CHAPTER -2

STUDY AREA
2.1 The Study area: North Eastern Region

The North eastern region of India spread over an area of 255,036 sq km. representing about 7% of the country, comprising of the states of Arunachal Pradesh, Assam, Meghalaya, Mizoram, Manipur and Tripura (Saikia, 2009). The northeastern region is characterized in three physical features viz- Eastern Himalayas, Brahmaputra and Barak Valley plains. The landforms of Northeast India have been developed since Archean to recent times. But after independence the country was so partitioned that the eastern part of the then Bengal was constituted into Bangladesh and this almost isolated the north-eastern part of India from the rest of the country, except for a narrow corridor of about 40 km width along the Bhutan and Nepal Himalayan foothills. Whereas this corridor placed between three countries viz. Bhutan, Nepal and Bangladesh and the major part of Northeast India is surrounded by four foreign countries, viz China, Myanmar, Bangladesh and Bhutan. The region is bounded by huge number of hills of various altitudes.

The forests of northeast India are rich in biodiversity and timber, while the cultural complexity of the region is surprising. The northeastern region consists 8% of total geographical area of India but it includes 25% of forest cover (Poffenberger.et.al 2007). The State of Forest Report, 2011, released by Forest Survey of India (FSI), shows the region has lost 549 sq km of forest cover in the last two years, while another 1,229 sq km forest land has also been degraded into scrub with canopy density of less than 10 per cent.
"This decrease is attributed to the biotic pressure and shifting cultivation in the region," the report stated. It is also mentioned that among the northeastern states Assam has lost 17 sq km of the very dense category forest cover in between (2009 and 2011) and there is also loss of 152 sq km of moderately dense type of forest which is highest in the country. The decline has been endorsed to illegal felling, encroachments in militancy-affected areas, shifting cultivation practice, increasing local extraction pressures with growing population etc.

The total forest cover of the northeastern states are, Arunachal Pradesh has 67,410 sq km, Assam has 27,673 sq km, Mizoram 19,117 sq km, Meghalaya 17,275 sq km, Manipur 17,090 sq km, Nagaland 13,318 sq km, and Tripura 7,977 sq km According to the FSI report, the northeastern region has a forest cover of 1,73,219 sq km, which constitutes 66.07% of its geographical area. The region constitutes about 7.98% of the total geographical area of the country, but consist approximately a fourth of India's total forest cover.

According to the official report the North east India has only 45 million people or about 3.76 per cent of the total population of the country (2011census). The total population density of the region is 159 persons per sq km. Assam the principal state of the entire region, has 397 persons per sq km of population density which is highest among the other states. It is recorded that over 68 percent of the total population of the region lives in Assam. The density of population of Northeast India varies from place to place, for example- In Arunachal Pradesh has density of 17 persons per sq km is the lowest
population density of the country as well as of the region and Assam has a density of 340 persons per sq km is the highest population density of the region (Table 2.1).

Table 2.1 Population growth of Northeast India (1901-2011)

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<tbody>
<tr>
<td>Arunachal Pradesh</td>
<td>10</td>
<td>13</td>
<td>____</td>
<td>846,558</td>
<td>1,091,117</td>
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<td>Assam</td>
<td>184</td>
<td>320</td>
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<td>22,414,322</td>
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<tr>
<td>Manipur</td>
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<td>107</td>
<td>284,465</td>
<td>1,837,149</td>
<td>2,388,634</td>
<td>2,721,756</td>
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<tr>
<td>Meghalaya</td>
<td>79</td>
<td>103</td>
<td>340,524</td>
<td>1,774,778</td>
<td>2,306,069</td>
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<tr>
<td>Mizoram</td>
<td>____</td>
<td>____</td>
<td>____</td>
<td>689,756</td>
<td>891,058</td>
<td>1,091,014</td>
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<tr>
<td>Nagaland</td>
<td>73</td>
<td>120</td>
<td>101,550</td>
<td>1,209,546</td>
<td>1,988,636</td>
<td>1,980,602</td>
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<tr>
<td>Tripura</td>
<td>263</td>
<td>304</td>
<td>173,325</td>
<td>2,757,205</td>
<td>3,171,168</td>
<td>3,671,032</td>
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Source- Census of India 2001, 2011

