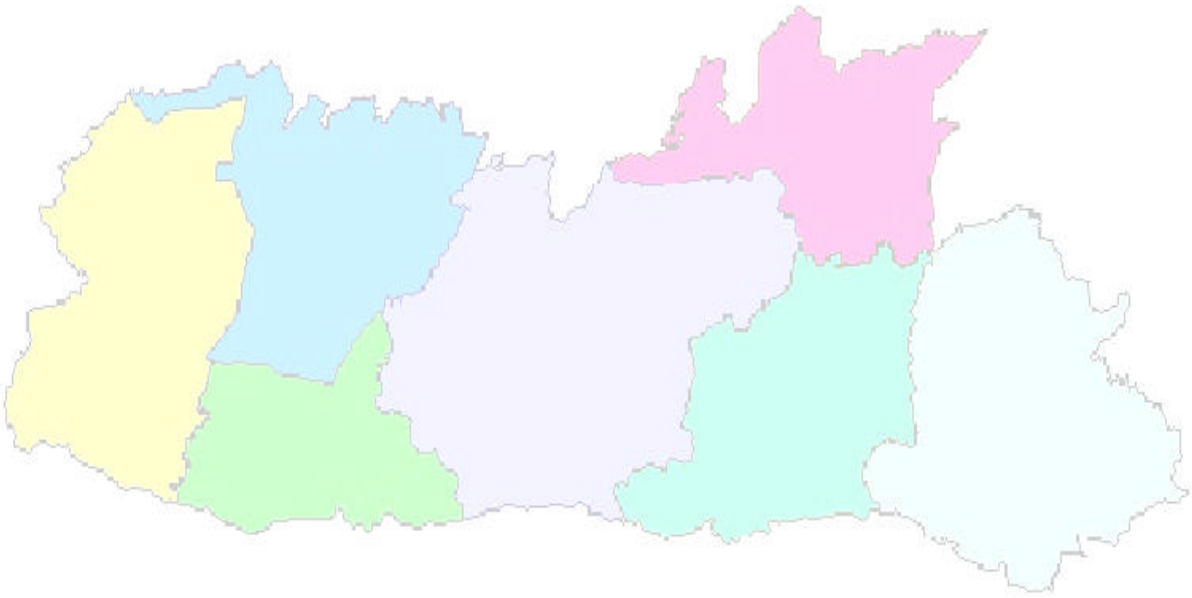
Central Statistical Organisation
Ministry of Statistics & Programme Implementation
Government of India, New Delhi

Environmental Accounting of Natural Resources of Meghalaya: Phase I- Land and Forest Resources

Technical Report
(Revised)



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Central Statistical Organisation
Ministry of Statistics & Programme Implementation
Government of India, New Delhi

Technical Report of the
Project entitled

'Environmental Accounting of Natural Resources of Meghalaya: Phase I– Land and Forest Resources'

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2008

Abbreviations

ESA	Ecologically Sensitive Area	**RB**	Ri-Bhoi
EKH	East Khasi Hills	**SGH**	South Garo Hills
EGH	East Garo Hills	**SFR**	State of Forest Report
FSI	Forest Survey of India	**SFD**	State Forest Department
GHADC	Garo Hills Autonomous District Council	**WKH**	West Khasi Hills
JHADC	Jaintia Hills Autonomous District Council	**GSDP**	Gross State Domestic Product
JH	Jaintia Hills	**NSDP**	Net State Domestic Product
KHADC	Khasi Hills Autonomous District Council	**ESDP**	Environment adjusted state domestic product
MoEF	Ministry of Environment and Forest	**NDP**	Net Domestic Product
NTFPs	Non-timber Forest Products		

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ACKNOWLEDGEMENTS

First, we would like to express our sincere thanks and gratitude to the Central Statistical Organisation (CSO), Ministry of Statistics and Programme Implementation, Government of India, New Delhi for assigning us this study with necessary financial support. During the study and preparation of report, we received help and support of a number of institutions, organizations and individuals in the form of publications, reports and personal discussion. We are highly grateful for their contribution which enabled us to complete the study and prepare this report on 'Environmental Accounting of Natural Resources of Meghalaya: Phase I- Land and Forest Resources'.

The Department of Statistics and Economics, Government of Meghalaya, Shillong; Department of Forest, Government of Meghalaya, Shillong; Department of Agriculture, Government of Meghalaya, Shillong; Department of Soil Conservation, Government of Meghalaya, Shillong; Autonomous District Councils of Khasi Hills, Jaintial Hills and Garo Hills and ICAR Complex for NEH Region, Umiam, Meghalaya were consulted, time to time for relevant information on land and forest resources of Meghalaya. We are highly grateful to them for sharing the valuable information in the form of publications, reports, and relevant data and maps. We also accessed some data and maps from various websites, which are also gratefully acknowledged.

It may not be possible to mention names of all those, whose contributions helped us in completing this report. However, we would like to make special mention of Dr. S. K. Nath, Director General, CSO, Ministry of Statistics and Programme Implementation, Government of India, New Delhi; Prof. Amitabh Kundu, Dean, Jawaharlal Nehru Univesity, New Delhi; Shri Vishnu Kumar, ADG, CSO for their expert advise and suggestions during the course of study and preparation of report. Generous technical and administrative support rendered by the officials of CSO particularly Shri Mohan Singh, DDG; Shri R. C. Aggarwal, Director; and Mrs. Rajnesh Jain, Director are gratefully acknowledged. We are also grateful to the members of Technical Monitoring Committee, CSO, Ministry of Statistics and Programme Implementation, Government of India, New Delhi and for their valuable suggestions and comments, which helped us in improving the content of this report.

Sincere efforts were made by Project Fellows, Ms. Marvellous B. Lynser and Mr. Sanjeeb Bharali in primary and secondary data collection, compilation, analysis and report preparation. We acknowledge their valuable contribution from the beginning to the end of this project. We also thank Shri S. Sarma for preparation of some of the maps included in this report. Finally, we would like to thank the Head, Centre for Environmental Studies, North-Eastern Hill University and the Vice-Chancellor, North-Eastern Hill University, Shillong for allowing us to undertake this work and other officials of the University for providing necessary administrative support.

March 13, 2008 **O. P. Singh and B. K. Tiwari**

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Chapter 1

Introduction

The main purpose of natural resource accounting is to gather information on the state of natural resources and the changes affecting them so as to help in sustainable development of these resources. It is the compilation of data on natural resources within an accounting framework and also covers the interpretation and reporting of data. Natural resource accounts may involve either physical quantities or stocks valued in monetary terms. The data generated can be used to maintain balance between economic growth and development and the state of environment. It can support policy for integrated environmental and economic analyses at the sectoral and macro-economic levels. Therefore, Environmental Accounting of Natural Resources is seen as a means of demonstrating linkages between the environment and the economy for promoting sustained productivity of the economy.

Meghalaya is endowed with rich natural resources, both renewable and non-renewable. However, no attempt has been made so far to account these natural resources. Very little data is available on types and extent of various natural goods and services of the state. As a result, the value of these resources, many times is underestimated. Hence, they are either overexploited or not put to use at all and lack proper management. This report aims to compile the data on natural resources particularly land and forest of Meghalaya both in physical and monetary terms. Such data are required for planning as well for formulation of policies that are conducive for conservation and management of forest and land resources.

In Meghalaya, forest and land resources are very important since 80 per cent of rural population of the state is either directly or indirectly dependent on agriculture and forest goods. The state has rich and diverse forest resources. About 75% of the state's total geographical area is under forest cover (FSI, 2003). The forests are contributing a considerable amount to the economy of the state by providing subsistence livelihood to a vast section of population. This can be in the form of labour in extraction and processing of timber, charcoal making, collection and marketing of Non-Timber Forest Products (NTFP) and Medicinal and Aromatic Plants (MAPs), and government sponsored afforestation projects. However, statistics records showed that the contribution made by forestry sector towards our economy in the year 1999-2000 is only 1.05 % of total GDP (Directorate of Economics and Statistics, 2003). This may be due to the reasons that most of the goods and services are not taken into account. Agriculture is equally important for the people of Meghalaya. However, this is practiced on less than ten percent of the land at any given point of time but supports livelihood of 80% people of the state.

The main aim of this study is to make an environmental accounting of the land and forest resources available in Meghalaya so as to reflect the real contribution of these resources to the state's economy. The main objectives in this study are:

- Generation of data pertaining to various components of Land and Forest Resources of Meghalaya and their types and extent
- Identification of goods and services rendered by forest and land and their annual output
- Valuation of these resources (components and goods and services) in economic terms
- Identification of ecologically sensitive areas and,
- Identification of various natural and anthropogenic threats to land and forest resources of Meghalaya

The study is mainly based on secondary data however primary data pertaining to forest goods were also collected by conducting village survey. To collect secondary data extensive survey of the available literatures on land and forest resources was carried out by visiting different institutions and libraries. Published and unpublished information/data on types and extend of land and forest resources, goods and services rendered by these resources, annual out-turn, market prices, etc., were collected from various sources like Government and Non-government Departments, Journals, Theses and Technical reports. Interviews were also conducted with officials of different departments and institutions. Compilation and analysis of the secondary data were done to give the state of the natural resources in Meghalaya.

The report documents various goods and services which are rendered by land and forests of the state. In the case of forest, a physical accounting has been done for forest goods available in the state. This includes Timber and Non- timber forest products like Bamboo, Firewood, Charcoal, Bay Leaf (*Cinnamomum tamala*), Broom grass (*Thysanolaena maxima*), Fodder, Thatch grass, Packing Leaf (*Phyrnium puvinerve*), Wild Pepper (*Piper peepuloides*), Pine resin, Torchwood, Wood Lichen (*Usnea* sp.) and Amla. Forest services like soil protection, water supply, biodiversity protection etc. have been documented. Monetary accounting using different methods was done only on the major goods and services.

The problem related with natural resource accounting in Meghalaya is non availability of relevant data. Most of the data required are either lacking or unavailable, especially in Meghalaya as individuals are the sole proprietors of the land resources so it is rather difficult to maintain information on these individual lands. In the case of forests, about 92% of forests in the state are not under the control of State Forest Department. On one hand this can be taken as an opportunity as the benefits of these forests can reach directly to the people who own and manage the land and forest but on the other hand, it is extremely difficult when it comes in terms of planning and laying out policies for management by the government.

The Study Area: Meghalaya

Meghalaya is one of the eight states of north eastern region of India. It emerged as a full fledged state on 21st January, 1972. The state lies between 25°4´ N to 26°10´ N latitudes and 89°48´ E to 92°50´ E longitudes with a total geographical area of 22,429 sq. km (Figure- 2.1). It is bound on the north by Dhuburi, Goalpara, Nogaon, Kamrup and Karbi Anglong districts and on the east by the Cachar and North Cachar Hills districts of Assam. On the South and West is Bangladesh. The total population of the state as per 2001 census is 23, 06,069 with an average density of 103 persons per sq. km (Directorate of Economics & Statistics, Meghalaya 2003).

2.1 Geographical Features

The Plateau with rolling grasslands interspersed by river valleys forms the main physical features of Meghalaya. The plateau of Garo Hills slopes down to the Brahmaputra valley in the north and drops down toward Bangladesh in the south and west. The state can be divided into three natural sectors, the Central plateau, the Southern border areas and the Northern border areas. The Central plateau forms the highest region of the state. It lies between 1230-1850m above mean sea level. It comprises mainly the highland of Khasi and Jaintia Hills, and is more or less centrally situated. The central plateau is the source of all the big rivers of the state. The southern border area has a highly irregular feature. This region begins where the central plateau ends. It is more or less continuation of the central plateau up to a few kilometers with interruptions here and there caused by sudden drops and depressions. As it recedes further from the central plateau and moves closer to the border of Bangladesh, the sudden drops and depressions become more prominent till they abruptly end in sheer precipices. The northern border area lies to the north of the state and merges with the border districts of Assam. The northern border area continues in features more or less similar to the Central Plateau in its gradual downward move till it merges with the border of Assam. The whole area of the state is full of scenic beauty. Waterfalls, lakes, peaks and hills, meadows, valleys and rushing rivers combine to make a rich panorama.

2.2 Geology

Meghalaya represents the remnant of the ancient plateau of pre-cambrian Indian peninsula. It forms a prominent geomorphic unit stretching across the Garo Hills, Khasi Hills and Jaintia Hills in East-West direction. Meghalaya consists of five geological formations, *viz*., (a) The Archean gneissic complex with acid and basic intrusive, (b) The Shillong group of rocks mostly quartzites, usually friable, phyllites, schists, conglomerates, (c) The Lower gondwana rocks, (d) The Sylhet traps and (e) The cretaceous tertiary sediments (*cf*. Tripathi *et al*., 1996).

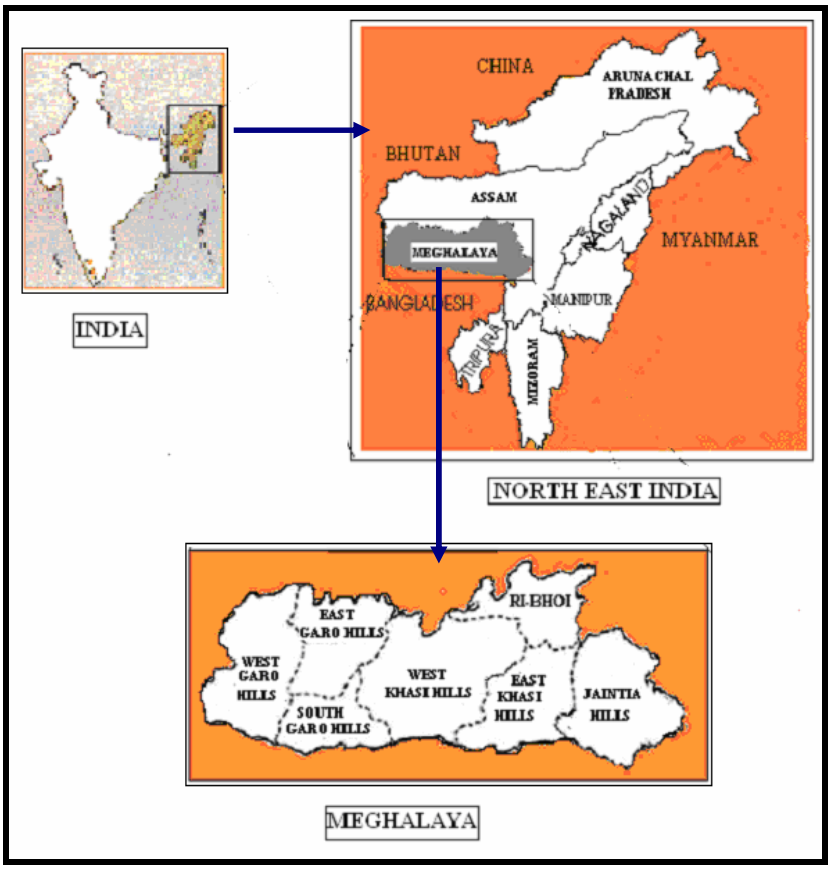


Figure-2.1 Location map of Meghalaya

2.3 Climate

Meghalaya has a monsoon type of climate and is directly influenced by the south-west monsoon originating from the Bay of Bengal and Arabian Sea. But there are some variations in the climatic variables from place to place depending upon altitude and physiographic differences of landmass. While the Shillong plateau (600-2000m) has a bracing climate verging towards the temperate type, 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. Cherrapunjee and Mawsynram are known to receive highest rainfall in the world.

2.4 People

Meghalaya is predominantly a tribal state and inhabited by 3 tribal communities, namely *Khasis*, *Jaintias* and *Garos* who account for 89% of the total population. The *Khasis* and *Jaintias* are held to be remnant of the first Mongolian overflow into India and inhabit eastern parts of Meghalaya, while Garos are believed to have migrated into Garo hills from Torue province of Tibet and inhabit the western part of Meghalaya. Rural Meghalaya covers about 98.97 % of the total geographical area and accounts for 80.37% of the population, with a substantial proportion of the population consisting of subsistence farmers (Directorate of Economics & Statistics, Meghalaya 2003).

Traditional Social Institutions in Meghalaya forming the lowest administrative tier play a vital role in the local administration. The village is the basic unit in the Traditional Institutions. It is the centre of community life and activities. Within the village, the Village Council is the authority in controlling and managing its affairs. The activities of the Village Council range from law and order, protecting customary beliefs and practices to initiating developmental programmes. Each village is governed, managed and controlled by the Village Council. The Headman represents the Village Council. Adult male members of the domestic groups are members of the Village Council as per the traditions. Every permanent resident of the village and belonging to a clan is recognized socially and enjoys the right of protection from the Village Council and also the use of common property resources. The functional aspects of the Village Councils are maintenance of law and order, settlement of intra-village disputes, community development, and interaction with government departments and implementation of government schemes.

2.5 Vegetation

Meghalaya is endowed with rich natural vegetation, ranging from sub-tropical to tropical. The actual forest cover in Meghalaya is 16,839 sq. km (75.08 % to the total geographical area) but the recorded forest area of the state is only 9,496 sq. km which accounts for only 42.34% of the state's geographical area (FSI report, 2003). Only a small portion of about 1,124 sq. km of the recorded forest is under the control of the State Forest Department while the remaining areas are managed and controlled directly or indirectly by the respective Autonomous District Councils of Khasi, Jaintia and Garo Hills as per the provisions of the Sixth Schedule of the Constitution of India. Few pockets of undisturbed natural forests exist in the state and are being protected by the tribals as 'Sacred Groves.

The state is very rich in its natural forest resources. Besides extraction of valuable timber yielding trees like *Tectona grandis, Shorea robusta, Terminalia myricarpa, Gmelina arborea, Pinus khasiana, Michelia champaca, Toona ciliata*, etc., a number of non-timber forest products (NTFPs) which have enormous economic, ornamental and medicinal values are extracted abundantly. Bamboo, cane, orchid, bayleaf, broomgrass, packing leaf and medicinal plants are some of the important forest products besides the traditional items like honey, wax and lac.

Bamboos form one of the important vegetations in the state and occupy about 5863 sq. km of the total geographical areas (Trivedi and Tripathi, 1984). As many as 325 species of Orchids grows in the state. The Khasi and Jaintia hills are considered the center of diversity for several primitive tree genera such as *Magnolia* and *Michelia* and for families such as *Elaeocarpaceae* and *Elaeagnaceae*. Meghalaya's endemic Pitcher Plant (*Nepenthes khasiana* Hk.) which grows well in the Jarain area of the Jaintia Hills, Baghmara area of the Garo Hills and in Southern parts of Khasi Hills remains till now an explicable phenomenon to the botanists. Despite the fact that the populations of several animal species have tremendously decreased and many species have also become extinct, Meghalaya is still rich in faunal wealth. It is considered by many biologists to

have been the gateway through which many species of Indo-Chinese origin, particularly mammals, migrated to Indian Peninsula. About 50% of the total number of mammal genera found in the entire Indian sub-continent can be seen in Meghalaya and its adjoining states in the North-East.

2.6 Minerals

The State of Meghalaya is a store house of economic minerals. The major minerals which are presently being mined are Coal, Limestone, Silimanite, Clay and Keolin, Glass sand, Quartz and Feldspar**.** Deposits of these minerals are spread through out the state. Recently presence of Uranium deposit was discovered in the Southern part of West Khasi Hills and this discovery brings Meghalaya into the uranium map of India. According to Directorate of Mineral Resources, Government of Meghalaya maximum limestone reserves are present in the Khasi Hills Districts while maximum coal reserves are present in Garo Hills Districts whereas, the extraction is more in Jaintia Hills District. Jaintia Hills District alone contributes more than 70% of total coal production of the state. The quality of limestone found in the state varies from cement grade to chemical grade. These minerals are utilized in several mineral based industries in the state as well as in the country. Coal and Limestone are also exported to Bangladesh.

2.7 Agriculture

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 2,23,756 hectares in 1990 to 2,65,874 hectares in 2004, which is 11.9% of the total geographical area of the state (Directorate of Agriculture, Government of Meghalaya, 2005). The development of agriculture in the state depends on a number of factors, including the method of cultivation, the ownership of land, the availability of irrigational facilities, the extent of soil conservation, the availability of cultivable land and its fertility. Ownership of land including most of the forest areas is mainly private *i.e*., with local tribals. Majority of people living in rural areas are dependent on the forest for their day-to-day needs of food supplements, fodder, medicines, fuel wood and construction materials. In addition to this, they also derive some income from forests by way of extraction and sale of forest products and employment in forest based industries. Still some farmers follow the conventional methods of cultivation known as Jhum or shifting cultivation which is widely practiced in some part of the state. The major food crops are Rice, Maize, Wheat, Millet etc. Besides these some of the important cash crops in the state are Potato, Ginger, Turmeric, Black Pepper, Arecanut, Tezpatta, Betelvine, Short-staple cotton, Jute, Mesta, Mustard and Rapeseed. The State is also renowned for its horticultural crops like Orange, Lemon, Pineapple, Guava, Litchi, Banana, Jack Fruits and Temperate fruits such as Plum, Pear, Peach etc. (Directorate of Agriculture, Government of Meghalaya, 2002).

Chapter 3

Methodology

The present study on Environmental Accounting of Natural Resources of Meghalaya is first of its kind in the state. The relevant information and data for preparation of this report were collected mainly from secondary sources available in publications and reports of various government departments and academic institutions. However, some information pertaining to forest resources was also collected by conducting primary sample survey at village level. The details of data collection and compilation are given below:

3.1 Collection of data from Secondary sources

An extensive survey of the available literatures on land and forest resources was carried out by visiting different government departments, academic institutions and various libraries. Published and unpublished data pertaining to land and forest resources, and their various goods and services were collected from journals, theses and technical reports. Some information was also collected by interviewing officials of the different departments and institutions.

Information/data on forest products, their quantity, transportation and trade chain were collected from sources such as, State Forest Department (Divisional Forest Office, Range Forest Office, Beat Office and Check gates), Autonomous District Councils. The data, thus collected were the source information on various NTFPs, their quantity and cost. The rate of Royalty of different forest products were collected from the respective Autonomous District Councils of the state to know the revenue earned by them. The usage of some important forest resources from Common Property Land Resources for the state was taken from the 54^{th} round National Sample Survey Report conducted by the National Sample Survey Organisation (NSSO).

The data for the changes in forest cover and the growing stock were collected from the Forest Survey of India Reports and other publications of the Forest Research Institute, Dehradun. The distribution of various types of forests in Meghalaya was localized with the help of relevant Satellite Imageries of National Remote Sensing Agency, Hyderabad and Topographic sheets of the Survey of India. The data pertaining to land resources of the state were collected from published and unpublished reports of different Government Department including Department of Agriculture, Government of Meghalaya, and Indian Council for Agricultural Research (ICAR) Complex for NEH Region, Umiam, Meghalaya. Further, journals, thesis and other publications were scrutinized and the relevant information and data were collected for the report. The soil quality data for different areas of the state were obtained from the Directorate of Agriculture, Government of Meghalaya.

3.2 Generation of Primary Data

Meghalaya is one of the biodiversity rich states of India. Different forest products, both timber and non-timber are collected by the people of state for their own consumption as well as for sales in market. Availability and types of forest products differs with the climatic and edaphic conditions and their collection varies with the type of forest and the way of living of the people from one region to the other. Previous studies have documented the availability and use of different forest products in the state. However, little information is available on types and quantity of forest products collected by rural households from different types of forests and by different tribal groups. During present study, primary survey was conducted to find out the types of forest products collected from different types of forests, their quantity and uses.

A village map of Meghalaya was superimposed over the remote sensing map showing different types of forests in the state, and the villages which fall under the different forest types were selected for conducting primary survey. Four major types of forests in the state viz., Tropical evergreen forest, Sub-tropical pine forest, Semi evergreen forest and Moist deciduous forest (Sal forest) were considered for the survey. These forests occur at different altitude through out the state. From each type of forest, a total of 6 villages were selected randomly from different divisions and districts of the state to capture variations of forest produce collected in different regions and by different tribal communities of the state.

In a selected village, stratification of the households was done on the basis of the income group. Ten percent of the total households were then randomly selected from each village with equal representations from the high, middle and low categories. The field survey was done during the month of May-August 2005 and 2006 by using a structured questionnaire. The field survey questionnaire was designed mainly to obtain adequate information on extraction of forest products, household use of these products, prices of these products and the source from where they were collected. Information, both at village level and household level were collected by interviewing the people. The interviews of the selected households were done by personal visits to the households.

The market price of various forest products at the producer level was considered for the study so as to avoid complications involving transportation cost and labour cost. The market rates for some forest produce used in the valuation were obtained from the Forest Resource Survey, Meghalaya while others were collected by interviewing the villagers who were involved in collection and marketing of goods.

Forests of Meghalaya

The state of Meghalaya is known for its diverse, extensive and luxuriant forests. The rich natural vegetation of the state ranges from Sub-tropical to Tropical owing to its diverse topography and varied climatic and edaphic conditions. Availability of fertile soil and its spatial variability in structure and texture provide rich substratum for growth and development of a wide range of vegetation. Further, luxuriant growth of wide range of flora is also attributed to differences in altitude and climatic conditions.

4.1 Forest Area

4.1.1 **Forest Cover**

According to Forest Survey of India (FSI) Report, 2003 the actual forest cover in Meghalaya is 16,839 sq. km which accounts for 75.08 % of the State's total geographical area, leaving only about 24 % non-forest land (Table- 4.1). The FSI had also classified forests into three categories *viz.*, Very Dense, Moderately Dense and Open Forest (Table- 4.2). A very small percentage of about 0.8 % (168 sq. km) of forest in the southern portion of the Garo Hills and Ri-Bhoi Districts comes under very dense forest category. Moderately dense forest is about 28.2 % (6,323 sq. km) and the rest 46.1 % (10,348 sq. km) is open forest.

