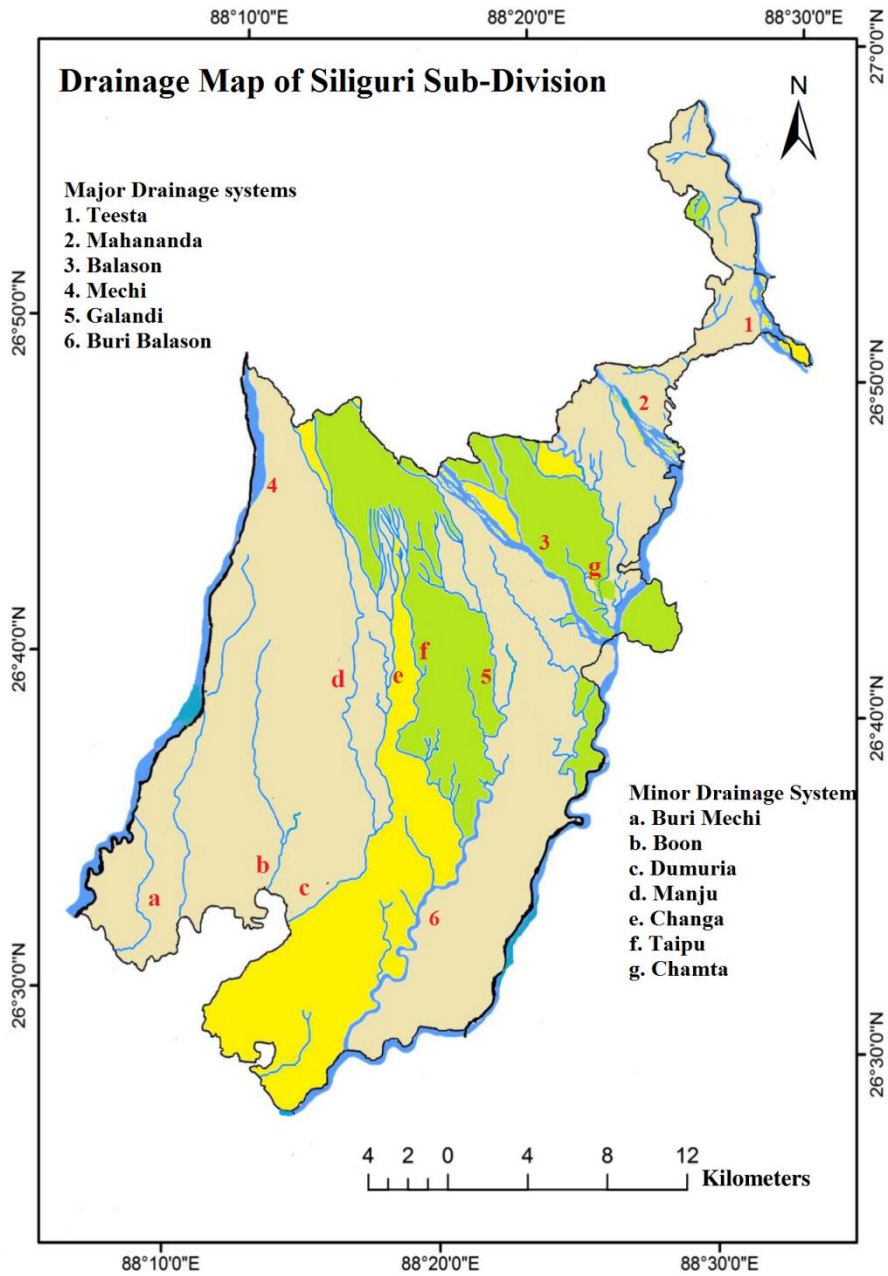
**Fig. 6:** Blocks of Siliguri Sub-division