The states comprising hilly terrain except Assam is host to a desirable ratio of tribal population ranging from 19.3 per cent in Assam to 94.5 per cent in Mizoram. The region has over 160 scheduled tribes and over 400 other tribal and sub-tribal communities and groups. It is known to the home of over 200 of India’s 635 tribal groups, speaking a variety of languages and dialects with strong tradition of social and cultural distinctiveness (Kumar, 2014).
2.2 Location

Northeast India is located between 24°N lat - 28°18′N lat, and 89°46′E long - 97°4′E long. It consists of the seven states of India viz: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. The North-East India has international boundaries with China, Myanmar, Bangladesh and Bhutan and is slightly linked with the Indian mainland by a slight strip of land in North Bengal. To the north of the region lie Bhutan and Tibetan part of China and the eastern boundary is covered by Myanmar. To the west of Northeast India lie West Bengal and Bangladesh and the southern boundary consist of Arakan Yoma of Myanmar, Chittagong and Tippera Hills and Surma Plain of Bangladesh (Figure: 2.1).

Northeast India is surrounded by hills and mountains on three sides. The total area of the region is 255,036 sq km, representing about 7% of the country. To the north of the region lies the Himalayan Kingdom of Bhutan and snow-clad Great Himalayan Mountain ranges, separating Tibet of China from India. The eastern part of the northern boundary runs from the northeastern corner of Bhutan to the tri-junction of China, Myanmar and India for a distance of 1140 Km. The south-eastern boundary follows the general alignment of the hill ranges and runs partly over the Patkai Range and partly over the ranges lying in the same alignment as the Patkai in Manipur and Mizoram. The south-western and western boundary is man-made and hence runs mostly along a random line over villages and crop fields. It also shares boundary with Bangladesh separating Mizoram, Tripura and
Karimganj district of Assam, Meghalaya and part of Dhubri district of Assam. In the northern most part of this boundary separates West Bengal from Assam.

Figure 2.1: Location map of Northeast India

Source: Topographical Survey of India
2.3 Natural vegetation and Forest resources

The Northeast region is distinctive in providing an abundance of habitats, which features diverse ecosystem with high level of endemism. The region comprises about fifty one (51) types of forest and out of nine (9) vegetation types of India six (6) are found here (Chatterjee et.al, 2006). The forest broadly classified into six types viz- Tropical moist deciduous, tropical semi evergreen, tropical wet evergreen, subtropical, temperate and alpine forest. The region consist more than 800 species of flowering plants. The forests of Northeast India provide 40 species of gymnosperms, 500 species of pteridophytes, 825 species of orchids, 80 species of rhododendrons, 60 species of bamboo, and 25 species of canes (Bhattacharya, 2005). The major forest types which are found in northeast India were discussed below.

a) Tropical Evergreen Forest:

This type of forest are found in Himalayan foothill region from Panch Nai eastward upto Luhit district of Arunachal pradesh, the foothills of Changlang and Tirap districts of Arunachal Pradesh, Nagaland and their adjoining districts of the Brahmaputra Valley, North Cachar Hills, the northern and eastern foothills adjoining the Barak Plain and higher altitudes of the Meghalaya Plateau (860m-1600m) bear tropical evergreen forests. This forest comprises pine vegetation and the temperate broad-leaved trees of the higher altitudes. The common plants of tropical evergreen forest are Titachampa (atrocarpus chaplasa), Champa, Garjan (Dipterocarpus turbinatus), Bonsom (Phoebe goalparensis), Amari (Amoora wallichii), Nageswar or Nahar (Messua ferra), Halong (Dipterocarpus
macrocarpus) Hallock, Makari Sal or Makai (Shorea assamica), Shishu (Dalbargia sиссо), Agaru (Aquilaria agallocha), Khakan, Beyleaf, Banaria Am (Mangifera sylvatica) etc. At higher altitude these forest also contain Chestnut, Maple, Magnolia, Laurel, Alder, Brich, rhododendron, willow, juniper, varieties of orchids and various species of pine. These forests generally support softwood for plywood industry and packing boxes for tea industry (Taher and Ahmed, 2001).