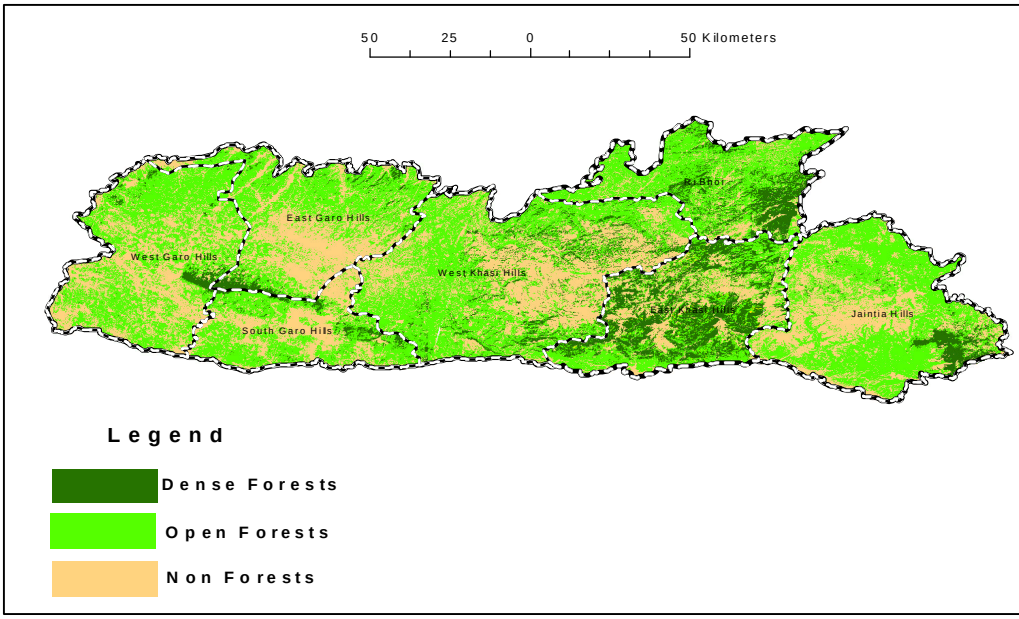


Figure- 4.1 Map showing forest cover in Meghalaya (Source: State of Forest Report, 2003)

District wise break-up of forest cover in the state shows that Ri-Bhoi district has the highest forest cover of 88.09% whereas Jaintia Hills has the lowest forest cover. The district wise extent of Dense and Open forests and their percentage of the state are shown in Table- 4.1. Dense forest is highest in the Ri-Bhoi district whereas Open forest is highest in East Garo Hills district. According to FSI 1995, the growing stock of the forest of Meghalaya is 6600 cu m/sq. km with an annual increment of 136.82 cu m/sq. km. The recorded forest area in the state is only 9,496 sq.km. (42.34%). It is divided into four categories *viz.*, Reserve Forest, Protected Forest and National Parks and Unclassed Forest (Table- 4.2). The Unclassed forest constitutes the highest percentage with nearly 90 % of the total recorded forest area.

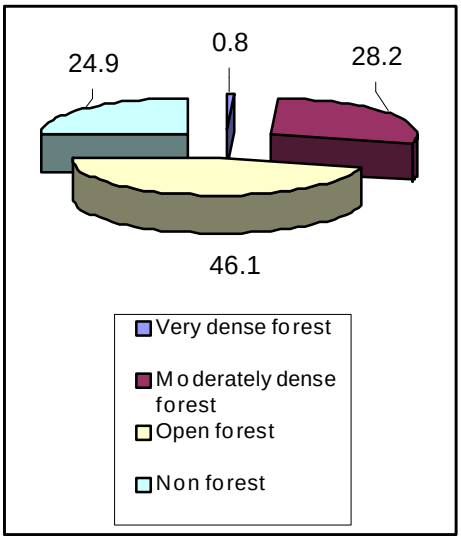


Figure- 4.2 Percentage of different types of forest in Meghalaya

Table- 4.1 Dense and Open forest cover in different districts of Meghalaya

District	Geographi-cal Area (sq. km)	Forest Cover (sq. km)					
		Dense forest		**Open forest**		**Total**	
		Area	%	Area	%	Area	%
East Garo Hills	2,603	653	30.5	1,486	69.5	2,139	82.17
South Garo Hills	1,849	599	41.1	858	58.9	1,457	78.80
East Khasi Hills	2,820	643	34.3	1,234	65.7	1,877	66.56
Jaintia Hills	3,819	1006	40.9	1,451	59.1	2,457	64.34
Ri Bhoi	2,376	863	41.2	1,230	58.8	2,093	88.09
West Garo Hills	3,715	1172	39.6	1,787	60.4	2,959	79.65
West Khasi Hills	5,247	1555	40.3	2,302	59.7	3,857	73.51
Total	**22,429**	**6491**	**38.6**	**10,348**	**61.5**	**16,839**	**75.08**

Source: Forest Survey of India (2003)

Table- 4.2 Recorded forest area in Meghalaya

Forest types	**Area (Sq. km)**	**Percentage**
Reserved Forest	712.7	7.51
Protected Forest	12.4	0.13
National Parks	267.5	2.82
Unclassed Forest	8503.0	89.55
Total	**9,495.6**	**100**

Source: Statistical Handbook, Meghalaya (2005)

4.1.2 **Change in forest cover**

The comparison of forest cover from 1991 to 2003 shows a significant variation in different years. There is a decreasing trend in total forest cover from 1991 to 2001. In 1991, the forest cover was 70.78 % of the total geographical area of the state, whereas it deceased to 69.48 % in 2001. However, in 2003 an appreciable increase in the forest cover was recorded and 75.1 % of the State's geographical area was found to be under forest. The reduction in forest cover during 1991-2001 may be attributed to shifting cultivation. The net change in the forest cover shows that an additional 1,291 sq. km. was brought under forest between year 2001 and 2003 (Table- 4.3).

Table- 4.3 Variation in forest cover during 1991-2003

Year	Forest cover (Sq. km)	Percentage	Net Change (Sq. km)
1991	15,875	70.78	-
1993	15,769	70.31	-106
1995	15,714	70.06	-55
1997	15,657	69.81	-57
1999	15,633	69.70	-24
2001	15,584	69.48	-49
2003	16,839	75.08	1,255

Source: Forest Survey of India Reports (1991-2003)

Though the percentage of total forest cover in the state is high however, a closer analysis of the data showed that a large chunk of the forest belongs to the open category. It has been found that except in Protected Areas, some isolated patches of community and sacred forests and in inaccessible places, old growth forests have vanished and composition of forest communities is changing very fast. It has also been noted that there was a significant variation in the area of dense and open forests in the previous years (Table- 4.4). While dense forest shows more or less increase in area, open forest decreased with increase in dense forest (Figure-4.4).

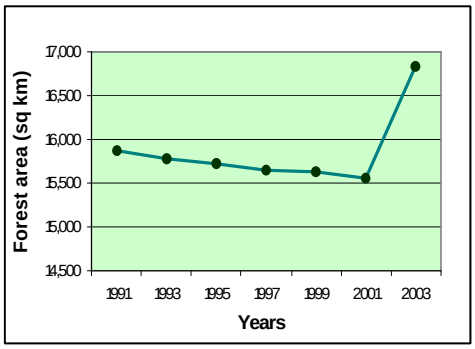


Figure- 4.3 Change in the forest cover during 1991-2003

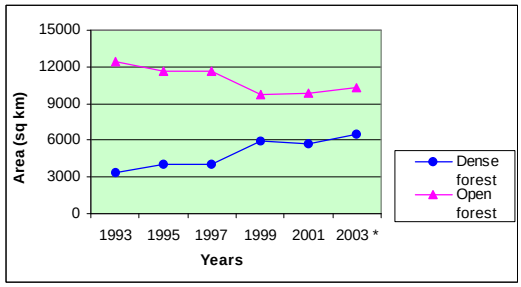


Figure- 4.4 Change in the dense and open forests during 1993-2003

Comparison of recorded forest area over a period of ten years showed that there is a slight change in the reserved forest area but no change in the other categories was recorded (Table- 4.5).

Table- 4.4 Change in Dense and Open forestS during 1995-2003 (in sq. km)

Year	Dense forest	Open forest	Scrub
1993	3,305	12,464	-
1995	4,045	11,669	816
1997	4,044	11,613	849
1999	5,925	9,708	261
2001	5,681	9,903	259
2003 *	6,491	10,348	74

* Dense forest = Very Dense Forest + Moderately Dense Forest.

Table- 4.5 Changes in Recorded forest area from 1990-91 to 2000-01 (sq. km)

Year	Reserved Forest	Protected Forest	National Park	Un-classed	Total
1990-91	71.31	1.24	26.75	850.30	949.60
1992-93	71.31	1.24	26.75	850.30	949.60
1994-95	71.31	1.24	26.75	850.30	949.60
1996-97	71.31	1.24	26.75	850.30	949.60
1998-99	71.27	1.24	26.75	850.30	949.56
2000-01	71.27	1.24	26.75	850.30	949.56

Source: Statistical Handbook, Meghalaya (2003)

4.2 Forest classification

Forest can be classified on the basis of legal status, density, ownership, functions, exploitability and species composition. Some common classifications used in Meghalaya are given below:

4.2.1 **Classification of forest based on legal status**

Based on the legal status, the forests of Meghalaya can be classified into categories such as Reserve forest, Protected forest and Unclassed forest. The area and percentage under different categories are given in Table- 4.6. Unclassed forests constitute the highest percentage (88%) of the total recorded forest area of the state (Figure 4.5). The Reserve forests are constituted under the Indian Forest Act (1927) and State Forest Act and have full degree of protection. Protected forests are constituted under chapter 4 of the Indian Forest Act having limited degree of protection. Reserved forest and Protected forest constitute only a very small percentage (11.84 %) of the total recorded forest area in Meghalaya. A list of the Reserve and Protected forests and their area is given in Annexure 1 and 2. Unclassed forests are those forests that are neither included in Reserve or Protected forest categories and whose ownership status varies in different states. In the case of Meghalaya, such forests belong either to District Councils or private parties and are rarely surveyed.

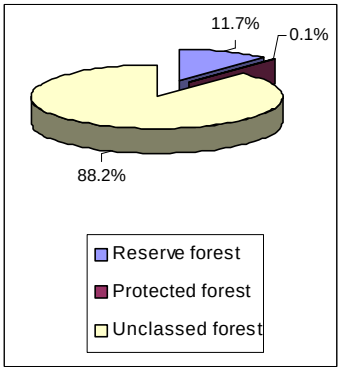


Figure- 4.5 Percentage of area under different types of forest based on legal status

Table- 4.6 Area under different categories of forests based on legal status

	Reserve forest	Protected forest	Unclassed forest	Total
Area (Sq. km)	1,112	12	8,372	9,496

Source: Forest Survey of India Report (2003)

4.2.2 **Classification of Forests based on density**

On the basis of the vegetation density, the forests of Meghalaya are classified into Dense forest (canopy density more than 40%) and Open forest (canopy density of 10 to 40 %). According to the FSI Report (2003), out of a total forest cover of 16,839 sq. km, Dense forest occupy an area of 6,491 sq. km (168 sq. km under very dense and 6323 sq. km under moderately dense) and open forest occupy an area of 10,348 sq. km (Table- 4.7). Figure- 4.6 shows the percentage of dense and open forests in the state. The open forest in the state are highly degraded either because of shifting cultivation or due to felling of trees for timber, fuel-wood and other purposes.

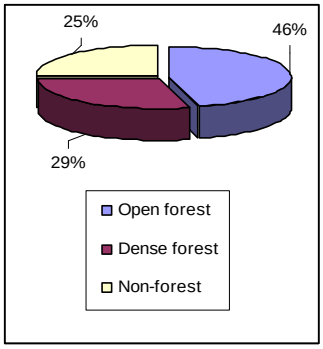


Figure- 4.6 Percentage of forest area based on density

Table- 4.7 Area OF Dense and Open forests in Meghalaya (in sq. km)

Geographic Area	Dense Forest	Open forest	Total forest cover
22,429	**6491**	**10,348**	**16,839**

Source: Forest Survey of India Report (2003)

4.2.3 **Classification of forest based on ownership**

In Meghalaya ownership of land including forest is governed by customary laws and practices. The land tenure system is influenced by the customary law of the tribe inhabiting the area and differs from one District Council to the other. Majority of the forests in the state belongs to individuals. Apart from the Reserve and Protected forests in and around Shillong which are under the control and management of the State Forest Department in arrangement with the District Councils, the rest of the forests are managed directly or indirectly by the District Councils of Khasi, Jaintia and Garo Hills in their respective areas. In practice, the real authority over these forests lies with the concerned owners. In the Garo Hills, the erstwhile *zamindary* estate known as B-Mahal are directly administered by the District Council while the *Akhing* land of the Nokmas are in the hands of the respective Nokmas or clan chiefs who look after the land under mutual understanding with the District Council. On the basis of ownership, the forests of Meghalaya have broadly been divided into Reserve forest, Un-classed forest, Private forest, Protected forest, Village forest and *raid* forest and the area under various categories is given in Table- 4.8.

Table- 4.8 Area under different types of forests on the basis of ownership

	Types of Forest	Area (sq. km)
1.	Reserve forest including Government Forests, National parks and Sanctuaries	993.0
2.	Un-classed forest	7,146.5
3.	Private forest	384.0
4.	Protected forest	179.0
5.	Village forest	25.9
6.	Raid (Community) forest	768.0
Total		**9496 .4**

4.2.4 **Classification of forest based on vegetation types**

The classification of Meghalaya forest based on vegetation types as mapped by Indian Institute of Remote Sensing (IIRS) IRS-ID LISS-III data is given below (IIRS, 2002):

1. Subtropical evergreen forest
2. Semi-evergreen forest
3. Sal forest
4. Sub-tropical Pine forest
5. Sub-tropical Mixed Pine forest
6. Moist Mixed Deciduous forest
7. Bamboo forest

The vegetation type map of Meghalaya and percentage of various types of forest based on vegetation are depicted in Figure- 4.7 and Figure- 4.8, respectively.

Another commonly used classification was the one given by Chauhan and Singh (1992). Here the forest of Meghalaya is classified into three groups viz., (1) Tropical forests (2) Sub-Tropical forests and (3) Temperate forests on the basis of altitude, rainfall and species composition (Table- 4.9). Tripathi (2002) conducted a detailed study on the four major forest types in

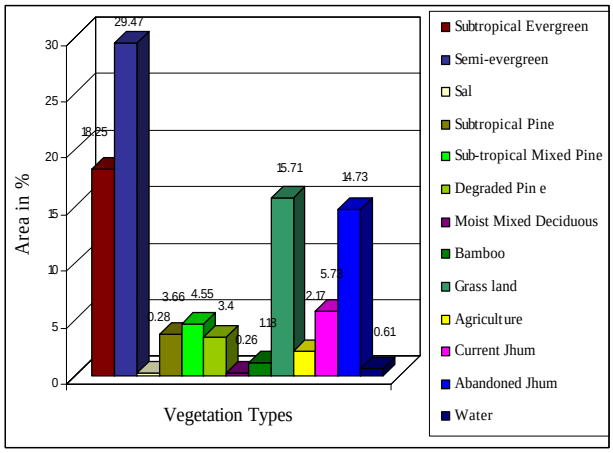


Figure- 4.8 Area under different types of vegetation types in Meghalaya (Source: IIRS, 2002)

the state which cover 42.2% of the state's total geographical area. The subtropical evergreen forest covers about 11.6%, subtropical semi-evergreen forest around 21.5 %, tropical moist deciduous forest 1.3% and subtropical pine forest 7.8 % of the total geographical area.

Table- 4.9 Forest types of Meghalaya and their species composition

Types of forest	Altitude (m)	Dominant species
Tropical forest	Upto 1000	*Acrocarpus froxinifolius, Bischofia javanica, Dillenia indica, D. pentagyna, Dysoxylum binectariferum, Elaecarpus floribunda, E. robusta, E. rugosus, Gynocardis odorata, Lannea coromandelica, Lithocarpus fenestratus, Mesua ferrae, Sapium baccatum, Terminalia spp., Vitex penduncularis.* *Antidesma acuminate, Aoprusa dioica, Dalbergia assamica, Ficus racemosa, Garcinia spp., Heritiera macrophylla, Mangifera sylvatica, Pterospermum lancifolius, Sterculia spp.* *Alchornea tiliaefolia, Antidesma buniuis, Gregia disperma, Premna barabata*
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* etc. *Pinus kesiya, Acacia dealbata, Elaeocarpus lancifolius, Erythrina arborescens, Quercus griffithii, Schima wallichii, S. khasiana.*
Temperate forest	Above 1350	*Castanopsis kurzii, C. armata, Elaeocarpus prunifolius, Ficus nemorlis, Lithocarpus fenestratus, Myrica esculenta, Manglietia insignis, Eurya japonica, Schima wallichi.*

(Chauhan and Singh, 1992)

4.3 Growing stock

In 1995, the Forest Survey of India had estimated the growing stock in India based on forest cover area and inventory results. According to this study for the corresponding dense forest area of 3305 sq. km, the growing stock is 51.02 million cu m and for 12,464 sq. km open forest, the growing stock is 53.12 million cu m. Thus, the total growing stock of Meghalaya forest is 104.14 million cu m with an overall volume of 66 cu m per hectare. Comparing the inventory results of 1990 and 1995, there is a decrease in average overall growing stock per hectare of forest from 100.71 cu m in the year 1990 to 66 cu m only in 1995. The estimated annual increment of growing stock for Meghalaya forest is 2.15 million cu m.

Figure- 4.9 Dense Sub-tropical forest in Mawriang (Pynursla, East Khasi Hills)

4.4 Afforestation

Afforestation programme is very much essential both from environmental as well as economic points of view. The Government of Meghalaya had taken up various programmes like Social Forestry through Forest Department in respect of tree plantation and also afforestation of depleted forest lands. Several other departments like Soil Conservation Department also took up programmes of afforestation in the private forest area and barren lands of private parties in order to rejuvenate the same with vegetation. The areas under afforestation maintained annually by the Forest Department are given in Table- 4.10. Tree species often recommended for plantations in the state are Teak, Sal, Pine, Gamari etc. Recommendation of tree species for plantation very much depends on the type of land. Pine, Mixed species and Bamboo are the common species for plantations under Social Forestry.

4.5 Shifting cultivation

Shifting cultivation is an age old agricultural practice in Meghalaya. It is still prevalent in many parts of the state. This type of cultivation might have been suitable in the past when population pressure was less and was practiced in a cycle of more than 20 years. But due to increase in population the Jhum cycle has now been reduced to 3-5 years. According to the report of the Task Force on Shifting Cultivation, Ministry of Agriculture (1983), about 52,290 families in the state were practicing shifting cultivation on 530 sq. km land area annually and the minimum area under shifting cultivation at one time or other is about 2650 sq. km. Every year large track of forest land is cleared for shifting cultivation but year wise data for this is not available. As per the State of Forest Report (1997), loss of forest due to shifting cultivation has been estimated to be 77 sq. km but 20 sq. km is recovered under natural regeneration leaving only 57 sq. km as loss in forest cover. The Forest Survey of India (1999) also reports the cumulative forest area affected by shifting cultivation in Meghalaya during the period 1987 to 1997 which is estimated to be 1800 sq. km (FSI, 1999).

Table- 4.10 Area under plantation in Meghalaya from 1995-96 to 2004-05 (in ha)

Year	Inside reserved forest	Outside reserved forest	Total
1995 - 96	180	2375	**2555**
1996 - 97	403	1993	**2396**
1997 - 98	233	75	**308**
1998 - 99	374	461	**835**
1999 - 00	244	338	**582**
2000 - 01	301	2080	**2381**
2001 - 02	44	810	**854**
2002 - 03	592	640	**1232**
2003 - 04	39	0	**39**
2004 - 05	22.5	0	**22.5**
Total	**2432.5**	**8772**	**11204.5**

Source: State Forest Department (2006).

Chapter 5

Biodiversity

Biological diversity or biodiversity refers to the variety of life forms at all levels of organization. It provides the basis for life on earth, including that of humans. Human society depends on biodiversity for meeting their basic needs such as food, clothing, medicine and building material. It also provides a number of raw materials for industries and contributes substantially towards economic development. Meghalaya is a treasure trove of biodiversity represented by its diverse forest types, habitats and rich flora and fauna. The 'Meghalaya Subtropical Forest Ecoregion' is one of the wettest ecoregions in the Indo-Pacific region (Rawat and Wikramanayake, 2001) and home of a large number of endemic and rare plant and animal species. The Khasi-Jaintia Hills of Meghalaya have been described as one of the richest botanical habitats of Asia (Rodgers and Panwar, 1988).

5.1. Forest diversity

The forests of Meghalaya ranges from Sub-tropical evergreen to Moist mixed deciduous types of forests, which harbour very rich species diversity of both plants and animals. Table- 5.1 shows plant diversity in 4 different types of forests in Meghalaya. Kumar et al. (2006) analysed the tree species diversity and distribution patterns in forests of Garo Hills and reported the presence of 162 tree species in primary forests, 132 in secondary forests, and 87 in sal forests.

Table- 5.1 Plant species diversity in different types of forests of Meghalaya

Forest Type	No. of Families	No. of Genera	No. of Species				Shannon-Wiever Index
			Tree	Shrub	Herb	Total	
Subtropical evergreen forest	107	213	183	85	99	367	4.379
Semi-evergreen forest	84	180	170	54	65	289	6.919
Sub-tropical pine forest	48	84	51	26	39	116	5.389
Sal forest	22	33	22	5	11	38	4.329

Source: Indian Institute of Remote Sensing, 2002

Dense impenetrable herbaceous undergrowth along with climbers and lianas is a common phenomenon in tropical evergreen, tropical moist and dry deciduous forests of Meghalaya. The high reaches of the lofty trees are often blanketed by a lush growth of epiphytic orchids in tropical evergreen forests. Sub-Tropical forests are composed mainly of evergreen elements and show abundant growth of mosses and epiphytes.

5.2 Floral and Faunal diversity

5.2.1 Floral Diversity

The richness in plant diversity in Meghalaya forests can be seen with 3,128 species of flowering plants including 1,237 endemic species (Khan et al., 1997). The flowering plants of Meghalaya comprise about 18% of the total flora of the country. A wide variety of wild cultivable plants, edible fruits, leafy vegetables and orchids are found in the natural forests of Meghalaya. Besides these, several valuable medicinal plants are also found. However, due to overexploitation,

deforestation and habitat destruction many endemic and threatened species are now mainly confined to the protected areas and scared groves. From the 91 species encountered in five sacred groves in Meghalaya, 60 species are endemic to northeast India or eastern Himalayas and 51 are rare to Meghalaya and 26 species are endemic to Meghalaya (Anon, 2005).

5.2.1.1 Rare, threatened and endangered plant species

There are about 200 taxa of plants in Meghalaya which are listed under different categories in the Red Data Book (Jain and Sastry, 1990). Rao and Haridasan (1983) have reported 54 rare and threatened plants and Haridasan and Rao (1985–1987) have listed 44 rare dicotyledonous plants from Meghalaya. A list of plants that have become extinct or at the verge extinction is given in Box 5.1.

Box 5.1. Extinct flora of Meghalaya

Michelia lanuginose Wall, *Cyathocalyx martabanicus* HK.F & Th, *Mahonia simonsii* Takeda, *Amirandra griffithii* Dyer, *Sterculia khasiana* Debai, *Impatiens depaupirata* HK.f., *Dumasia khasiana* (Baker) Thoth, *Cheirotheca khasiana* Hk.f., *Dyospyros pilosula* (DC) Hiern, *Strychnos axillaries* Coteber, *Trigonotis hookeri* Benth, *Premna punduana* Wall, *Artocarpus gomerianus* Wall.ex Trecul, *Bulbophyllum acutiflonim* Reichb.f., *B.penicillium* Par & Reichb.f., *Chamacrops khasiana* Griffi, *Dendrobium talconeri* HK.f., *D.Wardianum* Warn., *Geodorum citrinum* Jack, *Liparis dutheir* HK.f., *Oberonia tahitensis* Lindl (Chauhan and Singh, 1992).

5.2.1.2 Endemic Plants

About 40% of the total flora of Meghalaya is endemic. A very prominent plant species endemic to the state is the rare insectivorous plant (*Nepenthes khasiana*) (Figure- 5.1). A list of endemic flora of Meghalaya is given in Box 5.2.

Box. 5.2. Endemic plants of Meghalaya

Michelia punduana HK.f., *Trivalvaria kanjilalji* D Das, *Uvarial lurida* HK.f.& Sh, *Eurya eastanifolia* Vesque, *Elaeocarpus aeuminatus* Wall.ex Master, *Impatiens khasiana* HK.f., *Inula khalpani* Cl, *Ardisia quinquanqularis* A.Dc, *Nepenthes khasiana* HK.f., *Aphyllorchis vaginata* HK.f., *Corybus purpureus* Jos.et Yog, *Diplomeris pulchella* D.Don, *Gastrodia oxalis* HK.f., *Goodyera recurva* Lindl, *Hedychium ealearatum* Rao & Verma, *H.dikianum* Rao & Verma, *H. gratum* Rao & Verma, *H. rubrum* Rao & Verma, *Carex rara* Boot, *Agrostis griffithiana* Linn., *Festuca rubra* HK.f. (Chauhan and Singh, 1992).

5.2.1.3 Exotic Plants

A large number of exotic plant species is found growing luxuriantly in the state mostly in home gardens, crop fields, degraded lands, road sides, walls, etc. These plants have naturalised in Meghalaya and some of them pose a serious threat to many useful elements of the native flora. Rao

and Dam (1979) reported as many as 144 species of exotic plants from Shillong and its neighbourhood. Some notable exotic plants are listed in Box 5.3.

Box 5.3. Exotic plants of Meghalaya

Acacia dealbata, Albizzia lebbek, Ambrosia artemisifolia, Apodites benthamiana, Asclepias curassavica, Atylosia scarabaeoides, Brugmansia suaveolen, Cudrania cochinchinensis, Dillenia pentagyna, Elalostemma sessilis, Emilia sonchifolia, Eucalyptus spp, *Eupatorium* spp., *Eurya spp., Lagerstroemia indica, Malus baccata, Mimosa himalayana, Psidium guajava, Riparium adenopharum, etc.*

5.2.1.4 Orchids

Meghalaya is a storehouse of richly varied and colorful orchids. Out of 17,000 species of orchids found in the world nearly 300 species are reported from Meghalaya. The Khasi Hills alone are endowed with 75 orchid genera, represented by 265 species. In Meghalaya orchids are found growing at different altitudes, mostly on trees, on mossy rocks and also on the ground. Some commonly found orchids in the state are listed in Box 5.4.

Box 5.4 Orchids of Meghalaya

Dendrobium formosum, D. lendleii, D. aphyllum, D. Teriaeflorum, D. *lituflorum,* D. *moschatum,* D. *Fimbricatum,* D. *nobile,* D. *densifolium,* D. C*repidatum,* D. c*repidatum, Oberonia ensifornis,* O. *Iridifolia,* O. *Recurva, Bulbophyllum spp., Philodata articulata,* P. *Articulata, Pleione praecox, Cleogyne corymbosa, Arides multifolia, Eria spp., Rhyncostylis retusa, Vanda theres, Smitnandia micranthia, Stauropteris spp., Cymbedium elegans , Cleistoma spp., Paphiopedilum venustum (*Ladies slipper*), Paphiopedilum insigne, Perstylus goodyroides, Habeneria dentata, Pecteilis candida, Geodorum densifolium, Thelasis pygmea, Calenté masuca, Arandina gramnifolia, Liperis veridifolia, Malaxis latifolia, Thunia alba* (Department of Forest, Meghalaya).

