

Chapter 2

The Study Area

Abstract The seven states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura make up north east India. The region spreads over 255,037 km² or about 7.7 % of India's total geographical area. The relief is rugged with plateaus, hills and mountains dominating. Level lowlands are at a premium covering only 27 % of the area. Rainfall is torrential with 6,300 mm annually a routine occurrence in the Cherrapunji area. In the rest of the region, average annual precipitation ranges from 1,000 to over 4,000 mm with the bulk of it occurring during the monsoon months of June to October. Stemming from this a luxuriant tropical vegetation ranging from alpine, subtropical pine and montane to evergreen and moist deciduous thrives making the region a global biodiversity hotspot. The focus of development has centred around its primary resource base, largely around tea, timber and petroleum. What little else exists in the name of development has been concentrated in the urban landscapes. It is not surprising that in the region's rural areas a dependence on natural resources—forests in particular—exists and there is not much option than to exploit the region's forest resources.

Keywords Arunachal Pradesh • Assam • Manipur • Meghalaya • Mizoram • Nagaland • Tripura

2.1 The Land

Spread over an area of 255,037 km², the northeastern states of India, commonly referred to as north-eastern region (NER), comprise the seven states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura. Situated at the north eastern corner of India the area is connected with the rest of the country by a 21 km wide corridor called the “chicken's neck”. The NER shares international boundaries with China, Myanmar, Bangladesh and Bhutan.

Generally it has been an area where the level of technology available is on the low side and where humankind has struggled to assert itself; and its peripheral location has been helped. The physiography of the NER, with its imposing elevation, provides the basis upon which human activities are carried out. Given the size of the region and its highly variable terrain there exist not inconsiderable variations in the man-landscape interaction equation. While the landscape has varied from the smooth canvas of the Brahmaputra Valley to the rugged mountainous terrain of the Himalayan Arunachal Pradesh, variations in terms of anthropogenic activities emerged. A brief look at the physiography of the region and the impulses it generated is thus necessary. The NER has been divided into plains, plateaus and hills and mountains (Taher 1986). Low lying plains cover 27 % of the area. These stretches of level land, conducive to settled agriculture with minimal irrigation and other inputs, occur in the Brahmaputra valley which alone accounts for 82 % of the level land in the NER. This stretch of plains covers 56,480 km² and runs in a linear manner in a northeast–southwest stretch across the middle of the territory. The Brahmaputra valley plain stretches from Sadiya in the east to Dhrubi in the west and is a near flat stretch of level land built up by the aggradational deposits of the Brahmaputra river, with up to 1,500 m thickness of alluvium. The levelness of the plain is indicated by a fall of about 12 cm/km and the general level ranging from 30 to 130 m (Das et al. 1971) over a length of some 660 km and an average width of about 70 km (Taher 1986).

Other plains areas include the Barak valley (6,962 km²), the Manipur Basin (1,843 km²) and the piedmont plain of Tripura (3,500 km²) are dwarfed in comparison to the Brahmaputra valley. The Tripura plain, like the Barak is a piedmont plain and represents the northern margin of the Bangladesh plain. Both the Barak and Tripura plains contain erosional as well as depositional features with denuded hillocks and piedmont terraces (Taher 1986). The Manipur plain is the smallest of the plains in the NER and is of lacustrine origin (Taher 1986) probably formed due to the headward erosion of a tributary of the Chindwin river during its incision into the valley, draining out the excess water from the basin, and leaving behind at the deep end, the Loktak lake (Taher 1986). The elevation is less than the 900 m contour that bounds it and this low oval valley has been of seminal importance to the kingdom of Manipur. Like the larger plains, it has a number of local depressions, marshes and lakes, particularly in the south central part (Taher 1986).

Hills and mountains cover an area of some 150,000 km² and can be divided into the Arunachal Himalayas in the north; and the eastern hills and mountains consisting of the Dibang-Lohit-Patkai-Naga-Manipur-Mizo axis to the east ranging NE-SW with the Dihang-Dibang gorge being a convenient divisor.