b) Tropical Deciduous Forest:

This type of forest are found in the districts of Dhubri, Kokrajhar, Bongaigaon, Goalpara, Barpeta, Nalbari, Kamrup, Darrang, Morigaon, Nagaon, Sonitpur, Karbi Anglong, North Cachar Hills and the drier parts of the Barak Valley in Assam support tropical deciduous forests. It is also found in drier parts of Tripura, Mizoram, Manipur and Nagaland and parts of Arunachal Pradesh. In Meghalaya this forest are found in Garo and Jaintia Hills. The common specie
s of tropical deciduous plants are Sal (Shorea robust), Teak (Tectona grandis), Gamari (Gmelina arborea), Simul (Bombax malabaricum), Khoir (Acacia catechu), Au Tenga (Belenia indica), Jack fruit (Atrocarpus integrifolia), Kadam, Siris, Arjun, Silikha, Bhomora etc. The important products of this forest are sal and teak. These two species of plants supply hardwood for construction of buildings, bridges and railway sleepers (Taher and Ahmed, 2001).

c) Tropical Grassland:

However, most of the grasses of the region, except the alpine grasses of high altitude in the Himalayas do not exist. The grasses mainly found on the hill slopes of Northeast
India come up as a secondary growth after people clear the land for shifting cultivation and settlement. The tropical grasslands also found in the foothills of terai region, on the north bank of the Brahmaputra Valley. The grass land of Manas National Park is an example of this type. The river banks and riverine islands are mostly made of sandy soil where riparian vegetation is grown. The grasslands of Dhemaji, Majuli, Kaziranga, Bhurbanha, Pabitora, Orang etc. on the banks of the Brahmaputra belong to the riparian type of forest. Along with grasses these areas also contain tall grasses, such as various types of reed and thatch simul, khoir, karoi and local plum (zyzyphus) trees. In the plains of Northeast India, especially in the Brahmaputra and Barak Valleys and Manipur Basin, there are many marshes and swamps. These support various types of swamp grasses and other plants like lily, lotus, water hyacinth, taro etc. (Taher and Ahmed, 2001).

This forest represents the transition from the forested regions of Himalayas to the treeless of Alpine meadows. The alpine grassland grows in Himalayas at an altitude of 4000m to 5200m specially found in Arunachal Pradesh of Northeast India. Apart from various species of grass, it also contains some varieties of juniper, rhododendron, shrubs and mosses. This zone of grass lies above the coniferous forest belt which is mentioned in the evergreen group.

According to the Red data book 10% of flowering plants are endangered. Of the 1500 flowering plant species 800 are reported from Northeast India. Of 1,300 species of orchids documented worldwide, 700 are found in northeast India, with 550 species of orchids in Arunachal Pradesh alone. In Manipur, 430 species of plants are used for medicinal purposes. Over 50 percent of ferns are found in Northeast out of 1,000 species in
India. Fauna is also present in diverse forms throughout the region. According to an official estimate based on satellite images, the Northeastern Region has 137,519 square kilometers of forest, which is about 25 percent of the total forest cover in India (FSI, 2011). Although the region was once rich in forest resources, it is no longer so now. In recent decade’s deforestation, illegal cutting of trees, clearance of forest, timber demand from Bangladesh and other neighboring urban centers of India is increasing tremendously. The most important factors of forest loss are land clearing and illegal built up of houses by the local people. This results in abrupt changes in forest resources of Northeast India.

Some of the economically very important trees found in Northeast India are agar, sal, neem, champa, tea and bamboo. These forests of Northeast India provide hardwood and soft wood, for various construction, plywood, bamboo, thatch, and cane for furniture manufacturing. They also provide us various medicinal and ornamental plants, vegetable, fruits, honey etc to fulfill human needs. In the evergreen forests of Assam one can find Makari Sal (shorea assamica) which is one of the tallest trees in India. There also found various species of flowering plants and around 400 varieties of rare orchids. The forest also provides us varieties of carnivores’ plants viz pitcher plant; bludderwart and surujneor were found in Garo and Khasi hills of Meghalaya. Varieties of saprophytic and parasitic plants apart from epiphytes were found in this region such as Monotropa, Belonifora, etc. The region is globally famous for tea plantation, is the major beverages of the world (Taher and Ahmed, 2001).