5.2.1.5 Edible and medicinal plants

The people of Meghalaya use a variety of plant and animal species collected from the wild for food and medicinal purposes. For the poorer section of the society, wild foods are of particular value for tiding over the lean periods when resources from agriculture and animal husbandry are scarce. Out of a total of 105 plants used by the Khasis and Garos in the state, 44 are edible and 61 are used for medicinal purposes (Annexure- A and B). About 85 of these plants are used by the Garos alone and the rest 17 are shared by both the tribes (Maikhuri and Gangwar, 1993).

5.2.2 Faunal Diversity

The state is not only rich in flora but also in faunal resources. More than 135 species of mammals are known to occur in Meghalaya. The list contains all kinds of cats from the Royal Bengal Tiger to the Clouded Leopard, Leopard Cat, Wild Cat etc. Other large animals of significance include wild buffalo, gaur, serow, bear and tiger. Meghalaya is home of Binturong (*Arctictis binturong*), a very rare animal and the Hoolock (*Hylobates hoolock*), the only true ape found in India. The Tiger, Clouded leopard, Asian elephant, Assamese macaque, Bear macaque, Capped leaf monkey, Wild

dog, Sloth bear and Smooth-coated otter are threatened species found in the state. A list of higher animals found in the state is given in Table- 5.2. The state has got the highest concentration of elephants per sq. km of habitat in the entire country having 29 numbers per 100 sq. km of forests (Anon, 1985). Bird fauna is very rich, with more than 450 species. Some of the faunal species of conservation importance represented in the state are listed in Box 5.5.

Table- 5.2 Diversity of vertebrate fauna in Meghalaya

Category	Total number of known species in Meghalaya	Total number of known species in India
Mammals	139	410
Birds	540	1250
Reptiles	94	408
Amphibia	33	197
Pisces	152	2546

Source: Zooloogical Survey of India, Calcutta (1999-2000)

Box 5.5 Important mammal and bird species of Meghalaya

Mammals: Tiger (*Panthera tigris*), clouded leopard (*Pardofelis nebulosa*), Asian elephant (*Elephas maximus*), wild dog (*Cuon alpinus*), Malayan sun bear (*Ursus malayanus*), sloth bear (*Melursus ursinus*), smooth-coated otter (*Lutrogale perspicillata*), large Indian civet (*Viverra zibetha*), Chinese pangolin (*Manis pentadactyla*), Indian pangolin (*Manis crassicaudata*), Assamese macaque (*Macaca assamensis*), bear macaque (*Macaca arctoides*), capped leaf monkey (*Semnopithecus pileatus*) and hoolock gibbon (*Hylobates hoolock*).

Birds: Rufous-necked hornbill (*Aceros nipalensis*), white-winged duck (*Cairina scutulata*), ferruginous pochard (*Aythya nyroca*), Pallas's fish-eagle (*Haliaeetus leucoryphus*), marsh babbler (*Pellorneum palustre*), tawny-breasted wren-babbler (*Spelaeornis longicaudatus*), Manipur bush-quail (*Perdicula manipurensis*), bristled grassbird (*Chaetornis striatus*), Blyth's kingfisher (*Alcedo hercules*), greater spotted eagle (*Aquila clanga*), black-breasted parrotbill (*Paradoxornis flavirostris*), dark-rumped swift (*Apus acuticauda*), and beautiful nuthatch (*Sitta formosa*).

Anthropogenic activities like shifting cultivation, mining, expansion of agricultural land, developmental projects have lead to destruction and shrinkage of natural habitats and scarcity of food which have contributed to the rapid decline in the population of both plants and animals of the state.

Chapter 6

Forest Goods and Services

Forests provide a range of goods and services, some of which have significant economic value. Benefits obtained from forest goods usually fall in the category of direct use value. Forest goods include timber and non-timber forest products which have a market value. Forest services may have both direct and indirect use value. Some important forest services which have direct use value are recreation, education and research, which are often conducted on a non-commercial basis. The indirect use value of forest services are derived from supporting or protecting economic activities that have directly measurable market benefits. For example, some forest may have indirect use value through controlling sedimentation and flood damage that affects downstream agriculture, fishing, water supplies, biodiversity conservation, watershed protection and other economic activities.

6.1. Forest goods

The forests of Meghalaya provide both the timber and non-timber forest products (NTFPs) which are source of livelihood and income for the local people. Substantial quantities of NTFPs used for subsistence as well as cash income are extracted everyday from these forests. More than 380 different types of NTFPs are collected by the people of the state for various uses (Tiwari, 2002). Of these, 51 percent are used for medicinal purposes and 36 percent as food and the rest for other purposes.

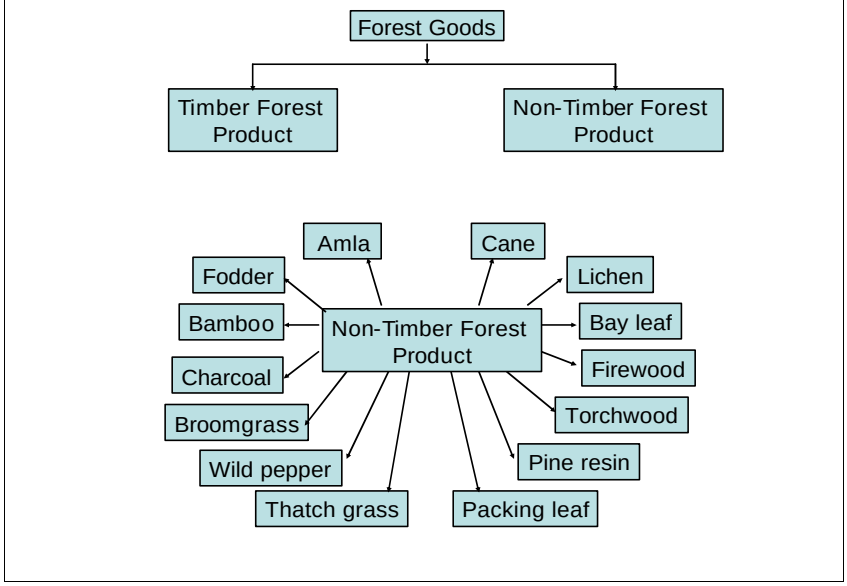


Figure- 6.1 Forest Goods

Important forest products of the state are indicated in Figure 6.1. The rich forest resources of Meghalaya are degrading at a very fast rate because of unsustainable practices. The ever increasing population puts a tremendous pressure on the existing resources as more and more forest resources are being exploited to meet the demand of the growing population.

6.1.1 Timber

6.1.1.1 Wood/ Stock and Increments

The state is rich in timber resource. The Forest Survey of India Report (1990) has identified six types of forest on the basis of availability of economically important tree species. The assessment of average stock (volume per hectare) and stand density (no. of stems per hectare) in respect to these six types of forests are given in Table- 6.1. The 'Teak forest' has been assessed to be having the best average stocking of 143.53 cu m per hectare and the lowest is that for 'Hardwood mixed with conifers forests' which has only 41.73 cu m stock per hectare. Miscellaneous type has the highest total volume of 72592452.7 cu m as more area was under this forest type. Hence, the total growing stock standing in the 8140.11 sq km (accessible tree forest area) has been assessed at 81.98 million cu m corresponding to 172.47 million stems.

Table- 6.1 Average Stock and Stand density in different types of forest

Sl. No.	Forest type	Total area (ha)	Vol / ha. (cu m)	Total volume (cu m)	Stems/ ha (Nos.)	Total stems (Nos.)
1	Khasi Pine	88704	50.45	4475205.5	228.06	20229834.24
2	Teak	6850	143.53	983207.9	438.57	3004204.5
3	Sal	30618	94.60	2896462.8	297.78	9117428.04
4	Hard wood mixed with conifers	17428	41.73	727340.15	154.25	2688269
5	Upland hardwood	6241	48.65	303593.44	141.43	882664.63
6	Miscellaneous	664170	109.30	72592452.7	205.60	136553352
7	Total	814011	100.71	81978233.8	211.87	172464510.6

Source: Forest Survey of India (1990)

6.1.1.2 Utilisation and Production

Timber is widely used for the construction of houses and for making furniture. Various timber species and their uses are highlighted in Table- 6.2. There is a great demand for timber both outside and inside the state. The statistics of Directorate of Industries, Government of Meghalaya and Autonomous District Councils show that as many as 75 saw and Veneer Mills and 6438 furniture and handicraft units are operating in the state demanding huge quantity of timber. Timber is also extracted and used as poles, beams, scaffolding and ladders for coal and limestone mining. For domestic purposes timber is mainly extracted for house construction. This is done on a small scale and mostly in a sustainable way.

Table- 6.2 Various Timber species of Meghalaya

Timber Species	
Timber	*Albizzia lebeck, Artocarpus integrifolia, Dipterocarpus macrocarpus, Gmelia arborea, Mesua ferra, Michelia champaca, Phoebe goalparensis, Pinus kesiya, Quercus spp., Schima wallichi, Terminalia myricarpa, Shorea robusta, Tectona grandis etc.*
Pulpwood	*Bichofia paliathum, Bombax ceiba, Duabanga indica, Shorea assamica.*
Plywood	*Bombax ceiba, Dipterocarpus macrocarpus, Mangifera indica, Schima wallichi, S. khasiana.*
Construction	*Artocarpus integrifolia, Duabanga sonneratioes, Gmelia arborea, Mesua ferra, Michelia champaca, Phoeba goalparensis, Schima wallichi, Shorea assamica, Terminalia myriocarpa.*

The Hon'ble Supreme Court of India's order on extraction of timber (December 1996) has had an impact on the extraction of timber. The demand and supply has slammed down and commercial exploitation of all kinds of timber has virtually stopped. Most of the timber trade goes through informal route and it is difficult to estimate the same. This ban had severely affected the livelihood of the people living in this state particularly those in the West Khasi Hills as timber activities generate employment to a large number of the people.

The extraction of timber is more from the unclassed forest of the state rather than the reserved forest but reliable information on the quantity extracted from these sources is not available (Table-6.3). Illegal felling is still going on in some pockets of the state even after the Hon'ble Supreme Court has imposed a ban on timber extraction. However, extraction of timber has reduced to a great extent in areas where strict rules have been implemented. This may be one of the reasons for the increase in forest cover in the state as shown in the Forest Survey of India Report, 2003.

Table- 6.3 Annual extraction of timber in Meghalaya (In cu m)

Year	SFD	JHADC	GHADC	KHADC	Illegal logging	Total
1995-96	1,872.56	0	6325	5,74,633.66	20.83	582852.05
1996-97	2131.51	21,828.5	5,250	2,98,875.27	45.39	328130.67
1997-98	945.25	0	NA	NA	67.15	1012.4
1998-99	607.08	0	NA	NA	409.15	1016.23
1999-00	213.38	0	NA	NA	691.88	905.26
2000-01	782.93	0	NA	NA	684.22	1467.15
2001-02	17,677.8	12.21	NA	NA	996.41	18686.42
2002-03	4,633.93	49.31	NA	NA	966.4	5649.64
2003-04	1,366.08	181.16	NA	NA	1015.83	2563.07
2004-05	N.A	15.61	NA	NA	1056.63	1072.24
Total	30230.5	22086.8	11575	873508.93	5953.89	943355.12

Source: State Forest Department and the Autonomous District Councils

Figure- 6.2 shows variation in the extraction of timber from Reserve forest of the state. There is rise and fall in timber extraction because in Reserved Forest extraction of timber is mainly done in accordance to the working plan in order to maintain the health of the forests. The market rate of timber varies with species to species and from one district to the other (Table 6.4).

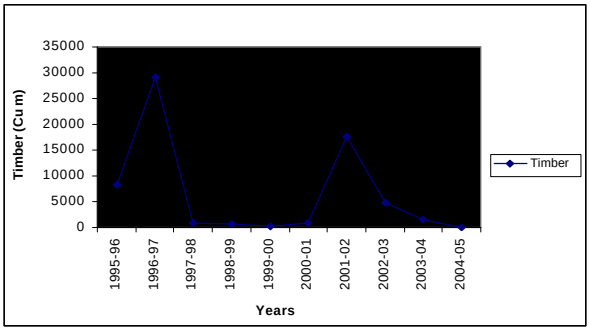


Figure- 6.2 Annual extraction of timber from 1995-96 to 2004-05

Table- 6.4 Market price of timber in different divisions of Meghalaya (Rs. per cu m)

Timber species	Khasi and Jaintia Hills	Garo Hills
Teak	15,750	11,025
Sal	12,100	10,500
Pine	4,200	3,150
Non Sal	6,183	5,600

Source- Present study

6.1.2 Non-Timber Forest Products (NTFPs)

6.1.2.1 Bamboo

Bamboo forms an important component of forest of Meghalaya. The total area under bamboo in the state is estimated to be 5,863 sq. km which is 26% of the total forest cover (Trivedi and Tripathi, 1984). The bamboo forests are mainly confined to the areas subjected to extensive jhumming in the past. The state has 33 species of bamboos belonging to 11 genera. Some important genera of bamboos found in Meghalaya are *Arudinaria, Bambusa, Chimonobambusa, Dendrocalamus, Dinochloa, Gigantochloa, Melocanna, Phyllostachys, Schizostachyum* and *Thamnocalamus* (Rawat and Kenduri, 1999). Of these *Arudinaria hirsute, A. manii, Bambusa jaintiana, B. pseudopallida, Phyllostachys manii*, *Schizostachyum griffitti, S. manii, S. pallidum* and *Thamnocalamus prainii* are endemic to Meghalaya. The endemic species belong to threatened category.

6.1.2.1 Bamboo area and distribution

According to the Forest Resource Survey of Meghalaya (1990), the total surveyed area under bamboo in 1986-88 (pure bamboo area and overlapping/mixed bamboo area) has been assessed to be 3,102.72 sq. km. It is highest in the Khasi Hills followed by Garo hills and least in Jaintia Hills (Table- 6.5). However, the surveyed area under bamboo in 2002-04 has been reported to be 1,464.68 sq. km. Under the over-lapping/mixed bamboo area the bamboo species are mixed together with wood forest and mostly found bamboo species are *Dendrocalamus strictus, Dendrocalamus hamiltonii* and *Bambusa tulda.* Under the bamboo brakes/pure bamboo areas, the bamboo species are mainly *Melocanna baccifera, Cinarundinaria* spp. *and Chimnobambusa griffithiana.* Pure bamboo brakes comprised only 664.72 sq. km which is a very small percentage of the total area under bamboo whereas 2,438 sq km is under overlapping/ mixed bamboo area (Forest Survey of India Report, 1990).

Table- 6.5 Distribution of bamboo bearing areas in Meghalaya (sq. km)

Sl. No.	Forest Divisions	Geographical Area	Bamboo bearing area	
			1986-88	2002-04
1	Khasi Hills	10,443	1,729.52	1,250.83
2	Jaintia Hills	3,819	140.18	60.312
3	Garo Hills	8,167	1,233.02	153.55
Total		**22,429**	**3,102.72**	**1,464.68**

Source: FSI (1990) and State Forest Resource Survey (2002-2004)

Distribution of different species of bamboo is not uniform. Some bamboo species like *Bambusa tulda, Dendrocalamus hookeri, Bambusa arundinacea Dendrocalamus hamiltonii* are mostly found in the Garo Hills, whereas *Melocanna baccifera, Bambusa pallida, Melocanna bambusoibes, Sinarundinaria* spp. are found in the Khasi Hills. *Chimnobambusa griffithiana* occurs both in the Khasi and Garo Hills (Table-6.6). Larger bamboo species such as *Bambusa balcooa, B. arundinacea, B. pallida, B. tulda, B. nutans, Dendrocalamus hamiltonii, D. hookerii* and *D. sikkimensi* are mainly distributed at the lower elevations (<500 m asl). These are larger size and have durable quality hence fetch good price. Narrow bamboo species such as *Phyllostachys assamica, Arundinaria hirsuta, A. suberecta* and *Chimonobambusa callosa* are mostly found at the higher elevations (>800 m asl). Although there is a reduction in size of bamboo with the increase in elevation, overall it has been observed that all the seven districts of Meghalaya support growth and high yield of bamboos (Bhatt et al., 2004).

6.1.2.2 Stock

The number of culms of non-clump forming bamboo species has been assessed at 350.34 million corresponding to an area of 472.54 sq. km with the total number of equivalent sound culms at 210.67 million (60.13 %). In respect of the 2630.18 sq. km area bearing clump forming bamboos, 2385.17 sq km fall under non-hacked category and the total number of clumps in this area is assessed at 16.3 million with an average of 68 clumps per hectare. The total number of equivalent sound culms has been assessed at 260.39 million (62.46%). Over the entire region the total stock of bamboo has been assessed at 471 million equivalent sound culms having a gross dry weight of 2644 thousand MT (FSI, 1990).

6.1.2.3 Utilisation and extraction

Bamboos are put to varied uses in the state. Most important of these, could be its use in the manufacture of paper and newsprint. The report of the 'Preinvestment Survey of Forest Resources' emphasized that there is great possibility for exploiting the naturally growing bamboo for paper pulp manufacturing. The bamboos are also used as building material in this region. Some varieties of bamboo *viz*., Kako, Jati and Terai are used for building houses, mats, basket etc. As food item *Dendrocalamus hamiltonii* constitute 76.52% of the total shoot consumption in Meghalaya followed by *Bambusa balcooa* (11.89%) and *Melocanna baccifera* (11.58 %) (Bhatt *et al.*, 2003). Bamboo extraction for local consumption, making of bamboo handicraft and its marketing provides livelihood to a large number of people of the state. Articles made from bamboo include mats *(Shylliah),* baskets *(Shang),* Khasi umbrella *(Knup),* and winnowing tray *(Prah),* which is used daily by the tribals.

Table- 6.6 Distribution of different bamboo species in Meghalaya (area in sq. km)

Sl No	Bamboo species		Districts							Total area
	Scientific name	Local name	EKH	WKH	JH	RB	EGH	WGH	SGH	
1	*Bambusa tulda*	Rngai (K) Wago(G)	-	-	-	-	8.63	12.19	0.57	21.39
2	*Melocanna baccifera*	Tyriaw (K)	-	-	0.68	0.42	-	-	-	1.1
3	*Bambusa pallida*	Skhen (K)	9.37	20.42	0.36	4.58	-	-	-	34.72
4	*Chimnobambusa griffithiana*	Sparheh (K)	5.84	-	0.76	-	-	-	-	6.60
5	*Sinarundinaria spp.*	Tyra(K)	-	1.88	0.64	-	-	-	-	2.52
6	*Melocanna bambusoides*	Muri(K) / \Wathrae (G)	18.52	64.32	-	-	16.32	25.31	24.3	148.77
7	*Dendrocalamus hamiltonii*	Siejbah (K)/ Wanok(G)	-	-	-	-	22.04	14.14	10.91	47.09
8	*Bambusa arundinacea*	Wakynta(G)	-	-	-	-	-	-	14.5	14.5
9	*Dendrocalamus hookeri*	Wadro(G)	-	-	-	-	-	5.2		5.2

Source: Forest Resource Survey, Meghalaya (2002-2004). K = Khasi, G = Garo.

Although there is no paper mill in the state, however a huge quantity of bamboo from the Khasi, Jaintia and Garo Hills finds its way to the paper mill in the neighbouring state of Assam. Unpublished literature revealed that there is an annual demand 50,000 MT bamboo from the state as raw material to Nagaon Paper Mill, Jagiroad. The largest part of bamboos supplied to this Paper Mill was actually met with *Dendrocalamus hamiltonii* from Ri-Bhoi District and *Melocanna baccifera* from Garo Hills District. In another paper mill, Cachar Paper Mill located at Hailakandi District of Southern Assam the demand and supply of bamboo from Meghalaya was estimated to be only 20,000 MT till the year 2004. This demand is actually being met from the bamboo forests of Jaintia Hills.

Bamboo also has a high market demand for food. Young tender shoots are sold in the markets. Bamboo shoot pickles and fermented slice bamboo are also sold in the markets throughout the year. A total of about 39.2 MT of fermented bamboo shoot is sold in Meghalaya (Bhatt *et al.,* 2005). Quantity of extraction of bamboo varies from year to year. Records from the State Forest Department as well as the respective District Councils showed low production of bamboo in the state (Table- 6.7). As most of the information is collected from various check gates hence they record only the quantities extracted for commercial purpose but do not take into consideration the quantity of bamboo that is used for local consumption or those which goes through the informal route of trade. Highest production was in the Khasi Hills with an average of 3610.52 MT annually. In the Garo Hills, official figure records a very low production of bamboo for commercial purpose. A highest production of bamboo (6017.32 MT) in the state was recorded in the year 2001-02 (Figure- 6.3).

Table- 6.7 Extraction of bamboo from forests of Meghalaya (in MT)

Year	SFD	KHADC	GHADC	Total
1995-96	0.00	4413.04	0.37	4413.41
1996-97	0.00	4281.33	0.30	4281.63
1997-98	0.00	2388.24	0.19	2388.43
1998-99	0.00	2625.67	0.10	2625.77
1999-00	4.33	2242.67	0.14	2247.15
2000-01	0.00	1533.40	0.11	1533.51
2001-02	152.60	5864.63	0.09	6017.32
2002-03	1978.01	2466.61	0.05	4444.68
2003-04	0.00	4580.86	0.10	4580.96
2004-05	0.00	5708.72	0.12	5708.84
Total	2134.94	36105.18	1.56	38241.68

Source: State Forest Department and KHADC, Shillong; JHADC, Jowai; GHADC, Tura

The price of bamboo is not the same in all districts. In Garo Hills the market rate of bamboo is Rs 225/MT, in Jaintia Hills the rate of bamboo is Rs 1500/MT and in Khasi Hills the rate is Rs 2100/Mt. Thus, the average rate of bamboo works out to Rs 1275/MT.

6.1.2.2 Firewood

Firewood is both an important domestic as well as commercial forest produce in the state. It is an essential commodity especially for the rural household where it is used for cooking, heating and lighting purposes. About 18,53,457 persons, reside in the rural areas in Meghalaya. Therefore they constitute the most important group of firewood consumers as nearly cent per cent of the rural households use firewood. However, in the urban areas only 7 per cent of household use firewood for domestic purposes (Forest Resource Survey, 2004). This may be because of constraints in obtaining firewood and availability of other alternatives which are more effective.

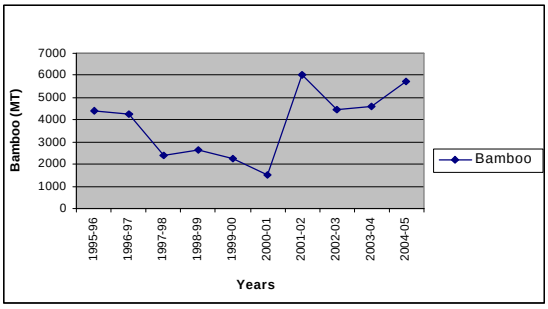


Figure- 6.3 Extraction of bamboo (MT) from 1995-96 to 2004-2005

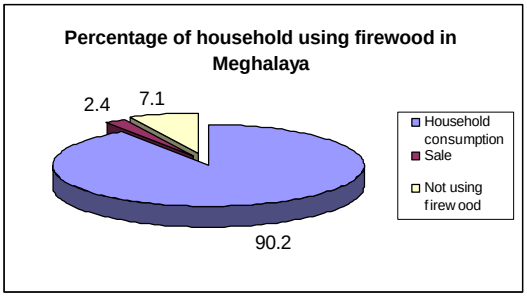


Figure- 6.4 Percentage of households using firewood in Meghalaya

For domestic purposes, the rural households collect firewood from the nearby forest irrespective of the ownership. Extraction of firewood for commercial purposes can be done only from one's own forest if it is a private forest or a person may rent to another person for a specified time for extraction of firewood. In case of community forest, commercial exploitation of firewood is generally not allowed except under certain conditions. For household consumption, dead and fallen tree is collected. Some important tree species mainly harvested for meeting the firewood demands are: *Lagerstroemia parviflora, Vitex pendularis, Bauhinia* spp., *Schima wallichii, Dillenia indica, Syzygium cuminii, Castanopsis* spp., *Macaranga denticulate, Careya arborea* and *Albizzia lebbek.* Very few urban households collect firewood as most of them purchase it.

Bhatt and Sachan (2004) studied the consumption of firewood by the Khasi, Jaiñtia and Garo communities and found that it is 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 54th Round National Sample Survey (NSS) on Common Property Resources (CPRs) of India conducted by the Ministry of Statistics and Programme Implementation (1999) estimated that the percentage of household using fuelwood in Meghalaya to be 93 per cent and the average quantity collected is 2558 quintals per year whereas in the 50th round (1993-94) it was 94 per cent with 2282

quintals per year as the average quantity consumed. A thorough survey on fuelwood collection by household was done in the 54th round survey and found that 90.2 percent of households used fuelwood for domestic purposes (cooking and heating) while those using for sale are 2.4 per cent, and not using fuelwood is 6.1 percent (Figure- 6.4). Firewood finds a good market inside the state itself because of heavy demand from the P.W.D contractors, bakery and limestone industries. According to the Forest Resource Survey, (2002-2004) the total annual firewood consumption in the state by different sectors was estimated to be about 921582.3 M.T (Table- 6.8).

Table- 6.8 Firewood consumption by different sectors in Meghalaya (MT)

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

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

The State Forest Department as well as the District Councils maintains data relating to extraction of firewood for market purposes by collecting information from the check gates (Table- 6.9). As per the information, supply of firewood for sale comes mainly from the Ri-Bhoi District whereas in the West Khasi Hills people take more interest in timber rather than firewood.

Table- 6.9 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)

Extraction of firewood for commercial purposes in the Garo Hills is highest with an average of 4,86,000 MT annually. In the Jaintia Hills the demand of firewood is met from the forest area under the administrative control of the Jaintia Hills Autonomous District Council. Figure- 6.5 compares the annual production of firewood in the three different forest divisions of the state during the year 1995-96 to 2004-05. Household consumption of firewood also constitute a huge quantity however, yearly data for this was not available. Collection of firewood not only involves men but also women and children. Its sale provides employment to a good number of people belonging to economically poorer section of the state. The main trading centres of firewood in the state are: Shillong, Nongstoin, Jowai, Tura, Williamnagar and Baghmara. In Khasi hills the rate of firewood/MT is fixed at Rs 2400/MT, in Jaintia Hills the rate of firewood is Rs. 900/MT while the least is in Garo Hills with a rate of Rs. 450/MT. The average rate of firewood in all districts is around Rs. 1250/MT.

