Report on

Identification of Drivers of Deforestation

in Meghalaya

2018-19

FUNDED BY:
MEGHALAYA BASIN
MANAGEMENT AGENCY

Rain Forest Research Institute
Indian Council of Forestry Research & Education
Jorhat- 785010, Assam

Identification of Drivers of Deforestation in Meghalaya

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Preface

Tropical Forests, covering about 7% of the earth's land surface, are amongst the most vulnerable land covers reported to be disappearing rapidly worldwide. Deforestation, though was necessary at some point of time, for human settlement and agriculture, has attained proportions that have had devastating consequences, such as, extinction of plants and animals, social conflicts, climate change and so on. Drivers of deforestation and degradation though follow a general framework and pattern, in many cases, they are region specific. Identification of drivers of deforestation, therefore, is a prerequisite for combating deforestation and forest degradation in a region.

As per the recent estimates by Forest Survey of India, more than three fourth (76.5%) area of Meghalaya is under forest cover. However, various drivers of deforestation, some of them typical to the state, have been operating since time immemorial in the region. While some of them are age old practices that are a part of the culture, such as, shifting cultivation, others are of recent origin, to take mining, for example. Identification of these drivers through a scientific empirical study following appropriate ecological/sociological methodology and arranging them in the right perspective following a perception based ranking is necessary for a proper understanding of deforestation going on in the state. A five pronged approach constituting consultation of existing literature, application of remote sensing and GIS as a tool to understand the spatial distribution and extent of the drivers, ecological studies along the disturbance gradient, consultation with local communities, and seeking expert opinion were followed for the present study. Though the overall state-wide results are on expected lines, the ranking of the drivers at local level revealed some uniqueness. Wood collection, Shifting cultivation, Permanent farming, and mining are some of the direct drivers of deforestation found predominantly operating in the state. The present study re-emphasises the importance of awareness creation among the communities regarding the ill effects of deforestation, strict monitoring of law enforcement, review of some of the existing laws, generation of sustainable and viable alternative income generation activities for communities, besides many recommendations addressing the issues related to deforestation and degradation. The present report is the result of research and review work for a period of about one year and hopefully would help in better understanding of the issues pertaining to deforestation and forest degradation in the state of Meghalaya and help in execution of appropriate strategies for the state in general and for the community in particular.

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Acknowledgement

Successful completion of this project would not have been possible without the funding, encouragement, guidance, support and active participation of the following organisation/ individuals. Rain Forest Research Institute duly thanks all of them:

- Meghalaya Basin Management Agency (MBMA), Meghalaya Basin Development Authority (MBDA), and World Bank for funding the project
- Director General, ICFRE - Dehradun for his continuous support and allowing to take up the consultancy
- PCCF and HoFF, Department of Forest and Environment, Govt. of Meghalaya for all logistic and moral support
- Autonomous District Councils, Meghhalaya for their support during the project period
- All the Forest Officials from Department of Forest and Environment, Govt. of Meghalaya
- All the State and Central Govt. Departments/ Universities/ NGOs for providing data/information, expert opinion and support during the project tenure.
- And most importantly, all the Community Heads and community as a whole for their support during the project period.

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Acronyms

AAU	Assam Agricultural University
AFOLU	Agriculture, Forestry and Other Land Use
BASP	Bhartiya Agni Suraksha Parishad
CF	Community Forest
COP	Conference of Parties
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
GHADC	Garo Hills Autonomous District Council
ha	Hectare
HH	Household
ICFRE	Indian Council of Forestry Research and Education
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Intergovernmental Panel on Climate Change
ISFR	India State of Forest Report
JHADC	Jaintia Hills Autonomous District Council
KHADC	Khasi Hills Autonomous District Council
km	Kilometre
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry Activities
MBMA	Meghalaya Basin Management Agency
MCLLMP	Meghalaya Community Led Landscape Management Project
MoEF&CC	Ministry of Environment, Forest and Climate Change
MRV	Measurements, Reporting and Verification
MT	Metric Tonne
NGOs	Non-Governmental Organizations
PESA	The Provisions of the Panchayats (Extension to Scheduled Areas) Act
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing emissions from deforestation and forest degradation, and role of conservation, sustainable management of forests and enhancement of forest carbon stocks
RFRI	Rain Forest Research Institute
SFD	State Forest Department
sq	Square
TERI	Tata Energy Research Institute
UNFCCC	United Nations Framework Convention on Climate Change
VC	Village Council

Executive Summary

Introduction

Deforestation and forest degradation, on a global scale, has become one of the major causes of greenhouse gas emissions resulting in large scale loss of biodiversity, global warming and subsequent climate change. According to fifth assessment report of Intergovernmental Panel on Climate Change (IPCC), annual Green House Gas (GHG) emission flux from land use, land-use change and forestry activities (LULUCF) accounted for about 9-11% of total anthropogenic GHG emissions. Forest vegetation sequesters carbon, while deforestation and degradation of standing forests lead to release of stored carbon.

There are various drivers of Deforestation and forest degradation operating in tropical countries for centuries. Identification and understanding of these drivers are key to all sustainable developmental activities. While discussing the proximate and underlying causes of deforestation, based on the various case study-based evidence, Geist and Lambin (2001) listed the drivers of deforestation, mostly operative in Tropical countries.The drivers were categorized under three basic types, *viz*.- proximate causes, underlying causes and other causes. Proximate causes include Agricultural expansion (Shifting and Permanent cultivation, etc.), Wood extraction (for Fuel wood, Pole wood, Charcoal production, etc.) and Infrastructure extension (Transport, Settlement expansion, Private enterprise, etc.). Underlying causes include Economic factors (Urbanization and Industrialisation), Policy and institutional factors (Formal polices, Informal polices, etc.), Technological factors (Agro-technological change, Technological application in the wood sector, etc.), Cultural /socio-political factors (Public attitudes, values, beliefs), Demographic factors (Population pressure, Immigration, etc.). Other factors deal with Land Characteristics (Soil quality, Slope, topography, Water, Vegetation related issues), Social trigger events (socio-political unrest, Health and economic crisis, Abrupt population displacement, Govt. Policy failure) etc.

Meghalaya, a northeast Indian state, unique in its own right is undergoing large and small scale deforestation and forest degradation due to various conspicuous and underlying reasons over the years. The present project was initiated to understand the various drivers of deforestation operating in Meghalaya and their ecological and socio-economic cause-effect relationship.

Background

The Meghalaya Basin Management Agency (MBMA), Govt. of Meghalaya is implementing the World Bank assisted Meghalaya Community Led Landscape Management Project (MCLLMP), of the Government of Meghalaya, that was officially launched on 8th of May, 2018. This project is set to spread over a period of five years and is aimed at strengthening rural communities and traditional institutions to empower the community to take charge of their natural resources and implement community led sustainable natural resource management plans.

Meghalaya is rich in forest resources and more than three fourth of its area under forest cover. However, about 40 per cent of these forests have degraded into open and secondary forests over the years. The reason behind this large-scale and sporadic deforestation/ degradation is manifold and requires systematic studies to understand the same. The major drivers of deforestation and degradation like mining and shifting cultivation (*jhum*ing) in the state are to be scientifically identified and here comes the role of MCLLMP as the project tries to find solutions through various interventions.

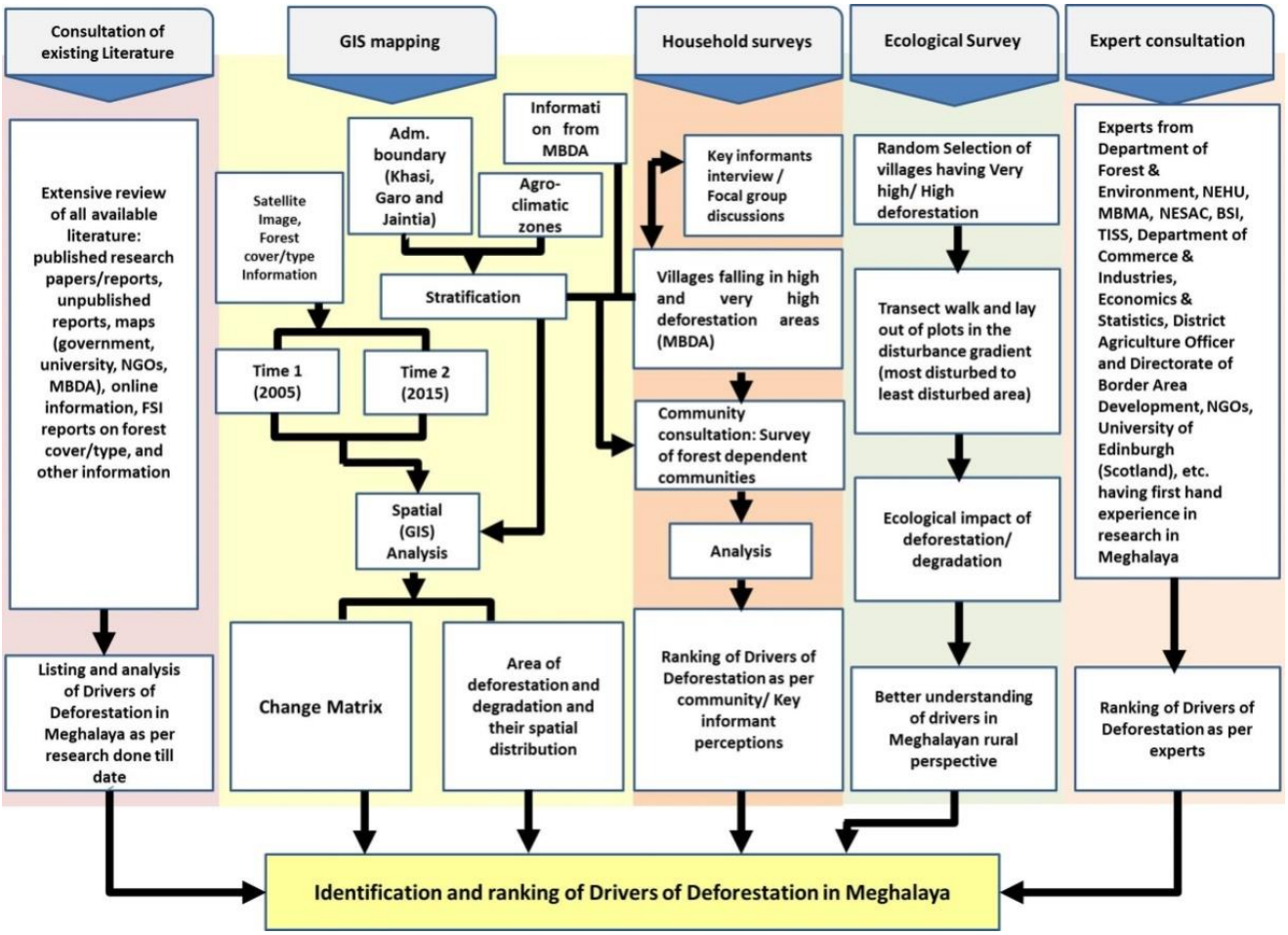
As a part of the broad goal of MCLLMP, Rain Forest Research Institute, Jorhat an institute of ICFRE under Ministry of Environment, Forests and Climate Change, Govt. of India, was given the responsibility to conduct the study on 'Identification of Drivers of Deforestation' in Meghalaya.

Objectives

The objective of the assignment is to identify potential drivers leading to deforestation in the state of Meghalaya *viz*.- faulty agricultural practices, social and cultural practices, mining activities, industrial pollution and other forms of developmental activities. As a pre-requisite, identification of drivers requires an in-depth understanding of the process of deforestation and degradation.

Methods

Addressing such a diverse issues require an integrated approach. In the present study we tried to understand the drivers of deforestation operative in Meghalaya following five approaches. These are consultation of existing literature, GIS mapping, Household surveys, Ecological study and Expert consultation. The paradigm of various approaches is shown in methodology flow diagram as given below:



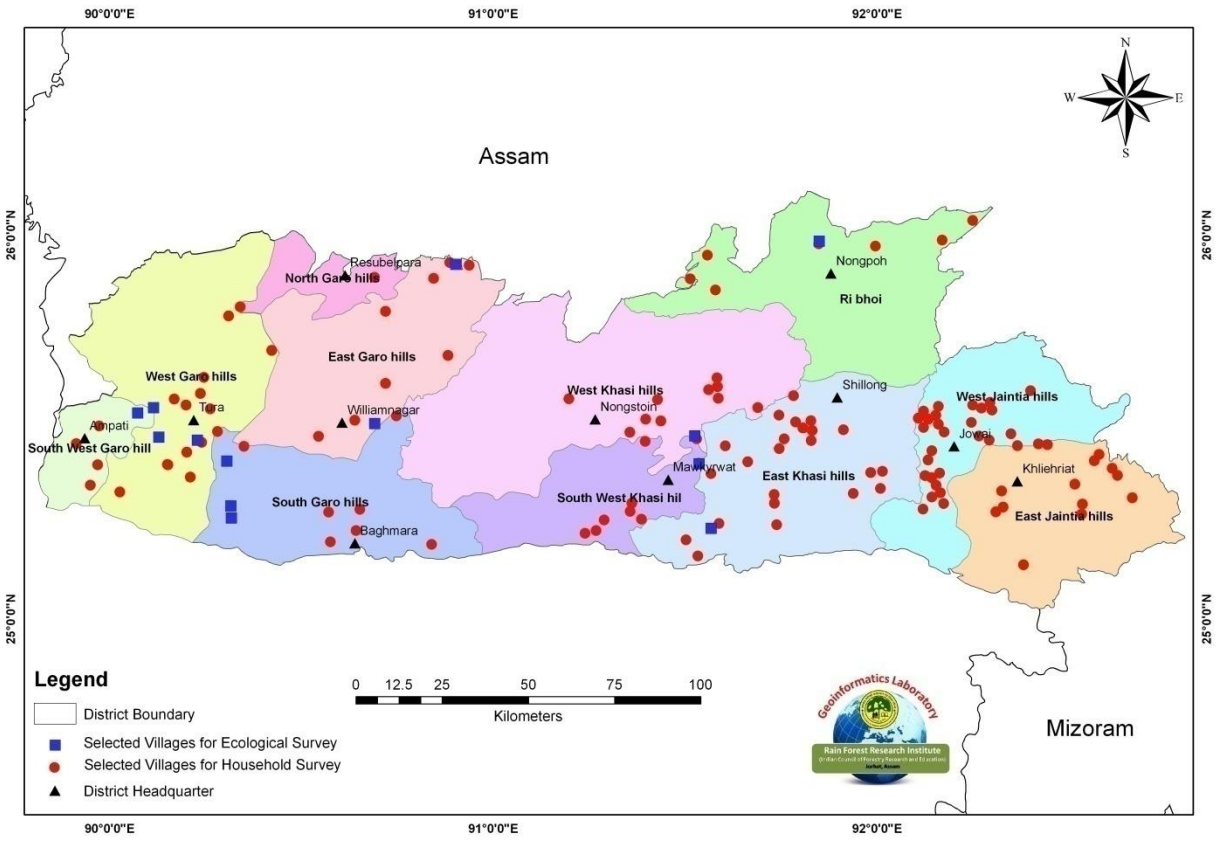
All the available literature was collected from all possible sources including published research papers/reports, unpublished reports, maps (government, university, NGOs, MBDA), online information, FSI reports on forest cover, etc. For GIS mapping and socioeconomic survey, the State was divided into three regions (Jaintia, Khasi and Garo Hills Division) which was further divided into Nine Agro-climatic zones, *viz*.- Hot (Extremely wet, Wet and Moist), Mild (Extremely wet, Wet and Moist) and Cold (Extremely wet, Wet and Moist) and 27 final strata were generated. Sample areas of deforestation were identified in different regions in a manner that areas of different socio-economic status, tribal groups and bio-physical and physiographic variations are covered. ArcGIS and ERDAS Imagine packages were used for GIS operation and generation of spatial maps.

Stakeholder consultation was done to develop an information database on drivers of deforestation by (1) Community consultation surveying forest dependent communities in all the three zones of Meghalaya, and (2) Key informants interview (KII). These were used to obtain information of drivers from forest department personnel, field staff of forest departments of Khasi, Garo and Jaintia autonomous councils and other key

persons on an *ad hoc* basis during the entire study period. Ecological samplings in some of the selected villages were undertaken to understand the disturbance gradient in the villages falling under high degradation zone. Transect walk from village boundary (assumed to be of the highest disturbance) to the core area of the nearest forest (assumed to be the least disturbed) were conducted in the selected villages. Qualitative information on various aspects of deforestation, degradation and other disturbances were noted. Presence of invasive species, signs of domestic grazing animals, denuded stems, if any, etc., were also noted. Three quadrats of 0.1 ha sizes were also taken along the disturbance gradients. A one-day Stakeholders' workshop was organized at Shillong on 29th January, 2019. The main focus was to have a discussion on the Stakeholders' perception on various drivers of deforestation in their respective zones of the State, in the light of facts and figures generated by the concerned Departments, and their subsequent ranking. Specially designed questionnaire was served to the participants with a request to fill the same based on their experience.

Study area

The study area is the state of Meghalaya as a whole. For Socio-economic data collection purpose however, a total of 130 villages falling in areas with high and very high deforestation rate were selected. Forty nine among them are falling in Khasi Hills followed by thirty nine and forty two in Garo and Jaintia hills, respectively. Besides, thirteen villages were selected randomly for ecological data collection.



Meghalaya – at a glance

The state of Meghalaya covers an area of 22,429 km^2 and comprises of 11 districts falling in three divisions *viz*.- Jaintia Hills Division (West Jaintia Hills and East Jaintia Hills) Khasi Hills Division (East Khasi Hills, West Khasi Hills, South West Khasi Hills and Ri-Bhoi) and Garo Hills Division (North Garo Hills, East Garo Hills, South Garo Hills, West Garo Hills and South West Garo Hills). The total population is 2.96 million and the population density is 132 persons per km^{2}and most of the population (79.9%) is in rural area (Census 2011). Meghalaya is predominantly a tribal state inhabited by three tribal communities, namely *Khasi*s, *Jaintia*s and *Garo*s accounting for 89% of the total population. As per the livestock census, 2012, the total livestock in the state is 1.19 million.

Overall, Meghalaya has a monsoon type of climate which is directly influenced by the south-west monsoon. There is heterogeneity in composition and character of soil. The colour of soil varies from dark brown to reddish brown. The texture of soil extends between loamy to fine loamy with the depth ranging from 50 to 200 cm across the State. The nature of soil is acidic which varies from acidic (pH 5.0 to 6.0) to strongly acidic (pH 4.5 to 5.0).

About 76.45% (17,146 km^2) of the area in Meghalaya is under forest cover (FSI, 2017) with 453, 9386 and 7307 km^2 of Very Dense, Moderately Dense and Open forests respectively. About 4.58% of the total geographical area and 6.56 % of the total forest area of the State (1,027.20 km^2 out of 15,657 km^2) is under the control of State Forest Department. Rest of the area is either private or clan/community owned and is under the indirect control and management of the Autonomous District Councils.

The forests of Meghalaya are under stress for decades due to various drivers of deforestation and degradation operating in the state. Forest cover, in most of the districts and overall, has been found to have decreased when compared with earlier assessments from 2009 onwards since when the spatial data are compatible and comparable to the present.

In Meghalaya, as a whole, moderately dense forests which is the biggest category among all forest cover classes, was found to have decreased. Open forest, on the other hand exhibited an increase in overall area indicating degradation; slight increase in the dense forest was also recorded. Overall, it can be summarised that forest cover in the state has decreased during the last decade (2009-2017). The major gainer in terms of forest cover in the state are East and South Garo Hills (49 km^2 each) and Ri-Bhoi district (22 km^2). While decrease in forest area is an indicator of deforestation, the decrease in the Dense and Moderately Dense forests is a sign of forest degradation, with the resultant increase in Open forests and is a matter of concern. While deforestation is immediately noticeable and remedial action can be taken, degradation is slow and not noticeable; and when the system is fully degraded, most of it is irrecoverable.

Drivers of Deforestation

(a) Agriculture/ Shifting cultivation: Agriculture is the main livelihood of the people of Meghalaya as nearly 81% of the population lives in rural areas. The area under agriculture, a proximate cause, in the state has increased from 2,23,756 hectares (9.98 % of the total geographical area) in 1990 through 2,65,874 hectares (11.85 %) in 2004 to 3,43,431 hectares (15.31 %) in 2015.The ethnic communities of Meghalaya follow two major types of agricultural practices, viz. – (1) Shifting Cultivation or Slash and Burn Agriculture or *Jhum*, and (2) Terrace or Bun Cultivation. Shifting cultivation is

practiced in and around forests, and terrace cropping is practiced in valleys and foothills, and inside plantation forests. Enormous increase in human population has led to massive coverage of land under shifting cultivation. *Jhum* cultivation is practiced chiefly for subsistence with surplus produce traded in local markets for additional income. Shifting cultivation was found to have decreased from 744 km^2 during 2001-03 to 449 Km^2 during 2005-06 and again increased to 541 km^2 during 2008-09. 'Current *Jhum*' is found to have increased in Jaintia Hills and Ri Bhoi districts of Meghalaya during the period from 2005-08 to 2008-09. For other districts, including East Garo Hills, West Garo Hills, South Garo Hills and West Khasi Hills district, however it was found to have decreased. '*Jhum* fallow' is found to have increased in all the districts of Meghalaya barring East Garo Hills.

(b) Wood collection: Meghalaya, possessing six types of forest on the basis of availability of economically important tree species, is fairly rich in timber resources. In terms of Volume/Area 'Teak forests are by far with the best average stocking (143.53 m^3 per ha); while the lowest (41.73 m^3 per ha) is that of 'Hardwood mixed with conifers forests'. Miscellaneous type has the highest total volume as more area is under this forest type. Hence, the total growing stock standing in the 8140.11 km^2 (accessible tree forest area) has been assessed at 81.98 million m^3 corresponding to 172.47 million stems. Continued extraction of this resource without commensurate regeneration can lead to loss of species and ecosystem functions.

(c) Mining: The valuation of mineral production in Meghalaya was estimated at Rs. 1,514 crore (2014-15) which has decreased by 63% as compared to that in the previous year (2013-14). About 84% of the total value of mineral production accrued from coal (25,00,000 MT) during the year 2015, whereas the remaining was contributed mainly by limestone (36,96,000 MT). There were 17 reporting mines in 2014-15 as against 14 in the previous years. Though mining has reduced due to judicial interventions, the illegal mining needs to be controlled. The areas degraded by mnining needs restoration.

(d) Population increase and Settlement expansion: In Meghalaya, during a span of 20 years from 1991 to 2011, an increase of 67.2% population has been registered. Again, the birth rate (per 1,000 people) in 2014 was 24.1 (26.2 in the rural areas and 14.7 in urban areas), higher than the national average of 21. Further, the State's birth rate was 23.7 pitted against the national average of 20.8 and 20.4, recorded during 2015 and 2016, respectively. Human habitation or settlement expansion is a direct function of population increase. The houses in the state have increased from 2.56 lakhs

in 1981 to 7.21 lakhs in 2011. The decadal growth rate was found highest in 1981-1991 (56.5%) followed by 2001-2011 (38.6 %), 1991-2001 (30.0%) and 1971-1981 (13.9%).

Relative importance of Drivers of deforestation

A total of 1366 households in 130 villages situated in forest fringe areas of Meghalaya were surveyed. In questionnaire based survey, questions related with the perception of local community was also asked and it was found the 99 percent of the respondents were aware about the deforestation and all of them state that the deforestation is not desirable and government along with communities should take the initiatives to stop the deforestation in the state of Meghalaya.

The key findings of the present work may be summarized below:

- Extensive literature review reveals the fact that in Meghalaya the following Direct Drivers of Deforestation are operating: Shifting cultivation, Permanent farming, Wood collection, Road network development, Settlement expansion, Charcoal making, Mining and Others minors drivers (irrespective of rank/ impact).
- On the other hand, the following Indirect Drivers of Deforestation are observed to impact, *viz*. - Poverty, Less awareness, Increase in population, Weak forest law enforcement, Lack of employment, Promotion of Agriculture, Non-availability of alternatives and Other minor drivers (irrespective of rank/ impact).
- With the advent of modern tools and technology, research on various issues related to natural resource management is going on. However, information gap in various sectors is still a major drawback. As for example, the latest data of Shifting cultivation for Meghalaya is available only for 2008-09 and not updated yet. Sporadic studies on Garo Hills and some other areas though available, data/ information gap on Shifting cultivation is obvious and immediate studies in this regard is required. Similarly, latest data/ information on Rubber plantation (area and productivity), Wood collection (both, commercial and illegal), Charcoal production, Forest vulnerability issues (forest fires, encroachments etc.), Land use change, Immigration etc.
- While most drivers were common to all the three regions of Meghalaya, the relative importance (weightage) of some drivers varied among the different regions.
- The 5 key direct drivers of deforestation in Khasi Hills are: Wood collection > Shifting cultivation> Settlement expansion> Permanent farming> Charcoal making.
- The 5 key direct drivers of deforestation in Garo Hills are: Shifting cultivation> Permanent farming> Wood collection> Settlement expansion> Road network expansion.

- The 5 key direct drivers of deforestation in Jaintia Hills are: Wood collection> Mining> Shifting cultivation> Charcoal making> Settlement expansion.
- The 5 key direct drivers of deforestation in Meghalaya, as a whole are: Wood collection (fuelwood and timber)> Shifting cultivation> Settlement expansion> Mining (in mining affected pockets of State)> Permanent farming (conversion of forested area into monoculture permanent farming of cashew nut, betel nut, tea and rubber).
- The key indirect drivers included poverty, overpopulation, non-availability of alternatives, lack of employment and several issues related to governance including: inadequate enforcement, inadequate policies or policies not followed and lack of harmony among forest departments of State and Autonomous Councils.
- With respect to the ecological study carried out in selected villages and nearby forests, it was observed that the diversity of plant forms (in terms of Shannon – Weiner Diversity Index) increased with the decrease in the level of biotic interference and disturbance. Large-scale deforestation/ degradation induced by biotic disturbance therefore found to disturb the ecological balance and biodiversity profile of the region. However, further study with greater sampling intensity is required to draw any final conclusion.
- The result of the spatial analysis between two time series (2005 and 2015) shows that 1705 km^2 area within the forest cover improved to denser category in time span of a decade in Khasi Hills. An area of 4830 km^2 remained intact in its original density class whereas 724 km^2 was converted from non-forest to forest class (Plantation). An area of 625 km^2 and 691 km^2 were recorded under Forest Degradation and Deforestation in Khasi hills, respectively.
- In Garo Hills, 1701 km^2 area within the forest cover improved to denser category in time span of a decade. An area of 4116 km^2remained intact as its original density class whereas 531 km^2 was converted from non-forest to forest class (Plantation). However, 531 km^2 and 568 km^2 were recorded under Forest Degradation and Deforestation in Garo hills. Drivers like 'Wood collection' are one of the most important reasons for this large scale forest degradation.
- In Jaintia hills, 557 km^2area within the forest cover improved to denser category in time span of a decade. An area of 1183 km^2remained intact as its original density class whereas 533 km^2 were converted from non-forest to forest class (Plantation). 270 km^2 and 228 km^2 were recorded under Forest Degradation and Deforestation in Jaintia hills.

Strategies to address deforestation

There are many challenges to check the deforestation in the state of Meghalaya, viz.- community ownership of forest, very less area with the State Forest Department to

manage, inadequacy of capacity of Forest Departments of state as well as of Autonomous District Councils and practically ineffectiveness of many existing policies and measures. The sheer complexities of direct and indirect drivers demand multiple strategies to reduce deforestation. The major direct drivers includes wood collection, shifting cultivation, settlement expansion, mining and permanent farming; where as indirect drivers were poverty, overpopulation, lack of awareness, weak enforcement of forest laws and policies and lack of land use plans. The scientific organisations need to be work on development of protocols or models, enhancement of productivity, livelihood sustainability and educate the society, to secure and support livelihoods of the people. Besides, the key recommendations and specific interventions that can be taken up under the MCLLMP project are as detailed below.

	Key Recommendations	Interventions
Measures to curb the Direct Drivers of Deforestation		
Wood Collection		
1.	Control of illegal wood collection especially in community managed forests	➢ Increase watch and ward by creation of village forest protection volunteers
2.	Plantation of indigenous fast growing species especially in home gardens, farmlands, Jhum lands, fallow lands, etc. to meet the increasing demand of wood.	➢ Increase availability of saplings of indigenous fast growing species ➢ Training on cultivation of indigenous fast growing species
3.	Promotion and use of energy efficient cooking devices along with the alternative fuel like LPG	➢ Distribution of energy efficient cooking devices ➢ Awareness on energy efficient cooking devices, alternative fuel and ill effects of indoor pollution due to use of fuelwood
4.	Promotion of use of seasoned/treated wood as well as composite wood to increase the life of wood products.	➢ Training on seasoning and preservation of wood and bamboo ➢ Large amount of fuel-wood is needed for heating the bitumen used for road construction. The concerned authority should ensure the application of bitumen heaters instead.
Shifting Cultivation		
1.	Increase the productivity of shifting cultivation fields	➢ Increase availability of seeds of high yieldingvarieties of indigenous crops ➢ Training on improved cultivation techniques and bio-fertilizers
2.	Annual monitoring programmes on shifting cultivation	➢ Collection of latest data of shifting cultivation ➢ Preparation of annual monitoring plan
3.	Transfer of technology from one tribe to another	➢ Documentation of different improved technologies ➢ Training of tribal communities
4.	Development, promotion and practice of agroforestry models to enhance overall productivity	➢ Documentation of improved agroforestry models ➢ Promotion of improved agroforestry models
5.	Marketing of products of shifting cultivation	➢ Marketing skill development in local youth Development of marketing strategies

Settlement expansion		
1.	Control migration from rural area to urban area	➢ Alternative sources of livelihoods in rural areas (Details are given separately in the Full Report)
2.	Enforcement of strict land use planning	➢ Awareness about land use planning
Mining		
1.	Control on Illegal mining activities	➢ Alternative sources of livelihoods (Details are given separately)
2.	Restoration of degraded mining sites through forestry interventions	➢ Awareness programme on conservation, restoration and management of forest resources
Permanent farming		
1.	Discourage monoculture plantation on forest area	➢ Promotion of tree crops should be in the form of agro forestry ➢ Series of awareness programmes on ill effects of monoculture on forest biodiversity and ecosystem services
Charcoal burning		
1.	Discourage of charcoal production from wood	➢ Promotion of bamboo charcoal ➢ Trainings on bamboo charcoal production ➢ Large scale deforestation is caused due to making of charcoal that is utilized in the ferro alloy industry. The legality and mode of production of such industries should be periodically and strictly monitored.

Measures to curb the Indirect Drivers of Deforestation		
Increase in population		
1.	Control on population growth in the state	➢ Series of awareness campaign on family planning and related matters
2.	Reducing poverty of forest-dependent people through alternative livelihood support	➢ Professional or technical trainings to the economically poor and marginalized people ➢ Training on cultivation and harvesting of commercially important medicinal, aromatic, wild edible etc. plants to the farmers
3.	Development of Eco-tourism facility	➢ Training to local youth on Eco-tourism ➢ Marketing of Eco-tourism sites of Meghalaya
Lack of Awareness		
1.	Training programmes on conservation, restoration and management of forest resources especially in shifting cultivation areas	
2.	Sensitization programmes for students against the adverse effect of deforestation on health and environment at school and college level	
3.	Plantation programmes at block and village level, on important social occasions and celebrations	
Weak enforcement of forest laws and policies		
1.	Awareness programmes on forest laws and policies	

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Chapter 1
Introduction

1.1 Background

The Meghalaya Basin Management Agency (MBMA), Govt. of Meghalaya is implementing the World Bank assisted Meghalaya Community Led Landscape Management Project (MCLLMP), a specialized project of the Government of Meghalaya, officially launched on 8th of May, 2018. This distinctive project is set to spread over a period of five years. The project is aimed at strengthening rural communities and traditional institutions to empower the community to take charge of their natural resources by implementing community led sustainable community natural resource management plans in a systematic manner.

Meghalaya is rich in forest resources and more than three fourth of its area under forest cover. However, about 40 per cent of these forests have degraded into open and secondary forests over the years. The reason behind this large-scale and sporadic deforestation/ degradation is manifold and requires systematic studies to understand the same. The major drivers of deforestation and degradation like mining and shifting cultivation (*jhum*ing) in the state are to be scientifically analyzed and here comes the role of MCLLMP as the project tries to find solutions through various interventions. In addition, MCLLMP is also playing an effective role in bringing communities together and binding them to a common and sustainable cause. Empowering the women folk of the matrilineal society of the State by giving them an opportunity in decision making processes is another goal of the project.

As a part of the broad goal of MCLLMP, Rain Forest Research Institute, Jorhat a premier institute of ICFRE under Ministry of Environment, forests and Climate Change, Govt. of India, was given the responsibility to conduct the study on 'Identification of Drivers of Deforestation' for the MCLLMP project in Meghalaya. Accordingly an 'AGREEMENT' was signed between MBMA, Shillong and RFRI, Jorhat on 13 December 2017.

1.2 Objectives

The objective of the assignment is to identify potential drivers leading to deforestation in the state of Meghalaya *viz*. faulty agricultural practices, social and cultural practices, mining activities, industrial pollution and other forms of developmental activities. As a pre-requisite, identification of drivers requires an in-depth understanding of the process of deforestation and degradation.

1.3 Deforestation and Forest Degradation-Cause and effect

Forests, which cover roughly one-third of the earth's land surface, provide several environmental benefits including its role in the hydrologic cycle, soil conservation, mitigation of climate change and conservation of biodiversity (Sheram, 1993).The total forest area in 2015 is estimated as 39.99 million km^2 with a maximum area of 10.15 million km^2 in Europe and a minimum of 1.74 million km^2 in Oceania (FAO, 2016). It is known that forest vegetation sequesters carbon, whilst deforestation and degradation of standing forests lead to release of stored carbon (Sathaye et al., 2011). Ample evidence is available suggesting that on account of heavy deforestation, the whole world is facing an environmental crisis, though unable to comprehend the dimensions of forest destruction, going on for years, until recently.

Tropical forests contain about 40% of global terrestrial carbon, which account for over half of global gross primary productivity (Pan et al., 2011) and are known to harbour about half of all species on Earth, reported to be at riskdue to rapid land use/ land cover change. The flora and fauna inhabiting these fragments of forest are becoming increasingly vulnerable and gradually moving towards extinction. Efforts to comprehend the causative pattern of tropical deforestation have shown that communities living in and around have tremendous role in it.

Deforestation is defined as the conversion of forest to an alternative permanent non-forested land use such as agriculture, grazing or urban development (van Kooten and Bulte, 2000), which causes a relatively large loss of carbon stock per deforested area (De Fries et al., 2006). In United Nations Framework Convention on Climate Change (UNFCCC) terms, it

involves a permanent change to another land use (Penman et al., 2003). It is a well-established fact that the total forest cover has been declining globally. Between 2000 and 2012, globally 2.3 million km^2 of forest were lost and 0.8 million km^2 of new forest gained (Hansen et al., 2013). However, the gross deforestation rate is estimated to have declined (FAO, 2016). Degradation, on the other hand, refers to reduction in productivity and/or diversity of a forest due to unsustainable harvesting (removals exceeding replacements and changes in species composition), fire (except for fire-dependent forest systems), pests and diseases, removal of nutrients, and pollution or climate change (e.g. changes in productivity, total organic matter, and forest composition) (TERI, 1998). Degradation due to tree cover loss, mainly owing to fire reached a record high of 0.29 million km^2 in 2016 (Weisse and Goldman, 2017).

Forests are known as source as well as sink of carbon. Deforestation and forest degradation lead to the release of carbon (as carbon dioxide) stored in the tree biomass. On a global scale, deforestation and forest degradation have become the major causes of greenhouse gas (GHG) emissions in addition to burning of fossil fuels (Rawat et al., 2017). According to fifth assessment report of Intergovernmental Panel on Climate Change (IPCC), annual GHG emission flux from land use, land-use change and forestry activities (LULUCF) accounted for approximately 4.3-5.5 Gt. CO_2eq/yr or about 9-11% of total anthropogenic GHG emissions (Smith et al., 2014).

The pre-requisite for development of policies and measures to amend contemporary trends in forestry towards a more climate and biodiversity friendly outcome is a fundamental understanding of the drivers of deforestation and degradation. Parties to the UNFCCC were keen to develop a mechanism for reducing emissions from deforestation and forest degradation, enhancing forest carbon stocks, sustainable management and conservation of forests (REDD+) in developing countries. Besides the discussion on policy incentives and modalities for measurements, reporting and verification (MRV), another issue which had received increasing attention in the REDD+ debate was identifying drivers and other activities causing forest carbon change (Bendorf et al., 2007; UNFCCC, 2010). The developing countries have been encouraged to identify land use, land use change and

forestry (LULUCF) activities, especially those linked with the various drivers of deforestation and forest degradation; apart from assessment of their potential contributions to the mitigation of climate change (UNFCCC, 2009, 2010). Accumulation of knowledge of context-specific drivers or activities along with a proper understanding of their underlying causes and processes (Huettner et al., 2009) will help to define proper policies (Boucher, 2011, Rudorff et al., 2011) and projecting expected developments, such as required for setting forest reference levels (UNFCCC, 2011). Accordingly, besides the essentiality of national data on forest area change and inter-linked changes in forest carbon stocks to estimate emissions and removals, the need for national data on categories of deforestation and degradation drivers along with their relative importance is also equally relevant to support national REDD+ activities.

Regardless of this relevance, national-level quantitative information on drivers and activities causing deforestation and forest degradation has largely remained unidentified. There are proximate or direct drivers of deforestation which are human-induced activities that directly affect through the loss of forests and consequently represent proximate sources of change that is outcome obtained from multifaceted interactions of underlying forces in social, political, economic, technological and cultural domains. Direct drivers can be grouped into different categories such as agriculture expansion, expansion of infrastructure and wood extraction (Geist and Lambin, 2001). Although, with respect to tropics, the key driver of deforestation has been agricultural expansion (Gibbs et al., 2010), while other drivers may vary on a regional level and tend to change over time (Rudel et al., 2009; Boucher et al., 2011). Many a times, the division between direct and underlying causes as well as amidst anthropogenically and naturally induced change is often not as apparent as it may possibly appear. In reality, deforestation or the degradation of forests are brought about by long, complex chains of causation (UNFCC, 2011b). Profound pressure on forests, largely owing to unsustainable extraction of fuel wood and over-grazing resulting in forest degradation has been the consequence of an ever-growing population, widespread poverty, and restricted employment prospects in agricultural and industrial sector (Joshi and Singh, 2003).

In an Indian perspective, the drivers of deforestation and forest degradation can be categorized as: firstly, which are planned in accordance with policies, legal framework, management plans, etc., and secondly, which are spontaneous, (beyond government and management control issues), and usually not accounted. The National Forest Commission pointed out that around 41 per cent of total forest is already degraded, 70 percent of the forests have no natural regeneration, while 55 per cent of the forests are prone to fire (MoEF, 2006). As discussed by Reddy et al. (2013), an annual gross deforestation rate of 0.6% between 1981 and 1990 was estimated, wherein the scale was unknown and afforestation areas were not included (FAO, 1997). Ravindranath and Hall (1994) suggestedan annual net deforestation to be 0.04% between 1982 (1:1 million scale) and 1990 (1:250,000 scale). Later, Ravindranath et al. (1997) suggested India's annual net deforestation to be 0.07% between 1981–83 and 1985–87 based on FSI assessment. The latest estimate of gross deforestation rate is -0.43% between 2009 and 2011 (Reddy et al., 2013). In India, a multitude of factors are found to be affecting forest degradation, inclusive of livelihood pattern, demand-supply gap of forests products, livestock overgrazing, illegal felling, forest fires, and diversion of forest land for non-forest uses due to competing land-use demand for development and so forth (FSI, 2003, 2011; MoEF, 2006, 2009; Gundimeda et al., 2007; Davidar et al., 2010; Nayak et al., 2012).

Keeping in mind, India's economic growth in the last decade, several concerns have been raised in terms of its present and future resource demands for material and energy (Singh et al., 2012). Indian forests, with roughly 2.4% of world's geographic area, are facing enormous biotic pressure catering to nearly 30% of fodder needs of the cattle population (i.e. 18% of global livestock population) and 40% of domestic fuel wood needs of the communities (*ca* 17% of world's population). The widening gap between demand and supply for fuel wood, timber, and fodder is further aggravating this pressure. Again, forest degradation is mainly a result of shifting cultivation practices over an area about 12,000 km^2 in Eastern and North-eastern India. Concerns over contemptible role of elected Panchayati Raj institutions *vis-a-vis* Joint Forest Management Committees (JFMCs) in forest management, limited involvement of non-profit-making voluntary sector, control over minor forest products, and implementation of Forest Rights Act and PESA are amongst a

few apprehensions recurrently voiced with slight recognition for the incredible efforts made to maintain forest cover in the contemporary circumstances (ICFRE, 2011).

Of the total wood extracted in India (434.77 million cum, 2011), the fuelwood volume was 385.25 million cum (FAO, 2015). The timber consumption was observed in three sectors (in non-fuelwood categories) i.e. housing, furniture and agricultural implements (FSI, 2011). Summing up all categories, the total estimated wood consumption (excluding fuelwood) in India comes to about 69 million cum annually (Shrivastava and Saxena, 2017). Considering the large share of wood markets (panel and plywood, and furniture), which are moderately unorganized, and absence of official estimates, there is likelihood of a gross underestimation. Fuelwood, still the dominant energy source in rural India, amounts to approximately 90 per cent of the total wood production in India (Bhushan and Saxena, 2016; Agarwal and Saxena, 2017), and this continues to be the major driver of deforestation.

Regional analysis of deforestation rate showed that 97,875 sq. km (40%) of the forest in NE India falls in the dynamic areas where rapid forest cover changes have been taking place since 1972. The analysis reported that overall dynamic areas are highest in Tripura (56%), Meghalaya (54%), Mizoram (48%), Nagaland (52%), Manipur (38%) and Assam (33%). Overall, the net deforestation rate in NE India was found to be slightly positive, i.e. 0.02 from 1989–1999 due to regrowth of vegetation in abandoned shifting cultivation areas and protection measures (Reddy et al., 2013).

1.4 Drivers of Deforestation and Forest Degradation

Deforestation is primarily a concern for the developing countries as it is shrinking areas of the tropical forests causing loss of biodiversity and enhancing the greenhouse effect. In global perspective (Hosonuma et al., 2012), agriculture is the main driver of deforestation, but with differences in the importance of commercial versus subsistence agriculture. Commercial agriculture is the most important driver in Latin America (68%), while in Africa and Asia it contributes to around 35% of deforestation. Local and subsistence agriculture is quite equally distributed among the continents (27–40%), since this type of

land use (change) remains widespread in all areas in the tropics and sub-tropics. Overall, agriculture reflects around 80% of deforestation worldwide, which is in line with estimates provided by Geist and Lambin (2002) for the 1980s and 1990s. A recent analysis has shown that as national economies grow, a large proportion of deforestation for agriculture will be driven by large industrial-scale sectors rather than small-scale clearings for subsistenceagriculture, which necessitates policy interventions (Austin et al., 2017). Mining plays a larger role in Africa and Asia than in Latin America. Urban expansion is most significant in Asia. De Fries et al. (2010) state that further urban population growth is expected across the tropics, which will likely be associated with increased pressure on tropical forests.

Timber extraction and logging account for more than 70% of total degradation in Latin America and Asia. Fuelwood collection and charcoal production is the main degradation driver for the African continent, and is of small to moderate importance in Asia and Latin America. Uncontrolled fires are most prominent in Latin America. In terms of absolute net forest area change over the period 2000–10, the largest driver remains commercial agriculture, with the largest deforested area located in Latin America. In Africa and Asia, subsistence and commercial agriculture contribute roughly equally to forest area change.

Drivers of Deforestation and Forest Degradation (after Kissinger et al., 2012) are given below:

Category	Types	General Remarks
Direct drivers of deforestation	1. Cropland, pasture and tree plantations 2. Subsistence agriculture including shifting cultivation 3. Mining 4. Infrastructure including roads, railroads, pipelines, hydroelectric dams, and 5. Urban expansion	On a global scale, Agriculture is the main driver (amounting to about 80%) of deforestation.
Direct drivers of forest degradation	1. Logging (both, commercial and subsistence use, including legal and illegal logging), 2. Uncontrolled fires, 3. Livestock grazing in forest, and fuelwood/charcoal (both domestic and local markets)	In Latin America along with tropical and subtropical Asia, timber extraction and logging activities account for more than 70% of total degradation.

Indirect drivers of deforestation and forest degradation	1. International (markets, commodity prices) 2. National (population growth, domestic markets, national policies, and governance) 3. Local circumstances (subsistence, poverty) 4. Weak forest sector governance and institutions, 5. Lack of cross-sect oral coordination, and 6. Illegal activity (related to weak enforcement).	For the most part, countries have defined strategies and interventions for dealing with drivers on a national and local scale, but have faced problems trying to address these international drivers, and have acknowledged that international pressures will keep persisting to augment.

While discussing proximate and underlying causes of deforestation, based on various case study-based evidences, Geist and Lambin (2001) listed the following drivers of deforestation, mostly operative in Tropical countries, details of which are given in Annexure 1.1.

I. Proximate causes

1. Agricultural expansion

2. Wood extraction

3. Infrastructure extension

II. Underlying causes

1. Economic factors
2. Policy and institutional factors
3. Technological factors
4. Cultural /socio-political factors
5. Demographic factors (Human Population dynamics)

III. Other Factors

1. Land Characteristics (Biophysical environment)
2. Biophysical drivers
3. Social trigger events

The drivers of deforestation and forest degradation in the context of Meghalaya is discussed elaborately in Chapter 5.

Chapter 2

Meghalaya - at a glance

2.1 General

The state of Meghalaya, an assemblage of rolling hills with east-west orientation, came into existence on 19 January, 1972. The altitude ranges between 50 to 1,950 metres with Shillong peak being the highest point lying centrally in the Khasi hills plateau. The state covers an area of 22,429 km^2 and extends from 25˚0’00’’N to 26˚10’00’’N and 89˚45’00’’E to 92˚45’00’’E (Fig. 2.1). The state of Meghalaya comprises of 11 districts falling in three geographical regions/ divisions *viz*. Jaintia Hills Division (West Jaintia Hills and East Jaintia Hills) Khasi Hills Division (East Khasi Hills, West Khasi Hills, South West Khasi Hills and Ri-Bhoi) and Garo Hills Division (North Garo Hills, East Garo Hills, South Garo Hills, West Garo Hills and South West Garo Hills). The features of the State that have impact on deforestation and degradation are broadly narrated below.

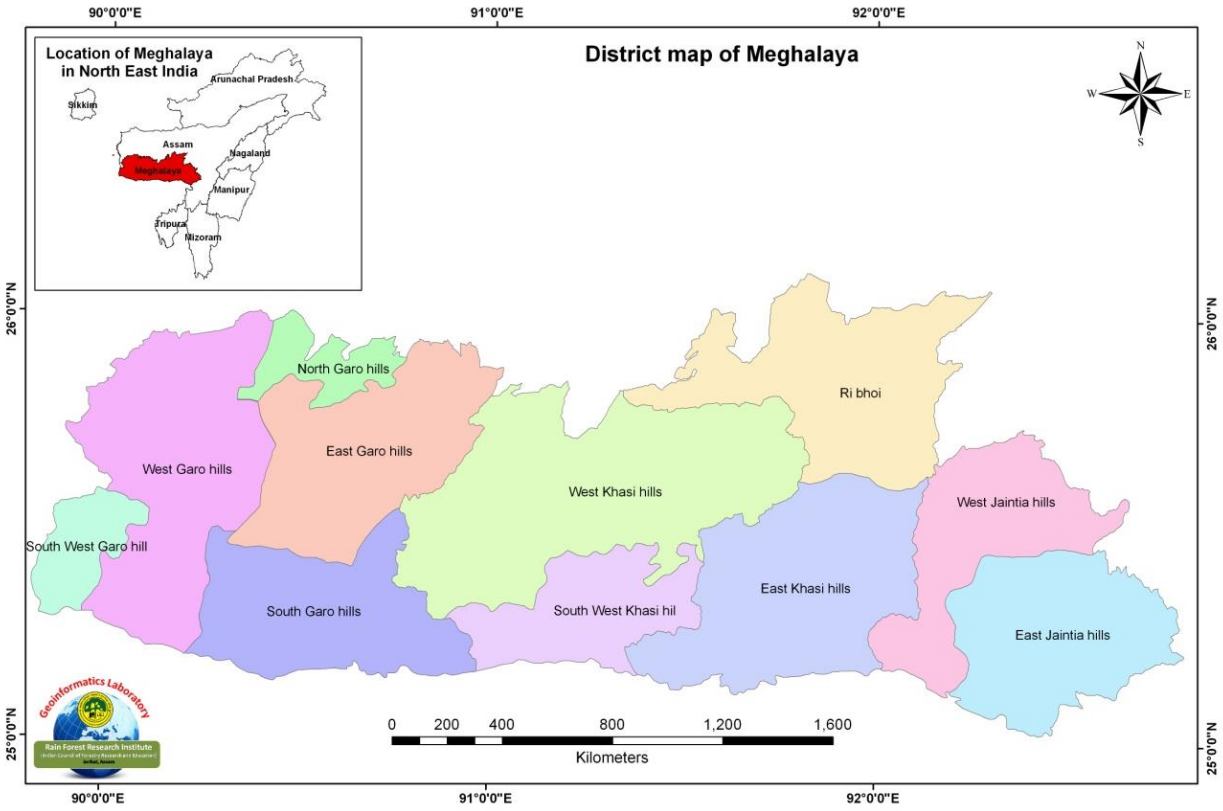
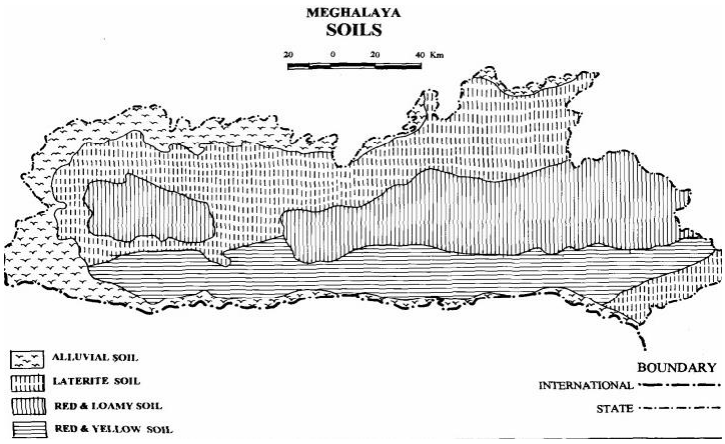


Fig. 2.1: District map of Meghalaya

2.2 Soil

In Meghalaya, due to high variation in climatic condition, rock type, topography and vegetation composition there is heterogeneity in composition and character of soil in the region. The colour of soil varies from dark brown to reddish brown. The texture of soil extends between loamy to fine loamy with the depth ranging from 50 to 200 cm across the State. The nature of soil is acidic which varies from acidic (pH 5.0 to 6.0) to strongly acidic (pH 4.5 to 5.0). Generally soils of higher altitude under high rainfall are strongly acidic in nature because of excessive leaching. In most of the State, the organic carbon concentration in soil is on the higher side (above 1.5%) with higher nitrogen supply potential. The soil is highly deficient in potassium and magnesium which lowers the productivity and sustainability of many crops. The soils of the State fall into four fertility classes namely, High Low Medium (HLM), High Medium Medium (HMM), Medium Medium Low (MML) and Medium Low Medium (MLM) as classified by the Directorate of Agriculture. The National Bureau of Soil Survey and Land Use Planning has classified the soils of Meghalaya into four soil orders according to the nature and property of soil (NBSS&LUP, 1993), as below:



(A)Red Loamy soils: As the name indicates, soils are having loamy texture and red colour, formed from weathering of rocks like diorites, gneisses, granite etc. The soil is highly fertile and suitable for agriculture, horticulture etc. The red loamy soils occur all along the foot hills and fringes of sub-mountain region of the state. These soils are predominantly found in entire central part of Garo Hills and central uplands of Khasi and Jaintia Hills from west to east except the valley of Simsang River.

(B) Red and Yellow soils: The soils are generally red and yellow in colour with fine texture ranging from loam to silty loam. It is highly fertile suitable for cultivation of rice and horticulture crops. It is distributed parallel west to east along the southern slope of Red Loamy soils.

(C)Laterite soils: Laterite soils are reddish to yellow in colour with lower base-exchanging capacity and a lower content of nitrogen, phosphorus, and potassium due to leaching by heavy rain. Therefore the fertility of soil is very poor and not suitable for agriculture. The soils extend from west to east in the northern part of the state.

(D) Alluvial soils. The soils are highly acidic in nature and ranging from sandy to clayey-loam texture. Soils are formed from the deposition of sand and clay and found in plain or nearly plain areas of state. This type of soil is highly fertile and suitable for agriculture and horticulture. The alluvial soils are distributed all along the northern, western and southern fringe of the state. This region is used for cultivation of rice and jute.

A detailed soil map with sub-types are given below (Fig. 2.2):

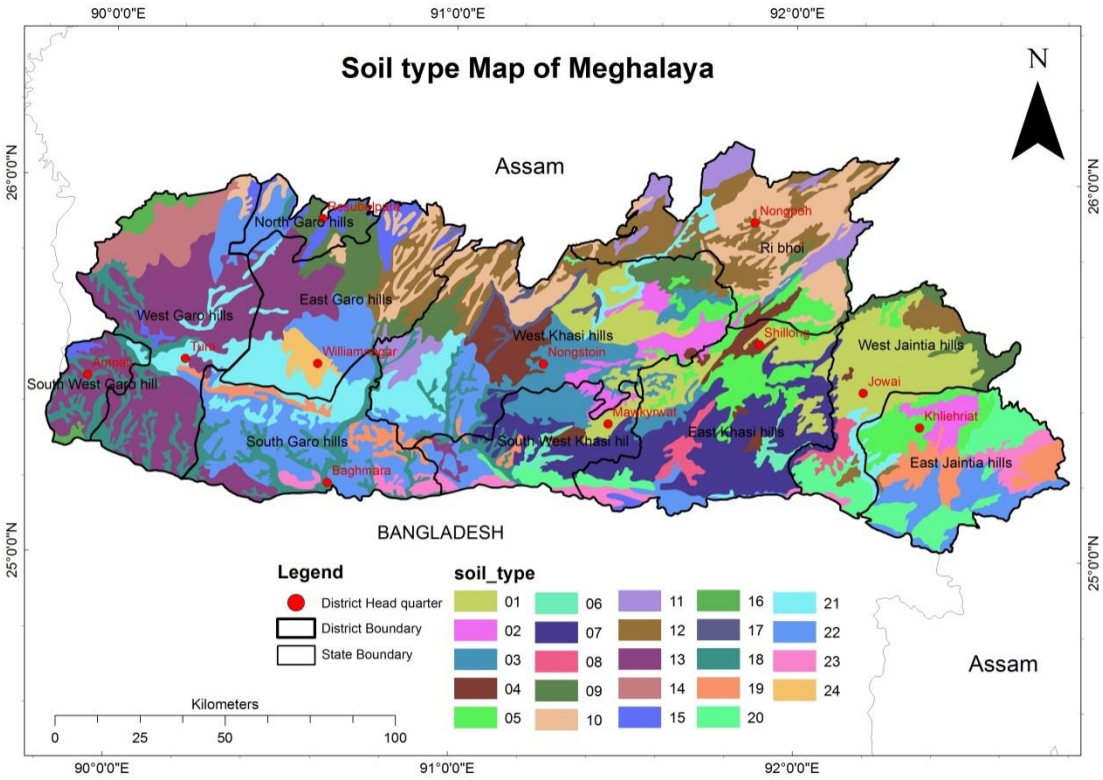


Fig. 2.2: Soil type map of Meghalaya

Soil Type Legends

SN	Soil Type	Soil sub-Type	SN	Soil Type	Soil sub-Type	SN	Soil Type	Soil sub-Type
1.	Typic Kandihumults	Typic Dystrochrepts	9.	Umbric Dystrochrepts	Typic Kandiudults	17.	Typic Haplaquepts	Aeric Haplaquepts
2.	Typic Haplohumults	Humic Haplaguepts	10.	Typic Kandihumults	Typic Haplumbrepts	18.	Typic Dystrochrepts	Umbric Dystrochrepts
3.	Typic Kandihumults	Typic Dystrochrepts	11.	Typic Kandihumults	Umbric Dystrochrepts	19.	Typic Haplumbrepts	Umbric Dystrochrepts
4.	Typic Kandihumults	Typic Dystrochrepts	12.	Typic Kandihumults	Typic Dystrochrepts	20.	Typic Haplumbrepts	Umbric Dystrochrepts

5.	Typic Kandihumults	Typic Dystrochrepts	13.	Typic Kandihumults	Dystric Eutrochrepts	21.	Ultic Hapludalfs	Typic Kandiudults
6.	Umbric Dystrochrepts	Umbric Dystrochrepts	14.	Aquic Eutrochrepts	Typic Kandiudults	22.	Typic Udorthents	Typic Kanhapludults
7.	Umbric Dystrochrepts	Typic Udorthents	15.	Humic Hapludults	Aeric Haplaquepts	23.	Pachic Haplumbrepts	Typic Udorthents
8.	Typic Dystrochrepts	Lithic Udorthents	16.	Umbric Dystrochrepts	Cumulic Humaquepts	24.	Umbric Dystrochrepts	Aeric Haplaquepts

2.3 Demography

The total population of Meghalaya is 2.96 million and the population density is 132 persons per km^2. The population density is variable across regions within the State and is on a steady increase (Fig. 2.3; Table 2.1). Most of the population (79.9%) belong to rural area (Census 2011), with a substantial proportion of the population consisting of subsistence farmers (Directorate of Economics & Statistics, Meghalaya 2015). Meghalaya is predominantly a tribal state and inhabited by 3 tribal communities, namely *Khasi*s, *Jaintia*s and *Garo*s who account for 89% of the total population. The indigenous communities are of Paleo-Mongoloid descent, one of the earliest waves of the East Asian settlers in Meghalaya, held to be remnant of the first Mongolian overflow to dwell in Meghalaya. Amongst them, the *Khasi*s and the *Jaintia*s belong to the *Mon-Khmer* family of Austric affiliation, while the *Garo*s belong to the *Bodo* group of the Tibeto-Burman family (Ali and Das 2003).

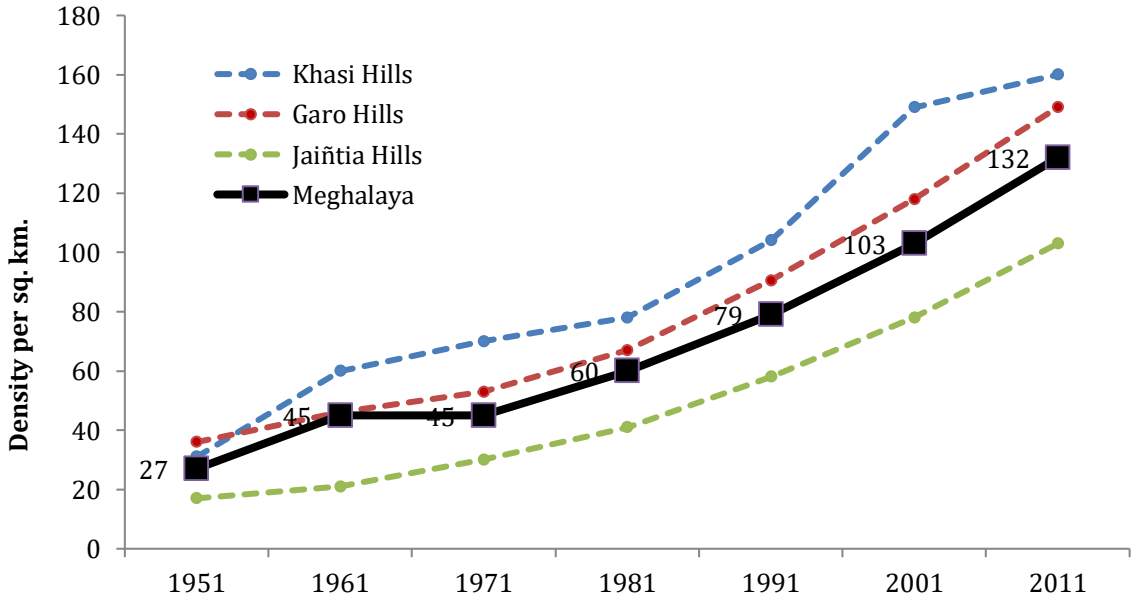


Fig. 2.3: Variation in population density in Meghalaya

The district-wise variation in population density is given in Annexure 2.1.

2.4 Livestock

As per the livestock census, 2012, the total livestock in the state is 11.94 lakh, with maximum and minimum population recorded in west Garo hills (4.63 lakhs) and South west Khasi hills (0.84 lakhs), respectively. The details are provided in Annexure 2.2.

2.5 Climatic Conditions

Overall, Meghalaya has a monsoon type of climate which is directly influenced by the south-west monsoon originating from the Bay of Bengal and Arabian Sea, with some variations in the climatic variables depending upon altitude and physiographic differences of landmass (BASP, 2004). While the Shillong plateau (600-2000m) has a bracing climate verging towards the temperate type; contrastingly, the lower regions adjoining the Surma and Brahmaputra Valley (100-300m) have a tropical climate. The average annual rainfall at Shillong, the capital of Meghalaya, is about 2000mm. The world's wettest place Mawsynram, located in the Khasi plateau currently holds the record for maximum rainfall in a year (11,873 mm, 2015), but till a decade back Cherrapunjee, lying in the Cherra plateau held the record (11,777 mm). Monthly average rain fall and mean maximum and minimum temperature of the state is given in the following graphs (Fig. 2.4 and 2.5):

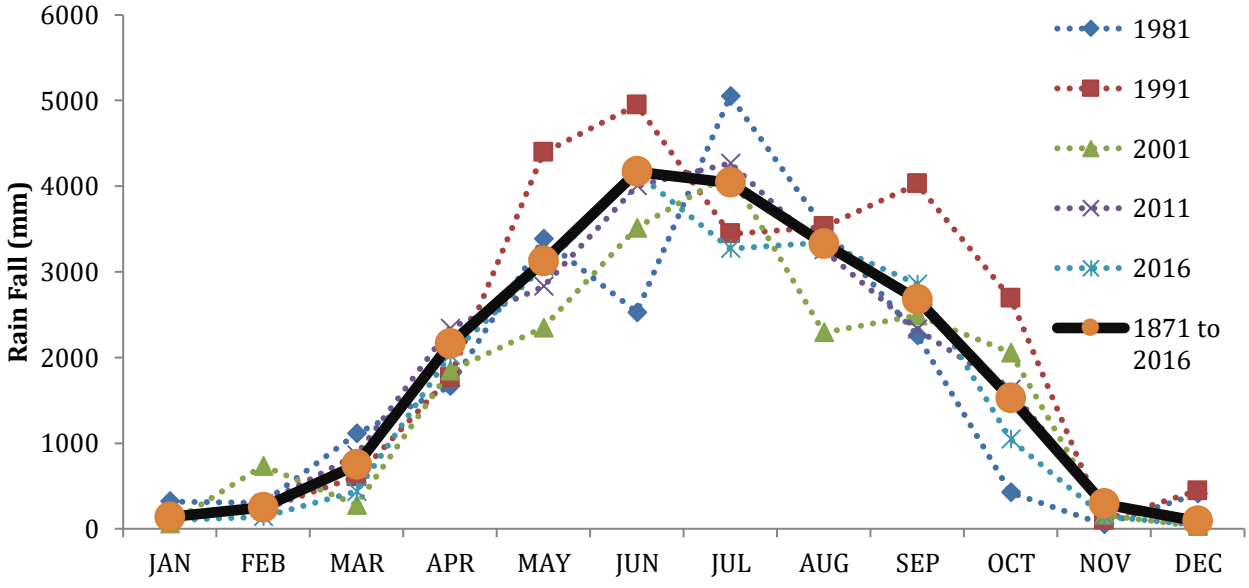


Fig. 2.4 Monthly average rain fall in Meghalaya

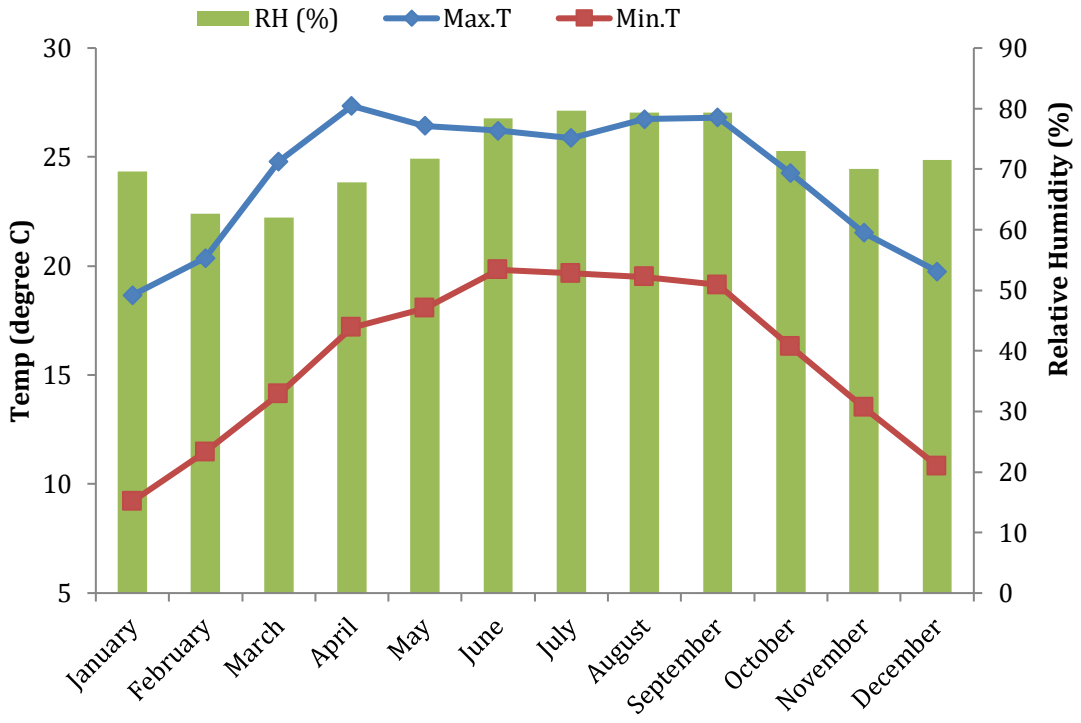


Fig. 2.5 Mean maximum and minimum temperature and Relative humidity in Meghalaya

2.6 Forests and Wildlife

About 76.45% (17,146 km^2) of the area under Meghalaya was reported to be coming under forest cover (FSI, 2017) with 453, 9,386 and 7,307km^2 of Very Dense, Moderately Dense and open forests respectively (Fig. 2.6). About 4.58% of the total geographical area and 6.56 % of the total forest area of the State (1,027.20 km^2 out of 15,657 km^2) is under the control of State Forest Department. Rest of the area is either private or clan/community owned and is under the indirect control and management of the Autonomous District Councils. The forest cover of Meghalaya, reportedly under stress for decades due to various drivers of deforestation and degradation operating in the state, has been found to have decreased when compared with earlier assessments from 2009 onwards since when the spatial data are compatible to the present. Considering the assessment of 2013-15, it is seen that all the districts barring Jaintia Hills have shown a net decrease in forest cover. The East Khasi hills district with 33 km^2 of deforestation tops the list followed by East and West Garo Hills with a deforested area of 17 km^2 each. Most of the deforestation was recorded in Moderately Dense forests (-105

km^2). If we consider last four assessments (2009 to 2015), Very dense forests are found to have decreased in East Garo Hills and West Khasi Hills (Fig. 2.6).