The forests of Northeast India are also rich in fauna. The mammals include various primates, carnivores and herbivores occur in this region. Prominent animals like hoolock
gibbon, one horned rhinoceros, wild buffalo, elephant in the forest of Kaziranga, Laokhowa, Orang, Pabitara and Manas. There are as many as 11 varieties of monkey including the rare golden langur and capped langur in this region. The four horned antelope, deer, barking deer, musk deer, pigmy hog, bear, bison and wild boar are some important herbivores of the region. Different species of carnivores are found here for example, Royal Bengal tiger, leopard, wild cats, civet cats, snow leopard, Himalayan bear etc. There is also a rich reptile’s population like marsh crocodile, fresh water gharial, turtle, tortoise, varieties of monitors, chameleons, lizards and different types of snakes. Among the snakes, the python is familiar in the hills, while krait, viper and cobra are found in the tropical forests and grasslands of the plains. The region is also rich in avifauna. Varieties of bird species like stork, pelican, ducks, pheasant, vulture, kite, eagle, varieties of doves and parrots, wren, linnet, tit, starling etc are found here (Taher and Ahmed, 2001).

There are many reserve forests, sanctuaries and a few national parks in this region, but some of these have been found to be partly destroyed by man either for jhum cultivation or for extracting fuel wood and timber. Many forests in this region have been ruined due to construction of road, railway lines for transport and communication and also due to rapidly growing urbanization and illegal migrants. It was found that during 1995-97 about 1800 sq km of forest was destroyed in Northeast India for shifting or jhum cultivation alone. On the other hand, poaching of rare and valuable animals like rhinoceros, elephant, bison, wild goat, deer, tiger, leopard etc for their meat and organs, has reduced the number and species of wild animals found abundantly earlier in the region. The region is now experiencing an extensive process of fragmentation, degradation and absolute deforestation and forest
adaptation. The forest management of the region has suffered in the recent past due to pressure on land, the decreasing cycle of shifting cultivation, exploitation of forest for timber, and lack of scientific management strategy. The annual estimated production of fuel wood from forest of Northeast India is 0.0274 million tones (SFR, 2011).

All the above factors have been paying to a rapid declining of the ecological balance in the region. It is, therefore found that many species of plants and animals are under threat to their extinction. The efforts of the state as well as the central Government to establish a network of protected areas in northeast India to conserve biodiversity have had limited impact due to a failure to involve indigenous communities and local government.

2.4 Soil

Soil is one of the important natural resources and is the topmost layer of the earth's crust. It consists of mixture of fine powdered rocks, organic matter, liquids, myriad organisms and other minerals. The proportion of the key ingredients determines the type of soil. But, factors such as vegetation, climatic conditions, human activities for e.g. grazing, farming, gardening etc also influence soil formation (DSR, 2017). The soil of Northeast India is distributed in the basis of altitudes as red soil over lower altitudes, and laterite soil over medium altitude, while the higher altitude have mountain soil. The alluvial soil is present in the plains of Brahmaputra and Barak in Assam and in the plains of Manipur and Tripura. The Soil of Assam is distributed as red soil in the most areas of Karbi Anglong and North Cachar Hills and alluvial soil over the plains of Brahmaputra.
On the other hand the existence of alluvial soil is in limited river valleys of Arunachal Pradesh, plains of Manipur, and the piedmont plains of Tripura. The red soil occurs in lower hills of Arunachal Pradesh, hills of Meghalaya and Tripura, some parts of Manipur and Nagaland. The central part of Meghalaya consist laterite type of soil and the rocks contain a higher quantity of iron so the red soil is brighter than other soil of hills. Laterite soil is also occurs in few patches of higher hills of Tripura. Most part of Mizoram consist residual type of soil weathered from shale.

2.5 Physiography

The physiographic structure of Northeast India can be classified into the Eastern Himalayas, North and the Brahmaputra and the Barak Valley Plains. The climate of Northeast India has predominantly humid sub-tropical climate with hot humid summers, severe monsoons, and mild winters. Beside the west coast of India, this region has some of the rain forests of the Indian sub-continent which support different species of flora and fauna and numerous crops. The petroleum and natural gas reserves in the region are expected to constitute a fifth of India's total prospective.