6.1.2.3 Cane

Cane (*Calamus* sp) is a woody climber, which often twins around trees and is commonly known as rattan palm. In Meghalaya, several wild species of *Calamus* are found. It mainly grows at the lower elevation exhibiting a warm, moist climate. In some villages like Mawdoh (Nongstoin block), Tynnai (Mawkyrwat block) in the West Khasi Hills, cane forms an important raw material for several households which are involved in making of handicraft items. Canes owe their chief value to their great pliability. As substitute to ropes they are invaluable and they are unsurpassed for basketwork and production of other handicraft items. Cane and bamboo craft is a very important handicraft sector in Meghalaya. It ranges from furniture, basket ware, mats, murrahs, bows and arrows and other artistic and carved items, which have over the years adorned every modest home of Khasi, Jaintia and Garo tribes of the state. Basketwork dominates varieties over other range of cane and bamboo products. Extraction of cane from the forest very much depends on the demand. As such demand is good and availability is sufficient, except for Garo Hills where data is not available (Table- 6.10). As per data recorded by the District Council, the highest extraction of cane was 12,090.6 running meters (Rm) during the year 1997-98 (Figure- 6.6).

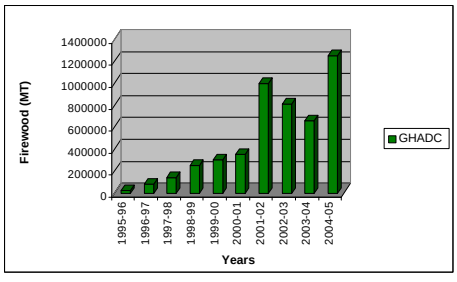


Figure- 6.5 Production of commercial firewood in the Garo Hills

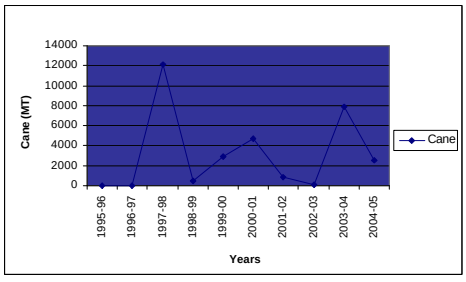


Figure 6.6 Annual extraction of cane from Meghalaya forest (Rm)

Table- 6.10 Annual extraction of Cane during 1995-96 to 2004-05 (In Rm)

Year	KHADC	JHADC	GHADC	Meghalaya
1995-96	-	0	NA	0
1996-97	N.A	0	NA	0
1997-98	12,000	90.6	NA	12,090.6
1998-99	80	350	NA	430
1999-00	2,680	240	NA	2,920
2000-01	1,570	3,150	NA	4,720
2001-02	190	690	NA	880
2002-03	84	0	NA	84
2003-04	5,840	2,030	NA	7,870
2004-05	104	2,400	NA	2,504
Total	22,548	10750.6	0	31,498.6

Source: KHADC, Shillong; JHADC, Jowai.

The state government as well as the district councils collects royalty for different species of cane at the rate of Rs 20-40 per 100 metres. The KHADC also has got its own royalty rate which is Rs. 10 per 100 metres for cane species *Calamus liptospadix* and *C. floribundus* and Rs. 10 per 1000 metres for others. The market rate of cane as obtained from the Forest Resource Survey, Meghalaya is Rs. 25 per Rm.

6.1.2.4 Broomgrass

Broomgrass *(Thysanolaena maxima),* an important forest produce of Meghalaya grows in the wild in almost all parts of the state. According to an estimate the total area for broom grass in the state is about 127 sq. km (Unpublished data from B.K.Tiwari). Recently this forest produce has emerged as the most widely domesticated and cultivated NTFP. Broomgrass finds a number of applications besides using the inflorescence of the plant for cleaning purposes, the leaves of the plants are used as fodder and the sticks (grass stems) as a raw material in the paper industries and small scale cottage industries for making mats. It is important for ecological point of view also as it protects the soil from erosion. The harvesting seasons for broomgrass is from December to March and the peak season of marketing is between February and April. About 80% - 90% of the production is sold during these months. An extensive study on broomgrass production in Meghalaya was done by Tiwari *et al*. (1995). The total export of broomgrass from the Garo Hills is 6480 MT per annum. In the Khasi Hills, maximum production of broomgrass i.e., about 50 % comes from the Ri Bhoi District; 30% from East Khasi Hills and West Khasi Hills Districts and the rest 20% comes from Jowai and other areas of Jaintia Hills District. The districts councils through their check gates at various places collect information and maintain records of the annual production of broomgrass (Table- 6.11). The Khasi

Hills record a highest production of broomgrass than the other two divisions with an average annual production of 22,402 MT.

In Jaintia Hills the average annual production is nearly about 400 MT whereas in Garo Hills it is very low, only about 1 MT annually as per data collected from the Garo Hills Autonomous District Council. It has been observed that many markets of Assam get huge supply of broomgrass from Garo Hills but the same is not reflected in the records of Garo Hills Autonomous District Council, Tura. Its overall annual production is more or less uniform except for the year 2003-04 where it is much high compared to the other years (Figure- 6.7). The price of Broomstick depends on the quality of the product. The middlemen usually have control over the market prices which differs from one area to the other. It is also subjected to change as per the demand and supply in the market. During the year 2006-2007 the price varied between Rs 20 to 26 per kg.

Table- 6.11 Production of broomgrass in Meghalaya from 1995-96 to 2004-05

Year	KHADC (MT)	JHADC (MT)	GHADC (MT)	Meghalaya (MT)
1995-96	1,483.6	0	0.9	1,484.5
1996-97	17,725.5	354.54	1.1	18,081.14
1997-98	17,535.1	213.37	0.5	17,748.97
1998-99	16,913.1	282.42	1.5	17,197.02
1999-00	18,323.8	250.81	0.7	18,575.31
2000-01	16,452.6	492.06	0.8	16,945.46
2001-02	17,576.6	543.28	0.6	18,120.48
2002-03	28,843.3	615.47	1.3	29,460.07
2003-04	70,401.8	293.4	1.7	70,696.9
2004-05	18,766.6	856.52	2.2	19625.32
Total	2,24,022	3,901.87	11.3	22,7935.2

Source: KHADC, Shillong; JHADC, Jowai, GHADC, Tura.

6.1.2.5 Charcoal

Charcoal is another important commercial NTFP of the state. After the ban on timber by the Hon'ble Supreme Court (December 1996), the people have taken up charcoal making as an alternate livelihood opportunity. This activity is very popular in the West Khasi Hills, East Khasi Hills and Ri-Bhoi Districts. However, it has been noticed that charcoal burning is more destructive than timber felling and has made large areas of green forest treeless and barren within a short span of time.

For making Charcoal, the size of the tree are not important. The woody part of a felled tree like stem and branches are chopped down and burnt in specially dug pit in the absence of air which yield a black porous solid substance known as charcoal. This is then packed in sacks or sometimes in case of

industrial use it is directly loaded in trucks and taken to the market. A large amount of charcoal is also produced as a by-product from saw mills and furniture workshops. For household consumption, charcoal is less important than firewood. Meghalaya has emerged as an important charcoal producing state in the country. 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. Annual production of charcoal as recorded from check gates is given in Table- 6.12.

Table- 6.12 Quantity of charcoal sold in Meghalaya

Year	SFD (MT)	KHADC (MT)	JHADC (MT)	Total (MT)
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
Total	**1405**	**82255.37**	**17091.7**	**98886.98**

Source: KHADC, Shillong; JHADC, Jowai and State Forest Department.

In the Khasi Hills the ten year average production is more than that in the Jaintia Hills. For Garo Hills the data on the quantity of Charcoal produced is not available. The annual production varies from year to year for instance; the highest production was 31060.72 MT in the year 2003-2004 and the lowest about 336 MT in the period 1995-96. Although there is fluctuation in the production of charcoal during the last ten years but the overall trend of charcoal production has been found increasing from 1995-1996 onwards after the enactment of the Hon'ble Supreme Court ban on timber (Figure- 6.7).

The prices and the quality of charcoal depend on the type of tree species from which it is made and varies from one place to another depending on local demand and availability. In East Khasi Hills the rate is Rs 8000 per MT, in West Khasi Hills the rate is comparatively lower at Rs 6500 and in Ri Bhoi District the rate is Rs 7000 per MT. In Garo Hills the market rate of Charcoal is Rs 600 per MT.

6.1.2.6 Bay leaf

Bay leaf (*Cinnamomum tamala)* is an aromatic plant whose leaves are used as condiment. It is a very important commercial NTFP in the state and has a ready market. It grows abundantly in the tropical and subtropical humid forests of the state. The tree grows naturally in the wild in association with a

variety of other native trees. They are protected and promoted to regenerate and grow in their natural habitat. The maximum production of bay leaf comes from the War area of Meghalaya which contributes 2798.4 MT/ year. The average production of bay leaf ranges between 12950-22200 kg/ha/harvests (Tiwari and Tynsong, 2004). The average annual production for the whole state ranges between 4300-7500 MT. According to the Check Gates of Autonomous District Council located at Byrnihat and Birubari (Bajengdoba), 8,128 MT and 8,728 MT of bay leaf was transported out of Meghalaya during the year 2003-2004 and 2004-2005, respectively which is more than the production data (Table- 6.13). Figure- 6.7 showed a trend of increase in the production of bay leaf over a period of ten years. Total revenues received by the State, District Council and Traditional Institutions accounts to more than Rs 5 million per annum.

Table- 6.13 Bay leaf production from 1995-96 to 2004-2005

Year	KHADC (MT)	JHADC (MT)	GHADC (MT)	Total (MT)
1995-96	4,527.13	0	0.28	4,527.41
1996-97	4,340.6	0	0.12	4,340.72
1997-98	5,783.75	0	0.33	5,784.08
1998-99	6,093.3	0	0.41	6,093.71
1999-00	6,546.7	2.5	0.27	6,549.47
2000-01	7,575.5	0	0.61	7,576.11
2001-02	5,671	3.9	1.1	5,676
2002-03	7,291	8.71	0	7,299.71
2003-04	6,777.5	0	0.51	6,778.01
2004-05	7,384	0	0.18	7,384.18
Total	61,990.48	15.11	3.81	62,009.395

Source: KHADC, Shillong; JHADC, Jowai, GHADC, Tura.

Market demand and price depends upon the quality of leaf and availability of goods. Bay leaf from Meghalaya is in huge demand all over the country. It is exported to Delhi, Mumbai, Kolkatta, Ahmedabad and even to Bangladesh. The marketing channel for this produce is a little complicated as it involves a number of intermediaries before the product reaches the final consumer. The market prices vary as it passes through number of intermediaries. The price at the producer level ranged from Rs. 5-10 per kg. Local traders/wholesalers sell it at the rate of Rs 13/kg to consumers outside the state. Wholesalers then sell the product to small cottage industries or retailers at the rate of Rs15/kg. These retailers then sell the product to consumers in Shillong at the rate of Rs 30/kg.

Bay leaf is a notified forest product and therefore, it attracts royalty and higher taxes. The traders have to pay these taxes to *Syiem* (Traditional Chief), District Council and the State Government. The taxes paid by the bay leaf traders to the Syiem are Rs 75/truck and to the district council is Rs. 50/truck. The

state government collects tax at two levels - i) purchase tax from the growers which is at the rate of 10% and ii) sale tax which is at the rate of 8 % to outside agency.

6.1.2.7 Thatch grass (*Imperata cylindrica)*

Thatch grass *(Imperata cylindrica)* is one important grass species that grows abundantly in the grasslands which have developed as a result of removal of natural forest cover. As such thatchgrass grows in wild conditions and the height of the plant is about a metre or so. It is usually harvested in the winter months during October- February.

This forest produce particularly finds its consumers in the rural areas only where people use it as roofing materials for their houses as well as their animal sheds. Few years back huts made of thatch grass was a common sight in villages. However, at present in most villages thatch roof has been substituted by metallic or cemented roof as it requires less labour and is more lasting. Very few houses made of thatch roof are still seen scattered here and there in some remote villages. One reason for this may be that procurement of other alternatives is difficult due to lack or non availability of transportation facilities.

Extraction of thatch grass is more prevalent in the Garo Hills as compared to the Khasi and Jaintia Hills. Thatch grass is extracted in less quantity and mainly for domestic use in the Khasi and Jaintia Hills; hence no data is available whereas in Garo Hills thatch grass is extracted for commercial purposes also (Table- 6.14). The extraction of thatch grass for the last ten years in the Garo Hills ranges between 240 to 9854.6 MT annually (Figure- 6.7). The maximum extraction was recorded in the year 1997-98 with 9854.6 MT. Per bundle of thatch grass weighs around 25-30 kg and the cost price per bundle vary from Rs. 20/- to Rs. 25/-, coming to Rs 920 per MT.

Table- 6.14 Annual extraction of Thatch grass (MT)

Year	GHADC	Meghalaya
1995-96	356	356
1996-97	7750	7750
1997-98	9854.6	9854.6
1998-99	240	240
1999-00	600	600
2000-01	1000	1000
2001-02	620	620
2002-03	516.1	516.1
2003-04	1521	1521
2004-05	1843.48	1843.48
Total	**24301.2**	**24301.2**

Source: GHADC, Tura

6.1.2.8 Torch wood

The stump of pine trees (*Pinus kesiya*) harvested for timber are principal source of torch wood. It is mainly used for lighting purposes. This is an important forest product of pine forest of Khasi and Jaintia Hills in the state. The production of torch wood in the state during the period 1995-96 to 2004-05 is shown in Table- 6.15. As per the District Council data, production of torchwood mainly comes from the Khasi Hills particularly West Khasi Hills. Maximum production of 7,034 MT of torchwood was recorded during the year 1997-98. In the Jaiñtia Hills, there was no production of torchwood except for the year 2003-04 (Table 6.15). This may be because in this district torchwood extraction for commercial purpose is low and usually for domestic use and local consumption, data were not maintained by the district councils. Royalty from this forest produce is collected by the District Council when it passes through check gates.

Table- 6.15 Production of torch wood from 1995-96 to 2004-05 (in MT)

Year	KHADC	JHADC	Meghalaya
1995-96	0	0	0
1996-97	5,123.7	0	5,123.7
1997-98	7,034.65	0	7,034.65
1998-99	6,734.9	0	6,734.9
1999-00	5,876.1	0	5,876.1
2000-01	2,725	0	2725
2001-02	519.5	0	519.5
2002-03	610	0	610
2003-04	470	12.2	4,82.2
2004-05	1,060	0	1,060
Total	**30,153.9**	**12.2**	**30,166.1**

Source: KHADC, Shillong; JHADC, Jowai

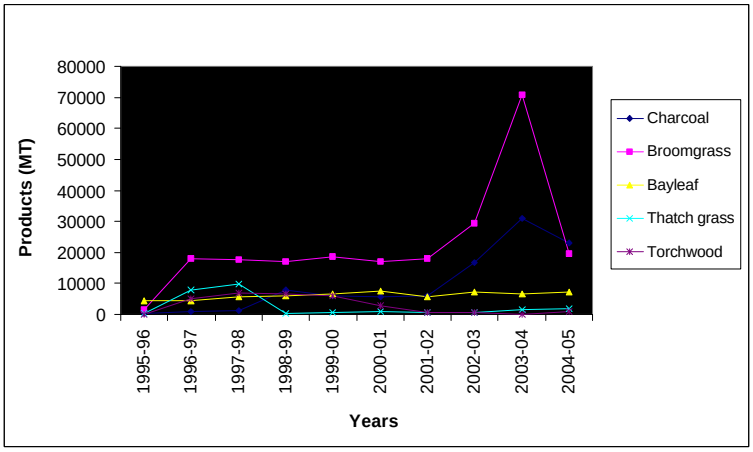


Figure- 6.7 Production of important NTFPs in Meghalaya (MT)

Previously there was no restriction on extraction of torch wood for commercial purposes but now extraction is limited only in small quantities and for domestic use only. Therefore production of marketable surplus has decreased with the passing of years (Figure-6.7).

6.1.2.9 Packing leaf

Leaves of *Phrynium pubinerve* locally known as 'sla met' is a commercial forest produce in the state. It is fairly distributed in all the districts of the state at altitudes ranging from 100-800 metres above mean sea level (MSL). It grows in the shade but more abundantly in a sparser tree cover area. The most exploited areas are mainly north-western part of the Ri-Bhoi district, Ri-War areas of East Khasi Hills, and the War-Jaintia areas of Jaintia Hills where it is mainly used for wrapping betel leaves growing in these areas. The leaves are also used for packing edible items especially meat, vegetables and fruits. The leaves are also used for packing edible items especially meats, vegetables and fruits.

Total production of this forest produce in the state is not known. However according to a recent survey conducted by Tiwari and Tynsong (2004), about 200 MT/yr of *Phyrinium* leaf comes to Shillong from War area of Meghalaya. A small quantity is also exported to Bangladesh. The price of the leaf depends on the size and the seasons when it is in more demand. The market price of the smaller leaf was Rs. 17.50/100 leaves and the bigger one was Rs.30.00/100 leaves. During summer months the leaves are in high demand for packaging of fruits.

6.1.2.10 Fodder

Rearing of cattle is being practiced by people in the state on a small scale. As such the demand for fodder is not so much. According to the NSSO 54th round Common Property Resource Survey, 37 per cent of rural household are reported to rear livestock, 6 per cent of the households depended on the CPR land for grazing of livestock and only 2 per cent of the households collected fodder from CPR. This shows low dependence on CPRs for grazing of livestock or collection of fodder by the people in the state. The average quantity of fodder collection per year per household is only 51 kg. Year wise data on the extraction of fodder from the forest is not available.

The all India average value of fodder is Rs. 183.5/ha (Haripriya *et al.*, 2005). Corresponding to an area of 403.25 sq. km subjected to heavy grazing in Meghalaya, the total value of value is found to be Rs. 73,99,638.

6.1.3 Other NTFPs

Many wild edibles are harvested from the wild by the poorer section of society and are sold in the market for cash income. They are chiefly bought by the tribal people living away from the forest or by the people outside the region. NTFPs like Stone and Wood Lichens, Torch wood, Mushrooms, Wild Pepper, Amla, Honey, Pine Resins, etc. are collected by people from the forests in small quantity. These forest products provide income to collectors as well as revenue to the state. The availability and collection of these NTFPs vary with regions and the types of forest.

6.1.3.1. Lichen *(Usnea sp.)*

Lichens are formed by the symbiotic association between an alga and a fungus. It usually grows through out the year on the bark of pine trees. Wood Lichen is one of the most important NTFPs of the forests of Meghalaya. Production of lichen mainly comes from the West Khasi Hills particularly areas like Markasa and Maroid under Mairang Sub-division. In the Jaintia Hills, lichen is commonly found in the villages under the Thadlaskein and Laskein sub-divisions where plenty of pine forests are available. In one village, Wahiajer under the Thadlaskein subdivision, villagers can sell around 400-500 kg of lichen per market day.

Lichen is consumed as condiment and has a good market in north-west and south India. It is also exported to Middle East. The state produces approximately 150 MT of lichen per year (Table- 6.16) and the variation in production annually is depicted in Figure- 6.12. The whole amount of the wood lichen which the state produces is exported to other part of India for processing and marketing. Stone lichen grows on the surface of rocks. It has a good market in the West Khasi Hills as it is used for making gun powder. Its annual production as recorded from data of Khasi Hills Autonomous District Council is given in Table- 6.17. Local villagers collect this forest produce and sell it to the local traders. Unprocessed wood lichen is sold by the producer at the rate of Rs 30/kg to local traders who then transport the produce to Shillong and sell it to dealers in Shillong at the rate of Rs. 40/kg. The dealers then sell it to wholesalers who in turn sell it to retailers from cities like Mumbai, Chennai and Pune for processing. After processing, it was sold to retailers at the rate of Rs 200/kg.

Table- 6.16 Annual production of wood lichens (MT)

Year	KHADC	JHADC	GHADC	Meghalaya
1995-96	49.66	0	N.A	49.66
1996-97	27.88	0	N.A	27.88
1997-98	123.4	18.52	N.A	141.92
1998-99	81.7	0	N.A	81.7
1999-00	93	37.07	N.A	130.07
2000-01	105.5	38.54	N.A	144.04
2001-02	130	44.46	N.A	174.46
2002-03	130.43	10.02	N.A	140.45
2003-04	99	40.28	N.A	139.28
2004-05	148.5	16.08	N.A	164.58
Total	989.07	206.98	0	1194.04

Source: KHADC, Shillong; JHADC, Jowai

Table- 6.17 Annual production of stone lichens (MT) in the Khasi Hills (In MT)

Year	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Production	0	0	58.6	32.4	36.1	14.8	1.5	0	2	23.01

Source: KHADC, Shillong.

6.1.3.2 Wild Pepper

Piper longum (wild pepper) is an aromatic herb found growing abundantly in the wild in the Khasi Hills. This species thrives well in the '*War areas'* of the Khasi Hills and production comes solely from these areas for meeting the commercial demands. *P. longum* flowers during the rainy season which starts from July onwards and bears fruits during November to January. Harvesting is done in the month of January while it is still green and unripe, as it is most pungent at this stage. The fruits are then dried in the sun until they turn grey. *P. longum* is an important condiment and there is high demand for this product in the state. It is also used for medicinal purposes. Therefore, a considerable quantity is also exported to other states in the country as there is demand from buyers outside the state. Commercial production of wild pepper comes only from the Khasi Hills (Table-6.18). The average production in the last ten year is approximately 120 MT/ year (Figure- 6.8). The market price of wild pepper is higher than that of the domesticated black pepper. It stands at Rs 150 per kg as against the price of black pepper, which is Rs 40 per kg.

Table- 6.18 Annual production of wild pepper in Meghalaya (In MT)

Year	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Production	127.27	100.7	122.8	137.4	154.6	124.4	16.14	166.2	161.3	121.7

Source: KHADC, Shillong.

6.1.3.3 Pine resin

Pine forest covers nearly 12% of the total geographical area of the state. When the trunk of a pine tree is wounded, pine resin, a thick, sticky material, oozes out to form a protective coat that seals the wound to pathogenic microorganisms and prevents the loss of sap. To obtain resin, a tapping cut is made in the pine bark and the resin drops are collected into buckets. Extraction of Pine resin is exclusively for commercial purpose only. Collection of pine resin is more popular in the Jaintia Hills than in the Khasi Hills and Garo hills (Table- 6.19). The annual extraction of pine resin is not uniform as people collect it only when there is demand. In 1998-99 its extraction is as low as 40 MT/yr whereas in 1996-97 it was as high as 690 MT/ yr (Figure- 6.8).

Table- 6.19 Annual extraction of pine resin (MT)

Year	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Production	0	690.6	0	40.10	470.2	140.8	153.5	160	83.32	183.62

Source: JHADC, Jowai

6.1.3.4. Amla *(Phyllanthus embilica)*

Amla **(***Phyllanthus embilica)* is usually collected by the people in the state as food item. This NTFP is consumed as fruit, used for making pickles and also for medicinal purposes. Amla tree is common in mixed deciduous forests throughout the greater part of India and Burma ascending the Himalaya to

4,500 ft. In Meghalaya it grows abundantly in many parts of West Khasi Hills, Jaiñtia Hills and in some parts of the East Khasi Hills.

Data on production of Amla in the Khasi and Jaiñtia Hills is presented in Table 6.20 whereas for Garo Hill data is not available. The production during 1995-2006 ranges from a low of 4 MT/ yr to 120 MT/ yr (Figure- 6.8). It is predominantly a commercial item and for household consumption it is used in very less quantity. Harvest depends on market demand. The consumer price of amla is Rs 10 – 15 per kg while at the producer level the price was Rs 7 per kg.

Table- 6.20 Annual production of Amla (MT) in Meghalaya

Year	KHADC	JHADC	GHADC	Meghalaya
1995-96	0	0	NA	0
1996-97	0	0	NA	0
1997-98	0	0	NA	0
1998-99	0	0	NA	0
1999-00	0	0	NA	0
2000-01	0	0	NA	0
2001-02	0	30.58	NA	30.58
2002-03	65.05	56.02	NA	121.07
2003-04	103	0	NA	103
2004-05	46.8	9.22	NA	56.02
Total	214.85	99.64	0	310.67

Source: KHADC, Shillong.

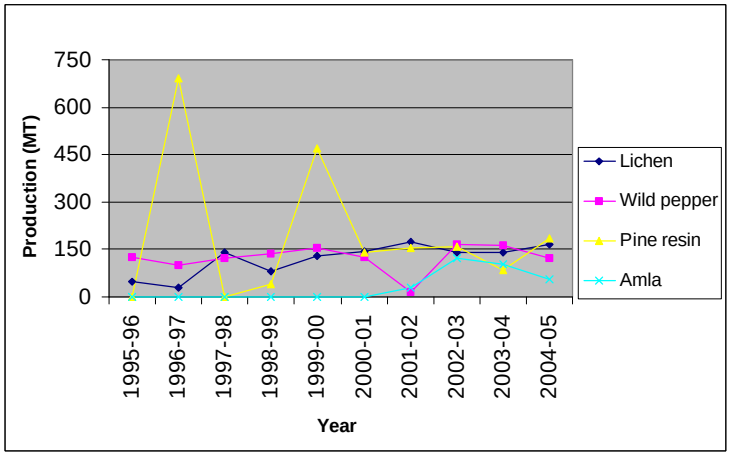


Figure- 6.8 Production of Lichen, Wild pepper, Pine resin and Amla (MT)

6.1.4 Quantity of Forest Produce transported outside the state

Most of the Timber and NTFPs produced in the state have high commercial value and is transported outside the state. Table 6.21 shows the quantity of forest produce which are transported outside the state during the year 2003-2005.

Table 6.21 Forest Products transported outside from Meghalaya during 2003-04 and 2004-2005.