The former is again divided into a Lesser Himalayan zone varying between 300 and 500 m and lying just adjacent to the Brahmaputra valley and to its latitudinal and directional north, the Greater Himalaya, varying in elevation between 5,200 and 7,200 m. The former, a foothills zone or the Sivaliks area, is the more habitable of the two and, given the heavy rainfall it receives, affords a thick, at times impenetrable vegetation. Bands of soft rock, resulting in varying erosion, mean that topographic changes are rapid and the region is generally “a confused

labyrinth of hills and ranges intervened by deep gorges” (Taher 1986) with small and marginal valleys scattered in a disorderly manner as if broadcast by some force. It is in such valleys that man is able to eke out a subsistence. Where relatively larger flatlands exist, as in the tablelands of Bomdila and Ziro the traditional shifting agriculture is abandoned for age-old traditional wisdom honed practices of terraced wet rice cultivation. Such enclaves are replaced by the periglacial and inhospitable highlands to the north where, with increase in altitude the vegetation cover peters out, and the snow-capped peaks vie for space with patches of alpine vegetation.

The eastern hills and mountains, aligned NE–SW, are, altitudinally, a poor cousin to the Arunachal Himalayas, ranging from 1,000 to 3,000 m in general and occasionally higher, with the elevation falling off to 150–900 m in Mizoram and Tripura to the south. Northwards, the elevation is the highest at Dapha Bum in Lohit area (4,579 m) gradually decreasing to sub-4,000 m at Saramati (3,826 m) in Nagaland, where the Patkai hills are their best; to Japavo (3,015 m) in Nagaland again in the Barail Range. This decreasing trend continues into Manipur, where the hills enclose the Manipur Central plain in which is embedded the Manipur basin (Taher 1986). Apart from the intermontane basin and a few flat topped valleys like the Khouppam, Manipur is criss-crossed by the Patkai and tributary ranges which trend NE–SW and vary in altitude from 750 m to about 3,000 m, with the highest part of Manipur lying on the north east at Mount Tenipu (2,994 m), Khayanghung (283 m), Leikot (2,832 m), Siroi (2,568 m) among others.

Plateaus make up the third physiographic division of the NER. Stretching over an area of 32,821 km² the Meghalaya-Karbi plateau with an elevation varying between 900 and 1,965 m is a rigid tableland composed of pre-Cambrian Archean gneisses interspersed with Lower Gondwana rocks, Sylhet traps and Cretaceous-Tertiary sedimentaries and the Shillong series (Das et al. 1971).

2.2 Climate and Vegetation

The region’s climate is a mixture of cold humid monsoonal climate in hills above 200 m, wet sub-tropical in southern Arunachal, Western Nagaland, Manipur and Mizoram and humid mesothermal monsoonal in the valley and plateau areas (Barthakur 1986). Almost the entire region receives copious rainfall, particularly the Cherrapunji-Mawsynram-Pynursla belt of the southern part of Meghalaya, which borders Bangladesh with a classic scarp face and with its funnel-like topography traps the rain laden winds to receive in excess of some 6,300 mm annually. In the rest of the region, average annual precipitation ranges from 1,000 to over 4,000 mm with about 60 % being concentrated during the months of June to October. This heavy rain, coupled with the hills has clad the region, at least the hills, with a luxuriant vegetation and rich biodiversity. Although the climate has been both a boon to the vegetation which has been much maligned, forests being

exploited recklessly, the fact that climate has a profound influence on the life, economy and cultural fabric of the region is undeniable.

Considering the variations in elevation, soil and climate local variations in vegetation are numerous. They can be broadly divided as follows: tropical, deciduous, grasslands, subtropical mixed, temperate and alpine forests (Gopalakrishnan 1991). 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 dappled with patches of wet bamboo brakes, cane brakes, riparian forests and swamps and pioneer euphorbiaceous serubs. Hollock (*Terminalia Myriocarpa*), Hollong, Bonsum (*Phoebe goalparensis*), Nahor (*Mesua ferrea*), Mekai, Sopa (*Magnolia* spp.), Tita sopa (*Michelia champaca*), Simul (*Bombax ceiba*), Kadam, Makrisal (*Schima wallichii*), Amari (*amoor wallichii*) are common trees.

The deciduous 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. Evergreen trees jostle for space with the deciduous trees with the former occurring in greater proportion on account of the high rainfall received across most of north east India.