Northeast India is distinguished by hills, plateaus, mountains, plains and river valleys. The most conspicuous physical feature is in inhibit Brahmaputra valley mutually the Arunachal Himalaya to the north, the Mishimi and Mizo hills to the east, the Patkai Naga- North cachar hills to the southeast, the Karbi and the Meghalaya plateaus to the south, Southeast of the north cachar hills is the Barak real of the Surma valley. The Naga Hills extend to the south into the highlands of Manipur and to the Southeast into the Mizo
Hills and adjoining Hills in Tripura and then into the alluvial plain of Bangladesh (Taher and Ahmed, 2001). In the Southern part Meghalaya plateau lies. The greenness of its scenery, the diversity of communities and geographical and ecological assortment makes the North East India quite different from other parts of the subcontinent. The region is enclosed by the mighty Brahmaputra-Barak river systems and their tributaries, valleys of Manipur, some leveled lands in between the hills of Meghalaya and Tripura. Nearly two-third of the region is covered with hilly terrain scattered with valleys and plains. The altitude of the region varies from almost sea-level to over 7,000 metres (23,000 ft) above mean sea level.

The landforms of Northeast India have been evolved since Archaean to recent times. Richard E Murphy has divided the landforms of Northeast India on the basis of both genetic and empirical factors.

1. The plateaus: Meghalaya plateau, Karbi Plateau


3. The Plains: The plains of Northeast India can be divided into Brahmaputra Flood Plain, Southern Built-up Strip, Southern Foot-hill zone, Intermontane and piedmont plains, Manipur Basin, Barak plain and Tripura Plain. Northeast India may also be divided into five physiographic units on the basis of lithology, age and mode of evolution.
2.6 Drainage

North-East India falls within the humid monsoon climate by the whole of an average rainfall of 200 cm. The place contains the rainiest locality of the world that is the Cherrapunji- Mausynram area. The region is also rich in drainage system as it consist seven sets of river basins. The seven sets of rivers decor up their surplus water systems are the Brahmaputra in the north- Barak- Surma – Meghna in the mid-south, Chindwin at the hand of Tizu, Yu and Manipur rivers in the east and Kaladan, Karnaphuli, Gumti and Fenny in the south and south- west. All these rivers are international in their scope and go inaccurate either to Bangladesh or to Myanmar. These rivers and their basins are discussed below.

i) The Brahmaputra basin 
ii) The Barak Basin

iii) The Chindwin Drainage basin 
iv) The Kaladan Drainage Basin

v) The Karnaphuli Basin

2.7 Climate

Northeast India has a subtropical climate that is influenced by its relief and influences from the southwest and northeast monsoons (Dikshit, et.al 2014). The Himalayas to the north, the Meghalaya plateau to the south and the hills of Nagaland, Mizoram and Manipur to the east influences the climate to a great extent. Since monsoon winds originating from the Bay of Bengal and move towards northeast, these mountains force the moist winds upwards, causing them to cool adiabatically and condense into clouds, releasing heavy rainfall on these slopes (Dikshit, et.al 2014). Generally the daily temperature in the plains of
Brahmaputra and the Barak Valley as well as in Tripura and in the western portion of Mizo Hills is about 15° C in January, whereas in other parts of the region, the temperature is between 10°C to 15°C.

From April it rises and in July castigates the south-eastern part of Mizo hills and Shillong, the average temperature ranges from 25 °C to 27.5 °C. During October, daily mean temperature in the hilly areas ranges between 20°C and 25°C, whereas in Brahmaputra and Barak Valley, Tripura and the western portion of the Mizo hills it is above 25°C. Further the lowest temperature is experienced below freezing point in the upper Himalayas in Arunachal Pradesh(Taher and Ahmed, 2001).