Sl. No.	Timbers and NTFPs	Quantity (MT)	
		2003-2004	2004-2005
1	Timber *Tectona grandis*** *Shorea robusta*** **Non teak and non sal tree species including *Pinus kesiya*	 10.8** 15.4** 13704.4**	 - 20.6** 14172.2**
2.	Bamboo *(Bambusa* spp., *Dendrocalamus* spp.*Melocanna* spp.)	41,200	58,800
3	Broomgrass *(Thysanolaena maxima)*	17,398	29,210
4	Bay leaf *(Cinnamomum tamala)*	8,128	8,728
5	Cane *(Calamus* spp.*)	7,36,000*	12,48,000*
6	*Amla (Emblica officinali)s*	-	48
7	Wild Pepper *(Piper* spp).	-	88
8	Mushroom	3.58	-
9	Wood lichen		240
10	Stone lichen	-	64
11	Pine cone (seeds)	-	344
12	Charcoal	-	5344
13	Fire-wood	15,172	23,890
14	Torch wood	384	904

*Units in running metre, **Units in cubic metre (Source: Check Gates of Autonomous District Council at Byrnihat and Bajengdoba)

6.2 Forest Services

In addition to multiple goods, forest also provides innumerable services which contribute to economic development and human welfare. Forests play a crucial role in the ecology of watersheds that supply much of our fresh water, conserve soil by controlling soil erosion, improve soil fertility, promote soil formation, protect and conserve biodiversity by acting as the natural habitat of wildlife, cleanse the air and water and also maintain the CO_2 balance and the aesthetic quality of the environment. The forests of Meghalaya also play important role in rendering enormous services. Although there is no empirical data on various services rendered by forest of Meghalaya as no systematic study has been conducted so far. In our study we have documented a few services rendered by the forest ecosystems of Meghalaya. Important services such as supply of water, stabilization of soil in hill slope, input of nutrient to near-by agricultural fields and protection of biodiversity are described below:

6.2.1 Water supply

There is a widespread assumption that forests help in maintaining a sustainable water supply of good quality for the people of the area as well as for the people downstream. Forest ecosystems act as a

sponge, soaking up and storing water when it is in abundant and releasing it during dry period. De Groot *et a*l. (2002) defined water supply as filtering, retention and storage of water in streams, lakes and aquifers. Filtering is performed by vegetation and soil biota and retention and storage depends on site characteristics. Loss of forests has been blamed for many problems ranging from flooding to aridity and for catastrophic losses to water quality. In fact, the hydrological role of forests is complex. Precise impact on water supply varies with location, age and composition of the forest. It has been reported that reduction in native forest cover causes substantial decrease in supply of drinking water (Nunez et al., 2006).

Meghalaya presents a typical monsoonic climate and gets sufficient rainfall during the summer monsoon beginning from April to September and very scanty rain during the dry winter months from November to February. There is a large variation in rainfall distribution through out the state. The average annual rainfall for Shillong is 200 cm whereas Cherrapunji - Mawsynram belt on the southern slope of the Khasi Hills has the distinction of the heaviest rainfall with an average of 1200 cm annually (Directorate of Economics and Statistics, 2005). The average annual precipitation is estimated to be 44.86 km^3. The precipitation that falls on the vegetative cover is first intercepted by the forest canopy or the leaf cover area. Of the water which falls directly on to the land surface, some evaporate back into the atmosphere and some goes away as surface run-off and some as groundwater infiltration. Interception varies with different tree species. On an average the total rainfall intercepted by forest is 35%, of which 20% is intercepted by trees, 10% by ground vegetation and 5% by the forest ground leaf litter (Kumar et al, 2006). Infiltration rate is higher in forests than in bare soil or in other vegetation type because of higher organic material in the soil which promotes the activities of microorganisms. In the case of loam soil infiltration capacity is 10-15 mm/ ha in bare soil whereas it is 20-30mm/ha in vegetated.

In Meghalaya, the flow of water in rivers and streams is regulated by forests of the catchment area. The flow of water in Wah Umiam near Mawphlang, East Khasi Hills; Wah Umngi in the Mawkyrwat, West Khasi Hills and others were maintained by forests of the surrounding areas. Thick and undisturbed natural forests maintain sustainable supply of water to these rivers all through the year even during lean seasons. Figure- 6.9 shows the river Pongtung near the Pongtung *Law Adong* on the way to Pynursla. Continuous flow of water is a service rendered by forest ecosystem.

Figure- 6.9 Pongtung river, Pynursla. Continuous flow- A service rendered by forest

Groundwater is of less importance in the state as majority of the population rely on surface water to serve their water requirements. So, in the study more emphasis is being laid on surface runoff. To calculate the volume of annual runoff with respect to annual precipitation we used Binnie's Method. Taking average rainfall of the year 2005 from selected centres in the state, the annual precipitation is found to be about 400 cms (0.004 kilometer) making the total volume of annual precipitation to be 89.72 km^3. Using Binnie's runoff percentage of 40% for annual precipitation over 110 cm, from the total volume about 35.89 km^3 will flow as surface and subsurface runoff. The runoff in forested area will be less than in non forested area.

Kumar *et al*., 2006 studied the runoff percentage for different land use pattern under different condition of soil type, slope and intensity of rainfall. Considering the types of soil, slope and rainfall in Meghalaya the runoff percentage for forest land according to Kumar *et al*., 2006 varies between 1 to 2 % (average =1.63 %). For non-forested land the average runoff is assumed to be 40%. Hence, per sq. km runoff for forested and non-forested land is calculated to be 0.00008 km^3 and 0.0016 km^3 respectively. We assumed that only dense forest can retain and store runoff water efficiently. Dense forest cover in Meghalaya is 6,491 sq. km (FSI report, 2003). Estimation of runoff under dense forest in absence of forest is found to be 10.39 km^3 and in presence of forest to be 0.51 km^3. Substracting the runoff in presence of forest from that in absence of forest we get the volume of runoff water which is retain by forest is about 9.87 km^3 annually.

6.2.1.1 Water consumption

Water consumption differs from region to region. The Central Water Commission, India (Information System Directorate) has fixed the norms at 70 litres per capita per day for domestic rural water requirement and 200 litres per capita per day for domestic Urban Water Requirement. Since there is sufficient rainfall in Meghalaya, we can assume that it can fulfill the water requirements of the people in the state. The total water consumption for domestic purposes both rural and urban population of Meghalaya is found to be 0.081 km^3 /yr (Table- 6.22). Agriculture in the state is more or less dependent on rain, and irrigation facilities are not so much in use. As per records, out of 2658.74 sq. km crop area only a small area of about 189.57 sq. km comes under surface water minor irrigation schemes of Agriculture Department

According to a study on the water resource management of Union Territory of Pondicherry, the water requirement to irrigate 1 ha of agricultural land is 0.007 million cu m/ yr (0.00007 km^3 /yr). Since, data on water requirement per hectare of agricultural use in the state is not available therefore we have used this figure for our study. Water consumed only by agricultural land under irrigation in the state is estimated to be 1.33 km^3 /yr. Therefore, the total water consumed for domestic and agricultural purposes (agricultural land under irrigation only) in Meghalaya was found to be 1.41 km^3 /yr. The

water available is far more than the water requirement in the state. Still there is water crisis in the state because of lack of proper conservation measures and management practices.

Table- 6.22 Water requirement for domestic purposes by rural and urban population in Meghalaya

Purpose	Water requirement (l/ capita/day)	Population	Total Water requirement (l/yr)	Total volume of water (km^3 /yr)
Domestic				
Rural	70	1864711	47512836280	0.048
Urban	200	454111	33059280800	0.033
Agriculture*	0.00007	189.57		**1.33**
Total water requirement				**1.41**

* For Agriculture water requirement is in terms of km^3/yr and area under irrigation in sq. km.

6.2.1.2 Monetary Valuation

In Meghalaya, taxes on water does not exist as in most part of the state, water for domestic uses is available in plentiful except in the case of municipal areas (Figure-6.10). Therefore, no data is available on the price of water, so benefit transfer method is used for valuing the cost of water which is being supplied by forest during the lean seasons. Cities in India like Delhi, Chennai and Hyderabad has assigned some price for domestic and Non-domestic use of water. The price of water in Hyderabad is quite high and is not applicable for Meghalaya, hence we take the average of the price of domestic and non domestic uses of water which is found to be Rs. 0.675/cu m and Rs. 3/cu m, respectively. By multiplying this with the amount of water used in Meghalaya we estimated the cost of water supplying service rendered by the forest to be Rs. 4,04,46,75,000 (Table-6.23).

Figure- 6.10 Water supply as an ecosystem service from forest (Saitbakon Village), East Khasi Hills

Table-6.23 Value of water supply services rendered by the forests of Meghalaya

Purposes	Price (Rs/ km^3)	Quantity of water used. (km^3 /yr)	Value (Rs. /yr)
Domestic	67,50,00,000	0.081	54675000
Agricultural and other uses.	3,00,00,00,000	1.33	3990000000
Total			**4,04,46,75,000**

6.2.2 Stabilisation of soil on hill slopes

Soils on soft rock and loose-mantled hill slopes are inherently weakly structured and at risk of large scale erosion, including slope failure. Failure to contain runoff and any sediment generated from land disturbance may lead to sediment movement into water bodies or onto land further down slope which may lead to adverse effects on water quality, and on the health of the instream aquatic environment. Sediment movement down slope may affect particular values of the land for biodiversity, cultural importance, landscape, amenity or recreation. Vegetation that grows on hill slope plays an important role in binding the soil particles, minimizing soil erosion and hence stabilizes the hill slope. The mechanical stabilisation of soil slopes by means of tree roots depends largely on the strength properties of the roots and their growth pattern within the soil. Soil particles on hill slope tend to be unstable and become easily mobilised when disturbed or exposed. But there are very less cases of erosion and landslide in the state as compared to other regions. This may be attributed to the protective role of forest in stabilization of the hill slope and controlling loss of soil**.** Most of the landslide and erosion prone area in the state is due to human activities like unscientific cutting of hill slopes for various developmental activities, mining, deforestation, shifting cultivation, etc.

6.2.2.1 <u>Area under steep slopes in Meghalaya</u>

About 90% of Meghalaya is hilly terrain with slopes varying from 5° to more than 20°. The south-eastern part has steep slope-gradients at higher altitudes of about 2000 m whereas the Central part of the state called 'central table land' has less sloppy land. Land slope classification will tell how much of land is prone to erosion. Sharma (2003) calculated the area under different slope category in the state (Table 6.24). The highest percentage was recorded under moderate slope (44.47 %) and area under very steep slope is less than 1 %.

Table- 6.24 Area under different slope categories in Meghalaya

Slope categories	Area in sq. km	Percentage to total area
Level to Gentle (Below 5°)	2,630.49	11.73
Moderate (5° to 10°)	9,975.32	44.47
Moderately Steep (10° to 15°)	8,374.30	37.35
Moderately Steep (15 ° to 20°)	1,239.71	5.52
Steep (Above 20°)	209.18	0.93

Source: Sharma, 2003

Area under steep slope in the state is 9823.19 sq. km (43.8 % of the total geographical area) and we assumed that this area of land is prone to erosion. The state also has a forest cover of about 16,839 sq. km (75 % of its total geographical area). Out of this, 6491 sq. km is under dense forest and 10,348 sq. km is under open forest. By superimposing forest cover over the slope map we can probably calculate the amount of soil erosion control (soil loss prevention) contributed by the forest. We take the ratio of

forest land to steep slope land and calculate the area of steep slope land under forest cover. Assuming that the forest cover in the state is uniform for both moderate and steep slope, we found that 7377.2 sq. km area under steep slope is covered with forest out of which 2847.2 sq. km is under dense forest and 4530 sq. km is under open forest.

6.2.2.2 Prevention of soil loss on steep slopes by forest

Using model given by Sedell (2000) we can estimate the amount of soil loss prevented by the forest. According to the model, for good ground cover (60-75 % vegetation) and fair ground cover (37 % vegetation) the loss of soil is 0.12 t/ha and 1.24 t/ha, respectively. We assume that ten percent ground cover can be considered as non-forest area. Loss of soil in the steep slope under this condition is 13.59 t/ha. Suppose the whole area under steep hill slope has no forest cover, by multiplying this with the area under steep hill slope, the loss of soil is 982320 X 13.59 t/yr = 1,33,49,728.8 t/yr (S). In our study we consider the soil loss under dense forest to be same with that under good ground cover and open forest with that of fair ground cover as given in the model. Hence, we obtained the amount of soil loss on the hill slopes under dense forest cover and open forest cover is 34,171.2 tons and 562588 tons, respectively. The total soil loss on the steep slope under forest cover is 596759.2 t/ yr (F) and under remaining steep slope without forest cover = 244600 X 13.59 t/yr = 33, 24,114 t/yr (N).

Soil loss prevented by forest cover on steep hill slope (T) = S – (F+N) tons/yr

= 1,33,49,728.8 – (596759.2 + 33,24,114) t/yr

= 1,33,49,728.8 – 39,20,873.2 t/yr

= 94,28,855 t/yr.

Hence, the overall all contribution of forest in preventing soil loss on steep hill slope is 94,28,855 t/yr. The following formula is used to obtain the amount of soil loss prevention by dense and open forests and shown in Table- 6.25.

Soil loss prevented by Dense forest = A/ 100 X T + (C X AOF)

Soil loss prevented by Open forest = A/ 100 X T - (C X AOF)

Where T is the total soil loss prevented by forest in the steep slope = 94, 28,855 t/yr

A is the percentage of area under dense or open forests.

C is the difference in amount of soil loss in dense and open forest = 0.88 t/ ha.

AOF is the area under open forest in the steep slope

Table- 6.25 Soil loss prevented by Dense and Open forests of Meghalaya

Types of forest	Area (ha)	Percentage	Soil loss prevented (tons/yr)
Dense	284760	39	40,76,509
Open	453700	61	53,52,346
Total			**94,28,855**

To estimate the amount of nutrients present in the soil that is lost from the hill slopes, we made use of the data available in literature. Ramakrishnan and Toky (1981) studied the soil nutrient status of hill agro-ecosystems in Meghalaya. They had analysed the nutrient contents of N, P, K, Ca and Mg in soil of different depths collected from forests of different ages. In this study we have considered the nutrients content in the soil layer of depth 0-7 cm since most of the soil which gets eroded is top soil. The nutrient content of soil collected from a fifty years old forested fallow is assumed to be same as that of dense forest and that of ten years old with that of open forest (Table- 6.26).

Table- 6.26 Nutrient content of soil under 10 and 50 years old forested fallow

Nutrients	N (kg/tons)	P (kg/tons)	K (kg/tons)	Ca (kg/tons)	Mg (kg/tons)
10 years	2.7	0.0078	0.1092	0.398	0.2088
50 years	2.4	0.107	0.3471	0.168	0.1272

Source: Ramakrishnan and Toky (1981)

The nutrient content in the 10 and 50 year old forested fallow is then multiplied with the amount of soil loss prevented by dense and open forest (Table- 6.27). It was found that the amount of nutrients present in 94, 28,855 tons of soil which is conserved or protected by forest annually are 25457.9 t/yr of N, 73.55 t/yr of P, 1029 t/yr of K, 3752.68 t/yr of Ca and 1968.75 t/yr of Mg. The highest nutrient present in the soil protected by forest on steep hill slope is Nitrogen and least is Phosphorus.

Table- 6.27 Nutrients conserved by dense and open forest on steep hill slope of Meghalaya

Nutrients	Dense Forest (50 years) Tons /yr	Open Forest (10 years) Tons /yr	Total nutrients conserved by forest Tons /yr
N	11006.57	14451.33	25457.9
P	31.8	41.75	73.55
K	445.15	584.48	1029.63
Ca	1622.45	2130.23	3752.68
Mg	851.18	1117.57	1968.75

6.2.2.3 Monetary valuation

From the study we have estimated the amount of soil loss annually that is prevented by forests in the hill slopes and also the amount of nutrients present in it. This is then converted to monetary terms using fertilizer equivalent with the amount of nutrients. Fertilizers like Urea [$(NH_2)_2CO$], Single Super Phosphate [Ca (H_2PO_4).H_2O], Muriate of Potash [KCL], Lime (Ca_2CO_3) and Dolomite (Mg Ca $(CO_3)_2$) are commonly used as source of N, P, K, Ca and Mg, respectively in Meghalaya. The government approved rate of fertilizer per kg was obtained from the Department of Agriculture. The cost of nutrient per kg was calculated using molecular weight and market price of the fertilizers. By multiplying the amount of nutrients found in the soil protected by forest with their equivalent fertilizer

prices we get the cost of soil loss prevention by forests on steep hill slope of Meghalaya (Table- 6.28). Therefore we found that the total cost of soil loss prevention on steep hill slope by forest in Meghalaya is Rs. 3202.99 lakh per year.

Table- 6.28 Cost of soil loss prevented by forests annually in Meghalaya

Nutrient	Fertilizer	Market rate of nutrients Rs. /kg. P	Amount of nutrients present in soil protected by forest. (Tons/yr) N	Cost of nutrients protected by forest (Rs. in lakh) P X N
N	Urea	10.04	25457.9	2555.97
P	Single Super Phosphate	10.83	73.55	7.97
K	Muriate of Potash	8.11	1029.63	83.51
Ca	Lime	3.75	3752.68	140.73
Mg	Dolomite	21.07	1968.75	414.82
Total				**3202.99**

Limitations

There are a number of limitations in applying the model to the study, however since there was no study done on this previously and no data is available for the area. Below are some of the limitation listed in terms of the model and data used in the estimation.

1. Data on forest cover on the hill slope is not truly available therefore, the ratio of forest cover: hill slope in the study may not reflect the extent of forest cover on hill slopes.
2. The soil loss prevention was estimated only on the basis of dense and open forest, other catergory of forests and vegetation was not included.
3. In the model, soil texture and intensity of rainfall are different from the conditions existing in Meghalaya, hence the rate of soil loss per hectare may also vary.

6.2.3 Nutrient replenishment of agriculture fields by forests

Forests play an important role in improving and maintaining the soil fertility status as forests are source of nutrients for nearby agricultural land. Agricultural fields close to forests show a sustainable and productive crop growth for many years without much input of chemical fertilizers (Figure- 6.11). Although there is no data or evidences to support this saying however, when we view at the agriculture scenario in Meghalaya we have found less use of chemical fertilizer compared to other states. Hence, more research is needed to investigate ambivalent tree effects on crop production and slope stability.

Figure- 6.11 Nutrient supply from forest to nearby agricultural fields

A comparison between fertilizer consumption for different zone in India as given by the Department of Agriculture and Cooperation (DAC) under the Essential Commodities Act, 1955 (ECA) makes it clear that the amount of nutrients (N, P and K) used in the various agricultural plots in Northeast India is much less than the other zones (Table- 6.29).

Table- 6.29 Nutrient wise fertilizer consumption in various zones of the country in ('000) tones for the year 2001.

Zone	N	P	K
South	2727.4	1238.4	717.4
West	2495.8	1186	348.5
North	4079	1198	140.1
East	1505.2	580.8	325.5
North-East	103.05	42.85	33.2

The reduced amount of application of the nutrients in the north-eastern states as recommended by the DAC may imply that the nutrient replenishment of soil of this region is much better than the other regions. This may be attributed to the high forest cover in the region. With the exception of Manipur we can see that higher percentage of forest cover has low fertilizer consumption (Table- 6.30). Assam and Tripura with 35% and 67% forest cover has higher fertilizer consumption per hectare than Mizoram, Arunachal Pradesh and Nagaland whose forest cover is 83 %, 81% and 80% respectively.

6.2.4 Protection to Biodiversity

Biodiversity is a direct source of a variety of ecosystem goods. It also supplies the genetic and biochemical resources that support our current agricultural and pharmaceutical enterprises and allows us to adapt these vital enterprises to global change. In addition to sustaining the production of

conventional crops, the biodiversity in natural ecosystems may include many potential new foods. Turning to medicinal resources approximately 80% of the human population relies on traditional medical systems, and about 85% of traditional medicines involve the use of plant extracts (Bhattacharjee, 2003).

Table- 6.30 Nutrient wise fertilizer consumption in various North-Eastern States

State	Forest cover (%)	Nutrient wise fertilizer consumption. (Tones/'000 ha)		
		N	P	K
Arunachal Pradesh	81.25	1.95	0.81	0.49
Assam	35.33	26.47	13.07	11.05
Manipur	75.81	131.50	16.43	9.5
Meghalaya	69.48	11.65	6.41	0.63
Mizoram	82.98	5.05	5.05	3.03
Nagaland	80.49	1.09	0.71	0.09
Tripura	67.38	24.87	6.25	1.95

Source: Bhattacharjee (2003)

As already discussed in the previous chapter, Meghalaya is rich in both floral and faunal diversity. Kumar et al. (2006) studied the tree species diversity and distribution patterns in tropical forests of Garo Hills and found that only in Garo Hills alone there are 165 tree species. Out of a total 1200 tree species in India (FRA- 2005), in Meghalaya only there are around 830 tree species. Data of other vascular plants for the whole of Meghalaya is not available, however it was reported that around 395 vascular plant species are found in scared grove of Jaintia Hills (Jamir and Pandey, 2004). The number of plants and animals species in the state is shown in Table- 6.31. Various ongoing anthropogenic and natural activities in the state pose a threat to many of our floral and faunal diversity reducing their status to rare, endangered and even extinct. However, some forest areas in the state still harbour a rich biodiversity and play a main role in their protection by providing a habitat to various wild plants and animal species. These areas have been given special protection in the form of wildlife sanctuary, National Park and Biosphere Reserve. The sacred grooves in the state are also one example of forest service rendering protection to the rich biodiversity (Box 6.1).

Apart from serving as direct ecosystem goods, biodiversity also perform key life support functions in ecosystems, such as seed dispersal, pollination, or pest regulation. We can thus say that forest contributes indirectly in protection of agricultural crop as it provides a habitat to many predators of pest that destroys the crop. Although very little information is available on services of the forests of Meghalaya due to lack of studies. However, it has tremendous role in providing various ecological services to the people of the state as well as to areas far beyond.

Table- 6.31 Diversity of some higher plants and animals groups in Meghalaya

Sl. No.		Total number of known species in India	Total number of known species in Meghalaya
1.	Trees Other vascular plants	1200 18664	830 395*
2.	Mammals Birds Reptiles Amphibia Pisces	410 1250 408 197 2546	139 540 94 33 152

Source: Zooloogical Survey of India, Calcutta, 1999-2000. * found in sacred groves of Jaintia Hills

Box 6.1 Biodiversity in Nongkhyllem Wildlife Sanctuary and Sacred Grove

The Nongkhyllem Wildlife Sanctuary in the Khasi Hills was notified on 1981 with the main aim to protect the rich diversity existing in the area. Total Number of higher plants known in the area is 1032. The area is also rich in animal species. There are 50 mammals out of which 30 are endangered, 400 birds species with 16 under endangered list and 25 reptiles species exist in the area out of which 2 are under the endangered list (Source: Bonney, 2004).

The Sacred groves of Meghalaya are rich in floristic diversity. A study by Tiwari *et al*. (1999) listed 23 tree species, 9 shrub species and 4 herb species in the Sacred groves of Jaintia Hills, 71 tree species, 56 shrub species and 53 herb species, 19 pteridophyte species and 22 epiphyte species in the Sacred groves of Khasi Hills and 67 tree species, 10 shrub species, 19 species of lianas and climber species and 5 orchids and parasite flora in the Sacred groves of Garo Hills. There are 45 rare and threatened plant species found in the scared forest of Meghalaya.

Chapter 7

Land Resources of Meghalaya

Land in Meghalaya is a very important resource since 81 per cent of its population is either directly or indirectly dependent on agriculture (Directorate of Economics and Statistics, 2003). About 90% of the total geographical area of Meghalaya is hilly. Plain land with fertile alluvial soil is located in river valleys in the form of narrow strips in the fringes of the state i.e., in the lower altitude areas to the north, west and south of the plateau region.

7.1 Soil

The soil of Meghalaya varies from dark brown to dark reddish-brown in colour. The depth of soil varies from 50 to 200 cm in different parts of the state with texture ranging from loamy to fine loamy. The soils are rich in organic carbon with high nitrogen supplying potential, but deficient in phosphorus and potassium. Soil reaction varies from acidic (pH 5.0 to 6.0) to strongly acidic (pH 4.5 to 5.0). Most of the soils occurring on higher altitudes under high rainfall belt are strongly acidic due to intense leaching. There is not much difference in fertility classes of the soils of the state. Four soils fertility classes, namely, High Low Medium (HLM), High Medium Medium (HMM), Medium Medium Low (MML) and Medium Low Medium (MLM) have been established in Meghalaya (Directorate of Agriculture, Meghalaya, 2002).

The Regional Centre of National Bureau of Soil Survey and Land Use Planning, Jorhat (NBSS & LUP 1993) has classified the soils of Meghalaya into 4 soil orders which are described below. However, the distribution of different types of soils in Meghalaya is shown in Figure- 7.1.

7.1.1 Red Loamy soils. The red loamy soils occupy the entire central part of Garo Hills and central uplands of Khasi and Jaintia Hills from west to east except the valley part of Simsang River. The soils are generally loamy and red in colour. Red Loamy soils are the result of weathering of rocks like granite, gneisses, diorites and others. These soils are suitable for the cultivation of potato, rice, fruits in hill slopes and terraces.

7.1.2 Red and Yellow soils. The Red and Yellow soils are extended parallely west to east along with the southern slope of Red Loamy soils. The soils are generally found in the grade of fine textured, ranging from loam to silty loam and are suitable for cultivation of rice and horticultural crops.