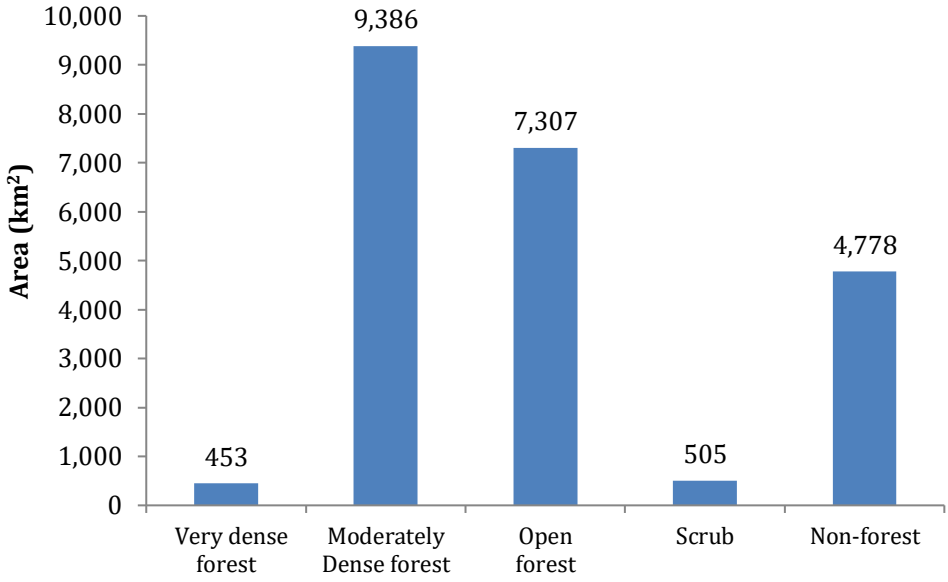


Fig. 2.6: Different types of forest (density wise) in Meghalaya (2017)

The major Forest types in the state are Cachar Tropical Evergreen forests, Assam Alluvial Plains Semi Evergreen Forests, Secondary Moist Bamboo brakes, Khasi Hill Sal Forests, East Himalayan Moist Mixed Deciduous forests; Khasi Subtropical wet hill forests and Assam Subtropical Pine Forests.

Meghalaya is blessed with a variety of wildlife. Meghalaya has 139 species of Mammals, 659species of Birds, 107 species of Reptiles, 55 species of Amphibia and 152 species of Fishes. Of these, 35 species of Mammals are endangered, vulnerable or insufficiently known. Similarly, 10 species of birds and 9 species of reptiles are either endangered or vulnerable. Along with the species diversity, the State has a significant percentage of endemic elements (Daniel, 1983; Talwar and Jhingran, 1991; Sharma, 1998, 2006; Sharma and Sharma, 1999; Kharbuli et al., 1999). There are nearly 110 genera and 439 taxa reported for Orchids (Rao and Singh, 2015), 191 genera and more than 1,000 species of Pteridophytes (Dixit, 1984) and 248 species belonging to 120 genera of Bryophytes (Bansal and Nath, 2012). Some salient and important wildlife species are listed in Annexure 2.3.

2.7 Shifting Cultivation

One of the obvious and major drivers of deforestation in Meghalaya is the age old traditional practice of shifting cultivation. The fallow period has reportedly decreased from 10-15 to 3-5 years over the years in the state and therefore becomes one of the major agents of deforestation in the state. Shifting cultivation was found to have decreased from 744 km^2 during 2001-03 to 449 km^2 during 2005-06 and again increased to 541 km^2 during 2008-09. The area under shifting cultivation in different districts of Meghalaya is shown in Fig. 2.7.

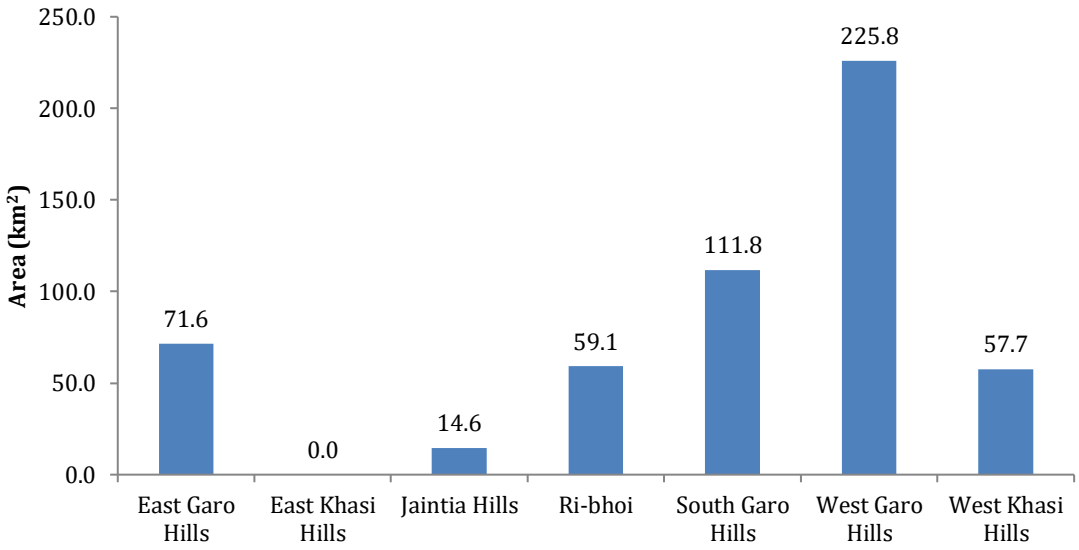


Fig. 2.7: Area under shifting cultivation in different districts of Meghalaya (2008-09)

2.8 Land use and Land Tenure System

The three tribes residing in Meghalaya *viz*.- *Khasi*, *Garo* and *Jaintia* have their own traditional institutions associated with land use and tenure. In terms of structure and composition, the traditional institution of the *Khasi* tribe is more elaborate than that of the *Garo* and *Jaintia* tribes.

In the *Khasi* community, a typical traditional institution constitutes larger territory base (the *Hima*) which is controlled by the *Syiem*. The *Syiem* is the head of the state (i.e. *Hima*) and looks after the general administration and management of forests along with other natural resources directly under his control. The head of the village council is known as

Rangboh Shnong, *Sordar* or *Myntri Shnong* who is responsible for governance of forests and other common property resources of the village. All affairs pertaining to the forests owned by the clan are looked after and controlled by the clan chief/ head of the clan and the elders.

Among the *Garo* tribe, the land and all land-based resources (*A'king* land) belong to the clan and are under the guardianship of a female head, *Nokma*. The husband of *Nokma* acts on her behalf in all clan decision-making (Goswami and Majumdar 1972). On the other hand, the decisions on the land and its use are made collectively by the clan representatives (*Chra*), as the *Nokma* has no authority to take such decisions. The *Chra* consists of the maternal uncle and brothers of the *Nokma*. Again, the Nokma without the permission of the *Maharis* in the village has no authority to sell any part of the territory to another village or person. Interesting is the fact that the institution of *Mahari* who are collectively responsible for the conduct and security of the members and protection of family property, consists of the members closely related through common motherhood (Tiwari et al., 1998). Thus all natural resources of the village are administered by people living in the village and decisions are made by an institution that collectively decides for the good of all.

In Jaintia hills, the concept of '*Elaka*' (province) i.e., villages clustered in a particular area recognized as a single political entity is prevalent. '*Doloi*' or the Chief of the *Elaka* iselected for life from amongst the senior members of a particular clan and the rule is strictly followed. *Doloi* is assisted by the *U Basan* (elder) who is also elected for a life term, though the number of *Basan* depends on the size of the *Elaka*. The institution of *Doloi* is the custodian of all natural resources including forests of the *Elaka*. However, the *Doloi* can be removed from his office for misrule or corruption by his people.

2.9 Forest Administration

Eight different types of forests have been recorded in the villages of Meghalaya, on the basis of the management rules, institutional organization, intended use, management

practices and ownership. A brief description (after Tiwari et al., 2013) of these types of forest governed by the traditional tribal institutions is given below:

1) **Group of village forest (*Raid* forest)**:

   Being jointly owned by a group of adjacent villages, the area under this type of forest is generally large and overlaps a number of villages. These forests are managed by a council comprising the head of the group of villages (*Syiem Raid* or *Sordar* in the *Khasi* tribe and *Doloi* in *Jaintia* tribe) as chairman and the headmen of all the villages within the territory (*Raid*) as members. All inhabitants of the territory have usufruct rights for collection from these forests.

2) **Village forest**:

   Village forests are called by different names by different tribes. The area under this type of forest covers 20–70 ha. In most of the villages, collection of timber and non-timber forest products (NTFPs) such as fuel wood is restricted to personal use only. Some villages have more than one village forest. The village council has the responsibility toguarantee sustainability of the forests and even-handedsharing of benefits. In most of the village forests, tree can be felled for construction of houses and other community uses with prior permission from the village council or traditional institutional head, i.e. *Doloi* (*Jaintia*) of the tribe. These forests are meant for supply of daily needs of the people and are often called “supply forests” (Tiwari et al., 2010).

3) **Restricted forest**:

   Similar to the earlier category in terms of overall management, this type of forest is locally referred to as a *Law Adong*, and it is either under the control of a particular village or under the control of a *Raid* (group of villages). The only difference is in the degree of protection, since, access to forest resources is restricted. Generally, as they are small, are particularly reserved for the poorer families in the village and for some occasional needs by the village as a whole. Restrictions are exercised on extraction of timber and fuel wood, but there are no restrictions on collection and extraction of mushrooms, edible fruits and vegetables if done without affecting the health of the forests. At Mawkohphet

village, these forests are managed by the *Myntri Shnong* (village elders) under the overall supervision of the village council.

4) **Sacred forests/groves**:

The ownership and management of sacred forests (forest patches maintained for religious purposes) may reside with individuals, clans or village councils. Sacred forest was found in all three clusters of Meghalaya and is named *Khloo U Blai, Law Kyntang* and *Asong Khosi* in Jaintia Hills, Khasi Hills and Garo Hills, respectively. Sacred forests are managed by religious heads or persons to whom the religious ceremonies for the particular locality or villages are entrusted in accordance with customary practice (e.g. *Lyngdoh* in *Khasi* tribe and *Doloi* in *Jaintia* tribe). Being mostly primary forests, they are well preserved and rich in biodiversity. The size of sacred forests in the study areas varied from a grove of a few trees to more than 100 ha.

5) **Clan forest**:

At times, more than one clan inhabits a village and each owns a patch of forest. Some clans may own forests located outside their village. For example, in Domjyrti village, clan forests belonging to clans *Jyrwa*, *Lyngdoh*, *Kharwar* and *Nongsiej* were recorded. All members of the clan are entitled to a share of the benefits derived from the use of these forests. The management of clan forests is the responsibility of the whole clan. Collection of timber is permitted only for households belonging to the particular clan but all village inhabitants are allowed to collect NTFPs for personal (non-market) consumption.

6) **Cemetery forest**:

These are basically forests owned and maintained by village churches, with the main purpose being burial of dead bodies. The cemetery forests are generally small in area (few hectares) but larger cemetery forests are not rare. For example, the cemetery forest of the Catholic Church in Mawkyndeng village of Jaintia Hills covers an area of about 30 ha. The Khasi and Jaintia tribe call them *Law Balang* and *Khloo Balang*, respectively. Cemetery forests are usually gifted by individuals or clans to the church or are bought by the church. The church

regulates the use and access to forest resources. In most cases, people have free access to collection of NTFPs.

7) **Regeneration forest**:

Regeneration forests are locally known as *Champea* and managed by the *Nokma*, the traditional female chief of Garo tribe. Extraction of trees is not allowed from this forest, but NTFP collection for personal consumption is allowed.

8) **Bamboo reserve**:

Bamboo reserve forest was recorded where village councils or *Nokma* (Garo Hills of Meghalaya) manage the forests. The villagers have full access to the bamboo reserve and collect bamboo for bonafide needs such as construction of houses or temporary sheds.

A tabular representation of the eight forest classes observed in Meghalaya (Tiwari et al., 2013) is shown in Annexure 2.4.

The State Forest Department has classified the forests of Meghalaya into the following six categories (Tiwari et al., 1999):

1. **Reserve forests** (including government forests, national parks and sanctuaries) cover 993.0 km^2 and are owned and controlled by the State Forest Department. These forests are among the best in the state, and local communities have very few rights over them.
2. **Unclassified forests**, which cover 7,146.5 km^2, are forests where local communities have all the rights and *de facto* control. Most of these forests are used for shifting cultivation.
3. **Private forests** cover 384.0 km^2 and belong to individuals, who use them primarily for personal consumption.
4. **Protected forests** cover 129.0 km^2 and are used by local communities, primarily for personal consumption. Local communities have rights to these forests, but they are controlled by the State Forest Department, which considers the status of protected forest as an interim measure; the department intends to convert these forests into reserve forests.

5. **Village forests**, which cover 25.9 km^2, demarcated and registered by the village community under the United Khasi–Jaintia Management of Forest Act 1958. Most of these forests are used for subsistence purposes.
6. **Community (*Raij*) forests**, which cover 768.0 km^2, are large community forests (*Raij* means commune) that are managed by the commune head under the local administrative head.

Chapter 3

Methodology for Identification of Drivers of Deforestation

Drivers of deforestation and degradation are multifaceted especially in a diverse region like Meghalaya. Addressing such a diverse issues require an integrated approach. In the present study, an attempt was made to understand the drivers of deforestation operative in Meghalaya following five approaches supplementing one another, such as:

- **Consultation of existing Literature**: Extensive review of all available literature including published and unpublished information on drivers of forest change in Meghalaya as well as in other regions of similar nature;
- **GIS mapping (Generation of spatial information):** based on the available information and results of the study.
- **Stakeholder consultation (Household surveys):** Collecting information directly about drivers from all forest stakeholder groups across the Meghalaya. These stakeholders include local residents, forest dependent communities, key informants etc.
- **Ecological Survey and sampling:** Ecological study of the selected clusters of high deforestation.
- **Expert consultation:** Expert consultation through workshops, group meetings etc.

The paradigm of various approaches is shown in methodology flow diagram (Fig.3.1).

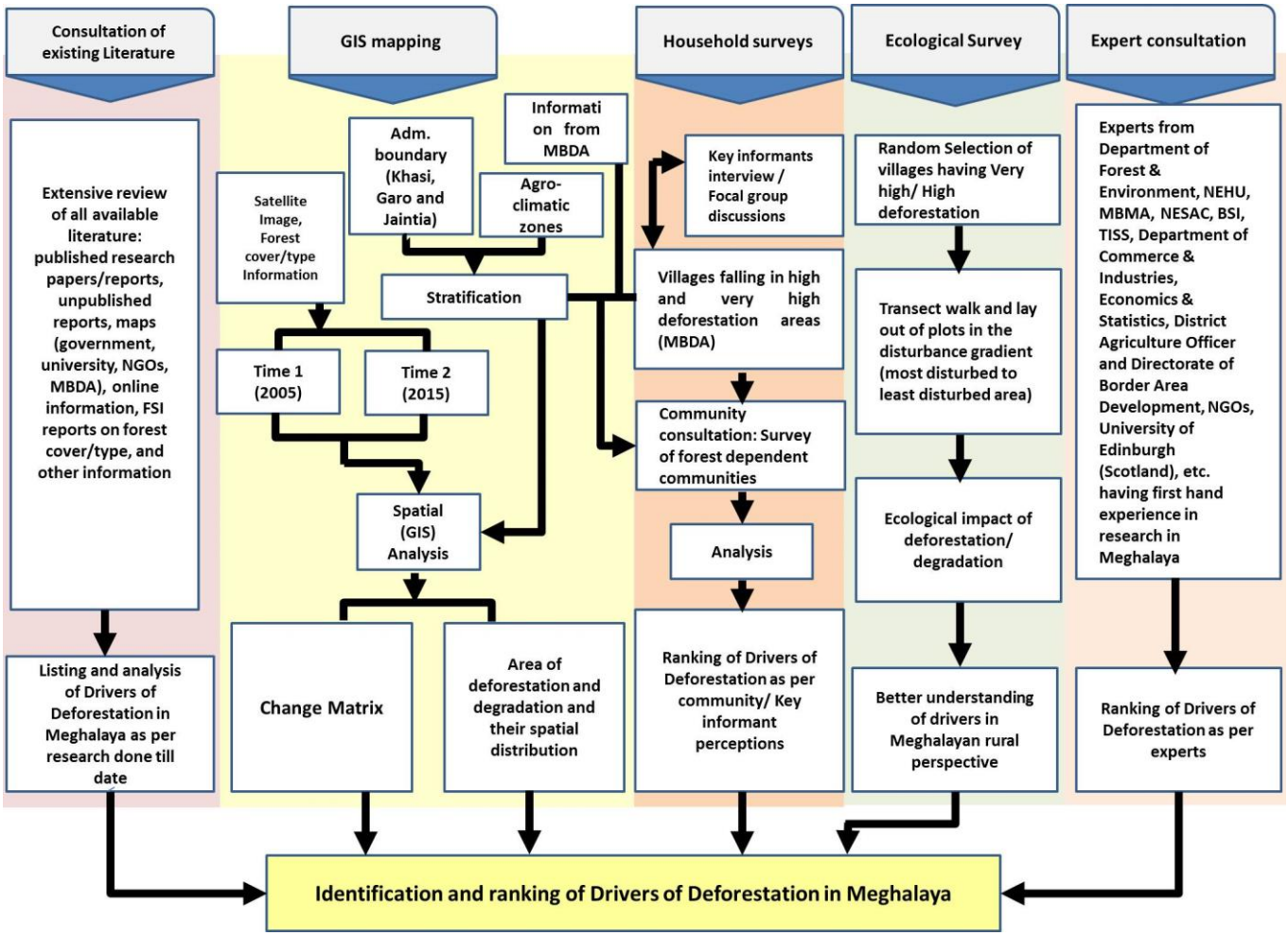


Fig. 3.1: Framework of methodology

The study was designed to assess drivers for all the nine agro climatic zones of Meghalaya for deforestation. The study was conducted in all the three regions i.e. Khasi, Jaintia and Garo Hills across Meghalaya, and every effort was made to be inclusive of all stakeholder groups at every region.

3.1 Consultation of existing Literature

Available literature was collected from all possible sources including published research papers/reports, unpublished reports, maps (Government, University, NGOs, MBDA), online information, FSI reports on forest cover, and other information. The literature study was used to assess the socio-cultural setup, governance, laws, socio-economic impacts of forest loss, drivers identified from other relevant studies and assessments

(e.g., other REDD and drivers of deforestation studies in Mizoram and other developing countries like Bangladesh, Nepal, Philippines, etc.).

3.2 GIS mapping (Generation of spatial information)

- The State was divided into three regions which are different from the view point of socio-economy, ethnicity and physiography. These regions are: Jaintia Hills Division, Khasi Hills Division and Garo Hills Division.
- Nine Agro-climatic zones exist in Meghalaya, *viz*. - Hot (Extremely wet, Wet and Moist), Mild (Extremely wet, Wet and Moist) and Cold (Extremely wet, Wet and Moist).
- The regions, as mentioned above, were integrated with Agro-climatic zones (Fig. 3.2) and final strata (27 strata) were generated. Sample areas of deforestation were identified in different regions in a manner that different aspects of socio-economic status, tribal groups and bio-physical status and physiography are covered.
- Forest type, forest cover and forest degradation information (spatial and attribute) was derived from original maps generated by Forest Survey of India.
- Point vector layer of household survey was generated using hand held GPS information collected during the survey and then bringing them in the GIS environment following appropriate procedure.
- Spatial data (classified forest cover map) of two time period was compared for spatial analysis and generation of change matrix.

ArcGIS and ERDAS Imagine packages were used for GIS operation and generation of spatial maps.

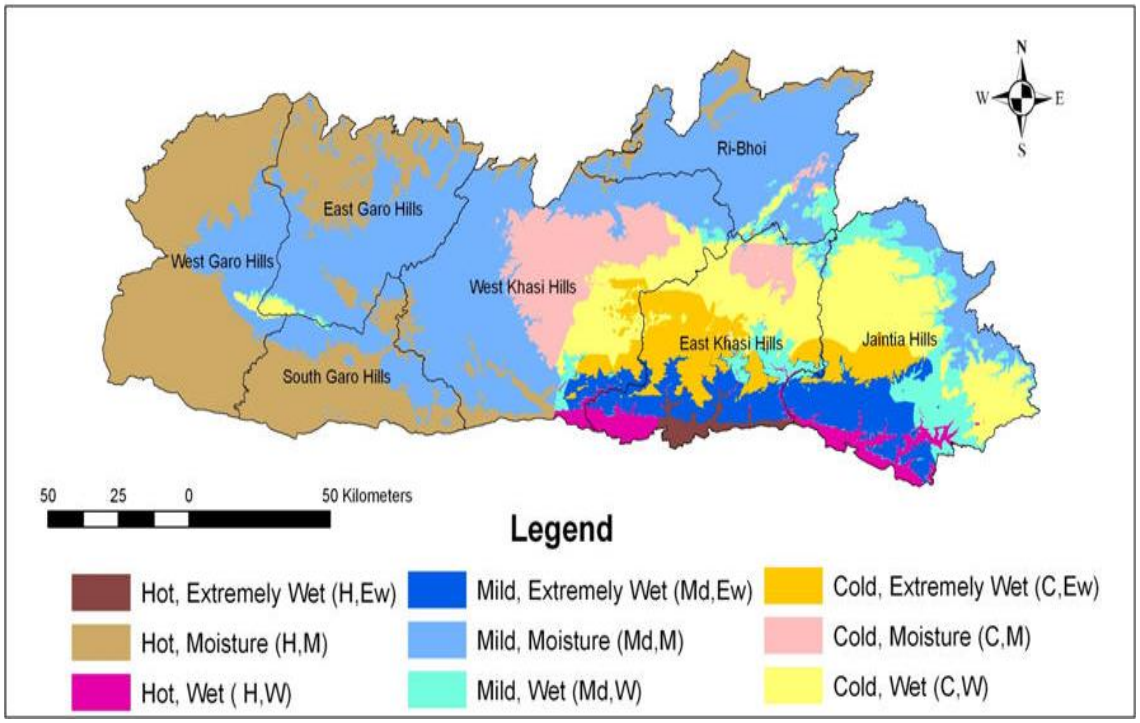


Fig. 3.2: Agro-climatic zones in Meghalaya

3.3 Stakeholder consultation (Household surveys)

Stakeholder consultation was done to develop an information database on drivers of deforestationby (1) Community consultation by means of surveying forest dependent communities in all the three zones of Meghalaya, and (2) Key informants interview (KII). These were used to obtain information of drivers from forest department personnel, field staff of forest departments of Khasi, Garo and Jaintia autonomous councils and other key persons on an *ad hoc* basis during the entire study period.

3.3.1 Community consultation

Community consultation was done by surveying forest dependent communities in the representative villages situated in critical and very critical landscapes in terms of deforestation in all the three zones. A total of 130 villages were selected from the whole state as per the agro climatic zones.

Selection of major drivers: The drivers of deforestation and forest degradation, as mentioned in the initial chapters, does not work in isolation and varies from region to

region. Some of the drivers are universal whereas, some of them are typical to that region. The drivers of deforestation and degradation, in many cases, overlap and can be addressed separately. The same is true for direct and indirect drivers too. In the present study selection and finalisation of direct and indirect drivers was done based on extensive literature survey and expert opinion. The major direct drivers selected for household survey includes Wood collection, Mining, Shifting cultivation, Charcoal making, Settlement expansion, Permanent farming, Road network expansion, and Others (Forest fire, landslides, other natural disasters) whereas major indirect drivers are Non-availability of alternatives, Increase in population, Poverty, Lack of employment, Less awareness, Promotion of Agriculture, Weak forest law enforcement and Others (pollution, soil fertility, wildlife poaching, insurgency, political disturbances, etc.)

Selection of villages: A list of 1931 villages falling in high and very high deforestation areas wasobtained from the MBDA. Locations of these villages were superimposed on the Agro-climatic zone map and all the villages were divided as per the respective agro-climatic zones (Fig. 3.3a and 3.3b). Nine Agro-climatic zones are prevailing in Meghalaya, namely: Hot (Extremely wet, Wet and Moist), Mild (Extremely wet, Wet and Moist) and Cold (Extremely wet, Wet and Moist). All three Khasi, Jaintia and Garo regions were integrated with Agro-climatic zones and final strata (9x3=27 strata) were generated. A total of 130 villages proportionate to the area of particular zone were selected randomly from 1931 villages for the final survey. List of the selected villages is given in Annexure-3.1. Ten percent of total households or 10 households (whichever is more) were selected on a random basis for the final survey in each selected village with the help of comprehensive questionnaire prepared for the purpose. Two Questionnaires designed separately for Household (Annexure-3.2) and village survey (Annexure-3.3) were used for socioeconomic survey. These questionnaires were tested during the preliminary survey and again modified accordingly.

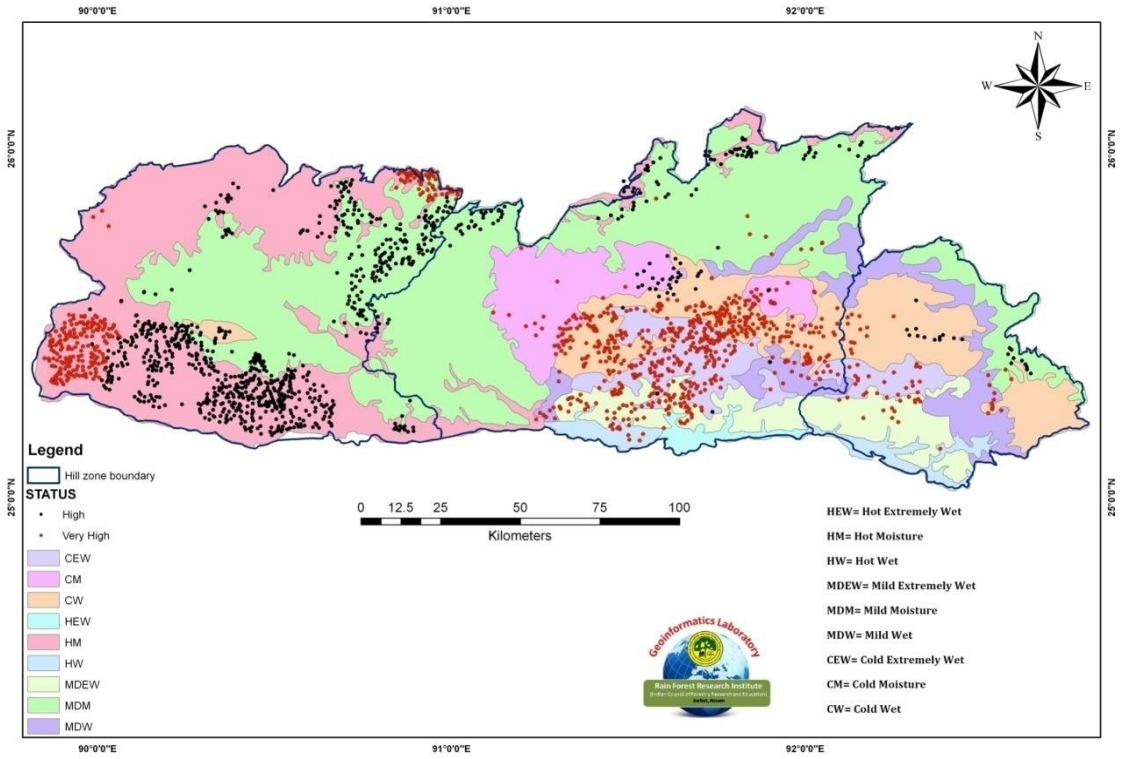


Fig. 3.3a: Location of the villages falling in areas with high deforerstation rate in different agro-climatic zones

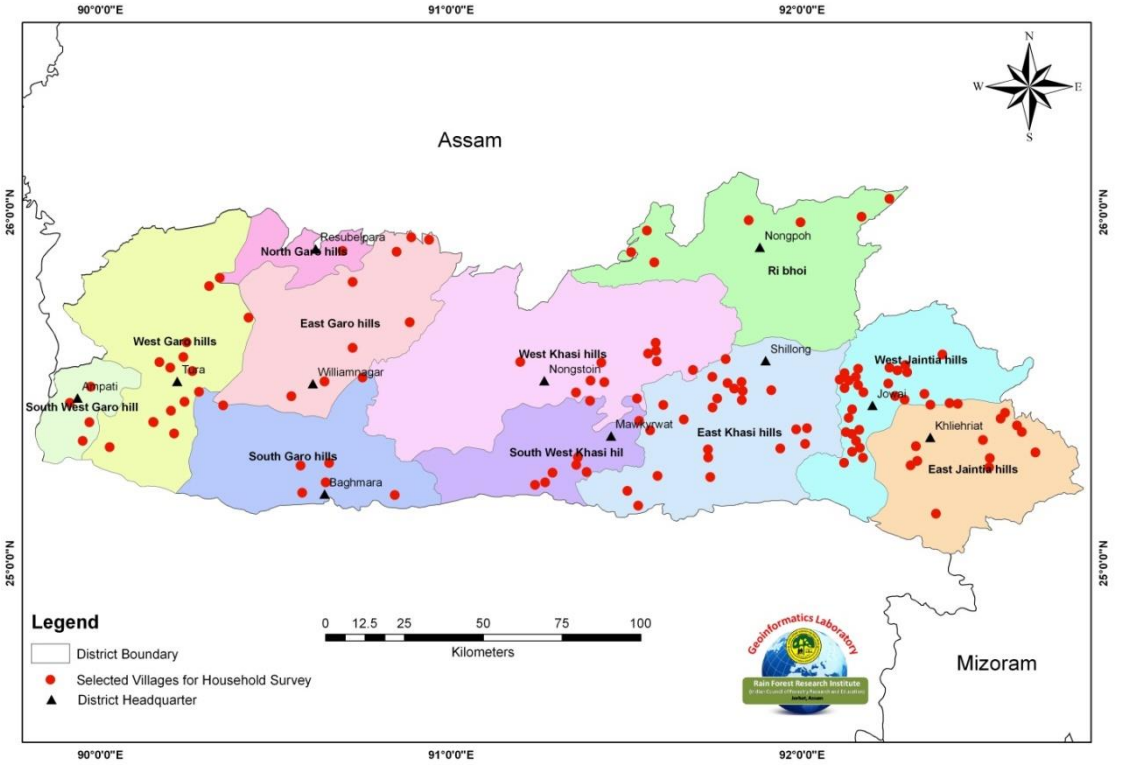


Fig. 3.3b: Location of the selected surveyed villages

3.3.2 Key informants interviews: A suite of interviews was conducted during the workshops and at other times on an *ad hoc* basis to bolster the sample from key informants like field staff of state forest department, personnel of forest departments of autonomous councils and others including interested members of the public (e.g., teachers, community leaders, etc.). Consultation with the senior officers of Forest Divisions, Autonomous Council's Forest Departments, researchers working in Meghalaya and other knowledgeable persons was also done wherever it was feasible.

3.3.3 Focal group discussions: To determine what the local communities and forest beneficiaries consider are the important drivers, focal group discussions were arranged. At these meetings, a team member administered the questionnaire orally in a group discussion. These meetings were designed to obtain a sample from groups of local forest users, as well as to gain some idea of how a payment for ecosystem service approach might be received. These data were added to the overall sample.

3.4 Ecological Survey and sampling

Ecological sampling in some of the selected villages were undertaken to understand the disturbance gradient in the villages falling under high degradation zone. List of the selected villages is given in Annexure-3.4. Transect walk from village boundary (assumed to be of the highest disturbance) to the core area of the nearest forests (assumed to be the least disturbed) were conducted in the selected villages. Qualitative information on various aspects of deforestation, degradation and other disturbances were noted. Presence of invasive species, signs of domestic grazing animals, denuded stems, if any, etc. were also noted. Three quadrats of 0.1 hecatre sizes were also taken along the disturbance gradients as shown in the Fig. 3.4.

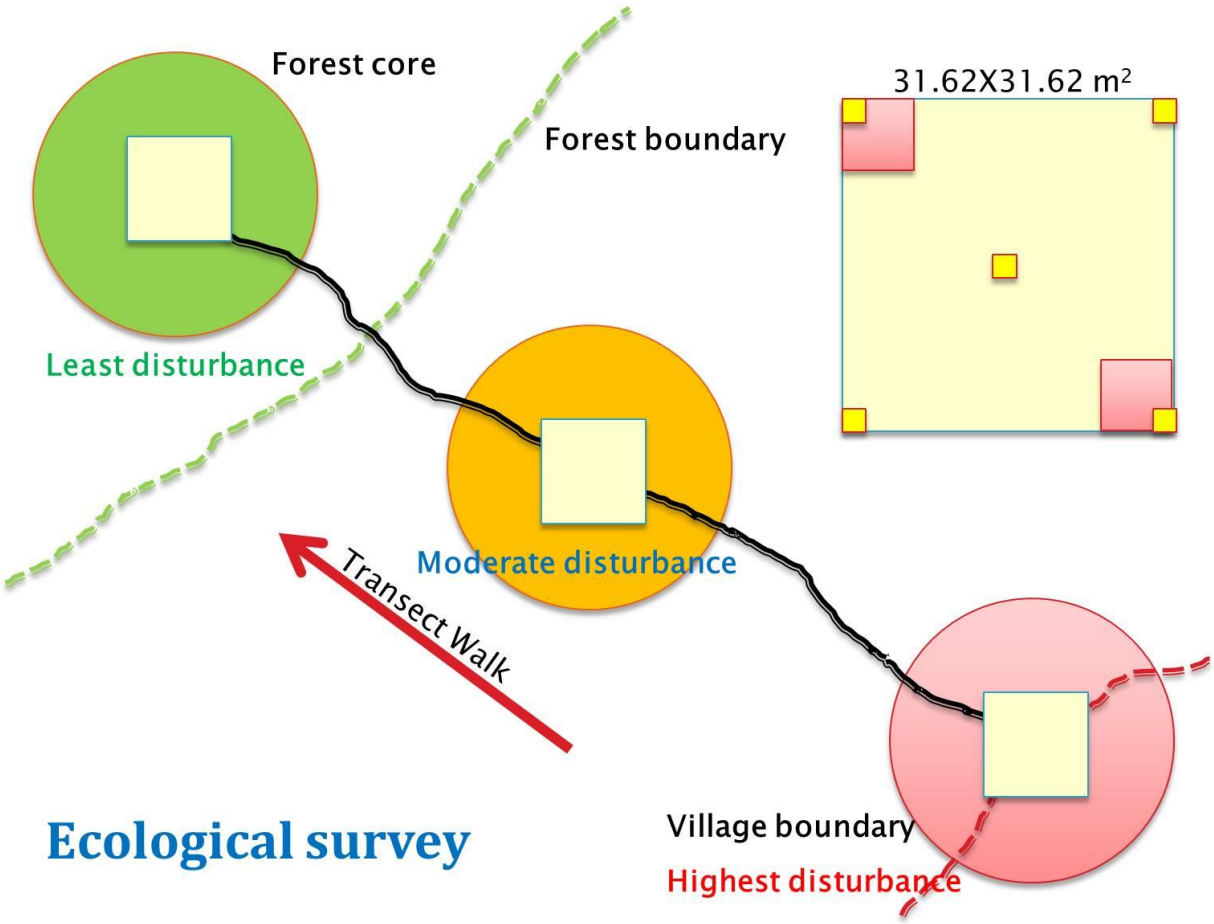


Fig. 3.4 Ecological Sampling design

3.5 Expert Consultation:

A one day Stakeholders' workshop was organized at Indian Council of Social Science Research (ICSSR), North Eastern Regional Centre, NEHU Campus, Umshing, Shillong under the Chairmanship of Shri Budstar Kharmawphlang, IFS, Principal Chief Conservator of Forests (Climate Change, Research & Training), Department of Forest & Environment, Government of Meghalaya on 29th January, 2019. The main focus was to have a discussion on the Stakeholder's perception on various drivers of deforestation in their respective zones of the State, in the light of facts and figures generated by the concerned Departments and their consequent ranking. The workshop was attended by 35 participants from Department of Forest & Environment, North-Eastern Hill University, Meghalaya Basin Management Agency, North Eastern Space Applications Centre, Botanical Survey of India (Eastern Regional Centre), Tata Institute of Social

Sciences, Department of Commerce & Industries, Department of Economics & Statistics, Office of the District Agriculture Officer and Directorate of Border Area Development, Non-Governmental Organizations, Researchers from the University of Edinburgh (Scotland), etc. Specially designed Questionnaire was served to the participants with a request to fill the same based on their zone wise experience.

Questionnaires were also sent to various researchers working on Meghalaya in General and on the issue of deforestation/ degradation in particular. Meghalaya Community forest administration (village council) officials were also consulted and their views on relative importance in terms of ranking the drivers were obtained.

Data analysis: Data from the Forest dependent communities, workshops, key informant interviews (KIIs), and focal group discussions (FGDs) were compiled and the results were assessed to determine the most important drivers. A ranking of these drivers were done by combining the ranked data from the literature survey, Interview of forest dependent communities, KIIs and FGDs, for each agro-climatic zone in each region.

Chapter 4

State of Forests in Meghalaya

4.1 Forest types: present scenario

Forests of Meghalaya is classified into three groups (Chauhan and Singh, 1992) *viz*.- (1) Tropical forests (2) Sub-Tropical forests and (3) Temperate forests on the basis of altitude, rainfall and species composition (Annexure 4.1).

As per the revised mapping of forest types of India (FSI, 2015) the major Forest types in the state (in terms of extent and percent of Geographical Area)are Cachar Tropical Evergreen forests (1612 km^2, 9.39%), Pioneer Euphorbiaceous Scrub (182 km^2, 1.06%), Assam Alluvial Plains Semi Evergreen Forests (148 km^2, 0.86 %), Secondary Moist Bamboo brakes (183 km^2, 1.07%), Khasi Hill Sal Forests (1528 km^2, 8.90 %), East Himalayan Moist Mixed Deciduous forests (9052 km^2, 52.72%), Khasi Subtropical wet hill forests (3041 km^2, 17.71%) and Assam Subtropical Pine Forests (1424 km^2, 8.29%).

4.2 Forest Cover and land use Change

4.2.1 State Forest Cover

The forest cover in the state is 17,146 km^2, which is 76.45 % of the State's geographical area. In terms of forest density canopy classes, the State has 453 km^2 under very dense forest, 9,386 km^2 under moderately dense forest and 7,307 km^2 under open forest (FSI, 2017). The State has reported a recorded forest area of 9,460 km^2, which is 42.21 % of the State's Geographical area. The varying forest cover and recorded forest area in the state is having its own implications. One of the major implication is that the role and responsibility of community in conservation of the forest resourtces and biodiversity in the state becomes even more as most of the forest resources are community controlled. Awareness among community about their role, right, and responsibility therefore becomes exterely vital. The diffrerent forest types occurring in Meghalaya are as shown in the Fig. 4.1.

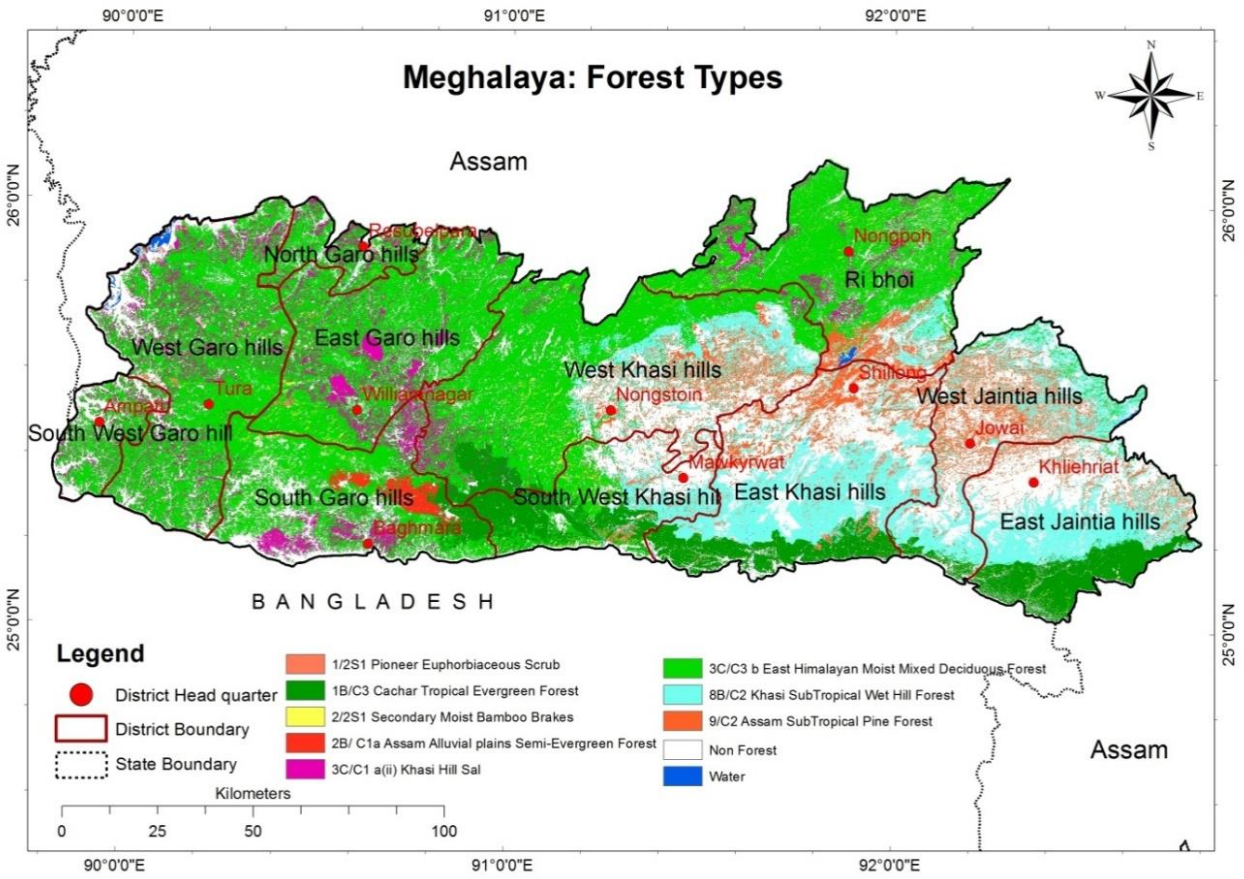


Fig. 4.1: Forest types of Meghalaya

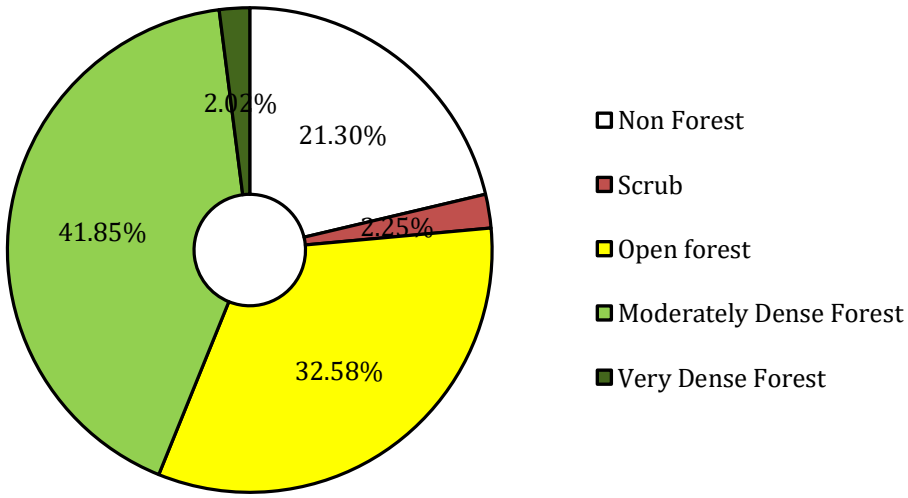


Fig. 4.2: Density classes of forest in Meghalaya

As per Forest Survey of India definition, the term 'Forest Cover' refers to all lands more than one hectare in area with a tree canopy of more than 10 %, irrespective of land use, ownership and legal status.

On the other hand, the term 'Recorded Forest Area' or 'Forest Area' refers to all the geographic areas recorded as 'Forests' in government records. Recorded forest area mainly consists of Reserved Forests (RF) and Protected Forests (PF), which have been notified under the provisions of Indian Forest Act, 1927 or its counterpart State Acts. Besides RFs and PFs, the recorded forest area may also include all such areas, which have been recorded as forests in the revenue records or have been constituted so under any state Act or local laws.

Recorded forests may have blank areas with tree density less than 10 % such as degraded lands, wetlands, rivers, riverbeds, creeks in mangroves, snow-covered areas, glaciers and other snow covered areas, alpine pastures, cold deserts, grasslands etc. As per the definition of forest cover, such areas are excluded from the assessment of forest cover. On the other hand, there are areas outside the recorded forests with tree patches of one hectare and more with canopy density above 10%. For example plantations on the private/ community lands, road, rail and canal sides, rubber, tea, and coffee plantations etc. Such areas also constitute forest cover and are included in the forest cover assessment.

(Source: ISFR, 2017)

The Very Dense Forests, Moderately Dense Forests and Open Forests account for 2.02 %, 41.85 % and 32.58 % (Fig. 4.2), respectively of the geographical area, which is depicted in the following Table 4.1.

Table 4.1: District-wise Forest Cover in the study area (for the year 2017)

District	Geographical Area (GA)	VDF	MDF	OF	Total	Percent of GA	Change*	Scrub
East Garo Hills	2603	63	1075	1128	2266	87.05	-1	53
East Khasi Hills	2748	3	1012	736	1751	63.72	6	106
Jaintia Hills	3819	100	1488	915	2503	65.54	-64	86
Ri Bhoi	2448	132	1096	915	2143	87.54	-2	35
South Garo Hills	1887	45	1014	629	1688	89.45	-2	12
West Garo Hills	3677	0	1244	1593	2837	77.16	-27	67
West Khasi Hills	5247	110	2457	1391	3958	75.43	-26	146
Grand Total	22429	453	9386	7307	17146	76.45	-116	505

* Change compared to updated 2015 assessment

Physiographic Zone wise forest cover in the study area is as follows (Fig. 4.3):

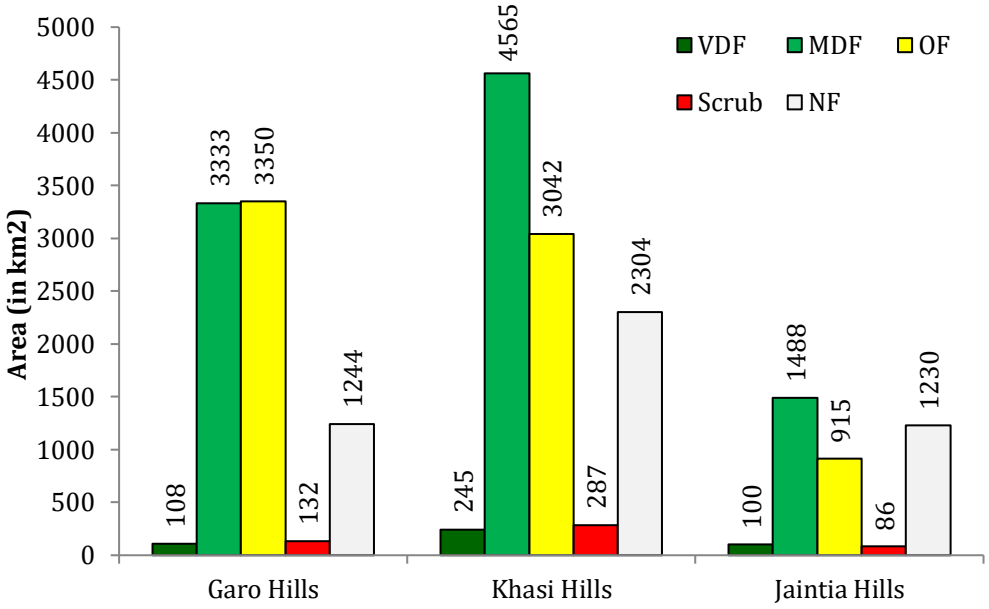


Fig. 4.3: Physiographic Zone wise forest cover in Meghalaya

Classification Scheme for Very Dense Forests, Moderately Dense Forests, Open Forests, Scrubs and Non Forests (Fig. 4.4)	
Category of Forest	*Classification criteria*
Very dense Forest	*All Lands with tree cover of canopy density of 70% and above*
Mod Dense forest	*All lands with tree cover of canopy density between 40% and 70% above*
Open forest	*All lands with tree cover of canopy density between 10% and 40%*
Scrub	*All forest lands with poor tree growth mainly of small or stunted trees having canopy density less than 10 percent*
Non Forest	*Any area not included in the above classes*
	(Source: ISFR, 2017)

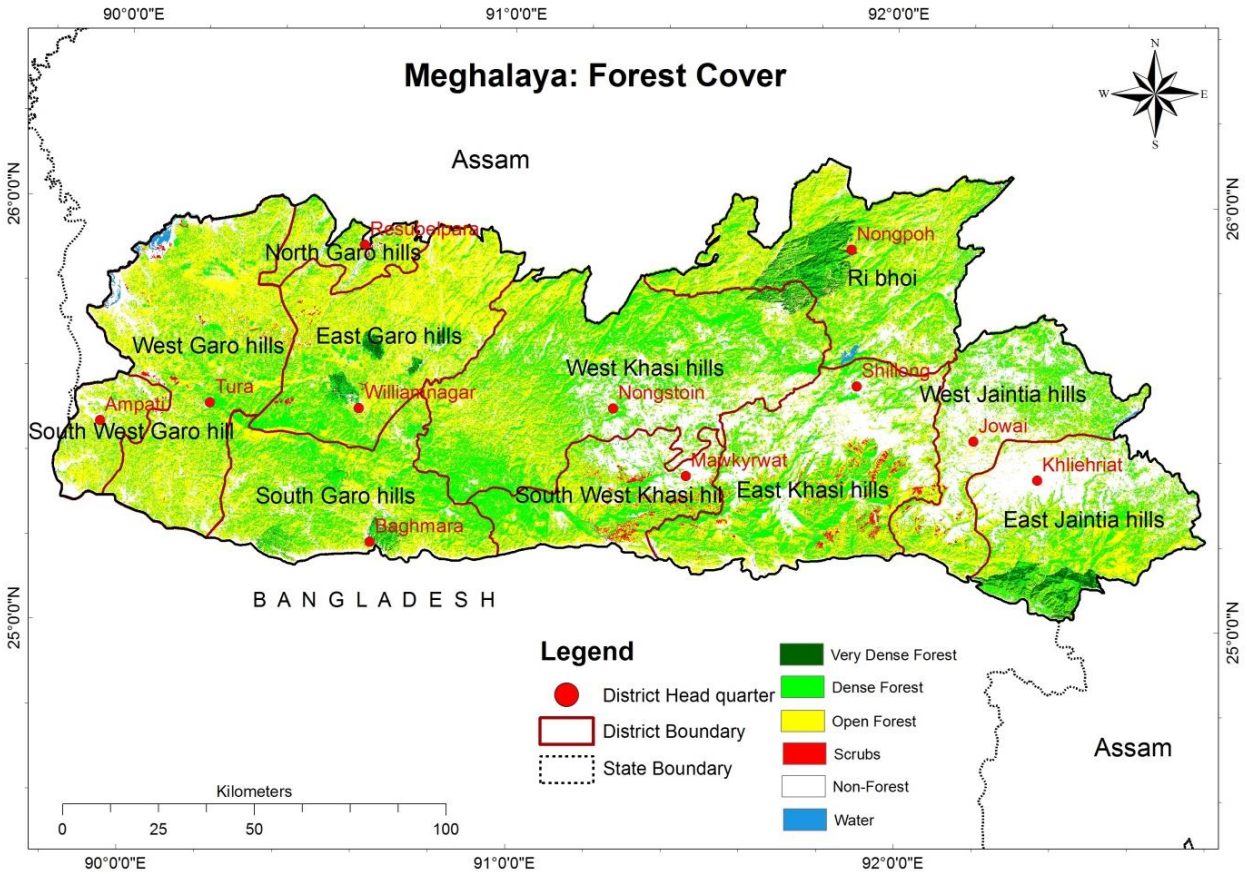


Fig. 4.4: Forest Cover map of Meghalaya

The forests of Meghalaya are reportedly under stress for decades due to various drivers of deforestation and degradation operating in the state. Forest cover, in most of the districts and overall, has been found to have decreased when compared with earlier assessments from 2009 onwards since when the spatial data are compatible to the present. District-wise state of forest cover is given below:

East Khasi Hills: The district is showing lowest forest cover among all the districts of Meghalaya (63.72%). Only 3 km^2 forest were recorded under the category 'Very Dense forests' which itself underlines the impact of forest degradation in the district. Moderately dense forest has decreased from 2011 to 2017 (Fig. 4.5). Open forest on the other hand showing no clear trend during this period. Overall, forest cover in the district was found to have somewhat decreased over a period of last seven years.

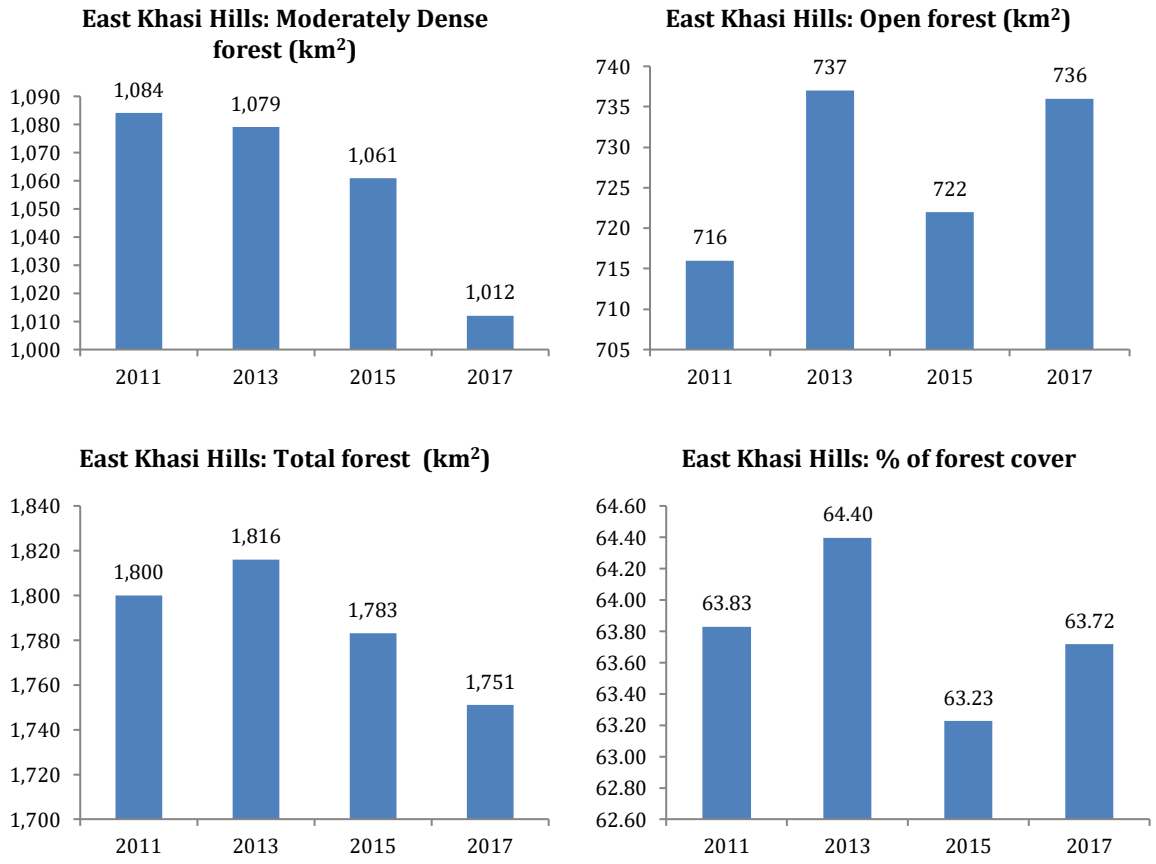
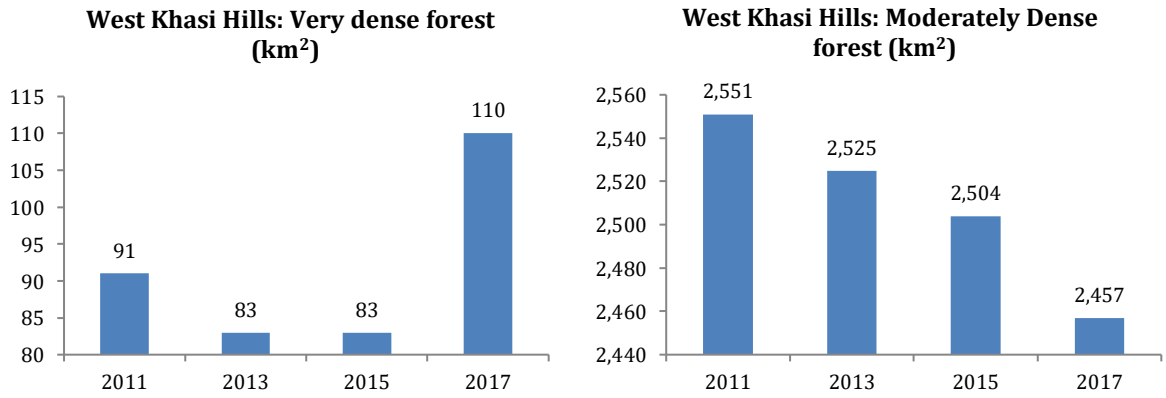


Fig. 4.5: Forest cover change in East Khasi Hills District (2011-2017)

West Khasi Hills: A slight increase in the very dense forest cover was noticed from 2011 to 2017 in the district. Moderately dense forest has decreased from 2011 (2551 km²) to 2017 (2457 km²). On the other hand open forest, as a whole, has shown some increase in area with some decline during 2017 (Fig. 4.6). Total forest cover in the district, was found to have decreased over a period of last seven years (4008 to 3958 km²).



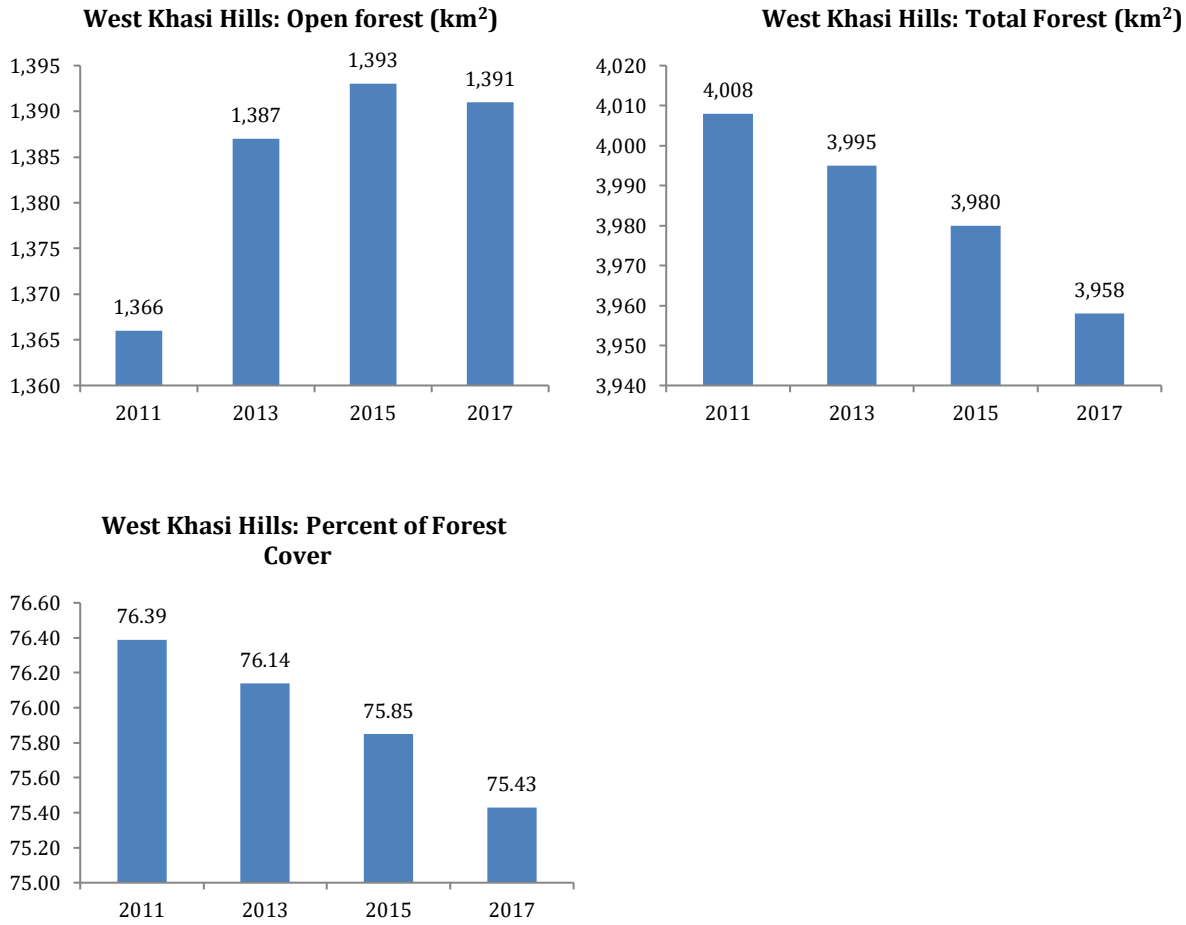
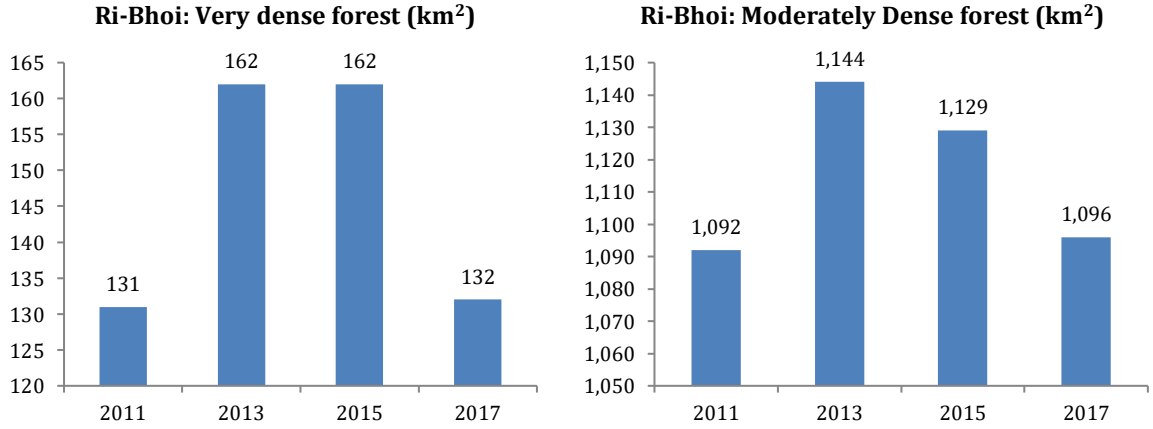


Fig. 4.6: Forest cover change in West Khasi Hills District (2011-2017)

Ri-Bhoi: The district is showing a good forest cover among all the districts of Meghalaya (87.54%) and ranked second. Area under Very Dense forests has decreased and moderately dense forest has also decreased from 2011 to 2017 (Fig. 4.7). Open forest on the other hand has increased. Overall, forest cover in the district has increased after an initial decrease, during the last seven years.