Grassland or savannah vegetation type are commonly found in the lowlands of the Brahmaputra valley which are subject to annual flooding and in area of the Meghalaya Plateau. The original semi-evergreen and deciduous forests have been degraded into grasslands, which represent secondary forests. Vegetation includes 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 (up to 1,500 m) 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, mulberry and cherry trees occur variously while in the alpine forests restricted to higher elevations in the Arunachal Himalayas between 2,700 and 4,300 m, shrubs, jumpers, pine, silver, fir, dwarf rhododendrous and conifers are found (Prasad 1971) Fig. (2.1).

2.3 Population and Resources

The focus of development in north east India (NEI) has centred around its primary resource base, largely around tea, timber and petroleum. What little else exists in the name of development has been concentrated in the urban

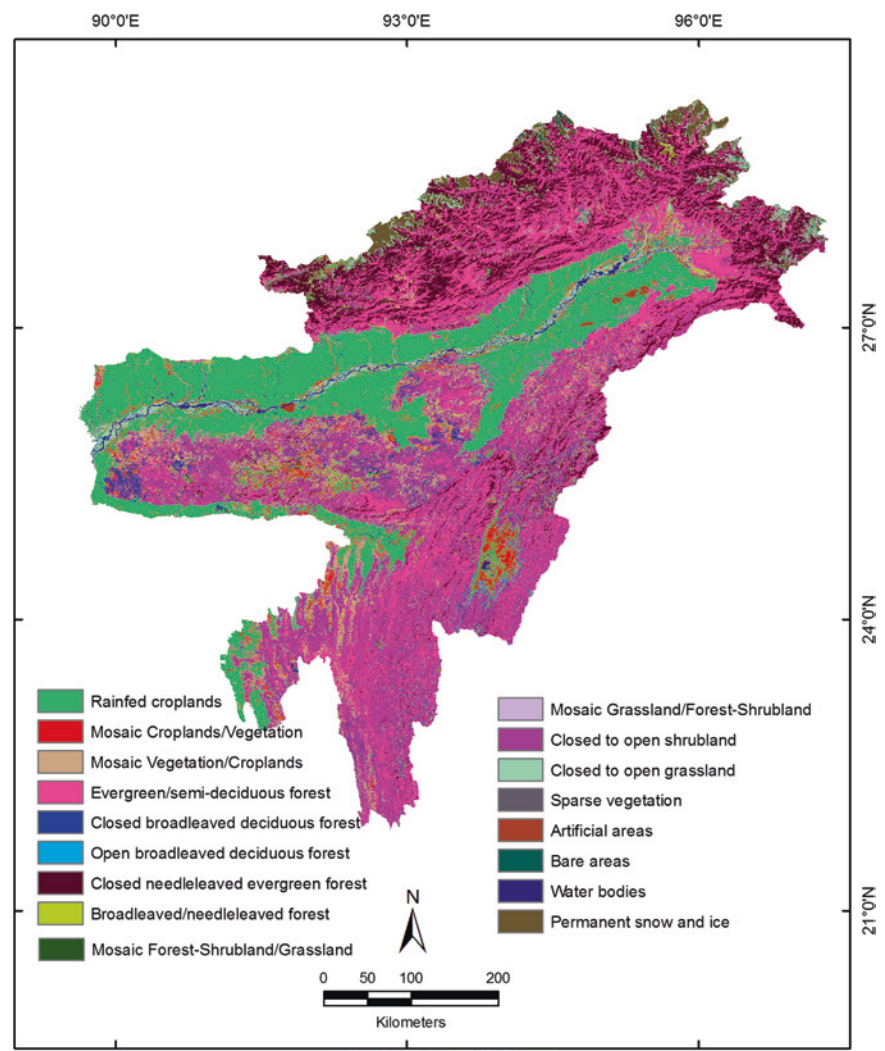


Fig. 2.1 Land use in the NER (© ESA 2010 and UCLouvain)

landscapes. Given such a context it is not surprising that in the region’s rural areas a dependence on natural resources (forests in particular) exists. Agriculture and diversification of the rural economy and development of a non-farm sector has developed but this is largely confined to the agriculturally rich lowlands of Assam. Elsewhere there is not much option than to exploiting what remains of the region’s forest resources.