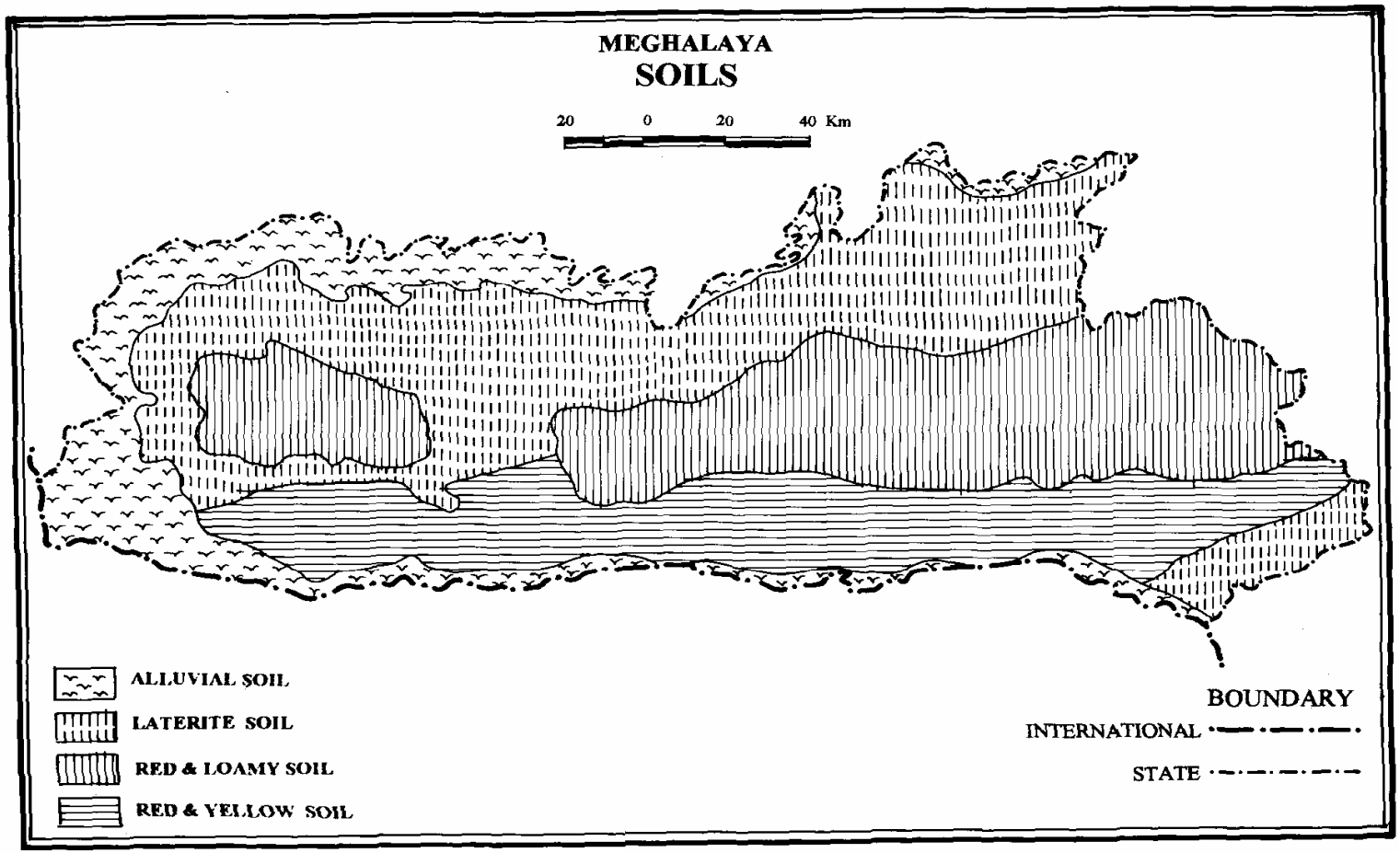


Figure 7.1 Soil Map of Meghalaya **Prepared by Dr. S. Sharma**

7.1.3 Laterite soils. The Laterite soils are extended from west to east in the northern part of the state. Most part of this belt falls under rain shadow area as a result of which dehydration takes place and most of the nutrients required by plant growth are leached out from the soil. This belt is therefore, not much important from the point of agricultural practice.

7.1.4 **Alluvial soils.** The Alluvial soils are found all along the northern, western and southern fringe of the state. The soil textures in this region vary from sandy to clayey-loam with varying degree of nitrogen and very much acidic in character. This belt is used for cultivation of rice and jute.

7.2 Drainage

The development of drainage network in Meghalaya is the result of the geological formation. The action of the streams to a considerable extent is favoured by heavy rainfall in the state. The central part of state is a rising landmass which slopes down towards the peripheral boundary and as a result, the central part is the source of almost all rivers, streams and spring which drain their water towards north and south. The Tura range in the Garo hills and Central uplands in the Khasi and Jaintia Hills forms a clear cut water divide which results into development of two drainage systems, the Brahmaputra system and the Surma system (Figure- 7.2). The rivers flowing towards Assam in the North to meet the Brahmaputra have gentle gradient and, therefore do not form any water falls and deep gorges. The rivers flowing towards Bangladesh in the South have steep gradient and form many waterfalls and deep gorges. Some of the important rivers in the Northern slopes from west to east are the Kalu, Ringgi, Didak, Didram, Krishnai, Dudhnoi, Ildek, Umkhri, Umtrew, Umiam, Umkhen and Kopili. Out of these Krishnai, Kalu and Umtrew are navigable. The important rivers of the southern slope from west to east are the Darong, Sanda, Bandra, Simsang, Kynshiang, Umngi, Shella, Myntdu etc. Simsang is the largest river in the Garo Hills and is navigable with considerable sizes of boats.

7.3 Slope

Slope is the angle of any element of the landscape with the horizontal plane. It determines factors such as development of soil, loss of soil due to weathering, mining operations, agricultural practices etc. As Meghalaya is a hilly state slopes vary from place to place. The south-eastern parts have steep slope-gradients at higher altitudes of about 2000m and have less sloppy and undulating land in the central part of the plateau called ‘central

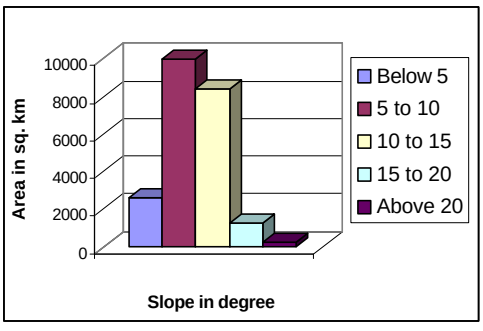
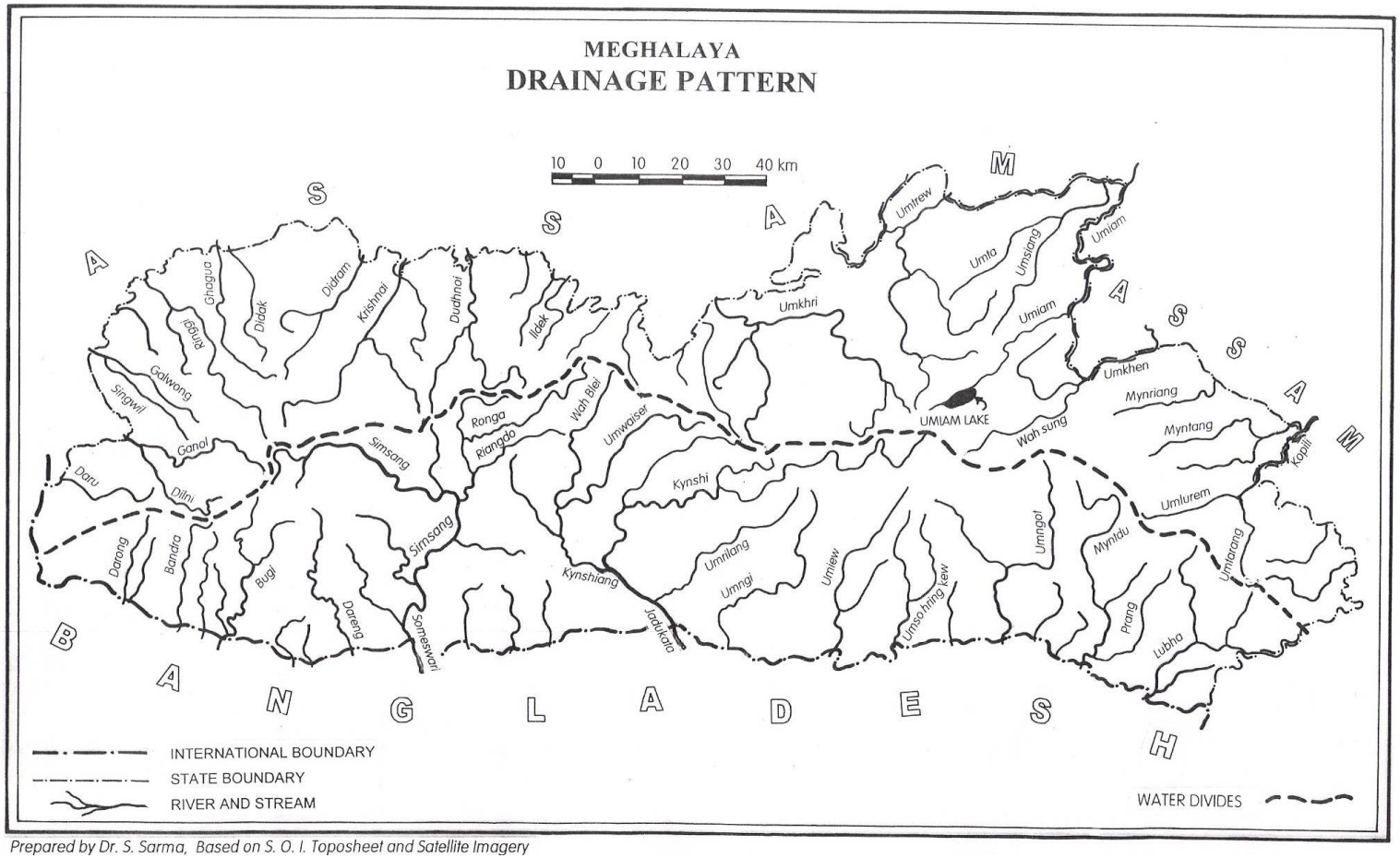


Figure- 7.4 Area under different slope categories in Meghalaya



Prepared by Dr. S. Sarma, Based on S. O. I. Toposheet and Satellite Imagery

Figure- 7.2 Drainage Pattern in Meghalaya

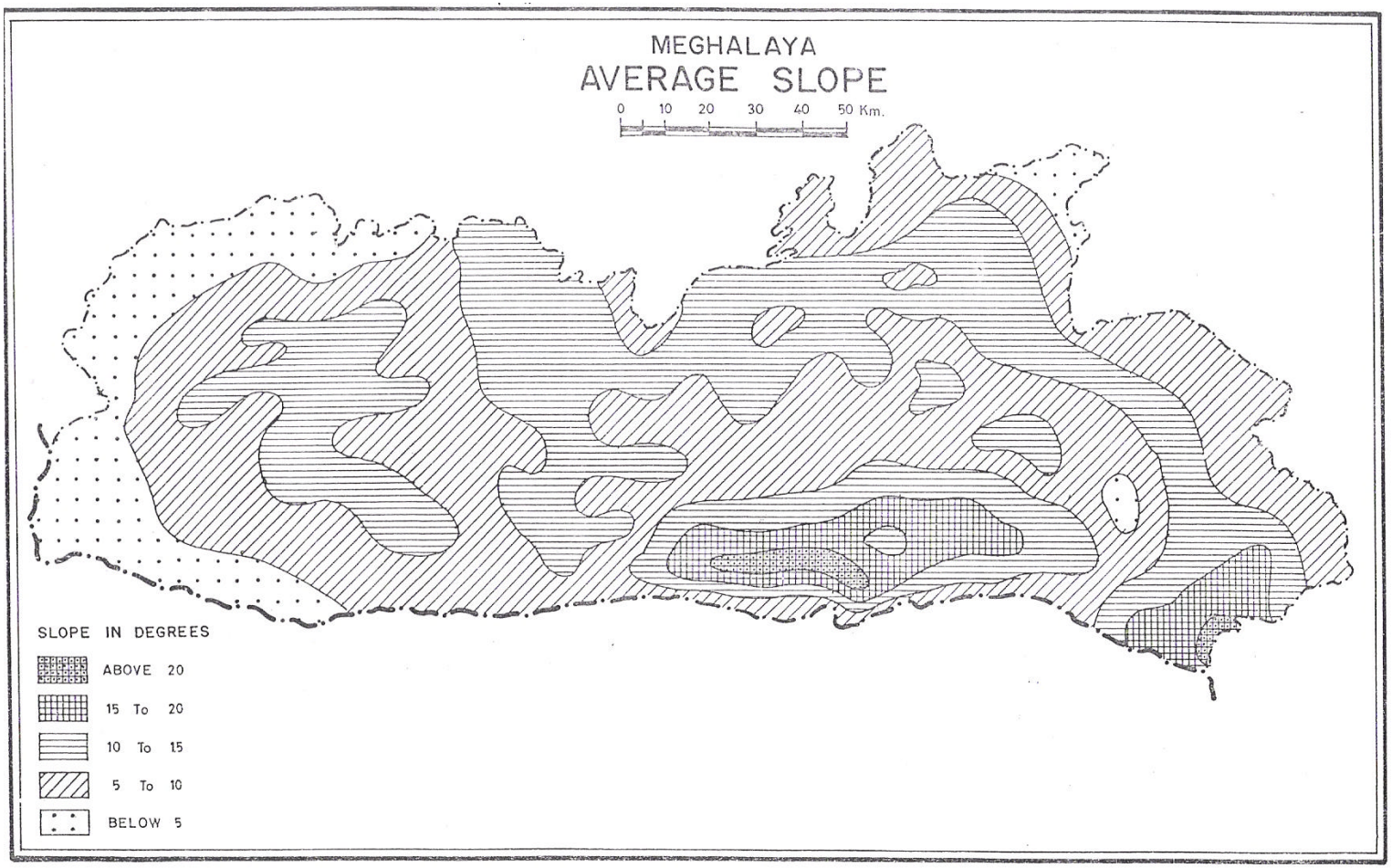


Figure- 7.3 Average Slope Map of Meghalaya Prepared by Dr. S. Sharma

table land' of Meghalaya. Based on the degree of slopes land in Meghalaya can be divided into 4 categories *viz.*, Level to Gentle Slope**,** Moderate slope, Moderately Steep Slope and Steep Slope and their area distribution is depicted in Figure 7.3. Average slope Map of the state can be seen in Figure-7.4. Details of the four categories of slope are given in Table- 7.1.

7.4 Land ownership pattern in Meghalaya

The land use and agricultural planning mainly depends on the pattern of land ownership. Traditional system of land ownership exists in the state. The land tenure system is influenced by the customary law of the tribal people inhabiting the area and differs from one tribe to tribe. The rules governing the transmission of these rights are usually explicit and generally known to local people. Two main types of land ownership system in Meghalaya are i) *Riotwary***,** where Government deals directly with the actual land holder without the intervention of intermediaries, and ii) *Customary land tenure system*, where the right to use a piece of land is governed by certain rules to be accepted by the community.

Table- 7.1 Distribution of land in different slop categories in Meghalaya

Slope category	Slope in Degrees	Area in sq. km	Percentage to total area	Places
Level to Gentle	Below 5	2630.49	11.73	Damra, Dainadubi, Mandipather, Resubelpara, Tikrikila, Phulbari, Garobadha, Mancacher, Mahendraganj, Dalu and south western part of South Garo Hills district
Moderate	5 to 10	9975.32	44.47	Northern part of Ri-Bhoi district, north and eastern part of Jaintia Hills district, central highland zone of East Khasi Hills district and Jaintia Hills district, Rangmil, Rangjeng, Darugiri Anogiri, Rangram, Tura, Adugiri Nengkhra, Nangalbibra, Siju, Baghmara and Chokpot
Moderately Steep	10 to 20	9614.01	42.87	Umsning till Sonapahar, Mawsynrut, Nongstoin and Wahlyngdoh
Steep	Above 20	209.18	0.93	Cherrapunjee, Mawsynram, Katdum

Source: Sharma (2003)

7.4.1 Ownership system among Garo Tribe

In *Garo* Hills, the *Riotwary* system of ownership is in practice in plains, while *customary* land tenure system is prevalent in the hilly areas. The land ownership pattern in *Garo* Hills is related to the type of cultivation practiced in the area. Often private ownership is associated with permanent holdings.

7.4.2 Ownership system among Khasi and Jaintia Tribes

In the Jaintia Hills, rigid, uniform or regular land ownership system do not exist. However, the land can be placed under the following categories Ri *Kynti* or private land, *Raij* land or land under the administration of the *Syiem* or *Doloi* which subjected to payment of annual revenue and *Zamindars* land which is owned by the big landholders or *Zamindars* who lease out their land on the basis of rent in cash or kind (Lahiri, 1979). In the Khasi Hills, four types of land ownerships patterns *viz.*, Private

lands, Group and Clan Land, Community Land and Government Land exist (Haloi, 1984). Private lands are owned by a single owner who enjoys all the right over the land and are not subjected to the control by any superior except under certain conditions of settlement of dispute. In Group and Clan land, the owner enjoys all the right over the land except the transferable right. In Government land, the Government enjoys all rights over the land. These lands are leased, purchased or acquired from the community under various rules issued from time to time by the Government.

7.5 Land use pattern

There are considerable variations in the land use pattern in different parts of the state in different communities. However, it mainly depends on spatial and temporal variations, in physical environment, climate, soil condition and topography (altitude and slope). The natural vegetation also plays a significant role in deciding the type of land use. Land use pattern is envisaged on land capability profile. Since land capability in the mountainous region is determined by the characteristics of micro and mini watersheds, land use pattern is therefore envisaged on the capabilities of each watershed. Thus the potential of each watershed is envisaged to be developed to yield sustainable land use. Table-7.2 shows the area under different land use category in Meghalaya. Forest land is the dominant type of landscape with 52 % of the total area of Meghalaya, agricultural land amounts to 28 %, wasteland to 19 % and water bodies to 0.76 %. The built-up land is less than 1 % of the total area of Meghalaya.

Table- 7.2 Area under different types land use in Meghalaya (sq. km)

Class	East Khasi Hills	West Khasi Hills	Jaintia Hills	West Garo Hills	South Garo Hills	East Garo Hills	Ri-Bhoi	Total
Forest	1191.96	2808.37	1768.49	2054.86	1186.07	1554.63	1196.92	11761.3
Agriculture	760.21	1301.43	1430.93	914.04	470.68	675.42	793.19	6345.90
Wasteland	764.06	1135.01	605.13	689.47	177.52	404.06	377.84	4153.09
Built up	16.46	NA	NA	NA	NA	NA	NA	16.46
Water bodies	15.31	20.19	14.45	55.63	15.73	3.86	45.08	170.25

Source: NEDFi Databank (2002)

7.6 Agriculture

The state consists predominantly of mountainous terrain with narrow valleys in between and strips of plain land in the southwest and north bordering Bangladesh and Assam, respectively. The nature of the terrain makes the net availability of land for cultivation at only 10% of the total geographical area and the possibility of mechanized cultivation is limited. Agriculture in the state is also highly dependent on the monsoon with the irrigation coverage being only 19% of the total cropped area. Hence proper planning is required as subsistence agriculture which provides livelihood to about 80% people in rural Meghalaya is practiced on less than 10 % of the land at any given point of time (Figure- 7.5).

Figure- 7.5 Agricultural land in Lyngiong, East Khasi Hills

7.6.1 Land utilization statistics

The state follows the standard land use classification. Land utilization statistics of Meghalaya from 1996-97 to 2003-04 is presented in Table- 7.3. It is quite satisfactory to note that over the years the total cropped area, area sown more than once as well as net area sown are increasing constantly. Jhum is the traditional cultivation of the local tribes. In Garo Hills it is reported that permanent cultivation is practiced only in the plain areas which is very minor portion of the total cropped area. These cropped lands are scattered throughout the state.

Table- 7.3 Land utilization statistics in Meghalaya 1996-2004 (Area in Sq. Km)

Land Classification	1996- 97	1997- 98	1998- 99	1999- 00	2000- 01	2001-02	2002-03	2003-04
Reporting area for land utilization statistics	22409.00	22409.00	22409.00	22409.00	22409.00	22271.00	22271.00	22271.00
1.Forest	9353.34	9339.98	9470.00	9415.03	9418.23	9505.33	9470.38	9472.19
2.Not available for cultivation	2236.95	2260.66	2224.95	2245.93	2154.84	2254.18	2253.21	2253.80
3.Other uncultivated land excluding fallow land	6323.55	6314.66	6214.20	6224.40	6303.23	6063.93	6008.24	5995.89
4.Fallow land	2344.78	2337.82	2286.00	2306.22	2314.40	2342.94	2383.92	2356.88
5.Net sown area	2164.18	2155.88	2213.85	2217.42	2218.30	2104.62	2155.25	2192.24
6.Area sown more than once	440.66	441.12	444.45	455.77	449.86	466.49	465.97	466.50
7.Total cropped area	2604.84	2597.00	2658.30	2673.19	2668.16	2571.11	2621.22	2658.74

Source: Directorate of Economics & statistics, Meghalaya 2003, 2005.

7.6.2 Area under different crops

Paddy is the dominant crop of the state which occupies more about 40% share of the total cropped area (Directorate of Economics and Statistics, 2003). The intensive paddy cultivation is practiced twice even thrice in a year in the river valleys and on the hill slope terraces. Coarse cereals have the second place in the cropping pattern. Table- 7.4 shows the areas under different crops in the state for the years 1999-2004.

Table- 7.4 Area under different crops for the years 1999-2004 (in ha.)

Sl No.	Crop	1999-2000	2001-2002	2003-2004
1	Rice	106411	107761	109721
2	Maize	16637	16866	16900
3	Wheat	4283	2753	862
4	Other	2829	2720	2661
5	Total Pulses	3288	3425	3420
Total Food grains		**133448**	**133525**	**133564**
6	Jute	5235	4061	4043
7	Mesta	4457	4550	4502
8	Cotton	7455	7323	7281
9	Potato	18339	18151	18035
10	Ginger	7606	8897	8882
11	Turmeric	1458	1523	1561
12	Arecanut	9645	11128	11189
13	Banana	5319	5311	5628
Total Cash crop		**59514**	**60944**	**61121**
Grand Total		**192962**	**194469**	**194685**

Source: Directorate of Economics and Statistics (2003)

It can be observed from the table that the crop area for almost all the crops has increased from the years 1999-00 to 2003-04 except for fibre crops, which may be attributed to the un-remunerative price. Figure- 7.6 shows the area under different crops during the last 5 years.

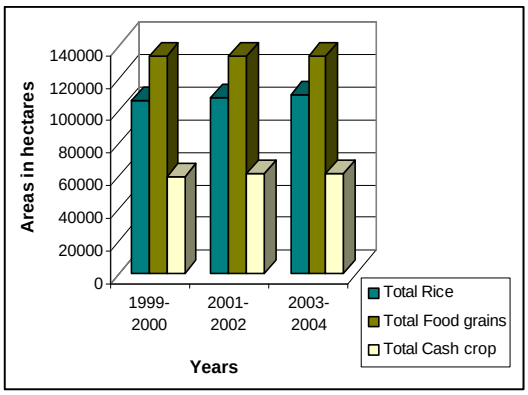


Figure 7.6 Area under different crops for the years

Table- 7.5 Physico-chemical characteristics of soils of different watershed project

Sl. No.	Name of the watershed project	Districts	%				pH	%	Kg/ha	
			WHC	Clay	Sand	Silt		OC	P_2O_2	K_2O
1	Lyngiong	KHASI HILLS	23.5-70.6 *50.76*	6.4-34.1 *21.13*	18.5-78.2 *48.3*	17.2-48.3 *29.9*	4.81-5.64 *5.29*	0.28-3.14 *1.71*	2.68-20.6 *7.65*	33.6-257.6 *72.58*
2	Kreit		40.1-69.6 *57.01*	14.9-33.4 *26.57*	20.2-65.8 *44.40*	16.1-48.5 *28.02*	5.29-6.03 *5.70*	0.54-2.72 *1.63*	1.79-12.04 *3.17*	33.6-168.0 *86.24*
3	Mawbyrthuh		51.4-85.1 *61.09*	30.2-55.7 *34.37*	12.5-50.9 *40.16*	6.3-36.9 *25.46*	4.79-5.36 *5.22*	1.63-2.72 *2.01*	1.79-8.06 *4.57*	56.0-190.4 *108.64*
4	Mawpyrshong		50.2-79.2 *71.08*	28.5-53.2 *34.48*	21.7-59.3 *36.33*	10.0-42.2 *30.03*	4.74-5.88 *5.55*	0.28-2.57 *1.26*	1.79-6.27 *4.14*	33.6-100.8 *54.60*
5	Proin		39.8-69.2 *54.07*	9.3-37.2 *26.67*	30.4-61.1 *48.01*	16.3-33.3 *25.33*	5.18-5.66 *5.39*	0.81-2.57 *1.52*	4.48-12.1 *9.14*	28.0-240.4 *71.37*
6	Phodjaud		30.1-58.2 *40.02*	11.3-28.3 *17.25*	55.8-73.6 *60.17*	11.3-30.7 *22.13*	4.37-5.36 *4.97*	1.72-3.14 *2.00*	1.79-8.02 *4.64*	22.4-39.2 *31.56*
7	Upper Shillong		36.3-66.4 *49.96*	14.3-34.3 *25.18*	41.4-59.2 *51.99*	10.9-29.6 *22.83*	5.0-5.35 *5.15*	0.28-2.57 *1.84*	2.68-8.96 *4.58*	39.2-420.0 *105.80*
8	Thaiem		30.0-51.0 *40.93*	10.1-32.9 *20.88*	46.5-83.0 *61.43*	6.9-28.9 *17.70*	4.16-5.40 *4.88*	1.42-2.57 *1.92*	2.68-8.86 *7.16*	28.0-100.8 *58.80*
9	Lamlyer		38.3-65.8 *54.43*	10.6-34.3 *26.86*	14.7-65.5 *49.6*	11.7-53.5 *23.5*	4.51-5.44 *4.89*	0.57-2.86 *1.69*	1.79-8.02 *3.16*	33.6-89.6 *55.25*
10	Jaidoh		37.8-62.5 *50.80*	11.5-33.6 *26.18*	31.9-62.3 *52.74*	14.3-34.9 *21.08*	4.86-5.75 *5.37*	0.57-2.57 *1.36*	0.89-5.38 *1.79*	28.0-106.4 *65.10*
11	Pansharing		45.1-71.3 *55.81*	5.4-35.12 *21.13*	26.24-58.62 *47.32*	21.45-40.57 *31.55*	4.50-5.31 *4.91*	0.54-1.63 *1.09*	6.58-14.78 *7.41*	33.6-134.4 *69.62*
12	Wahkroh		43.9-69.4 *56.59*	17.3-38.4 *27.74*	43.9-69.4 *56.43*	14.7-54.4 *29.94*	5.04-5.98 *5.58*	1.63-2.18 *1.97*	0.89-8.69 *3.47*	28.0-78.4 *42.00*
13	Tishang		37.2-74.4 *59.69*	9.9-45.1 *30.69*	23.6-60.2 *39.2*	19.6-43.7 *30.1*	4.48-6.27 *5.28*	0.81-2.72 *1.55*	1.79-5.38 *2.96*	39.2-145.0 *71.62*
14	Umtaru		38.1-63.9 *57.31*	11.7-59.8 *29.26*	18.6-81.2 *41.84*	8.2-44.5 *28.90*	4.64-6.47 *5.34*	0.57-1.72 *1.29*	1.79-13.44 *6.45*	39.2-106.4 *56.00*
15	Sohkhwai	Ri-Bhoi	50.14-79.11 *64.12*	21.23-32.24 *27.3*	10.75-60.45 *48.2*	14.11-57.65 *25.4*	5.2-6.19 *5.63*	0.23-1.92 *0.76*	5.6-22.4 *13.3*	39.2-134.4 *68.73*
16	Mynsain		24.8-69.3 *53.21*	3.1-36.5 *25.54*	29.1-88.0 *53.61*	8.9-39.9 *21.96*	4.23-5.23 *4.70*	1.42-2.86 *2.02*	0.89-4.48 *2.54*	33.6-207.2 *87.73*
17	Paham Syiem		30.4-67.3 *53.13*	11.3-48.3 *27.78*	12.3-62.3 *38.90*	11.4-57.4 *33.27*	5.01-5.84 *5.43*	0.3-2.29 *1.44*	4.48-11.2 *6.45*	33.6-436.8 *152.32*

Source: Directorate of Agriculture, Govt of Meghalaya, 1994-2004. Remarks: Figures in *Italics* are the mean value.