The Himalayas in the north, the Patkai and diverse hills and mountains in the east and the Meghalaya plateau in the center have exaggerated the overall tropical warm climate of the region. Many of these hills and mountains are steep enough interpreting the calm and brisk climate. Besides the Himalayan mountain chain, the Patkai and the steep hill ranges overall Manipur and Mizoram borders by the whole of Myanmar hinder the rain generous monsoon winds from this region. On the other hand these ranges do not have the means for the dry and cold winds of inner Asia to attain the North East region. The Meghalaya plateau standing diagonally in the course of the southwest monsoon winds, make them rise orographically, causing the heaviest rainfall in the world in its southern orographically, causing the heaviest rainfall in the world in its southern margin. The Himalayan and eastern hill ranges also cause orographic rise of the monsoon winds with consequent heavy rainfall in Northeast India (Taher and Ahmed, 2001).
Another absolutely important consequence of the counter clockwise hills and mountains on the climate of the region is that in summer interval the plains become warm and the air over the hills and mountain stay relatively cool. The low pressure system conquers the valleys of Brahmaputra and Barak and apparently changes the climate in this region.

The Northeast India is known as the rainiest region in the country, as many places receiving an average annual rainfall of 2,000 mm. The rainy season mainly occurs in summer during the monsoon season. In Meghalaya plateau, Cherrapunji and Mawsynram are the rainiest places in the world with an annual rainfall of 11,418.7mm. The southwest monsoon is responsible for bringing 90% of the annual rainfall to this region. April to late October are the months where virtually the rainfall occurs and in June and July the rainfall amount is highest as a result of the rainiest months of Northeast India. The southern parts of the region are the first to receive monsoon (May or June) while the Brahmaputra valley and the northern mountain receives later. In the hilly tracts of Mizoram, the closer proximity to the Bay of Bengal causes it to experience early monsoons with June being the wettest season (Dikshit, et al 2014).

2.8 Landuse

Landuse and landcover comprises the natural environment or wilderness to build environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type." (IPCC special report,). They are
instantly related with the activities of human being on their environment. In northeast India land use and land cover signifies a distinct pattern as related to rest of the country. About 35% area in the region is plain except Assam where plain is about 84.4% of its geographical area (GA). Nearly 15.7% GA area is under cultivation; forest cover (open and dense) in the region varies from 40.2% (Assam) to 72.99% (Arunachal Pradesh) (Choudhury et.al 2014). In Northeast India shifting cultivation conquer 2.88% (0.754 Mha) whereas Grasslands occupy 6.06%, wastelands occupy 6.22% and about 4.53% of water bodies of the total Geographical area.

The rapid landuse and landcover change due to large scale of deforestation, transformation to temporary agricultural land through adoption of shifting cultivation, conversion of natural forests/ grasslands into plantation/horticultural lands and other forms are mostly contributing to massive loss of biomass in the region (Choudhury et al., 2013). The forest land is slash and burn annually for shifting cultivation and farming along the steep slopes in high rainfall areas resulted in acceleration of soil erosion. There is annual loss of organic matter by 6.0 million tons and available plant nutrients (Ghosh et al., 2009).

Out of the 4.0 million hectare net sown area of the region roughly 1.3 million hectare suffers from serious soil erosion problem. Presently, shifting cultivation and associated deforestation remains one of the largest degrading forces for the loss of forest cover and subsequent imbalance in aggradation to degradation cycle of land-soil and environmental flexibility. The scarcity of water and moisture stress brought erratic droughts.
during ultimate crop growing season which is another leading challenge in sustaining crop productivity as well as the food security of the region.

Figure 2.2: Landuse and Landcover map of Northeast India

Source: Globe cover 2009
The variations in elevation, soil and climate local variations in vegetation are abundant. They can be broadly divided as follows: tropical, deciduous, grasslands, subtropical mixed temperate and alpine forests. Of these the tropical forests which include wet evergreen and semi evergreen forests, dry and moist deciduous forests are the single most extensive category covering large stretches of Assam, Meghalaya, Tripura, Mizoram and Manipur. Such forests are spotted with patches of wet bamboo brakes, cane brakes, riparian forests and swamps. Hollock (*Terminalia Myriocarpa*), Hollong, Bonsum (*Phoebe goalparesis*), Nahor (*Mesua ferrea*), Mekai, Sopa (*Magnolia spp.*), Tita sopa (*Michelia champaca*), Simul (*Bombax ceiba*), Kadam, Makrisal (*Schima wallichii*), Amari (*amoora wallichii*) are common trees (Saikia, 2014).