Additionally the ethnic multiplicity of the region, frequent clashes between them and militancy have placed environmental priorities low in the list of priorities for the region’s state governments. Rapid growth rates of population, the bulk of it

attributed to trans-national flows from Bangladesh have not alleviated matters, as an expanding rural population needs a minimum level of fuel wood for subsistence purposes.

To understand land use change in North East India a quick look at its changing population profile seems necessary. Population density is a useful indicator of the form and intensity of human interactions with their ecosystems, as increasing populations have long been considered both a cause and a consequence of ecosystem modification (Ellis and Ramankutty 2008).

Distribution of population in NEI seems closely linked with the physiography. The low lying valleys are densely habited while the hills and plateaus have relatively

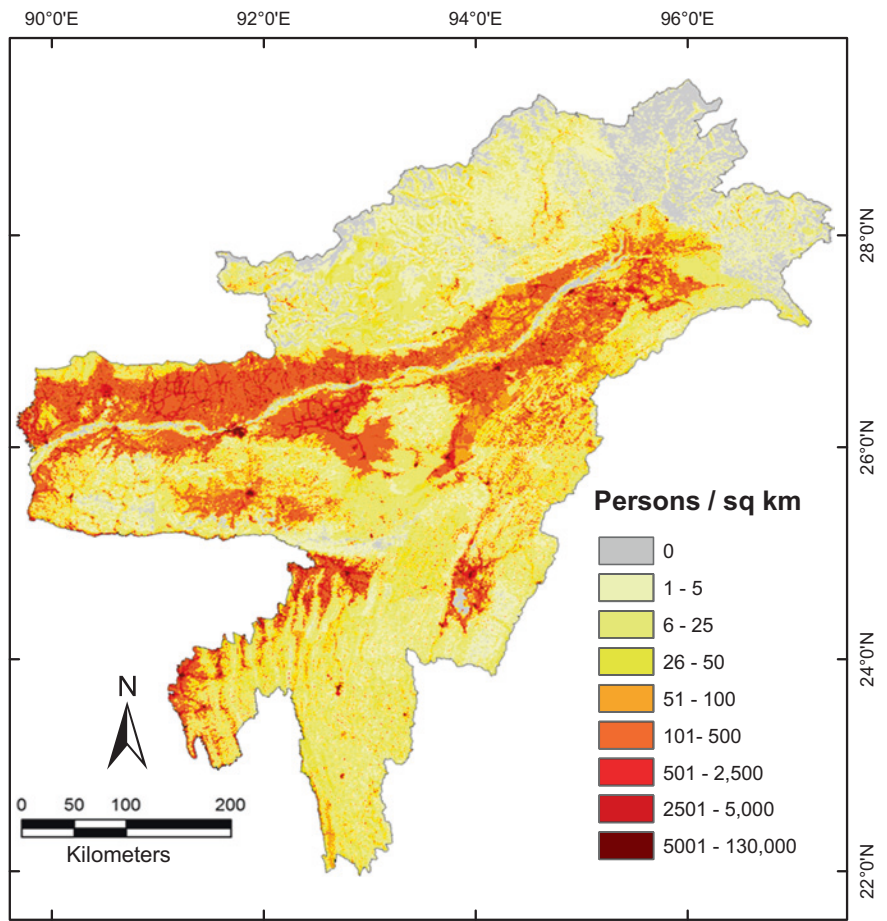


Fig. 2.2 Population density in north east India, 2008 (Source Landscan 2008™ data provided by www.ornl.gov). The northern-most state, Arunachal Pradesh is the most rugged and mountainous and has the lowest density overall. It possesses snow and ice bound areas in its northern limits as well a few glaciers and densities are in sharp contrast to the Brahmaputra valley that stretches in the middle of the NER ranging NNE-SW

lower densities. With the Brahmaputra river cutting through the territory from north east to south west dominates the landscape of Assam, population densities are dense here at 397 persons/km². The other high density patches are in Tripura and in central Manipur, both areas being lowlands drained by smaller rivers. In the rest of the NEI dominated by hills and plateaus densities are far lower. The region's population distribution (Fig. 2.2) reflects these vicissitudes.

Indeed, from a slow growing epidemic-ravaged population prior to 1,900 in a jungle infested backwater, population has climbed consistently in recent decades. In the past century population growth in NEI has been rapid and sustained.