7.7 Wasteland

According to the Wasteland Maps prepared based on Land sat TM/IRS LISS II and IRS-LISS III Data the waste land of Meghalaya can be categorized into 9 types. Their extent and percentage is given in Table 7.6. Some of these wastelands are natural in occurrence while some originated due to shifting cultivation and mining activities. Most of these wastelands are under the jurisdiction of community and private ownership.

Table- 7.6 Category wise wastelands in Meghalaya (2003)

Sl. No.	Types of Wastelands	Area (sq. km)	% to total waste land	% to total Geographical area
1	Land with scrub	1010.35	29.617	4.50
2	Land without scrub	1584.11	46.436	7.06
3	Waterlogged and Marshy land (Permanent)	11.52	0.338	0.05
4	Waterlogged and Marshy land (Seasonal)	4.18	0.123	0.02
5	Shifting cultivation area (Abandoned Jhum)	116.62	3.419	0.52
6	Shifting cultivation area (Current)	627.21	18.386	2.80
7	Sands (Flood Plain)	0.04	0.001	0.0002
8	Mining Wastelands	2.15	0.063	0.010
9	Barren Rocky/Stone Waste/Sheet Rock Area	55.23	1.619	0.25
Total Wasteland		**3411.41**	**100**	**15.21**

Source: 1:50,000 Wasteland Maps-2003 prepared based on IRS-LISS III Data

7.8 Minerals

Geologically the state of Meghalaya is characterized by Archaean gneisses complex. As a result, the state is rich in mineral resources such as coal, limestone, sillimanite, granite, kaolin, uranium, glass-sand, quartz, feldspar, clay etc. The main mineral deposits of Meghalaya and the places of their availability are described below:

7.8.1 Limestone: Limestone is a major mineral that occurs in an extensive belt (approx. 200 Km. long) along the southern border of Meghalaya. Limestone found in the state is fine grained, hard, compact and fossiliferous with little variation in colour from light to dark grey. Total inferred reserve of limestone in the state is about 5,000 million tonnes. The CaO content in limestone of Meghalaya may be found upto 53% and can be of great use to the steel, fertilizer and chemical industries.

7.8.2 Coal: Coal deposit can be found in all districts and particularly in the Southern slopes of the State. The coal of Meghalaya is characterized by low ash content, high calorific value (ranges between 6,500 and 7,500 K Cal/Kg) and high sulfur content. The total estimated inferred reserve of coal in the state is about 563.5 million tonnes. The coal is mainly of sub-bituminous type and can be utilized for various purposes. The coalfields of the Jaintia Hills are small and spread out in different patches. Coal

occurs in nine important deposits of the district. Jaintia Hills district has a total coal deposit of about 40 million tonnes, which is only 7 percent of the total coal deposits of the state but production more than 70 percent of the total coal produced in the state (Table- 7.7; Figure- 7.7).

Table- 7.7 Coal production ('000 tonnes) and percentage in Jaintia Hills district of Meghalaya

Year	Meghalaya	Jaintia Hills	% of the District
1992-1993	3487.70	3040.80	87.18
1993-1994	2583.50	2062.20	79.82
1994-1995	3266.20	2389.70	73.16
1995-1996	3247.50	2159.50	66.49
1996-1997	3240.90	2273.60	70.15
1997-1998	3233.50	2414.60	74.67
1998-1999	4237.80	3246.00	76.59
1999-2000	4057.00	2935.00	72.34
2000-2001	4160.80	2839.80	68.29
2002-2002	5149.32	3869.32	75.14
Total	**36664.22**	**27230.62**	**74.27**

Source: Directorate of Mineral Resources, Government of Meghalaya, 2003

7.8.3 Granite: The state is also endowed with abundant sources of granite and other crystallized rocks of different colours and shed (viz. black, pink, gray etc).

7.8.4 Clay: Clay of various types such as Kaolin (China clay), White clay and Fire Clay is also found in various parts of the state. The clay found in the state is suitable for ceramic, paper, rubber and refractory industries. It has been estimated that there are a few hundred million tonnes of clay reserves in the state.

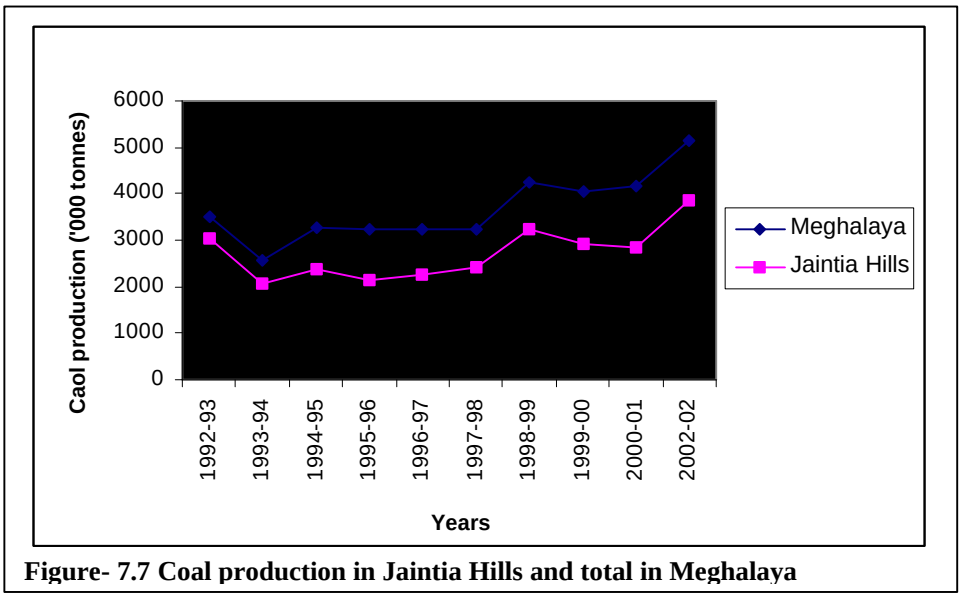


Figure- 7.7 Coal production in Jaintia Hills and total in Meghalaya

7.8.5 Sillimanite: Sillimanite is one of the important minerals found in West Khasi Hills district of Meghalaya. This mineral is considered to be one of the best in the world. The state is the leading producer of this mineral and 95% of India's Silimanite comes from the state. It occurs predominantly at Mawshynrut (Sonapahar) region of the West Khasi Hills District. In addition to these, other economically viable minerals like uranium, glass-sand, quartz, feldspar etc. are also found in the state. The estimated reserves of important minerals in Meghalaya are given in the Table-7.8. It is to be noted that in terms of size of the estimated reserves, the most important mineral of the state is limestone, followed by coal, clay, kaolin, glass sand, feldspar and sillimanite. One of the essential functions for the assessment of geological and natural resources is a continuous process of exploration which would include geological mapping, core drilling and exploratory mining. This work is mainly being carried out by the Geological Survey of India, Government of India and the Directorate of Mineral Resources, Government of Meghalaya.

Table- 7.8 Estimated Reserve of various minerals in Meghalaya

Mineral	Areas where found	Reserves (in MT)
Limestone Khasi Hills	Cherrapunjee, Laitryngew, Mawlong, Ishamati, Komorrah, Shella, Borsora	2,537.00
Jaintia Hills	Lumshnong, Sutnga, Nongkhlieh, Lakadong, Syndai, Nongtalang	1,050.00
Garo Hills	Darrang-Ear-Aning, Siju-Artheka, Chokpot	560.00
Total in Meghalaya		**4,147.00**
Coal Khasi Hills	Laitryngew, Cherrapunjee, Laitduh, Mawbehlarkar, Mawsynram, Lumdidom, Langrin, East Darrangiri, Pynursla, Lyngkyrdem, Mawlong-Shella-Ishamati and Borsora	164.50
Jaintia Hills	Bapung, Lakadong, Sutnga, Jarain, Musiang Lamare, Toksi, Khliehriat, Lumshnong.	40.00
Garo Hills	West Darranggiri, Siju, Pemdemgri-Balphakram, Selsela	359.00
Total in Meghalaya		**563.50**
Kaolin Khasi Hills	Mawkriah-Mawphlang, Smit, Laitlyngkot	1.30
Jaintia Hills	Thadlaskein, Shangpung, Mulieh, Mynsngat	1.94
Garo Hills	Daruggiri	1.20
Total in Meghalaya		**4.44**
Clay Khasi Hills	Cherrapunjee, Kut Madan, Mahadek, Sohrarim, Umsten	2.47
Jaintia Hills	Larnai, Tongseng	0.50
Garo Hills	Nangwalbibra, Nengkrah, Dobu, Rewak, Damukgithim, Tura, Rongram, Khobal, Rongrenggiri-Kherra, Songsak	78.00
Total in Meghalaya		**80.97**
Sillimanite Khasi Hills	Sonapahar, Nongstoin, Mawpomblang	2.045
Jaintia Hills	-	-
Garo Hills	Dapsi-Thologiri	0.001
Total in Meghalaya		**2.046**
Glass Sand Khasi Hills	Umstew, Kreit	2.40
Garo Hills	Tura	0.14
Total in Meghalaya		**2.54**
Quartz Khasi Hills	Hahim, Mairang, Nongkhlaw	0.02
Jaintia Hills	-	-
Garo Hills	Tura, Bonsomgiri, Rombhagiri, Nengkhra	0.057
Total in Meghalaya		**0.077**
Feldspar Khasi Hills	Hahim, Mairang, Nongkhlaw	0.02
Jaintia Hills	-	-
Garo Hills	Tura, Bonsomgiri, Rombhabiri, Nengkhra	0.057
Total in Meghalaya		**0.077**

Source: Directorate of Mineral Resources, Meghalaya: http://meghalaya.nic.in/MIDC/pot_inv.htm.

Chapter 8

Primary Survey

The main aim of the Primary Survey is to collect data on the types and quantity of forest products used and collected by the people of Meghalaya. According to the study conducted by the Indian Institute of Remote Sensing (2002), the percentage of area under different types of forest in the state is given in Table- 8.1. Nine villages were selected from each of the three major forest types *i.e.*, Tropical evergreen forest, Sub-tropical pine forest and Semi evergreen forest. From the other two types of forest *viz.*, Bamboo forest and Moist deciduous forest which constitute only a small percentage of the geographical area, only 2 villages from each forest were selected for the survey. For the study, about 5% of the households were selected from the villages under each type of forest.

Table-8.1 Major forest types and their area in percentage

Forest type	Percentage to geographical area
Subtropical evergreen	18.25
Semi evergreen	29.47
Subtropical pine*	11.61
Moist deciduous	0.26
Bamboo forest	1.18

Source: Institute of Remote Sensing (2002). * including mixed pine and degraded pine

A preliminary survey was conducted to gather information on the types of forest in the villages, demography, occupation pattern, land and cattle holding and other socio-economic aspects of the villages. The size of the villages taken for survey ranges from 26 households to 960 households and the population per household ranges from 3.95 to 6.95 persons. The average size of the villages is 143 households per village and population per household is 5.6 persons. The general information of the villages in the different type of forest is given in Table- 8.2.

Table- 8.2 General information of the surveyed villages in different types of forest

Types of forest	No. of villages	Avg. no of HH/ village	Avg. Population/ HH	Total no. of sampled HH	Ownership of the forest
Subtropical evergreen	9	104	5.8	57	Private, Community, Government.
Semi evergreen	9	140	5.22	62	Private, Community, Government.
Subtropical pine*	9	218	5.94	40	Private, Community, Government.
Moist deciduous	2	79	5.24	12	Community
Bamboo forest	2	61	5.38	13	Community

The different forest products commonly used and collected by the people of Meghalaya and their seasonal variation in availability is depicted in Figure- 8.1.

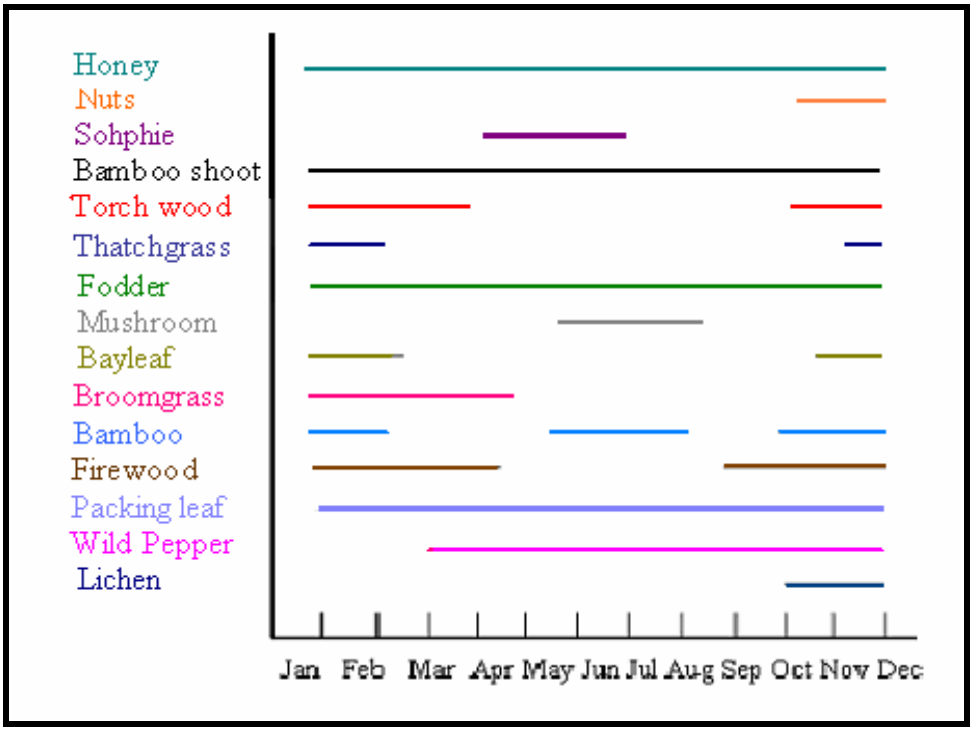


Figure- 8.1 Seasonal variation in availability of important forest products

Forest products in the state are collected both for subsistence as well as for commercial use. The average quantity of forest products collected per household for subsistence use only is given in Table- 8.3. The main commercial forest products in the state include Timber, Firewood, Bamboo, Packing leaf, Broomgrass, Bayleaf, Charcoal, Torchwood, Brut, Mushroom, Wild pepper, Bamboo shoot, Lichen, Nuts and fruits like Sohphie and Amla. Torchwood, Brut, Mushroom, Wild pepper, Bamboo shoot, Lichen, Nuts and fruits are collected in small quantity as compared to other products. Only a small percentage of household in the village is involved in collection of forest products for commercial purposes. The average quantity of forest products collected for commercial purpose per gathering household in five different type of forest is given in Table- 8.5. It has been found that significant quantity of forest products are gathered in the three forest types both for subsistence and commercial purposes. However, in the Moist deciduous and Bamboo forests, forest products are collected by the people only for subsistence use as only community forest are available in the surveyed villages and from such type of forest commercial collection of forest produce are not allowed.

Table- 8.3 Quantity of forest products (FPs) collected per gathering household for commercial purposes

Forest product	Percentage of household collecting	Quantity/ gathering HH/yr (kg)	Main uses
Semi evergreen – sample size – 57 HH			
Timber*	10.53	836.8	Raw material to Saw & Veneer Mills, for making railway sleepers.
Firewood	5.26	6727.27	For cooking, industrial purposes, etc.
Bamboo #	7.02	813	For handicraft making, fencing, raw material for making houses
Packing leaf	3.51	48500	For packing.
Broom grass	10.53	2000	Household article
Brut #	1.75	9000	Household article
Mushroom	7.02	21.67	food
Wild Pepper	1.75	120	spices & for medicinal purposes
Torch wood	1.75	17.92	for lighting purposes
Bamboo shoot	3.51	140	pickles, food.
Bayleaf	7.02	1016.1	spices and condiments
Sohphie	3.51	105	fruit, pickle, squash.
Amla	1.75	794.44	fruit, pickle, Medicinal purposes.
Charcoal	5.26	9067.5	Heating and cooking
Nuts	1.75	300	edible.
Tropical evergreen – sample size – 62 HH			
Timber	7.02	1026.32	Raw material to Saw & Veneer Mills, for making railway sleepers.
Firewood	5.26	7000	For cooking, industrial purposes, etc
Bamboo*	7.02	1956	For handicraft making, fencing, raw material for making houses
Packing leaf	3.51	4059.03	For packing
Broom grass	12.28	7723.4	Household article
Mushroom	5.26	40	food
Bamboo shoot	5.26	236.36	pickles, food.
Bayleaf	7.02	4377	spices and condiments
Charcoal	3.51	7764.7	Heating and cooking
Sub-tropical pine – sample size – 40 HH			
Timber*	12.28	1504.85	Raw material to Saw & Veneer Mills
Firewood	7.02	14000.59	For cooking, industrial purposes, etc
Bamboo #	3.51	1100	For handicraft making, fencing, raw material for making houses
Broom grass	3.51	1500	Household article
Mushroom	5.26	40.68	food
Torch wood	5.26	1120	For lighting purposes.
Bamboo shoot	3.51	260	pickles, food
Sohphie	3.51	53.33	fruit, pickle, squash
Amla	1.75	243.90	fruit, pickle, Medicinal purposes.
Charcoal	7.02	30,080	Heating and cooking
Nuts	1.75	100	edible.
Lichen	5.26	566.67	Condiment.

* Units in cu m; # Unit in numbers.

Some important forest products like Timber, Firewood, Bamboo, Charcoal are available in all types of forest and collected by the people. But produce like Lichen, Torchwood, Bayleaf, fruits and nuts are selectively available. Average price of NTFPs is given in Table 8.4.

Table 8.4 Average Price of NTFPs

NTFP	**Rate (Rs/MT)**
Bamboo	1275
Firewood	1250
Charcoal	7,000
Cane# (Rs./RM)	25
Broomgrass	23,000
Bayleaf	13,000
Thatch grass	920
Lichens	40,000
Torchwood	10,000
Wild Pepper	150,000
Pine resin	50,000
Amla	10,000

Table- 8.5 Forest products for subsistence use per household per year (in Kg)

Forest Product	Semi evergreen		Subtropical evergreen		Subtropical pine		Moist deciduous		Bamboo forest	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Fodder	300	150	278	120	265	156	255	213	185	150
Firewood *	412.45	233.6	543.85	240.9	459.9	262.8	580.35	511	507.35	412.45
Bamboo #	44	7	39	3	31	5	21	12	103	6
Packing leaf	1	0.1	1.5	0.3	0.5	0.2	0	0	0	0
Broom grass	2.8	2.5	6.6	1.8	2.34	0.3	3	2.2	1.9	0
Thatchgrass	15.27	2.40	29.27	0.18	6.92	4.21	0.58	0.23	0.42	0
Mushroom	1.66	0.3	1.46	0.94	1.77	0.91	0	0	0	0
Wild Pepper	1	0	0.23	0	NA	NA	NA	NA	NA	NA
Torch wood	75	2	NA	NA	92	15	NA	NA	NA	NA
Bamboo shoot	7	1.5	7.83	2	4	1.03	13.1	5.6	44	30.6
Sohphie	7.9	3.25	NA	NA	13.25	4.66	NA	NA	NA	NA
Nuts	0.57	0.23	NA	NA	0.57	0.14	NA	NA	NA	NA
Honey	1.50	0.07	0.37	0.08	0.31	0.03	NA	NA	NA	NA

***** Firewood consumption is calculated in terms of kg/person/yr. **#** Unit of bamboo is in number. **NA**– not avail

Chapter 9

Accounting

9.1 Accounting of Forest Resources

9.1.1 Physical accounting

Physical accounting for forest resources was done following the framework adapted from the UNEP (2001). Accounting was done only for the year 2003-2004. The opening stock of forest or the volume of standing timber at the beginning of the accounting period was extrapolated from FSI, 1995 assessment. It was estimated to be 11,11,37,400 cu m corresponding to a total forest area of 16,839 sq. km. For timber and fuelwood, using method given by Gudimeda *et al.*, 2006, we take into account changes due to logging/ harvesting, afforestation and other activity that affects the stock of the forest by either increasing or decreasing it. Clearing of forest for shifting cultivation, forest encroachment, forest fire contribute to changes in the volume of the stock. Other accumulation arises due to regeneration and transfer of land to other activities. Reduction in the volume occurs due to grazing activity, natural mortality and other natural disasters.

The average volume of timber logged legally and illegally was obtained from the State Forest Department as well as the district council. With effect of the 1996 timber ban by the Hon'ble Supreme Court, records showed a decrease in the production of timber in the state. The average quantity of fuelwood (including firewood and charcoal wood) which was in MT was converted to the same unit cu m as timber using Weight and Volume for forest Product (FSI, 2003). The area subjected to logging is derived from the volume accounts by dividing the total volume harvested by the growing stock per sq. km. From the total volume harvested some portion remains on the stump or is damaged and this logging damage is assumed to be 10 % of the total production for both timber and fuelwood.

The State Forest Department keeps record of area under afforestation both inside and outside reserve forest annually which also includes the area under compensatory afforestation. Various species planted as well as the growing stock per hectare in these afforested areas is not available. Therefore for the study, volume addition due to afforestation was estimated by multiplying the area afforested with the mean annual increment per sq. km.

Only qualitative studies on regeneration status of the sub tropical forest of Meghalaya exist. For the year 1996-97 and 1997-98 area under regeneration was found to be 7.81 ha and 6.93 ha respectively. So, taking the average of these two years we assume that this will be the area regenerated annually for the other years also. The volume added due to regeneration is estimated by multiplying the area

regenerated with the mean annual increment per hectare. Record on diversion of forest land for non-forest uses do not exist for Meghalaya except for the year 1996-97, where 0.0025 ha of forest was diverted for use by M.S.E.B. However, some area of forest land is diverted for compensatory afforestation and this was accounted together under afforestation. Other volume changes comprise reductions due to forest fire, grazing, shifting cultivation, encroachment and other natural disaster. Area subjected to heavy forest fire as per FSI Report, 1990 is 26.75 sq. km. For the study we considered only area under very heavy forest fire incidence. The volume of forest stock affected by forest fire is derived by multiplying the naturally regenerated volume and the afforested volume with the percentage area affected by the forest fire.

About 403.25 sq. km area in the state is subjected to heavy grazing (FSI, 1990). The volume lost due to grazing is derived by multiplying the naturally regenerated volume and the afforested volume with the percentage area affected by heavy grazing. Cumulative area for shifting cultivation from 1987 to 1997 in Meghalaya was 1800 sq. km but data on area involved in shifting cultivation annually is not available for this time period. According to the Report of the Task Force on Shifting Cultivation Ministry of Agriculture (1983), the annual area under shifting cultivation in Meghalaya is 530 sq. km. The volume lost due to shifting cultivation is obtained by multiplying the area subjected to shifting cultivation with the growing stock per sq. km. Crop injury can be of two types– natural and unnatural. Natural injury means those caused by wind or flood, climber, wildlife, borer attack, leaf defoliator or other posts whereas unnatural injury are man-made injury as a result of girdling, felling, fire, lopping etc. For the study we consider only natural injury because unnatural injury is accounted together in logging and harvesting. About 302.52 sq. km of the forest area is affected by natural injury. The volume lost due to natural injury is estimated by multiplying the area with the growing stock. As per ICFRE Report, area subjected to encroachment in the year 2001-2002 in Meghalaya was 65.85 sq. km. The volume affected due to encroachment is estimated by multiplying the area with the growing stock. The closing stock is computed by subtracting the reductions and adding the accumulations from the opening stock.

9.1.2 **Monetary accounting**

9.1.2.1 Value of Timber: Timber is valued using the net price method. It is given by the formula $V_t = (P_t - C_t) R_t$, where V_t, the value of resource at the beginning of period t, is the volume of the opening stock (R_t) multiplied with the difference between average market value per unit of the resource (P_t) and the per unit marginal cost of extraction, development and exploration (C_t). The cost items considered by the forest department include logging cost, transportation costs and overhead costs. The market price was obtained through market survey and the prices per cu m for

logging, transportation cost etc., is derived using the value of output and total quantity extracted as recorded by the Working Plans of the State Forest Department.

Although, the prices vary with regard to the quality and with species, but since sufficient data are not available therefore we just consider the average price without taking into consideration species wise or quality wise. The average net price of timber per cu m is Rs 5095.67. The value obtained for timber is given in Table- 9.3.

Table- 9.3 Average annual production and value of Timber in Meghalaya

Item	Production/yr (cu m)	Rate (Rs)/unit	Total value (Rs. in lakhs)
Timber	6389.23	5095.67	323.57

9.1.2.2 Value of Non-Timber Forest Products (NTFPs): The data on quantity of different NTFPs extracted in the state annually was collected from the Autonomous Districts Councils and the State Forest Department. NTFPs prices were collected during surveys from the producers or collectors. The average production (1994-95 to 2004-05) of important NTFPs, their rate/unit and total value are given in Table- 9.4.

Table- 9.4 Average annual production of NTFPs in Meghalaya

Item	Production/yr (MT)	Rate (Rs)/unit	Total value (Rs. in lakhs)
Bamboo	3824.17	1275	48.76
Firewood	488112.6	1250	6101.41
Charcoal	9888.70	7,000	546.35
Cane#	3149.86 Rm	25	0.79
Broomgrass	22793.52	23,000	5242.50
Bayleaf	6200.94	13,000	806.12
Thatch grass	2430.12	920	22.36
Lichens	121.70	40,000	48.68
Torchwood	3016.61	10,000	301.66
Wild Pepper	123.26	150,000	184.89
Pine resin	192.21	50,000	96.11
Amla	31.07	10,000	3.11
Fodder/Grazing*	40325 ha	183.5	73.99
Total			**13476.73**

production in terms of rolling meter. *grazing area in hectare.