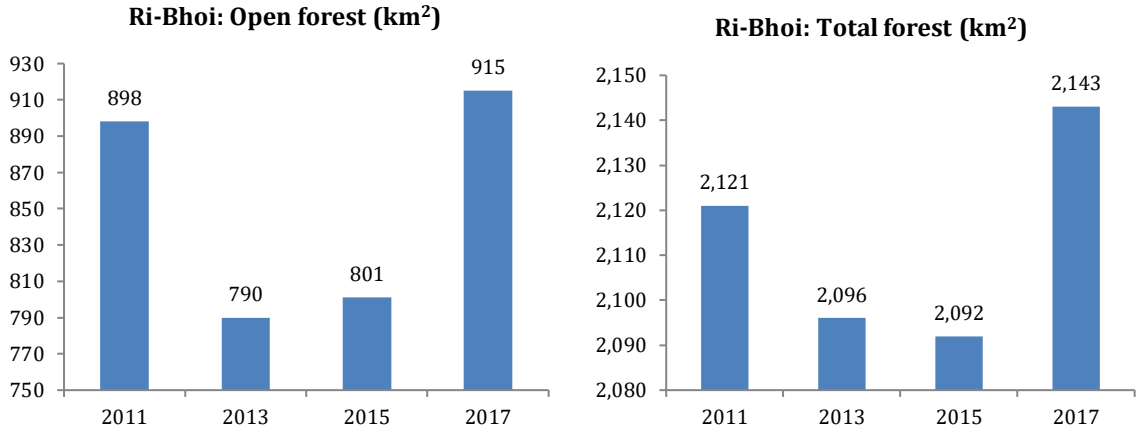
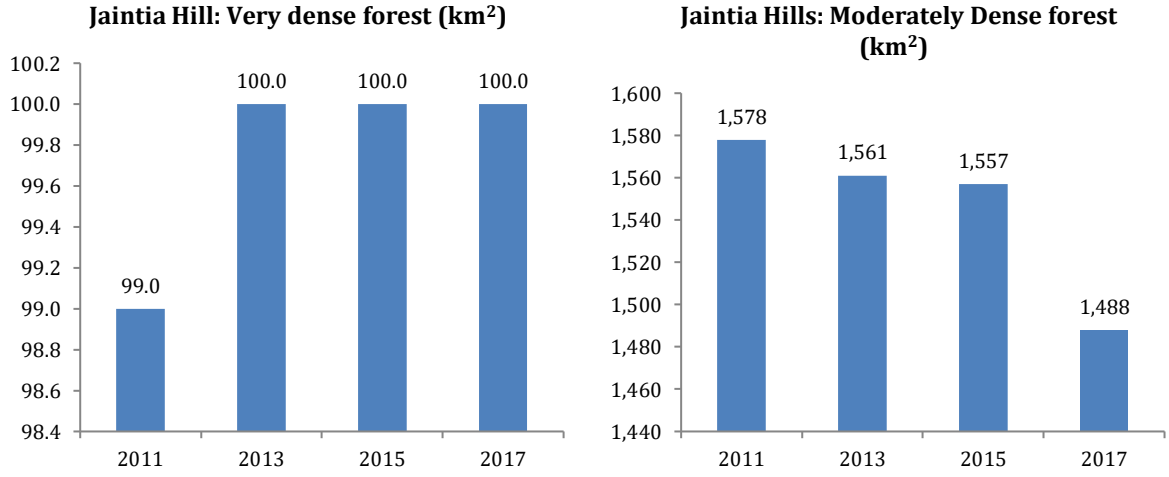


Fig. 4.7: Forest cover change in Ri Bhoi District (2011-2017)

Jaintia Hills: Very dense forest in Jaintia hills remained more or less steady during the period 2011-17. A slight decrease in the moderately dense forest cover was noticed from 2011 to 2017 (Fig. 4.8) in the district. Open forest however has increased from 2011 (839 km²) to 2017 (915 km²). Total forest cover in the district increased till 2015, but sharply decreased during 2017.



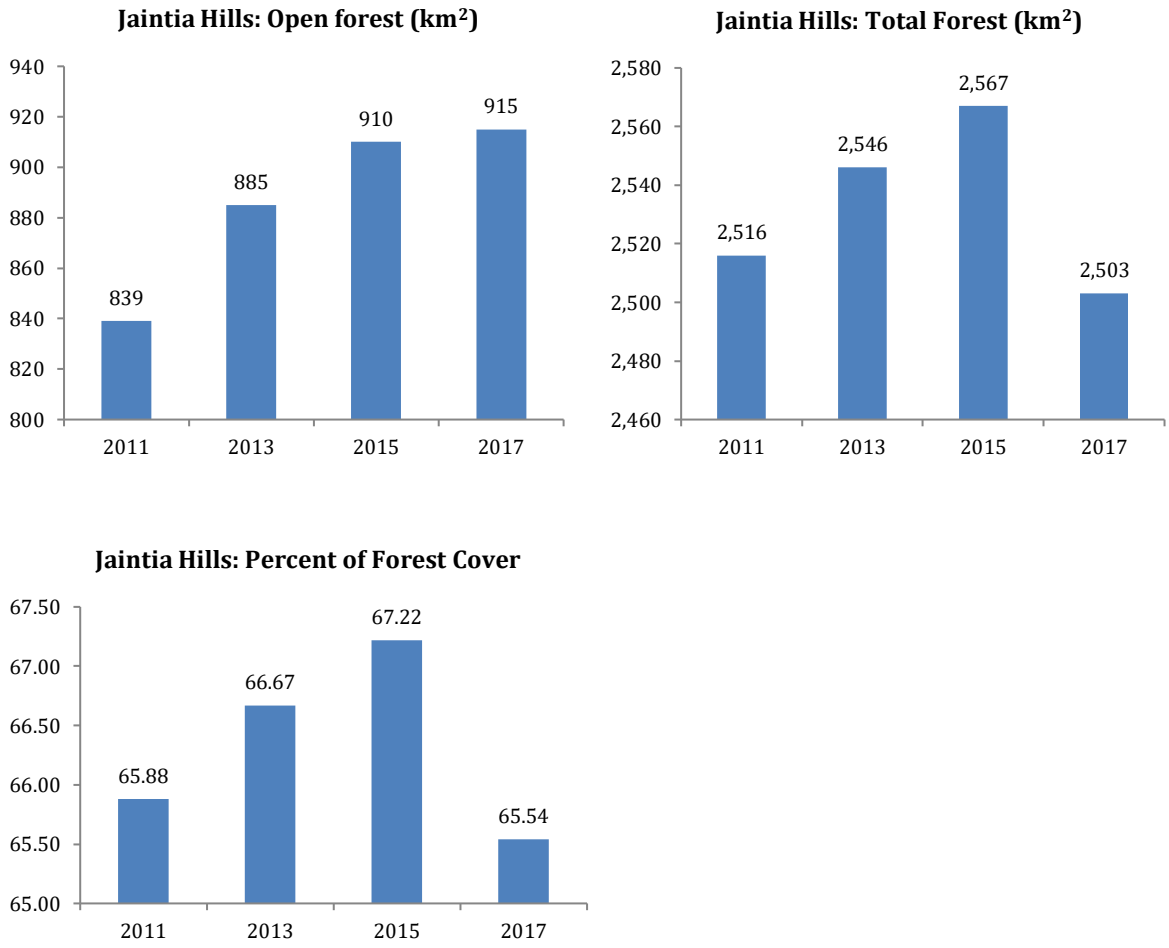
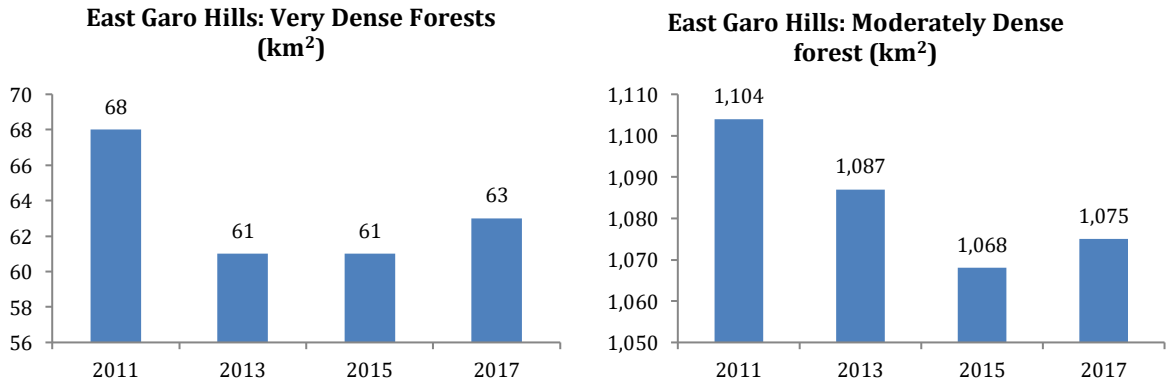


Fig. 4.8: Forest cover change in Jaintia Hills (undivided) District (2011-2017)

East Garo Hills: After the initial decrease from 2011 to 2015, Very Dense Forest in East Garo Hills was found to increase slightly. Moderately dense forest and total forest cover are exhibiting fluctuation whereas open forest exhibits a steady increase in its area (Fig. 4.9).



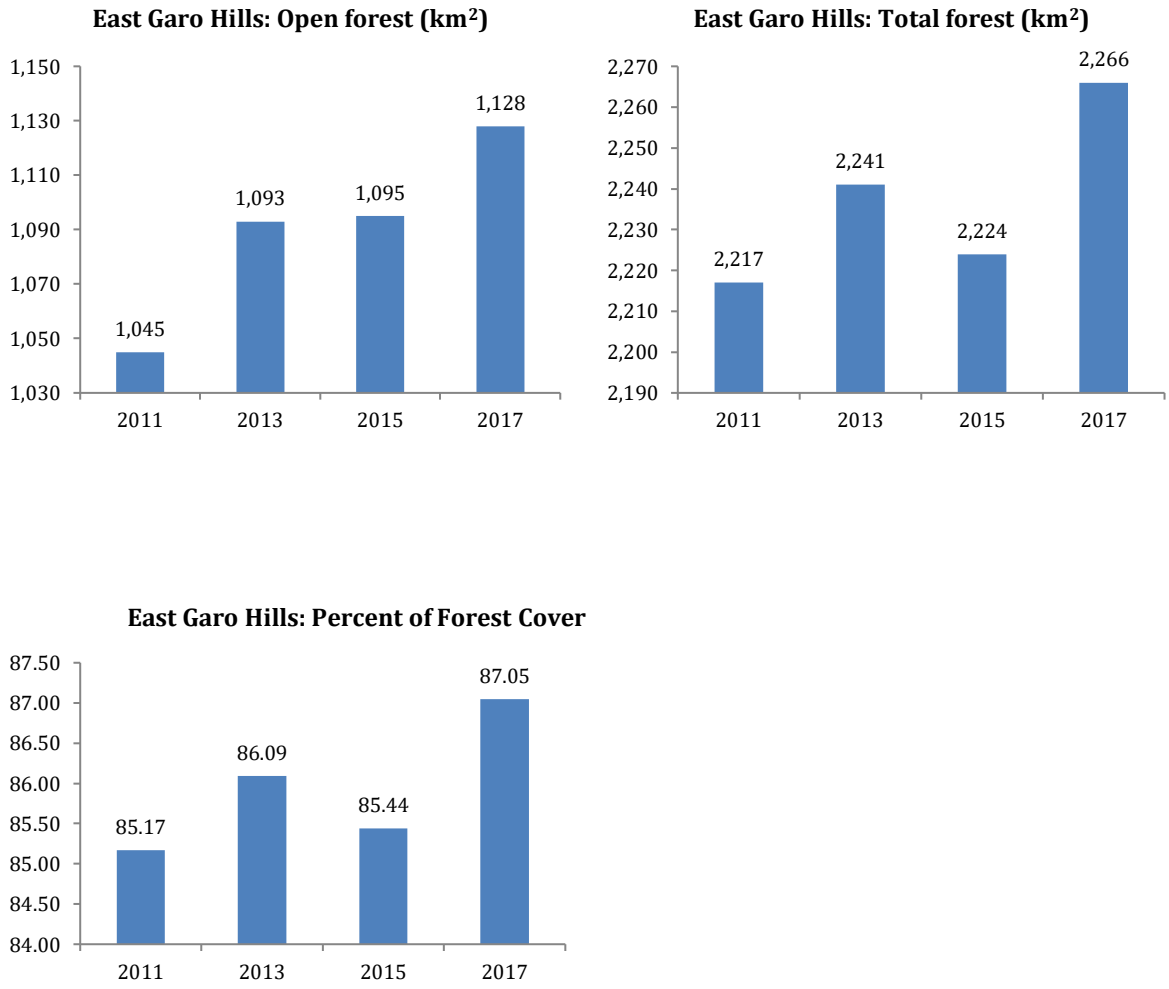


Fig. 4.9: Forest cover change in East Garo Hills District (2011-2017)

West Garo Hills: A clear decrease in the overall area under moderately dense forest and total forest cover was noticed during the period of 2011-17 (Fig. 4.10) in West Garo Hills. Open forest increased till 2015, but with a sharp decrease in 2017. Area under Very Dense forests is negligible in the district.

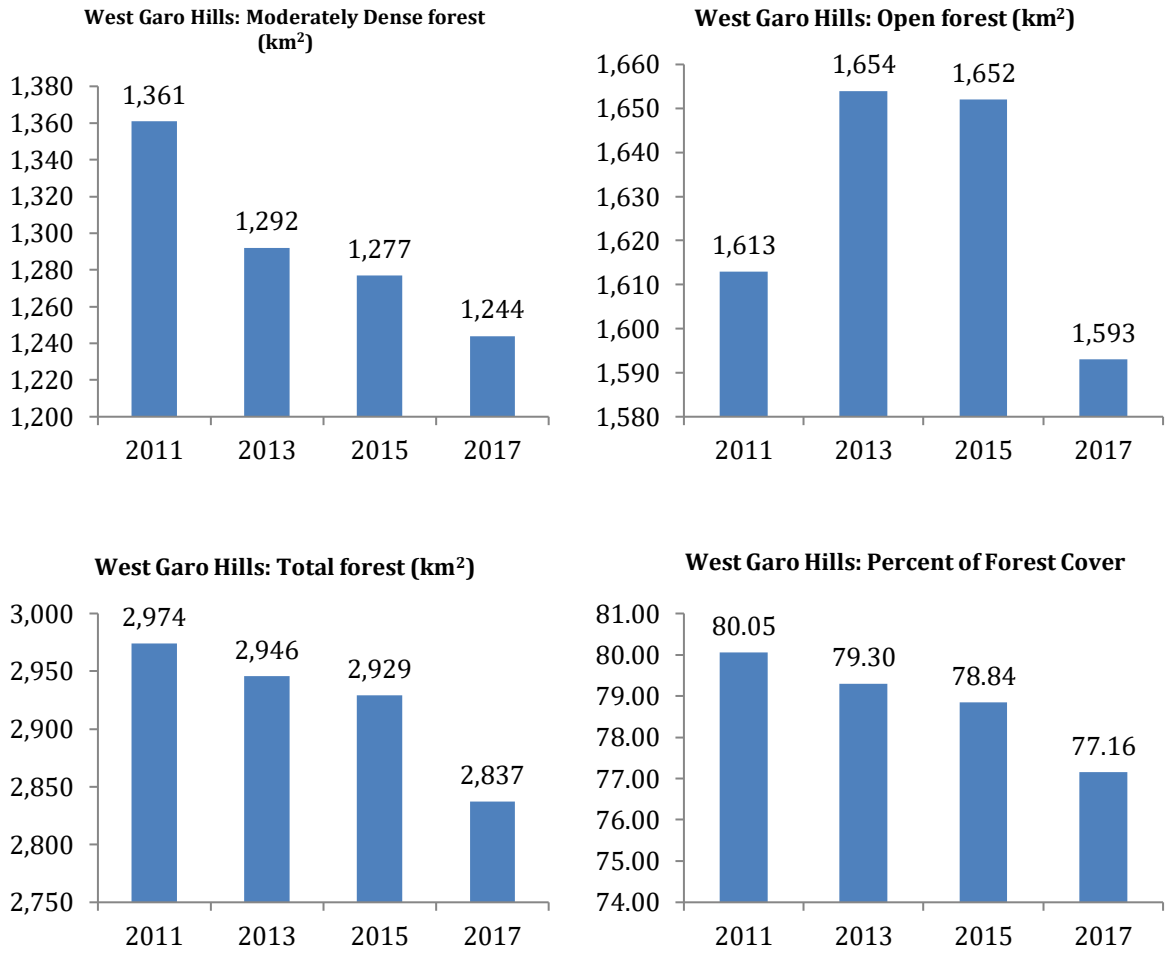
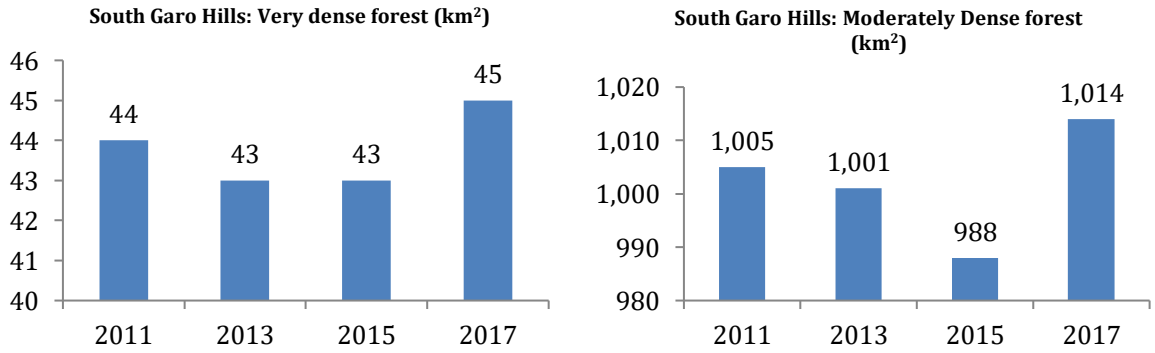


Fig. 4.10: Forest cover change in West Garo Hills District (2011-2017)

South Garo Hills: The district is endowed with the highest forest cover among all the districts of Meghalaya (89.45%). The 'Very Dense forests' cover an area of 45 km² during 2017. Open forest and total forest cover have increased whereas Moderately Dense forests exhibit no clear trend (Fig. 4.11).



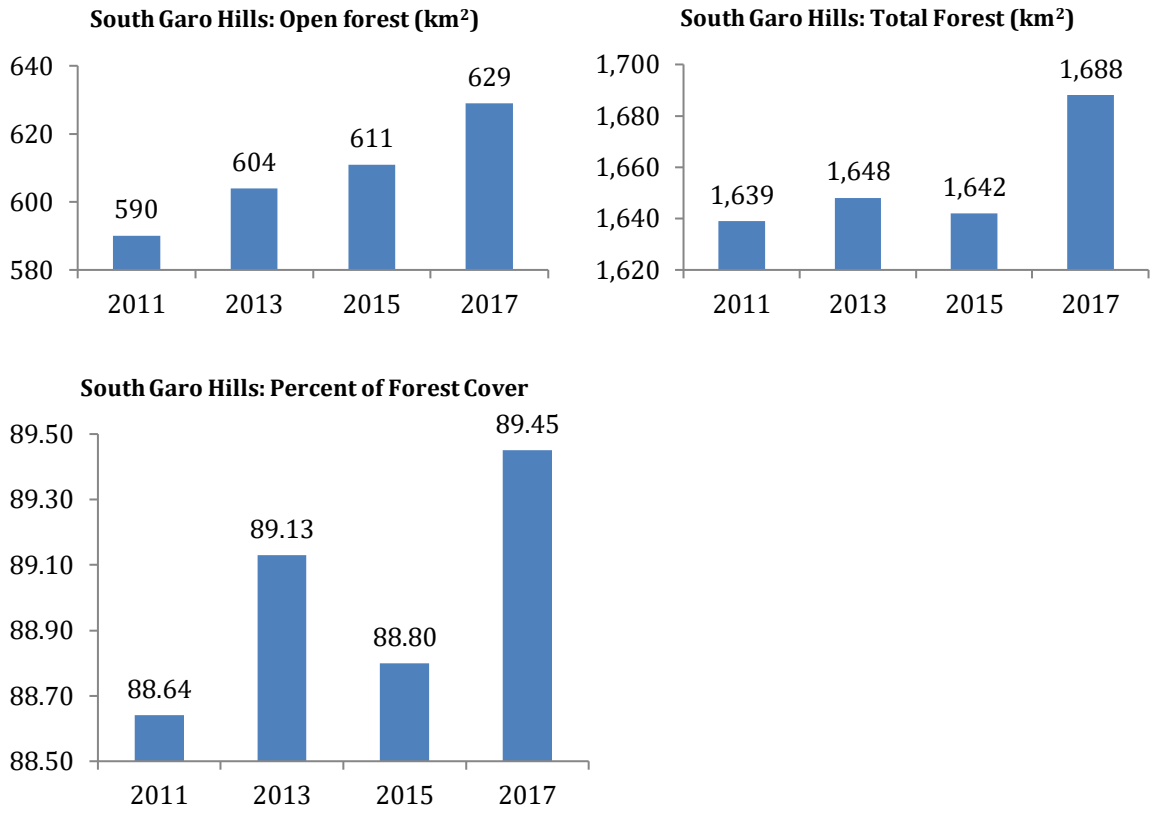


Fig. 4.11: Forest cover change in South Garo Hills District (2011-2017)

Meghalaya: On the whole, moderately dense forests which is the biggest category among all forest cover classes, was found to have decreased in Meghalaya. Open forest, on the other hand exhibited an increase in overall area; slight increase in the dense forest was also recorded. Overall, it can be summarised that forest cover in the state has decreased during the last decade (2009-2017) (Fig. 4.12). The major gainer in terms of forest cover in the state are East and South Garo Hills (49 km^2 each) and Ri-Bhoi district (22 km^2) (Fig. 4.13).

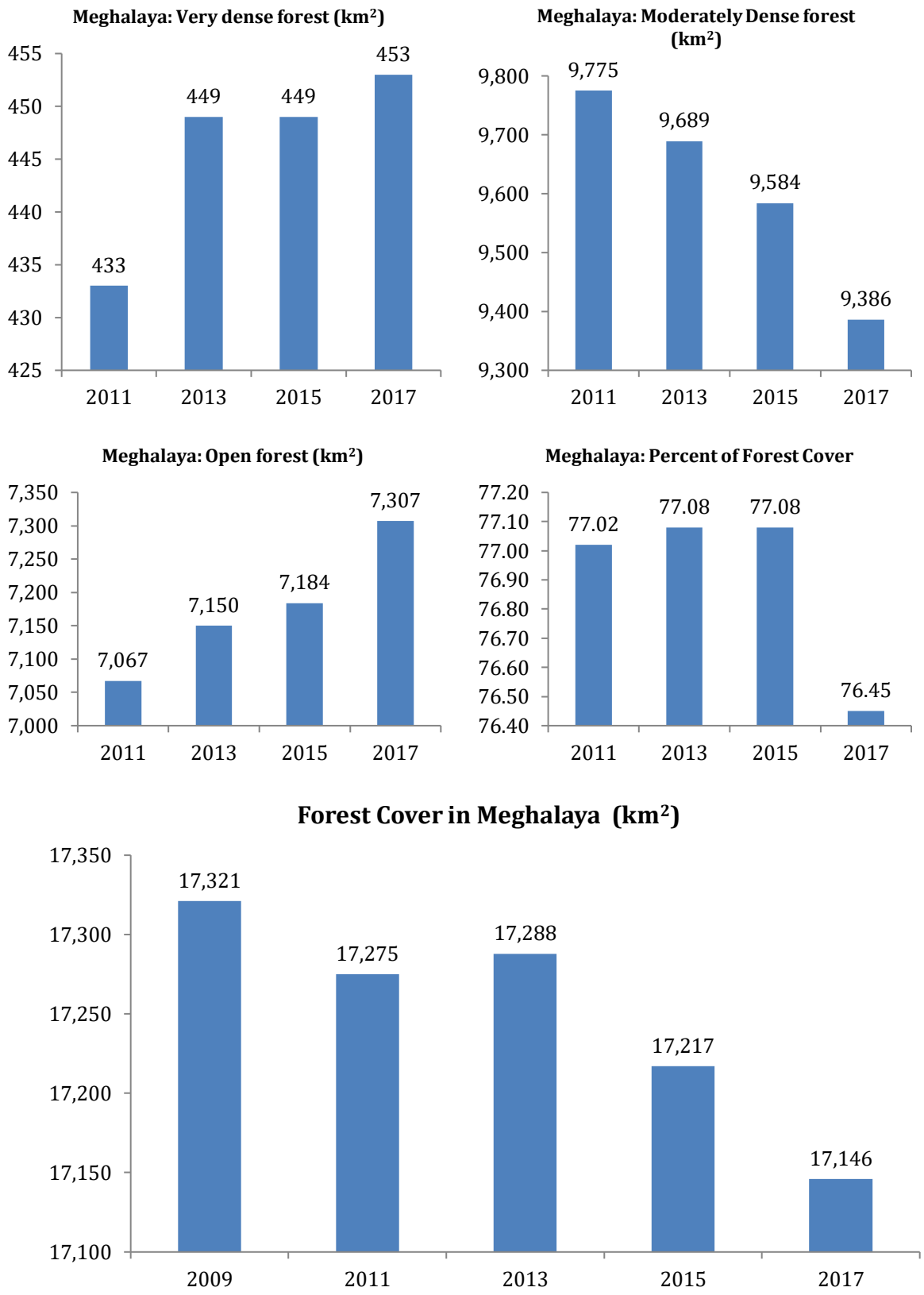


Fig. 4.12: Forest cover in Meghalaya in different years (2011-2017)

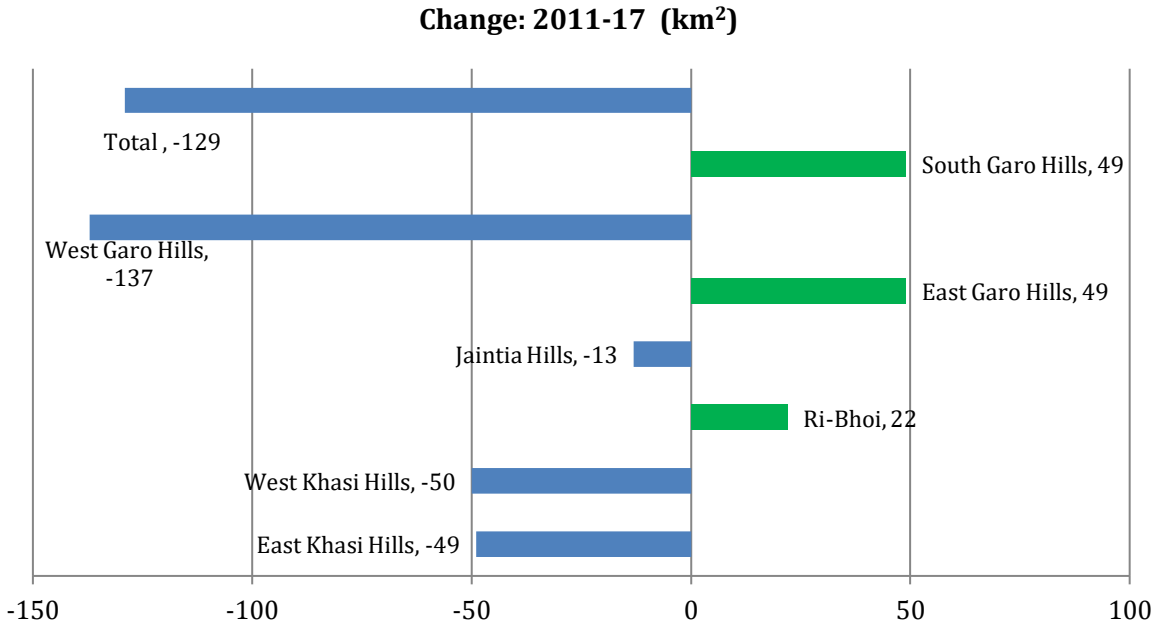


Fig. 4.13: Forest cover change in Meghalaya state (2011-2017)

Other Land use Changes

Forest is the major land use in Meghalaya, covering three-fourth of the total geographical area in the state. The other land uses, dominated by agricultural activities, cover an area of about one fourth of the total land area. Analysis from 2010-11 to 2015-16 shows that Gross cropped area in the state increased from 3,378.5 km^2 to 3,436.0 km^2, with a net increase of about 57.5 km^2. A total of 24.5 km^2 under 'Net sown area' increased during the same period, and 'Area sown more than once' increased from 5393.7 km^2 to 5727.6 km^2 registering an increase of 33.0 km^2 (Fig. 4.14).

An area of 17.4 km^2 increased under the category 'Fallow land' during this period (2010-16). Not much change was observed in the category 'Uncultivated land excluding Fallow' (0.47 km^2 in five years). Area 'Not available for cultivation' increased from 2,365 km^2 to 2400 km^2. The details of the changes are shown in the figures 4.15, 4.16, 4.17.

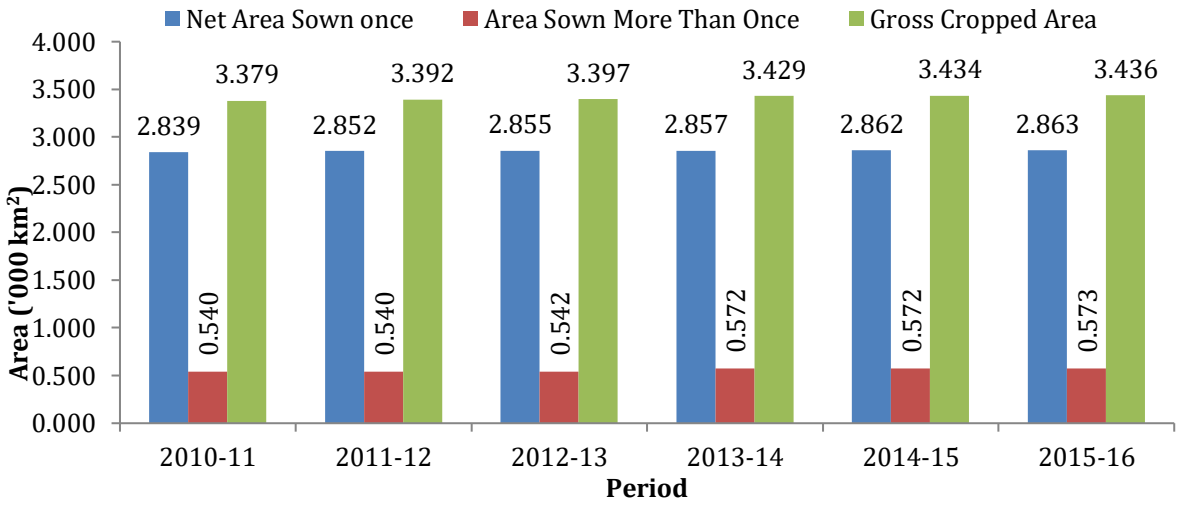


Fig. 4.14: Other land uses (other than forest) changes in Meghalaya

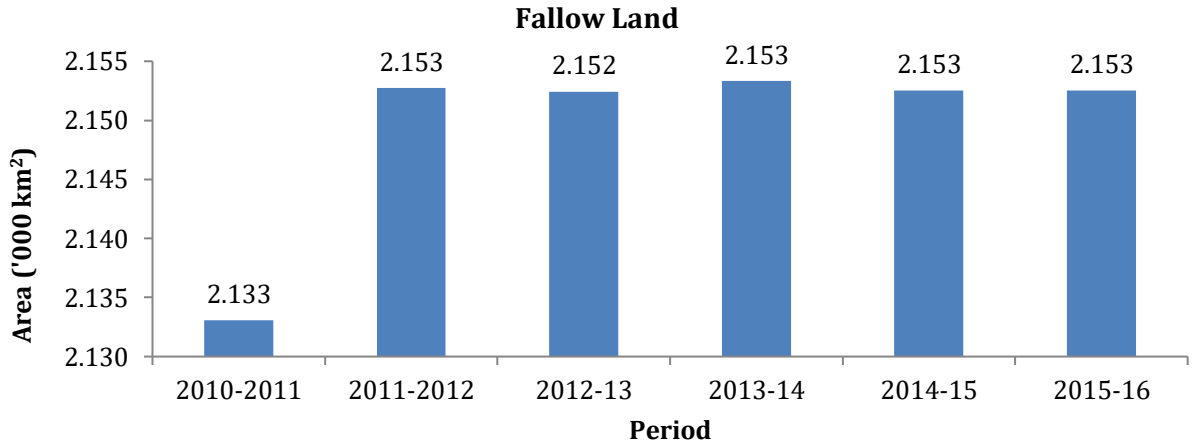


Fig. 4.15: Fallow lands changes in Meghalaya

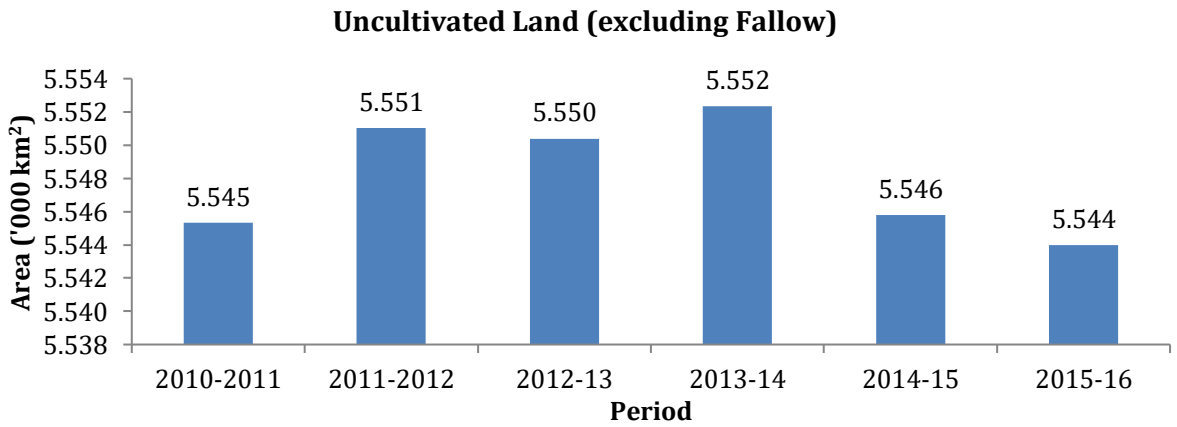


Fig. 4.16: Uncultivated land (Excluding fallow) change in Meghalaya

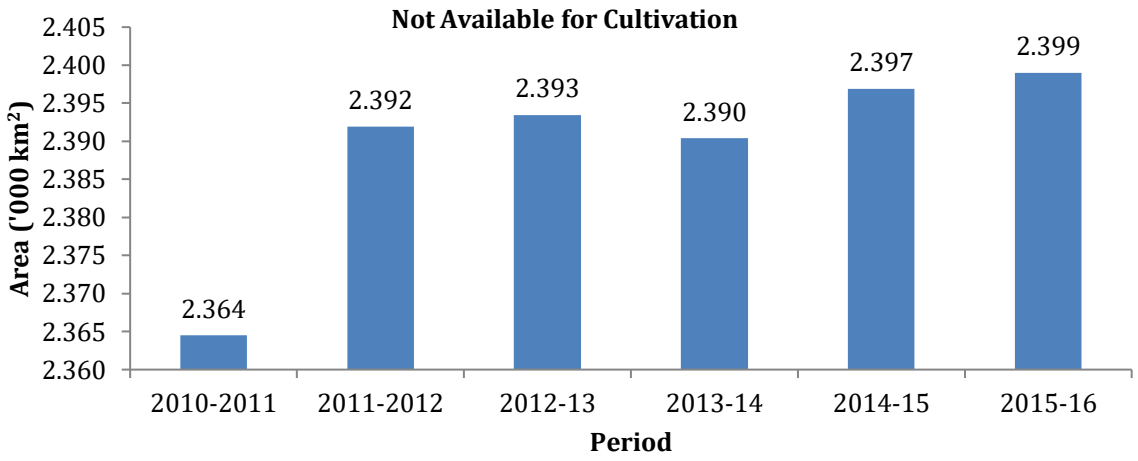


Fig. 4.17: Changes in Land not available for cultivation in Meghalaya

Crop-wise land use changes:

As far as land uses covered by different crops are concerned, rice which is the staple food in the State is showing increase in overall area. In 1990-91, an area of 1040 km² was recorded under rice crop whereas during 2014-15 total area under rice crop increased to 1121 km², an increase of 52 km² in a span of 15 years (Fig. 4.18). Maize, on the other hand exhibits a mixed pattern of land use change. Overall, it was found to have decreased by 52 km² during this period (Fig. 4.19). Pulses show some increase from 52 km² to 63 km² during 1990 to 2015, whereas area under wheat was found to have decreased by 62 km² during the same period. Other cereals show steady state in terms of area (Fig. 4.20). Changes of area under Oilseeds, Fibre and other crops are shown in Fig. 4.21.

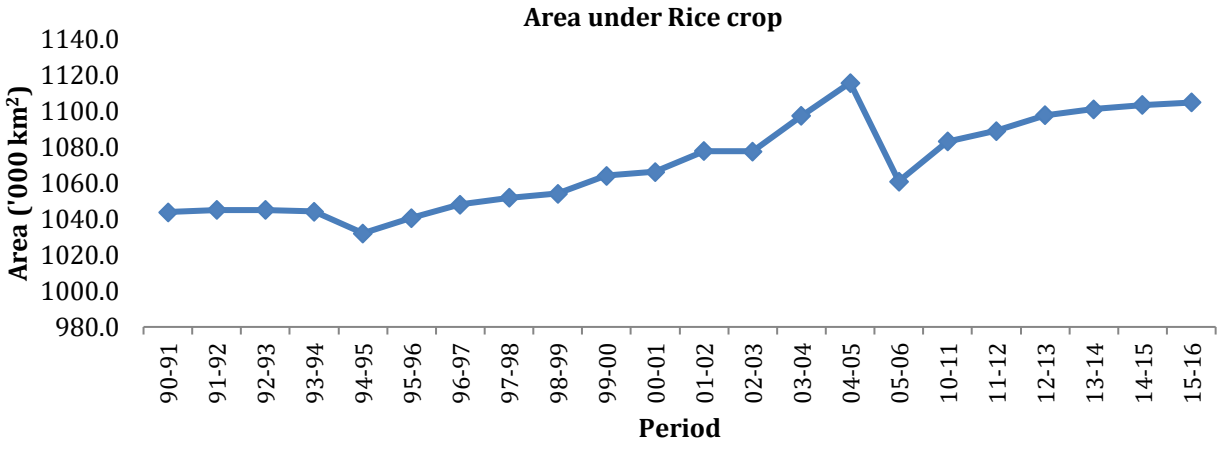


Fig. 4.18: Land use covered by rice cultivation

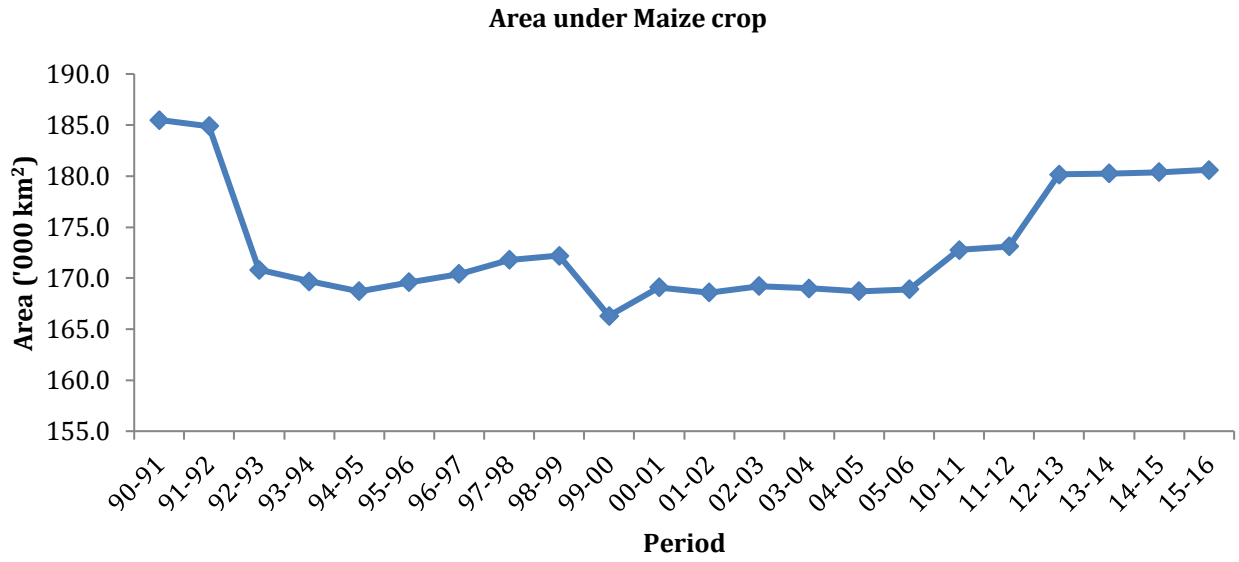


Fig. 4.19: Land use covered by maize cultivation

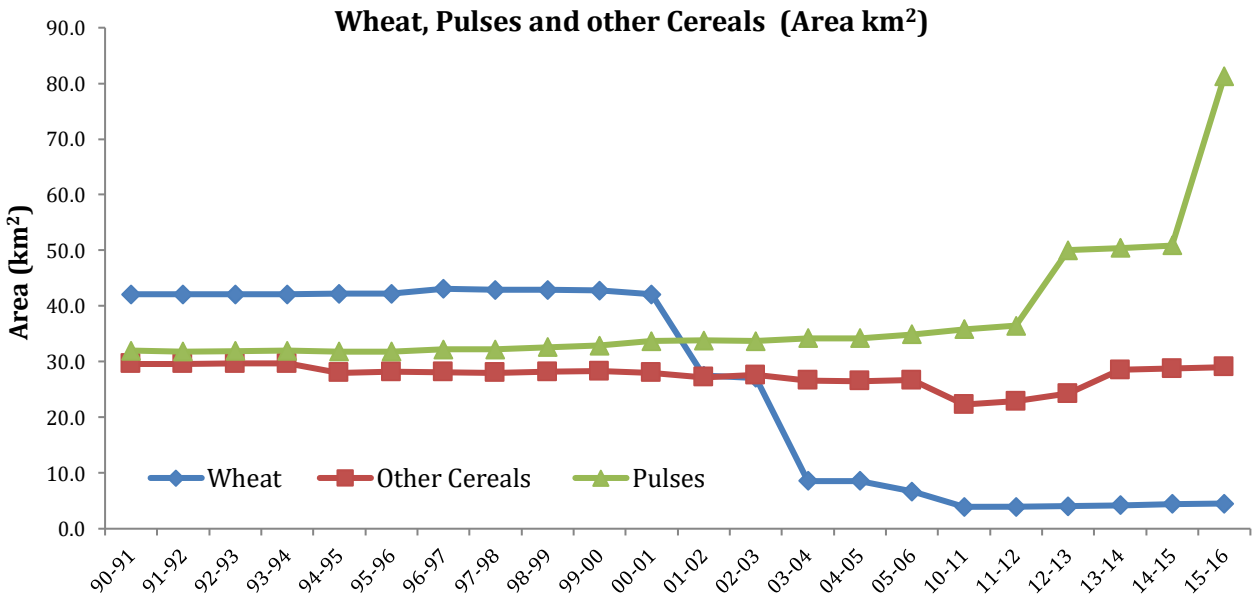


Fig. 4.20: Land use covered by wheat, pulses and other cereals cultivation

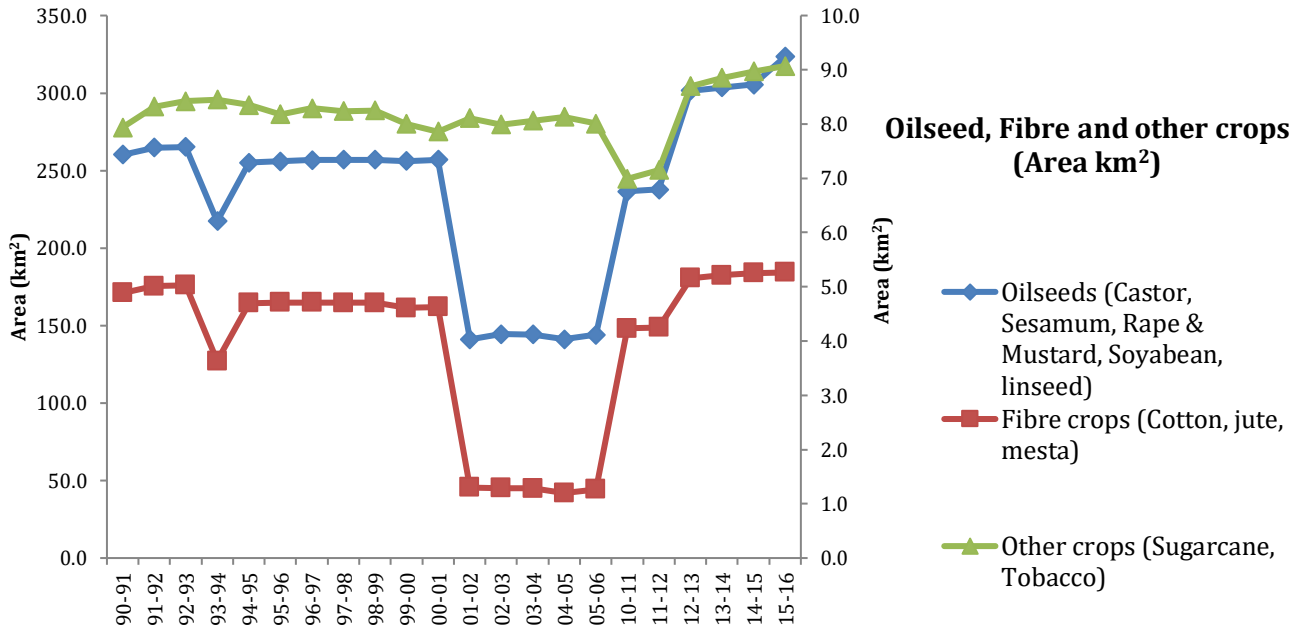


Fig. 4.21: Land use covered by oilseed, fibre and other crops cultivation

4.3 Practice of Community Forest Conservation

In Meghalaya, a Sixth Schedule state of North East India, communities exercise direct or *de-facto* control over most (90%) of the forests (Poffenberger, 2006). A very complex and diverse pattern of community forest ownership is in vogue, with the forests being classified into different types depending on their customary laws and intended use (Kumar 2008; Tiwari et al., 2010). These are managed by '*Traditional Institutions*' (TIs), which are organized at village level (Anon., 1950). These forests provide livelihood, apart from being of cultural value for the communities (Tiwari et al., 2013). A List of Notified Community Reserves in Meghalaya is given in the Annexure 4.2. This category of protected areas was introduced in the Wildlife (Protection) Amendment Act of 2002 and it recognizes that local communities can participate in protection of threatened species and natural resources, and thus the law accords official recognition to such efforts. These categories were also created to strengthen conservation in and around existing or proposed protected areas.

In the *Khasi*, *Garo* and *Jaintia* tribes, the tradition of forest conservation is passed on from generation to generation in the form of beliefs and customs. Since the days of yore, maintenance of sacred forests and restricted forests (*Law Adong*) has been in vogue

(Gurdon, 1975). Apart from assistance to conserve forest resources, evident from the presence of large patches of well protected forests and insurance of its sustainable use, these traditional management practices are also doling out as a '*safety net*' for the communities, by perpetuating to guarantee a common good (Tiwari et al., 2010). It is interesting to note that there occurs even more than one category of forest within the boundary of a single village. Inferentially, at a micro level unlike many national or international initiatives that aim to meet these requirements on national or global scales, these communities have evolved a system of combining forest conservation and sustainable use.

The institution of *Syiem*ship, being the traditional rulers of the Khasi Hills is one of the most important elements, which has held *Khasi* society together, since they were. However, the *Syiem*s lost their political importance to the British, except retaining their position as an administrative entity with a focus on perpetuating cultural and customary practices of the *Khasi*s. The position of the *Syiem*s had been altered and their status was reduced to that of officials and functionaries of the District Council, after independence.The *Syiem*s had to remit a portion of the royalties collected by them to the District Council. However, with promulgation of laws for the management of such forests by the District Council, authorised by the Constitution's Sixth Schedule, the customary laws of Raid forest management became abrogated. Consequently, the *Syiem*s, deemed as administrative officers by the District Council derive their right of management from the law made by the Council. However, in practice, they continue to function with their untouched status.

4.4 Sacred Groves: from a Traditional Knowledge concept to a Conservation practice

Sacred groves are depictive of the respect of local tribal communities of Meghalaya for nature. Sacred groves are virgin forest tracts, considered residence of local deities, scattered in all the districts of Meghalaya (Jeeva et al., 2006). It is an accepted myth that felling of trees and plucking of twigs, flowers and fruits would offend the Sylvan deities *Ryngkew* and *Basa*; while upholding these groves in undisturbed condition will bestow welfare to the people, their cattle and land, apart from keeping the evil spirit away. Variousreligio-cultural rites and rituals are performed in these groves; while none of the

plant species are harmed in any manner, except for medicinal purposes (Jeeva et al., 2005; 2006). Any person culpable of sacrilege is believed to fall under the deity's curse and face ominous consequences, even amounting to premature death, sickness, poverty, etc. These forests represent a long tradition of environmental conservation based on ecological principles practiced by the indigenous people of the *Khasi*, *Garo* and *Jaintia*. Tribal communities living near sacred forests possess a wealth of knowledge about conservation and utilization of genetic wealth, which has evolved over generations and is being endangered with the onslaught of modernization.

These forests are biodiversity-richassemblageswhich offer safe haven to a large number of endemic, endangered and rare species of flora and fauna; more than 1,886 plant species that include various orchids, medicinal and ornamental plants, timber and resin yielding plants; with more than 110 mammal species that include some endangered (such as Clouded leopard, Assamese macaque, Capped leaf monkey and Sloth bear, etc.) and a large number of phylogenetically primitive plant families such as *Magnoliaceae, Digneriaceae, Himantandraceae, Eupomataceae, Winteraceae, Trochodendraceae* and *Lardizabalaceae* are found in these groves along with Poaceae, Fabaceae and Orchidaceae plant species which dominate the list (Tiwari et al., 1998; Kumar, 1991; Jamir and Pandey, 2003; Jeeva et al., 2005). The whole concept of conservation associated with sacred groves is believed to be an indigenous knowledge, which was envisioned, built upon and propagated by the Meghalayan tribal communities (Jeeva et al., 2005). Out of 41 sacred groves that are reported in Meghalaya, there are 15, 19 and 7 groves in the Khasi Hills, Garo Hills and Jaintia hills district. On an average, area of an individual grove ranges from 300-500 ha. (see Annexure 4.3).

It is quite generalized that the natural vegetation of *Khasi* and *Jaintia* hills of Meghalaya consists of either mono-dominant secondary pine forests or meadows. As a matter of fact, the Meghalayan pristine forests are currently mainly restricted within Biosphere Reserve, Wild Life Sanctuaries, National Parks, and Sacred Groves. Amongst these, sacred groves have gained importance owing to their high species richness (Jamir and Pandey, 2002, 2003; Upadhaya et al. 2003) and quite large area when compared to their counterparts elsewhere. Besides acting as a gene pool, they also deliver ecological services such as

perennial water sources, maintenance of local micro-environmental conditions and help in bio-geochemical cycles (Upadhaya, 2002). A relict of the original forests, these are scattered at different places and generally found below the hill brows. At the first glance, the sacred groves of Meghalaya may not emerge to be of much significance in terms of biodiversity, in view of the fact that the bulk of them are quite limited in their coverage. Moreover, from the conservation point of view, the Sacred groves are far excessively spread to be regarded as one viable unit. Again, most of them are also in a degraded status. Studies conclude that merely 1 % of the total area of sacred groves is undisturbed. The bulk of the sacred groves are subjected to assorted degrees of disturbance.

The *Lyngdoh*s and other such categories of religious priests have been entrusted the management of sacred groves i.e. *Law Lyngdoh*, *Law Kyntang* and *Law Niam* by the District Council. However, they are also getting destroyed and mismanaged, in a manner similar to that of private and *Raid* Forests. The *raison d'être* for the destruction and mismanagement of sacred groves, is however dissimilar to that of Raid and private forests, i.e. the loss of `sanctity'. In the days of yore, sanctity of the groves was honoured and nothing in this category of forests was removed with the exception of religious purposes. In the present scenario, on account of an expanding population and comparatively materialistic younger generation coupled with religious conversion which does not subscribe to such beliefs, the sacred forests are losing their status. Subsequently, a lot of groves have been totally destroyed; while in others the frequency of felling trees and violation of the age-old customs are on the rise. The groves are also not protected by the extant laws.

Sacred groves are declared under the United Khasi and Jaintia Hills Autonomous District (Management and Control of Forests) Act, 1958 and Garo Hills Autonomous District (Management and Control of Forests) Act 1961. According to these laws, the sacred groves are to be managed and controlled by the *Lyngdoh* (priest or religious head) or other person(s), who are entrusted with the religious ceremonies for the locality or village, in accordance with the customary practices and rules framed by the Executive Committee of the concerned Autonomous District Council. They prohibit felling of trees inside the sacred groves without the written sanction of the concerned Chief Forest Officer or any other officer. These laws state that no tree/trees shall be felled or removed from the *Law*

Lyngdoh, Law Niam and *Law Kyntang* (Sacred groves) except for purpose connected with the religious function or ceremonies recognized and sanctioned by the *Lyngdoh* (priest) or other persons in accordance with law.

Nevertheless, in the face of such a bleak scenario, the sacred groves are amongst the last treasure house of the region's biodiversity. Being attached to solely religious sentiments which have been instrumental in protection of these groves, a revival strategy pertaining to these sentiments, beliefs and myths in the modern world is altogether impossible and undesirable. The focus could be to re-educate the people about their values. This "*value*" could be explained in terms of its botanical wealth *viz*., medicinal plants wealth, the rare and endangered species, ecological importance, etc. Moreover, other important functions of sacred groves in terms of serving as a safety reserve in cases of emergency apart from its soil conservation functions require emphasis.

5.5 Protected areas

Certain Protected Area (PA)s were established in Meghalaya (see Annexure 4.4) by acquiring land from the local communities. Thus these PAs, which include National Parks, Wildlife Sanctuaries, Reserved Forests and Conservation Reserves, are mostly bounded by community lands or some private forests. Comprising only 6% of the State's geographical area, as no other activities are allowed inside these PAs, except NTFP extraction according to the rights of the communities, they provide best protection to the biodiversity. Since, most community forests lack any legal protection, the PAs serve as the best refuge for the State's flora and fauna.

Chapter 5

Drivers of Deforestation

The impacts of the individual drivers acting at a global to local extent tend tochange over time. For example, forests in a country with internal political turmoil are unlikely to be under the influence of identical drivers as the forests in a comparatively stable country. Likewise, with any change in technology, the impact of drivers will also change in time and over space. Therefore, what we see currently on the landscape is the sum total of effects of past and present drivers, which have acted at different times and at multiple scales.

Previous published works have discussed the basic model of drivers or proximate causes, which in turn assess factors that result in the indirect drivers. These key factors are economic, demographic, technological, cultural, and socio-political (Geist and Lambin, 2002), which may act at various levels of extent, i.e. either globally, regionally or nationally. These factors each produce a suite of indirect drivers, and for Meghalaya, in particular, these are generally as follows, for both deforestation and degradation.

5.1 Proximate Causes

5.1.1 Agricultural Expansion

Agriculture is the main livelihood of the people of Meghalaya as nearly 81% of the State's population lives in rural areas. The area under agriculture in the state has increased from 2,23,756hectares(9.98 % of the total geographical area)in 1990 through 2,65,874 hectares (11.85 % of the total geographical area) in 2004 to 3,43,431 hectares (15.31 % of the total geographical area) in 2015 (Directorate of Agriculture, Government of Meghalaya, 2005, 2017).Perusal of data is indicative of the fact that area under agriculture in the state exhibits a two-fold decadal increase from 43,529 hectares (1990-2000) to 82,106 hectares (2001-2011) (Directorate of Economics and Statistics, Government of Meghalaya, 2017). This may sound heartening in the context of food production, but poses a risk factor for ensuing loss of forest cover.

The development of agriculture sector is dependent on a number of factors, which include the cultivation method, land ownership, irrigation facilities, extent of soil conservation, land cultivability and fertility. Ownership of land including most of the forest areas is mainly private i.e., with local tribals.Farmers follow the conventional methods of cultivation known as *Jhum* or shifting cultivation which is widely practiced in many parts of the state. The people cultivate millet, rice, maize, soya, tubers, oilseeds, spices, vegetables, and leafy vegetables for household consumption, while crops like broom grass (*Thysanolaena maxima*), areca nut, rubber, cashew nut, black pepper, tea, coffee, and various fruits are grown as cash crops (Behera et al., 2016). The State is also renowned for its horticultural crops like Banana, Guava, Jackfruit, Orange, Lemon, Pineapple, Litchi and Temperate fruits such as Plum, Pear, Peach etc.(Directorate of Agriculture, Government of Meghalaya, 2002).

With recent researches in crop varieties and release of high yielding varieties of food grains, an increase in crop production has been observed in the State. Mansuri, Pankaj IR8 (High yielding varieties of paddy) and other varieties like IR36 (for Rabi season), which support the multi-cropping system has been encouraged and is cultivated in most of the state. Megha I and Megha II, the cold tolerant varieties of rice developed at ICAR, Meghalaya was released in 1991-92 for high altitude regions of the state (BSAP, 2004).

The details of land use pattern from 2000 to 2016 are given in Annexure 5.1, apart from depicting gross cropped area in Figure 5.1.

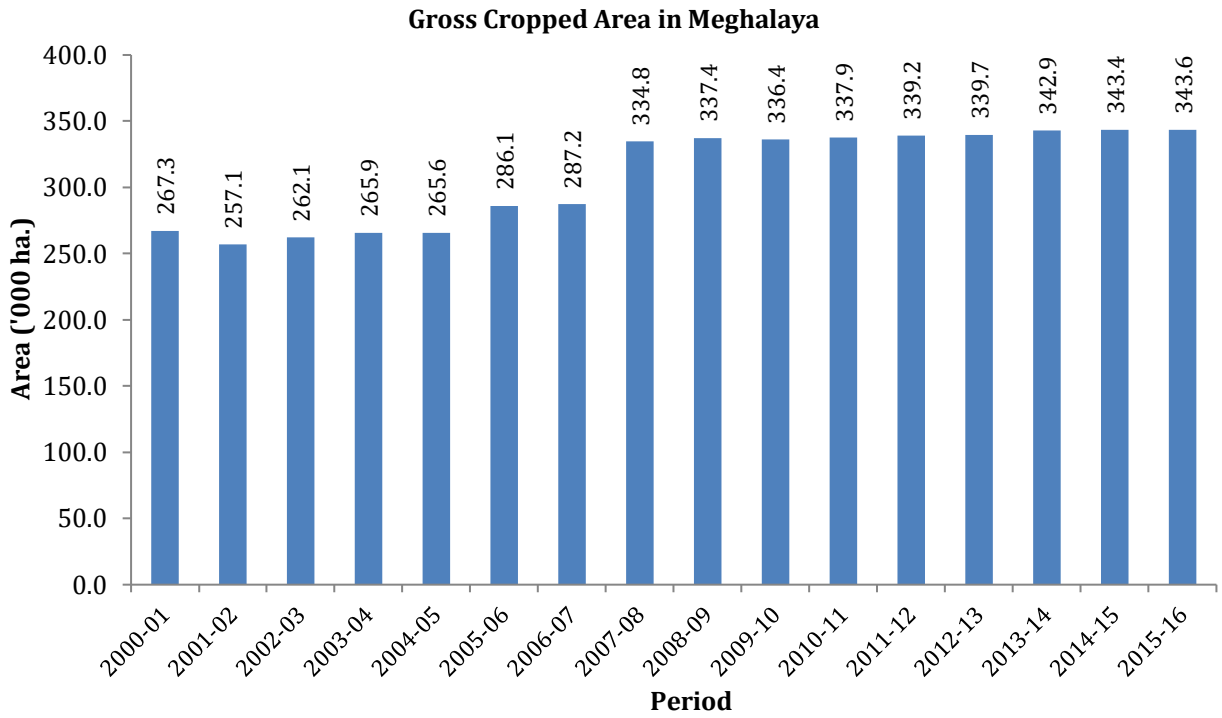


Fig 5.1: Gross cropped area from 2000 to 2016

People's livelihoods mostly revolve around agriculture and other primary activities. The variety of crops cultivated can be classified into two broad groups, *viz*. - subsistence (includes millet, rice, maize, soya, tubers, oilseeds, spices, vegetables, and leafy vegetables for household consumption) and cash-crops (like broom grass, areca nut, rubber, cashew nut, black pepper, tea, coffee, various fruits etc). The rise in modern cash-crops in the Khasi Hills is less prominent compared to the Garo Hills. It has been observed that distribution of many modern cash-crops (e.g., rubber and cashew nut) is also high in the Garo Hills. For example, Rubber and cashew nut (introduced in 1957–1958 and 1962–1963, respectively) were planted at low altitude and in the foothills with relatively high temperatures in the Garo Hills (Behera et al., 2016). However, there are only sporadic mentions of Rubber Plantation scenario in Meghalaya (Behera et al., 2016; Chakraborty et al. 2018) and there is clear data gap in this regard. The area under rubber is reported to have increased from 4029 ha. in 2000-01 to 5,331 ha. in 2006-07, indicating an increasing trend. As far as areca nut is concerned, a steady rise in productivity from 1.27 t ha.$^{-1}$ in 2002-03 to 1.58 t ha.$^{-1}$ in 2015-16 is noticed. The Total area under arecanut cultivation during a period of 14 years (2002 to 2016) has increased from 11189 ha. to 16965 ha.in Meghalaya (Fig. 5.2).

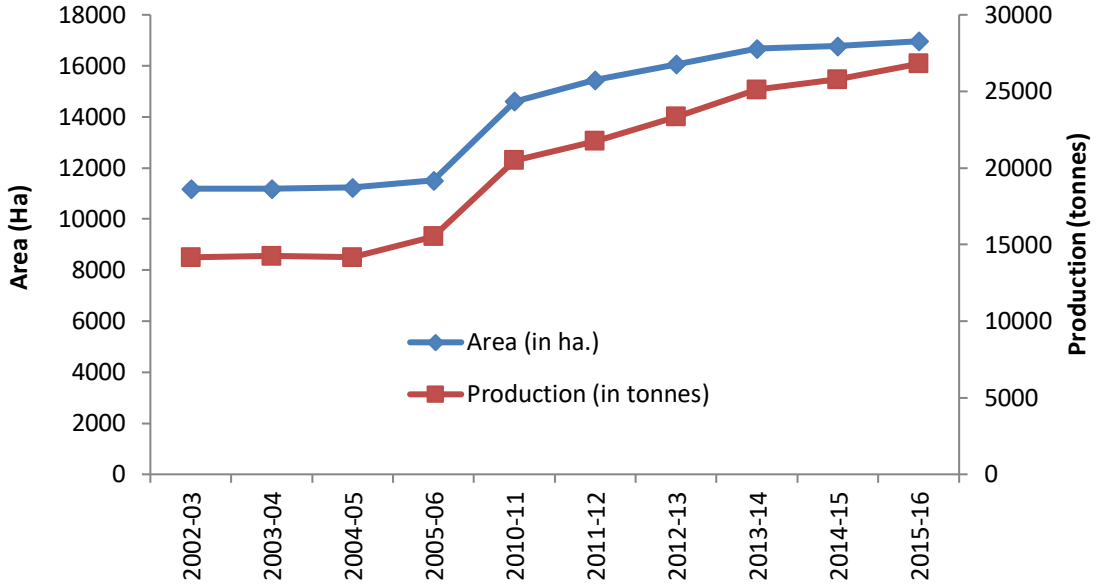


Fig 5.2: Area and Production of Arecanut in Meghalaya (2002 to 2016)

Shifting cultivation: The ethnic communities of Meghalaya follow two major types of agricultural practices, viz. – (1) Shifting Cultivation or Slash and Burn Agriculture or *Jhum*, and (2) Terrace or Bun Cultivation. Shifting cultivation is practiced in and around forests, and terrace cropping is practiced in valleys and foothills, and inside plantation forests. Enormous increases in human population have led to massive coverage of land under shifting cultivation. *Jhum* cultivation is practised chiefly for subsistence with surplus produce traded in local markets for additional income.

One of the obvious and major drivers of deforestation in Meghalaya is the practice of Jhum cultivation, which is the most prevalent form of agricultural practice. A piece of land is earmarked and trees are felled, bushes are cut down, left to dry and burnt *in situ*. Rice, maize or any other agricultural crop are grown in this land without using plough or animal power fora limited period (i.e., until the yield begins to decrease). Then, the *jhummia* (cultivator) moves on to a new patch of forest and repeats the process, thereby allowing the abandoned land to recuperate. Bamboo drip irrigation is used to provide irrigation in which water from a nearby upland stream is trapped and carried to the cropland using

various forms of bamboo culms, further distributed in bamboo channels (Jeeva et al., 2006; Jaiswal, 2006).

The fallow period has reportedly decreased from 10-15 to 3-5 years over the years in the state and therefore becomes one of the major agents of deforestation in the state (Tiwari, 2003). Shifting cultivation was found to have decreased from 744 Km^2 during 2001-03 to 449 Km^2 during 2005-06 and again increased to 541 km^2 during 2008-09 (Fig. 5.3).

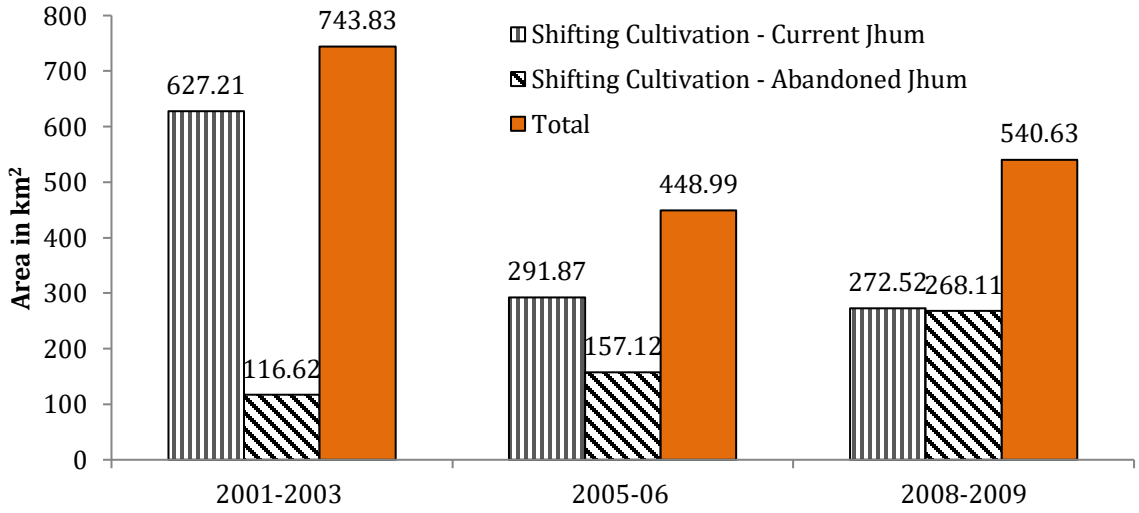


Fig 5.3: State of Shifting cultivation in Meghalaya

'Current Jhum' is found to have increased in Jaintia Hills and Ri Bhoi districts of Meghalaya during a period of 2005-08 to 2008-09. For other districts, including East Garo Hills, West Garo Hills, South Garo Hills and West Khasi Hills district, however it was found to have decreased. '*Jhum* fallow' is found to have increased in all the districts of Meghalaya barring East Garo Hills (see Annexure 5.2).