North-east India consists of seven hill states: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Of these, Assam is the least hilly since much of it lies in the plains of the Brahmaputra river system (Tisdell and Roy 1997). Most of north-east India, however, consists of hills or mountains deeply dissected by rivers and streams owing to uplifting of the land (Tisdell and Roy 1997). Tribal people make up the overwhelming majority of the population of these states, except for Assam, and shifting agriculture and forest resources play a major role in their economic life (Tisdell and Roy 1997).

The rate of growth of all the states of North East India has been—almost without exception—much higher than the all India level (Table 2.1). The decadal rate of increase of population that was markedly above the national aggregate during the 1971–91 period, though it declined in 1991–2001. While the rates of increase for the North East were 35.87 and 27.45 those at the all India level were 24.66 and 23.85 during 1971–81 and 1981–91 respectively.

Without going into the reasons underlying these high growth rates, the effect of a rapid population growth on land-use/land-over change and forest loss/degradation needs to be kept in perspective. In largely rural societies, north east India included, the domestic energy and fuel wood requirement are largely source from free common resources. Thus fuel wood demand and usage escalates as population pressure increases. Second, it has been established by several studies that the fallow period in shifting cultivation declines with population pressure. Additionally there are other effects such as increased grazing cattle pressure and hunting activities (even poaching) as population growth occurs.

Table 2.1 Growth rates of population in North East India

State/region	Decadal growth rate			
	1971–81	1981–91	1991–2001	2001–2011
Arunachal Pradesh	35.15	36.83	26.21	25.92
Assam	36.05	24.24	18.85	16.93
Manipur	32.46	29.29	30.02	18.65
Meghalaya	32.04	32.86	29.94	27.82
Mizoram	48.55	39.70	29.18	22.78
Nagaland	50.05	56.08	64.41	–0.47
Tripura	31.92	34.30	15.74	14.75
India	24.66	23.85	21.34	17.64

Source Census of India, various years

2.4 The Extent of Deforestation

Compared to the rest of the Indian mainland the NER was brought under British rule relatively late in 1826 and transport, commerce and trade were less developed in this region than elsewhere. Although depletion of forests occurred more slowly in the face of limited accessibility, it also meant that government control of the twin scourges of expanding tea plantations established on cleared forest lands and the encroachment of immigrants peasants from present day Bangladesh on forest lands, were much more ineffective (Tucker 1988). Additionally the opening of timber mills during the 1920s along with the grant of long term leases on ‘exceptionally favourable terms’ to Marwari and Bengali contractors resulted in the commercialisation of the upper Assam forests (Tucker 1988a). The magnitude of forest loss between 1826 and 1950 is difficult to gauge. Thereafter, however, estimates on the extent of forest are available. Estimates by the Central Forestry Commission reveal a loss of 1,763 km² of forest area in the NER between 1951 and 1983 (Kashyap 1990).

Between 1989 and 1993 the NER lost 1,418 km² of forest while the rest of India recorded an increase of 1,836 km² (SFR 1995). With an additional loss of 316 km² recorded during 1993–95 (SFR 1997), the magnitude of forest loss over the 6 year period between 1989 and 95 amounted to 1,734 km². This closely approximates the loss which occurred over the earlier three decade period pointing to a clear acceleration in the rate of forest depletion. In reality the extent of forest loss was much higher at 6,066 km² but was compensated for by forest regeneration in the abandoned shifting cultivation areas.

Since 1989 the State of Forest Reports (SFR) started being prepared biennially by the Forest Survey of India (FSI) under the Ministry of Environment and Forests, Government of India (<http://www.fsi.org.in/>). A few states of north east India have registered improvements to their area under forest during the period 1989–2009, barring Arunachal Pradesh, Manipur and Nagaland (Table 2.2). The area under forest climbed from 169,379 km² in 1989 to 173,780 km² in 2009, a

Table 2.2 Changes in forest cover in NER (area in km²)

	1989	1999	2009	Variation '89 – '09
Arunachal Pradesh	68,763	68,847	67,353	–1,410
Assam	26,058	23,688	27,692	1,634
Manipur	17,885	17,384	17,280	–605
Meghalaya	15,690	15,633	17,321	1,631
Mizoram	18,178	18,338	19,240	1,062
Nagaland	14,356	14,164	13,464	–892
Sikkim	3,124	3,118	3,357	233
Tripura	5,325	5,745	8,073	2,748
NER	169,379	166,917	173,780	4,401
All India	640,134	637,293	690,899	50,765

Source SFR various years

gain of some 4,401 km². This meant the NER registered an increase of 2.59 %; over the same period forest cover increased at a substantially higher rate of 7.93 for India as a whole.