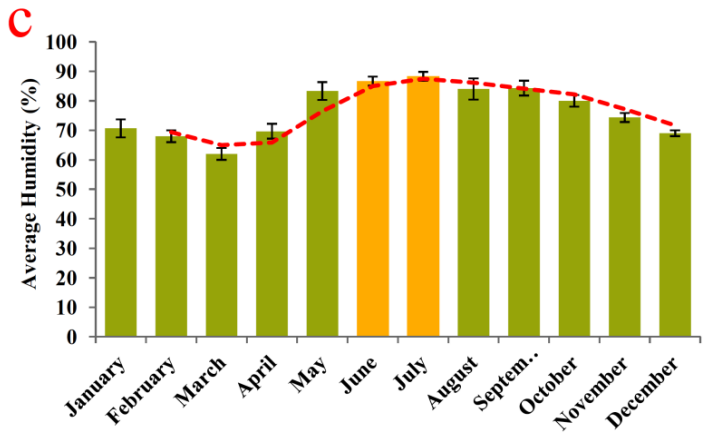
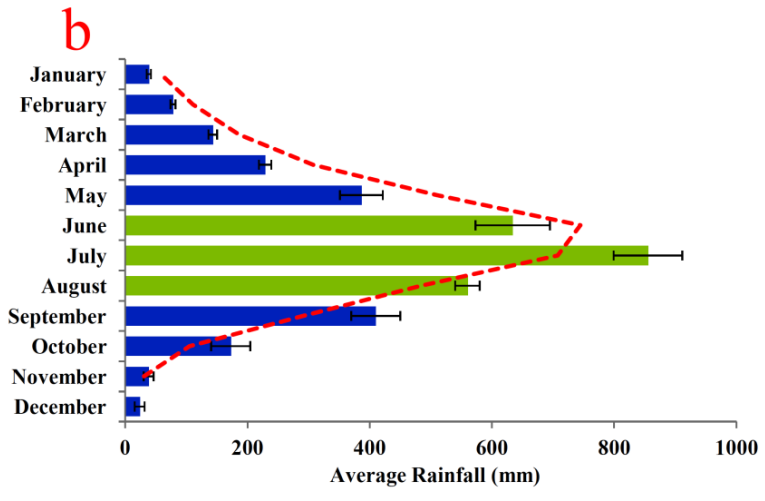
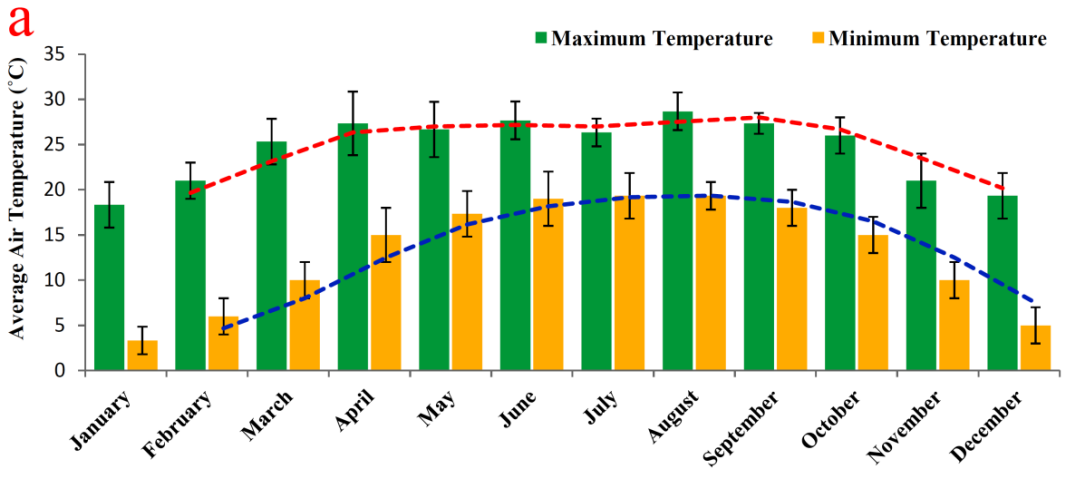
**Fig. 7:** Soil distribution pattern of Siliguri Sub-division

that are brought down by the rivers of the Himalayan range. The area slopes down from north-east to south-west directions. The alluvium plain in this region is the compositional deposition brought down by the river Mahananda, Balason and Mechi along with their confluence (Bandyopadhyay et al. 2014). Siliguri sub-division has diverse drainage system with river Mahananda and Teesta draining through Matigara block, Mechi and Balasan passing through Naxalbari block, river Mechi also crossed through Kharibari block and river Mahananda, Buri Balasan, Galandi forms the drainage system of Phansidewa block (Fig. 8). Siliguri sub-division being adjacent to hilly area is characterised by humid atmosphere and abundant rains, with temperature being rarely extreme (Fig. 9). The area receives huge proportion of rainfall that is influenced by South-West monsoon. The average precipitation in this area ranges between 2500–3500 mm. Rainy season begins in the month of June and last till the mid or end of September (Nandargi and Barman 2018). The area comes under moderate temperature zone with average summer temperature ranges between 28–32°C and average winter temperature ranges between 14–18°C. The atmospheric moisture content is always high in this area with the rainy season bearing the highest humidity content of >80%. The gentle land slope of this sub-division favours the growth of wide range of vegetation including simul, wild banana, mixed sal, khair, screw pine, siris, sisoo and large healthy dense bamboo forest. The Naxalbari block regularly faces elephant invasion into the agricultural lands and due to which people of this block cultivate mulberry and carries out sericulture practice as mulberry plantation is not preferred by elephant as food source.