Jhumia families dependent on *Jhum* is given in the following graph (Fig 5.4), though the data is quite old but would give some indication of the distribution of families in all the districts (Fig 5.5).

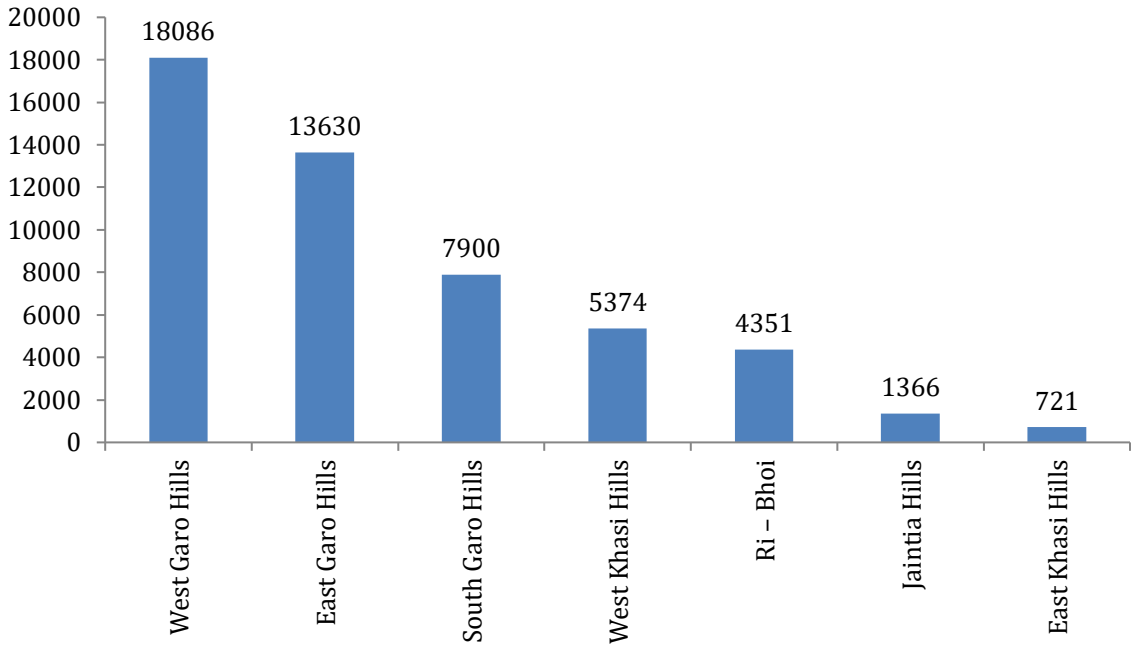


Fig 5.4: *Jhumia* families dependent on Jhum (2001)

An account of the *Jhumia* population dependent on *Jhum* is given below (Fig 5.5).

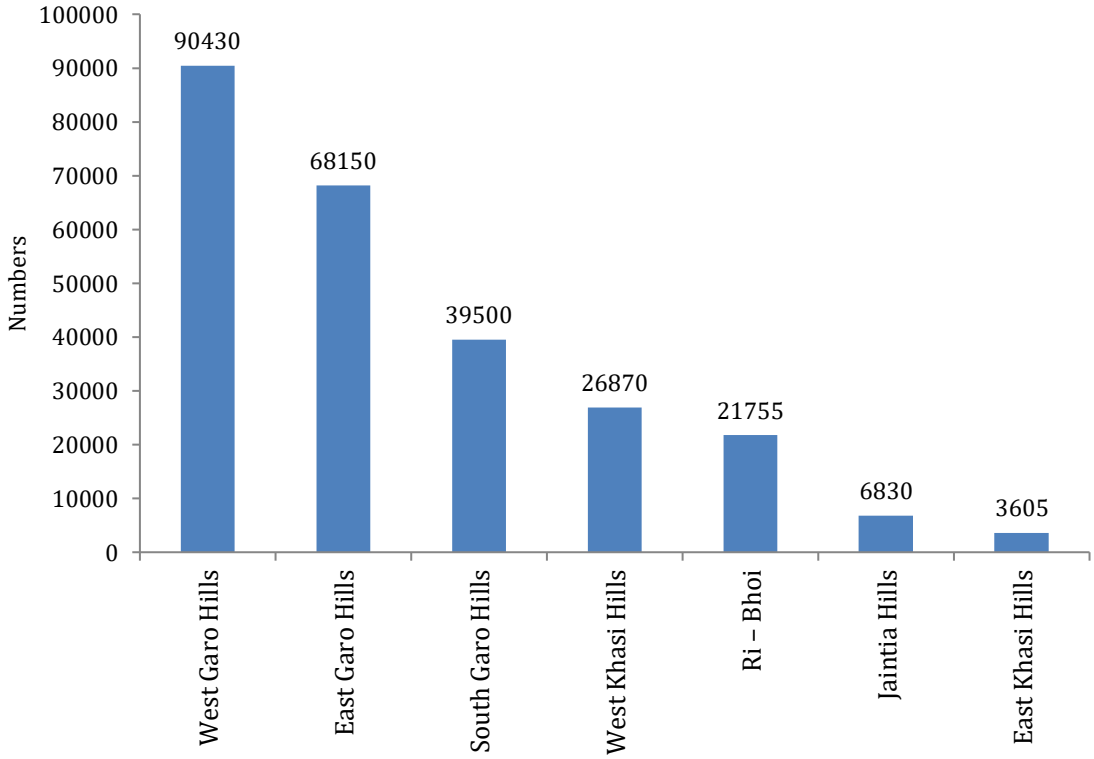


Fig 5.5: *Jhumia* population dependent on Jhum (2001)

As per some old studies (1980–1995), land use under shifting cultivation presents two scenarios, *viz*.- towards abandoned and current shifting cultivation. Seasonal type vegetation were observed to be changing towards shifting cultivation in both the time phases studied (i.e. 1980–1989 and 1989–1995); while a shift from Bamboo brakes towards shifting cultivation was observed to increase in the second time phase. On the contrary, no shift was evident from current shifting cultivation to non-forest or vice versa during 1989-1995 (Roy and Tomar, 2001). Change in shifting cultivation patterns in Meghalaya during 1980–1995 is given in Annexure 5.3.

Another study was carried out by Riahtam et al. (2018) in East Garo Hills Districts, where Shifting cultivation is predominant (see Annexure 5.4). Total area under shifting cultivation was 88.33 km^2 in the year 1980 which decreased to 62.3 km^2 in 1990. There is a trend of increase in the area from 74.87 km^2 in the year 1995 to 78.38 km^2 in 2000 and 89.16 km^2 in 2005. The area started decreasing from 47.92 km^2 in 2010 to 39.53 km^2 in 2016.

The area under current shifting cultivation in East Garo Hills was about 64.75 km^2 in 1980 which decreased to 46.24 km^2 in 1990 and 34.97 km^2 in 1995. From the year 2000 to 2005 current shifting cultivation area increased from 46.87 km^2 to 54.08 km^2 but there is a decrease from 24.80 km^2 in 2010 to 17.42 km^2in 2016. Regenerating shifting cultivation in East Garo Hills was found to be decreasing from 23.58 km^2 in 1980 to 16.06 km^2 in1990. In 1995 the area increased to 39.90 km^2 and decreased to 31.51 km^2 in 2000. In 2005, there is an increase to 35.08 km^2. Subsequently, the area decreased in 2010 (23.12 km^2) and in 2016 (22.11 km^2).

There was a pattern of change in shifting cultivation from 1980-2016. Some of the current areas changed to regenerating jhum in the early part of the period, i.e., 1980 to 1990. In some areas non-jhum areas were converted to jhum areas. From 1995, there is a change of regenerating jhum to current jhum areas in some part of the study areas.

Area under shifting cultivation

Although the exact figures for the total area under shifting cultivation and total number of households involved in the practice are hard to come by, the Task Force on Shifting Cultivation set up by the Government of India, in their report of 2003, estimated a cumulative area of 1.73 million hectares under the practice in NE India during the period 1987-97, based on a report of the Forest Survey of India published in 1999. The Task Force also reported that an estimated 620,000 families are dependent on shifting cultivation, based on the Ministry of Agriculture Task Force Report of 1983. More recent figures provided by the Indian Council of Forestry Research and Education, published in the Statistical Year Book 2014 by the Ministry of Statistics and Programme Implementation (MoSPI), suggest significant reduction in the area under shifting cultivation over the last decade (2000-2010). A comparison of the data, however, suggests that the data for 2010 presented in the Indian Council of Forestry Research and Education (ICFRE) document is more or less the same as published in Wastelands Atlas of India (2010) for the year 2005/06 for Assam, Manipur, Mizoram and Tripura. The Wastelands Atlas Map shows a reduction in shifting cultivation in north-eastern states from 16435.18 $km^2$to 8771.62 km^2 in two years. A reduction of >92% in Assam in two years and 82% in Manipur in the same period were mentioned in the report.

It has been observed that the *jhum* fallows have been gradually converted to permanent cultivation, especially in Garo Hills of Meghalaya where jhum is practiced extensively. A high rate of demographic increase has altered the man–land ratio, thereby altering shifting cultivation into an increasingly non-viable practice (Behera et al., 2016).

The variation in data published by various agencies raises serious concerns regarding the accuracy and veracity of figures provided by different agencies and highlights the need for urgently generating authentic data and/or reliable estimates for the current area under shifting cultivation on a decadal time series basis. This should be possible through remote sensing and such an exercise should then be able to provide a reliable basis on which to accurately assess the area under shifting cultivation in each State as well as temporal trends of change over the last few decades. NITI AYOG has also remarked that "*non-*

availability of reliable data on variation and extent" proves as a hindrance in "*proper planning and implementation*" (Anon., 2018a).

Households practicing shifting cultivation

While the ICFRE report provides figures for the area under shifting cultivation, statistics for the number of households continuing the practice of shifting cultivation could not be retrieved despite a search of available documents from the concerned Ministries. This lack of information on the total population or the number of households presently practicing shifting cultivation constitutes a major information gap. The Ministry of Agriculture Task Force of 1983 has given a figure of 6.2 lakh families. All subsequent publications have quoted this data. In the absence of any official data on this aspect, inferences are to be based on published research findings available in the public domain. Research studies conducted in the West Garo Hills, Meghalaya and Ukhrul district, Manipur by the International Centre for Integrated Mountain Development (ICIMOD) in collaboration with NERCORMP and MRDS during the period 2002-2009, suggest that despite transformations and adoption of multiple farming systems, 70% of the households in Ukhrul and over 90% in West Garo Hills still continue to practise shifting cultivation, complementing other farming systems that they may have adopted. The findings from these studies suggest that it would be erroneous to conclude that the mere adoption of a form of settled agriculture by upland farmers in the NE region means that the same farmers have given up shifting cultivation. A shifting cultivator may adopt multiple settled farming practices, but still practice shifting cultivation. Therefore, in addition to generating accurate estimates on the area under shifting cultivation, it is imperative to enumerate the exact number of households continuing with the practice of shifting cultivation. These two data sets are crucial for arriving at a realistic and accurate understanding of the magnitude of the 'problem'. The generation of exact estimates of households practicing shifting cultivation and the population dependent on the practice, therefore, is a fundamental action required to be taken up before effective plans to address the issue of transformation of shifting cultivation can be drawn up. Data on geographical distribution and typology of shifting cultivation (distorted, innovative, modified or traditional) are also required for designing interventions.Non-availability of reliable data on temporal variation and extent of jhum in

terms of area, population involved and geographical distribution makes proper planning and implementation of any project/ scheme difficult (Anon., 2018).

Permanent cultivation (Terrace/ Bun Cultivation): Literally, 'Bun' refers to a forest. Bun or terrace cultivation is commonly practiced in slopes and valleys of Meghalaya, prevalent for the last three decades. Being a settled cultivation system, it is practiced to improve production of crops, conserve soil moisture and prevent soil erosion (Jaiswal, 2006). Here, bench terraces are constructed on hill slopes with a vertical interval of 1 m (approx.), which helps in retention of maximum rainwater within the benches and disposes the excess runoff from the slopes to the lower bench down tothe foothill. The gap between each bun is levelled using the cut-hill method. In this system, bench terraces are built on the hill slopes, preventing erosion and maintaining a balanced water holding capacity within the slopes. It also helps to safely transfer the additional runoff from the slopes to the lower areas. It provides an improved production system, helps conserve soil moisture, and prevents land degradation and soil erosion. Crops such as maize, bean and potato that require less water are planted on upper benches, whereas crops like jute and rice that require more water are grown on lower benches (Jeeva et al., 2006).

5.1.2 Wood extraction

Possessing six types of forest on the basis of availability of economically important tree species, Meghalaya is fairly rich in timber resources. In terms of Volume/Area, 'Teak forests' are by far with the best average stocking (143.53 cu m per hectare); while the lowest (41.73 cu m stock per hectare) is that of 'Hardwood mixed with conifers forests'. Miscellaneous type has the highest total volume as more area is under this forest type. Hence, the total growing stock standing in the 8140.11 km^2 (accessible forest area) has been assessed at 81.98 million m^3 corresponding to 172.47 million stems.

Timber is widely employed in house construction and furniture making. As many as 75 Saw and Veneer Mills, and 6,438 furniture and handicraft units are operating in the State demanding enormous quantity of timber (Directorate of Industries, Government of Meghalaya and Autonomous District Councils). A list of timber species popular in general

usage, occurring in forests as well as planted in Meghalaya is given in the Table 5.1 (Singh et al., 2008).

Table 5.1.: Utility-based Categories of wood and species utilized

Category	Species utilized
Timber	*Albizzia lebeck, Artocarpus integrifolia, Dipterocarpus macrocarpus, Gmelina arborea, Mesua ferrea, Michelia champaca, Phoebe goalparensis, Pinus kesiya, Quercus* spp*., Schima wallichii, Terminalia myriocarpa, Shorea robusta, Tectona grandis.*
Pulpwood	*Bischofia paliathum, Bombax ceiba, Duabanga grandiflora, Shorea assamica.*
Plywood	*Bombax ceiba, Dipterocarpus macrocarpus, Mangifera indica, Schima wallichii, S. khasiana.*
Construction	*Artocarpus integrifolia, Duabanga sonneratiodes, Gmelina arborea, Mesua ferrea, Michelia champaca, Phoebe goalparensis, Schima wallichi, Shorea assamica, Terminalia myriocarpa.*

The extraction of timber is more from the unclassed forest rather than the reserved forest, but reliable information on the quantity extracted from these sources is not available. Annual extraction of timber in Meghalaya from State owned forest is given in Annexure 5.5. Further, contribution of Forestry and Logging to Net District Domestic Product and Net State Domestic Product (NSDP) in Meghalaya during 1980-81 to 2017-18 is provided in Annexure 5.6. Contribution of Forestry and Logging to Net District Domestic Product and NSDPin Meghalaya during 1993-94 to 1999-2000 in terms of percentage is given in Annexure5.7and in absolute figures in Annexure 5.8. Data beyond 1999-2000 is not available district-wise.

Illegal felling: As a matter of fact, large quantities of timber are illegally transported outside from the state, rampant along the Indo-Bangladesh border. The *modus operandi* (employed during the monsoon period) of the timber smugglers in the State is that trees are cut at night, marked with initials known to their counterparts at the receiving end and timber are floated on the waterways acting as a transportation passage. For this illicit trade, the rivers utilized are Umngot or Piang river (Dawki); Dulai river (Hathimara), Umew (Shella), Khasimala (Rynkua), Thamalia (Balat), Jhadukata (Ghomaghat), Chira

(Lalghat), Lubia, Harai and Paru Rivers in Jaintia Hills. The seizure of timber in 2005 was worth Rs 2.34 crore. While, the amount of seized timber is startling, largely the seized timber is kept in the remote jungles owing to the lack of facilities for transportation (Anonymous, 2006). These figures are representative of only a small fraction of the actual smuggled timber, given that most of it goes undetected.

Fuelwood/ Polewood extraction: Extracted timber is also used for poles, beams, scaffolding and ladders for coal and limestone mining. On the domestic front, timber is extracted mainly for house construction, on a smaller scale and for the most part in a sustainable manner.

Firewood, conversely, is both an important domestic as well as commercial forest produce in the state, especially for the rural household where it is used for cooking, heating and lighting purposes. An estimated 18,53,457 persons reside in the rural areas in Meghalaya, thereby constituting a very important group of firewood consumers. Only 7 per cent of urban households use firewood for domestic purposes (Forest Resource Survey, 2004); chiefly due to constraints in obtaining firewood as well as availability of other, more effective alternatives.

The rural households collect firewood from the close at handforests, regardless of the ownership pattern. Commercial firewood extraction can be done only from one's own forest (private forest) or rented forests (with time period specified for extraction). Except under certain conditions, commercial firewood exploitation is not allowed in community forests, though dead and fallen trees can be collected for household consumption. The Agro-ecological Zone wise preferred fuelwood species in Meghalaya is given below.

Agro-Ecological Zone of Meghalaya	**Preferred fuelwood species**
Western Region	*Schima wallichii, Quercus* spp., *Castanopsis indica, Betula alnoides, Callicarpa vestita, Bauhinia semla, Aporusa* spp. and *Macaranga denticulata*
Central and Upland Region	*Schima wallichii, Quercus lancefolia, Quercus dealbata, Quercus spicata, Betula alnoides, Callicarpa vestita, Bauhinea semla, Pinus kesiya, Albizzia lebbek, Macaranga*

	denticulata, Styrax serrulatum, Dendrocalamus hamiltonii and *Bambusa* spp.
Northern Undulating Region	*Dendrocalamus hamiltonii, Bambusa* sp., *Actinodaphne ovota, Antidesma khasianum, Schima wallichii, Elaeocarpus* spp., *Glochidion khasicum, Ilex* spp., *Macaranga denticulata, Sarcosperma griffithi* and *Cinnamomum tamala*
South Precipitations Region	*Phoebe cooperiana, Lithocarpus fenestratus, Artocarpus heterophyllus, Eurya acuminata, Macaranga denticulata, Styrax serrulatum, Schima wallichii, Ligustrum robustum, Dendrocalamus hamiltonii* and *Bambusa* spp.

According to the estimates of Forest Resource Survey (2002-2004), the total annual firewood consumption in the state by different sectors was 921,582.3 MT. Within the state itself, firewood finds a good market owing to the heavy demand from the P.W.D contractors, bakery and limestone industries. The consumption data (in MT.) of firewood by different sectors (Household, Bakery, PWD, Road construction and Lime industry) in Meghalaya is provided in Annexure 5.9.

Bhatt and Sachan (2004) had reported that firewood consumption, amongst the Meghalayan tribes, was highest in the *Khasi* community (5.81 kg/capita/day), followed by the *Garo* (5.32 kg/capita/day) and *Jaintia* (3.90 kg/capita/day), irrespective of their socio-economic status.

The data relating to extraction of firewood for market purposes by collecting information from the check gates, maintained by the State Forest Department as well as the District Councils are presented in Annexure 5.10 and 5.11. The data vaialble is scanty and incomplete, and does not appear reliable. A robust mechanism of data collection and nalysis is required in respect of natural resources, for any meaningful conclusion. It is observed that the commercial firewood supply comes mainly from the Ri-Bhoi District, whereas in the West Khasi Hills individualsare more interested in timber to a certain extent than firewood.

Commercial firewood extraction in the Garo Hills is highest with an average of 4,86,000 MT. per year. The firewood demand is met from the forest area under the administrative

control of the Jaintia Hills Autonomous District Council in the Jaintia Hills. Household firewood consumption also constitutes a huge quantity, though data for this purpose was not available. Firewood collection involves persons from both the sexes, apart from providing employment to even economically poorersectionsresiding in the State. Shillong, Nongstoin, Jowai, Tura, Williamnagar and Baghmara are the main trading centres of firewood in the state. On an average, rate of firewood in Meghalaya is around Rs. 1250/MT. The rate of firewood/MT. is variable and fixed at Rs 2400/MT., Rs. 900/MT. and Rs. 450/MT. for Khasi hills, Jaintia Hills and Garo Hills.

Charcoal production: Another important commercial NTFP of the state is Charcoal. It is much preferred by the masses owing to reasons such as quick combustibility, prone to breakage during transportation, easy handling and cleaner combustion. Being able to produce a considerable quantity of charcoal, Meghalaya has emerged as an important charcoalproducing state in the country. Subsequent to the timber ban by the Hon'ble Supreme Court of India (December, 1996), charcoal making has been taken up by the people as an alternate livelihoodopportunity. Comparatively, this activity is very popular in the West Khasi Hills, East Khasi Hills and Ri-Bhoi Districts. There is huge demand of charcoal for industrial purposes. About 20,000 MT. per year of charcoal produced in the state is being sold to the industries in Byrnihat areas where it is used as raw material.

However, it has been noticed that charcoal burning has made large areas of green forest treeless and barren within a short extent of time, which is more vicious than even timber felling. It must be borne in mind that for making Charcoal, the size of the tree is not important. *Castanopsis indica, Schima wallichii* and *Quercus* spp., produces the topquality and fetches good price, while charcoal made from *Bombax ceiba*, *Bischofia javanica*, *Dendrocalamus hamiltonii*, *Litsea* spp., *Stereospermum griffithii* etc. fetches lesser price. Charcoal is also produced as a by-product from saw mills and furniture workshops. It is more preferred for industrial rather than human consumption, as firewood is the predilection. The annual production of charcoal as recorded from check gates is given in Annexures 5.12 and 5.13. These data are also scanty and incomplete.

In the Khasi Hills, the average decadal production is more than in the Jaintia Hills. For Garo Hills, the data on the quantity of Charcoal produced is not available. The annual production varies on yearly basis. For example, the highest production was 31060.72 MT in the year 2003-2004 and the lowest was about 336 MT in the period 1995-96. Even though, there is an ebb and flow in the production of charcoal during the last ten years, yet the overall trend of charcoal production has been found to be increasing from1995-96 onwards, i.e. the ban on timber extraction.

Dwelling on the commercial aspect, it is to be noted that the price as well as quality of charcoal depends on the tree species utilized and varies from one place to another depending on local demand and availability. As per the recent estimates for the year 2016-17, in Garo Hills, the rate per MT is Rs. 4914/- and the rate is Rs. 4126/- in Khasi Hills. Comparatively, the rate is lower in Jaintia Hills (i.e. Rs. 2073/- per MT). During 2004-05, in East Khasi Hills, therate was Rs 8,000/- per MT, in West Khasi Hills the rate was comparatively lower at Rs 6,500/- and in Ri-Bhoi District the rate was Rs 7,000/- per MT. In contrast, the market rate of Charcoal was Rs 600/- per MT at Garo Hills.

The unsustainable use of charcoal by ferro-alloy industries in the state is also worth mentioning. Unfortunately, no comprehensive and compiled data is available on the total ferro alloy production in the state. Sporadic reports here and there give some idea about the severity of the problem that needs immediate attention.

Meghalaya State Disaster Management Plan (2016) published a list of six top ferro alloy industries operative in Megahalaya which were certified as 'hazardous'. Five out of these were located in Byrnihat and the rest one in Umiam (Annexure 5.14.A). Some of the cases were brought to light by the Maitshaphrang Movement. As per one report, Ri Bhoi and West Khasi Hills district were severely affected by large-scale deforestation to feed the ferro alloy units there. It was found that around 11 ferro alloy industries in Ri Bhoi district had consumed 5.61 lakh tonne of charcoal till August 2010 resulting in large-scale denudation, amounting to a loss of Rs 785,96 crore (The Shillong Times, 2011). It is roughly estimated that to produce one tonne of charcoal about three tonnes of fuel wood is required. Threfore, the estimate of fuel wood used alone in 11 units of Ri Bhoi district goes to a staggering 16.83 lakh tonne, which is huge. Further, in a report about 50 MT of charcoal

was available in the factory storage yard, wherein the Distrcit administration concluded that the charcoal procured appeared to have been "illegal" (The Northeast Today, 2018; Shillong News, 2018). Unauthenticated report also states that hundreds of trucks, each carrying six tonnes of charcoal, exit from West Khasi Hills every month. Some of the important alloy industries in the state are shown in Annexure 5.14.B.

As a positive development, however, the Meghalaya Charcoal Control of Production, Storage and Transit Rules, 2019 made it very clear that ferro alloy industries in Meghalaya would no longer be allowed to use charcoal produced within the state but it has to be sourced from outside the state.

5.1.3. Developmental activities

Road Network: Road network is an essential component, descriptive of overall developmental activities of a state. The total length of road during 1975-76 was 3,315 km which has increased to 8,567 km during 2015-16 in Meghalaya, about 75% of which is already surfaced. The overall increase of road network is shown in the following graphs (Fig. 5.6, 5.7) and Annexure 5.15.

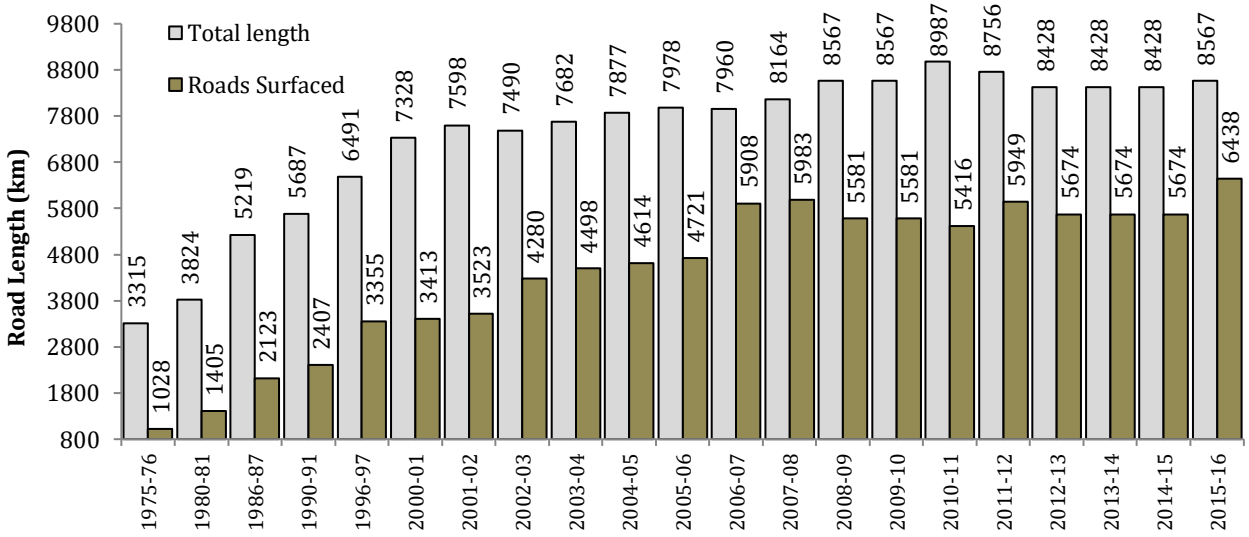


Fig 5.6: Overall increase of road network in Meghalaya
(Source: Statistical Handbook Meghalaya, 2017)

A graphical representation of percentage of Roads surfaced at an interval of 5 years is shown below. Roads Surfaced (%) was observed to increase at every time period. A decadal

increase with respect to Road density (per 100 km^2) was also observed for 2000-01 to 2010-11 and 2005-06 to 2015-16.

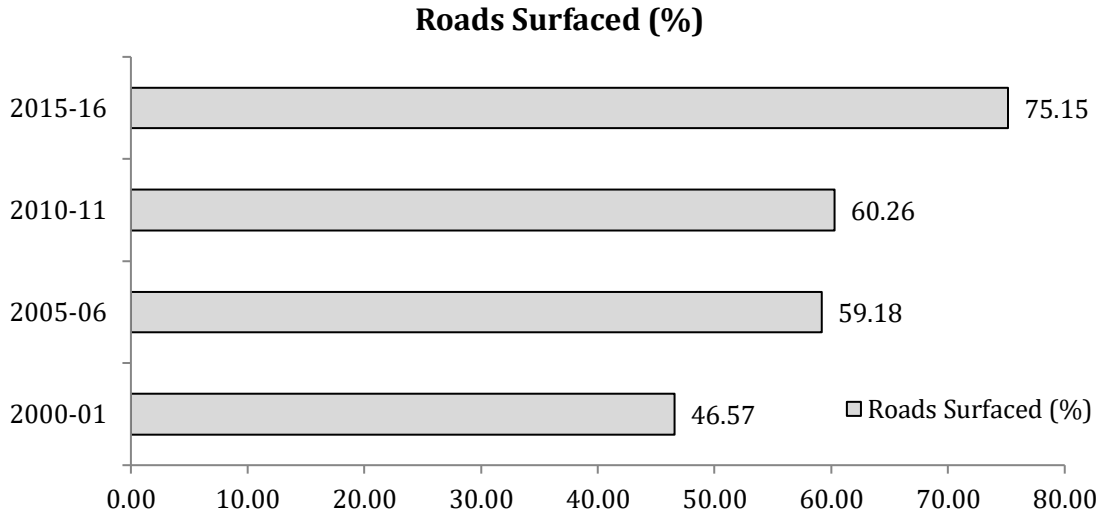


Fig 5.7: Road density and percentage of Roads surfaced at an interval of 5 years (Source: Statistical Handbook Meghalaya, 2017)

The length of surfaced road has increased from 1028 to 5983 km during a period of 33 years or so (1975 to 2008). At the same time, it is learned that the amont of firewood utilized in heating of bitumen during road construction is roughly 90 m^3 per km, irrespective of road specification (personal communication with the Engineer, Public Works Department, Government of Meghalaya). It can therefore be estimated that fuel wood consumption for surfaced road construction in Meghalaya is roughly 5,38,000 m^3 uptill 2008 and has increased by 5.8 time during a span of 33 years (Fig. 5.8). However, the Government of Meghalaya had introduced The Meghalaya Charcoal (Control of Production, Storage, Trade and Transit) Rules, 2008 (Govt. of Meghalaya, 2008), wherein production, storage and transit of charcoal was regularised with even imposition of penalty. Thus, the data from 2008 is mere extrapolation which requires ground verification. However, it is expected that the increasing use of bitumen heaters might lead to a gradually decrease in fuelwood utilization.

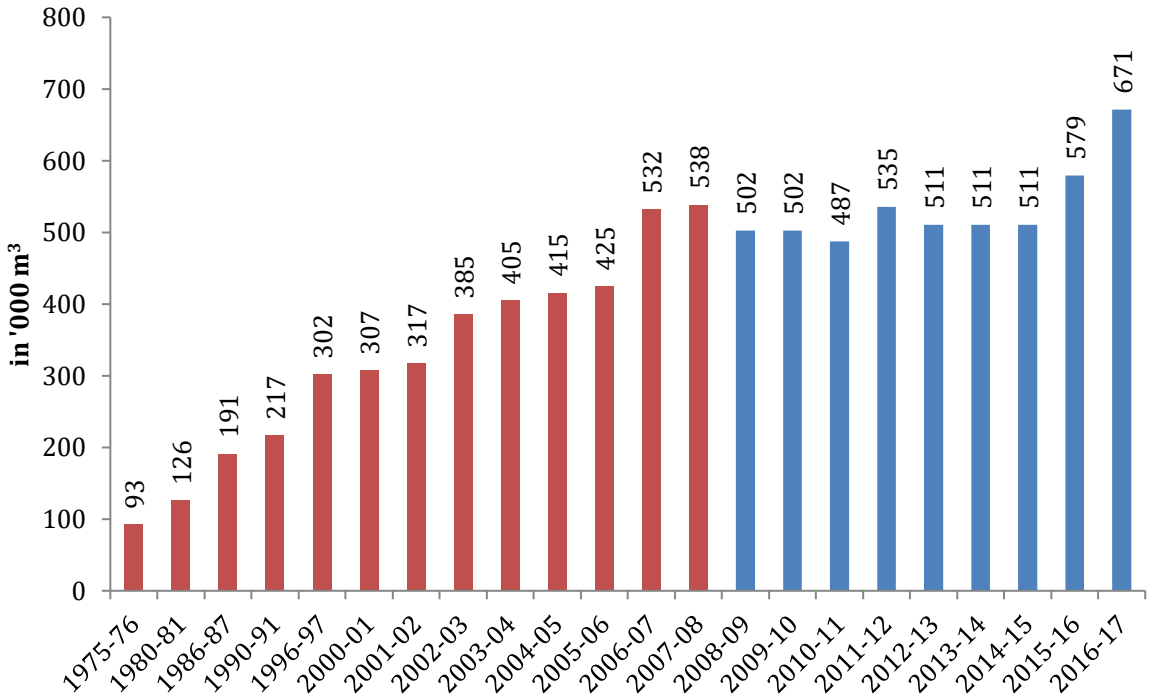


Fig 5.8: Amount of firewood utilized in road constrcution
(Source: Statistical Handbook Meghalaya, 2017; Red coloured bar denotes actual data, Blue denotes extrapolation based on assued data)

Settlement expansion: Human habitation or settlement expansion is a direct function of population increase. The houses in the state have increased from 2.56 lakhs in 1981 to 7.21 lakhs in 2011. The decadal growth rate was found highest in 1981-1991 (56.5%) followed by 2001-2011 (38.6 %), 1991-2001 (30.0%) and 1971-1981 (13.9%). The details are given in Annexure 5.16 and 5.17. Again, thetotal Houses and Houses Allotted to Women under Indira Awaas Yojana, during the period from 1999 to 2009 is provided in Annexure 5.18.

Hydropower, oil exploration etc: In spite of the generous hydropower potential bestowed upon Meghalaya, hydropower projects from 2009 have not been augmented till date. The installation capacity of power projects (MW) has increased from 186.7 to 314.7 MW from 2009 to 2015 (Fig. 5.9). Hydropower projects, therefore, have minimal impact as driver of deforestation.

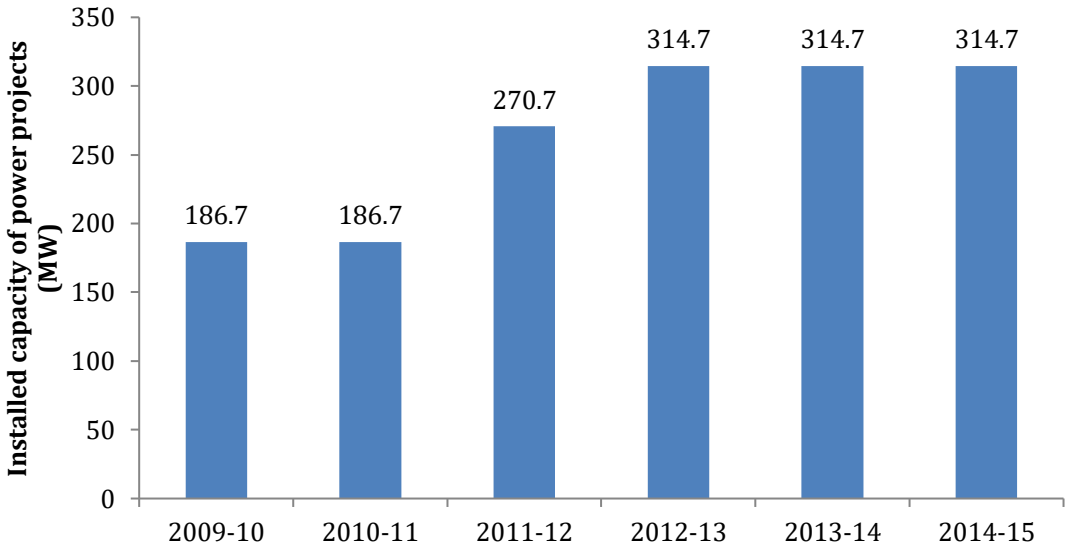


Fig 5.9: Hydropower projects initiated in Meghalaya

The hydroelectricity potential of Meghalaya is 3,000 MW, which is roughly 3 per cent of the country's total hydel potential. Up till March 2016, the state with seven operating hydroelectric power stations owned and operated by the Meghalaya Power Generation Corporation Limited, could harness only 10.49% of its hydro potential. Being a power-deficient state, Meghalaya had to depend heavily on import of power from outside the State to meet its demand during 1990-91. Later, the State was able to internally generate 38.23 % of its power consumption from 2011-2012 to 2015-2016, of which 2.78 per cent was met from the state's share of free power from the central government's power generation utilities while the balance 58.99 per cent was purchased from outside the state. The Meghalaya Power Policy (2007) had envisaged commissioning of 24 projects during the XI Plan (10 projects with capacity of 558.50 MW) and XII Plan (14 projects with capacity of 891 MW) periods. A bird's-eye view of the various Hydel Power Projects installed for the period spanning from 2009-10 to 2016-17 is presented in Annexure 5.19.

Legal/ Illegal Mining: The State of Meghalaya is bestowed with an array of minerals including Coal, Limestone, Silimanite, Clay and Kaolin, Glass sand, Quartz and Feldspar, with deposits spread throughout the state (see Annexure 5.20). The recently discovered presence of Uranium in the Southern part of West Khasi Hills, positions Meghalaya in the Uranium map of India. The Directorate of Mineral Resources, Government of Meghalaya is

of the opinion while maximum coal reserves are present in Garo Hills, the extraction is more in Jaintia Hills. The latter alone contributes more than 70% of the State's total coal production., The quality of limestone found ranges from cement grade to chemical grade, with maximum limestone reserves being concentrated in the Khasi Hills. These minerals are utilized in the different mineral-based industries both, in the State as well as in the country. Coal and Limestone, on the other hand, are also exported to Bangladesh.

An increase in the mining sector has had a detrimental impact on ecology of the surrounding biodiversity-rich forest-dominated landscape of Meghalaya. Mining as an important driver of deforestation, has both direct and indirect impact on land-use change in terms of both extent and feature. Unbridled mining has resulted in large-scale forest cover denudation, water scarcity, pollution (air, water and soil) and agricultural land degradation. Meghalaya has 576.48 million tonnes reserves of sub-bituminous coal. The coal mining '*boom'* in the State has seen annual production rise from 39,000 tonnes (1979) to 5 million tonnes (2014-15). Prior to the NGT ban in 2014, coal mining contributed 7-8 per cent to the state's GDP and accounted for 27 per cent of the revenue.

Land in Meghalaya is owned either privately or by any community, which is protected by the Autonomous District Councils formed under Sixth Schedule of the Constitution. The government has control over only 5 per cent of the land. Before the NGT ban, mining was being carried out without government regulation on the pretext that it was being done on Sixth Schedule land.

The production and estimation of value of minerals over the years are shown in Annexure 5.21. The valuation of mineral production (excluding atomic mineral and value for February and March in respect of 31 minerals notified as minor mineral vide Gazette notification dated 10.02.2015) in Meghalaya was estimated at Rs. 1,514 crore (2014-15) and this had decreased by 63% as compared to that in the previous year (2013-14). About 84% of the total value of mineral production accrued from coal (25,00,000 MT) during the year 2015, whereas the remaining was contributed mainly by limestone (36,96,000 MT).

There were 17 reporting mines in 2014-15 as against 14 in the previous years (Anon., 2015).

While coal mining in the State was illegal, in pursuance of the Order of NGT (dated 17th April, 2014) it was observed for the period 2013-14 to 2017-18 that the district administration had noticed three cases of illegal mining and 847 cases (716 cases belong to East Jaintia Hills and Ri-Bhoi districts) of transportation of illegal extracted coal involving 24750 MT of coal after NGT prohibition (Govt. of Meghalaya, 2019). The details of which are appended in Annexure 5.22.

5.2 Underlying causes

5.2.1 Economic factors

Poverty: Poverty has been considered as one of the main drivers of deforestation, particularly in the tropical countries. Meghalaya, as is evident from the data generated from various studies, is not exceptional. Over half of the rural families in Meghalaya are categorized as being below poverty line (54.5%). Garo Hills (55.89%) tops the list as far as percentage of rural BPL families are concerned, which is followed by Khasi hills (53.96%) and Jaintia Hills (44.19%) (Fig. 5.10). The details of Rural Poverty in Meghalaya are shown in Annexure 5.23.

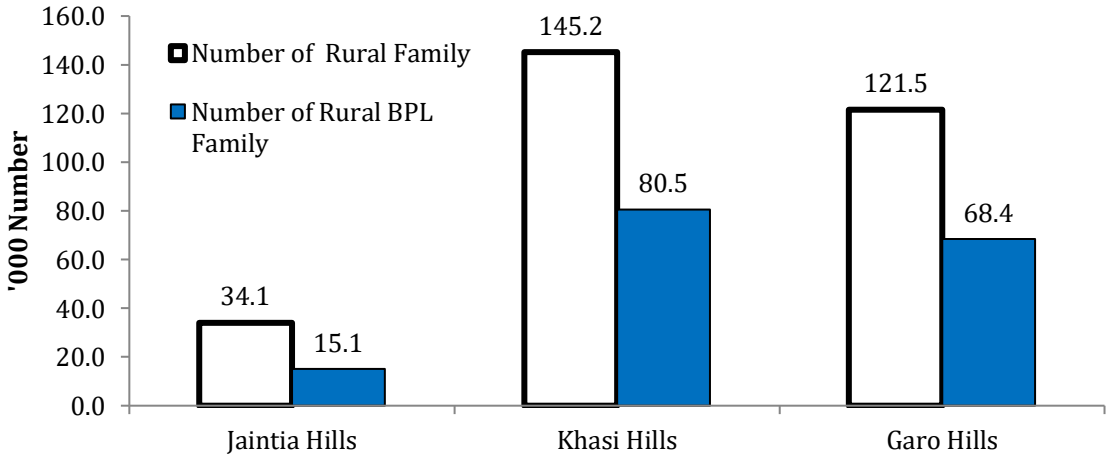


Fig. 5.10: Rural Poverty in Meghalaya

Nair et al. (2013) have assessed poverty levels in Meghalayan districts, compared to other states, to observe very high to moderate poverty levels (71%). East Khasi Hills, West Garo Hills, Ri-Bhoi and South Garo Hills present a very low score in the poverty scale. Simultaneously, the per capita income, literacy rates, alternate income sources and urban population are also very low. East Garo Hills, West Khasi Hills and Jaintia Hills have moderate poverty levels. In these districts, the per capita income and number of livestock with the landowners are higher when compared to the other districts of Meghalaya. They detected that income disparities among the population are high in Meghalaya. There were a total of 3.61 lakh (3.04 lakh rural and 0.57 lakh urban) of Meghalayan population under the category BPL (2011-12) as per Tendulkar methodology.

A few recent reports conversely, are of the view that the main drivers of deforestation worldwide are no longer subsistence-level farmers but corporations, accelerating massive land use changes. Commercial drivers of deforestation are gradually gaining impetus, than some decades earlier. This inclination can be viewed increasingly driven by profit rather than as an implication of poverty and by regional or international markets rather than local needs or aspirations (Henderson, 2002).

Urbanisation and Industrialisation:

Urbanisation, in generalized terms, is an ever escalating phenomenon. However, upon its rate of expansion will depend its categorization as a driver of deforestation. The urbanisation pace is quite low in North-east India and Meghalaya has maintained a steady growth. Only 19.58 % urban population was recorded during 2001, which was lower than the national average (28%). Again, in the subsequent decade, the population of Meghalaya was recorded to be 2.96 million (0.24% of India's population). This increase in urban population was found to be 20.07% which was not significant. Therefore, it can be concluded that 'Urbanisation', as an indirect driver in Meghalaya, doesnot have much impact.The Hill zone-wise urban population pattern of Meghalaya as well as increase in the Hill zones and the State on a decadal and bi-decadal basis have been illustrated in Fig. 5.11. The state has 16 urban centres, predominant amongst them being the Shillong urban agglomeration, situated in Khasi Hill Zone. The bi-decadal increase in the Garo Hills is

found to be much higher than the pan-Meghalayan average. This abnormal increase in population growth with respect to the Garo Hills Zone can be a driver of deforestation.

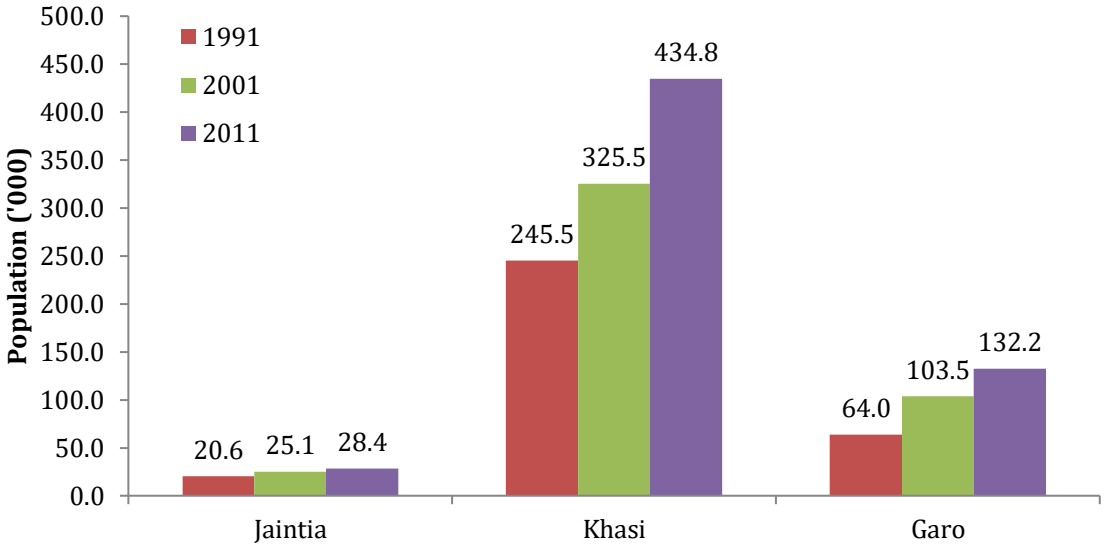


Fig. 5.11 a: Zone wise growth of urban population in Meghalaya

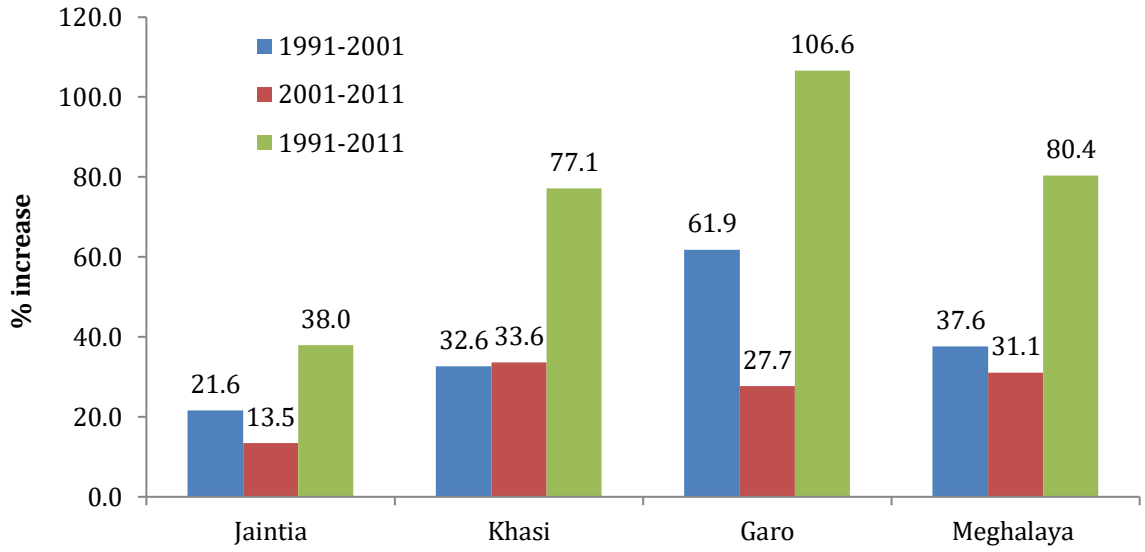


Fig. 5.11 b: Zone wise percentage growth of urban population in Meghalaya

Another important *albeit* indirect aspect of 'urbanization' and 'infrastructure development' can be 'major sources of drinking water in households'. Use of tap as a source of drinking water has increased considerably in the State, at a decadal variation from 29.8% (1991-2001) to 45.7% (2001-2011). Use of Hand Pump and Tube-well, too was observed to

increase from 18.1% (1991-2001) to 57.2% (2001-2011) (Fig 5.12). Nevertheless, it must be borne in mind that urbanization rate of the state is lower than pan-Indian average.

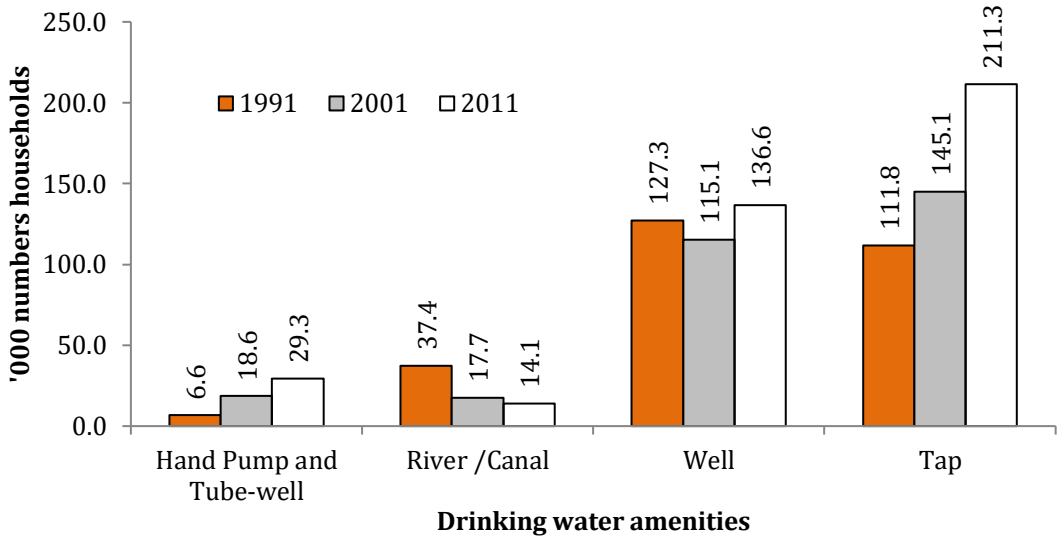


Fig. 5.12: Drinking water sources in Meghalaya in different decades

Market Growth and Commercialisation/un-employment: Unemployment amongst the youth is of immense impact on overall process of deforestation, as another indirect driver. Over the years, the un-employability in the state has increased, which may be chiefly attributed to the lack of skills and experience among the youths. Another effect that can be attributed to unemployment is the large-scale emigration of rural students to town and cities. Unemployment rate (per 1000) in the state in the age group of 15-29 and >30 years is 115 and 11 persons, respectively. The number of registrations at the employment exchange waas 43,371 till 2017. Again, 3623 unemployed youth had registered during 2018, while 964 vacancies were notified. Though Meghalaya is the State with the least unemployment (1.6%) in the country and is low compared to the national average (6.5%). However, the unemployment is localized in urban areas (6.8%) and relatively low in rural areas (0.6%). The urban unemployed youths are literate and in search of white collar jobs and ther continued unemployment will be a serious issue (MoSPI, 2019). When State-wise Average Daily Employment (excluding fuel, atomic & minor minerals sector) is considered, employment in the state was found to dwindle which is a matter of concern as these unemployed youths are prone to be trapped in the illegal mining and other illicit/ delinquent activities that may fuel indirectly the process deforestation (Fig. 5.13).

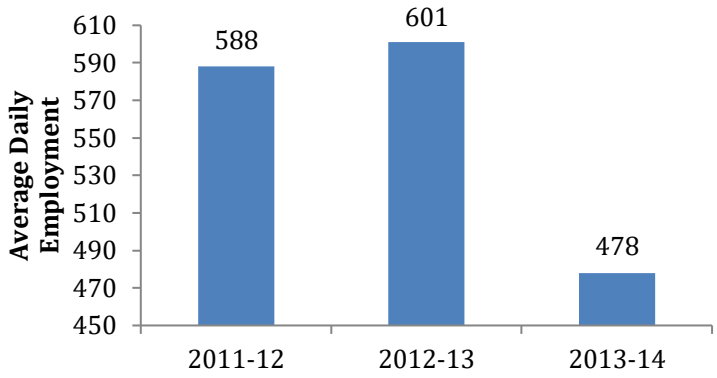


Fig. 5.13: Average Daily Employment (excluding fuel, atomic & minor minerals sector)

The Employment scenario in both, public and private sector in the state over the years (2004-05 to 2017) is provided in Annexure 5.24. Further, the summary of twelve employment exchange statistics around the state is provided in Annexure 5.25.

5.2.2 Policy and institutional factors

Community consultations in Meghalaya have shed light on the influence of land tenure and management arrangements on the prevalence of fires in some forests. Here, nearly 88 percent of forests are either controlled by communities or private individuals, outside the authority of the state forest department. However, with the gradual weathering and weakening of traditional institutions, community members have felt that forest management is more of a challenge. Resource/ incentive/ capacity-restricted individual ownership combined with a weakening of societal forest management norms have made these forests more vulnerable to fires. For instance, fire incidences are found to be on a rise in *Law Raid* and Village forests, where there is a tendency for intense exploitation and neglect. The Village Fire Control Committees (VFCCs) of Meghalaya (eg. Jirang VFCC) were created to lend a hand in reinforcement of joint management and fire prevention in some of these forests. The details of forest fires and encroachments in Meghalaya for the years 2012-13 to 2016-17 are presented in Annexure 5.26, though the information available is scanty.

Weak forest law enforcement: The analysis of the District Council laws on the management and control of forests brings us to the following important conclusions:

Laws in concert with the ensuing Rules regarding forests have been made keeping in view the requirements of trade and commerce, with a focus on forests as a revenue generating source for District Councils. This observation is illustrated by the definition of "Forests" in the United Khasi-Jaintia Hills Autonomous District (Management and Control of Forests) Rules 1960, i.e. "*An area shall be deemed to be a forest if there are a reasonable numbers of trees, say not less than 25 trees per acre or any forest produce growing in such area, which are capable of being exploited for the purpose of business and trade*". Although, the District Councils have been constitutionally empowered for management of forests (other than Government Reserved Forests), yet the control over most of the forests has only been notional. Hence, it was observed that the District Council had failed to assert its sole managerial authority, and as such a bulk of forests was supervised mostly in conformity with the customary laws (acutely in the Khasi and Jaintia Hills).

For the most part, the laws enacted by the District Councils for the management of forests are far from being comprehensive and adequate for dealing with the distinctive circumstances prevalent in that particular Autonomous District. Thus, the Jaintia Hill District Council has applied the Forest Acts of the Khasi Hills *mutatis-mutandis*, whereas the Garo Hills District Council has applied the various provisions of the Assam Forest (Regulation) Act, 1891 *mutatis-mutandis*.

Certain other factors also exist, which have contributed to the depletion of forests particularly under the control of the District Councils; these to a large extent are common to all the three District Councils. To start with, there exists no fixed financial provision to cater to their administrative needs, either through plan or non-plan, regardless of the constitutional status accorded to the District Council. Whatsoever financial assistance is offered from the State Government, is mostly in the form of grant-in-aid and thus, for limited purpose. For example, the Khasi Hills District Council is left for financing its whole administrative set-up with whatever resources it has. Hence, the District Councils have no

choice but to depend chiefly on revenue from forest resources. Previous records (1990) confirm that out of the entire receipt of the Khasi Hills District Council, revenue from timber exports accounts for 70%. This amount is then used to finance the entire District Council administration comprising of the executive, the legislature and the judiciary; while there could be no allocation made for afforestation.

The District Councils had modified some customary laws on forests emphasizing the aspect of the revenue generation with total disregard to the dire consequences. A very glaring example in this regard is the *A'Wil* fees, previously applicable in the Garo Hills to only those who cultivated in a land which belongs to another clan. However, the Garo Hills District Council made the levy of *A'Wil* fees valid to the removal of timber and other forest produce, which consequently contributed in a major way to the forest depletion. Customarily, A' Wil fees was levied only on the non-clan tribals, solely for cultivation. The District Council has, by making *A'Wil* fees applicable to any person, other than the owner of *A'Khing* land, in fact has legitimised the exploitation of forests by tribals [vide the Garo Hills District (A Wil Fees) Act, 1960], who have turned into professional timber contractor and traders. A deliberation on the obvious non-levy of taxes for the timber and other forest produce to the people, might have propelled the District Council to make no singular effort for preventing the indiscriminate felling of trees since, that alone constitutes the largest source of revenue for the District Council.

Secondly, while various provisions of the Forest Acts of the District Councils are penal in nature, it doesn't have law enforcement machinery. The village courts set up by the District Council can by no means compel the attendance of the accused before it. Therefore, the village courts usually make request to the police for getting the accused arrested. Consequently, the police treat these requests as a F.I.R., get the accused arrested, and produce them in the District Magistrates Courts. For this reason, the village courts are incapable to perform their obligation of administering justice.

In the end, the whole forest administrative structure with regard to the District Council is highly "*bureaucratic*", quite similar to the State Forest Department. In the backdrop of the

right to make laws and manage forests in the manner best suited for the tribals, by the Constitution makers to the District Council, they created an administrative structure with an elaborate hierarchy of posts (Chief Forest Officer, Assistance Forest Officer, Forest Ranger, Deputy Forest Ranger, Forest Guard etc.) which was unknown in the tribal customary management (Dutta, 2001).

5.2.4 Cultural /socio-political factors

5.2.4.1 Public attitudes, values, beliefs (Lack of awareness): Lack of awareness regarding deforestation and its insidious effect on overall ecology, socio-economy and cultural environment of the State, among the populace is an extremely important *albeit* neglected factor. Lack of long-term vision, prevalence of short-span concern (focussing on the immediately adjacent environment) and subsistence-level lifestyle are also factors worth deliberation. Deforestation, as a landscape-level phenomenon warrants understanding of some basic ecological concepts. This is a matter elaborately discussed in Chapter 6.

5.2.4.2 Non-availability of alternatives: Availability of economically-viable and legalised alternative energy source(s) to the community is a key factor; its lack creates pressure on the adjacent forest resources. Accessibility of rural Meghalaya has not increased substantially to alternative energy sources like Charcoal, Kerosene and LPG, whereas percentage electricity availability in rural household is exactly at the same point since 2001 upto 2011. In contrast to 0.8% households of the rural Meghalaya having access to electricity, their urban counterparts have progressed from 3.8% (2001) to 4.5% (2011). The details are given in the following graphs (Fig. 5.14 and Fig. 5.15).

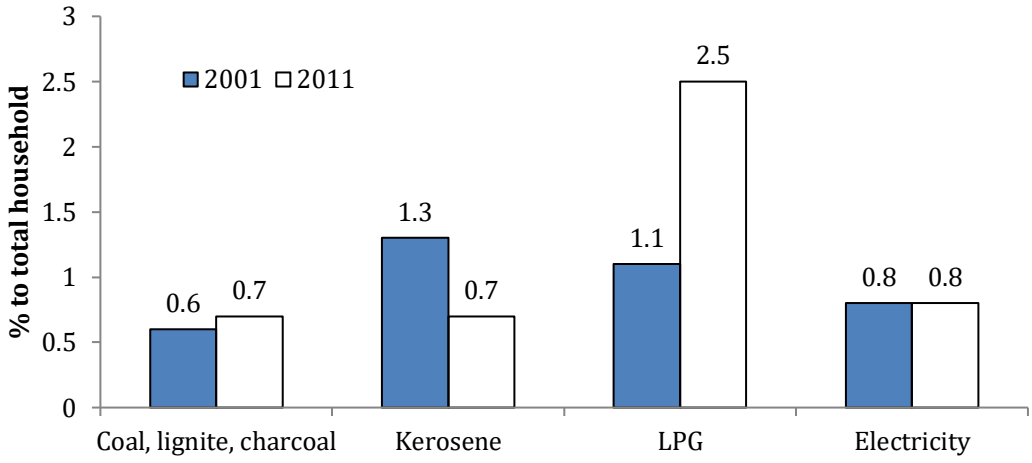


Fig. 5.14: Fuel usage among rural households in Meghalaya

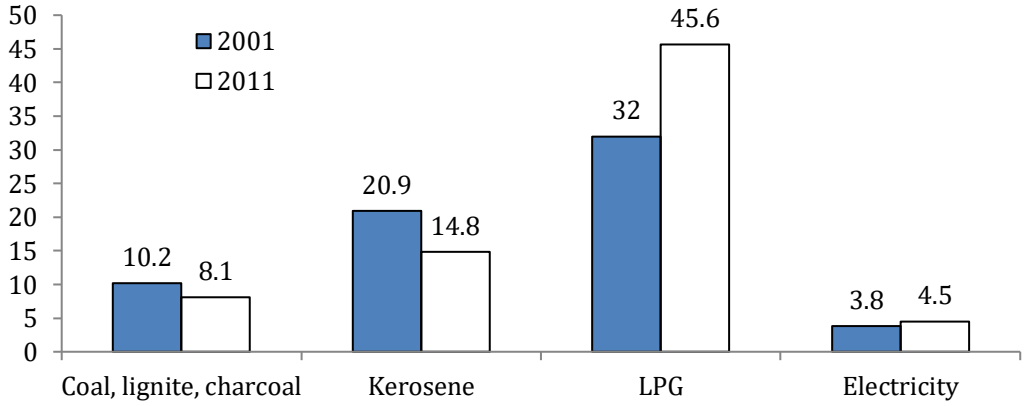


Fig. 5.15: Fuel usage among urban households in Meghalaya

The details on fuel type usage by populace at an interval of 10 years are presented in Annexure 5.27.

5.2.5 Demographic factors (Human Population dynamics)

5.2.5.1 Population pressure (growth): In Meghalaya, during a span of 20 years from 1991 to 2011, an increase of 67.2% population has been registered. In this, percentage of urban population has scantily increased from 18.6 % to 20.1% only. Therefore, Meghalaya can be predominantly categorized as a rural state with almost 80% of its populace concentrated in rural areas (Fig. 5.16).

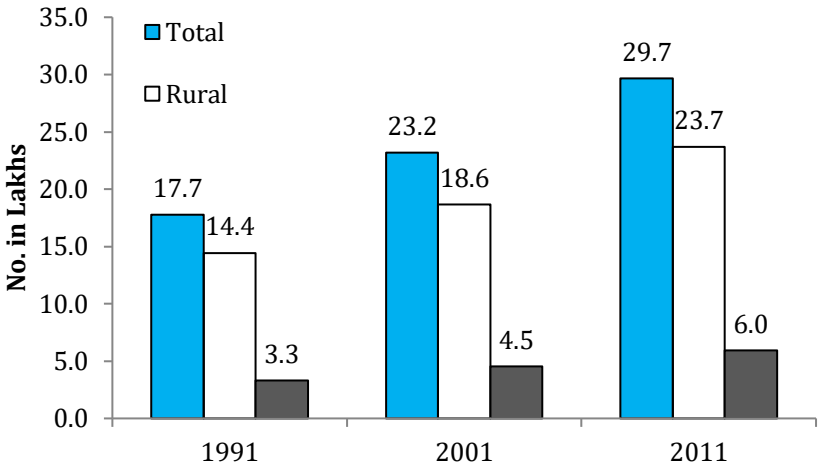


Fig. 5.16: Percentage population distribution in rural and urban area

The District-wise growth of population in Meghalaya from 1991 to 2011 is shown in Annexure 5.28, upon two criteria – Urban/ Rural and Male/ Female. Again, the District-wise population density, sex ratio & population growth during 1991, 2001 and 2011 is shown in Annexure 5.29.

The projected population for 2020 for Meghalaya is 36.9 lakhs, which is about 24.3% more than the estimation for 2011 (Fig. 5.17). Population growth rate in Meghalaya is below the pan-India average, however, if left unmanaged, may function as a key driver of deforestation in the state, either directly or indirectly. The details of the projection are given in Annexure 5.30.

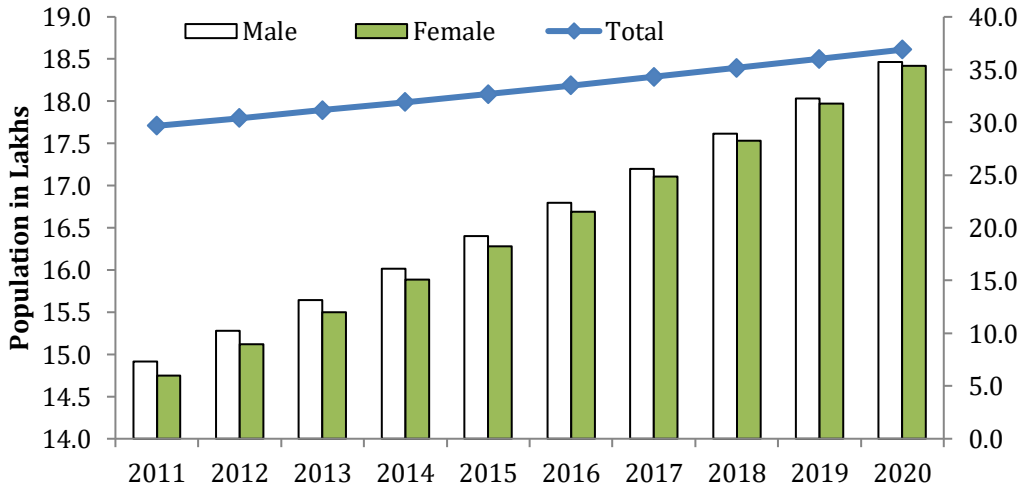


Fig. 5.17: The projected population for 2020 for Meghalaya

Gender perspective in Working Population of Meghalaya

The community-based resource management in Meghalaya clubbed with comparatively greater responsibilities and participation in management and decision-making by women has accorded the womenfolk a higher status (Fernandes et al., 2007). By and large, the matrilineal *Khasi* society appeared to be more egalitarian with respect to the more flexible gender roles, and men plainly acknowledged the significance of womenfolk in the community.