In Northeast India the deciduous type of forests are spread over parts of Assam, Meghalaya, Tripura and Mizoram. In Meghalaya such forests, in low altitudes of the Khasi and Garo Hills support sal (*Shorea Robusta*) forests (Bhakta 1991), while in the Goalpara, Kamrup, Dhubri, Kokrajhar, Nagaon districts sal species occur, although in limited extent. Other species include Simul (*Bombax ceiba*), Sidha, Gameri (*Gmelina Arborea*), Makri-Sal. The evergreen trees throng for space with the deciduous trees with the former arising in greater quantity on account of the high rainfall received transversely in most of north east India.

Grassland or savannah vegetation type is commonly found in the lowlands of the Brahmaputra valley which are subject to annual flooding and in area of the Meghalaya Plateau (Saikia, 2014). The semi-evergreen and deciduous forests have been shifted into grasslands, which signify secondary forests. Vegetation comprises grasses, marsh forests and swampy vegetation along with species like *Cayera arborea, wrightia tomentosa, Zizyphus,*
Randia and ‘rata’ (Imperata arundinacea) (Das et al. 1971). Subtropical mixed forests in low elevations (upto 1500 metres) of areas of Arunachal Pradesh and temperate forests in parts of the Meghalaya-Karbi plateau and Naga-Mizo Hills and alpine forests in higher elevations of Purvanchal complete the picture. In the temperate belt species like pine, fir, oak, birch, chestnut, magnolia, maple, cherry, fig and cherry trees occur, while in the alpine forests restricted to higher elevations in the Arunachal Himalayas between 2700 m to 4300 m, shrubs, jumpers, pine, silver, fir, dwarf rhododendrons and conifers are found (Prasad, 1971).

Forest areas are generally protected, managed and controlled by the Forest Department of Government. Lands not available for cultivation are the area covered by homesteads, roads, towns, villages, rivers, ponds etc. As of now the total area of protected forests in the Assam is 3,925 sq km. Of these, 1,978 sq km fall under the five national parks. The rest 1,947 sq km are under wildlife sanctuaries, including the two proposed ones (SFR,2011). The area under the sanctuaries, again, constitutes 20 per cent of reserve forest areas and five per cent of the total land area of the State. It is observed that the growing pressure of population requires expansion of the cultivated land either by decreasing forest land or by reducing the length of fallow period in jhuming. Both the phenomena are seen in North East India.

The economic condition of the states of North East India is conquered by agriculture and associated activities. But the land under cultivation in the region is only 16 per cent of its total geographical area. It varies from 2.5 per cent in Arunachal Pradesh to 7.2 percent in Manipur, 9.4 percent in Meghalaya, 4 per cent in Mizoram, 15 per cent in Nagaland, 36 per cent in Tripura and 45 per cent in Assam. The shifting cultivation is the common method of agriculture in the hilly areas. It is practiced by about 4,44,400 families over an area of 3900 sq.km. This method of cultivation has given rise to problems of landslide and erosion,
deforestation, loss of fertility of the soil etc. Flood, bank erosion and drought in certain areas are the main hurdles to the development of agriculture in the plains. Besides there is little crop diversification in the states of North East India. About 76 per cent of cultivated area is under food grains, 5 per cent under oil seeds and 3 per cent under fiber crops. The food grain situation in the region is not good. According to ICAR estimates the requirement of food grain in the year 2000-01 was 7,940 million tons while its production for the same year was only 6,346 million tones. (Bhattacharya, 2005) In Northeast India the main occupation of about 450,000 families of rural areas were engaged with agriculture and annually cultivate 10,000 sq km in forest land. The total area of forest land is affected by Jhum Cultivation (shifting cultivation) is believed to be 44,000 sq km (Singh, 1990). Shifting cultivation has been an important factor which plays a vital role in transforming forest into “open forest” category, especially in the states of Manipur, Meghalaya, Mizoram and Nagaland. In these states most of their land area is labeled as unclassified forest.