The marginal improvement in the region's forest acreage as evidenced from a state level disaggregation of the SFR is one apparent aspect of the story and a more complete understanding is possible when data is further disaggregated.

Before delving further into the matter, a rider needs to be spelt out: that strictly speaking, the SFR assessments of various years are not comparable since different data sets and interpretation methods were followed. Generally coarser data sets were available during the early assessments. Likewise the methodology also differed. Visual interpretation methods employed initially; these were replaced by digital interpretation in the post-2001 assessments; the latter is more accurate, efficient and reliable particularly when supported by sufficient ground truth verification methods, since there exists, quite often, certain features that can be mis-classified or mis-interpreted with digital interpretation methods as well. The scale of interpretation puts a limitation on the mapping and delineation of a geographical feature: for instance, at 1:250,000 scale, the smallest forest cover that could be delineated was 25 ha while at 1:50,000 scale this limit is reduced to 1 ha (SFR 2001). Thus the post 2001 assessments enabled smaller patches of forest and tree canopies (1 – 25 ha in extent), to be detected and mapped (SFR 2001).

Prior to 2001, the assessments used coarser satellite imageries, varying between the 36.25 m IRS-1B to the 80 m Landsat MSS, those after 2001 used better resolution Indian Remote Sensing (IRS) satellite data, namely IRS 1C/1D imageries with 23.5 m resolution. Resolution in this context refers to the minimum spatial size of an object on a satellite imagery that can be correctly identified.

The SFR points out this categorically in stating that a direct comparison with the previous assessment of 1999 was not possible on account of differences in technique and scale (SFR 2001) and that most of the 38,245 km² gains recorded in the 2001 assessment could be attributed to technical factors and that only a net increase of 418 km² had in fact occurred (SFR 2001).

Thus at least some portion of the encouraging gains determined using state level data for the NER must be watered down as well. Nonetheless a comparison between the SFR assessments over various years is necessary since they are the best and only reliable data source pertaining to India's forest scenario on a consistent and repetitive basis. Further the SFR assessments are far more scientific and reliable than those made by other government agencies that are not always substantiated by field verification. Usually there exist considerable differences between the recorded area under forests (the latter based on returns by the states and annual administrative reports for forest area) and the SFR data.

While the early SFR assessments categorized forests as dense, open and degraded from the 2003 assessment onwards data is available at a more meaningful level of disaggregation and categorization into very dense, moderately dense and open forests. The states of the NER fared moderately well, largely propped

Table 2.3 Forest cover by density categories 2003–09

State	2003			2009		
	VD*	MD	OF	VD	MD	OF
Arunachal Pradesh	13,904	39,604	14,508	20,858	31,556	14,939
Assam	1,684	11,358	14,784	1,461	11,558	14,673
Manipur	720	5,818	10,681	701	5,474	11,105
Meghalaya	168	6,323	10,348	410	9,501	7,410
Mizoram	84	7,404	10,942	134	6,251	12,855
Nagaland	57	5,650	7,902	1,274	4,897	7,293
Tripura	58	4,988	3,047	111	4,770	3,192
Sikkim	458	1,904	900	500	2,161	696
NER	17,133	83,049	73,112	25,449	76,168	72,163

*VD denotes Very Dense, MD Moderately Dense and OF Open Forest

Source SFR (2005, 2009)

up by Arunachal Pradesh (Table 2.3). Excluding Arunachal Pradesh a gain of only 1,362 km² was registered in the very dense category.

In spite of the generally benign picture derived from the recent SFR documents, the fact remains that forests in the NER are under pressure (Arunachalam et al. 2004; Lele and Joshi 2009; Hazarika and Saikia 2013; Saikia et al. 2013). Herein lies the need of a study to assess the drivers of forest loss in the NER.

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Over-Exploitation of Forests

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