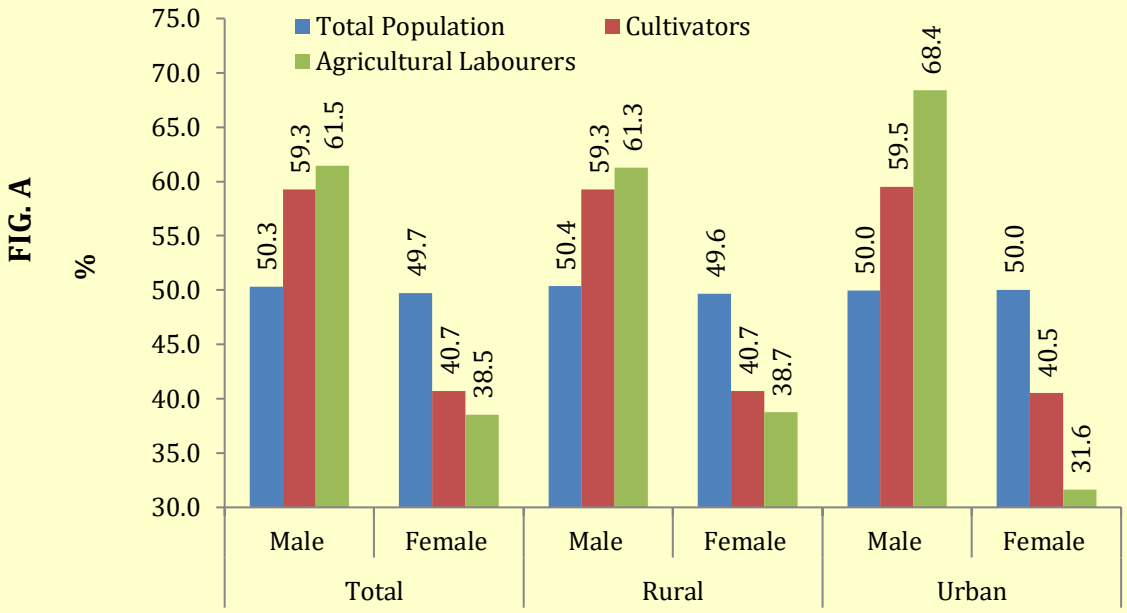
Although, the common narrative is that men hold decision-making power about community administration, management, planning, and development; yet women hold significant decision-making power in the family. An illustration of the *Khasi* women and their significant role in the family and community is depicted below (Ellena and Nongkynrih, 2018). The *Khasi* woman's domain is primarily childcare, household management, and subsistence farming. The daily activity clocks exercise conducted by various researchers provide evidence that *Khasi* women spend longer hours in the agricultural fields and work longer hours per day, in comparison with men.

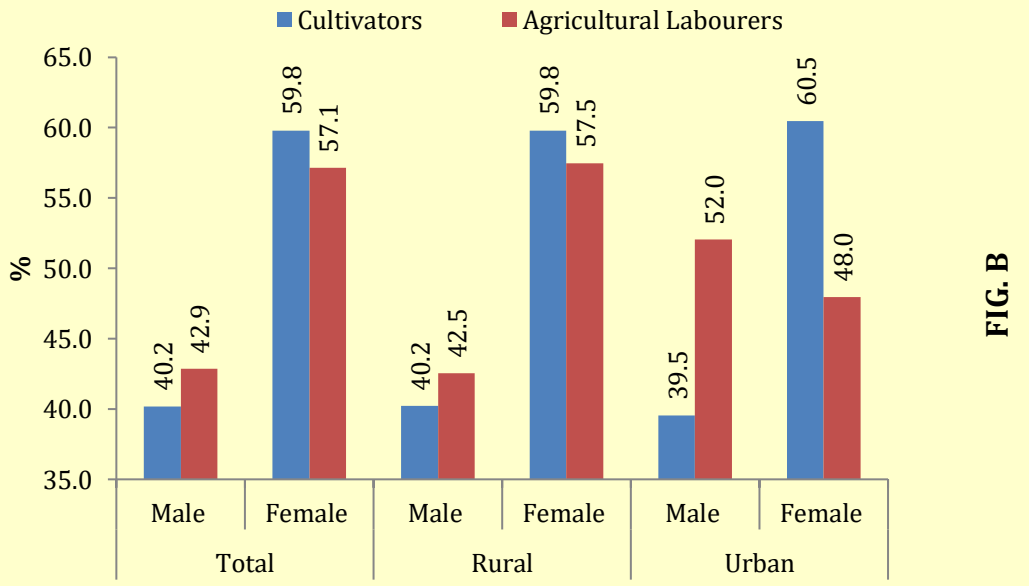
The socialization of both girls and boys into household chores in the *Khasi* society, illustrates that there is flexible gender division of labour. With regard to agricultural production, the *Khasi* female and male share responsibilities in the same agricultural fields, while supporting each other's work; which also depicts equal share in decision-making. Again, *Khasi* men were noted to be mostly involved in the rice field and in the bun field, further from the household, whereas women were almost exclusively responsible for the homegarden.

Khasi men tended to work the jobs requiring strength (cutting the trees and burning jungle patches in *jhum* field; building terraces and canals and cutting rice for harvest in rice field etc.) whereas the women performed what male informants referred to as "*lighter activities*" (eg. managing the fields, sowing, weeding, and collecting seeds). Whereas, both the gender classes engage in fishing, hunting is exclusively task of the men.

As the main holders of this information regarding uses of plants, it is women who are primarily involved in transferring knowledge of the wild edible plants and minor crops (including their cultivation, uses, cooking, and processing) to the next generation. Studies on children's valuation of wild food plants in Meghalaya and other parts of India have found that mothers were the primary means of cultural values transmission pertaining to food plant consumption and their health benefits to the next generation (Ellena, 2013; García, 2006). Due to their role in the kitchen, the women's criteria are related to the plant's yield, production, storage, preservation, and culinary qualities, such as taste and texture. Providing women and communities with information on the nutritional value of Indigenous crop resources has been shown to contribute to enhancing their cultural value and consumption, contributing to dietary diversity and food and nutritional security (Kuhnlein et al., 2013).

The percentage of women in the Meghalaya is 49.7% where as percentage of Main Cultivator and Agricultural Labourers are 40.7 and 38.5%, respectively. As far as Marginal workers are concerned, percentage of Cultivator and Agricultural Labourers are substantially higher, 59.8 and 57.1%, respectively (Fig. A and B).





The presence of women in Meghalayan agrarian society is substantial and plays a pivotal role in daily livelihood actions and decisions making including environmental conservation. Therefore, in any decion making process views of woman folk has to be given due importance as it was given in the case of the present study. Gender perspective in Meghalayan society should therefore be taken very seriously and adequate attention should be devoted while formulating any policy.

5.2.5.2 Natural increment (fertility, mortality): The birth rate in Meghalaya has remained by and large steady although higher than the national average, in recent years

along with the infant mortality. National Health Profile (2018) data depicts a consistent decrease in birth rate, death rate and natural growth rate in India from 1991 to 2016.

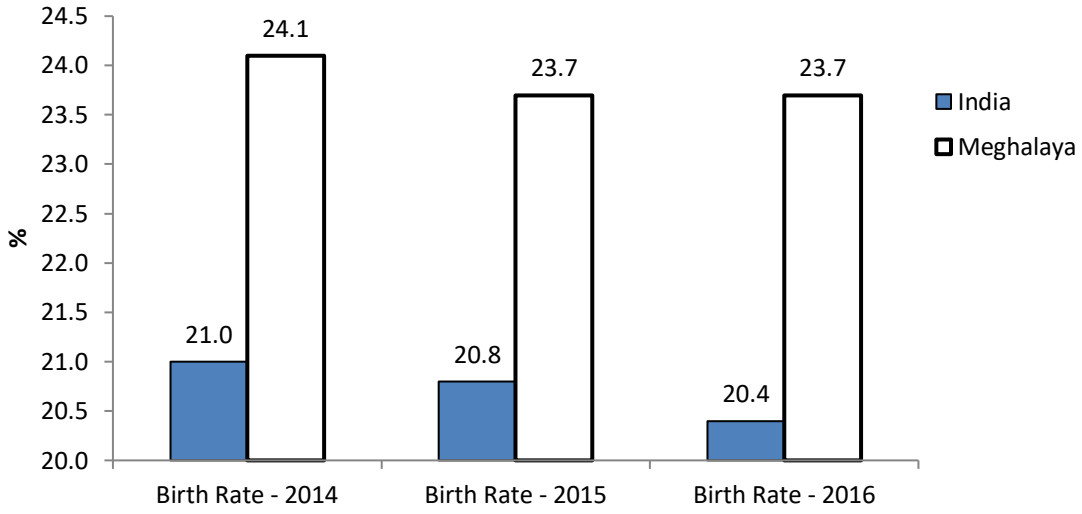


Fig. 5.18: Birth rate trend in Meghalaya and India

In 2016, India registered a natural growth rate (per 1,000 people) of 14, birth rate (per 1,000 people) of 20.4 and death rate of 6.4 (per 1,000 people). Higher birth rate, death rate and natural growth rate were reported from rural areas compared to the urban parts. In Meghalaya, the birth rate (per 1,000 people) in 2014 was 24.1 (26.2 in the rural areas and 14.7 in urban areas), higher than the national average of 21. Again, the State's birth rate was 23.7 pitted against the national average of 20.8 and 20.4, recorded during 2015 and 2016, respectively. The state, in 2015, recorded death rate of 7.4 against a national average of 6.5. Of this, higher value was recorded from the rural areas (7.8) in contrast to the urban centres (5.5).

However, a decline was registered in the infant mortality rate in Meghalaya. In 2015, Meghalaya had a staggering infant mortality rate of 42 per 1,000 births against a pan-Indian average (37). In a parallel development, the figure came down to 39 as the national average slid to 34 in 2016. Yet, the difference in rural (38) and urban (23) centres of Meghalaya is still far above the ground.The historical birth, death and natural growth rates in Meghalaya are given in the Annexure 5.31.

5.2.5.3 Immigration: Meghalaya, along with the other North-Eastern states has experienced large scale illegal immigration from Bangladesh, in the form of two massive, historical immigration waves from independence of East Pakistan in 1947 and formation of Bangladesh in 1970, which had a profound consequence on social harmony and well-being (Sarma, 2003; Singh, 2009).

More than 6,000 Bangladeshis were detected in Meghalaya during 2012, an increase of nearly 4,000 from 2011. A total of 18,951 Bangladeshis were detected in the state from 2008 to September 2013, while 978 were prosecuted, and the remaining 17,973 were pushed back (see Annexure 5.31).

5.3 Other Factors

5.3.1Social trigger events

5.3.1.1 Social and political unrest: During the early years of the '*coal boom*', migrant labour was put up with, but from the late 2000s local opposition grew, as more and more migrants arrived in the Meghalaya coal fields-affected by a range of factors including the end of Nepalese civil conflict coupled with the need for former fighters to come across livelihood options, the Global Financial Crisis, Bangladesh's political turmoil, and conflict acceleration in adjacent parts of the North-eastern India (e.g. Bodo residing areas of Assam, etc.). The main focus of this local-scale opposition has been on Nepali-speaking migrant miners (some from Nepal, while others residing in other parts of India) who have been accused of snatching jobs from locals in the mines, apart from threatening tribal land and culture (Wagle, 2010); an allegation which was instrumental for a long-term expulsion of *Nepalis* from Meghalaya even during the 1970s and 1980s.

While seemingly unrelated to coal mining, the violent incident at *Lampi* (Langpih) village—a disputed area on the border between Meghalaya and neighbouring Assam, wherein territory-based violence climaxed with the shooting of four *Khasi* villagers by the Assam State Police and subsequent formation of a high-level government inquiry (The Justice PC Phukan Inquiry Commission), heightened wide-ranging hostility to Nepali-speakers settledin Meghalaya. Eight (migrant) coal workers were killed in the South Garo Hills,

promoting several others to flee the area in 2013 (The Hindu, 2013). Data on fatalities recorded in the state of Meghalaya during 2005-2018 is provided in Annexure 5.32.

5.3.1.2 Economic crisis: With roughly 49 per cent of the population below the poverty line (2002), empowering the poor by capacity-building is imperative in realising the vision of accelerated economic growth. The persistence of high poverty in rural areas of the state is dependent on certain reasons, *viz*. - minimum prospects for employment and income-generation, meagre market linkage, and shifting cultivation-mediated low productivity and employing of traditional cultivation methods. A high rate of unemployment and underemployment, especially amongst the youth, is but an outcome of the slow industrialisation pace and limited involvement of the population in productive, economic activities. The tempo of development is the effect of the development-approach followed up to now, which has been centre-generated rather than being determined through participatory decision involving the people of the state. Only when the people impinged upon are involved in priorities, planning, and strategies it will accurately lead to improving capacities and livelihoods. Otherwise, these schemes will remain vistas for unaccountable spending.

5.3.1.3 Loopholes in Govt. Policy: Bulk of deforestation has occurred during the British period as well as post-independence period, to be precise during 1880–1960, in the Indian context. It was only after enactment of The Wildlife (Protection) Act, 1972 and The Forest (Conservation) Act, 1980 that concentrated effort was made at lowering the deforestation rate by controlling conversion of forest land to non-forestry purposes, and reserving forests for wildlife management.

The policies and policy instruments for the management of forest resources of Meghalaya were formulated and implemented at three levels, *viz*., (1) National level, (2) State level and (3) Autonomous District Council level. Owing to the fact that, 42nd Amendment Act of 1976 (of the Indian Constitution) placed the forests under the concurrent list, the responsibility of policy making lies with both the state and national governments. In addition, the Autonomous District Councils have the responsibility to formulate policies for the

management of natural resources at local level within their respective areas. The legal policy(ies) instrument(s) relating to Forestry Sector in Meghalaya are listed in Annexure 5.34 and 5.35. The shortcomings associated with the Acts and policies (as applicable) have been delineated in Annexure 5.36 (Barik and Darlong, 2008).

With regard to Laws and policy enforcement in forests, whose management is outside the realm of jurisdiction of the State Department, there function myriad factors, viz. - absence of any fixed financial provision catering to the administrative needs of the Village Councils, regardless of the constitutional status accorded to the District Council; various penal provisions of the Forest Acts *vis-a-vis* absence of law enforcement machinery and rather unfamiliar, highly "bureaucratic" structure of the District Council.

Coal mining opposition, shows two patterns of disagreement. First, an internal force focussed on the labour force and an extra-Meghalayan environmental concern-driven obligation. The National Green Tribunal (NGT) had instructed the Meghalaya Government to ban illegal 'rat-hole' coal mining and transportation of the product in April, 2014. In contrast to Nagaland, wherein the state government imposed the ban as an effort to wield control over coal mining, the Meghalayan counterparts are in a predicament of implementing a national body-imposed ban and contending with the knock-on effect on a local scale.

Moreover, the Meghalaya Government had passed its own mining laws under The Meghalaya Mines and Mineral Policy (2012) which adheres to the principle of customary land use and tribal land control in the state, despite the consequences which may contravene elements of national coal laws and policies. The policy, in question, does not talk about rat-hole mining, although outlined as a 'traditional' mining form beyond state intervention, stating in clause7.6 that 'small and traditional system of mining by local people in their own land shall not be unnecessarily disturbed' (Government of Meghalaya,2012: 392). The NGT, criticizing the Meghalaya Mines and Mineral Policy (2012) had directed for a revised version by late 2015 (Shillong Times, 2015a, 2015b). A draft Policy (2015) was placed on record before the NGT, wherein the contention of the State was that "no mining lease is to be obtained for privately owned/ community owned land",

which was "unacceptable" as well as "not in a good spirit" according to the NGT (Order dated 03rd July, 2019).

From a policy-based perspective, the informal coal utilization pattern, under tribal authority, has led to creation of a '*new coal elite*', a bloc empowered by the tribal provisions. These coal elite are in charge of an impoverished (often migrant) labour force, coupled with escalating land degradation and waterway pollution. The national-level coal ban imposition alters this issue, from socio-environmental into cultural autonomy, which in the cases highlighted as above has sometimes rebounded, and coal has been mired in an increasingly multifarious battle over resource control. The policy of ban at a national-level could be re-contemplated, with local community-centric autonomy can be agreed as safeguards thereby ensuring that the downstream strata bearing the coal boom costs, i.e. the mine workers, are empowered and protected rather than being simply penalized.

With regard to the displacement of population due to mines and their rehabilitation, the policy is rather ambiguous. Although it considers the "local population adversely affected in terms of biotic regimes, water regimes, environmental disturbance etc." as stakeholders, the responsibility is placed upon the shoulders of the Mine owners, explicitly. It states, thus:

> *16.2 Mining Operations often involve acquisition of land held by individuals, clans or communities. Apart from granting compensation to the owner for acquisition of land by any authority, effort will be made to ensure that those belonging to the weaker sections, if any, and who are likely to be deprived of their means of livelihood as a result of such acquisition, get proper rehabilitation.*
>
> *16.3 The mine owners shall be required to take full responsibility of rehabilitating the people affected by land acquisition, displacement and hazards of mining such as subsidence and environment pollution. The State Government will extend administrative cooperation for successful execution of the rehabilitation programmes.*
>
> *(Section 16, Mines Safety and Rehabilitation of Affected People, The Meghalaya Mines & Mineral Policy, 2012. Source: http://megpns.gov.in/gazette/2012/11/05-11-12-X.pdf)*

Accurate numbers, with respect to migrant labour, are very difficult to ascertain provided certain migrants come from outside of India, while some from within India. *Nepalis*, *Bodos*, *Bengalis*, and a large number of tribals from the Ri-Bhoi district in Meghalaya are reported to live and work in the mine sites. Hitherto opposition to coal mining within Meghalaya comes not from the environmental impacts but from concern over an apparent peril to livelihoods, and territory, apart from way of life of tribal communities.

A comprehensive analysis of the various policy instruments formulated for the Forestry sector in Meghalaya shows certain shortcomings (as illustrated in Annexure 5.35). The issues which need to be addressed along with suggested remedies are appended in Annexure 5.36. Most policies, which are being implemented in Meghalaya lack livelihood focus. Appropriate provisions need to be introduced in conservation and development policies and projects so that synergies can be established between livelihoods and conservation, and trade-offs between the two can be reduced. These policies should attempt for more equitable local distribution of the benefits through social mobilization, institution building and improved livelihood opportunities as evidenced in IFAD and NAP projects.

Taking cue from Tribal Rights Act, 2006; NAP Guidelines, 2002; and IFAD's NERCORMP project experience, all the policies being implemented in Meghalaya, with respect to the Forestry sector, regardless of their derivation (i.e. whether formulated by Government of India, State Government or Autonomous District Councils) needs reassessment and appropriate policy amendments as discussed above need to be effected. Even the policies with stringent conservation objectives such as Wildlife (Protection) Act, 1972; Biodiversity Act, 2002 need to have a pro-poor livelihood approach, which is imperative not only for their successful execution, but obligatory to improve the social, human, economic and the physical capital of the forest dependents, thereby reducing the trade-offs between conservation and livelihoods.

Spatial Analysis

Spatial analysis of certain direct drivers' *viz*.- Shifting cultivation, settlement expansion, permanent farming and Road network expansion of deforestation is possible. All these land uses mentioned above falls in 'Non forest' category of Forest Survey of India classification. In the present study, zonewise spatial analysis was done the details of which are given below. However, drivers like Wood collection, Mining and Charcoal making cannot be analysed spatially with the present available data/ information.

Garo Hills: Garo Hills Division presently comprises of five districts namely North Garo Hills, East Garo Hills, South Garo Hills, West Garo Hills and South West Garo Hills. However, for the sake of compatibility with Forest survey of India data, three previously prevailing districts under Garo Hills Division namely, East Garo Hills, South Garo Hills, West Garo Hills were considered.

The result of the spatial analysis between two time series (2005 and 2015) shows that 1701 km^2 area within the forest cover improved to denser category in time span of a decade. An area of 4116 km^2 remained intact as its original density class whereas 531 km^2 was converted from non-forest to forest class (Plantation). However, 531 km^2 and 568 km^2were recorded under Forest Degradation and Deforestation in Garo hills. Drivers like 'Wood collection' are one of the most important reasons for this large scale forest degradation. The change matrix of the decadal changes in Garo Hills is shown in Table 5.2.

Table 5.2 Change matrix of the decadal changes in Garo Hills (2005 and 2015)

		2015						
		DF	MDF	OF	Scrub	NF	Water	Total
2005	DF	52.2	14.7	2.1	0.0	2.3	0.5	71.8
	MDF	52.0	1602.2	514.0	12.9	105.1	3.0	2289.2
	OF	7.2	1642.0	2461.9	85.6	351.1	7.6	4555.5
	Scrub	0.0	1.8	14.9	6.3	13.5	0.3	36.7
	NF	0.9	141.9	366.6	21.0	602.2	31.1	1163.6
	Water	0.0	2.2	2.9	0.3	24.3	20.4	50.2
	Total	112.4	3404.7	3362.5	126.1	1098.5	62.9	8167.0

The spatial distribution of changes recorded during a decade is given in the following map where distribution of area with no change (light yellow), forest degradation (purple), Deforestation (red), area of improvement (Dark and light green) are shown (Fig. 5.19).

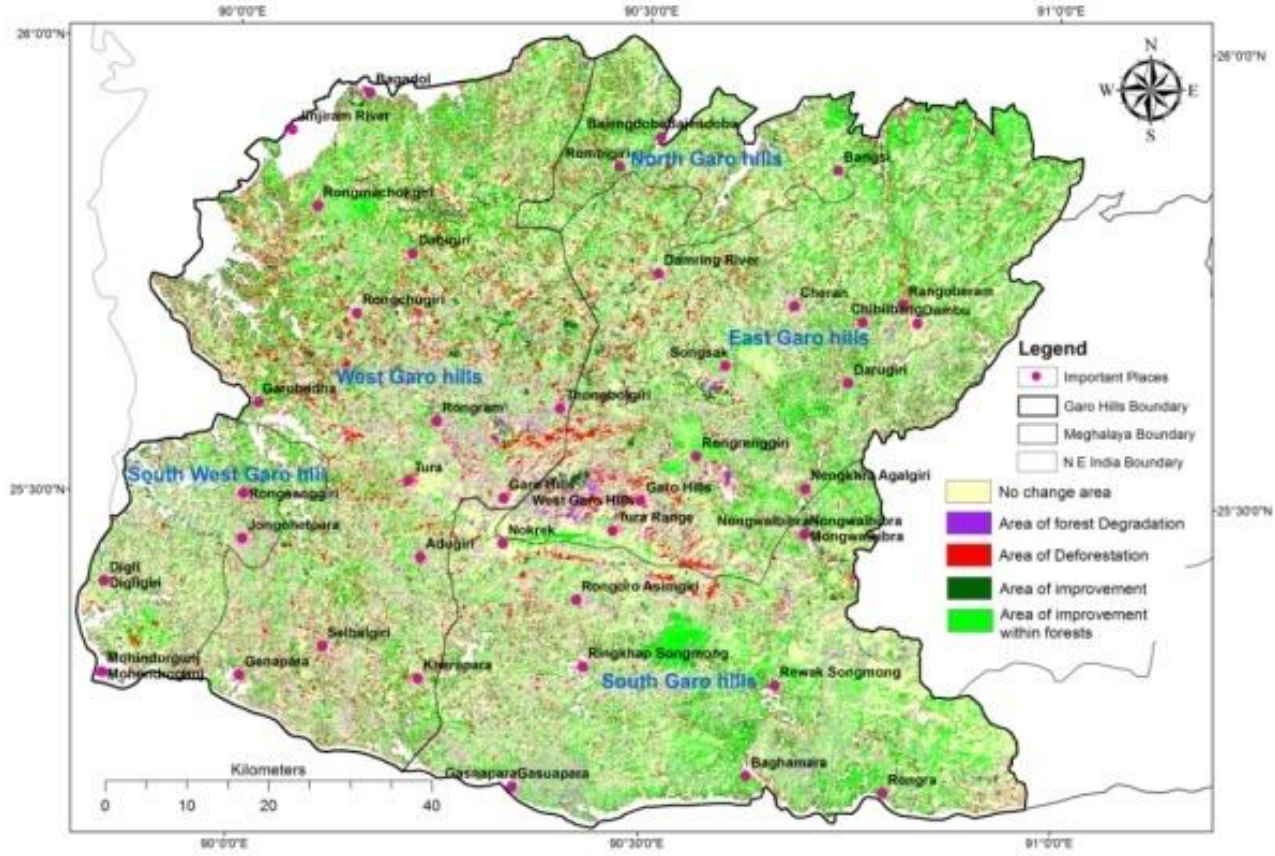
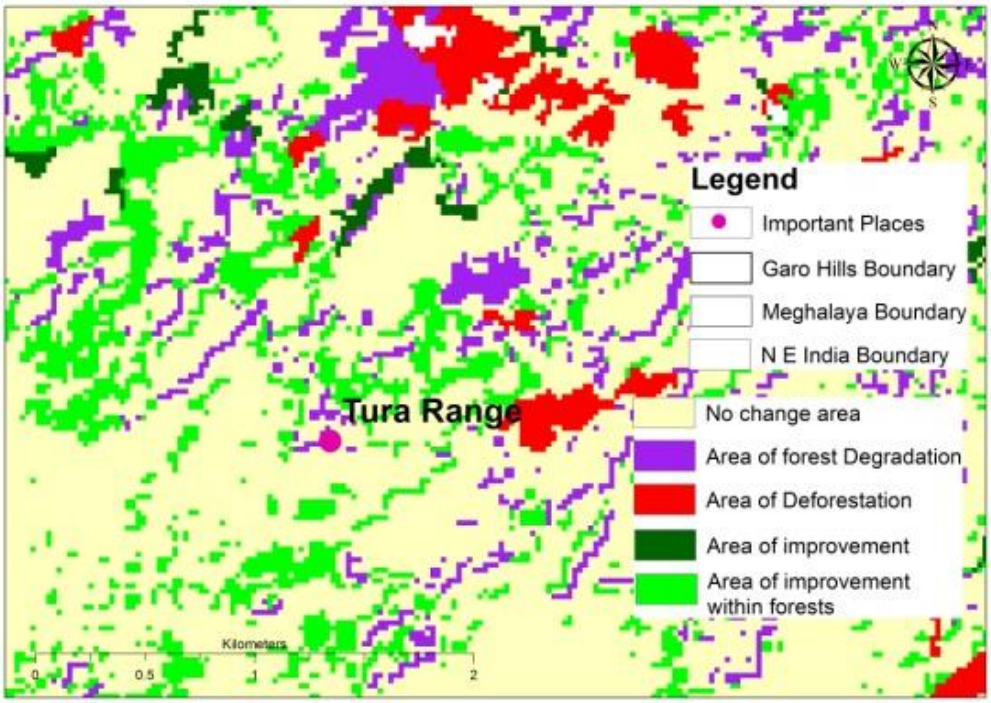


Fig. 5.19: Spatial distribution of forest cover changes in Garo Hills

A zoomed view of all the land use/ cover interchange is shown in the following map.



When compared with 2017 FSI data, it was estimated that an area of 107 km^2 was converted from forest to non-forest classes in Garo Hills region.

Khasi Hills: There are 4 districts in Khasi hills zone, *viz*.- East Khasi Hills, West Khasi Hills, South West Khasi Hills and Ri-Bhoi. Spatial analysis between two time series shows that 1705 km^2 area within the forest cover improved to denser category in time span of a decade (2005 and 2015). An area of 4830 km^2 remained intact in its original density class whereas 724 km^2 was converted from non-forest to forest class (Plantation). An area of 625 km^2 and 691 km^2 were recorded under Forest Degradation and Deforestation in Khasi hills, respectively. The change matrix of the decadal changes in Khasi Hills is shown in Table 5.3.

Table 5.3 Change matrix of the decadal changes in Khasi Hills (2005 and 2015)

		2015						
		DF	MDF	OF	Scrub	NF	Water	Total
2007	DF	92.0	58.3	9.5	0.0	5.6	0.9	166.4
	MDF	86.5	2720.8	556.9	11.4	164.5	11.5	3551.6
	OF	22.9	1595.9	2017.2	100.2	383.9	13.0	4133.2
	Scrub	0.0	11.6	64.6	50.1	6.6	0.2	133.1
	NF	3.2	292.7	345.5	16.3	1762.4	14.9	2435.0
	Water	0.0	4.6	2.0	0.0	3.0	14.1	23.7
	Total	204.6	4683.9	2995.7	178.1	2326.2	54.5	10443.0

In comparison with 2017 FSI data, it was estimated that an area of 12 km^2 was converted from forest to non-forest classes in Khasi Hills region.

Changes recorded and spatial distribution is given in the following map (Fig. 5.20).

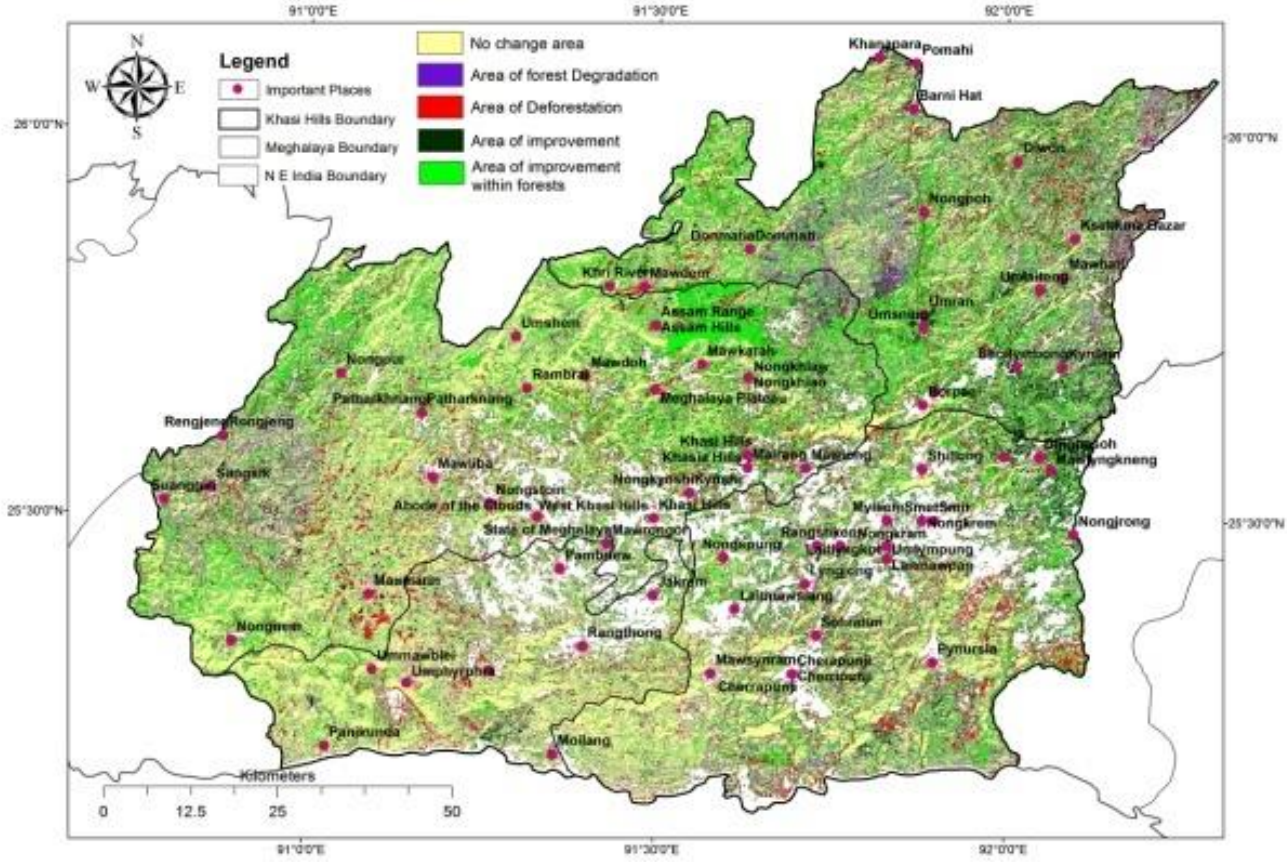
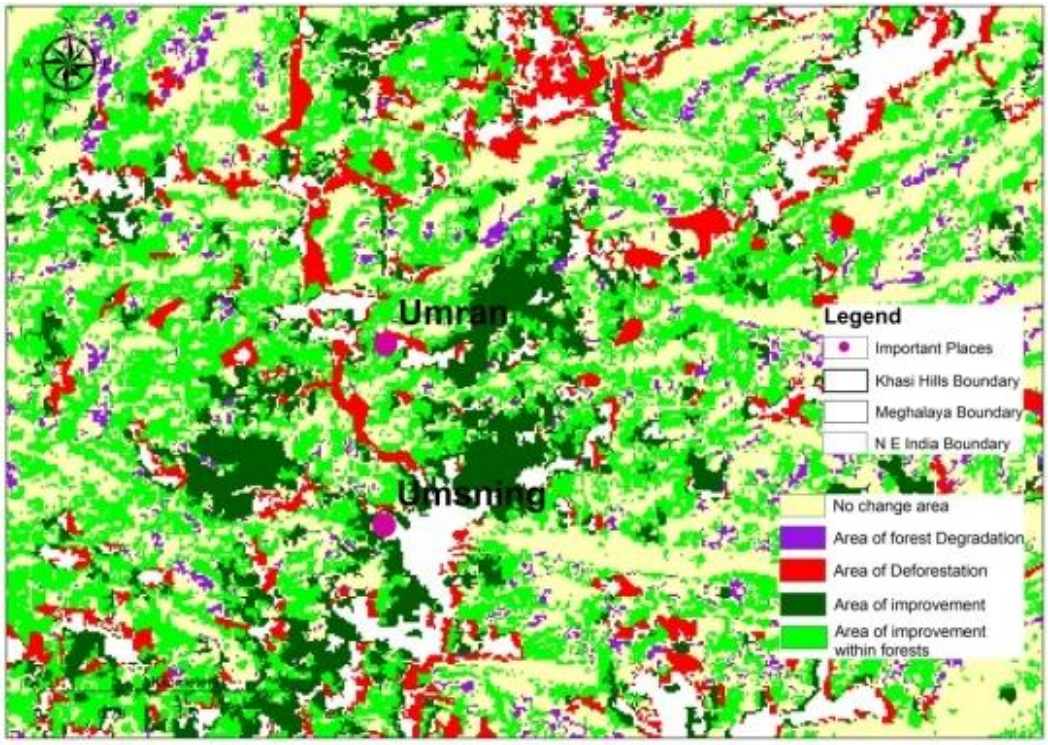


Fig. 5.20: Spatial distribution of forest cover changes in Khasi Hills

A zoomed view of all the land use/ cover interchange is shown in the following map



Jaintia Hills: Jaintia Hills Division presently comprises of two districts, *viz*.- West Jaintia Hills and East Jaintia Hills. For present study, however, one previously prevailing district under Jaintia Hills was considered for the sake of compatibility with data of Forest survey of India. The spatial analysis between two time series (2005 and 2015) shows that 557 km^{2}area within the forest cover improved to denser category in time span of a decade. An area of 1183 km^2 remained intact as its original density class whereas 533km^2 were converted from non-forest to forest class (Plantation). 270 km^2 and 228 km^2 were recorded under Forest Degradation and Deforestation in Jaintia hills.

The change matrix of the decadal changes in Jaintia Hills is shown in Table 5.4.

Table 5.4 Change matrix of the decadal changes in Jaintia Hills (2005 and 2015)

		2015						
		DF	MDF	OF	Scrub	NF	Water	Total
2007	DF	63.9	28.4	7.8	0.0	0.6	0.8	101.6
	MDF	26.6	634.9	233.4	6.4	70.7	3.6	975.7
	OF	7.7	522.2	484.0	33.5	106.4	5.9	1159.7
	Scrub	0.0	1.0	3.1	6.1	1.0	0.1	11.2
	NF	1.4	364.3	162.3	11.7	1023.2	4.3	1567.2
	Water	0.1	0.4	0.3	0.0	0.3	2.5	3.6
	Total	99.8	1551.1	891.0	57.7	1202.1	17.2	3819.0

FSI (2017) however estimated an area of 277 km^2 was converted from non-forest to forest classes in Khasi Hills region during this span of one decade (Fig. 5.21).

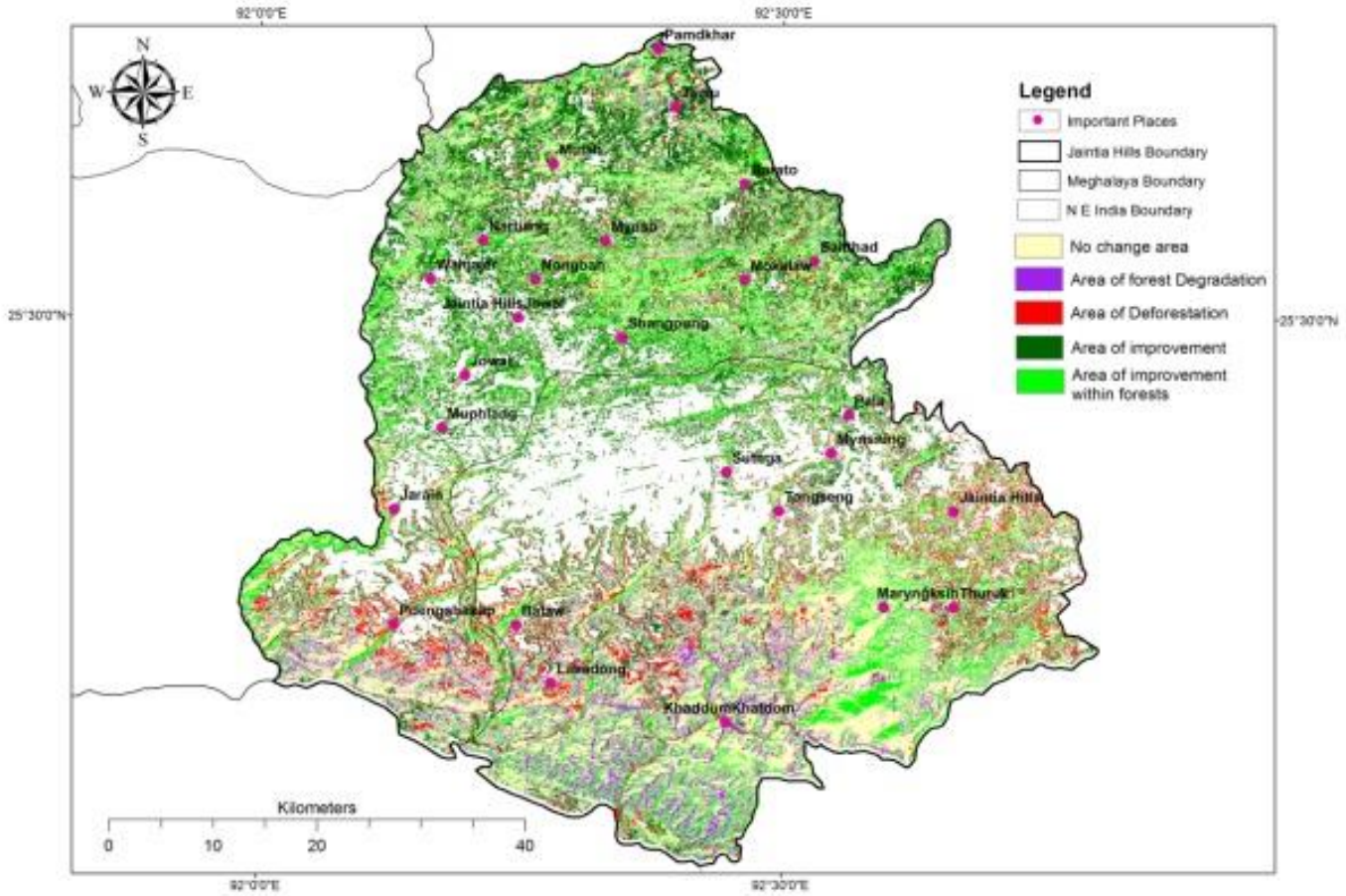
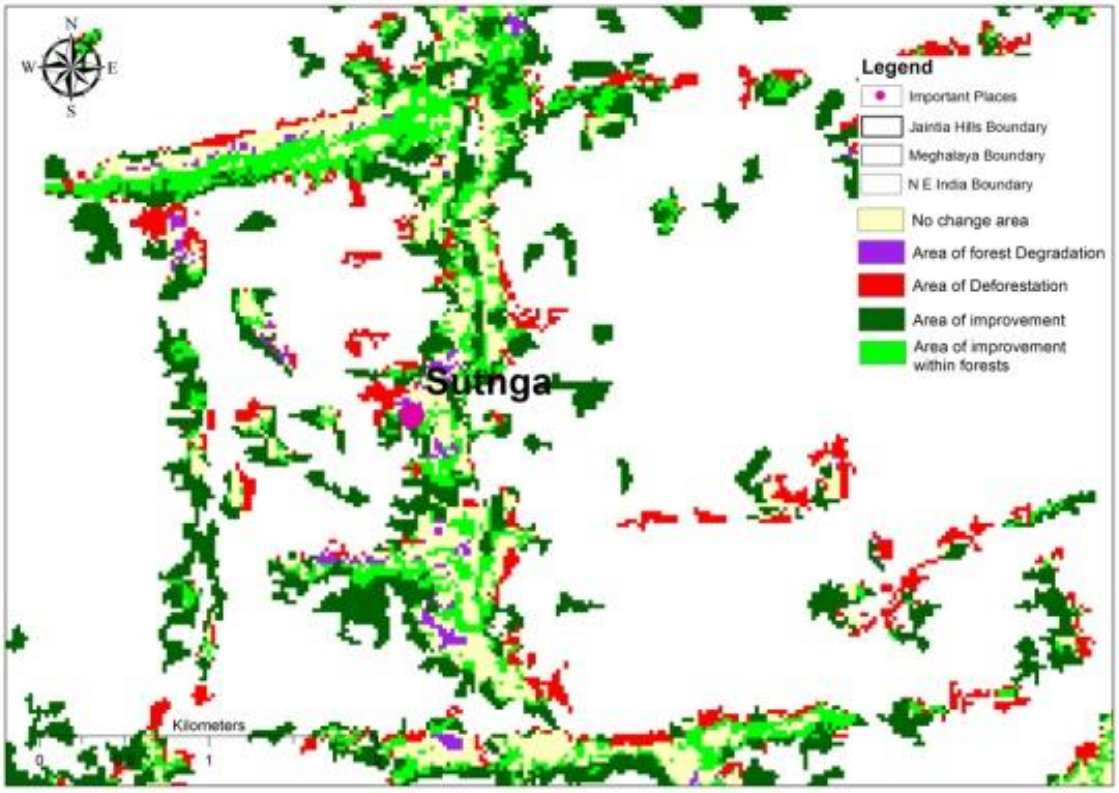


Fig. 5.21: Spatial distribution of forest cover changes in Jaintia Hills



The primary data source of Spatial Analysis is forest cover map generated byForest Survey of India in different temporal periods. The Forest Cover map was generated based on several ground-truth information collected during subsequent years. However, some amount of ground-truthing of present data was done during our ecological and socio-economic studies in selected villages too.

Chapter 6

Relative Importance of Drivers of Deforestation

In the present study, a questionnaire survey was conducted among forest dependent communities, key informants and forest and environment experts. Separate sets of questionnaires were prepared for each type of respondents. Questionnaire for the forest dependent rural communities were having the question related with the basic socio-economic information of respondents, use of forest products and the ranking of selected 8 direct and 8 indirect drivers of deforestation. Key informants include the field staff of forest department of concerned district and concerned autonomous council and village headmen of the villages chosen for the study. Divisional Forest Officers of the Forest Department, Chief Forest Officers of Autonomous Councils and researchers were considered as experts. Expert consultation was done by organizing a workshop and also by mail survey and personal contacts. Report from the consultation workshops is in the Annexure 6.1. Table 6.1 represents the total number of respondents (as listed in Annexure 6.2) of different experience level.

Table 6.1: Sample sizes of different groups of stakeholders by the zone

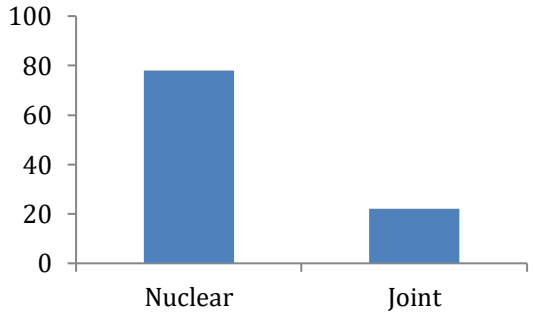
Zone	Type of respondents	Total Participants
Khasi Hills	Village surveyed	49
	Forest Dependent households	520
	Key Informants	34
	Experts	22
Garo Hills	Village surveyed	39
	Forest Dependent households	440
	Key Informants	31
	Experts	16
Jaintia Hills	Village surveyed	42
	Forest Dependent households	435
	Key Informants	29
	Experts	13

6.1 Socio-economic profile of the respondents in forest fringe communities

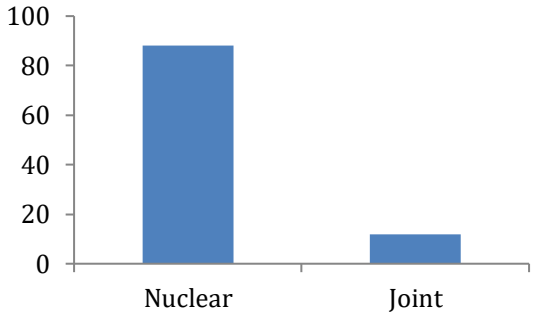
A total of 1395 households in 130 villages situated in forest fringe areas of Meghalaya were surveyed. Analysis of household data reveals that 75 percent of the overall surveyed households were living as nuclear family and 58.23 percent of family members of surveyed respondents were aged more than 18 years, and 28.95 percent were adult male and 29.33 percent were adult female. Figure 6.1 and table 6.2 represent the family structure of respondents.

Table 6.2: Percentage of Age wise family distribution of respondents

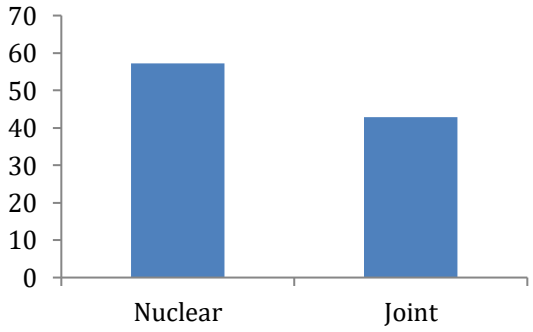
Zone	Adult Male	Adult Female	Below 18 yrs
Khasi	27.20	27.79	45.01
Garo	31.48	31.72	36.71
Jaintia	28.88	29.14	41.98
Meghalaya	28.95	29.33	41.72



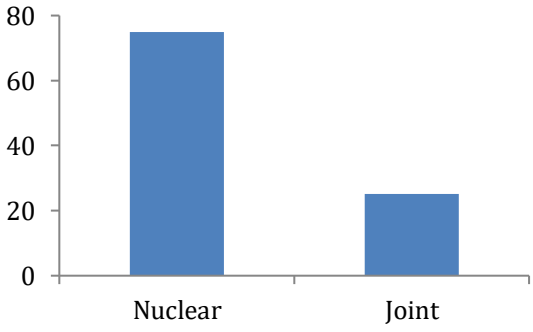
a. Khasi Hills



b. Jaintia Hills



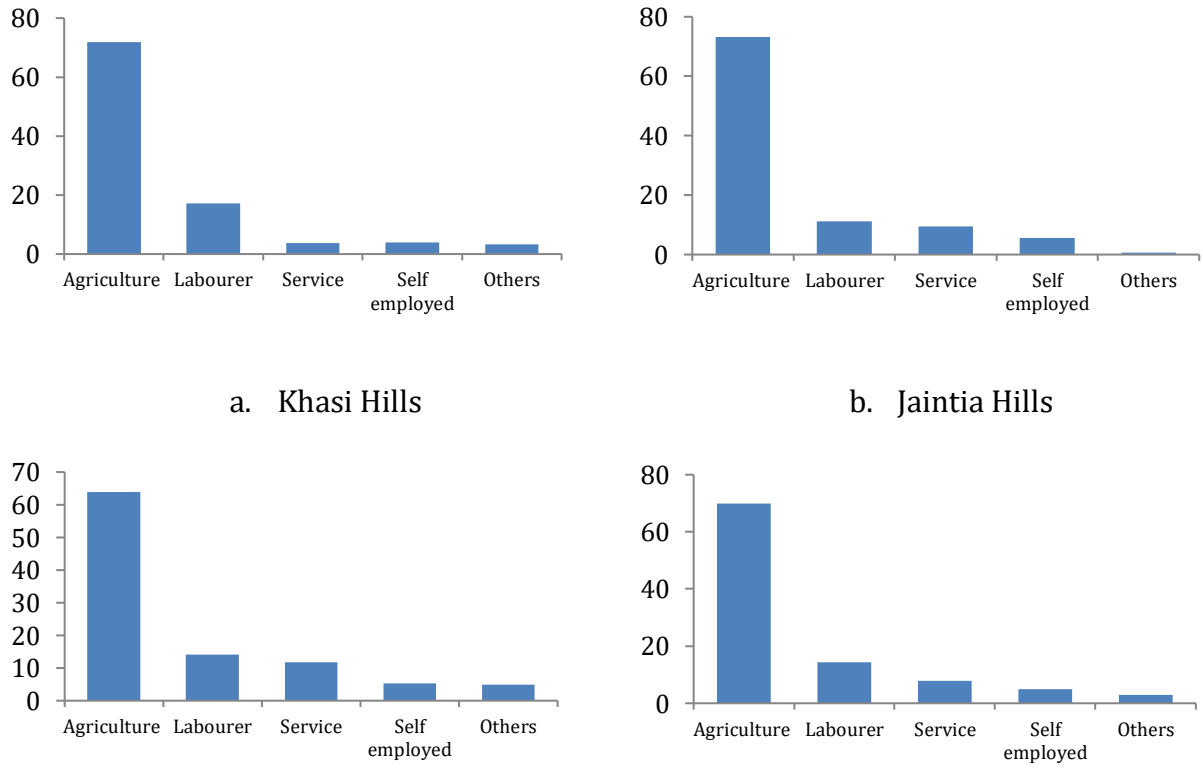
c. Garo Hills



d. Meghalaya

Fig. 6.1: Percent distribution of type of the families of the respondents

The survey reflects that the local communities are involved in agriculture as their main source of livelihood. Among all the respondents 68 per cent were involved in agriculture and 32 per cent were engaged in government/private jobs, self-employed/ business and as daily wages labour (Fig.6.2). Many families, especially marginal farmers involved in agriculture also do the daily wage works in village and nearby towns as secondary source of income. The landless families are engaged in other occupations like local petty business, labour works etc. Among the families involved in agriculture, most of them practice shifting cultivation, which is one of the major drivers of deforestation along with wood collection.



a. Khasi Hills

b. Jaintia Hills

c. Garo Hills

d. Meghalaya

Fig. 6.2: Percent distribution of primary occupation of the respondents

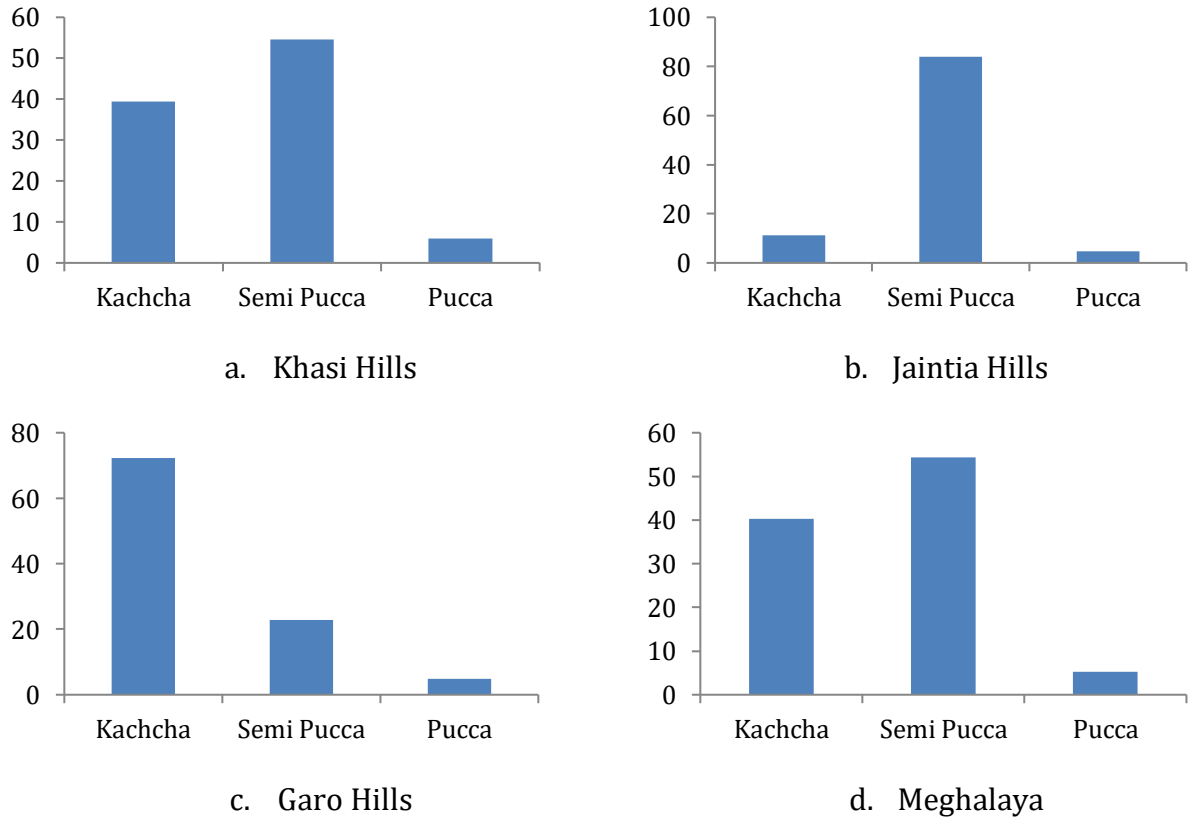
Among all the respondents it has been found that the average monthly family income of the 46 percent respondents is Rs. 5000 to Rs. 10,000, whereas 19 percent of respondents have income less than Rs. 5000 per month and 19 percent are in Rs. 15000-20000 income group

(Table 6.3).In terms of livestock, 90% of the household are engaged poultry, primarily for own consumption rather than sale.

Table 6.3: Percentage of monthly family income of respondents

Monthly Income (in Rs.)	Garo	Khasi	Jaintia	Meghalaya
less than 5000	9.29	4.60	45.29	18.96
5000-10000	38.14	56.70	42.53	46.63
10000-15000	22.74	28.54	4.83	19.25
15000-20000	19.80	7.09	2.53	9.44
20000-30000	8.56	2.11	3.22	4.39
30000-40000	0.98	0.96	1.15	1.02
More than 40000	0.49	0.00	0.46	0.29

Results of household survey reveal that the living standard of the respondents is not so high. Majority of the individuals have semi-*pucca* (semi-strong) house (55%) followed by *kuchcha* (made of wood, thatch grass and mud) house (40%) and only 5% of the population have *pucca* (bricks with RCC roof) house (Fig. 6.3).



a. Khasi Hills

b. Jaintia Hills

c. Garo Hills

d. Meghalaya

Fig. 6.3: Percent distribution of types of houses

Fuel wood consumption

During the household survey, 94 percent of households told that their family is using fuelwood for cooking and heating purpose. Only 25 percent surveyed households are using LPG along with fuelwood. Many of them having the LPG connections also do not refill the cylinders due to the easy availability of fuelwood in vicinity. Fuelwood is almost free of cost and only labour is required to collect it, whereas LPG is found to be expensive by these respondents. Therefore there is high dependency of fuelwood for meeting the energy requirement for cooking and heating. Fuelwood collection is one of the major drivers of deforestation in northeastern region of the country and Meghalaya is no exception (Hazarika, 2013). In a few pockets, where coal mining is prevailing, coal also forms one of the major energy source, mainly being used for heating purpose during winters.

A recent study conducted by the Forest Research Institute, Dehradun (FRI, 2017) estimated 15,30,885.02 MT of fuelwood consumption annually in Meghalaya. Forest fringe communities in Meghalaya use different types of energy sources like fuelwood, crop residue, kerosene, LPG, electricity and coal. Fuelwood is the main source of energy for cooking. The report states that fuelwood extraction was mainly done from community land; other sources such as forest and own land were also used. Sometimes it was also purchased from market. In Ri-Bhoi district, 28.32% of fuelwood was extracted from forest, followed by South Garo Hills (16.51%), East Khasi Hills (9.31 %), undivided Jaintia Hills (7.49%), undivided West Khasi Hills (4.65 %), undivided West Garo Hills (3.51%), and East Garo Hills (2.17%).The daily fuelwood consumption per household was highest in undivided West Khasi Hills (15.91 kg) and lowest in South Garo Hills (6.18 kg).

The preferred species for fuelwood are *Albizia procera, Pinus kesiya*, *Artocarpus chaplasha*, *Alnus nepalensis*, *Macaranga denticulata*, *Artocarpus heterophyllus*, *Ficus fulva*, *Ficus hispida, Melia azedarach*, *Schima wallichii*, *Shorea robusta, Bauhinia purpurea*, *Duabanga grandiflora*, *Syzygium cumini*, *Mesua ferrea*, *Gmelina arborea*, *Ficus auriculata*, *Toona ciliata*, *Mangifera indica* etc. Bamboo species like *Dendrocalamus hamiltonii* and *Bambusa vulgaris* are also used as fuelwood in bamboo occurring areas.

6.2 Local community's perception towards deforestation

In questionnaire based survey, questions related to the perception of local community was also asked and it was found the 99 percent of the respondents were aware of the deforestation and all of them stated that deforestation is not desirable and the government along with communities should take initiatives to stop the deforestation in Meghalaya.

6.3 Ranking of drivers of deforestation

During the field visits, particularly during thehousehold surveys and key informant interviews, the respondents were asked to give importance to the drivers of deforestation that they themselves identified on a scale of 1 to 8 where 1 is the most important driver and 8 is the least important based on their perceptions and local knowledge of the state of forests in their respective areas. In the analysis, the most important driver was given a weight of 8 while the least important was given a weight of 1 during the aggregation. Indicatively, the driver that got the highest numbers after aggregation was ranked as first; the next driver that got the second most number of points was ranked as second and so on. This procedure tried to capture the relative importance of each direct and indirect driver as perceived by the respondents themselves. Ranking of the drivers was also obtained from the subject experts in forestry and environment sector in Meghalaya. Many experts attended the workshop conducted in Shillong, where they were asked to rank the drivers of deforestation according to their experience. Emails of a number of experts were obtained from published scientific literature and were contacted via email. A total of 51 experts provided the ranking of drivers of deforestation.

6.3.1 Criteria for ranking of drivers of deforestation

A total of eight direct drivers and eight indirect drivers which are most prevalent in Meghalaya were shortlisted from the comprehensive list of all drivers of deforestation in tropical regions based on the available literature and perception of the experts included in the project team.

Direct Drivers

1. **Shifting cultivation:** Shifting cultivation as discussed in previous chapters is one of the major drivers of deforestation in Meghalaya. All type of shifting cultivation was included under this head and questions were asked accordingly to the respondents.
2. **Wood Collection:** All legal or illegal wood and timber collection was considered as drivers and termed as wood collection in the exercise of ranking of drivers. Fuelwood and timber collection by the forest dependent communities and timber merchants/smugglers are recorded as a major driver of deforestation in published literature.
3. **Mining:** As discussed in previous chapters mining whether legal or illegal is much prevalent in Garo and Jaintia Hills regions of Meghalaya, and therefore it was also included in the ranking exercise. All types of mining like sand, stone and coal mining was considered under this head.
4. **Settlement expansion:** Due to the population growth in the region, settlement expansion is also a driver of deforestation because whatever new settlements are being built are on the forested areas as non-forested area is already under the agriculture or settlements, etc.
5. **Road Network Expansion:** Maximum roads of the state are going through the forested area and any type of road widening activity or building of new road is directly affecting the forest cover of the state, and therefore expansion of road network was also included in the priority list of drivers of deforestation.
6. **Permanent Farming:** Horticulture plantations, tea garden and rubber plantation in Garo Hills region and other types of settled agriculture were included in permanent farming. As this type of farming permanently converts forest area into non-forest area, this was also considered as driver of deforestation.
7. **Charcoal Making:** In many parts of the state especially in Jaintia and Khasi Hills charcoal making is very much prevalent. Local communities cut trees for the charcoal production as there is substantial demand of charcoal in Shillong and other parts of northeast. Dependence on forest for charcoal making is also a driving force of deforestation.

8. **Other direct drivers:** Forest fire, landslides and other natural disasters were asked to be ranked by the respondents under other category.

Indirect drivers are basically the cause behind the direct drivers and contributing to deforestation indirectly. The following eight indirect drivers were selected based on the available literature and experts' opinion:

1. **Non-availability of alternatives:** There are very less number of alternatives of fuelwood, wood and shifting cultivation available, and therefore communities' dependency on forest is still high in Meghalaya. Non-availability of alternatives is one of the major indirect drivers of deforestation.
2. **Increase in population:** Population of Meghalaya increased by 27.95 percent during 2001-2011 and by 29.94 percent during 1991-2001. This increase in population poses a lot of pressure on natural resources especially forests in Meghalaya. More population will require more fuelwood, more land for agriculture and settlement, which ultimately affects the forests causing deforestation indirectly.
3. **Poverty:** High rate of population growth increases the competition for access to natural resources and this competition increases the poverty. Poor communities consume available natural resources for their immediate survival. For example, in the absence of the provision of gas and electricity or the availability of renewable sources of energy at affordable rates, wood is the major source of energy for communities in hilly areas.
4. **Lack of employment:** Unemployment is considered to be directly linked with the poverty of the person or associated dependent family members. Unemployed persons use the natural resources for survival of their families and indirectly accelerate the rate of deforestation.
5. **Less awareness:** Lack of awareness refers to both formal and informal education to increase awareness about benefits of forests and their associated ecosystem services. Many people are unaware or unable to appreciate forests' role in providing intangible benefits, especially environmental benefits. They only can think of wood as forest product and services. This leads to the attitude to overlook the need for forest protection and management.

6. **Promotion of Agriculture:** Agriculture is globally one of the most well-known drivers of deforestation. Agriculture causes direct conversion of forests into agricultural landuse. Agricultural runoff of pesticides and chemical nutrients can also cause indirect degradation and gradual deforestation of forested land.
7. **Weak forest law enforcement:** Weak enforcement is a governance issue of non-implementation of forest laws and policies in place. The reasons for non-implementation are many but are usually related to inadequate staff, insurgency or lack of desire on the part of staff to enforce laws for some reason. Corruption is also a type of weak law enforcement.
8. **Others:** Other indirect drivers like pollution, soil fertility, wildlife poaching, insurgency, political disturbances, etc. were asked to be ranked by the respondents under 'other' category.

6.3.2 Ranking of drivers of deforestation by the forest fringe community

As mentioned above, a list of eight direct and eight indirect drivers of deforestation was included in the questionnaire. During the household survey respondents were asked to rank them according to their perception and experience related with deforestation in their respective districts. Data was analysed district wise and a cumulative rank for each driver was calculated at zonal level as well as at state level.

Khasi Hills Zone: Wood collection and shifting cultivation were ranked as top priority drivers of deforestation in Khasi Hills zone (Table 6.4), whereas mining and other factors like natural calamities and fire were placed on 8th and 7th rank respectively. Three districts of Khasi Hills ranked shifting cultivation as the principal driver of deforestation in Khasi Hills. As far as the indirect drivers are concerned, respondents placed lack of employment, poverty and promotion of agriculture on priority (Table 6.5). They think that communities are aware about the ill effects of deforestation but due to poverty and lack of alternatives and employment they are forced to depend on forest resources and shifting cultivation.

Table 6.4: Ranking of direct drivers of deforestation by the local community in various districts of Khasi Hills Zone:

Direct drivers of deforestation	Ranking in individual district				Composite ranking for Khasi Hills
	West Khasi Hills	East Khasi Hills	South-West Khasi Hills	Ri Bhoi	
Wood collection	1	2	2	2	**1**
Shifting cultivation	5	1	1	1	**2**
Permanent farming	2	3	3	6	**3**
Road network expansion	4	4	5	3	**4**
Settlement expansion	3	5	4	5	**5**
Charcoal making	6	7	8	4	**6**
Mining	8	6	7	7	**7**
Others	7	8	6	8	**8**

Table 6.5: Ranking of indirect drivers of deforestation by the local community in various districts of Khasi Hills Zone:

Indirect drivers of deforestation	Ranking in individual district				Composite ranking for Khasi Hills
	West Khasi Hills	East Khasi Hills	South-West Khasi Hills	Ri Bhoi	
Lack of employment	2	1	1	4	**1**
Poverty	1	2	4	1	**2**
Promotion of Agriculture	4	5	2	3	**3**
Non-availability of alternatives	3	3	5	5	**4**
Weak forest law enforcement	7	7	3	6	**5**
Less awareness	6	4	6	2	**6**
Increase in population	5	6	7	7	**7**
Others	8	8	8	8	**8**

Garo Hills Zone: In contrast to the Khasi Hills permanent farming, settlement expansion and shifting cultivation were ranked as priority drivers of deforestation in Garo Hills (Table 6.6), whereas mining and charcoal making were placed at 6thand 8thrank respectively. Permanent farming includes cultivation of tea, betel nut, cashew, rubber and other horticulture crops. As far as the indirect drivers are concerned, respondents placed increase in population, lack of employment and awareness on priority (Table 6.7). They consider that poverty is not the main indirect driver but the lack of alternatives for the increasing population in Garo hills region is driving deforestation.