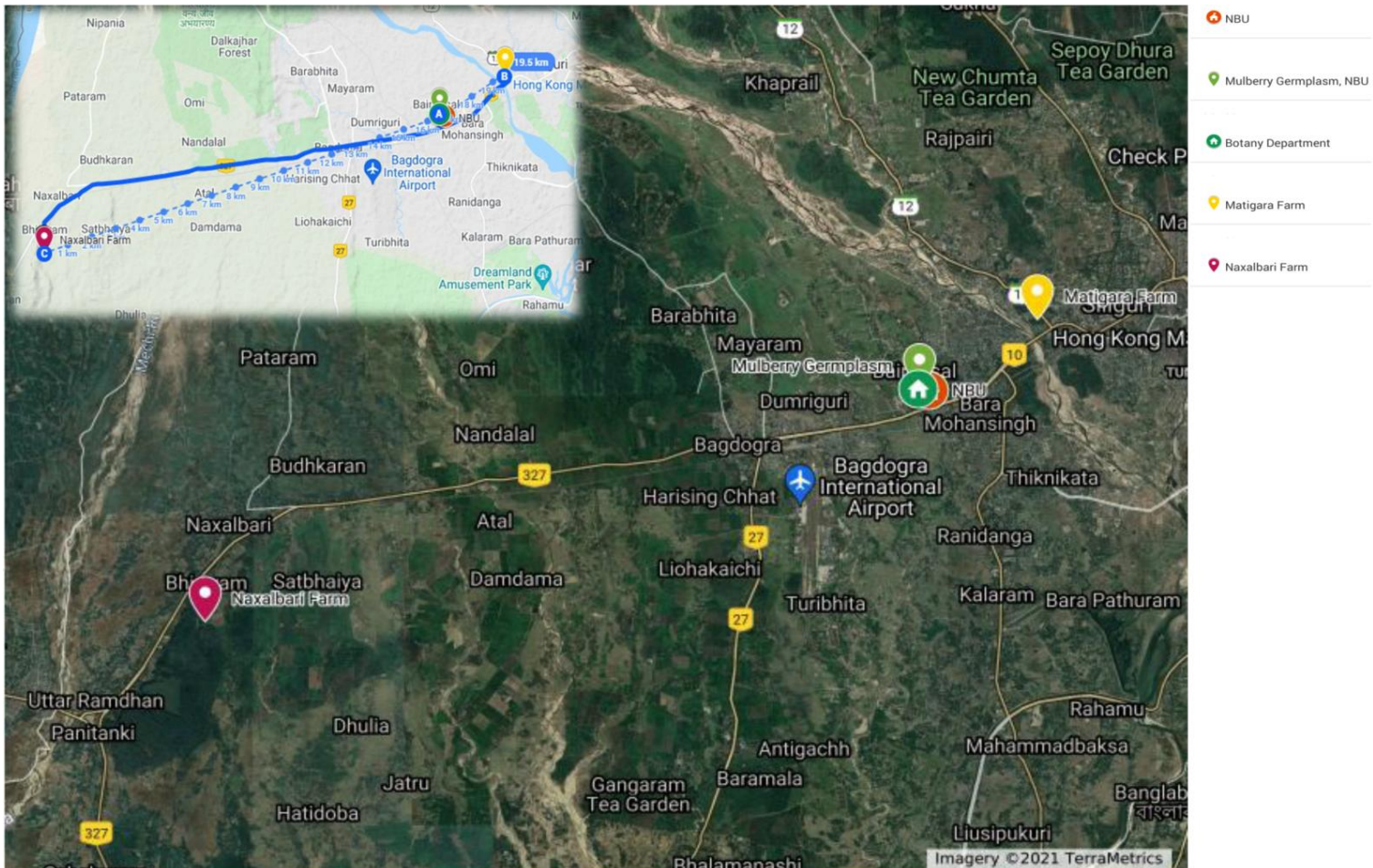
The Siliguri sub-divisional region contains a technical service centre of Sericulture under Department of Textile (Sericulture) in Phansidewa block; Sericulture farm (Naxalbari Sericulture Complex) under Department of Textile (Sericulture) in Naxalbari block; and Farm and Grainage centre (Matigara Sericulture Complex) under Department of Textile (Sericulture) in Matigara block. Beside this, a mulberry plantation unit was also present in Department of Botany, University of North Bengal. In the present study mulberry leaves for experiment was collected from Matigara Sericulture Complex, Naxalbari Sericulture Complex and mulberry germplasm unit of Department of Botany, University of North Bengal (Fig. 10); while the required silkworm larvae were obtained from Matigara Sericulture Complex and Naxalbari Sericulture Complex.



**Fig. 8:** Drainage system of Siliguri Sub-division



**Fig. 9:** Average monthly temperature (a), rainfall (b) and humidity (c) of Siliguri sub-divisional region under Darjeeling district of West Bengal, India for the period of 2016 – 2020



**Fig. 10:** Google Map representation demarcating areas of sample collection in the present study