2.9 Assessment of fuel wood consumption

The fuelwood utilization studies done by the Forest Survey of India in the forested areas of the country also give high consumption rates, especially in the forest rich states of Arunachal Pradesh, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The per capita fuel consumption ranged from 423 kg to 1320 kg (Rai and Chakrabarty, 1996). According to the report the Northeast region recorded a decline of 244 square kilometers of forest area during the period 1997 to 1999. In addition to areas being cleared of forest, a substantial area of forest is experiencing ongoing degradation through cutting, fires, practicing agriculture and grazing (Proffenberger et.al 2007). In the recent past, the forests were suffering a great loss due to pressure of population on land, the increasing cycle of shifting cultivation, over exploitation of forest for timber etc. The timber trade,
tourism and wildlife resorts, and shifting cultivation in the hill areas are slowly weakening the region’s forest wealth (Saikia, 2000).

Fuelwood consumption is a main reason of forest degradation in many tropical forests around the world. Since, fuelwood is still the only inexpensive and accessible energy source for people living in rural areas of Northeast India. The people living in and around of forest in the region consume wood as their major energy source and few alternatives such as agricultural by-products exist. The fuelwood is used for many activities such as burnt for cooking, heating water and space, lighting and cook food for livestock, rice beer preparation, festival celebration, etc. Among various activities, cooking required maximum energy, people uses commercial fuel like LPG or kerosene which is beyond the reach of rural and tribal communities due to their poor economic conditions. Therefore they prefer fuelwood as domestic energy which is free as well and can be easily found from the forest. The excessive use of firewood has triggered ruthless deforestation in the region.

One of the important reasons behind the forest loss is the increasing of population in northeast India. According to 2001 census the total population was 38,475,089 and it was increased by 5,122,594 in 2011. The present population in 2011 census is 43,597,683. This increasing population caused an increase in timber extraction, grazing, fuelwood collection, shifting cultivation and use of other forest products, and the combined effect of these activities impacted on the forest in Northeast India. The fuelwood consumption pattern of some tribal communities of different states in Northeast India is stated below.

The fuel wood is an intimate part of basic energy needs emerged as an integral to the ambitious plans for renewable energy in many countries to produce cost-effective; high-quality energy services at various scales (Banyal et al., 2013). It is also used for crop and
house protection from wild animals by these tribal communities of Northeast India. The forest dominated states of Northeast India have higher prevalence of firewood used for domestic energy (Table:2.3). The preferred tree species used were Schima wallichi, Castanopsis, indica, Dendrocalamus hamiltonii and Dillinia indica (Maikhuri et.al 2003).

Table 2.3: The forest cover of the states with higher incidences of firewood use.

<table>
<thead>
<tr>
<th>Name of the State</th>
<th>Percentage of Households using Firewood for cooking*</th>
<th>Percentage of Total Geographical Area of the State under Forest Cover#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arunachal Pradesh</td>
<td>68.7</td>
<td>80.5</td>
</tr>
<tr>
<td>Assam</td>
<td>72.1</td>
<td>35.28</td>
</tr>
<tr>
<td>Manipur</td>
<td>65.7</td>
<td>76.54</td>
</tr>
<tr>
<td>Meghalaya</td>
<td>79</td>
<td>77.02</td>
</tr>
<tr>
<td>Mizoram</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Nagaland</td>
<td>77.9</td>
<td>80.33</td>
</tr>
<tr>
<td>Tripura</td>
<td>80.5</td>
<td>76.07</td>
</tr>
</tbody>
</table>

Source: *Census of India 2011; # India State of Forest Report 2011

Depending on forest by the rural population for persisting livelihood is affecting the forest resources in Northeast India. This involves scheming and implementing policy that creates alternative livelihood opportunities and reduces their dependence on forest land. The livelihood necessity of the people fully dependent on forest varies and these need to be taken into concern while designing the policy (Nayak et.al 2012). The policy building for fuelwood
conservation in the states of Northeast India may reduce forest degradation. Unplanned shifting cultivation and fuelwood extraction will be surrogated by promoting option on energy sources like biogas, solar energy and improved cook stoves. The development of provisions for cleaner cooking fuels such as LPG in rural areas will help to reduce pressure on forest land in Northeastern states.