Table 6.6: Ranking of direct drivers of deforestation by the local community in various districts of Garo Hills Zone:

Direct drivers of deforestation	Ranking in individual district					Composite ranking for Garo Hills
	East Garo H.	West Garo H.	South Garo H.	South West Garo H.	North Garo H.	
Permanent farming	1	1	4	1	2	**1**
Settlement expansion	2	2	2	2	5	**2**
Shifting cultivation	4	3	3	3	1	**3**
Wood collection	5	4	1	5	3	**3**
Road network expansion	3	5	5	4	4	**5**
Mining	6	6	6	7	7	**6**
Others	8	6	7	6	8	**7**
Charcoal making	7	6	7	8	6	**8**

Table 6.7: Ranking of indirect drivers of deforestation by the local community in various districts of Garo Hills Zone

Indirect drivers of deforestation	Ranking in individual district					Composite ranking for Garo Hills
	East Garo H.	West Garo H.	South Garo H.	S-W Garo H.	North Garo H.	
Increase in population	2	1	2	2	4	**1**
Lack of employment	3	2	4	1	2	**2**
Less awareness	1	4	6	4	1	**3**
Promotion of Agriculture	5	3	3	3	3	**4**
Poverty	4	5	1	7	5	**5**
Non-availability of alternatives	7	6	5	5	7	**6**
Weak forest law enforcement	6	7	7	6	6	**7**
Others	8	8	8	8	8	**8**

Jaintia Hills Zone: In Jaintia Hills zone wood collection, shifting cultivation and mining were ranked as priority drivers of deforestation (Table 6.8), whereas road network expansion and charcoal making were placed on 6th and 7th rank respectively. Other factors like natural calamities, fire, etc. were placed at 8th rank. Respondents considered mining as the principal driver of deforestation in East Jaintia Hills district. In case of indirect drivers, situation was more or less similar to Khasi Hills, respondents placing poverty, non-availability of alternatives and increase in population on rank 1, 2 and 3 respectively (Table 6.9). They consider that poverty is the product of lack of employment and alternatives.

Table 6.8: Ranking of direct drivers of deforestation by the local community in various districts of Jaintia Hills Zone:

Direct drivers of deforestation	Ranking in individual district		Composite ranking for Jaintia Hills
	West Jaintia Hills	East Jaintia Hills	
Wood collection	1	3	**1**
Shifting cultivation	3	2	**2**
Mining	7	1	**3**
Settlement expansion	2	4	**4**
Permanent farming	4	5	**5**
Charcoal making	6	6	**7**
Road network expansion	5	6	**6**
Others	8	8	**8**

Table 6.9: Ranking of indirect drivers of deforestation by the local community in various districts of Jaintia Hills Zone:

Indirect drivers of deforestation	Ranking in individual district		Composite ranking for Jaintia Hills
	West Jaintia Hills	East Jaintia Hills	
Poverty	5	1	**1**
Non-availability of alternatives	1	2	**2**
Increase in population	6	5	**3**
Lack of employment	3	4	**3**
Promotion of Agriculture	4	3	**5**
Less awareness	7	6	**6**
Weak forest law enforcement	2	7	**7**
Others	8	8	**8**

6.3.3 Final ranking of drivers of deforestation

As mentioned above that ranking of drivers of deforestation was done in 3 steps. Ranking (SE Rank) by the forest fringe communities was described above. The other two stages were the ranking from key informants and subject experts. SE Ranking was done in each district but ranking by the key informants and subject experts was obtained on regional or zonal level since experts were unable to rank drivers on district basis as some of the districts have been created recently. Final ranking of drivers of deforestation was achieved by combining the ranked data from the socioeconomic survey (SE Rank), key informants (KI Rank), and expert opinion (Ex Rank), for each zone of Meghalaya. Final rankings of the drivers of deforestation are presented in Table 6.10 to 6.15.

Khasi Hills Zone: Experts agreed with the community perception in case of wood collection and shifting cultivation in Khasi Hills Zone. They also ranked wood collection and

shifting cultivation as 1 and 2 respectively. Key informants have different opinion regarding the shifting cultivation and placed it on 5th rank; however they also consider wood collection as principal driver of deforestation. In final normalized ranking, wood collection, shifting cultivation and settlement expansion was placed at 1st, 2nd and 3rd ranking respectively. Mining and others factors like natural calamities, land slide, fire, etc. were placed last in the ranking table (Table 6.10). In case of indirect drivers of deforestation poverty, lack of employment and non-availability of alternatives occupy first 3 ranks after combining all 3 ranking data sets (Table 6.11). Data analysis indicates that adequate employment generation can be a solution to discourage deforestation because it will help to eradicate the poverty which is top ranked indirect driver of deforestation in Khasi Hills. Subsequently it will also help in purchasing alternate energy sources.

Table 6.10: Final ranking of direct drivers of deforestation in Khasi Hills Zone

Direct Drivers	**SE Rank**	**KI Rank**	**Ex Rank**	**Normalized Rank**	**Final Ranks**
Wood collection	1	1	1	0.028	**1**
Shifting cultivation	2	5	2	0.083	**2**
Settlement expansion	5	2	3	0.093	**3**
Permanent farming	3	3	7	0.120	**4**
Charcoal making	6	4	4	0.130	**5**
Road network expansion	4	6	5	0.139	**6**
Mining	7	7	6	0.185	**7**
Others	8	8	8	0.222	**8**

Table 6.11: Final ranking of indirect drivers of deforestation in Khasi Hills Zone

Indirect Drivers	**SE Rank**	**KI Rank**	**Ex Rank**	**Normalized Rank**	**Final Ranks**
Poverty	2	2	3	0.065	**1**
Lack of employment	1	3	5	0.083	**2**
Non- availability of alternatives	4	1	4	0.083	**2**
Increase in population	7	4	1	0.111	**4**
Less awareness	6	6	2	0.130	**5**
Promotion of Agriculture	3	5	7	0.139	**6**
Weak forest law enforcement	5	7	6	0.167	**7**
Others	8	8	8	0.222	**8**

Garo Hills: In Garo Hills, most of the rural households are engaged in shifting cultivation. Although local communities ranked shifting cultivation as 3rd most important direct driver key informants and experts found shifting cultivation as the principal direct driver and ranked it as 1st. After normalization permanent farming and wood collection were other two direct drivers, occupying 2nd rank together. Charcoal making, mining and other factors occupy the last 3 places in ranking table (Table 6.12). As far as the indirect drivers are concerned, all the three types of informants put population growth on rank 1st. Lack of employment and awareness are ranked 2ndand 3rdrespectively (Table 6.13). Induction of advanced techniques in agriculture including shifting cultivation along with awareness programmes is required to check deforestation in Garo Hills. Measure should be taken to control the population growth also.

Table 6.12: Final ranking of direct drivers of deforestation in Garo Hills Zone

Direct Drivers	**SE Rank**	**KI Rank**	**Ex Rank**	**Normalized Rank**	**Final Ranks**
Shifting cultivation	3	1	1	0.046	**1**
Permanent farming	1	3	3	0.065	**2**
Wood collection	3	2	2	0.065	**2**
Settlement expansion	2	4	4	0.093	**4**
Road network expansion	5	5	6	0.148	**5**
Mining	6	6	5	0.157	**6**
Charcoal making	7	7	7	0.194	**7**
Others	7	8	8	0.213	**8**

Table 6.13: Final ranking of indirect drivers of deforestation in Garo Hills Zone

Indirect Drivers	**SE Rank**	**KI Rank**	**Ex Rank**	**Normalized Rank**	**Final Ranks**
Increase in population	1	1	1	0.028	**1**
Lack of employment	2	2	5	0.083	**2**
Less awareness	3	5	2	0.093	**3**
Poverty	5	3	3	0.102	**4**
Promotion of Agriculture	4	4	6	0.130	**5**
Weak forest law enforcement	7	7	4	0.167	**6**
Non- availability of alternatives	6	6	7	0.176	**7**
Others	8	8	8	0.222	**8**

Jaintia Hills: All three types of informants have different opinion about wood collection, mining and shifting cultivation and gave different ranks to these direct drivers but after normalization of ranks given by communities, key informants and experts, wood collection and mining are together ranked 1st. Jaintia hills region is a mining affected region and even after banning of rat hole mining, it is still one of the principal direct drivers of deforestation. Shifting cultivation is on 3rd rank (Table 6.14). Poverty is judged as top ranked indirect driver by all types of informants. Population growth and lack of alternatives, awareness and employment occupy next 3 ranks in ranking table (table 6.15).

Table 6.14: Final ranking of direct drivers of deforestation in Jaintia Hills Zone

Direct Drivers	**SE Rank**	**KI Rank**	**Ex Rank**	**Normalized Rank**	**Final Ranks**
Wood collection	1	3	2	0.056	**1**
Mining	3	2	1	0.056	**1**
Shifting cultivation	2	1	4	0.065	**3**
Charcoal making	6	4	3	0.120	**4**
Settlement expansion	4	6	5	0.139	**5**
Permanent farming	5	5	7	0.157	**6**
Road network expansion	7	7	6	0.185	**7**
Others	8	8	8	0.222	**8**

Table 6.15: Final ranking of indirect drivers of deforestation in Jaintia Hills Zone

Indirect Drivers	**SE Rank**	**KI Rank**	**Ex Rank**	**Normalized Rank**	**Final Ranks**
Poverty	1	1	1	0.028	**1**
Increase in population	3	3	3	0.083	**2**
Non- availability of alternatives	2	2	6	0.093	**3**
Less awareness	6	5	2	0.120	**4**
Lack of employment	3	6	4	0.120	**4**
Promotion of Agriculture	5	4	7	0.148	**6**
Weak forest law enforcement	7	7	5	0.176	**7**
Others	8	8	8	0.222	**8**

During the process of ranking of drivers of deforestation, while some drivers ranked higher than others, it is important also to view most of the drivers (even direct and indirect) as a set of variables that are often inter-linked and acting together, even synergistically in many

cases, causing more deforestation than while acting alone. As in the case of indirect drivers, poverty is one of the major drivers of deforestation because poverty makes an individual unable to access resources and is directly linked with lack of employment due to which there is lack of earning and access to resources. Solution of problem of unemployment will eradicate the poverty and ultimately will reduce the pressure on the forest for biomass needs.

The key common direct drivers included wood collection (fuelwood and timber), shifting cultivation and settlement expansion, and mining in mining affected pockets of state and conversion of forested area into monoculture permanent farming of cashew nut, betel nut, tea and rubber. The key indirect drivers included poverty, overpopulation, non-availability of alternatives, lack of employment and several issues related to governance including: inadequate enforcement, inadequate policies or policies not followed and lack of harmony among forest departments of state and autonomous councils. While most drivers were common to all the three regions of Meghalaya, the relative importance of some drivers varied among the different regions and as compared to ranks from the study. It is well established fact that population density is directly related with deforestation and population growth rate of Meghalaya is maximum among all states of the country. This increasing population is putting additional pressure on forests of the state. Increased population needs more fuelwood; more land for agriculture, more houses and all these activitiesare directly related with deforestation.

6.4 Ecological Case studies in selected villages

A total of 13 (thirteen) fringe forest villages falling in highly degraded zones were selected for ecological case studies to understand the disturbance gradients. Locations of selected villages are as shown in Fig. 6.4.

Fig. 6.4 – Location of villages taken up for ecological survey

In Khasi Hills, *Jhum* cultivation has become co-dominant with a rise in the people converting their *Jhum* lands into cultivation of para-Rubber tree (*Hevea brasiliensis*) and Broom grass (*Thysanolaena maxima*). Prevalence of *Jhum* results in recurring incidents of forest fires, one of the direct drivers of deforestation, in the fringe forest area. Cattle grazing were common in the fringe forests, thereby affecting the plant species regeneration. Illegally felled tree are used to prepare charcoal, which is a driver of deforestation. Mining inside the forest area, observed in Khasi Hills, is found to accelerate the deforestation process. Again, community forests were observed to deplete, due to lack of proper forest management.

'*Rat-hole*' mining was found as one of the major direct drivers of deforestation in Jaintia Hills. It had caused massive damage to the landscape as well as biological communities. *Jhum* cultivation was also observed as one of the drivers of deforestation. Invasive species,

indicative of disturbance in the biological niche, were found dominant. Fire incidents had also occurred in Jaintia Hills, another driver worth cognizance.

Again, most of the people have started preferring settled cultivation like Cashew nut and Areca nut in lieu of *Jhum* lands. In contrast to the improper management scenario in Khasi Hills, the community forests in Garo Hills are well managed. Biotic pressure was observed to increase proportionately with the degree of disturbance.

Zone, Disturbance and Vegetation category-wise Shannon –Weiner Diversity Index calculated indicated that in general, the diversity of plant forms increased with the decrease in the level of biotic interference and disturbance (Table 6.16).

Table 6.16: Zone-wise, Disturbance-wise and Vegetation category-wise analysis of Shannon –Weiner Diversity Index

Level of disturbance	**Vegetation category**	**Khasi Hills**	**Jaintia Hills**	**Garo Hills**	**Meghalaya**
Maximum disturbance	Tree	2.10	2.02	1.96	2.03
	Shrubs & Regeneration	2.05	2.37	1.99	2.14
Moderate disturbance	Tree	1.89	2.27	2.49	2.22
	Shrubs & Regeneration	2.07	2.61	2.315	2.33
Least disturbance	Tree	2.23	2.22	2.84	2.43
	Shrubs & Regeneration	2.38	2.82	2.69	2.63

Chapter 7

Strategies to address deforestation

7.1 Challenges to check deforestation

There are lots of challenges to check the deforestation in the state of Meghalaya. Some of these challenges include community ownership of forest, very less area with State Forest Department to manage, lack of capacity of forest departments of state as well as of Autonomous District Councils of all the three regions and ineffectiveness of many existing policies and measures. Besides these the complexity of direct and indirect drivers is also a major challenge to reduce the deforestation in Meghalaya.

7.1.1 Complexityof direct and direct drivers

As discussed in previous chapterswhile some drivers ranked higher than others, it is important also to view most of the drivers (even direct and indirect) as a set of variables that are inter-linked and acting together. Meghalaya is a culturally, ecologically and geographically diverse state and divided into three distinct regions based on the cultural variation. There is diversity in management of the forests also. There are clan forests, community forests and government forests. This culturaland socio-economic diversity in forest dependent communities provides a diverse type of community – forest interactions and different types of interactions that result in diverse modes of deforestation and degradation, so that a single solution does not fit everywhere.

7.1.2 Different management options

The specific management approach of forests creates important governance, institutional, and behavioural elements that play a key role in efficient management of the forests. The perception of rights, the feeling of ownership, the level of surveillance, the degree of rule compliance all depend on the specifics of the institutional arrangements. In Meghalaya, more than 90% of forests are under the control and jurisdiction of Autonomous District Councils. The ADCs also have jurisdiction on regulation of shifting cultivation practices. There is conflict between State Forest Department and forest department of these councils.

These different types of management regime not only result in different bundles of rights but also diverse management forms which are strong determinants of health and condition of both government and community forests. Therefore, it is suggested that forest departments of ADCs should be merged with the state forest department as in other States, and people's committees and government should jointly manage the community forests, as in other states. Rights of ownership of the individuals who control most of the forests in the state must be recognized, but with the condition that the area is not to be deforested.

7.1.3 Insufficient capacity and preparedness of forest departments

As discussed in previous chapters, there is acute shortage of staff especially front line staff in State Forest Departments. The capacities and capabilities of the staff of forest departments of all the three ADCs to provide technical services to private forest owners are negligible. Their departments lack technical expertise as well as funds to cater for the requirements of the forest owners, or to motivate people to protect open access lands.This has seriously destabilized the capacity of the forest departments to enforce law and order, implement policies, monitor and impose certain incentives and disincentives. Low levels of staff morale, proficiency, assurance and commitment, coupled with insufficient resources such as transportation, information, equipment and technology have also undermined the capacity of the forest departments to manage available forest efficiently and to enforce law and order. This is further worsened by weak coordination amongst concerned line departments of state government and district councils.

7.1.4 Ineffectiveness of many existing Acts, policies and measures

As discussed above the drivers of deforestation are so diverse, discreteand complex that it makes it difficult to address deforestation, as no single strategy for a particular driver can work. Meghalaya is having lots of Acts and policies related with forest resources management. The existing Assam Forest Regulation adopted by the state as the Meghalaya Forests Regulation is far from adequate to achieve the aims and objectives of the policy. Therefore, a few other Acts have been legislated in the state like the Meghalaya Removal of Timber Regulation Act, the Meghalaya Tree Preservation Act etc. but these Acts are also found to be not so effective to achieve their objectivesdue to weak implementation capacity and low political will. Many of Acts, policies and measures are limited to paper onlyin the

state of Meghalaya. The potential gains from illegal logging are so high the risk taken in crossing the check points, seizing of their vehicles, arrest of loggers and timber transporters or even bribing the forest official are small compared to the potential gains.Uncertainty about the power sharing between the State Forest Departments and District Councils leads to confusion and indecision.

7.2 Strategies to reduce deforestation

The large number of direct and indirect drivers of deforestation, their underlying causes and their different combinations demand multiple strategies to reduce deforestation. However, as discussed in the previous chapter, the analysis in this report considered just eight direct drivers and eight indirect drivers and some of their underlying causes. Even with the eight drivers, it is unlikely that state forest department or other agencies would be able to mobilize funds in the near future sufficient for the required capacity building and implementation of interventions to eliminate all the drivers. Therefore, it is necessary to prioritize these drivers. The following sections suggest some potential strategies and interventions.

7.2.1 Strategies for direct drivers

As discussed in previous chapter, 'wood collection' including fuelwood, legal and illegal timber extraction from forest areas and 'shifting cultivation' are the major direct drivers of deforestation in all the regions of Meghalaya. 'Encroachment of forest land' for settlement expansion and other non-forest purposes, which is directly linked with the population growth, is the third important direct driver of deforestation. Emphasis is given on mainly these three drivers along with other drivers.

Wood Collection

Wood collection for fuelwood and timber (legal or illegal) is most important driver of deforestation in the state. There is a huge gap between demand and supply of wood from forests. This gap can be narrowed by reducing the demand of wood and increasing the productivity of forests. The sustainable management of forests, especially under jurisdiction of district councils, can lead to considerable increase in the supply of wood (timber and fuelwood). Sustainable forest management helps in rapid growth and increase

in productivity of forests, and this can narrow the gap between the demand and supply of wood and timber, and so to discourage illegal logging and illegal collection of fuelwood. It must be noted here that sustainable forest management will also require improved technologies and organizational arrangements combining modern forestry science with indigenous knowledge. There is a gap between potential of sustainable production through vigorous forest management interventions and the current production levels through traditional management in Meghalaya's forests. This is applicable both to state forest department managed and community or district council managed forests. Following strategies should be adopted to reduce wood collection from the forests:

- As discussed above there is inadequate capacity and preparedness of forest management agencies in the state and it is even worst when coupled with inefficient forest laws and policies. Strict enforcement of the existing forest laws should be ensured to check illegal wood collection especially in community managed forests.
- Modern tools and techniques like Remote Sensing should be used to trace the location and cause of forest destruction.
- Plantation of indigenous fast growing species especially in home gardens, farmlands, Jhum lands, fallow lands, etc. to meet the increasing demand of wood, should be promoted.
- There should be promotion of energy efficient cooking devices along with the alternative fuel like LPG. '*Pradhan Mantri Ujjawala Scheme*', is a good initiative of the Ministry of Petroleum & Natural Gas, Government of India impacting reduction of fuelwood usage and during the household survey, it was found that many of the rural households got LPG cylinder under this scheme but they were not able to refill this cylinder due to its high cost compared with fuelwood. Focused awareness campaign should be organized on the negative impacts, ill effects of indoor pollution due to use of fuelwood and resultant pulmonary disorders, and other unseen cost and externalities of using fuelwood, so that rural community starts using more LPG and reduce their dependency on fuelwood.
- Most of the timber is being used in housing and furniture making. Use of seasoned and treated wood to increase the life of wood products should be promoted. Promoting the

use of composite wood products or alternatives to wood viz, bamboo, cane etc. will also help in reduction of use of wood in furniture as well as in housing.

Shifting Cultivation

Shifting cultivation is the second most important direct driver of deforestation. More or less all the three major tribes of Meghalaya are involved in shifting cultivation. The farmers use the specific allocated area for crop cultivation and leave that area after a period of 2-3 years, when the productivity declines. Farmers further shift to new forest areasand clear it for cultivation. As discussed in previous chapters, earlier the jhum cycle was more than 10 years long but now to sustain the increasing population the jhum cycle has reduced even up to 2 years. This reduced period of jhum cycle is not providing time to the fallow lands to restore. Short jhum cycles have put tremendous pressure on resources thus affecting productivity of land caused by increased soil erosion and forest degradation and ultimately deforestation. A holistic approach for sustainable development that would link agriculture, animal husbandry, and domestic sub-systems of the village ecosystem in the overall context of the forest ecosystem function and management is needed. Following strategies should be adopted to reduce the ill effects of jhum cultivation:

- Use of high yielding varieties of indigenous crops along with improved cultivation techniques should be promoted. Rice is the major crop of the state and wet rice cultivation is the most favorable type of cultivation technique to increase the production of rice. Therefore promotion and facilitation of wet rice cultivation can increase the production of rice manifold in the state.
- Research shows that the use of bio-fertilizers can increase the productivity of jhum fields. Therefore, the use of bio-fertilizers to enhance the productivity of Jhum fields should be promoted.
- Annual monitoring programmes on shifting cultivation should be started at regional level to plan proper management practices like plantation, soil erosion control, soil fertility management etc.
- Permanent farming system such as plantation and terrace farming should be promoted in shifting cultivation areas.

- Transfer of technology from one tribe to another should also be encouraged. For example, emphasis on potato at higher elevations compared to rice at lower elevations has led to a manifold increase in economic yield despite the low fertility of the more acid soils at higher elevations.
- The agro-forestry models should be developed, promoted and practiced to enhance the productivity of the land. Alder (*Alnus nepalensis*) based agroforestry model is one of such models, which is already adopted and successfully practiced in Nagaland.
- Non-availability of alternatives coupled with widespread poverty is one of the underlying causes of shifting cultivation as well as fuel wood dependency. Providing alternative sources of livelihood (discussed under indirect drivers) will also be helpful in reducing the dependency on shifting cultivation.
- There is a great potential for marketing jhum rice as an organic product, both in India and abroad, but it will require high skills and consistent effort in marketing.
- By controlling shifting cultivation, fire incidents can also be controlled as maximum number of forest fires are induced by the burning of forest to prepare jhum fields.

Settlement expansion

Settlement expansion is directly linked with the population growth, which is highest in Meghalaya among all states of the country. Population growth rate of Meghalaya was 29.94% during 2001-2011, which is much more than national rate of 17.64%. This high growth rate of population is exerting pressure on forests to convert forested land into settlement and most of these settlements are coming up on the encroached forest land. Following strategies are suggested to reduce the forest land encroachment for settlement expansion:

- It was observed that there is a lot of migration from rural areas to urban areas. In urban fringes this migrated population is being settled legally or illegally. Most of the urban areas in Meghalaya are surrounded by forests; therefore this migration is causing deforestation in these surrounding forests. There should be a check on this migration and as discussed above, alternative sources of livelihoods in rural areas can help significantly to reduce this migration.

- Vertical expansion instead of horizontal expansion in case of buildings construction should be promoted in urban areas. There is a lot of space available between the houses in rural areas of Meghalaya, and this space should be utilized for the construction of new houses and arrangement of houses in the villages should be more compact.
- Encroachment of forest areas should strictly be monitored and tough action taken against encroachers.
- There should be a policy for expansion of settlement in rural area also. Proper planning and mapping should be done during the expansion of settlements.

Permanent farming

It was also found that some of the regions, especially in Garo hills of Meghalaya forest area have been largely converted into permanent farming especially for horticulture plantations. The open area of forest is gradually converted into betel nut, tea, cashew nut, palm and rubber plantation. No doubt these plantations helps farmer to earn livelihood and their day-to-day requirements but it needs to be checked because it will gradually decrease overall health of forest ecosystem. Therefore following steps should be taken to reduce this problem.

- The permanent farming or monoculture plantation by clearing forest area should be discouraged. On the other hand existing agriculture areas can be converted to horticulture or cash crops or introduction of tree crops should be in the form of agro forestry.
- Series of awareness programmes should be conducted to discourage such type of practices. Ill effects of monoculture on forest biodiversity and ecosystem services should be highlighted.

Road network expansion

As to meet the demands and improvement of living standard of the peoples of any state a well-developed surface transport system is required. The data on expansion of road shows that road network in Meghalaya has expanded about 2.5 times during 1976-2016, which is a good sign of development in the State but at the cost of forest and land resources. The

development activities will never stop in any country but it can go ahead in an eco-friendly and sustainable way so that destruction of natural resources can be minimized. The following measures must be adopted before planning any expansion of road network:

- The laws related to conversion of forest area into non forest area, or using forest land for non-forestry proposes should be strictly implemented.
- There should be no expansion of road in dense forest areas and eco-sensitive zones.
- Meghalaya is a hilly state and expansion of any road leads to the erosion and landslips on hill slopes. Therefore, proper scientific methods should be adopted to stabilize the slope while expanding the roads in hills.
- The plantation of suitable indigenous species should be done on both the sides of the road to avoid landslide and soil erosion and to absorb sound and pollutants etc.
- The technologies available for improving the life in high rainfall areas (viz. plastic roads) should be adopted.
- Usage of fuel wood for heating bitumen should be discouraged; bitumen heaters fuelled by kerosene, diesel or gas should be used. Also, no bituminous material should be discharged into side drains

Mining

As discussed in the previous chapters, the state of Meghalaya is endowed with a number of minerals like Coal, limestone, uranium, granite, kaolin, clay etc. Various studies in Meghalaya have found that mining activity has a detrimental impact on ecology of the surrounding biodiversity-rich forests and it is one of the major drivers of forest degradation and deforestation. Keeping in view the ill effects of mining on forests and biodiversity, NGT ordered a ban on coal mining activities in Meghalaya but illegal mining of coal is still on. The future course of action to arrest Unregulated & Illegal Coal Mining in Meghalaya (after Anon., 2018b) is detailed in Annexure 7.1. Further, the following measures are recommended to check the ill effect of mining activities on forest and biodiversity:

- Illegal mining needs to be checked and stopped, with imposition of stricter penalties to the coal, sand, stone and lime mafias.

- The trade of minerals at state levelas well as regional level, needs to be closely monitored.
- Site specific plan for restoration of degraded mining sites through forestry interventions, need to be developed. Suitable integrated approaches for the restoration of ecosystem of mine areas exist.
- Proper treatment of mine spoils and over burden dump is required.
- The restoration and corporate social responsibility (CSR) work carried out by governmental and non-governmental agencies in the state need to be closely monitored.
- Awareness programme on conservation, restoration and management of forest resources, needs to be done on a large scale.

Charcoal burning

Charcoal making is most prevalent in Khasi Hills Zone, especially in West Khasi Hills and Ri-Bhoi districts. The Supreme Court has banned charcoal burning and its transportation in the state but it's still continuing. The state government had notified Meghalaya Charcoal (Control of Production, Storage, Trade and Transit) Rules, 2008 to prevent illegal charcoal production and trade and every charcoal producer and trader should be registered with the DFO (T). Banning on coal mining has also accelerated the charcoal burning as people associated with it lost their jobs and some of them have started charcoal making businessto earn their livelihood. Following measures are suggested to control charcoal burning and its adverse effects on forests.

- Although all charcoal trade is under the monitoring of DFO(T), strict surveillance of the network of raw material supply for charcoal making industries is required.
- Charcoal production from wood needs to be discouraged and bamboo charcoal production or production from wood waste of saw mills should be encouraged.
- Skill development of charcoal producers with modern technology and instrumentation is required to reduce waste.
- Illegal charcoal producers as well as large scale users should be identified. Charcoal industries need to be monitored and certified to check the uncontrolled destruction.

- Plantation of suitable bamboo species for charcoal making in open or degraded community and fallow lands will help in providing enough raw materials for charcoal production.

7.2.2. Strategies for Indirect drivers

Indirect drivers of deforestation are basically the underlying causes of direct drivers of deforestation. In the present study Poverty, increase in population, non- availability of alternatives coupled with unemployment and weak enforcement of forest laws and lack of awareness are found to be most important indirect drivers of deforestation in the state.

Increase in population

As discussed above Meghalaya is the fastest growing Indian state in terms of population and having a population growth rate of 29.94% during 2001-2011. Over population is directly related with the unemployment and lack of education. More population requires more fuelwood, more land for agriculture and settlement, which ultimately affects forests and causes deforestation. Overpopulation is also an underlying cause of wide spread poverty in the state. Following are the strategies, which can be adopted to control the population in Meghalaya:

- To control the population a series of awareness campaign on family planning and related matters is very much required.
- Capacity of and availability of maternity centers should be increased in rural areas. ASHA workers should be trained in family planning related issues.
- Availability of male and female contraceptives should be ensured with all local ASHA workers and nearby hospitals.

Poverty

Poverty is the major underlying cause of many direct drivers of deforestation. Wood collection and shifting cultivation are also induced by poverty. Reducing poverty of forest-dependent people through alternative livelihood support fulfils the dual objectives of improving the living standard of people and decreasing the pressure on forests. However,

any alternative livelihoods programme needs to be practical, applicable to local people, and approached with a well-formulated implementable business plan. The following strategies are suggested to reduce the deforestation arising due to poverty.

- Financial assistance should be provided to the forest based enterprises to create more employment opportunities in the forestry sector.
- Professional or technical trainings should be given to the economically poor and marginalized people under various skill development programmes.
- Various poverty eradication schemes of governmentshould be channelized to forest dependent communities to reduce the dependency on forest and to facilitate livelihood shift.
- Wildlife/ Eco-tourism related professional education and training should be started for local people to build their career as wildlife guides and Eco-tourism facilitators.
- Payment for ecosystem services (PES) mechanisms should be promoted to provide incentives to forest conservation. PES may prove to be a useful market instrument to conserve village forests especially sacred groves in Meghalaya.
- Skill development trainings/workshops should be started to train the poor families in bamboo and cane handicrafts making.
- Training on cultivation and harvesting of commercially important medicinal, aromatic, wild edible etc. plants should be provided to the farmers for enhancement of their livelihood.
- The participatory forest resource management plans should be prepared and practiced for sustainable utilization of forest resources.
- Investment in non-forestry sector employment programmes targeting rural areas should be promoted to reduce forest dependency.
- There should be well focused awareness programme to spread the knowledge about various governmental schemes on poverty alleviation.

Lack of Awareness

This is an important indirect driver that should be paid attention by the MCLLMP, possibly through an extension programme developed in association with the State Forest Department and forest departments of district councils. Creating awareness on forestry related problems and enhancing their capacity for forest management and conservation are required.Awareness programmes are required to address all direct or indirect drivers of deforestation, as without public participation nothing can be achieved in Meghalaya since majority of forest land is under community ownership. Awareness campaign should be organized as follows:

- Forest and environmental destructive traditions and cultural practices should be discouraged through awareness programmes.
- Training programmes on conservation, restoration and management of forest resources especially in shifting cultivation areas should be started.
- Sensitization programmes for students against the adverse effect of deforestation on health and environment should be started at school and college level.
- Plantation programmes should be started at block and village level, on important social occasions and celebrations.
- A mission such as plantation of one tree one family, one tree one person, one tree at the time of birth and death should be popularized or started.

Weak enforcement of forest laws and policies

As discussed above, Meghalaya is having a lot of Acts and policies related with forest resources management, but these Acts are found to be not so effective in achieving their objectives because of their weak enforcement. There are many reasons behind weak enforcement of laws and policies which include corruption, regulation of forests by two bodies, lack of sufficient staff, lack of use of modern tools and techniques, lack of awareness among the villagers and even in forest department officials about forest laws and policies etc. To handle these problems following steps need to be adopted:

- As suggested above forest departments of ADCs should be merged with the state forest departmentand people's committees and government should jointly manage non-private forests, as in other states. This will be a great help to ensure the implementation of forest laws and policies by the state forest department, besides providing employment to a large number of people.
- The laws and policies related to forest, wildlife and biodiversity conservation should be strictly enforced by increasing the capacity and capability of state forest department.
- Most of the forest laws and policies are incapable of addressing the present problems of forest management. These forest laws and policies need to be amended accordingly. For example provisions of penalties for illegal logging are insufficient in comparison to the potential gains from it.
- Integrated approaches between forest department, autonomous district councils, police department, central forces (in border areas or disputed areas) and village communities should be taken to control the forest crimes.
- Modern technologies like remote sensing & GIS, wood forensics, wildlife forensics etc. should be adopted to trace the type, intensity and gravity of crime.
- The field officials of forest department should have advance weapon and modern instruments to tackle the modern forest criminals.
- More watch and ward should be posted at the highly eco-sensitive areas and regular patrolling should be increased in such areas.
- Awareness programmes on forest laws and policies should be conducted for villagers as well as for forest department officials at division, block, range and village-level.

Lack of land use plans

In Meghalaya, due to complex land tenure system, land ownership, traditional belief and practices, topographical variation, cultural variations etc., proper land use planning is lacking. In many areas of state there is no clear distinction between government forest and private owned forest. The government owned forests have forest management plan but most of the council owned forest do not have any management plan. The shifting cultivation practices prevalent in Meghalaya are without proper planning which results in heavy destruction of forests. There should be an integrated sectoral planning, monitoring and evaluation of land use planning.

- The participatory approach must be adopted before formulating any land use plans.
- State land use plans in context with conservation of forest area should be strictly followed.
- As discussed earlier, a number of community conservation reserves have been declared in the state. More well established community forests should brought under this scheme and conserved. Financial and technical support to the community for maintaining these areas should be enhanced.
- Restoration plans for degraded sites like mining, eroded, disastrous, hazardous area should be formulated and strictly monitored.
- Practice of shifting cultivation need to be improved. Proper rotation and restoration plan should be prepared with appropriate scientific approaches at village level.

Categorization of strategies to control different direct and indirect drivers of Derforestation into short-term and long-term along with the suggested agencies for implementation of different measures in the Table 7.1.

Table 7.1: Long term and short term measures to control direct drivers of deforestation

S. N.	Long Term Measures	Short Term Measures	Agency required to take action
Wood Collection			
1.	Control of illegal wood collection especially in community managed forests	Increase watch and ward by recruitment of sufficient field staff	SFD/ADCs
		Increase watch and ward by creation of village forest protection volunteers	MCLLMP
		Use of modern tools and techniques like Remote Sensing/GIS, Drone based monitoring system etc to trace the location and cause of forest destruction.	SFD
2.	Plantation of indigenous fast growing species especially in home gardens, farmlands, Jhum lands, fallow lands, etc. to meet the increasing demand of wood.	Increase availability of saplings of indigenous fast growing species through establishment of new nurseries and upgradation of the existing one.	SFD/ADCs/ MCLLMP/ RFRI
		Plantation of indigenous fast growing species	Community
		Training on indigenous fast growing species	MCLLMP/ RFRI
3.	Promotion and use of energy efficient cooking devices along with the supply of alternative fuel like LPG	Increase availability of energy efficient cooking devices and alternative fuel in locality	Government
		Distribution of energy efficient cooking devices	MCLLMP
		Use of energy efficient cooking devices and alternative fuel	Community
		Awareness on energy efficient cooking devices, alternative fuel and ill effects of indoor pollution due to use of fuelwood	MCLLMP
4.	Promotion of use of seasoned/treated wood as well as composite wood to increase the life of wood products.	Training on seasoning and preservation of wood and bamboo	MCLLMP
		Provision of financial assistance to start small wood/bamboo treatment units in each district	Government
		Large amount of fuel-wood is needed for heating the bitumen used for road construction. The concerned authority should ensure	Government

		the application of bitumen heaters instead.	
Shifting Cultivation			
1.	Increase the productivity of shifting cultivation fields	Increase availability of seeds of high yieldingvarieties of indigenous crops	MCLLMP / Agri. Dept.
		Cultivation of high yieldingvarieties of indigenous crops	Communities
		Use of bio-fertilizers to increase the productivity	Communities
		Training on improved cultivation techniques and bio-fertilizers	MCLLMP / RFRI
2.	Annual monitoring programmes on shifting cultivation	Collection of ground based latest data on shifting cultivation	MCLLMP /SFDs/ADCs
		Satellite based periodic monitoring	RFRI/ FSI/ NESAC
		Preparation of annual monitoring plan	MCLLMP /SFD/ ADCs
3.	Transfer of technology from one tribe to another	Documentation of different improved technologies	MCLLMP / TISS
		Training of tribal communities	MCLLMP /RFRI/ TISS
4.	Development, promotion and practice of agroforestry models to enhance overall productivity	Documentation of improved agroforestry models	MCLLMP / RFRI/ AAU
		Promotion of improved agroforestry models	MCLLMP
		Practice of agroforestry models	Communities
5.	Marketing of products of shifting cultivation	Marketing skill development in local youth	MCLLMP
		Development of marketing strategies	MCLLMP
Settlement expansion			
1.	Control migration from rural area to urban area	Alternative sources of livelihoods in rural areas (Details are given separately)	Govt./ MCLLMP
2.	Improved housing development	Promotion of compact arrangements of new buildings in rural as well urban areas	Government
3.	Enforcement of strict land use planning	Development of land use plan for habitation	Government
		Awareness about land use planning	MCLLMP
Permanent farming			
1.	Discourage monoculture plantation on forest area	Promotion of tree crops should be in the form of agro forestry/ Mixed cropping	MCLLMP

2.		Series of awareness programmes on ill effects of monoculture on forest biodiversity and ecosystem services	MCLLMP
Road network expansion			
1.	Strict implementation of laws related to conversion of forest area into non forest area, or using forest land for non-forestry proposes		SFD
2.	Recommendation of EIA/ BIA/EMP reports should be strictly implemented and monitored		SPCB/SFD
3.	No expansion of road in dense forest areas and eco-sensitive zones		SFD
4.	Adoption of proper scientific methods to stabilize the slope while expanding the roads in hills		PWD/BRO
Mining			
1.	Control on Illegal mining activities	Increase monitoring by recruiting more field staff	SFD/ADC/Mining Dept. / Police
		Imposition of stricter penalties on defaulters	Govt.
		Alternative sources of livelihoods (Details are given separately)	MCLLMP /ADCs
2.	Restoration of degraded mining sites through forestry interventions	Assessment of potential of restoration of mining areas	Research organization (like RFRI and others)
		Development of site specific plan for restoration of degraded mining sites	Research organization (like RFRI and others)
		Restoration of degraded mining sites through forestry interventions	SFD/ADCs/ Mining agencies
		Awareness programme on conservation, restoration and management of forest resources	MCLLMP
Charcoal burning			
1.	Strict surveillance of the network of raw material supply for charcoal making industries	Registration and certification of charcoal producers and seller	SFD
		Channelizing the charcoal marketing	SFD
2.	Discourage of charcoal production from wood	Promotion of bamboo charcoal	MCLLMP
		Trainings on bamboo charcoal production	MCLLMP
		Plantation of suitable bamboo species for charcoal making in open or degraded community and fallow lands	Communities/ ADCs

		Large scale deforestation is caused due to making of charcoal that is utilized in the ferro alloy industry. The legality and mode of production of such industries should be periodically and strictly monitored	Government

Table 7.2: Long term and short term measures to control indirect drivers of deforestation

S. No.	Long Term Measures	Short Term Measures	Implementing agency(ies)
Increase in population			
1.	Control on population growth in the state	Series of awareness campaign on family planning and related matters	CLLMP
		Availability of male and female contraceptives should be ensured	Dept. of health
2.	Availability of better maternity facility in rural area	Increase in capacity of and availability of maternity facilities in rural areas	Dept. of health
		Training of ASHA workers on family planning related issues	Dept. of health
Poverty			
1.	Reducing poverty of forest-dependent people through alternative livelihood support	Financial assistance to the forest based enterprises to create more employment opportunities in the forestry sector	Government
		Professional or technical trainings to the economically poor and marginalized people	MCLLMP
		Training on cultivation and harvesting of commercially important medicinal, aromatic, wild edible etc. plants to the farmers	MCLLMP
2.	Development of ecotourism facility	Assessment of ecotourism potential of various landscape in the state	Research Organizations
		Financial assistance to local youth to develop ecotourism activities	Banking sector
		Training to local youth on ecotourism	MCLLMP
		Marketing of ecotourism sites of Meghalaya	MCLLMP, Tourism Dept.
3.	Investment in non-forestry sector employment programmes	Assessment of potential of non-forestry sector employment programmes	Dept. of Indutries
		Development of non-forestry sector income sources	Dept. of Indutries
Lack of Awareness			
1.	Training programmes on conservation, restoration and management of forest resources especially in shifting cultivation areas		MCLLMP
2.	Sensitization programmes for students against the adverse effect of deforestation on health and environment at school and college level		MCLLMP
3.	Plantation programmes at block and village level, on important social occasions and celebrations		SFD/ MCLLMP

Weak enforcement of forest laws and policies			
1.	Merger of forest depts. of ADCs with the state forest department	Studies on possibilities of merger of forest department of ADCs with state forest department	Research Organization
		Declaration of more community conservation areas	SFD
2.	Increase the capacity and capability of state forest department	Recruitment of sufficient field staff	SFD
		Training of existing field staff	SFD
		Use of advance weapon and modern instruments to tackle the modern forest criminals	SFD
3.	Amendment in forest laws and policies in Meghalaya as per modern requirement		SFD
4.	Awareness programmes on forest laws and policies		SFD/ MCLLMP
Lack of land use plans			
1.	Formulation of land use plans	Survey and assessment of various land uses	RFRI, NESAC, FSI, SRSC
		Digital mapping of land use	RFRI, NESAC, FSI, SRSC
	Establishment of Community Conservation Reserves	Inclusion of more community forests under CCR network	SFD/ADCs
		Financial and technical support to the community for maintaining the CCR	SFD

7.3 Alternate livelihood generation through forestry and other activities

7.3.1 Planted forests

It is the most common intervention for livelihood generation. Planted forest can be utilised for industrial production of timber, handicrafts, fuel, fibre, fodder, essential oil, rubber, charcoal, NTFP etc. and it can also be useful for the non-industrial purpose like restoration, recreation, shelter belt, landscaping, combating desertification and soil and water conservation. The planted forest can also be used as seed source to supply quality seeds to forestry nurseries.

Importance of planted forest

- It provides jobs to poor landless labourers at the time of plantation, maintenance and harvesting. The taxes and royalties in forestry sector can be generated through this activity which directly or indirectly creates job opportunity for the people.

- It supports other sectors like transport, power & energy, manufacturing & construction, tourism etc.
- It can generate income through export of forestry products like timber, fruits and essential oils, etc.
- The planted forests at degraded areas or in mine areas are helpful for restoration of soil quality which ultimate reduces the cost of fertilizers and secures financial resources.
- It has capability to bring development fund from national and international carbon markets under UN REDD+ programme or similar schemes.

Opportunities for Meghalaya:

Meghalaya is blessed with natural resources, favourable climatic conditions, high floral and faunal diversity, etc. About 30% area of the state is underutilized or unutilized (cultivable wasteland, fallow lands and current fallow). Therefore this area can be used to generate more income and planted forest is one of the best options for that. The people of Meghalaya can use certain specifictimber species (listed in Annexure 7.2) for plantation.

Steps to be taken for the success of planted forest

The success of plantation dependents upon proper planning and strategies, which start with site selection, in which, suitable soil quality, availability of water, terrain, connectivity etc. are required while selecting site. The second important step is to identify the suitable species for plantation which requires complete knowledge about local environment and vegetation, and the fast growing native species should be preferred for plantation. Quality of plantation depends upon quality seedling and therefore a nursery needs to be prepared for quality planting stock production under the supervision of skilled technical staff. Periodic tending operations are requiredto ensure desired quality and growth of plantation and therefore it needs to be done in time with modern tools and techniques. In case of any damage or casualty in plantation there should be gap filling or replacement options for damaged plants with new healthy plants before onset of monsoon. There should be periodical growth and health monitoring programme to get the desired yield. It has been reported that due to lack of proper harvesting tools and techniques there is loss of quality

and quantity of timber at the time of harvesting. Therefore to avoid such damages, appropriate scientific methods and tools should be used during harvesting.

7.3.2 Agro-forestry

Agroforestry is an integrated management system that integrates trees is an agriculture landscape for diversifying and increasing production. Agroforestry system has lots of potential to reduce poverty along with food security. It provides multiple alternatives to growers to enhance farm production and income along with productive and protective function to ecosystem. Agroforestry system practices includes land restoration, home gardens, alley cropping, multi-storey cropping, bund planting, woodlots, orchards, shelterbelts, fodder bank, live fencing etc.

Advantage of Agro-forestry system in income generation

- Allow product diversification which enhances profit within the limited resources.
- Provide long term and short term returns like tangible livelihood benefits like food, fodder, fuelwood, timber, fibres etc.
- Improve the environment condition for farming and reduce the cost of fertilisers, pesticides, irrigation etc.

Opportunities of Agro-forestry in Meghalaya:

Meghalaya has a diverse agro-climatic and geographical condition. It has a predominantly humid sub-tropical climate with hot, humid summer, severe monsoon and mild winter with altitudinal gradients which provides multiple opportunities for agriculture practices. Therefore practisesof Agroforestry in this region provide a big deal ofvariation in crop and helpful to generate or enhance the income of farmers. The people of Meghalaya can practice the following tested traditional agro-forestry systems (AFS) (Bhatt et. al., 2006):

1. **Khasi Mandarin-based agri-horticulture AFS:** In this system Groundnut, soybean, turmeric, ginger and taro are intercropped with the Mandarin (*Citrus reticulata*) at a density of 800 plants/ ha. The monetary benefit only through Mandarin will be 81.0%,

irrespective of crop species. Among various crops, ginger farming is the most beneficial, followed by soybean, groundnut, turmeric and taro, respectively.

2. **Guava (*Psidum guajava*) based agri-horticulture AFS:** In this system Groundnut, chilli, soybean, turmeric and ginger is intercropped with guava with plant density of 400/ha. The net profit under this system is estimated at about 15 % of the total input.
3. **Assam lemon (*Citrus lemon*) based agri-horticulture AFS:** In this system ginger, radish, turmeric and soybean is intercropped with *Citrus lemon* at a density of 400/ha. The net return will be the highest for Assam lemon+ ginger cultivation, followed by radish as intercrop.
4. **Multipurpose tree species (MPTS) based AFS:** Six indigenous multipurpose tree species i.e *Alnus nepalensis*, *Gmelina arborea*, *Michelia oblonga*, *Parkia roxburghii*, *Prunus cerasoides* and *Symingtonia populnea*can be planted at a density of 416 plants per ha along with soybean, Linseed, Pineapple, ginger, turmeric and taro. Ginger will bethe most profitable intercrop, followed by pineapple in the understory of MPTs.
5. **Som (*Machilus bombycina*) based AFS:** Som tree is suitable for rearing of Muga silkworm Maize and broom grass can be inter-cropped with it. The net profit will be about 65% to the total cost of input.
6. **Sericulture based AFS:** This is a commercial AFS owing to high returns in terms of monetary benefits. In this system seven mulberry varieties, seven silkworm breeds including a bivoltine breed are cultivated.
7. **Alder based multistoried AFS:** In this system multistoried approach with top storey of *Alnus nepalensis* and second storey of tea, large cardamom, turmeric, ginger, taro and black pepper is intercropped**.** The net profit will be about 72% to the total cost of input.

Beside, the above traditional agroforestry systems some other agroforestry systems which can also be adopted, as provided in Annexure 7.3.

7.3.3 Non wood forest products

These are the products other than wood, extracted from forest, plantation and tree outside forests. It includes fruits, mushrooms, edible nuts, spice and condiments, aromatic plants, gums, fibres& floss, resin and other plant and animal products (FAO, 1999). NWFPs play a

vital role in meeting the subsistence needs of large part of world's population residing around forests. NWFPs are also important interms of their potential to improve livelihoods through the sale of surplus.

Opportunities in NWFPs for Meghalaya

As per the published literature and studies conducted by various organisation and individual scientists following are the main areas of NWFPs where opportunities exist for livelihood generation.

Cultivation of Medicinal and Aromatic Plants

The demand of herbal and ayurvedic products has increased manifold. Due to the vast variation in climatic conditions in Meghalaya there is ample scope for cultivation of medicinal plants. The National Medicinal Plant Board has prioritized 121 medicinal plants in Meghalaya for their conservation and development (ICAR-KIRAN-EAKINE website). The species prioritization is based on different criteria such as (a) high trade value (b) prevalence in agro-climatic condition of state (c) having consistently high demand (d) possessing enough scope for value addition. Preference is given to those species which can grow in multi-tier plantation system. The list of top 50 prioritized species is given in Annexure 7.4.

Cultivation of commercially important wild edible plants

Wild edible species are important source of carbohydrate, protein, vitamins, minerals and antioxidants. It plays an important role in economy of tribal communities and forest dwellers. The state has ample scope of revenue generation from this sector. As per the published literature, the list of trees yielding commercially important edible material which can be cultivated in fallow as well as in agriculture lands is given in Annexure 7.5.

7.3.4 Cultivation of Bamboo

Bamboo species play a crucial role in village economy. It is used in building material, scaffolding, agriculture implements, basketry, furniture, food, medicines, charcoal etc. Besides serving domestic use, bamboo can also be cultivated commercially for industrial

use for production of paper, plywood, particle board and ethanol. About 35 species, 2 varieties and 11 genera were reported throughout the state. Out of this following 15 species are important for commercial purposes, as stated in Annexure 7.6.

7.3.5 Cultivation of Canes

Cane is a woody climber, commonly known as rattan. Meghalaya hasa wide range of canes.It ismainly found at the lower elevation having warm, moist climate. In Meghalaya, cane craft is a very important handicraft sector and various items. Furniture, basket ware, mats, *murrahs*, bows and arrows as well as other artistic and carved items are made up of cane. The important commercial species of cane which can be cultivated to generate income are enlisted in Annexure 7.7.

7.3.6 Cultivation of Broom grass

Broom grass (*Thysanolaena maxima*) is a tall perennial grass of family Poaceae. It is an important forest produce that grows well along hill side naturally in temperate and sub-tropical regions upto the 2000m elevation.It has a number of applications besides using the inflorescence of the plant as a broom; the leaves are used as fodder, sticks in the paper industries and small scale cottage industries for making mats. In Meghalaya cultivation of broom grass is very common and has potential for income generation.

7.3.7 Cultivation of Mushrooms

Mushrooms are the fruiting body of macro-fungi and are highly nutritive. Its farming can directly improve livelihood through economic, nutritional and medicinal contributions. It has a potential to improve the sustainability of small farming system by recycling of organic matter which can be used for soil quality improvement.In Meghalaya, climatic conditions and availability of resources are good for mushrooms production and have great opportunities for income generation. The list of mushrooms which can be used forincome generation is appended in Annexure 7.8.

7.3.8 Ecotourism

It is a type of tourism that includes visiting fragile, pristine, and relatively undisturbed natural areas, intended as a low-impact and often small scale alternative to standard commercial mass tourism. Nowadays, it is widely promoted as an important conservation tool and which impacts and changes the people's mindset against the destruction of nature and natural resources. It has a vast potential to improve public education on biological diversity, conserve wild habitats, and improve economic status. In Meghalaya, due to nature's endowment, rich cultural heritage and ethnological diversity there is a lot of scope for development of ecotourism.

Potential sites for Ecotourism in Meghalaya

In Meghalaya, there are many forest areas which can be good spots or site for ecotourism but some efforts are required to explore these sites for ecotourism. Already there are many sites which are identified for ecotourism in different zones (Pyngrope, 2013) but more can be explored through complete studies following available standards for ecotourism (Boyd and Butler, 1996). Following are the number of natural forests/sites which can be used for ecotourism in different zones.

Table: 7.3: Number of natural/forest sites under different categories which can be used for ecotourism.

S. No	Zones	Sacred groves	Community Reserve Forests	Reserve forests	National Park	Wildlife sanctuaries
1	Jaintia Hills	74	7	3	-	-
2	Garo Hills	16	19	16	2	2
3	Khasi Hills	3	15	5	-	1
	Total	105	41	24	2	3

A few good practices (international / national experience) already implemented in a few of the Himalayan or mountain states, where forests have improved by way of community efforts is also provided in Annexure 7.9

7.4 Role of Research organization in livelihood generation

Role of different research organization in livelihood generation with possible strategies is given below. A list of institutions that could provide support in establishing planted forests/ agroforestry models/ NWFP is appended in Annexure 7.10.

7.4.1 Development of Protocols or model

i. Preparation of nursery protocols for endangered commercially important species.
ii. Developing the site-suitable models for restoration of degraded sites
iii. Developing eco-friendly and economically effective agro-forestry models to enhance the land productivity
iv. Developing protocols for cultivation, harvesting and post harvesting techniques for commercially valuable, endangered species

7.4.2 Enhancement of productivity

i. Developing a modern tools and instruments for cultivation, harvesting and management of crops
ii. Preparing the package/strategies for improvement and management of productivity of land
iii. Working on value addition and improvement of shelf life of products.

7.4.3 Livelihood Sustainability

i. Identifying alternative areas for the livelihood generation.
ii. Preparation of scientific plans/strategies for the sustainable livelihood.
iii. Developing sustainable harvesting technologies.

7.4.4 Educate the society

i. Conducting workshops, training, seminar, meetings for technology transfer.
ii. Publishing paper, book, popular articles, pamphlets etc. to disseminate the research findings.
iii. Organizing the awareness programmes on various issues related to conservation, restoration, management of natural resources.

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ANNEXURE 1.1

Proximate and Underlying causes of Deforestation in tropical countries (after Geist and Lambin, 2001)

Proximate causes		
1. Agricultural expansion	i.	Shifting cultivation
	ii.	Permanent cultivation
	iii.	Colonisation, Transmigration, resettlement
2. Wood extraction	i.	Commercial wood extraction (Clear cutting, selective harvesting)
	ii.	Fuelwood extraction
	iii.	Polewood extraction
	iv.	Charcoal production
3. Infrastructure extension	i.	Transport
	ii.	Market
	iii.	Public services
	iv.	Settlement expansion
	v.	Private enterprise (Mining, Hydropower, oil exploration)
Underlying causes		
1. Economic factors	i.	Market Growth and Commercialization
	ii.	Specific economic structures
	iii.	Urbanization and Industrialization
	iv.	Special Economic parameters
2. Policy and institutional factors	i.	Formal polices
	ii.	Informal polices (policy climate)
	iii.	Property right regime
3. Technological factors	i.	Agro-technological change
	ii.	Technological application in the wood sector
	iii.	Other production factors in Agriculture
4. Cultural /socio-political factors	i.	Public attitudes, values, beliefs
	ii.	Individual and household behaviour
5. Demographic factors (Human Population dynamics)	i.	Population pressure
	ii.	Population growth
	iii.	Natural increment (fertility, mortality)
	iv.	Immigration
	v.	Population density
	vi.	Uneven spatial population density
	vii.	Life cycle features
Other Factors		
1. Land Characteristics (Biophysical environment)	i.	Soil quality
	ii.	Slope and topography related
	iii.	Water related

	iv.	Vegetation related
2. Biophysical drivers	i.	Soil related
	ii.	Water related
	iii.	Vegetation related
3. Social trigger events	i.	social and political unrest
	ii.	Health and economic crisis
	iii.	Abrupt population displacement
	iv.	Govt. Policy failure

ANNEXURE 2.1

Variation in Density of Population in Meghalaya (1951- 2011) – persons per km^2

State/District/ Zone	1951	1961	1971	1981	1991	2001	2011
District							
Jaiñtia Hills	17	21	30	41	58	78	103
East Khasi Hills	81	103	119	149	191	241	300
West Khasi Hills	13	17	21	31	42	56	73
East Garo Hills	24	30	39	52	73	96	122
West Garo Hills	48	62	67	82	108	140	175
Ri Bhoi	N.A	22	48	54	79	NA	106
South Garo Hills	N.A	N.A	27	34	42	55	76
Zone							
Khasi Hills	31	60	70	78	104	149	160
Garo Hills	36	46	53	67	90.5	118	149
Jaiñtia Hills	17	21	30	41	58	78	103
State							
Meghalaya	27	45	45	60	79	103	132

Sources: Census of India, 2001; Basic Statistics of North Eastern Region, 1981 and 2002. Note: Census of India, 2011)

ANNEXURE 2.2

Livestock Population 2012 Census and Growth Rate as compared to 2007 Census

S. No.	Species	Population (Numbers)			Total	Growth Rate (%)
1	Cattle	Crossbred	Male	5602	26458	-1.45
			Female	20856		
		Indigenous	Male	355705	879295	2.2
			Female	523590		
2	Buffalo	Indigenous	Male	16363	24894	10.02
			Female	8531		
3	Goat	Indigenous	Male	179502	472325	29.23
			Female	292823		
4	Pig	Exotic/ Crossbred	Male	72834	137984	96.68
			Female	65150		
		Indigenous	Male	224672	431317	-5.04
			Female	206645		
5	Sheep	Exotic/ Crossbred	Male	299	805	232.64
			Female	506		
		Indigenous	Male	7434	20186	-2.95
			Female	12752		
6	Poultry	Fowl	Improved	344157	3541716	25.84
			Desi	3197559		16.15
		Duck	Improved	514	22845	-93.56
			Desi	22331		-61.76
		Others	Turkey	498	498	2271.43
7	Dog	-	-	256972	256972	14.66

Source: http://megahvt.gov.in/livestockcensus.html

ANNEXURE 2.3

Wildlife of Meghalaya - At a glance

Wildlife Flora	
Category	**Species**
Orchids:	*Podocarpus neriifolia, Cyathea gigantea, Ilex khasiana, Balanophora dioca, Galeola falconeri, Epipogium roseum, Eulophia sanguine* etc.
Pteridophytes:	*Dipteris wallichii, Cyathea gigantean, Ilex embeloides, Styrax hookerii, Fissistigma verrucosum* etc.
Bryophytes:	*Bryum argenteum, B. medianum, B. caespiticium, B. coronatum, B. alpinum, B. porphyroneuron, B. paradoxum, Frullania udarii, Leptolejeunea subdentata* etc.
Wildlife Fauna	
Category	**Species**
Mammals	**Primates:** Western Hoolock Gibbon (*Hoolock hoolock*), Northern Pig-tailed Macaque (*Macaca leonina*), Stump-tailed Macaque (*Macaca arctoides*), Rhesus Macaque (*Macaca mulatta*), Assamese Macaque (*Macaca assamensis*), capped langur (*Trachypithecus pileatus*), and the Bengal Slow Loris (*Nycticebus bengalensis*).
	Carnivores: Leopard (*Panthera pardus*), clouded leopard (*Neofelis nebulosa*), the Asiatic black bear (*Selenarctos thibetanus),* the Malayan sun bear (*Helartos malayanus)*, Sloth bear (Meursus ursinus) Asiatic golden jackal (*Canis aureus*), Bengal fox (*Vulpes bengalensis*), Yellow throated Martin (*Martes flavigula flavigula*), Yellow bellied weasel (*Mustela kathiah*), Burmese Ferret Badger (*Melogale personata nipalensis*), Hog-Badger (*Arctonyx collaris*), Common Otter (*Lutra lutra monticola*), Smooth-coated Indian Otter (*Lutra perspicillata perspicillata*), Oriental small-clawed Otter (*Aonyx cinereus concolor*), Large Indian Civet (*Viverra zibetha zibetha*), Small Indian Civet (*Viverricula indica*), common Palm Civet (*Paradoxurus hermaphrodites*), Masked Palm Civet (*Paguma larvata neglecta*), Small Indian Mongoose (*Herpestes auropunctatus*), Indian Grey Mongoose (*Herpestes edwardsi*), Crab eating Mongoose (*Herpestes urva*), etc.
	Ungulates: Asiatic wild water buffalo (*Bubalus arnee*), Indian Gaur (*Bos gaurus*), Himalayan serow (*Capricornis thar*), sambar (*Rusa unicolor*), four horned antelope (*Tetracerus quadricornis*), barking deer (*Muntiacus muntjak*), wild pig (*Sus scrofa*), Chinese Pangolin (*Manis pentadactyla*), Indian Pangolin (*Manis crassicaudata*)
Aves	Oriental white-backed vulture (*Gyps bengalensis*), Slender-billed vulture (*Gyps tenuirostris*), White-winged duck (*Cairina scutulata*), Greater spotted eagle (*Aquila clanga*), Wood snipe (*Gallinago nemoricola*), Dark-rumped swift (*Apus acuticauda*), Rufous-necked hornbill (*Aceros nipalensis*), Tawny-breasted wren-babbler (*Spelaeornis longicaudatus*), Darter (*Anhinga melanogaster*), Lesser grey-headed fish-eagle, (*Ichthyophaga humilis*), Red-headed vulture (*Sarcogyps calvus*), White-cheeked hill-partridge (*Arborophila atrogularis*), Blyth's kingfisher (*Alcedo hercules*), Great pied hornbill (*Buceros bicornis*), Brown hornbill (*Anorrhinus tickelli*) etc.
Reptiles	**Snakes:**

	Diard's blindsnake (*Typhlops diardii*), Burmese python (*Python bivittatus*), Günther's reed snake (*Liopeltis frenatus*), Collared reed snake (*Calamaria pavimentata*), Light-barred kukri snake (*Oligodon albocinctus*), Cantor's kukri snake (*Oligodon cyclurus*), Theobald's kukri snake (*Oligodon theobaldi*), Günther's kukri snake (*Oligodon cinereus*), Blyth's reticulate snake, iridescent snake (*Blythia reticulata*), Twin spotted wolf snake (*Lycodon jara*), Wall's bronzeback (*Dendrelaphis cyanochloris*), Eastern Himalayan Bronze-brown Snake (*Dendrelaphis gorei*), Zaw's wolf snake, (*Lycodon zawi*), Collared black-headed snake (*Sibynophis collaris*), Gunther's whip snake (*Ahaetulla prasina*), Monocled cobra (*Naja kaouthia*), King cobra (*Ophiophagus hannah*), Mountain pit viper (*Ovophis monticola*), Jerdon's pit viper (*Protobothrops jerdonii*), Red-tailed bamboo pit viper (*Trimeresurus erythrurus*), White-lipped pit viper (*Trimeresurus albolabris*), Gumprecht's green pitviper (*Trimeresurus gumprechti*), Modest keelback (*Amphiesma modestum*) **Lizards:** Brooke's house gecko (*Hemidactylus brooki*), Tokay gecko (*Gekko gecko*), Assamese day gekko (*Cnemaspis assamensis*), Indo-Pacific gecko (*Hemidactylus garnoti*), Green fan-throated lizard (*Ptyctolaemus gularis*), Indo-Chinese forest lizard (*Calotes jerdoni*), Emma Gray's forest lizard (*Calotes emma*), Oriental garden lizard (*Calotes versicolor*), Khasi Hills forest lizard (*Calotes maria*), Small forest lizard (*Oriocalotes paulus*), Smooth-scaled mountain lizard (*Japalura planidorsata*), White-spotted supple skink (*Lygosoma albopunctata*), Indian forest skink (*Sphenomorphus indicus*), Stream-side skink (*Sphenomorphus maculatus*), Keeled Indian Mabuya (*Eutropis carinata*), Bronze mabuya (*Eutropis macularia*), Many-lined sun skink (*Eutropis multifasciata*), Khasi Hills long-tailed lizard (*Takydromus khasiensis*), Asian grass lizard (*Takydromus sexlineatus sexlineatus*), Burmese glass lizard (*Ophisaurus gracilis*), Bengal monitor (*Varanus bengalensis*), Water monitor (*Varanus salvator*), Yellow monitor or golden monitor (*Varanus flavescens*)
Turtle/ Tortoise	Asian forest tortoise (*Manouria emys*), elongated tortoise (*Indotestudo elongata*), the three striped roof turtle (*Batagur dhongoka*), Crowned river turtle (*Hardellathurjii*), the black spotted turtle (*Geoclemyshamiltonii*), The Indian roofed turtle (*Pangshuratecta*), Three-keeled Tortoise (*Melanochelystricarinata*), Peacock-marked soft shelled turtle (*Nilssoniahurum*) etc.
Amphibian	Himalayan Crocodile Salamander (*Tylototriton verrucosus*), Rock toad (*Bufoides meghalayanus* and *B. kempii*) etc.
Pisces	Nemacheiline loach (*Schistura papulifera*), *Neolissochilus hexagonolepis*,*Tor* spp. etc.
Invertebrates	*Brachionus mirabilis, Tripleuchlanis plicata, Lecane arcula, L. blachei, Sinantherina socialis, S. spinosa, Philodina citrine, Rotaria macroceros, Micraspis pusillus, Alaptus jowainus, Paraleptomenes darugiriensis, Gonatocerus jaintiacus, Berta apopemta* etc.

Source: BSAP (2004)

ANNEXURE 2.4

Tabular representation of the eight forest classes observed in Meghalaya

Sl. No.	Forest Type	Local Name	Size (in ha.)	Mnagement Institutions	Degree of protection	Access to forest resources	Shifting cultivation	Collection of timbers	Collection of NTFPs	Collection of fuelwood	Hunting	Grazing
1.	Raid forest	Law raid (Khasi)	35-50	Group of villages/ Council	Low	All	Allowed	Allowed	Allowed	Allowed	Prohibited	Allowed
2.	Village forest	Law shnong (Khasi)/ Khloo chnong (Jaintia)/ Songni borung (Garo)	20-27	Village Council	Low	All	Allowed	Allowed	Allowed	Allowed	Prohibited	Allowed
3.	Restricted forest	Law adong (Khasi)	4-10	Village Council	High	Prior permission	Prohibited	Prohibited	Allowed	Prohibited	Prohibited	Prohibited
4.	Sacred forest	Law kyntang (Kahsi)/ Khloo U Blai (Jaintia)/ Asong kusi (Garo)	1-100	Village Council	Very high	None	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
5.	Clan forest	Lak kur (Khasi)/ Khloo kur (Jaintia)	5-20	Clan Council	Very high	Clan members	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
6.	Cemetery forest	Law balang (Khasi)/ Khloo balang (Jaintia)	1-30	Church	High	All	Prohibited	Prohibited	Allowed	Prohibited	Allowed	Prohibited
7.	Regeneration forest	Champe (Garo)	3-5	Village Council	Very high	None	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
8.	Bamboo Reserve	Wa Grin (Garo)	10-15	Village Council	Low	All	Prohibited	Allowed	Allowed	Allowed	Prohibited	Allowed

Source: Tiwari et al., 2013

ANNEXURE 3.1

List of villages Surveyed in each zone of Meghalaya

Surveyed villages in Khasi Hills Zone

SN	Village	Longitude	Latitude
East Khasi Hills District			
1.	Iewrynghep	91° 58′ 59″ E	25° 22′ 53″ N
2.	Lawbah	91° 35′ 17″ E	25° 14′ 55″ N
3.	Rangsyuin	91° 49′ 21″ E	25° 29′ 17″ N
4.	Wahlhuh	91° 43′ 58″ E	25° 19′ 43″ N
5.	Delsora	91° 31′ 59″ E	25° 09′ 51″ N
6.	Dewsaw	91° 46′ 55″ E	25° 34′ 53″ N
7.	Dira	91° 44′ 38″ E	25° 31′ 51″ N
8.	Khwad	92° 00′ 51″ E	25° 23′ 05″ N
9.	Laitryngew (Dong Rngi)	91° 43′ 55″ E	25° 19′ 26″ N
10.	Langsymphut	91° 34′ 01″ E	25° 22′ 44″ N
11.	LytingLyngdoh	91° 56′ 16″ E	25° 19′ 36″ N
12.	Maweitnai	91° 49′ 04″ E	25° 29′ 57″ N
13.	Mawkhriah (West)	91° 47′ 15″ E	25° 30′ 48″ N
14.	Mawpynthaw	91° 54′ 45″ E	25° 29′ 35″ N
15.	Mawrasai	92° 00′ 31″ E	25° 20′ 24″ N
16.	MawrohrohTyrsad	91° 39′ 47″ E	25° 24′ 35″ N
17.	Pomlum (Raid Mawlieh)	91° 49′ 40″ E	25° 31′ 01″ N
18.	SohramLwai	91° 45′ 28″ E	25° 28′ 10″ N
19.	Sunei	91° 44′ 43″ E	25° 26′ 38″ N
20.	Thyllaw	91° 30′ 06″ E	25° 12′ 22″ N
21.	Umsaw	91° 34′ 43″ E	25° 51′ 27″ N
22.	Umtyngngar	91° 49′ 42″ E	25° 27′ 53″ N
West Khasi Hills District			
1.	Mawkhap	91° 35′ 04″ E	25° 36′ 20″ N
2.	Mawlumkohkhrang	91° 33′ 39″ E	25° 35′ 50″ N
3.	Mawphyrnai	91° 35′ 11″ E	25° 34′ 31″ N
4.	Mawsmai	91° 44′ 17″ E	25° 14′ 44″ N
5.	Wahra	91° 35′ 03″ E	25° 36′ 49″ N
6.	Mawlangdep	91° 11′ 48″ E	25° 34′ 25″ N
7.	Domkohsam	91° 23′ 50″ E	25° 31′ 15″ N
8.	Dommyntong	91° 23′ 45″ E	25° 27′ 45″ N
9.	Kynsew	91° 41′ 21″ E	25° 33′ 04″ N
10.	MawkaiangLangdain	91° 21′ 20″ E	25° 29′ 11″ N
11.	Mawkyllei	91° 31′ 47″ E	25° 28′ 09″ N
12.	Mawkynrum	91° 26′ 11″ E	25° 30′ 57″ N
13.	MawlumNginiong	91° 25′ 40″ E	25° 34′ 19″ N
14.	Nongspung	91° 36′ 15″ E	25° 27′ 02″ N
South West Khasi Hills District			
1.	Domsohkhai	91° 21′ 23″ E	25° 16′ 48″ N
2.	Khangkhlak	91° 16′ 04″ E	25° 13′ 48″ N
3.	Mawphuli	91° 17′ 18″ E	25° 15′ 28″ N

4.	Nongdewsaw	91° 21′ 34″ E	25° 17′ 39″ N
5.	Ranikor	91° 14′ 21″ E	25° 13′ 24″ N
6.	Trongpleng	91° 23′ 08″ E	25° 15′ 36″ N
7.	Umjarain	91° 32′ 07″ E	25° 24′ 21″ N
Ri Bhoi District			
1.	Amdubighat	92° 15′ 46″ E	26° 03′ 33″ N
2.	Bilpara	91° 29′ 16″ E	25° 52′ 39″ N
3.	Mawker	92° 10′ 46″ E	25° 58′ 40″ N
4.	Narang	91° 50′ 52″ E	25° 58′ 39″ N
5.	Pahamjri	91° 59′ 44″ E	25° 58′ 17″ N
6.	UmkremDyngkhong	91° 32′ 56″ E	25° 56′ 21″ N

Surveyed villages in Garo Hills Zone

SN	Village	Longitude	Latitude
West Garo Hills District			
1.	Gambegre	90° 12′ 04″ E	25° 26′ 06″ N
2.	Genapara	90° 01′ 33″ E	25° 19′ 50″ N
3.	Lower Darengre	90° 16′ 52″ E	25° 29′ 17″ N
4.	Moropgre	90° 12′ 36″ E	25° 22′ 11″ N
5.	TebronggreSongma	90° 20′ 24″ E	25° 48′ 47″ N
6.	Chibragre	90° 13′ 40″ E	25° 34′ 58″ N
7.	Edenbari	90° 11′ 55″ E	25° 33′ 26″ N
8.	Masumatagre	90° 15′ 44″ E	25° 32′ 52″ N
9.	Pagugre	90° 14′ 10″ E	25° 35′ 15″ N
10.	Badupara	90° 09′ 07″ E	25° 24′ 07″ N
11.	Dangsapara	90° 14′ 24″ E	25° 27′ 36″ N
12.	Lower Adingre	90° 39′ 07″ E	25° 17′ 09″ N
13.	Rongmasugre	90° 18′ 36″ E	25° 47′ 24″ N
14.	Watregre	90° 25′ 19″ E	25° 42′ 00″ N
East Garo Hills District			
1.	Raksingre	90° 32′ 38″ E	25° 28′ 35″ N
2.	Gaoram	90° 52′ 55″ E	25° 41′ 13″ N
3.	Nengkra Awe-1	90° 44′ 49″ E	25° 31′ 44″ N
4.	Rongonggre	90° 38′ 20″ E	25° 31′ 04″ N
5.	BolmoronAngkekolgre	90° 43′ 08″ E	25° 36′ 50″ N
6.	New Ameran	90° 50′ 38″ E	25° 53′ 16″ N
7.	DagalChiwate	90° 43′ 08″ E	25° 48′ 07″ N
South West Garo Hills District			
1.	Badupara	90° 09′ 01″ E	25° 24′ 08″ N
2.	Bildoba	89° 56′ 57″ E	25° 20′ 54″ N
3.	Dinangpara	89° 54′ 45″ E	25° 27′ 25″ N
4.	Marahalipara	89° 58′ 07″ E	25° 24′ 07″ N
5.	Parengpara	89° 58′ 20″ E	25° 30′ 10″ N
6.	Wadagre	90° 10′ 04″ E	25° 34′ 23″ N
South Garo Hills District			
1.	ChambilBadimagre	90° 34′ 31″ E	25° 12′ 04″ N

2.	DabitAmpangdam	90° 38′ 31″ E	25° 13′ 48″ N
3.	Mindikgre	90° 34′ 14″ E	25° 16′ 43″ N
4.	Nadangkolj	90° 50′ 21″ E	25° 11′ 40″ N
5.	RongdiAdinggre	90° 21′ 00″ E	25° 27′ 00″ N
6.	Chidabetgre	90°31' 11" E	25° 16' 26" N
7.	Karawengre	90° 22' 37" E	25° 13' 28" N
8.	Telekali	90° 22' 56" E	25° 13' 34" N
9.	Wage Chirang	90° 45' 44" E	25° 12' 10" N
North Garo Hills District			
1.	Soenang Aga	90° 41′ 24″ E	25° 53′ 24″ N
2.	lower Kharkutta	90° 54′ 00″ E	25° 56′ 16″ N
3.	RajasimlaMongsi	90° 56′ 13″ E	25° 55′ 19″ N

Surveyed villages in Jaintia Hills Zone

SN	Village	Longitude	Latitude
East Jaintia Hills District			
1.	Larket	92°37′ 35″E	25°22′ 28″ N
2.	Mynthning	92°36′ 45″E	25°23′ 32″ N
3.	Samasi	92° 33′ 59″E	25°24′ 45″ N
4.	Umkyrpong	92° 34′ 42″ E	25°25′ 44″ N
5.	Lum Bangla	92° 39′ 56″ E	25°18′ 56″ N
6.	Deinsatlang	92° 18′ 35″ E	25°16′ 45″ N
7.	Lelad	92° 32′ 06″ E	25°17′ 58″ N
8.	Rymbai	92° 19′ 30″ E	25°20′ 00″ N
9.	Shnongrim	92° 30′ 57″ E	25°21′ 04″ N
10.	Tangnub	92° 32′ 01″ E	25°16′ 47″ N
11.	Umsatai	92° 19′ 11″ E	25°16′ 58″ N
West Jaintia Hills District			
1.	Khliehrangnah	92° 25′ 14″ E	25° 27′ 22″ N
2.	Mynska	92° 26′ 39″ E	25° 27′ 15″ N
3.	Phramer	92° 17′ 34″ E	25° 27′ 57″ N
4.	Shangpungkhliehmushut	92° 21′ 56″ E	25° 27′ 06″ N
5.	Shangpungpohchnong	92° 20′ 57″ E	25° 28′ 58″ N
6.	Ionglwit	92° 15′ 26″ E	25° 33′ 15″ N
7.	Larnai	92° 09′ 29″ E	25° 32′ 56″ N
8.	Lumsharatoh	92° 08′ 36″ E	25° 31′ 31″ N
9.	Lumtrep	92° 17′ 58″ E	25° 32′ 40″ N
10.	Mookaswan	92° 15′ 57″ E	25° 28′ 37″ N
11.	Moolephaw	92° 17′ 52″ E	25° 33′ 13″ N
12.	Moopasi	92° 14′ 45″ E	25° 30′ 44″ N
13.	Nongjngikhliehshnong	92° 16′ 18″ E	25° 32′ 57″ N
14.	Samanong	92° 08′ 31″ E	25° 22′ 06″ N
15.	Sohmynting	92° 08′ 34″ E	25° 26′ 19″ N
16.	Tyrshang	92° 09′ 12″ E	25° 31′ 51″ N
17.	Amlarem	92° 07′ 10″ E	25° 17′ 11″ N
18.	Jarain	92° 09′ 00″ E	25° 22′ 49″ N

SN	Village	Longitude	Latitude
19.	Madantyrpait	92° 08′ 57″ E	25° 20′ 30″ N
20.	Maskut	92° 07′ 12″ E	25° 31′ 01″ N
21.	Modymmai	92° 07′ 51″ E	25° 31′ 42″ N
22.	Mookyndur	92° 07′ 16″ E	25° 29′ 56″ N
23.	Moosakhia	92° 07′ 31″ E	25° 22′ 25″ N
24.	Mukhlasohshrieh	92° 10′ 30″ E	25° 29′ 15″ N
25.	Phlongingkhaw	92° 07′ 58″ E	25° 24′ 50″ N
26.	Shkenpyrsit	92° 08′ 56″ E	25° 20′ 09″ N
27.	Shkentalang	92° 08′ 34″ E	25° 19′ 34″ N
28.	Tongseng	92° 22′ 54″ E	25° 08′ 27″ N
29.	Umladkhur	92° 10′ 25″ E	25° 18′ 03″ N
30.	Ummulong	92° 09′ 23″ E	25° 30′ 57″ N
31.	Umsalang	92° 23′ 59″ E	25° 35′ 40″ N

ANNEXURE 3.2

S.No._____ Date:_____
Time: _____

Rain Forest Research Institute (ICFRE), Jorhat, Assam

QUESTIONNAIRE: IDENTIFICATION OF DRIVERS OF DEFORESTATION IN MEGHALAYA

(I) Household Level Information

Zone	Khasi Hills	Garo Hills	Jaintia Hills
Questionnaire No.			

❖ **GENERAL INFORMATION**

Date of Survey	Name of Village	Name of District

❖ **SOCIO-ECONOMIC INFORMATION**

1. Name of Respondent: _____Age:_____
2. Occupation: _____ Contact no:_____
3. Name of Head of household: _____Relation with Respondent: _____
4. Type of house (√): Kachcha Semi Pucca Pucca
5. Type of family (√): Nuclear Joint
6. No. of family members : Male_____ Female_____ Children _____ Total_____
7. (i). Religion: _____ (ii). Tribe/Caste_____
8. Average monthly income of family (Rs): Less than 2,500 2,500-5,000
   5,000-10,000 10,000-15,000 15,000-20,000 20,000-30,000 30,000or above
9. Household Accessories(√): TV Refrigerator Mobile/phone Car
   Tractor Scooter/bike Others
10. Energy sources (√): (for cooking and heating) L.P.G. Electricity Charcoal Coal
    Fuel wood Kerosene Biogas Others
11. What is the primary livelihood activity of your household?(√)
    Shifting Cultivation Terrace Cultivation Other agriculture Wage labour _____
    Forest Products Mining_____ Business Service_____ Others
12. Livestock profile (Nos):
    (i) Cow___ (ii) Buffalo___(iii) Bulls___ (iv) Goats___ (v) Pigs___ (vi) Hen/ducks___ (vii) Others____

INFORMATION ON DRIVERS

B: Awareness of community on deforestation (√)

1. Do you know about the effects of deforestation? Yes No
2. How do you perceive the deforestation? Good Bad Can't say
3. Is the community involved in managing the forest? Yes No
4. Are there any activities which you do in conservation of forest? Yes No

   If yes, what are they……..

❖ **AGRICULTURAL EXPANSION**

1. **What is the traditional means of Agriculture followed by your family:**

   Shifting Cultivation Terrace Cultivation Other agriculture Others

2. **If Shifting Cultivation, what is the total area:**

   Current Jhum- <1 ha 1-5 ha 5-10 ha 10-20 ha >20 ha

   ***Jhum*fallow -** <1 ha 1-5 ha 5-10 ha 10-20 ha >20 ha

3. **Major crops**: 1. ....., 2. ....., 3. .....,

   4. ....., 5. ....., 6. .....

4. **Involvement in Shifting Cultivation (No. of male/female out of total):**

   Male_____/_____ Female_____/_____ Children_____/_____ hired Labour_____

5. **Whether Shifting Cultivation area has increased or decreased during the last ten years:**

   Increased Decreased steady cannot say

6. **Jhuming cycle followed now :**

   <3 years 3-5 years 5-10 years >10 years

7. **Jhuming cycle followed earlier (before 10 years) :**

   <3 years 3-5 years 5-10 years >10 years

8. **Jhuming cycle followed earlier (before 20 or more years):**

   <3 years 3-5 years 5-10 years >10 years

9. **Conversion of shifting cultivation to any other land use, if any:**

   Terrace Plantation _____Horticulture_____Others _____

   a. **If yes, for how long :**

   <3 years 3-5 years 5-10 years >10 years

   b. **If yes, what is the total area:**

   <1 ha 1-10 ha 10-50 ha >50 ha

   c. **Major crops**: 1. ....., 2. ....., 3. .....,

   4. ....., 5. ....., 6. .....

   d. **Involvement in Cultivation (No. of male/female out of total):**

   Male_____/_____ Female_____/_____ Children_____/_____ hired Labour_____

- **BIOMASS EXTRACTION**

1. Fuel wood consumption ……. kg/month		
3. Source of Fuel Wood in percentage (%):		
Source of Fuel Wood	Percentage (%)	Collected By (M/F/Both)
(i) Forest		
(ii) Jhum land		
(iii) Ag Land		
(iii) Purchase		

2. Fuel wood sale …….. kg/month		
4. Source of fodder in percentage (%):		
Source of Fodder	Percentage (%)	Collected By (M/F/Both)
(i) Forest		
(ii) Jhum land		
(iii) Ag Land		
(iii) Purchase		

5. Use of Timber

Purpose	**Quantity Kg/year**	**Species**	**Source**
Housing			
Sell			
_____			

6. Use of Bamboos

Purpose	**Quantity pole/year**	**Species**	**Source**
Housing			
Boundary			
Bamboo shoots	**Kg/year**		
_____			

7. Dependence on forests(√)

S. N.	**Type of land**	**Wood Products**			**Non-wood products**							
		Fuel wood	Timber (for housing)	Small timber	Fruits	Seeds	Veget-able	Fodder	Bark	Green manure	Medicine	Others
1.	**Nearby forests**											
2	**Jhum lands**											
3	**Patch vegetation**											
4	**Trees in Ag land**											
5	**Roadside plantations**											
6.	**Scattered trees**											
7.	**Other**											

8. Do you use charcoal, If yes, what is the daily consumption:……kg

9. What is the source: Homemade purchase Other

10. Do you have any charcoal production unit, if yes, what is the monthly production (kg):

11. Do you sell charcoal, if yes, what is the amount (kg/ month) and at what rate (Rs/kg):

12. Plants used and source: 1. ……

2. ……,……,……

3. ……,……

❖ **RANKING OF THE DRIVERS OF DEFORESTATION IN NEARBY FORESTS:**

(Scale from 1 to 8, with 1 being the most severe and 8 the least severe)

DIRECT DRIVERS	Ranking	INDIRECT DRIVERS	Ranking
Shifting cultivation		Poverty	
Permanent farming		Less awareness	
Wood collection		Increase in population	
Road network development		Weak forest law enforcement	
Settlement expansion		Lack of employment	
Charcoal making		Promotion of Agriculture	
Mining		Non-availability of alternatives	
Others		Others	

❖ **OTHER ISSUES:**

1. **Do you think NTFPs collected for your daily consumption is sufficient: yes/ No**

2. **If not, what should be done for that:**

3. **What kind of community intervention you want for stopping deforestation in your area**

4. **What kind of Govt. intervention you want for stopping deforestation in your area**

Sign.of investigators

ANNEXURE 3.3

S. No._____ Date:_____
Time: _____

Rain Forest Research Institute (ICFRE), Jorhat, Assam

QUESTIONNAIRE: IDENTIFICATION OF DRIVERS OF DEFORESTATION IN MEGHALAYA

(I) Village Level Information

GENERAL INFORAMATION

1. Name of the Village: _____ Name of the Panchayat: _____

2. (i). Name of District_____ (ii). Name of Forest Division_____

	Latitude(dd/mm/ss)	**Longitude**(dd/mm/ss)	**Altitude** (m)
GPS Data			

3. Infrastructure facilities (√): Primary School Sec. School College Post Office

Bank PHC Panchayat House Others (Please specify) _____

4. Distance From Nearest Town (Km.): Less than 1 1 to 2 2 to 3 3 to 4 4 to 5

5. (a). House hold type (#): Total_____ (i) Kaccha _____ (ii) Semi Pacca _____ (iii) Pacca_____

(b). No. of house increased: in last 10 years _____ , In last 5 years _____ , In last 2 years _____

6. Is the village electrified? (√): Yes No if yes, no. of household having electricityfacility (#):_____

7. Drinking water (√): Tap water Hand Pumps River Others_____

8. Village population(#): (i) Male_____ (ii) Female_____ (iii) Total_____

9. Occupational Status(#): (i) Agriculture _____ (ii) Cattle rearing _____ (iii) Govt. Service_____

(v) Business _____ (iv) Private Service _____ (vi) Labour _____

10. Land availability of farmers(#): (i) Landless farmer _____ (ii) Land between less than 7.5 bigha _____

(iii) Land between 7.5 to 15 bigha _____ (iv) Land greater than 15 bigha _____

11. Literacy (#): (i) Male _____ (ii) Female _____ (iii) Total _____

12. Source of Fuel wood(√): Forest Agriculture Wasteland Others _____

13. Live stock (#): (i) Cow _____ (ii) Buffalo _____ (iii) Goat _____ (iv) Bulls _____ (v) Sheep _____

(vii) pig _____ (viii) Horse_____ (ix) Donkey_____ (x) Mule _____ (xi) Others _____

14. Source of Fodder (√): Forest Agriculture Wasteland Others_____

15. Irrigation Facility (√): Rain Tube Well Canal Pond Others_____

16. Status of Water resources (√): 1. Water Table: No Change Increasing Decreasing

2. Water Bodies: No Change Increasing Decreasing

3. Available of water in water bodies for (#)_____ months

(#) = Give the Numbers, **(√)** = Put the Tick Mark

DRIVERS OF DEFORESTATION RELATED INFORMATION

17. Formation of JFMC in the village: Yes No

    a. If yes, year of formation:_____, Number of members (#)_____

    b. Status of the JFMC in the village: Functioning well defunct for namesake

    c. Area allotted to JFMC_____, Total Plantation done till date _____ha.

18. Availability of village/community forest: Yes No

    a. If yes, what is the area _____ha. b. Distance from the village _____km.

    c. Current status Dense Moderately dense Open Degraded

19. Is any sacred groove available with the villages Yes No

    a. If yes, Area of sacred grove _____ha., b. Distance from the village _____km

    c. Reason of sacredness_____

    d. Conservation mechanism of sacred grove_____

    _____

    _____

20. Status of density forest/sacred grove in last 10 years: No Change Increasing Decreasing

21. Status of Area forest/sacred grove in last 10 years: No Change Increasing Decreasing

    a. If decreasing, What are the reasons behind:_____

    _____

    _____

    b. Is there any social and cultural programmes related to the forest and wildlife: Yes No

    If yes,

S. No.	Name of programme	Duration	Role of forest/wildlife

c. Is there, any mining activities in and around the village: Yes No

    d. If yes, type of mining: Coal Sand Stone Others _____

    e. Location of mining sites: : Forest Community land Private Others_____

    f. Methods of mining: Open Cast Rat hole Digging small pockets Others_____

    g. Area of mining affected land _____ha.

    h. No. of families involved (#) _____ No. of persons involved (#) _____

d. information_____

_____

Sign of investigator

ANNEXURE 3.4

List of villages selected for Ecological Survey in each zone of Meghalaya

District	Village name	FirstQuadrats		Middle Quadrats		Last Quadrats	
		Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
Khasi HillsZone							
East Khasi Hills	Lawbah	25°14′09.1”	91°34′04.0”	25°15′03.1”	91°34′05.0”	25°14′03.5”	91°34′17.4”
West Khasi Hills	Mawkyllei	25°28′35.1”	91°31′29.8”	25°28′40.1”	91°31′29.3”	25°28′44.5”	91°31′32.8”
South West Khasi Hills	Umjarain	25°24′14.1”	91°32′11.6”	25°24′07.1”	91°32′11.3”	25°23′58.5”	91°32′10.4”
Ri-Bhi	Narang	25°59′03.9”	91°50′58.4”	25°58′59.8”	91°50′56.0”	25°58′54.6”	91°50′57.4”
Jaintia Hills Zone							
West Jaintia Hills	Maskut	25°33′00.6”	90°06′50.3”	25°33′00.1”	90°07′01.2”	25°32′65.2”	90°07′01.7”
	Phlonging Khaw	25°28′25.3”	90°07′42.0”	25°28′23.4”	90°07′31.2”	25°28′17.1”	90°07′19.0”
East Jaintia Hills	Umsatai	25°17′40.3”	90°18′57.2”	25°17′57.1”	90°19′11.2”	25°18′10.3”	90°19′23.9”
	Deinsatlang	25°16′33.6”	90°18′54.7”	25°16′24.5”	90°18′54.8”	25°16′25.4”	90°18′54.9”
Garo Hills Zone							
East Garo Hills	Nengkra	25°30′31.7”	90°41′27.0”	25°31′17.3”	90°41′29.9”	25°31′13.8”	90°41′24.43”
West Garo Hills	Rongronggree	25°27′55.0”	90°13′43.0”	25°27′59.7”	90°13′46.8”	25°28′05.8”	90°13′56.2”
North Garo Hills	Kharkutta	25°55′25”	90°54’08”	25°55’25”	90°54’11”	25°55′22”	90°54′14”
South Garo Hills	Rongdi Adinggre	25°24’38.8”	90°18’20.3”	25°24’40.8”	90°18’22.5”	25°24′41.6”	90°18′23.5”
South West Garo Hills	Ronchadenggre	25°32’12.1”	90°04’21.9”	25°32’30.1”	90°04’43.0”	25°32′18.1”	90°04′48.9”

ANNEXURE 4.1

Forest types of Meghalaya (Chauhan and Singh, 1992)

Sl. No.	Forest Type	Altitude	Species composition
1.	Tropical forest	Upto 1000	*Acrocarpus froxinifolius, Bischofia javanica, Dillenia indica, D. pentagyna, Dysoxylum binectariferum, Elaeocarpus floribundus, E. robusta, E. rugosus, Gynocardia odorata, Lannea coromandelica, Lithocarpus fenestratus, Mesua ferrea, Sapium baccatum, Terminalia* spp.*, Vitex penduncularis, Antidesma acuminata, Aporusa dioica, Dalbergia assamica, Ficus racemosa, Garcinia* spp.*, Heritiera macrophylla, Mangifera sylvatica, Pterospermum lanceifolium, Sterculia* spp.*, Alchornea tiliaefolia, Antidesma buniuis, Gregia disperma, Premna barbata*
2.	Sub- tropical forest	Between 1000 and 1350	*Alcimandra cathcartii, Betula alnoides, Castanopsis* sp.*, Lithocarpus elegans, Manglietia insignis, Talauma phellocarpa, Vitex* spp.*, Adina cordifolia, Daphne involucrata, Ehretia acuminata, Garuga pinnata, Milletia prainii, Symplocos ferrunginea, Syzygium macrocarpus, Pinus kesiya, Acacia dealbata, Elaeocarpus lancifolius, Erythrinaarborescens, Quercus griffithii, Schima wallichii, S. khasiana.*
3.	Temperate forest	Above 1350	*Castanopsis kurzii, C. armata, Elaeocarpus prunifolius, Ficus nemorlis, Lithocarpus fenestratus, Myrica esculenta, Manglietia insignis, Eurya japonica, Schima wallichi*

ANNEXURE 4.2

Notified Community Reserves in Meghalaya (WII, 2017)

S.N	Name	Year of Estd.	Area (km^2)	District	Physiographic Zone
1	Ka Khloo Thangbru Umsymphu	2014	0.196	East Jaintia Hills	Jaintia Hills
2	Ka Khloo Pohblai Mooshutia	2014	0.335	East Jaintia Hills	
3	Ka Khloo Langdoh Kur Pyrtuh	2014	0.154	West Jaintia Hills	
4	Khloo Blai Sein Raij Tuber	2014	0.965	West Jaintia Hills	
5	Khloo Blai Kongwasan Khloo Blai Chyrmang	2014	0.07	West Jaintia Hills	
6	Khloo Amrawan	2015	1.29	West Jaintia Hills	
7	Khloo Blai Ka Raij U Landoh longlang	2016	0.15	West Jaintia Hills	
8	Mandalgre Community Reserve	2013	0.5	East Garo Hills	Garo Hills
9	Daribokgre Community Reserve	2013	1.73	East Garo Hills	
10	Dura Kalkgre Community Reserve	2013	0.6	East Garo Hills	
11	Dumitdikgre Community Reserve	2013	0.7	West Garo Hills	
12	Sakalgre Community Reserve	2013	1.22	West Garo Hills	
13	Sasatgre Community Reserve	2013	0.6	West Garo Hills	
14	Selbalgre Community Reserve	2013	0.2	West Garo Hills	
15	Chandigre Community Reserve	2013	0.37	West Garo Hills	
16	Baladingre Community Reserve	2013	0.5	West Garo Hills	
17	Mongalgre Community Reserve	2014	0.2	West Garo Hills	
18	Aruakgre Community Reserve	2014	1.0	North Garo Hills	
19	Resu Haluapra Community Reserve	2014	0.5	North Garo Hills	
20	Kitmadamgre Community Reserve	2014	0.7	North Garo Hills	
21	Rongma Paromgre Community Reserve	2013	0.62	South Garo Hills	
22	Rongma Rekmangre Community Reserve	2013	1.92	South Garo Hills	
23	Eman Asakgre Community Reserve	2013	0.30	South Garo Hills	
24	Bandarigre Community Reserve	2013	0.67	South Garo Hills	
25	Mikadogre Community Reserve	2013	0.01	South Garo Hills	
26	Dangkipara Community Reserve	2014	0.025	South Garo Hills	
27	Raid Nongbri Community Reserve	2014	0.7	Ri-bhoi	Khasi Hils
28	Lum Jusong Community Reserve	2014	0.7	Ri-bhoi	
29	Jirang Community Reserve	2014	2.0	Ri-bhoi	
30	Raid Nonglyngdoh/Pdah Kyndeng Community Reserve	2014	0.75	Ri-bhoi	
31	Nongsangu Community Reserve	2014	1.0	Ri-bhoi	
32	Nongumiang Community Reserve	2003	0.31	West Khasi Hills	
33	Kpoh Eijah Community Reserve	2014	0.17	West Khasi Hills	
34	Miewsyiar Community Reserve	2014	0.87	West Khasi Hills	
35	Phudja-ud Community Reserve	2014	1.2	South WestKhasiHills	
36	Umsum Pitcher Plant Community Reserve	2014	0.4	South WestKhasiHills	
37	Lumkohkriah Community Reserve	2014	6.11	West KhasiHills	
38	Lawbah Community Reserve	2014	2.1	East Khasi Hills	
39	Ryngibah Community Reserve	2014	0.8	East Khasi Hills	
40	Ryngud Community Reserve	2014	5.22	East Khasi Hills	
41	Thangkharang Community Reserve	2014	1.11	East Khasi Hills	
		Total Area (km^2)			38.89

ANNEXURE 4.3

List of Sacred Groves in Meghalaya (BSAP, 2004)

Sl.No.	Name	Location	Area (Hectares)
Khasi Hills Zone			
District - East Khasi Hills:			
1.	Diengkain	Umwai	400
2.	Dienglengbah	Rngiksheh	0.50
3.	Ingkhrum	Cherrapunji	0.25
4.	Ingkhrum	Cherrapunji	0.25
5.	Kharai Law Lyngdoh	Nongkhieng	150
6.	Khlaw Ram Jadong	Mawsmai	50
7.	Kynsang	Mawlong	150
8.	Law Adong	Mawsmai	400
9.	Law Adong Laitryngkew	Laitryngkew	20
10.	Law Adong, Khlieh Shnong	Cherrapunji	90
11.	Law Blei Beh	Mawsmai	120
12.	Law Dymmiew	Sohrarim	200
13.	Law Kyntang, Khlieh Shnong	Cherrapunji	90
14.	Law Lieng	Sohrarim	20
15.	Law Lyngdoh	Mawphlang	75
16.	Law Lyngdoh Lyting Lyngdoh	Lyntilew	100
17.	Law Lyngdoh Mawshun	Mawshun	100
18.	Law Lyngdoh, Smit	Nongkrem	6
19.	Law Mawsaptur	Sohrarim	50
20.	Law Nongshim	Mawmihthied	5
21.	Law Suidnoh	Lait-Ryngew	80
22.	Law-ar-Liang	Lait-Ryngew	25
23.	Lawthymmal	Cherrapunji	2
24.	Law–u-Niang	Lait-Ryngew	10
25.	Lum Diengjri	Khada Snoing	25
26.	Lum Shillong	Laitkor	7
27.	Madan Jadu	Lait-Ryngew	5
28.	Maw Kyrngah	Umwai	1200
29.	Mawlong Syiem	Mawsmai	120
30.	Mawlot	Phyllut	20
31.	Raid Shabong Law Adong	Wahpathew-urksew in Pynursla	700
32.	Niangdoh	Wahlong	0.0
33.	Mawmang	-	15
34.	Mawryot	Wahlong	40
35.	Mawsawa	Mawmluh	50
36.	Mawthoh	Umwai	30
37.	Nongbri	Pyndeng-Nongbri	5
38.	Pohsurok	Cherrapunji	0.50
39.	Pom Shandy	Mawsmai	80
40.	Rangbaksaw	Cherrapunji	1
41.	Rilaw Khaiti	Wahlong	35
42.	Swer	Lum Swer	12
43.	Umkatait	Dieng Ksiar	100

44.	Umthri	Nongduh	80
45.	Umtong	Umwai	400
46.	Wahkhem	Khadar Blang	10
47.	Wanning Sawkpoh	Shngimawlein	7
48.	Lum Shyllong	Laitkor	7
49.	Rijaw	Wahlong	35
50.	Dienglengbah	Rngiksheh	0.50
District - West Khasi Hills:			
51.	Boro Miaparara-Rayggadam	Bora Miapara	1
52.	Ganna Ram-ram Rock	Bokma Megap giri	30
53.	Jongola Ranggadam	Jongala	1
54.	Kimpra Hills	Resubakrapara	20
55.	Kongkal Hills	Resubakrapara	10
56.	Kyllai Lyngngun, Mariam	Nobosohphoh Syiemship	80
57.	Law Adong Lyngdoh, Mawlong	Nongkhlaw Syiemship	200
58.	Law Kyntang, Mawlangwir	Maharam	300
59.	Law Kyntang, Mawten	Maharam	100
60.	Law Kyntang, Whawiaw	Maharam Syihip	100
61.	Law Lyngdoh, Kinglang	Maharam Syihip	200
62.	Law Lyngdoh, Nonglait	Mawiang Syiemship	50
63.	Law Lyngdoh, Nonglyngkien	Maharam Syihip	90
64.	Law Lyngdoh, Rangmaw	Maharam Syihip	400
65.	Lawren	Nongstoin	10
66.	Lum Blei, Nonglyngkien	Maharam Syihip	55
67.	Lum Sanglia, Nonglyngkien	Maharam Syihip	45
68.	Rautagiri Sacred grove	Rautagiri	37
69.	Wahlang-Nongklung	Nongklung	10
70.	Walchi Ruram Hills	Resubakrapara	25
71.	Nongkynrih Sacred Grove	NongKynrih	100
District - Ri Bhoi			
72.	Nong Lyndoh, Nongkhrai	Nongpoh	90
73.	Pahamodem	Umsaw Nongkhrai	900
74.	Sohpethneng	Nongpoh	90
Jaintia Hills Zone			
District - Jaintia Hills			
75.	Blai Law	Raliang	50
76.	Dpepat Myndihati	Sutnga	15
77.	Ka Pun Lyngdoh	Raliang	15
78.	Khlaw Blai	Dien Shynrum	15
79.	Khlaw Byrsan	Raliang	50
80.	Khloo Lyndoh	Jowai	15
81.	Khloo Paiu Ram Pyrthai	Jowai	150
82.	Law Kyntang	Shanpung	400
83.	Lawianlong	Jowai	12
84.	Lumtiniang Mokaiaw	Syndai	25
85.	Mokhain	Jowai	45
86.	Poh Lyndoh	Shanpung	30
87.	Poh Moorang	Raliang	20
88.	Poh Puja Ko Patti	Raliang	4
89.	Trepale Jowai	Jowai	70
Garo Hills Zone			
District - East Garo Hills			

90.	BoraMiapara	BoraMiapara	1
91.	Ganna Ram Rock	Megapgiri	30
92.	Jongola	Jongola	1
93.	Kimpra Hills	Risubakrapara	20
94.	Konkal Hills	Risubakrapara	10
95.	Miapara Rongadom	Miapara	1
96.	Rautagiri	Rautagiri	37
97.	Walchi Ruram Hills	Risubakrapara	25
District - West Garo Hills			
98.	Angalgiri	-	20
99.	Asigiri	-	4
100.	Damalgiri	-	50
101.	Daronggiri	-	25
102.	Goragiri	-	25
103.	Jelbongpara	-	20
104.	Jhanjipara	-	7
105.	Sadolpara	-	30

ANNEXURE 4.4

Reserved Forests and Protected Forests in Meghalaya (BSAP, 2004)

Serial Number	Name of Reserved Forests	Gazette Notification and date	Area (in km²)
1	**Jaintia Hills District**		
	Saipung R.F.	Number 26/7/1876 and 5 of 17.10.1877	150.35
	Narpuh Bl. I	Number 3978 F of 17.6.1909	62.42
	Narpuh Bl. II	Number 1106 R of 9.3.1918	98.68
			Total: 311.45
2	**East Khasi Hills District**		
	Riatkhwan R.F.	Number 806 R of 5.3.1892 & 4287 R of 1.9.1892	3.91
	Shyrwat R.F.	Number FOR.179/80/187 of 28.3.1988	0.44
	Riat Laban R.F.	Number FOR 179/80/183 of 28.3.1988	2.05
			Total: 6.40
3	**Ri-Bhoi District**		
	Nongkhyllem R.F.	Number 4692 F of 23.7.1909 & 864 G. J of 4.2.1939	125.91
	Umsaw R.F.	Number G.F.R. 234/46/3 of 16.12.1946	0.44
			Total: 126.35
4	**East Garo Hills District**		
	Chimabongshi R.F.	Number 28, dt 19.6.1883 & FOR/Sectt/492/63/4 dt 22.12.1965	23.28
	Dhima R.F.	Number 28 of 19.6.1883 &3715 R of 11.8.1904	20.72
	Dilma R.F.	Number 28 of 19.6.1883	2.59
	Rajasimla R.F.	Number 28 of 19.6.1883 &665 R of 15.2.1899	18.13
	Ildek R.F.	Number 28 of 19.6.1883	2.59
	Darugiri R.F.	Number 28 of 19.6.1883 & 373 R of 29.1.1932	10.36
	Rongrenggiri R.F.	Number 28 of 19.6.1883 & 375 R of 29.1.1932	36.26
	Dambu R.F.	Number 22 of 12.3.1880 & 4276 R of 14.10.1962	18.13
	Songsak R.F.	Number 29 of 1.10.1885 & 3583 R of 5.9.1902	23.31
			Total: 155.37
5	**West Garo Hills District**		
	Dibru Hills R.F.	Number 28 dt.19.6.1883 & 3526 R of 10.12.1930	15.02
	Tura peak R.F.	Number FOR.10/75/32 dt 23.6.1982	4.19
			Total: 19.21
6	**South Garo Hills District**		
	Baghmara R.F.	Number 12 dt 24.2.1887	43.91
	Angratoli R.F.	Number 3 dt 7.11.1883 & 2478 R of 15.6.1915	30.11
	Rewak R.F.	Number 44 dt. 7.11.1883 & 1699 R of 26.7.1932	6.47
	Emangiri R.F.	Number 44 dt. 7.11.1883 & 1699 R of 26.7.1932	8.29
	Siju R.F.	Number 44 dt. 7.11.1883 & 1699 R of 26.7.1932	5.18
	Cittingiri R.F.		2.40
			Total: 96.36
			Total Reserved Forests : 715.14

Area acquired but yet to be declared as Reserved Forest:

Serial Number	Name	Area (sq. km.)	District
1	Nongumiang	0.31	West Khasi Hills
	Total	**0.31**	

Protected Forests

Number	Name	Area (sq. km.)	District
1	Upper Shillong P.F.	7.66	East Khasi Hills
2	Short Round P.F.	1.13	East Khasi Hills
3	Laitkor P.F.	3.25	East Khasi Hills
4	Green Block Number 2	0.21	East Khasi Hills
5	Umkhuti P.F.	0.14	Ri-Bhoi
	Total	**12.39**	

ANNEXURE 5.1

Land Use Pattern in Meghalaya

Land use	Reporting Area for Land Utilization Statistics	Forest	Not Available for Cultivation	Uncultivated Land Excluding Fallow	Fallow Land	Net Area	Area Sown More Than Once	Gross Cropped Area
2000-01	2240900	950575	222465	617865	228096	221899	45386	267285
2001-02	2227100	950533	225418	606393	234294	210462	46649	257111
2002-03	2227100	947038	225321	600824	238392	215525	46597	262122
2003-04	2227100	947219	225380	599589	235688	219224	46650	265874
2004-05	2227100	941786	227945	607717	230760	218892	46680	265572
2005-06	2227100	943746	226783	594976	224726	236869	49215	286084
2006-07	2227100	944108	226939	594752	224526	236775	50419	287194
2007-08	2227100	946247	225870	554410	217981	282592	52176	334768
2008-09	2227100	948133	225921	553444	215453	284149	53245	337394
2009-10	2228914	946318	230525	555840	213292	282939	53477	336416
2010-11	2234283	946116	236447	554532	213309	283879	53974	337853
2011-12	2240837	946089	239194	555104	215273	285177	54040	339217
2012-13	2241254	946127	239348	555039	215241	285499	54226	339725
2013-14	2241462	946197	239041	555234	215331	285659	57226	342885
2014-15	2241922	946201	239690	554579	215253	286199	57232	343431
2015-16	2242002	946248	239960	554424	215045	286325	57276	343601

Source: Statistical Handbook Meghalaya 2019

ANNEXURE 5.2

Shifting cultivation scenario in Meghalaya

Zones	2005-08			2008-09		
	Current Jhum	*Jhum*fallow	Total	Current Jhum	*Jhum*fallow	Total
East Garo Hills	39.90	77.23	117.13	27.23	44.34	71.57
East Khasi	0.00	0.00	0.00	0.00	0.00	0.00
Jaintia Hills	10.52	0.09	10.61	14.53	0.09	14.62
Ri-bhoi	9.67	0.00	9.67	50.00	9.14	59.14
South Garo Hills	76.35	52.06	128.41	38.51	73.30	111.81
West Garo Hills	123.38	13.52	136.90	114.68	111.13	225.81
West Khasi Hills	32.05	14.22	46.27	27.57	30.11	57.68
Total	**291.87**	**157.12**	**448.99**	**272.52**	**268.11**	**540.63**

ANNEXURE 5.3

Change in shifting cultivation patterns in Meghalaya during 1980–1995

Change in vegetation categories	1980–1989 (%)			1989–1995 (%)		
	Garo Hills	Khasi Hills	Jaintia Hills	Garo Hills	Khasi Hills	Jaintia Hills
Seasonal type to abandoned shifting cultivation	2.09	1.02	0.27	0.86	0.35	0.2
Seasonal type to current shifting cultivation	1.84	0.89	0.08	0.43	0.28	0.25
Pine to abandoned shifting cultivation	—	0.16	*	—	0.04	0.04
Pine to current shifting cultivation	—	0.05	0.03	—	0.06	0.03
Abandoned shifting cultivation to current shifting cultivation	0.17	0.08	—	0.08	0.05	*
Current shifting cultivation to abandoned shifting cultivation	0.23	0.14	*	0.76	0.33	—
Current shifting cultivation to bamboo brakes	0.06	*	—	—	—	—
Abandoned shifting cultivation to pine forest	—	0.22	0.1	—	0.07	—
Bamboo brakes to abandoned shifting cultivation	—	—	—	0.46	*	—
Bamboo brakes to current shifting cultivation	—	—	—	0.54	0.04	—
Current shifting cultivation to non-forest	0.15	0.4	0.06	—	—	—
Non-forest to current shifting cultivation	0.09	0.23	0.09	—	—	—

*Changes insignificant. Source: Roy and Tomar, 2001

ANNEXURE 5.4

Area under shifting cultivation in East Garo Hills District, Meghalaya (1980-2016)

Years	Current jhum (km^2)	Current jhum (Change %)	Regenerating jhum (km^2)	Regenerating jhum (Change %)
1980	64.75	-	23.58	-
1990	46.24	(-) 28.59%	16.06	(-) 31.91%
1995	34.97	(-) 24.37%	39.90	59.76%
2000	46.87	25.39%	31.51	(-) 21.02%
2005	54.08	13.33%	35.08	10.19%
2010	24.80	(-) 54.14%	23.12	(-) 34.11%
2016	17.42	(-) 29.75%	22.11	(-) 4.35%

Source: Riahtam *et al.*, 2018

ANNEXURE 5.5

Annual extraction of timber in Meghalaya, from State owned forests

Year	Khasi Hills		Garo Hills		Jaintia Hills	
	Quantity (m^3)	Value (in Rs. lakhs)	Quantity (m^3)	Value (in Rs. lakhs)	Quantity (m^3)	Value (in Rs. lakhs)
2006-07	13937	5.31	NA	NA	NA	NA
2007-08	107679.342	13.86	NA	NA	NA	NA
2008-09	123475.612	14.05	NA	NA	NA	NA
2009-10	211471	56.78	NA	NA	NA	NA
2010-11	NA	NA	322.765	78.09	NA	NA
2011-12	NA	NA	238.932	13.50	NA	NA
2014-15	373894	0.97	289.68	18.57	NA	NA
2015-16	1222.227	5.34	283.013	9.02	NA	NA
2016-17	288.768	11.91	426.643	20.96	1.101	0.03

Source: Office of the PCCF & HoFF, Department of Environment and Forests, Govt. of Meghalaya

Note: The information has gaps in data

ANNEXURE 5.6

Net State Domestic Product at current prices (in Rs. lakhs)

Years	Agriculture	Forestry and Logging	Mining and Quarrying
1980-81	**6923**	**311**	**299**
1981-82	7379	538	471
1982-83	7898	495	553
1983-84	9079	570	753
1984-85	10560	677	1135
1985-86	11430	733	1035
1986-87	11806	765	1045
1987-88	14990	891	1204
1988-89	12264	928	1627
1989-90	19011	972	2709
1990-91	**20461**	**1051**	**4802**
1991-92	24758	1044	4784
1992-93	30218	1059	6256
1993-94	34100	1913	4428
1994-95	37446	2736	6164
1995-96	46274	3218	6050
1996-97	51995	3079	6838
1997-98	58980	2841	6044
1998-99	64542	2930	14815
99-2000	70738	4180	23706
2000-01	**78367**	**4711**	**29191**
2001-02	87397	5453	40927
2002-03	92660	5874	33704
2003-04	95538	7053	44550
2004-05	100246	39627	50441
2005-06	111472	38092	50413
2006-07	139604	48679	59273
2007-08	147008	46683	78616
2008-09	152961	53008	66462
2009-10	158037	49920	66618
2010-11	**165314**	**52155**	**69648**
2011-12	204717	55478	122605
2012-13	238413	55120	107852
2013-14	253082	57034	161604
2014-15	270915	100260	65574
2015-16	296304	126270	114027
2016-17(Q)	312997	135190	136328
2017-18(A)	330158	139936	148821

N.B.: Q – Quick estimates, A – Actual estimates

ANNEXURE 5.7

Contribution of Forestry and Logging to Net District Domestic Product and NSDP in Meghalaya during 1993-94 to 1999-2000 (all data in Percentage)

State/Year	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
Jaiñtia Hills	1.69	2.18	2.19	1.95	1.61	1.25	1.16
East Khasi Hills	0.55	0.56	0.55	0.48	0.39	0.35	0.31
West Khasi Hills	3.48	4.52	4.39	3.88	3.24	2.86	2.68
East Garo Hills	2.42	3.22	3.08	2.73	2.25	2.01	1.68
West Garo Hills	1.41	1.87	1.8	1.6	1.28	1.17	1.02
Ri Bhoi	2.03	2.82	2.62	2.28	1.99	1.87	1.52
South Garo Hills	3.25	3.9	3.79	3.39	2.93	2.4	2
Meghalaya	1.48	2.05	2.17	2.02	1.78	1.67	1.82

Source: Government of Meghalaya: Meghalaya District Gross Domestic Product, 1993-94 to 1999-2000, Directorate of Economics and Statistics, Shillong

Note:Data beyond 1999-2000 is not available for the districts of Meghalaya

ANNEXURE 5.8

District-wise Variation in Net Output of Forestry and Logging in Meghalaya during 1993-94 to 1999-2000 (Rs in Lakhs at 1993-94 Prices)

State/Year	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
Jaiñtia Hills	313	449	531	515	480	500	497
East Khasi Hills	318	310	363	352	331	345	341
West Khasi Hills	427	615	728	692	650	677	677
East Garo Hills	253	362	429	416	389	405	399
West Garo Hills	341	489	579	560	522	455	542
Ri Bhoi	173	248	293	284	270	279	271
South Garo Hills	206	295	350	338	316	330	324
Meghalaya	1931	2768	3273	3157	2958	3080	3051

Source: Government of Meghalaya: Meghalaya District Gross Domestic Product, 1993-94 to 1999-2000, Directorate of Economics and Statistics, Shillong

Note: Data beyond 1999-2000 is not available for the districts of Meghalaya

ANNEXURE 5.9

Firewood consumption by different sectors in Meghalaya (MT)

	Household		Bakery	PWD Road construction	Lime industry
District	Rural	Urban			
East Khasi Hills	155745.5	1301.01	27648		1050
West Khasi Hills	70810	799.97	6048	116160	-
Ri Bhoi	29778.53	202.23	7776		-
Jaintia Hills	80734.35	740.57	13248	42400	70
East Garo Hills	59265.05	302.77	9504		-
West Garo Hills	128191.7	7067.77	13248	62080	-
South Garo Hills	83417.1	537.83	3456		-
Total	607942.2	10952.14	80928	220640	1120

Source: Forest Resource Survey, Meghalaya (2002-2004)

Note: The information has gaps in data

ANNEXURE 5.10

Commercial production of firewood in Meghalaya (MT)

Year	KHADC	JHADC	GHADC	Total
1995-96	8571.79	-	20000	28571.8
1996-97	9325.29	608.35	80000	89933.6
1997-98	2198	38.2	140000	142236
1998-99	30	1.55	250000	250032
1999-00	3	96.55	300000	300100
2000-01	-	15	350000	350015
2001-02	-	81.475	1000000	1000081
2002-03	-	77	810000	810077
2003-04	-	10.2	660000	660010
2004-05	-	70.35	1250000	1250070
Total	20128.08	1077.63	4860000	4881126

Source: KHADC, Shillong; JHADC, Jowai; GHADC, Tura. (1995-2005)

Note: The information has gaps in data

ANNEXURE 5.11

Commercial production of firewood in Meghalaya (2006-2017)

Year	Firewood						Bamboo					
	KH		GH		JH		KH		GH		JH	
	Quantity (m^3)	Value (in Rs. lakhs)	Quantity (m^3)	Value (in Rs. lakhs)	Quantity (m^3)	Value (in Rs. lakhs)	Quantity (m^3)	Value (in Rs. lakhs)	Quantity (m^3)	Value (in Rs. lakhs)	Quantity (m^3)	Value (in Rs. lakhs)
2006-07	5413.915	3.9	-	-			1815	5.45	-	-		
2007-08	7010.324	2.35	-	-			1391	4.17	-	-		
2008-09	496.153	2.75	-	-			805	2.42	-	-		
2009-10	10,733.00	3.52	-	-			982	2.94	-	-		
2010-11	-		-	-			-		-	-		
2011-12	-		-	-			-		-	-		
2014-15	31.121		-	-			1424		-	-		
2015-16	9.313		-	-			309		-	-		
2016-17	15.36		-	-			-		-	-		

Source: Office of the PCCF & HoFF, Department of Environment and Forests, Govt. of Meghalaya

Note: The information has gaps in data

ANNEXURE 5.12

Quantity of charcoal sold in Meghalaya

Year	SFD (MT)	KHADC (MT)	JHADC (MT)	Total
1995-96	N.A	336	0	336
1996-97	N.A	97.7	891.37	989.07
1997-98	N.A	560.69	817.74	1378.43
1998-99	N.A	7111.1	819.58	7930.68
1999-00	N.A	4832	1239.86	6071.86
2000-01	N.A	4100.2	1452	5552.2
2001-02	1405	3570	2280.77	5850.77
2002-03	N.A	14621.05	2050.14	16671.19
2003-04	N.A	28951.08	2109.64	31060.72
2004-05	N.A	18075.55	4970.51	23046.06

Note: The information has gaps in data

ANNEXURE 5.13

Charcoal production in Meghalaya (2014 to 2017)

	Khasi Hills		Garo Hills		Jaintia Hills	
	Quantity (MT)	Value (in Rs. lakhs)	Quantity (MT)	Value (in Rs. lakhs)	Quantity (MT)	Value (in Rs. lakhs)
2014-15	200.32	15.43	N.A	N.A	N.A	N.A
2015-16	1222.227	5.34	N.A	N.A	N.A	N.A
2016-17	150	14.05	N.A	N.A	N.A	N.A

Source: Office of the PCCF & HoFF, Department of Environment and Forests, Govt. of Meghalaya

Note: The information has gaps in data

ANNEXURE 5.14

(A) List of hazardous Ferro-Alloy Industries in Meghalaya as furnished by the Meghalaya Pollution Control Board

SN	Name of Unit	Location	Employment
1.	M/s RNB Caribide & Ferro Alloy Pvt Ltd	Umiam Industrial Area	16
2.	M/s F.W. Ferro Tech Pvt Ltd	EPIP, Byrnihat	31
3.	M/s Nalari Ferro Alloy Pvt Ltd	EPIP, Byrnihat	19
4.	M/s Trikuta Ferro Alloys Pvt Ltd	EPIP, Byrnihat	18
5.	M/s Khasi Alloys Pvt Ltd	EPIP, Byrnihat	15
6.	M/s Shyam Century Ferrous	EPIP, Byrnihat	133

Source: Anonymous. 2016. Meghalaya State Disaster Management Plan 2016 Volume 1. Meghalaya State Disaster Management Authority, Government Of Meghalaya.

(B) List of Major Alloy industries operating in Meghalaya

Sl. No.	**Name of Alloy industry**	**Date of registration**
1.	Shree Sai Megha Alloys Ltd	21/06/1996
2.	Satyam Steels And Alloys Pvt Ltd	22/07/1996
3.	Shivam Ispat And Alloys Pvt Ltd	03/04/1997
4.	Shree Sai Prakash Alloys Private Limited	06/04/1999
5.	Burakia Steel Alloys Private Limited	29/10/1999
6.	Nezone Power & Alloys Limited	09/12/1999
7.	Gita Ferro Alloys Private Limited	13/06/2000
8.	Ess Dee Alloys Private Limited	04/01/2001
9.	Meghalaya Cast & Alloys Private Limited	19/01/2001
10.	Nalari Ferro Alloys Private Limited	27/02/2001
11.	Meghalaya Sova Ispat Alloys Limited	10/04/2001
12.	Prism Alloys Private Limited	24/04/2001
13.	Jaintia Ferro Alloys Limited	23/05/2001
14.	Bimla Ispat & Alloys Private Limited	30/05/2001
15.	R N B Carbides & Ferro Alloys Private Limited	22/02/2002
16.	Nezone Alloys Limited	30/05/2002
17.	Meghalaya Alloys Private Limited	28/06/2002
18.	Khasi Alloys Private Limited	04/09/2002
19.	Jai Kamakhya Alloys Private Limited	13/11/2002
20.	Purbanchal Alloys Limited	13/12/2002
21.	Byrnihat Alloy Private Limited	16/06/2003
22.	Good Luck Ferro Alloys Private Limited	06/08/2003
23.	Pioneer Cast Alloys Private Limited	23/12/2003
24.	Shree Shakambari Ferro Alloys Private Limited	25/02/2005
25.	Times Alloys & Power (Meghalaya) Limited	25/03/2008
26.	H.M.Ferro Alloys Private Limited	14/11/2008
27.	Meghalaya Ferro Alloys & Power Limited	14/07/2011

ANNEXURE 5.15

Status of roads during last four years in different districts of Meghalaya

Class of Road	Year	East Jaintia Hills	West Jaintia Hills	Ri-Bhoi	East Khasi Hills	West Khasi Hills	South West Khasi Hills	North Garo Hills	East Garo Hills	West Garo Hills	South Garo Hills	South West Garo Hills	Meghalaya
Surfaced	2012-13	416.72	693.3	555.565	1491.5	515.724	283.174	226.573	223.775	580.488	365.25	322.204	5674.285
	2013-14	341.418	767.5	561.02	1537.8	606.534	287.884	263.603	280.942	661.731	212.9	505.548	6026.86
	2014-15	351.47	793.2	536.63	1683	606.082	280.18	301.08	280.942	568.179	392.01	395.434	6248.167
	2015-16	395.47	934.4	606.373	1632.8	613.758	282.55	322.988	241.259	623.231	394.014	451.643	6498.466
Unsurfaced	2012-13	105.42	366.9	219.212	538.68	392.16	205.672	111.432	76.045	429.817	164.4	144.055	2753.754
	2013-14	195.152	286.5	297.95	395.56	462.166	197.774	263.603	280.942	661.731	212.9	505.548	6026.86
	2014-15	233.267	296.7	274.48	392.09	447.909	205.376	301.08	280.942	568.179	392.01	395.434	6248.167
	2015-16	233.267	268.1	256.932	417.55	506.018	228.996	180.517	204.556	298.587	156.4	100.526	2851.431
Total	2012-13	522.14	1060	774.777	2030.2	907.884	488.846	338.005	299.82	1010.305	529.65	466.259	8428.039
	2013-14	536.57	1054	858.97	1933.4	1068.7	485.658	369.285	387.038	1084.811	254.5	773.703	8806.54
	2014-15	584.737	1090	811.11	2075.1	1113.991	485.556	481.227	387.038	954.047	542.11	500.152	9024.894
	2015-16	628.737	1202	863.305	2050.4	1119.776	511.546	503.505	445.815	921.818	553.414	552.169	9352.897

Source: Statistical Handbook Meghalaya 2000, 2019

ANNEXURE 5.16

Number Of Census Houses And Households from 1981 To 2011

Items	1981	1991	2001	2011
Houses (Vacant & Occupied)	2,55,826	4,00,428	5,20,602	7,21,467
Households	255131	327295	420246	538299
Decadal Growth Rate Houses (Vacant & Occupied)	13.93	56.52	30.01	38.58
House holds	26.85	28.29	28.4	28.09

Source :Tables on Houses, Household Amenities & Assets for total, S.C &S.T., Census Office, RGI

ANNEXURE 5.17

Decadal Growth Rate and Decadal Variation of Populationin Meghalaya

Districts	Decadal Variation in Population				
	1971-81	1981-91	1991-2001	2001-2011	1971-2011
Jaiñtia Hills	37.72	40.97	35.67	31.34	247.94
East Khasi Hills	25.48	30.72	22.86	24.68	152.94
West Khasi Hills	45.73	36.26	34.47	30.25	241.58
East Garo Hills	32.96	38.29	32.7	25.84	207.04
West Garo Hills	23.07	31.08	29.09	26.73	163.60
Ri Bhoi	89.51	27.4	51.44	34.02	390.85
South Garo Hills	15.5	23.61	28.59	29.33	141.12
Meghalaya	32.04	32.86	30.65	27.82	193.26
India	24.66	23.86	21.56	17.64	120.87

Sources: Census of India, 2001, 2011; Basic Statistics of North Eastern Region, 1995, 2000 and 2002

ANNEXURE 5.18

Total Houses and Houses Allotted To Women under Indira Awaas Yojana,1999-00 to 2008-09

Years	New Construction		Up-gradation	
	Total Houses	Houses for Women	Total Houses	Houses for Women
1999-2000	1987	1510 (76 percent)	415	330 (79 percent)
2000-2001	4377	2590 (59 percent)	2173	1363 (63 percent)
2001-2002	2030	1197 (59 percent)	948	648 (68 percent)
2002-2003	3405	1609 (47 percent)	1735	824 (47 percent)
2003-2004	4331	3003 (69 percent)	2392	1726 (72 percent)
2008-2009	2283	1627 (71 percent)	372	372 (100 percent)

Source: http://rural.nic.in/rural/Stmonth/.aspx

ANNEXURE 5.19

Installed Capacity of Power Projects (MW)

Project	2009 -10	2010 -11	2011 -12	2012 -13	2013 -14	2014 -15	2015 -16	2016 -17
1. Umiam Hydel Poject								
Stage -1	36	36	36	36	36	36	36	36
Stage -2	18	18	18	20	20	20	20	20
Stage -3	60	60	60	60	60	60	60	60
Stage -4	60	60	60	60	60	60	60	60
2. Umtrew Hydel Project	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
3. Sunapani Micro Hydel (SESU)Project.	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
4. Myntdu Leshka	0	0	84	126	126	126	126	126
Meghalaya	186.7	186.7	270.7	314.7	314.7	314.7	314.7	314.7

Source: Additional Chief Engineer (Commercial)Meghalaya Energy Corporation Ltd.,Shillong.

ANNEXURE 5.20

Location of important minerals in Meghalaya

Name of Mineral	Location/ Occurrence
Coal	➢ West Darrangiri, Siju, Pendengru-Balpakram in the South Garo Hills district ➢ Borsora Langrin in the West Khasi Hills district ➢ East Darrangiri partly in West Khasi Hills and partly in East Garo Hills ➢ Mawlong-Shella and Sohra-Cherrapunjee in the East Khasi Hills district ➢ Bapung-Sutnga in the Jaintia Hills district
Limestone	➢ An extensive bed of limestone occurs in the Southern part of the State from Jaintia Hills in the East and Garo Hills in the West ➢ Cherrapunjee, Mawlong, Ichamati, Shella, Komorrah in the East Khasi Hills district; Borsora and Bagli in the West Khasi Hills district ➢ Lakadong, Lumshnong and Nongkhlieh in the Jaintia Hills district ➢ Darrang Era-aning, Siju, Chokpot in the South Garo Hills district
Uranium	➢ Domiasiat and Wahkyn area in the West Khasi Hills District
Granite	➢ Nongpoh in the Ri-Bhoi District; Mylliem in the East Khasi Hills District ➢ Mawkyrwat and Nongstoin in the West Khasi Hills District ➢ Mendipathar and Songsak in the East Garo Hills District
Kaolin	➢ Mawphlang, Smit and Laitlyngkot in the East Khasi Hills District ➢ Thandlaskein, Shangpung, Mulieh and Mynsngat in the Jaintia Hills District ➢ Darugiri in the East Garo Hills District
White Clay	➢ Cherrapunjee and Mahadek in the East Khasi Hills ➢ Nangwalbibra in the South Garo Hills ➢ Rongrengre in the East Garo Hills District
Glass Sand	➢ Laitryngew, Umstew and Kreit in the East Khasi Hills ➢ Tura in the West Garo Hills.
Sillimanite	➢ Mawthengkut Block at Sonapahar of the West Khasi Hills District
Other minerals	➢ Quartz occurs almost in all districts in the Northern part of the State. ➢ Feldspar and iron ore are reported in the Ri-Bhoi and West Khasi Hills Districts ➢ Bauxite and rock phosphate are found in the Jaintia Hills District

Source: Mineral Policy, Meghalaya

ANNEXURE 5.21

Production and estimation of value of minerals since 2001to 2015

	Coal		Limestone	
Year	Production ('000 MT)	Value (Rs in Crore)	Production ('000 MT)	Value (Rs in Crore)
2001-2002	5149.3	N.A.	585	8.78
2002-2003	4405.9	N.A.	641	9.62
2003-2004	5439.3	N.A.	721.8	13.1
2004-2005	5345.2	N.A	655	12.19
2005-2006	5629.3	N.A.	1044.2	16.75
2006-2007	5786.5	N.A	2132.7	35.3
2007-2008	6541.1	N.A.	2153	32.87
2008-2009	5488.6	N.A.	3875.9	85.82
2009-2010	5767	N.A.	3882.1	91.19
2010-2011	6974.1	N.A.	2667.7	N.A.
2011-2012	7205.9	N.A.	4825.8	N.A.
2012-2013	5649	N.A.	4543.7	N.A.
2013-2014	5732	N.A.	4364.9	N.A.
2014-2015	2521	N.A.	4345.5	N.A.

Source : Directorate of Mineral Resources, Govt. of Meghalaya (2017)

ANNEXURE 5.22

Illegal mining and transportation of coal reported by district administration during NGT ban period

Name of the District	No of illegal mining cases reported	No of illegal transportation cases transportation (Quantity of coal in MT)
Ri-Bhoi	-	256 (8523 MT)
South West Khasi Hills	1 (20 MT)	7 (202 MT)
East Khasi Hills	2 (1294 MT)	104 (1194 MT)
East Garo Hills	-	6 (35 MT)
West Garo Hills	-	9 (100 MT)
South Garo Hills	-	1 (2 MT)
North Garo Hills	-	4 (NA)
West Khasi Hills	-	Not furnished
East Jaintia Hills	Not furnished	460 (13380 MT)
West Jaintia Hills	-	Not furnished
Total	3 (1314 MT)	847 (23436 MT)

Source: APPENDIX-XIII, Audit Report for the year ended 31 March 2018 – Revenue Sector. pp. 122.

ANNEXURE 5.23

Rural Poverty in Meghalaya (2002)

District/Zone/ State	Rural Family	Number of Rural BPL Family	Percentage of Rural Families BPL
District:			
Jaintia Hills	34142	15086	44.19
East Khasi Hills	76656	42284	55.16
West Khasi Hills	41320	26822	64.91
East Garo Hills	31949	10911	34.15
West Garo Hills	75500	47542	62.97
Ri Bhoi	27211	11376	41.81
South Garo Hills	14087	9941	70.57
Zone:			
Jaintia Hills	34142	15086	44.19
Khasi Hills	145187	80482	53.96
Garo Hills	121536	68394	55.89
State			
Meghalaya	300865	163962	54.5

*Source: Community and Rural Development Department, Government of Meghalaya, Shillong

ANNEXURE 5.24

Employment in public and private sector (Nos)

Sector	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2013	2014	2015	2016	2017
Public Sector													
1. Central Government	7761	5853	5370	4594	4086	4639	4863	1577	3556	3693	6748	8706	7350
2. State Government	33381	29655	32728	30399	27465	27657	32527	41719	37836	40444	39124	36743	40603
3. State Quasi Government	4523	3048	3408	3423	1358	1606	3038	3443	3642	3546	4494	5546	5791
4. Central Quasi Government	6510	5873	5657	6007	2694	2741	3937	6520	5398	4583	3356	6863	7133
5. Local Bodies	2702	2796	2155	2217	768	810	2724	2448	3102	2919	4318	4280	4340
Total	54877	47225	49318	46640	36371	37453	47089	55707	53534	55185	58040	62138	65217
Private Sector													
1. Larger Establishment	4440	4655	4834	5415	3024	3723	4147	5273	4960	5177	6496	7156	7965
2. Smaller Establishment	1930	2419	2393	2396	1193	1471	1207	1719	1141	1213	1423	1892	1831
Total	6370	7074	7227	7811	4217	5194	5354	6992	59635	61575	65959	71186	75013

Source: Directorate of Employment &Craftsmen Training, Meghalaya, Shillong.

ANNEXURE 5.25

Employment Exchange Statistics of Meghalaya

Item	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
No. of Employment Exchanges	12	12	12	12	12	12	12	13	13	13	13
Registration	9639	7012	11575	6261	5145	14700	18200	6243	17729	8161	5685
Vacancies Notified	811	626	563	595	577	200	100	107	1709	1043	964
Placement	43	28	34	30	15	N.A	N.A	20	35	29	10
No. of applicants on the Live Register	31299	29161	34597	32906	29834	33600	36200	37950	46272	46012	43371

N.A – Not Available. Source: 1. Directorate of Employment & Craftsmen Training Meghalaya, Shillong. 2. Statistical Hand Book Meghalaya 2019.

ANNEXURE 5.26

Vulnerability issues (forest fires and encroachments) of forests in Meghalaya

Vulnerability categories	Unit	Year				
		2012-13	2013-14	2014-15	2015-16	2016-17
I. Forest fires						
Number of instances	No.	32	66	202	52	142
Area burnt	Ha.	21.31	274.6	202	161	520
Reason of fire		Accidental, Man-made or Unknown				
Estimated loss	In Rs. Lakhs	--	--	--	--	--
Funds allotted for fire protection	In Rs. Lakhs	41.32	49.87	--	19.18	44.8
Area covered under fire protection	Ha.	1125.39	1125.39	1125.39	1125.39	1125.39
Fire watchers	No.	210	210	210	210	210
Squads deployed	No.	--	--	--	--	--
Funds utilized	In Rs. Lakhs	41.32	49.87	--	19.18	44.8
II. Encroachment						
Area under encroachment	Ha.	6.496	15.389	4.51	8088.424	2.08
Activity of encroached area	Text	--	--	--	--	--
Evictions carried out	No.	--	--	--	--	--
Area freed	Ha.	4.65	2.832	0.07	--	--
Cases under litigation	No.	--	--	--	--	--
Convictions	No.	--	--	--	--	--
Cases regularised	No.	15	16	--	--	--
Area regularised	Ha.	4.65	2.832	0.07	--	--

Source: Office of the PCCF & HoFF, Department of Environment and Forests, Govt. of Meghalaya

ANNEXURE 5.27

Distribution of Households by type of Fuel used for Cooking (2001 & 2011 Census) in Meghalaya

Type of Fuel used	2001					2011				
	Total Households (No.)	Rural (No.)	P.C. to total household	Urban (No.)	P.C. to total household	Total Households (No.)	Rural (No.)	P.C. to total household	Urban (No.)	P.C. to total household
Firewood	338600	310373	94.1	28227	31.2	425353	395409	93.6	29944	25.8
Crop Residue	5482	4623	1.4	859	0.9	4601	4108	1	493	0.4
Cowdung Cake ,	254	148	-	106	0.1	1349	1243	0.3	106	0.1
Coal, lignite, charcoal	11309	2067	0.6	9242	10.2	12355	2935	0.7	9420	8.1
Kerosene	23114	4194	1.3	18920	20.9	20050	2884	0.7	17166	14.8
LPG	32520	3551	1.1	28969	32	63768	10783	2.5	52985	45.6
Electricity	6211	2754	0.8	3457	3.8	8417	3219	0.8	5198	4.5
Biogas	570	392	0.1	178	0.2	991	549	0.1	442	0.4
Any other	501	253	0.1	248	0.3	468	381	0.1	87	0.1
No cooking	1685	1323	0.4	362	0.4	947	686	0.2	261	0.2
Total	420246	329678	-	90568	-	538299	422197	100	116102	100

Source: Office of the Registrar General & Census Commissioner, Govt. of India, Census 2001 & 2011

ANNEXURE 5.28

District –wise population in Meghalaya, Census 1991, 2001 & 2011

Districts	Total/ Rural/ Urban	1991			2001			2011		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
	Total	220473	111753	108720	299108	149891	149217	395124	196285	198839
	Rural	199872	101322	98550	274051	137629	136422	366694	182610	184084
Jaintia hills	Urban	20601	10431	10170	25057	12262	12795	28430	13675	14755
	Total	537906	276094	261812	660923	333553	327370	825922	410749	415173
	Rural	306763	154806	151957	383175	194118	189057	459441	228409	231032
East khasi hills	Urban	231143	121288	109855	277748	139435	138313	366481	182340	184141
	Total	220157	112860	107297	296049	150419	145630	383461	193715	189746
	Rural	205818	105469	100349	261451	132981	128470	340356	172380	167976
West khasi hills	Urban	14339	7391	6948	34598	17438	17160	43105	21335	21770
	Total	188830	96444	92386	250582	127474	123108	317917	161223	156694
	Rural	176826	90041	86785	214675	109090	105585	273725	138763	134962
East garo hills	Urban	12004	6403	5601	35907	18384	17523	44192	22460	21732
	Total	403027	205703	197324	518390	263424	254966	643291	324159	319132
	Rural	356961	181529	175432	459412	233219	226193	568433	286923	281510
West garo hills	Urban	46066	24174	21892	58978	30205	28773	74858	34236	37622
	Total	77073	39257	37816	100980	52007	48973	142334	73170	69164
	Rural	71179	36122	35057	92337	47399	44938	129203	66470	62733
South Garo Hills	Urban	5894	3135	2759	8643	4608	4035	13131	6700	6431
	Total	127312	65576	61736	192790	99319	93471	258840	132531	126309
	Rural	127312	65576	61736	179610	92563	87047	233587	118705	114882
Ri Bhoi	Urban	-	-	-	13180	6756	6424	25253	13826	11427
	Total	1774778	907687	867091	2318822	1176087	1142735	2966889	1491832	1475057
	Rural	1444731	734865	709866	1864711	946999	917712	2371439	1194260	1177179
Meghalaya	Urban	330047	172822	157225	454111	229088	225023	595450	297572	297878

Source: Office of the Registrar General & Census Commissioner, Govt. of India

ANNEXURE 5.29

Density of population, sex ratio & growth of Population by Districts, 1991, 2001 & 2011

District	Total/Rural /Urban	Density per Sq. Km			Sex ratio (No. of Females Per '000 Males			Population Growth During	
		1991	2001	2011	1991	2001	2011	1991-2001	2001-2011
Jaintia Hills	Total	58	78	103	973	996	1013	35.67	32.1
	Rural	52	72	96	973	991	1008	37.11	33.81
	Urban	2641	3212	4061	975	1043	1079	21.63	13.46
East Khasi Hills	Total	128	234	301	947	981	1011	22.87	24.96
	Rural	84	138	165	970	974	1011	24.91	19.9
	Urban	6962	7970	10779	906	992	1010	120.16	31.95
Ri Bhoi	Total	-	81	106	-	941	953	51.43	34.26
	Rural	-	77	100	-	940	968	51.43	30.05
	Urban	-	286	549	-	951	826	-	91.6
West Khasi Hills	Total	42	56	73	951	968	980	34.47	29.53
	Rural	51	66	66	966	974	974	30.18	30.18
	Urban	189	358	449	940	984	102	141.29	24.59
East Garo Hills	Total	73	96	122	958	966	972	32.7	26.87
	Rural	68	83	106	964	968	973	21.4	27.51
	Urban	1235	2071	2599	875	953	968	199.13	23.07
West Garo Hills	Total	86	140	175	960	968	984	28.62	24.09
	Rural	77	124	154	967	970	981	28.7	23.73
	Urban	1917	3224	4159	903	953	1010	28.03	26.93
South Garo Hills	Total	-	55	75	-	942	945	31.02	40.95
	Rural	-	50	70	-	948	944	29.73	39.93
	Urban	-	982	1641	-	876	960	46.64	51.93
Meghalaya	Total	79	103	132	955	972	989	30.65	27.95
	Rural	65	84	107	966	969	986	29.07	27.17
	Urban	2146	1977	2600	910	982	1001	37.59	31.12

Source: Statistical Hand Book, Meghalaya 2007 & 2017, Directorate of Economics & Statistics, Govt. of Meghalaya

ANNEXURE 5.30

Projected Population, Density Of Population & Sex Ratio, 2011-2020

Year	Population			Density per Sq Km	Sex Ratio (Females per '000 Males)
	Total	Male	Female		
2011	2966889	1491832	1475057	132	989
2012	3039568	1527635	1511933	136	990
2013	3114030	1564299	1549731	139	991
2014	3190317	1601842	1588475	142	992
2015	3268472	1640286	1628186	146	993
2016	3348544	1679653	1668891	149	994
2017	3430578	1719965	1710613	153	995
2018	3514623	1761244	1753379	157	996
2019	3600727	1803514	1797213	161	997
2020	3688942	1846798	1842144	164	997

Source:Census office, RGI. (Statistical HandBook Meghalaya 2017)

ANNEXURE 5.31

Birth and Death Rates in Meghalaya during 1976 to 2016 (per 1000 persons)

Year	Meghalaya		All India	
	Birth Rate	Death Rate	Birth Rate	Death Rate
1976	33.5	15.5	34.4	15
1977	32.5	14.1	33	14.7
1978	32	10.2	33.3	14.2
1979	33.2	12.1	33.1	13
1980	31.2	11.1	33.3	12.5
1981	32.6	8.2	33.9	12.5
1982	31.1	8.9	33.8	11.9
1983	30	8.3	33.7	11.9
1984	38.3	11.8	33.9	12.6
1985	39.1	12.7	32.9	11.8
1986	33.4	10.1	32.6	11.1
1987	39.9	9.1	32.2	10.9
1988	36.4	9.1	31.5	10.9
1989	31.9	11.9	30.6	10.3
1990	31.8	7.8	30.2	9.7
1991	32.4	8.8	29.5	9.8
1992	29.8	8.5	29.2	10.1
1993	28.5	6.8	28.7	9.3
1994	29.5	7.1	28.7	9.3
1995	29	8.9	28.3	9
1996	30.4	8.9	27.5	9
1997	30.2	8.8	27.2	8.9
1998	29.2	9	26.5	9
1999	28.7	9.1	26.1	8.7
2000	28.5	9.2	25.8	8.5
2001	28.3	9	25.4	8.4
2002	25.8	7.7	25	8.1
2003	24.7	7.4	24.8	8
2004	25.2	7.2	24.1	7.5
2005	25.1	7.5	23.8	7.6
2006	24.7	8.0	23.5	7.5
2007	24.4	7.5	23.1	7.4
2008	25.2	7.9	22.8	7.4
2009	24.4	8.1	22.5	7.3
2010	24.5	7.9	22.1	7.2
2011	24.1	7.8	21.8	7.1
2012	24.1	7.6	21.6	7.0
2013	23.9	7.6	21.4	7.0
2014	24.1	7.5	21.0	6.7
2015	23.7	7.4	20.8	6.5
2016	23.7	6.6	20.4	6.4

Source: Statistical Handbook Meghalaya 2014, 2017, 2019

ANNEXURE 5.32

Status of Immigration in Meghalaya

Years	Detected	Prosecuted	Pushed back
2008	3,201	171	3,030
2009	2,043	124	1,919
2010	1,562	133	1,429
2011	2,800	156	2,644
2012	6,182	268	5,914
2013	3,163	126	3,037
Total	**18,951**	**978**	**17,973**

Source: Lyngdoh, A.W. 2013.

ANNEXURE 5.33

Fatalities recorded in Meghalaya

Year	Civilians	Security Force Personnel	Terrorists	Total
2005	2	1	26	29
2006	7	0	17	24
2007	4	1	13	18
2008	0	1	12	13
2009	1	0	4	5
2010	3	0	17	20
2011	11	10	8	29
2012	27	2	19	48
2013	28	9	23	60
2014	23	6	47	76
2015	19	8	34	61
2016	10	0	16	26
2017	2	0	6	8
2018	2	2	3	7

https://www.satp.org/satporgtp/countries/india/database/fatalitiesnorteast2006.htm

ANNEXURE 5.34

List of Rules, Regulations, Instructions, Manual and Records for Discharging Functions in Forest and Environment Department, Government of Meghalaya

(Source: megrti.gov.in/17/01_4.pdf)

SN	Subject	G.R./Circular/Office order Rule No. Notification etc date	Remarks if any
1	Assam Forest Regulation, 1891 as Adopted by Meghalaya vide Meghalaya Forest Regulation (application and amendment) Act, 1973	Assam Regulation 7 of 1891, adopted by Meghalaya through Meghalaya Act 9 of1973	A regulation enacted in the year 1891 to amend the law relating to forests, forest produce and duty leviable on timber in the erstwhile un-divided Assam
2	General Rules Framed under the Assam Forest Regulation having Force of law as Adopted by Meghalaya vide Meghalaya Forest Regulation (Application and Amendment) Act,1973	Meghalaya Act 9 of 1973	Rules framed to ensure carry out various provisions contained in the Assam Forest Regulation, 1891 containing the detailed provision in respect of the Powers of Forest officers, management of Unclassed State Forests, regulation of Grazing in the Unclassed State Forests, import of forest produce, transit of forest produce, salvage collection and disposal of drift and other timber, establishment and control of forest villages, preservation of wildlife in preserved forests, protection of forests from fire and eviction from reservedforests.
3	Meghalaya Forest Based industries (Establishment & Regulation) Rules, 1998.		Rules framed in compliance of the interim orders passed by the Hon'ble Supreme Court of India ion the Writ Petition (Civil) 202/95 to regulate establishment and operation of Forest based industries viz. Saw Mill, Saw Pit, Veneer Mills, Plywood Millsetc.

4	The MeghalayaForests (Removal of Timber) (Regulation) Act, 1981	Meghalaya Act 12 of 1981	An Act to regulate and control removal of timber outsidethe State for preservation offorests and to prevent their indiscriminate destruction and for matters connected therewith and incidental thereto.
5	Forest (Conservation) Act, 1980		An Act to provide for the conservation of forests by way of regulation of the de-reservation of the reserved forests and diversion of forest land for non- forest purposes and for matters connected therewith or ancillary or incidental thereto
6	Forest Conservation Rules, 2003		Rules framed to carry out the provisions of the Forest (Conservation) Act, 1980
7	The IndianForest Act, 1927	Act 16 of 1927	A central Act relating to forests, forest produce and duty leviable on timber
8	The Meghalaya Forests (Removal ofTimber) (Regulation) Rules 1982		Rules framed to ensure carry out various provisions contained in the Meghalaya Forests (Removal of Timber) (Regulation) Act, 1981 containing the detailed provision related to the grant of licenses for removal of timber outside the State, establishment of trading depot within the state, Licence fee payable, records to be maintained and furnished by the license holder, verification by the competent authority, etc.
11	Meghalaya Forest (Ejectment of unauthorised persons from ReservedForest) Rules, 1979	Government of Meghalaya, Forests & Environment Department Notification No. M.F.G. 1/ 36 dated 08.08.1979	Rule empowering Divisional Forest Officer in-charge of a Division to eject any person who has entered into unauthorised occupation of land in a reserved forest or order him to vacate such

		unauthorised occupant including power to sell, confiscate or destroy any crops raised, building or construction erected on the land without authority
12	Rules for grants-in- aid to District Councils for implementation of Forest Scheme	Rules regulating terms and conditions for sanction of grants- in- aid to District Councils for implementation of Forest Scheme in the District Council Sector
13	The Meghalaya Tree Based Industries (Establishment and Regulation) Rules, 1998.	To regulate establishment and functioning of saw mills within the State
14	Assam Forest Manual – Vol-II	A manual containing detailed provisions regarding day to day working of the Forest Department
15	Forest Accounts Code	Code containing detailed provisions regarding maintenance & submission of Accounts by the Forest Department
16	Meghalaya Forest Service Rules	Rules governing appointment and condition of service of the members of the Meghalaya Forest Service

ANNEXURE 5.35

List of Policies related to Forestry Sector in Meghalaya

Autonomous District Council Policies and Policy instruments impacting Forestry sector in Meghalaya	State Policies and Policy instruments impacting Forestry sector in Meghalaya
• The Garo Hills District (Jhum) Regulation, 1954 • United Khasi-Jaintia Hills Autonomous District (Management and Control of Forests, Rates of Royalty) Rules, 1959 • The Garo Hills District (Forest) Act, 1958 • The United Khasi & Jaintia Hills Autonomous District (Management and Control of Forest) Act, 1958 • United Khasi-Jaintia Hills Autonomous District (Management and Control of Forests) Rules, 1960 • Khasi Hills Autonomous District (Management and Control of Forests, Revised)	• The Bengal Cruelty to Animal Act, 1869 • AWIL Fees Act, 1960 • The Meghalaya Wild Animal and Birds Protection Act, 1971 (Act 9 of 1971) • Meghalaya Forest Regulation (Application and Amendment) Act, 1973 • Meghalaya Tree Preservation Act, 1976 • Meghalaya Forest (Removal of Timber) Regulation Act, 1981 • The Garo Hills Regulation, 1882 (Regulation 1 of 1882) • Meghalaya Forest (Removal of Timber) (Regulation) Rules, 1982 • Meghalaya Protection of Catchment Areas Act, 1988 • Meghalaya Forest Authority Act, 1991

ANNEXURE 5.36

Certain policy instrument with their shortcomings (after Barik and Darlong,2008)

Acts/ Policies/ Instruments	Shortcomings
NATIONAL POLICIES	
Forest (Conservation) Act, 1980	The act is totally silent about creating alternate livelihood opportunities for the forest-dependents when forest areas are diverted for non-forestry purpose. Furthermore, under the compensatory afforestation component, the act can provide provisions for species which would be useful for livelihood earning.
Wildlife (Protection) Act, 1972 and amendments, 1991	The act completely lacks any livelihood orientation. Rather the act has been a major hurdle for forest-based livelihood earning as it completely prohibits any form of product extraction from the protected areas (National Parks and Wild Life sanctuaries). It also displaces people from the Protected Areas completely dislocating the forest-based livelihood systems hitherto followed.
Project Tiger Guidelines	It has too little provisions for addressing the issues of livelihood even in buffer areas.
Supreme Court Orders	The Supreme Court interventions are primarily focused on timber (i.e. trees) and related issues, the orders have serious implications on the livelihood issues. Unfortunately, the orders were silent in providing alternate livelihoods to the affected populations, particularly the private forest owners and labourers engaged in timber related activities.
Mineral Policy 1993 and Mining Act, 1957	Since many of the rich minerals are located in forest-rich land inhabited by the native and rural communities, it implies that the livelihood base located in these areas would have adequate attention while minerals are mined and such mined out areas are ecologically restored through plantation/ afforestation. However, the policy does not explicitly address the livelihood issues of the affected communities.
STATE LEVEL POLICY INSTRUMENTS	
Meghalaya Forest Regulation (Application and Amendment) Act, 1973	The act is silent on livelihood issues of the forest dwellers or forest-fringe dwellers.
Garo Hills Regulation, 1882	This old Regulation did take care of livelihood concerns of the local tribal populations.
DISTRICT COUNCIL LEVEL POLICY INSTRUMENTS	
• United Khasi-Jaintia Hills Autonomous District (Management and Control of Forests) Act, 1958 • United Khasi & Jaintia Hills	Although there has been some concerns for addressing the livelihood issues in these acts, both these important acts have ample scope to specifically mention and implement sustainable forest management and livelihood linkages.

	Autonomous District (Management and Control of Forests) Rules, 1960

ANNEXURE 5.37

Issues to be addressed while formulating policy instruments

Policy Instrument	Issues to be addressed	Suggested remedies / inclusion
Supreme Court Intervention	The apparent misinterpretation of supreme court orders/ policies has resulted in non achievements of the objectives through conversion of forests into other land uses.	Both the state government and the district councils must reach to the people with correct interpretation of the underlying objectives of the supreme court orders. Therefore, the extension wing within the forest department and district council needs to be strengthened.
	Livelihood needs till the Working Scheme is approved have not been considered.	A complementary programme with livelihood diversification has always neutralized the impact of supreme court intervention. Therefore, it is recommended that programmes with strong livelihood component should supplement the supreme court interventions. Appropriate programme support to the forest owners / dependents should be recommended. This may be achieved through synchronizing the forest area affected and the developmental programmes of different line departments.
	Although autonomous district council forest acts provide provisions for registering the forests under private and community ownership, the same has never happened.	An analysis of the problems reveal that there is no land record or boundary mapping of such forests making it difficult for registration. Hence, immediate policy should be adopted to map and register the forests by the communities themselves through their capacity development and convincing them the benefits of such policy. Further while adopting such policy care must be taken to get rid of the fear psychosis in the minds of the forest owners that if the forests are registered the ownership may be diluted through government interventions.
	Considering the vast areas under private / community ownership, and given the limitations of human and financial resources with the forest department / district councils, appropriate and	Villagers / forest owners need to be trained on the techniques of working scheme preparation, at least ground enumeration methods. Capacity of the forest officials in the forest dept and district council needs to be strengthened in terms of equipping them with modern technologies such as GIS for working scheme preparation. Preparation of working scheme should be a

	realistic strategy is not in place to complete the working scheme preparation.	joint responsibility of the land owners / communities / district councils and state forest department.
Industrial Policy	As an inter-sectoral policy fall out, the use of forest based raw materials by some specific industries is not only degrading the resource base of the state but also destroying / affecting the long-term livelihood of the forest dependent poor	Industries utilizing forest products through unsustainable harvest need to be identified and completely debarred to operate till alternative technologies and/or sustainable harvest mechanism are in place
Mining Policy	Although Mining Policy, 2003 deals with the livelihood issues of the displaced population, it does not specify the strategies and no Guidelines or Rules have so far been framed to implement these measures.	Appropriate regulatory mechanism giving adequate awareness and power to the traditional institutions need to be in place. Sustainable mining has to be practiced giving adequate attention towards environmental conservation and ensuring secured livelihood for the natural resource dependent population. This has to be achieved both through appropriate policy amendments at national level,introduction of new policy measures both at state and district council level and adopting large scale awareness programme among the land/mine owners and the traditional institutions who would have regulatory power to streamline the mining sector of Meghalaya.
NTFP Policy	No policy for any of the NTFP species of Meghalaya has been formulated, as a result of which NTFP remains neglected forest economy sector.	Policy for cultivation, harvesting, marketing, value addition, technology transfer and financial investment need to be formulated for each of the important NTFP species of Meghalaya, ensuring the private / community ownership of the resources, and discouraging the state monopoly. The policy should aim at improving the livelihood of the NTFP cultivators / collectors through reducing the length of the market chain, providing support price at the time of need, imparting training on value additions, organizing the communities into self help groups for securing easy financing, entrepreneurship development and reduced dependency on middlemen and other exploiters.
Agriculture	Given the fact that	Improvement in jhum systems either

Policy	agriculture is the second most important occupation following forest based livelihood, and the experience of IFAD intervention to enhance agriculture productivity through appropriate intervention necessitates adopting an effective agricultural policy for the state.	through following the jhum regulation act strictly or reducing pressure on jhumland through diversification of livelihood opportunities should be undertaken.
Poverty alleviation Policies	Forestry component is either absent or constitute a minor component in most poverty alleviation policies implemented by Department of Rural Development.	Given the fact that forestry has the potential both to increase the natural capital as well as address the livelihood issues, poverty alleviation policies, strategies and programmes take into account forests and forestry in a way that promotes rural livelihoods.

ANNEXURE 6.1

Proceeding of the Stakeholders' workshop on "Identification of Drivers of Deforestation in Meghalaya" under the Meghalaya-Community Led Landscape Management Project (CLLMP) funded by Meghalaya Basin Management Agency

A one day Stakeholders' workshop under the aegis of Meghalaya – Community Led Landscape Management Project (CLLMP) was organized by Rain Forest Research Institute, Jorhat, Assam at Conference Hall of Indian Council of Social Science Research (ICSSR), North Eastern Regional Centre, NEHU Campus, Umshing, Shillong under the Chairmanship of Shri Budstar Kharmawphlang, IFS, Principal Chief Conservator of Forests (Climate Change, Research& Training), Department of Forest & Environment, Govt. of Meghalaya on 29th January, 2019.The main focus was to have a discussion on the Stakeholder's perception on various drivers of deforestation in their respective zones of the State, in the light of facts & figures generated by the concerned Departments and their consequent ranking. The workshop was attended by 35 participants from Department of Forest & Environment, North-Eastern Hill University, Meghalaya Basin Management Agency, North Eastern Space Applications Centre, Botanical Survey of India (Eastern Regional Centre), Tata Institute of Social Sciences, Department of Commerce & Industries, Department of Economics & Statistics, Office of the District Agriculture Officer and Directorate of Border Area Development, Non Governmental Organizations, Researchers from the University of Edinburgh (Scotland), etc.

In the **Inaugural Session**a presentation was made by **Dr. Dhruba J. Das**, Head, Forest Ecology &Climate Change(FE&CC) Division, RFRIon the project activities; while **ShriAjay Kumar**, Scientist presented some outcomes of the project based on the Direct & Indirect Drivers ranking data collected from the villages distributed within the 3 Hill Zones, *viz*. – Khasi, Garo and Jaintia Hills of Meghalaya.

The **Technical Session** began with discussion and brainstorming amongst the participants. The stakeholders' comprising of Academia, representatives of concerned Departments (Govt. of Meghalaya) and Non-Governmental Organizations expressed their views and assigned ranks to direct and indirect Drivers of Deforestation.

Sri Tambor Lyngdoh, Chief Community Facilitator cum Project Director, Khasi Hills REDD+ project Mawphlang asked about the selection of villages for survey. Dr. Dhruba Jyoti Das, told that the villages were selected randomly covering 27 agro-climatic zones of Meghalaya from the village list which were already marked as highly & very highly degraded Forest area by North Eastern Space Applications Centre (***NESAC***), Umiam, Meghalaya. In this regards, **Dr. K.K. Sarmah,** Scientist presented a short

presentation. Mr. Lyngdoh suggested that the selection of villages for survey should be proper in order to reflect the real drivers of deforestation in Meghalaya. He also suggested, creating awareness among the people of Meghalaya to change their mindsets for conservation of forests and to minimize the use of forest and natural resources. He emphasized to introduce alternative stall-feeding and intensive farming in the villages.

Ms. Shubhi Sharma, Ph. D Researcher (The University of Edinburgh, Scotland, UK) told that wood collection and increase in population are the main direct and indirect drivers of deforestation in Meghalaya respectively. She also suggested for providing alternative livelihoods only for the poor.

Dr. K.K. Sarmah, Scientist (NESAC), recommended that shifting cultivation is the main direct driver and increase in population is the main indirect drivers of deforestation in Meghalaya. He also suggested to make aware the people about the negative impact of deforestation on climate change.

Sri James M. Pohsngap, IFS, suggested that mining & charcoal making is the main drivers of deforestation in Meghalaya. He also suggested for afforestation in a big way and to strengthen implementation of the Biodiversity Act.

Dr. Debendra Kumar Nayak, Professor, Department, NEHU suggested that only the perceptions of the villagers are not sufficient to rank the drivers of deforestation. He ranked road network development and increase in population is the topmost direct & indirect drivers respectively.

Ms. A. Dkhar, Industrial Promotion Officer, Department of Commerce & Industries, Meghalaya told that mining and less awareness is the topmost direct & indirect drivers respectively. According to her the people of Meghalaya should be made aware about the consequences of deforestation and make available alternatives of firewood to reduce deforestation.

Mr. Jerrymaya Lyngdoh, Inspector of Statistics, Department of Economics & Statistics, Govt. of Meghalaya, suggested that settlement expansion and increase in population as the main direct & indirect drivers respectively. He recommended for implementation proper policies and strict enforcement of forest Law to check deforestation. He recommended that socio-economic factors have a complex interaction with the direct drivers of deforestation, which may be given appropriate weight-age. He also suggested that non-availability of alternatives (an indirect driver) may have connection with poverty and lack of employment opportunity. Hence, these rankings may be clubbed together.

Mr. Syiemlich, ACF (MFS), Department of Forest & Environment, Govt. of Meghalaya, told that ranking of drivers of deforestation is not an easy task. He suggested to encourage the villagers to raise nurseries and plantation in the barren area. Awareness programme should be conducted to aware the villages people about

the negative effect of shifting cultivation, burning in the forest and charcoal making. The young generation should be given education for planting of seedlings.

Md. Abdul Ali Sheikh, Agriculture Inspector, O/O District Agriculture Officer, Shillong, ranked charcoal making and less awareness as the topmost direct & indirect drivers respectively.

Mr. P.K. Marbaniang, Deputy Project Director, Meghalaya Basin Management Agency (MBMA), Shillong ranked mining and poverty as the topmost direct & indirect drivers respectively. He also suggested regulating the operation of timber based industries, cement & other mineral based industries to check deforestation in Meghalaya. He also suggested, looking for sustainable livelihood to the people affected by coal mining.

Mrs. Philarisha Mary Thangkiew, Manager (M & E), MBMA, Shillong, suggested village people should start using biogas or other means of fuel instead of wood collection in order to mitigate the pressure on forest.

Mr. D.S. Kharshing, Soil & Water Conservation Department, Govt. of Meghalaya, Shillong, suggested to conduct awareness programme and make involvement of communities in aforestation activities. Moreover, he also suggested to provide alternative sustainable livelihood to the rural people involved in charcoal making, wood collection, stone & sand quarrying. He also suggested for enforcement of strong policies that can conserve and protect the existing forest area apart from the Govt. reserve forest.

Ms. Nimanchwa Laloo, DFO, Social Forestry Division, Jaintia Hills, Department of Forest & Environment, Govt. of Meghalaya, ranked mining & increase in population as the topmost direct & indirect drivers respectively in Jaintia Hills. She also suggested to provide more awareness programme and involvement of community in the afforestation programme.

Dr. Krishna Upadhyay, Assistant Professor, NEHU, Shillong, ranked wood collection & mining as the topmost direct drivers of deforestation in Meghalaya. He suggested to provide alternative way of living to the local people and to increase protected areas by govt./community notification. He also suggested about some research papers to go through.

Dr. Chaya Deori, Scientist-D, BSI, Eastern Regional Centre, Shillong, suggested to do plantation in the degraded area and make aware the rural people about the importance of trees.

Mr. I. Arul Gnana Mathuram, DFO, Shillong, Department of Forest & Environment, Govt. of Meghalaya, suggested for proper identification and delineation of forest under District Council. He also suggested to provide proper alternative livelihood to the rural people and to enforce strong forest legislation in the forests of District Council to minimize deforestation.

Mr. M. J.A. Sangma, DFO, Social Forestry, East Khasi Hills, Shillong, suggested for providing awareness, training and capacity building upto the grassroot level. They should do afforestation in the barren or existing forests. The local people should be provided alternative way of livelihoods and promoted poverty elevation programme.

Mr. A. Lavane, Divisional Soil & Water Conservation Officer, Polo Hills, Shillong, Department of Forest & Environment, Govt. of Meghalaya, ranked charcoal making and less awareness is the topmost direct & indirect drivers respectively in Meghalaya.

Mr. Dawanroi Pyrbot, Agriculture Marketing Officer, Department of Argiculture, Govt. of Meghalaya, Shillong, ranked mining and less awareness is the topmost direct & indirect drivers respectively in Meghalaya. He suggested for afforestation in the barren land.

Mr. J. Dkhar, DFO Social Forestry Division, Nongpoh, Department of Forest & Environment, Govt. of Meghalaya, suggested to create more awareness to the local people of Meghalaya and to raise plantation every year in the wasteland and degraded land in order to increase forest cover in Meghalaya.

Mr. H. Lato, DFO Wildlife, Jowai,Department of Forest & Environment, Govt. of Meghalaya, suggested to provide alternative livelihood for the people to reduce poverty. He recommended for reclamation of degraded area especially the mining area through afforestation programme in Jainitia Hills of Meghalaya. It is necessary for the enforcement of forest laws in Meghalaya to reduce deforestation. He also suggested that lack of employment is one of the major drivers of deforestation, so, the local people should provide alternative livelihood to stop deforestation.

Mr. Hamklet Suchang, Assistant Conservator of Forests, Jaintia Hills Territorial Division, Jowai, Department of Forest & Environment, Govt. of Meghalaya, suggested to find alternative way of livelihood and to generate employment to solve the unemployment problem which causes deforestation.

Mr. Shaphrang B. Rumut, Nongjugi, West Jaintia, Field Assistant, RFRI, Jorhat under the project "Identification of Drivers of Deforestation in Meghalaya", suggested for alternative way of livelihood in Jaintia Hills because mining and shifting cultivation increase pressure on the existing forests.

The meeting ended with Concluding Remarks and Vote of thanks by Dr. Dhruba J. Das, Head, FE&CC Division.

ANNEXURE 6.2

List of Expert Consultants/ Participants of Workshop

SN	Zone/ District	General Information					
		Name	**Designation**	**Department**	**Address**	**Contact No.**	**E-mail**
1	Khasi Hills	Tambor Lyngdoh	CCF/PD, Khasi Hills REDD+ Project	NGO/CBO Synjuk,	Mawphlang, EKH	9863082456	tamborlyngdoh70@gmail.com
2	East Khasi Hills	Shubhi Sharma	PhD Scholar	School ofSocial and Political Sciences, Edinburgh		8794886930	subhi.sharma@ed.ac.uk
3	Meghalaya	Dr. K.K. Sarma	Scientist G	NESAC, Umium	NESAC, Umium	0364 2570138	sarmakk@gmail.com
4	Meghalaya	James Monroe Pohsagap	CCF, R&T, Meghalaya	SFD, Meghalaya	Sylvon House, Shillong	9402507158	monreo_mfs@rediffmail.com
5	Meghalaya	James Monroe Pohsagap	CCF, R&T, Meghalaya	SFD, Meghalaya	Sylvon House, Shillong	9402507158	monreo_mfs@rediffmail.com
6	Meghalaya	James Monroe Pohsagap	CCF, R&T, Meghalaya	SFD, Meghalaya	Sylvon House, Shillong	9402507158	monreo_mfs@rediffmail.com
7	Meghalaya	James Monroe Pohsagap	CCF, R&T, Meghalaya	SFD, Meghalaya	Sylvon House, Shillong	9402507158	monreo_mfs@rediffmail.com
8	East Khasi Hills	Debendra Kumar Nayak	Professor	Geography	NEHU Shillong	9436103290	dknak@rediffmail.com
9	East	A. Dkhar	Industrial	Commerce and	Lumjinegshai,	9774183223	gmdcicshg@gmail.com

	Khasi Hills		Promotion Officer	Industries, Meghalaya	Shillong		
10	Ri-Bhoi	Jerrrymaya Lyngdoh	Inspector of Statistics	Department of ecosnomics and statistics	Lower Lachumiere, Shillong	9436105272	jerrylyngdoh2011@gmail.com
11	East Khasi Hills	S. Syiemheli	ACF	SFD, Meghalaya	Mawlai Mawdathaki, Shillong	9856035137	
12	East Khasi Hills	Abdul Ali Sekh	Agriculture Inspector	Department of Agriculture	District Agriculture Officer, Shillong	9436313603	
13	Meghalaya	P.K. Marbaniang	deputy Project Manager	MBMA	Nongrhim Hills	9436103717	
14	East Khasi Hills	P. M. Jhangkhiew	Manager (M&E)	MBMA	Nongrhim Hills	8119088868	
15	East Khasi Hills	D. S. Kharshing	Soil and Water Conservation ranger	Soil and Water Conservation	Shillong	7640940580	donor_us@yahoo.com
16	Jaintia Hills	Nimanchwa Laloo	DFO, SF, Jaintia Hills	SFD, Meghalaya	West Jaintia Hills	9436999122	dfosocialforestryjowai123@gmail.com
17	Jaintia Hills	Dr. Krishna Upadhayay	Asstt. Professor	Deptt of Social Sciences	NEHU Shillong	9436119857	upkri@yahoo.com
18	Jaintia Hills	Dr. Krishna Upadhayay	Asstt. Professor	Deptt of Social Sciences	NEHU Shillong	9436119857	upkri@yahoo.com
19	Jaintia Hills	Dr. Krishna Upadhayay	Asstt. Professor	Deptt of Social Sciences	NEHU Shillong	9436119857	upkri@yahoo.com
20	Khasi Hills	Dr. Chaya Deori	Scientist D	BSI Shillong	Shillong	9436117339	drchayadeoribsi@gmail.com
21	Khasi Hills	I. Arul G Mathuram	DFO	SFD, Meghalaya	Shillong	9485104805	

22	Khasi Hills	MJA Sangma	DFO, SF, EKH	SFD, Meghalaya	Shillong	9436998862	dcf.sfenv@gmail.com
22	Garo Hills	MJA Sangma	DFO, SF, EKH	SFD, Meghalaya	Shillong	9436998862	dcf.sfenv@gmail.com
23	Jaintia Hills	A. Lamare	DSWC Officer	Soil and Water Conservation	Shillong	9863475797	
24	Jaintia Hills	Dawanroi Pyrbot	Agri Marketing Officer	Agriculture	Shillong	9436106298	dawanroipyrbot@gmail.com
25	Ri-Bhoi	J. Dkhar	DFO, SF, Nangpoh	SFD, Meghalaya	Nangpoh	9436999101	jdsfs07@gmail.com
26	Jaintia Hills	H. Lato	DFO, WL	SFD, Meghalaya	Jowai	9436999834	heisa22_lato@gail.com
27	Jaintia Hills	Hamklet Suchiang	ACF, JH T Division	SFD, Meghalaya	Jowai		hamklet12@gmail.com
28	Jaintia Hills	Shaphrung B Rumut	FA	RFRI	Jowai	7005564227	

Annexure7.1

Future Course of Action to arrest Unregulated & Illegal Coal Mining in Meghalaya (Anon., 2018b)

SN.	Particulars/ Activities
1.	Strict enforcement of existing laws is urgently required.
2.	There is a need to freeze all land registraions in and around the mining areas till land holdings can be Court has to uphold NGT ruling on ban till proper regulatory framework on prospecting, granting of leases, granting of necessary clearances, environmentally sustainable mining, mine reclamation, land laws and labour laws are in placeascertained and area properly mapped to indicate forest land, community land etc.
3.	Plans have to be mine specific, within the larger state framework to ensure that there is proper and standard processes for all operators.
4.	An immediate order to direct that all commercial vehicles plying into North East from bolero pickup, dumper, trucks 4, 6 wheel 12 wheel, 16 wheel etc be fitted with GPS so as to be able to track and figure out their entry and exit including mapping the weight as the National Highways cuts across Assam to Meghalaya to Mizoram to Tripura. Technology is available for this.
5.	The State Government must develop and host in the public domain an endto end, transaction based, management information system that enables *suomoto*disclosure (as mandated under Section 4, Right to Information Act) ofleases granted, mining lease documents, environment clearance, forestclearance, Pollution Control Board clearance, Royalties paid, quantum of mineralextracted and royalty paid. The MIS should also include real time tracking of GPStagged trucks transporting coal from and to pre-determined locations within aframework wherein automated information pertaining to weight of mineralextracted and its conformation at the State operated weighbridge take place.Such initiatives have been operationalized in the State Governments of Rajasthanand Odisha, and can easily be replicated in the State of Meghalaya.
6.	There is urgent need to MAP entire Meghalaya on a war footing speciallybeing declared as a part of bio-diversity hotspot.
7.	The State must ensure that all the information relating to mining operations in the State be made public such that citizens and regulatory authorities can exercise constant vigilance over mining operations and report discrepancies if any. This information should be:
	i) Terms, conditions and norms under which exploration can be carried out
	ii) Statement of purpose for the proposed auction underlying intended production, projected revenue, impact on environment, geology and livelihood foreseen
	iii) List of "no go areas" where exploration and mining cannot take place to protect the environment, geology and habitations
	iv) Information pertaining to distribution of minerals and their location in various geographic locations of the country as recorded by the Geological Survey of India
	v) Details of the entity conducting the 'Environment Impact Assessment' and terms of reference of the same
	vi) Schedule of Environment Impact Assessment and date of public hearing
	vii) Environment Impact Assessment Report
	viii) Environment Clearance
	ix) Clearances granted by the Pollution Control Board and Consent to Operate
	x) Clearances granted by the Department of Forests
	xi) Clearances given by various Line Departments
	xii) Summary of the impact of extraction operations on land, water, air, vegetation and livelihoods
	xiii) Environment Compliance Report

Annexure7.2

Timber yielding species suggested for the plantation forests

Sl. No.	Scientific name	Rotationperiod	Commercial use	Habitat
1	*Albizia lebbeck*	10-15	Timber, plywood	Tropical semi-evergreen and deciduous
2	*Ailanthus grandis*	25-30	Plywood, timber	Tropical semi-evergreen and deciduous
3	*Altingia excelsa*	50-60	Timber, plywood	Tropical semi-evergreen and deciduous
4	*Artocarpus integrifolia*	20-25	Timber, Construction	Tropical evergreen and semi-evergreen
5	*Chukrasia velutina*	20-25	Timber	Tropical evergreen and semi-evergreen
6	*Dipterocarpus macrocarpus*	20-25	Timber	Tropical evergreen
7	*Duabanga grandiflora*	25-30	Timber	Tropical evergreen and semi-evergreen
8	*Gmelina arborea*	10-15	Timber, construction	Tropical semi-evergreen and deciduous
9	*Machilus bombycina*	20-25	Timber	Tropical evergreen and semi-evergreen
10	*Mesua ferrea*	25-30	Timber, construction	Tropical evergreen
11	*Melia azedarach*	10-15	Plywood	Tropical evergreen and semi-deciduous
12	*Michelia champaca*	20-25	Timber, construction	Tropical semi-evergreen and evergreen
13	*Phoebe goalparensis*	25-30	Timber, construction	Tropical evergreen and semi-evergreen
14	*Pinus kesiya*	25-30	Timber, construction	Sub-tropical evergreen
15	*Quercus dealbata*	30-35	Timber, plywood	Sub-tropical evergreen
16	*Schima wallichii*	15-20	Construction, plywood	Tropical evergreen and semi-deciduous
17	*Shorea assamica*	20-15	Timber, Construction	Tropical semi-evergreen and deciduous
18	*Shorea robusta*	20-25	Timber, construction	Tropical semi-evergreen and deciduous
19	*Tectona grandis*	20-25	Timber, construction	Tropical semi-evergreen and deciduous
20	*Terminalia myriocarpa*	20-25	Timber, construction	Tropical evergreen and semi-evergreen

(Source: MBDA, 2014, Forest department, Meghalaya website

ANNEXURE 7.3

Other Important Agro-forestry systems in Meghalaya

Elevation	System	Components		
		Top storey	**Middle storey**	**Lower storey**
Upto 700 m asl	Agri-silviculture	*Lagerstroemia speciosa* +	Paddy	-
		Schima wallichii+	Paddy	
		Schima wallichii +	Ginger + *Colocasia* + Chilli+	*Dioscoria* + Pumpkin + Sweet potato
		Bambusa pallida (Bund plantation)+	Paddy	-
	Agri-horticulture	*Psidium guajava*+	Maize + turmeric	-
		Citrus grandis +	Maize	
		Artocarpus hetrophyllus + *Litchi chinensis* +	Maize + Ginger + *Colocasia* +	Bottle gourd
		Artocarpus hetrophyllus + *Litchi chinensis* +*Areca catechu*		Betel vine
	Silvi-Horticulture pure horticulture	*Acacia auriculiformis*		Pineapple
		Schima wallichii+ *Musa paradisica* +		Pineapple
		Musa paradisica +		Pineapple
		Areca catechu+		Pineapple
700-1400m asl	Agri-silviculture	*Michelia oblonga* +	Paddy	
		Michelia oblonga +	Ginger	
		Michelia champaca +	Paddy	
		Pinus kesiya +	Paddy	
		Pinus kesiya +	Ginger	
		Pinus kesiya +	Turmeric +Maize	
		Erythrinia indica (boundary plantation)	Ginger + *Colocasia* + lady's finger +Chilli	Sweet potato

			+ Perilla+	
700-1400m asl	Agri-silviculture	*Bambusa pallida* (boundary plantation)+	Paddy + Ginger + Chilli + Tapioca + lady's finger + Colocasia+Perilla+	Sweet potato
		Michelia oblonga + Pinus kesiya+	Ginger + Chilli + *Colocasia*+Perilla + Maize + Turmeric	
		Bambusa pallida +Erythrinia indica+	Maize +	Sweet potato
		Schima wallichii+	Paddy	
		Schima wallichii +	Ginger + *Colocasia* + Chilli+	*Dioscoria* + Pumpkin + Sweet potato
	Silvi-pastoral system	*Schima wallichii*+	Broom grass	
		Michelia oblonga+	Broom grass	
		Michelia champaca + *Schima wallichii* +*Pinus kesiya* +	Broom grass + setaria	
	Horti-pastoral system	*Musa paradisica* +	Broom grass	
		Musa paradisica +*Citrus reticulata* +	Broom grass + setaria	
1400 m asl and above	Agri-silviculture	*Pinus kesiya* +	Paddy	
		Pinus kesiya +	Ginger	
		Pinus kesiya +	Turmeric +Maize	
	Agri-horticulture	*Pyrus communis* +	Maize +	Cabbage + Cauliflower
		Citrus reticulata +	Turmeric + Ginger + Mustard	
		Citrus reticulata +	Maize + Turmeric + Ginger + Mustard+	Cauliflower + Potato

(Bhatt et al., 2005)

ANNEXURE 7.4

List of top 50 prioritized species of Medicinal and aromatic plants

S.No.	Botanical name	Common name	Areas of occurrence
1	*Cinnamomum tamala*	Tejapat/bay leaf	Sohra, west Khasi Hills, Ri Bhoi and War areas of Khasi Hills
2	*Piper longum*	Pippali	Throughout the state
3	*Aloe barbadensis*	Greekwar	Throughout the state
4	*Rauvolfia serpentina*	Sarpagandha	Garo Hills, Ri-Bhoi
5	*Symplocos racemosa*	Lodh/lodh Pathani	Garo Hills, Ri-Bhoi, Garampani
6	*Swertia chirayita*	Chirayita	Shillong, Jowai
7	*Acorus calamus*	Vaach	Marsh,Tropical
8	*Homalomena aromatica*	-	Ri-Bhoi, East/Khasi and Garo hills
9	*Rosa damascens*	Gulab Phool	Shillong, Lowai
10	*Saraca asoca*	Ashoka	Garo Hills, Ri-Bhoi
11	*Emblica officinalis*	Amla	Garo Hills, Ri-Bhoi, Garampani
12	*Asparagus racemosus*	Shapawar/Satawar	Garo Hills, Ri- Bhoi, Garampani
13	*Tinospora cordifolia*	Giloe	Garo Hills, Ri-Bhoi,
14	*Andrographis paniculata*	Kalmegh	Garo Hills, Ri-Bhoi,
15	*Plumbago zeylanica*	Chitrak/Sheetraj Hindi	Garo Hills, Ri-Bhoi,
16	*Mucuna pruriens*	Kawanch	Garo Hills, Ri-Bhoi,
17	*Embelia ribes*	Vayavidanga/Baobarang	Shillong
18	*Valeriana wallichii*	Tagar	Shillong peak
19	*Caesalpinia sappan*	Patanga	Garo Hills
20	*Taxus wallichiana*	Dieng Blei	East and West Khasi Hills
21	*Hedychium spicatum*	-	Ri-Bhoi, East Khasi and Garo Hills
22	*Panax wangianus*	Ginseng	East and West Khasi Hills
23	*Solanum indicum*	Barikatai	East Khasi Hill
24	*Mesua ferrea*	Nagkesara	Ri-Bhoi
25	*Operculina turpethum*	Trivert	Garo Hills, Ri-Bhoi
26	*Oroxylum indicum*	Shayonak	Garo Hills, Ri-Bhoi
27	*Garcinia indica*	Kokam	Garo Hills, Ri-Bhoi
28	*Piper cubeba*	Kababchina	Garo Hills
29	*Vetiveria zizanoides*	Usir/Khas	Garo Hills, Ri-Bhoi
30	*Smilax chinia*	Chobchini	Ri-Bhoi
31	*Pterocarpus santalinus*	Rakta chandan	Garo-Hills

32	*Curculigo orchiodes*	Kali musli	Garo Hills
33	*Uraria picta*	Dabra	Garo Hills, RiBhoi
34	*Centella asiatica*	Manduk parni	Khasi Hills, Jantia Hills, RiBhoi
35	*Baliospermum montanum*	Danti	Garo Hills
36	*Crataeva nurvala*	Varun	Garo Hills, Ri-Bhoi
37	*Gloriosa superba*	Langli	Garo Hills, Ri-Bhoi
38	*Gymnema sylvestre*	Mesasringi	Garo Hills, Ri-Bhoi
39	*Piper chaba*	Chab/Peepal chab	West Khasi Hills
40	*Zanthoxylum alatum*	Tejbal	Garo Hills
41	*Microstylis wallichii*	Rishwak	Hills, Ri-Bhoi
42	*Elaeocarpus sphaericus*	Rudra	Garo Hills, Ri – Bhoi
43	*Prunus cerasoides*	Paddam	East Khasi and West Garo Hills
44	*Piper mullesua*	Pippali	West Khasi and East Khasi Hills
45	*Gaultheria fragrantissima*	Jirhapiong	West and East Khasi Hills
46	*Houttuynia cordata*	Jamyrdoh	East Khasi Hills
47	*Garcinia cowa*	Rengran	East Khasi Hills
48	*Terminalia chebula*	Harar/Halelal	Zard East Khasi Hills
49	*Aegle marmelos*	Bael/Belgiri	Garo Hills, Ri-Bhoi
50	*Boerhaavia diffusa*	Purnava	Garo Hills

(http://www.kiran.nic.in)

ANNEXURE 7.5

List of commercially important edible plants

S. No.	Scientific name	Local Name	Commercial Parts used	Habitat
1	*Aegle marmelos*	Soh-bel	Juice, Powder	Tropical, wet and dry
2	*Artocarpus chaplasha*	Deing-soh-ram	Fruit	Tropical, wet and dry
3	*Azadirachta indica*	Deing-neem	Fruits leaves, bark	Tropical dry
4	*Castanopsis indica*	Deingh-sarang	Fruit	Tropical semi-evergreen forest
5	*Cinnamomum tamala*	Deing-la-tyrpad	Leaves, Bark	Tropical evergreen
6	*Citrus hystrix*	Soh-kyniet	Fruit	Tropical evergreen
7	*Cornus capitata*	Deing-soh-japhon	Fruit	Tropical evergreen and semi-evergreen
8	*Cyathocalyx martabanicus*	-	Fruit	Tropical forest
9	*Dillenia indica*	Soh-kyrban	Fruit	Tropical evergreen
10	*Diospyros kaki*	Deing-iong	Fruit	Tropical evergreen and semi-evergreen
11	*D. lancifolia*	Deingh-thang	Fruit	Tropical evergreen and semi-evergreen
12	*Docynia indica*	Deingh-soh-phoh	Fruit	Tropical evergreen and semi-evergreen
13	*Elaeocarpus floribundus*		Fruit	Tropical evergreen and semi-evergreen
12	*Emblica officinalis*	Soh mylleng	Fruit	Tropical deciduous
13	*Eugenia roxburghii*		Fruit	Tropical evergreen and semi-evergreen
14	*Eugenia jambolana*	Deingh-ramai	Fruit	Tropical evergreen and semi-evergreen
15	*Flacourtia cataphracta*	Deingh-soh-mluh	Fruit	Tropical deciduous
16	*Garcinia cowa*	Rengran	Fruit	Tropical evergreen
17	*G.lanceifolia*	Dieng-soh-jadu	Fruit	Tropical evergreen
18	*G. pedunculata*	Deiengh-soh-kwang	Fruit	Tropical mixed forest
19	*Horsfieldia amygdalina*		Seeds Aril	Tropical evergreen and semi-evergreen
20	*Hovenia dulcis*	Deiengh ja-lyntep	Peduncles	Tropical evergreen and semi-evergreen

21	*Litchi chinensis*	Soh-manir	Fruit	Tropical evergreen and semi-evergreen
22	*Mangifera indica*	Deieng-soh-pieng	Fruit	Tropical evergreen and semi-evergreen
23	*Moringa oleifera*		Fruit leaves ,Flowers	Tropical deciduous
24	*Myrica esculenta*	Deieng-soh-phie	Fruit	Sub tropical or temperate evergreen
25	*Nephelium longana*	Dieng-loba	Aril	Tropical evergreen and semi-evergreen
26	*Parkia roxburghii*	Aoelgap	Pod	Tropical evergreen
27	*Prunus cerasoides*		Fruit	Sub tropical or temperate evergreen
28	*Psidium guajava*	Soh-pyriam	Fruit	Tropical semi-evergreen and deciduous
29	*Pyrularia edulis*	Deieng-soh-klong	Fruit	Tropical evergreen and semi-evergreen
30	*Rhus javanica*	Sa-ma	Pulp	Tropical evergreen and semi-evergreen
31	*R. semialata*	Deieng-soh-ma	Fruit	Sub-tropical evergreen
32	*Syzygium cuminii*	-	Fruit	Tropical evergreen and semi-evergreen
33	*S.tetragonum*	Dieng-soh-sarlei	Fruit	Tropical evergreen and semi-evergreen
34	*Tamarindus indica*	Deieng-soh-kyntoi	Fruit	Tropical semi-evergreen and deciduous
35	*Zanthoxylum budrunga*	Dieng-ka-shyrang	Fruit and leaves	Tropical evergreen and semi-evergreen
36	*Ziziphus mauritiana*	Soh-bori	Fruit	Tropical semi-evergreen and deciduous

(Source: Sawian et. al. 2007)

ANNEXURE 7.6

List of commercially important bamboo species

S. No.	Scientific name	Habitat	Part used	Use
1	*Bambusa balcooa*	Cultivated and wild	Branch, culm, leaf, young shoots	Agricultural implements, construction, firewood, basket
2	*B. bambos*	Cultivated and wild	culm	Walling, flooring, partition walls, basket
3	*B. caharensis*	Cultivated and wild	Branch, culm, leaf, young shoots	Construction, roofing thatching, partition wall, scaffolding
4	*B. jaintiana*	Cultivated and wild	Branch, culm, leaf, young shoots	Construction, roofing thatching, partition wall, scaffolding
5	*B.nutans*	Cultivated and wild	culm, leaf, young shoots	Construction, ropes, water pipe, spindle pulp for paper
6	*B. pallida*	Cultivated and wild	Culm	Supporting material for construction, pulp for paper, basket, mats
7	*B. polymorpha*	Cultivated	Culm	Supporting material for construction, baskets, mats
8	*B. tulda*	Cultivated and wild	Culm young shoots	Supporting material for construction, walling, roofing, scaffolding, pulp for paper, rayon, musical instrument basket, mats
9	*B. vulgaris*	Cultivated and wild	Culm, shoots	Thatching, walling, roofing, scaffolding, pulp for paper, basket, mats, furniture, animal cages, poles, handicraft
10	*Dendrocalamus hamiltonii*	Wild	Branch, culm, leaf, young shoots	Material for construction, bridge construction fencing agriculture implement, kitchen and cookware components, handicrafts, poles, water and milk vessels, floats for timber rafts. walling, roofing, scaffolding, pulp for paper
11	*D. longispathus*	Cultivated and wild	Branch, culm, leaf, young shoots	Raw material for pulp and paper industries, thatching, tooth picks
12	*D. sikkimensis*	Wild	Branch, culm, leaf,	Raw material for pulp and paper industries, thatching,

			young shoots	tooth picks
13	*D. strictus*	Cultivated and wild	Culm young shoos	Supporting material for construction, walling, roofing, scaffolding, pulp for paper, rayon, tooth brush instrument basket, mats
14	*Melocanna baccifera*	Cultivated and wild	Branch, culm, leaf, young shoots	Raw material for pulp and paper rain industries, thatching, tooth picks
15	*Schizostachyum dullooa*	wild	Culm	Supporting material for construction, thatching, walling roofing, handicrafts, water vessel, basket, mats, boxes to carry pan.

(Source: Kharlyngdoh and Barik, 2008)

ANNEXURE 7.7

List of commercially important Cane species

S.No.	Species	Local Name	Uses	Distribution
1	*Calamus acanthospathus* Griff.	Dieng sohmir	Rope, of suspension bridges, chair making, walking sticks, basket and containers, umbrella handles, polo sticks and furniture	Nokrek, Chandigre in Garo hills; Jarain, Jowai, Syndai in Jaintia Hills; Whole Khasi hills.
2	*Calamus flagellum* Griff.			Khasi hills
3	*Calamus floribundus* Griff.	Ryshamg	Basket making	Garo Hills: Balphakram WLS, Nokrek, Sohka; Jaintia hills: Dawki, Syndai, Rytiang Khasi hills: Nongpoh
4	*Calamus guruba* Buch-ham		Furniture, basket and containers	Khasi hills
5	*Calamus latifolius* Roxb.		Furniture, basket and containers, umbrella handles	Garo Hills: Balphakram WLS, Chandigre, sisubibra; Jaintia hills: Dawki, Jarain, Narpuh reserve.
6	*Calamus leptospadix* Griff	Thrisaw	Furniture. handicrafts and baskets	Jaintia hills: Jowai, Khleihriat, Sonapur, Syndai; Khasi hills
7	*Calamus rotang* L.	Slasoh-thri	Furniture, walking sticks, basket, mats, blinds	Khasi hills
8	*Calamus tenuis* Roxb.	Thriia	Furniture, basket, chair seats etc.	Garo hills: Nokrek
9	*Daemonorops jenkinsiana* Griff.		Basket making crook of umbrella handles etc.	Khasi hills

(Mao et al., 2016, Biswas and Ramesh, 1995)

ANNEXURE 7.8

Edible mushrooms of Meghalaya

Species	Habit	Cultivation techniques	Market potential
Agaricus biosporus	Cultivated and wild	Developed	Sold in market
Albatrellus sp	Wild	Not developed	Sold in market
Armillaria mellea	Wild	Developed	Sold in market
Boletus edulis	Wild	Not developed	Sold in market
Cantharellus cibarius	Wild	Not developed	Sold in market
Clavaria aurea	Wild	Not developed	Not sold in market but consumed by people
Clavaria cinerea	Wild	Not developed	Not sold in market but consumed by people
Clavaria flava	Wild	Not developed	Not sold in market but consumed by people
Craterallus odoratus	Wild	Not developed	Not sold in market but Consumed by people
Gomphus floccosus	Wild	Not developed	Sold in market
Laccaria lateritia	Wild	Not developed	Sold in market
Laccaria laccata	Wild	Not developed	Sold in market
Lactarius deliciosus	Wild	Not developed	Sold in market
Lactarius indigo	Wild	Not developed	Not sold in market but Consumed by people
Lactarius rubidus	Wild	Not developed	Sold in market
Lactarius volemus	Wild	developed	Sold in market
Lentinus edodes	Wild	Not developed	Not sold in market but consumed by people
Ramaria boyrytis	Wild	Not developed	Not sold in market but Consumed by people
Ramaria formosa	Wild	Not developed	Sold in market
Russula parvovirescens	Wild	Not developed	Not sold in market but consumed by people
Suillus bovinus	Wild	Not developed	Not sold in market but consumed by people
Tricholoma Saponaceum	Wild	Not developed	Not sold in market but consumed by people
Tricholoma viridiolivaceum	Wild	Not developed	Not sold in market but consumed by people
Terimitomyces macrocarpus	Cultivated and wild	Developed	Sold in market

(Source: Kailta et al., 2016; Khaund and Joshi, 2013)

ANNEXURE 7.9

List of Good practices (international / national experience) of Himalayan or mountain states where forests have improved by way of community efforts

SN	Good practices	References
1.	Nepal	
	Inculcating awareness • Use of quotas on management boards and within organizations and user groups to try to ensure the inclusion of socially marginalized people. In Nepal, as more widely in the HKH, this most often means quotas for women, deprived and indigenous communities. While these provisions may not safeguard the rights of marginalized people, they do provide legal and normative grounds for such people to demand a greater stake in decision-making processes. • The promotion of marginalized community members into leadership roles within organizations. This is sometimes done by quotas and sometimes promoted by donors as a desirable practice. We see more of this practice within community-level institutions than at other levels. • The formation of community-level management groups that are restricted to women or deprived or indigenous communities. These groups are intended to help overcome some of the broad discrimination that all members of these groups feel. Groups composed of marginalized people often find it difficult to retain control over their resources, however, and face greater challenges in negotiating with powerful government actors.	Acharya, 2004 Nightingale, 2006 Hobley and Jha, 2012
	Facilitate markets for non-timber forest products • An enterprise promotion program in Nepal doubled the price received by collectors of essential oils and bark for traditional paper in 30 villages simply by gaining approval for direct marketing and advertising market prices paid by intermediate buyers in neighboring India. The market price information generated by this small program became common knowledge and producers throughout Nepal and northern India were able to gain higher prices for these products. In the program area, biodiversity in fact increased as producers now had both incentives and income to invest in improving their resource base.	Subedi, 2002
2.	Waiga, Uttarakhand, India	
	• Putting a stop to open grazing of their cattle on the proposed plot. As mentioned earlier, they had decided to begin with protection work on only 8 hectares, but the physical continuum of the two parts of the plot made it difficult for them to leave one section open to their cattle and prevent them from entering the restricted area. So after 6 months of failing to make this combination work they decided to protect the whole of the leased land and subsequently stopped the practice of free grazing on the entire 15 hectares. This too was a big step, as it meant that they had to find alternative places to graze their livestock or use a different approach to cattle rearing. • Planting of around 1500 plants of Utis in the spring of 1995. They used their experience of planting Utis on their private lands to good effect. • Preventing the livestock of Chulkot from free grazing on their	FES, 2003

proposed forest plot, this would also then protect their agriculture fields. Since no physical activity of walling or fencing was feasible at that time, they decided to patrol the forest plot in turns or to go to the plot whenever they saw livestock in it. • Protecting their plot from annual fires that were set by people. This they did by not putting their plots to fire themselves. And whenever they saw their plot being set on fire a group rushed up to the site and put it off.	
3. Mawphlang, Meghalaya, India	
• Communities in the project area were aware and concerned about forest loss, erosion, changes in stream flows, and shortages of forest products but lacked the financial and technical resources to address the problem. • When financial and technical assistance was provided, local leaders and community institutions mobilised members to renew and strengthen resource management rules and regulations and implement them through consensus-based community action. • Community discussions were held to identify the opportunity costs of conservation and restoration and find mutually agreeable activities to generate alternative income to compensate for lost income. • Performance-based conservation award money provided effective incentives for implementation of watershed restoration activities and funded a revolving community bank account that sustained the community resource-management system after the project ended.	Poffenberger, 2006
4. Senapati district, Manipur, India	
• The village authority in association with some elderly persons from within the village, select the area to be used for jhum every year and then distribute plots among individual families who will carry out shifting cultivation. Once the annual shifting cultivation area is earmarked by the village authority it is divided among the individual households, with each household identifying the natural boundaries of its plot. Individual households are responsible for managing their plot; their use rights are withdrawn once the area is abandoned when shifting to a new site. • However, there is a rule in the village that any individuals leaving the village permanently have to surrender their land (homestead area and terraced field) and the trees growing on the area to the village authority. They cannot sell the land to any other persons either inside or outside the community. The village authority will then decide whom to allot the terraced land to, giving priority to young couples who have separated from their parents, or will put the land up for auction.	Poffenberger, 2006
5. Dhara Vikas initiative, Sikkim, India	
• Developing para-geohydrologists to bridge the knowledge gap regarding geo-hydrology and revival of springs at the village level • Landscape level approach by reviving springs, streams and lakes • Community driven initiative which created a grassroots demand by successfully demonstrating pilot projects in springshed development • Linked with MGNREGA national programme for sustainable funding support	SAARC, 2013

6. Swat valley, Khyber Pakhtunkhwa, Pakistan	
• The JFMC and the constituent villagers were made aware about the deleterious practices leading to the deterioration of the forest resources after overcoming the initial resistance to the changed paradigm. • The JFMC trained the villagers in appropriate lopping techniques to generate renewable production, and with this improvement visible signs to this effect have been noted obtain healthy conifer trees crop. • The bio-mass production in the forests has been increased considerably; as local livestock owners are encouraged to cut grasses and promote stall feeding instead of open grazing in the forests. • The collectors were made aware of the proper timings and trained in the collection and pre and post collection processing of plant material of various species (Medicinal and aromatic plants) for obtaining quality products and value added marketing.	SAARC, 2013

Annexure 7.10

List of institutions that could provide support in establishing planted forests/ agroforestry models/ NWFP

Some of the premier institutions engaged in research and extension works are as listed below.

Sl. No.	Name of Institution	Geographical coverage
1.	Rain Forest Research Institute, Jorhat, Assam (India) (Indian Council of Forestry Research and Education)	North-East India
2.	North Eastern Region Community Resource Management Society (NERCRMS), Shillong, Meghalaya (India) (a joint developmental intiative of the North Eastern Council(NEC), Ministry of DoNER, Govt. of India and International Fund for Agricultural Development (IFAD))	Meghalaya
3.	North Eastern Hill University (NEHU), Shillong, Meghalaya (India)	North-East India
4.	Meghalaya State Rural Livelihoods Society (MSRLS), Shillong, Meghalaya (India)	Meghalaya
5.	ICAR-Agricultural Technology Application Research Institute (ATARI), Umiam, Meghalaya (India)	Meghalaya
6.	Forests & Environment Department, Government of Meghalaya (India)	Meghalaya
7.	Soil & Water Conservation Department, Government of Meghalaya (India)	Meghalaya
8.	G.B. Pant National Institute of Himalayan Environment & Sustainable Development NE Regional Centre, Arunachal Pradesh (India)	North-East India
9.	CSIR-North East Institute of Science & Technology (Formerly, Regional Research Laboratory), Jorhat, Assam (India)	North-East India
10.	National Research Centre for Orchids, Pakyong, Sikkim (India)	North-East India
11.	Assam Agricultural University, Jorhat, Assam (India)	North-East India

Annexure 8

Photographs

Ecological survey in Khasi Hills

Rubber plantation in Khasi Hills

Regeneration of *Castanopsis* spp. in Khasi Hills

Jewel orchid in natural habitat of Khasi Hills

Rock mining in Khasi Hills

Charcoal making in Khasi Hills

Grazing evidences in Khasi Hills

Fuelwood collection in Khasi Hills

Current *Jhum* land in Khasi Hills

Fire evidences in Khasi Hills

Laying Quadrats in Jaintia Hills

Rat-hole coal mining in Jaintia Hills

Abandoned Rat-hole coal mining in Jaintia Hills

Current Rat-hole coal mining in Jaintia Hills

Grazing evidences in Jaintia Hills

Fuelwood collection in Jaintia Hills

Fire evidences in Jaintia Hills

Felling evidences in Jaintia Hills

Cashew Plantation in Garo Hills

Areca nut Plantation in Garo Hills

Natural regeneration of *Garcinia* sp.

Ecological survey in Garo Hills

Felling evidences in Garo Hills

Invasive species in Garo Hills