The study revealed the total value of marketable timber and non-timber forest products obtained annually from the forest of Meghalaya to be Rs. 13476.73 lakh. The estimation done in this study was purely based on marketable forest products only. In the case of timber and fuelwood, a huge quantity is collected for the household consumption. Illegal and informal trade of timber is assumed to be much higher than the ones traded through formal routes.

Table- 9.1 Physical accounts of Timber and Fuelwood (Area) Area in sq. km

Year	Opening stock	Reduction (R)							Accumulations (A)		Net disturbance = A - R	Closing Stock
		Logging/ harvesting +illegal logging	Logging damage	Forest fire	Shifting cultivation	Animal grazing	Forest encroachment	Transfer of land to other activities	Afforestation	Regeneration		
2003-04	16,839	0.55	0.06	26.75	530	403.25	65.85	0.000025	25. 55	7.37	-993.54	15845.46

Table- 9.2 Physical accounts of timber and fuelwood (Volume) Volume in '000 cu m

Year	Opening stock	Reduction (R)							Accumulations (A)		Net disturbance = A - R	Closing Stock
		Logging/ harvesting +illegal logging	Logging damage	Forest fire	Shifting cultivation	Animal grazing	Forest encroachment	Transfer of land to other activities	Afforestation	Regeneration		
2003-2004	103712.40	3.66	0.37	0.72	3498	17.26	9.01	0.00017	3.50	1.01	-3524.51	100187.89

The study revealed that firewood constitutes the main marketed forest product in the state with its average annual production of 488112.6 MT worth Rs. 6101.41 lakh (Figure- 9.4). The production of charcoal (9888.70 MT/yr) is a little lower than firewood but is quite significant as compared to others. This may be due to the fact that the timber ban by the Supreme Court has forced people in the state to opt for other alternatives like commercialization of charcoal and firewood in place of timber and also because of high demand of fuelwood in neighbouring areas like Assam.

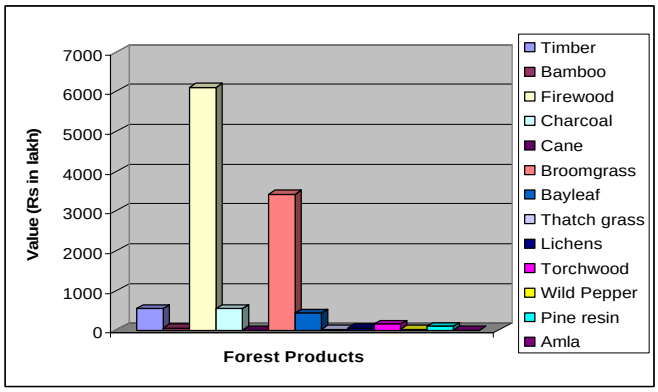


Figure-9.1 Value of different forest products (in lakh)

Production of Bamboo in the state is very low, about 3824.17 MT per year which comes to Rs. 48.76 lakh only. This may be due to the fact that, records were not maintained for the quantity of bamboo which was supplied to neighbouring paper mills. Broomgrass and bayleaf are also contributing significantly to the economy of the state. The average annual production of broomgrass and bayleaf is 22793.52 MT (Rs. 5242.50 lakh) and 6200.94 MT (Rs. 806.12 lakh), respectively. This encourages people in the state to not only depend on timber as their source of income as we have seen that contribution by many NTFPs is more than that of timber. Thatchgrass is not a very popular commercial forest product in the state except in part of Garo Hills. Therefore, the average production is quite low only about 2430.12 MT and generating a value of Rs. 22.36 lakh annually. The reason for low production is that in the Khasi and Jaintia Hills thatch grass is used only for household consumption and not for sale hence data for this is not available.

Other NTFPs like Lichens, Torchwood, Wild pepper, Pine resin and Amla although they were produced in small quantity but the price for these forest produce is high. The average yearly production of lichens is around 121.70 MT amounting to Rs. 48.68 lakh. The production of Torchwood is 3016.61 MT per year. Considering the market price at the producer level which is Rs 10,000/MT the value of torchwood produce in the state comes to Rs 184.89 lakh per year. Wild pepper has a very good market in the state and the price is quite high even at the producer level also. Around 123.26 MT of Wild pepper and 192.21 MT of pine resin are produced in the state annually. The value obtained from Wild pepper and pine resin annually Rs.184.89 lakh and Rs. 96.11 lakh, respectively. It was found that the production of Amla annually is only 31.07 MT giving an average return of Rs. 2.17 lakh per year. Low production of Amla may be because of the non availability of

data on production for most of the years, on account to absence of market for it. The all India average value of fodder is Rs. 183.5/ha (Haripriya *et al.*, 2005). Corresponding to an area of 403.25 sq. km subjected to heavy grazing in Meghalaya, the total value of value is found to be Rs. 73.99 lakh/ year.

9.1.3 Integration of forest resource accounting with SNA

In the next step, we incorporate the information on 'depletion', 'degradation' and 'other accumulation' in the national accounts. Instead of considering only the depletion of the man made assets to get the NSDP (Net State Domestic Product) from the GSDP (Gross State Domestic Product) as in conventional system of accounting, we tried to incorporate the depletion of forest due to various economic activities to get the ESDP (Environment Adjusted State Domestic Product). To get the ANSDP (Adjusted Net State Domestic Product), the GSDP is adjusted by netting out the value recorded by the CSO accounts and adding the value added estimates obtained in our study to avoid double counting. In the second stage, we adjusted the revised NSDP by netting out the depletion of forests due to various disturbances (Table- 9.7). The gap between NSDP and ESDP indicates the extent of environmental degradation caused due to economic activity. If the ratio of ESDP to NSDP is greater or equal to 1, then the economy is doing well in terms of environment but if it is lower, the growth has come at the expense of environmental degradation. For the study we have taken the advance estimate at current prices for the year 2002-03 both for GSDP and NSDP as data for 2003-04 is not available. Data for forestry and logging for the year 1999-2000 was derived from District GDP.

9.2 Accounting of Land Resource

9.2.1 Soil Resource

Soil is one of the most important resources in the Meghalaya economy, especially because the state is predominantly agriculture-based and 81 per cent of the population of the state is either directly or indirectly dependent on agriculture. In 1999-2000, the agriculture sector contributed about 23.7 percent (at constant prices) to the Gross Domestic Product (Directorate of Economics and Statistics, 2003). Majority of the Meghalaya soil are best suited for cultivated crops, some soils are economically important for rice and other major crop production. Some are considered problem soils because of high erodibility and low nutrient content but still has potential for agricultural production.

According to the nine-fold classification of land use, of Meghalaya's reported geographical area of 22,271 sq. km for land utilization statistics, about 42.5% of the land is forested, 10.5% is cultivated, 3.9% is put to non-agricultural uses, 6.1% falls under barren and uncultivable land, 0% is under permanent pastures and grazing lands, 7% is under miscellaneous tree crops and groves, 19.8% is cultivable waste, 7.2% is fallow land other than current fallow, and 2.9% land is under current fallow in 2004 (Table- 7.3). This classification is largely based on whether a particular area is cultivated, grazed, or forested and is based on actual use.

Table- 9.5 Monetary accounts of timber and fuelwood (Rs. in lakhs)

Year	Opening stock	Reduction (R)							Accumulations (A)		Net disturbance = A - R	Closing Stock
		Logging/ harvesting + illegal logging	Logging damage	Forest fire	Shifting cultivation	Animal grazing	Forest encroachment	Transfer of land to other activities	Afforestation	Regeneration		
2003-2004	5284561.63	186.49	18.85	36.69	17822.31	879.47	459.10	0.01	178.34	51.46	-19173.12	5265388.51

Table- 9.6 Monetary account of NTFPs (Rs. in lakh)

Value of opening stock	Value loss of NTFPs due to				Value gained of NTFPs due to		Net loss
	Logging of timber and fuelwood	Forest fire	Shifting cultivation	Transfer of forests for non- forests purposes	Afforestation	Regeneration	
218907	7.15	347.75	6890	0	332.15	95.81	-6816.94

Table- 9.7 Integration of forest resources into the national accounts (in lakhs)

GSDP	NSDP	Forestry and Logging	Adjusted NSDP	Depletion of timber and fuelwood	Depletion of NTFPs	Total depletion	ESDP	ESDP/NSDP	Depletion of timber as % of NDP	Depletion of NTFPs as % of NDP	Total depletion of as % of NDP
434292	384227.0	376.50	39927.60	-19173.12	-6816.94	25990.06	13937.54	0.03	-4.99	-1.77	-6.76

The net sown area of the state has been increased by 0.6% during the last 5 years. This is because new areas from other land use brought under agriculture. Moreover the production of crops also increased. The general view is that the key causes for the success were better genetic material with higher production potential and better ability for nutrient uptake, higher demands on irrigation, improved cultivation practices, and, of course, higher profitability which led to area expansion. At the same time the fertilizer consumption also increased in the state from 3,970 tones in 1999-2000 to 5,385 tones in 2003-04 (Directorate of Economics & Statistics, Meghalaya, 2005). In Meghalaya there is a scope of increasing the agriculture land as 25.9% of the reported area is under Barren & Uncultivable lands and Cultivable waste lands. However, most of this area comprises marginal and sub-marginal lands and the extension of agriculture into this area will be costly, as it requires extensive work for soil and water conservation, irrigation, and reclamation.

9.2.2 Agricultural land

In this study we used the net present value approach to estimate the value of the asset and the changes in assets. The conceptual framework behind the net present value approach is as follows. A piece of agricultural land is characterized by several attributes: soil quality, soil texture, soil fertility measured in terms of nutrients, associated water resources, etc. With the help of these natural factors and other inputs such as seeds, rainfall, fertilizers, etc. some output is produced which can be marketed at some market value. When the values of man-made inputs are deducted from the output, we get the economic rent or land rent, which is considered as payment for the use of natural resources. The variations in these economic rents or land rents are due to differences in the quality of land and the inputs mentioned earlier. The economic rent is expected to change every year with changes in the levels of outputs/input use, their prices, and the discount rate.

9.2.3 Degraded land

Due to unsustainable practices, some of the lands become degraded and are categorized as wastelands. These lands comprise, land subjected to shifting cultivation, gullied land, waterlogged land, etc., which can have an effect on productivity. Hence, from time to time, the government incurs some expenditure in treating these lands.

9.2.4 Soil erosion

Land has an infinite life, if used sustainably. The use of land for agricultural purposes, using unsustainable practices would mean degradation of the land due to soil erosion in the form of the loss of nutrients from the topsoil, movement of soil (changes in soil depth). This is a common phenomenon in Meghalaya. Soil erosion is a natural process and only when it erodes beyond the tolerable rate, it has an impact. Under natural conditions, the soil lost is largely replenished. However, when the natural rate of replenishment is exceeded by erosion, a physical reduction of soil resources takes place. In the absence of other forces at play, any loss of soil erosion beyond a tolerable level can be considered as

human induced. The most common approach for valuing the loss of soil and soil nutrients is the replacement cost method. This is based on the cost of replacing soil nutrients with artificial fertilizers.

Meghalaya is a hilly state and the agricultural practices are done mostly on the hilly slopes and only a small proportion is practiced in the plain. Soil erosion is a regular phenomenon in Meghalaya. The two main agents of soil erosion are wind and water. Water-related erosion takes place directly through surface run off. Although soil erosion is caused mainly by natural factors (climate and hydrology), soil topography, soil surface conditions and their interactions, the management and use of land play a major role in aggravating the situation. However we do not have data for the total soil loss from agricultural land in the form of soil erosion. We made use of the data published in the *Monograph 2 GAISP December 2005,* which estimates the soil erosion rates for the entire country. We used the medium estimate of soil erosion rate. The erosion rate contributed by agricultural land use is then computed using the share of the agricultural area of Meghalaya to the total in India (Table- 9.8).

Table- 9.8 Estimated soil erosion rate in Meghalaya

Area (sq. km)		Soil Erosion (MT per year)	
Agricultural land in India	Agricultural land in Meghalaya	Soil erosion in India	Soil erosion in Meghalaya
1411010.00	2217.42	376.10	0.59

9.2.5 Monetary accounting

For estimating the change in asset accounts, we used the net present value, method. The agricultural sector has subsidies going into it, in reality we should adjust the values for the subsidies and deducted from the GSDP as well (Table- 9.9). To compute the net present value we had to estimate the present value of the future net returns from the land. To find the net present value we made some assumptions about the discount rate, life of the agricultural plot, and value at the end of the lifetime etc. We assumed the discount rate to be five per cent and the lifespan of the plot to be 10 years as most of the agricultural land are on hill slopes and the land become unproductive after 10 years. However, the data for input/output is not available for the entire crop; hence we considered the data only for paddy, maize and spices for the accounting work. The opening stock is multiplied with the net present value of the agricultural land from 1999-2009 and closing stock is multiplied with the net present value of the agricultural land from 2004-2009 to obtain the monetary estimates (Table- 9.10).

Table- 9.9 Agricultural subsidies incurred to develop the agricultural land in Meghalaya (in lakh)

Actual expenditure incurred during 9^{th} plan	Actual expenditure incurred during 10^{th} plan	Total
405.7	388.9	794.6

Source: Directorate of Economics & statistics, Meghalaya 2003-2005

Table- 9.10 Monetary estimates of Agricultural land and productivity loss due to degraded land in Meghalaya (in lakh)

Agricultural land		Changes	Waste land	
Opening stock	Closing stock		Water logged	Shifting cultivation
1231.6	1690.0	458.4	05.6	42

For estimating the value of degraded land, we used the lost in productivity method for valuation of degraded land. For calculating the loss in productivity we used net present value of agricultural land. The degraded lands are shown in Table- 7.6. We assumed that 50% on an average productivity loss due to water logging and shifting cultivated areas (Reddy, 2003). For the rest of the degraded land we assumed that the entire value is lost. To obtain the monetary estimates, the degraded lands are multiplied with the net present value of agricultural land from 2004-09 (Table- 9.11).We also estimate the value of degraded land through the maintenance cost approach. Given the scale of land degradation and soil erosion, from time to time the government incurs some expenditure in repairing and rehabilitating the degraded land (for example various watershed development programmes). We took the expenditures incurred from the Ninth Plan onwards during 1997–2002 to rehabilitate the lands and deducted these from the estimates accordingly (Table- 9.11).

To estimate the cost of the loss of nutrients through soil erosion, we used the replacement cost approach. As soil erosion represents a major cause of on-site nutrient loss, the volume of soil loss can be used to estimate the nutrient loss of the study area. Ramakrishnan and Toky (1981) studied the soil nutrient status of hill agro-ecosystems in Meghalaya. They had analyzed the nutrient contents of N, P and K in soil of different depths collected from fallow land of different ages. We used the same proportion of nitrogen, phosphorus, potassium, calcium and magnesium lost through erosion in the soil layer of depth 0-7 cm since most of the soil which gets eroded is top soil. We estimated the cost of soil erosion by analysing soil nutrient expressed per tonne of soil basis. Because most data are available for NPK, the analysis has focused on these nutrients only. The values of available nitrogen, phosphorus, and potassium are estimated in terms of the equivalent levels of urea (46 0 0), single super phosphate or P_2O_5 (0 16 0), and murate of potash or K_2O (0 0 60). Valuation was done using the price of fertilizer per kilogram of nutrient (Table- 9.12). The nutrients lost were multiplied with the price of fertilizer per kilogram of the nutrient to get the replacement costs.

Table- 9.11 Total investments made in treating the degraded lands under various schemes in Meghalaya

A. Jhum Control Scheme (Upto 2001-2002)

Items	Physical (sq. km)	Financial (Rs. in Lakhs)
1. Land Development (Terracing & Land Reclamation)	87.72	551.16
2. Afforestation	36.12	111.51
3. Water Conservation & Distribution Works	68.35	371.54
4. Cash Crop Development	72.44	1626.17
5. Follow Up Programme	58.28	82.04
Total	**322.93**	**2742.42**

B. Watershed Management (Upto 2001-2002)

Items	Physical (sq. km)	Financial (Rs. in Lakhs)

1. Land Development (Terracing & Land Reclamation)	38.86	209.55
2. Erosion Control	15.26	134.28
3. Afforestation	65.29	354.50
4. Water Conservation & Distribution Works	39.11.	275.16
5. Cash Crop Development	23.52	639.26
6. Follow Up Programme	29.25	57.77
7. Fodder & Pastures Development works	0.22	1.35
Total	**172.42**	**1462.32**

C. Soil Conservation Scheme (In General Area) Upto 2001-2002

Items	Physical (sq. km)	Financial (Rs. in Lakhs)
1. Land Development (Terracing & Land Reclamation)	114.74	182.38
2. Erosion Control	74.79	523.90
3. Afforestation	203.43	818.14
4. Water Conservation & Distribution Works	77.18	499.30
5. Cash Crop Development	8.69	196.77
Total	**478.86**	**2,220.49**

Source: Soil & Water Conservation Meghalaya Newsletter. Vol. 4 (4) July - December, 2002

Table- 9.12 Rate of nutrient loss from eroded soil in Meghalaya and their estimated cost in lakh

Nutrients	Rate Nutrients loss in eroded soil in Meghalaya (Million tones/year)	Cost in Rs. lakh
N	0.002	215.6
P	0.000005	0.4875
K	0.00006	4.38
Total		220.5

9.2.6 Integration of land resource accounting with SNA

The total adjustments for depletion and degradation were computed by summing up the depletion and externality costs imposed by agriculture on the environment. The cost of externalities considered included the replacement cost of soil nutrients and the cost of rehabilitating the degraded land. The reason we deducted the cost of rehabilitating the lands was because from time to time the government incurs some expenditure in rehabilitating these lands, which should be deducted. Moreover, any land if left untreated causes more harm than good to the environment. We computed the ESDP (Environment Adjusted State Domestic Product) for the state after adjusting for subsidies. Our estimates indicate that if environmental externalities are taken into account, the contribution of agriculture to GDP is lower than what the estimates indicate. The results also indicate the proportion of NSDP that has to be set aside to maintain the environmental capital intact (Table- 9.13).

Table- 9.13 Adjustment of the agricultural land resource in the state GDP of Meghalaya

	Value (In lakh)
GSDP **(A)**	48157.5
NSDP (current price) **(B)**	43487.4
Changes in quantity of land **(C)**	458.4
Cost of land reclamation **(D)**	642.5

Replacement cost of nutrients **(E)**	220.5
Total adjustment for depletion **(F)**	-1321.4
ESDP **(G=B-F)**	42166
ESDP/NSDP **(H=G/B)**	9.7
Value added by agriculture **(I)**	10269.1
Agricultural subsidies **(J)**	794.6
Value added by agriculture adjusted for subsidies (**K=I-J)**	9474.5
ESDP after adjusting for agricultural subsidies **(L=G-J)**	41371.4

9.3 Valuation of Forest Services

9.3.1 Water Supply

In Meghalaya, taxes on water does not exist as in most part of the state, water for domestic uses is available in plentiful except in the case of municipal areas. Therefore, no data is available on the price of water, so benefit transfer method is used for valuing the cost of water which is being supplied by forest during the lean seasons. Cities in India like Delhi, Chennai and Hyderabad has assigned some price for domestic and Non-domestic use of water. The price of water in Hyderabad is quite high and is not applicable for Meghalaya, hence we take the average of the price of domestic and non domestic uses of water which is found to be Rs. 0.675/cu m and Rs. 3/cu m, respectively. By multiplying this with the amount of water used in Meghalaya we estimated the cost of water supplying service rendered by the forest to be Rs. 4,04,46,75,000 (Table- 9.14).

Table-9.14 Value of water supply services rendered by the forests of Meghalaya

Purposes	Price (Rs/ km^3)	Quantity of water used. (km^3 /yr)	Value (Rs. /yr)
Domestic	67,50,00,000	0.081	54675000
Agricultural and other uses.	3,00,00,00,000	1.33	3990000000
Total			**4,04,46,75,000**

9.3.2 Prevention of soil loss

From the study we have estimated the amount of soil loss annually that is prevented by forests in the hill slopes and also the amount of nutrients present in it. This is then converted to monetary terms using fertilizer equivalent with the amount of nutrients. Fertilizers like Urea [$(NH_2)_2CO$], Single Super Phosphate [Ca $(H_2PO_4).H_2O$], Muriate of Potash [KCL], Lime (Ca_2CO_3) and Dolomite (Mg Ca $(CO_3)_2$) are commonly used as source of N, P, K, Ca and Mg, respectively in Meghalaya. The government approved rate of fertilizer per kg was obtained from the Department of Agriculture. The cost of nutrient per kg was calculated using molecular weight and market price of the fertilizers. By multiplying the amount of nutrients found in the soil protected by forest with their equivalent fertilizer prices we get the cost of soil loss prevention by forests on steep hill slope of Meghalaya (Table- 9.15). Therefore we found that the total cost of soil loss prevention on steep hill slope by forest in Meghalaya is Rs. 3202.99 lakh per year.

9.3.3 Reduction of Carbon dioxide (CO_2)/ Carbon Sequestration

Forests play a profound role in reducing the atmospheric CO_2 level as plants sequester carbon (C) during photosynthesis and convert it into biomass. Thus, forests act as carbon sinks by increasing

aboveground biomass through increased forest cover and by increased levels of soil organic carbon. On average, 50% of the biomass is estimated as the carbon content for all species of trees (MacDicken, 1997). Maintenance of forest cover is very important in reducing the green house gases (GHGs) and the adverse effects of climate change. Rana et al. (1989) and ICIMOD reported the mean carbon sequestration rate at 3.7 t C/ha/yr or 13.57 t CO_2/ha/yr for forests of Central Himalayan region. By applying this value for the forests of Meghalaya we reach a value of 12885529 tones of CO_2 sequestered by the forests of Meghalaya (Table- 9.16). Under Clean Development Mechanism (CDM) of Kyoto Protocol, if this value of CO_2 is converted into Rupees it comes around 61,850.54 lakhs (at current price of USD 12 per tone of CO_2 and at the rate of 1 USD equal to Rs. 40/-).

Table- 9.15 Cost of soil loss prevented by forests annually in Meghalaya

Nutrient	Fertilizer	Market rate of nutrients Rs. /kg. P	Amount of nutrients present in soil protected by forest. (Tons/yr) N	Cost of nutrients protected by forest (Rs. in lakh) P X N
N	Urea	10.04	25457.9	2555.97
P	Single Super Phosphate	10.83	73.55	7.97
K	Muriate of Potash	8.11	1029.63	83.51
Ca	Lime	3.75	3752.68	140.73
Mg	Dolomite	21.07	1968.75	414.82
Total				**3202.99**

Table- 9.16 Contribution of forests of Meghalaya in reducing the Carbon dioxide (CO_2)

Total Recorded Forest in Meghalaya (ha)	Rate of CO_2 Sequestration by forest per ha per year	Total CO_2 sequestered by the forests of Meghalaya	Current rate of CO_2 under CDM	Contribution in monitory terms (in Rs. lakhs)
949560	13 tCO_2/ha/yr	12885529 tones	USD 12/tone or Rs. 480/tone	61850.54

9.4 Summary of valuation of timber, NTFPs and services of the forests of Meghalaya

On accounting of timber, NTFPs and some important services of the forests of Meghalaya, we find that the value of services is much more than the value of various goods (Table- 9.17).

Table 9.17 Total value of timber, NTFPs and services of the forests of Meghalaya

Sl. No.	Goods and Services	Value in Rupees lakhs
	Goods	
1.	Timber (refer to Table- 9.3)	323.57
2.	NTFPs (refer to Table- 9.4)	13476.76
	Services	
3.	Water supply (refer to Table- 9.14)	40446.75
4.	Prevention of soil loss (refer to Table- 9.15)	3202.99
5.	Carbon Sequestration (refer to Table- 9.16)	61850.54
	Total	**119300.61**

Chapter 10

Ecologically Sensitive Areas (ESA)

The legislative framework in India has attempted to create several legal spaces for the protection of fragile ecosystems. Many government and non-governmental sectors have used clauses such as Section 3(2) v of the Environment (Protection) Act (EPA), 1986, and section 5 (1) of the Environment (Protection) Rule (EPR) 1986 to highlight the sensitivity of a region and thus grant it a special status, "to protect and improve quality of the environment". In the more recent instances, these areas have been called Ecologically Sensitive Areas (ESAs) or Ecologically Fragile Areas (EFAs).

The use of the concept of Ecologically Sensitive Areas/Ecologically Fragile Areas together with the Environment (Protection) Act is gradually gaining recognition as a strategy for the conservation and sustainable development of sensitive areas. In year 2000, ESAs got a formal status when a comprehensive set of guidelines laying down parameters and criteria for declaring ESAs was approved. Declaring an area as ESA allows for planning by taking into account the livelihood of the people living in and around such an area. The planning and management of an area notified as an ESA can include the effective participation of local communities. A committee constituted by the Ministry of Environment and Forest (MoEF) put together detailed criteria based on which an area can be declared ecologically sensitive. Some of the criteria are:

- species based (endemism, rarity, and so on)
- ecosystem based (sacred groves, frontier forests, and so on) and
- geomorphological-feature-based (uninhabited islands, points of origin of rivers, and so on).

Meghalaya particularly known as the 'abode of clouds' is popular for its diverse land and forest resources and also considered to be the original home of many species of plants and animals. The magnificent terrain of the state attracts a large number of tourists every year. However, the fact that 90% of the state is covered by hilly areas, like many other hill resorts in the country it is also under severe threat from urbanization, industrialization, mining, unplanned and unbridled growth and development of infrastructure. These activities lead to fragmentation of natural habitats of plants and animals. Considering the above criteria put forward by the MoEF, some areas in Meghalaya can also be termed as ESAs. Some of these areas are described below:

10.1 Southern slope

On the basis of geo-morphological features, one of the most sensitive areas of Meghalaya is the southern slope. The area includes most of the southern part of West and East Khasi Hills, some part of the Jaintia Hills and a very small area of South Garo Hills District (Figure- 10.1). A unique combination of climate, topography and geology is responsible for the development of this area. The altitude ranges from 400 to 1200 m and the important soil types are Red, Yellow and Alluvial Soil. The area receives very heavy rainfall; annual rainfall ranging from 6,000-10,000 mm. Cherrapunjee/Mawsynram Plateau which receives highest rainfall in the world is located in this zone. The region is characterized by steep slopes. There are vast tracts of grasslands on highly drained flats and slope of hills with isolated patches of crooked forests only in low lying areas. Tropical moist deciduous type of forest is the dominant forest type of the region. The southern slope of the state is rich in floral and faunal diversity.

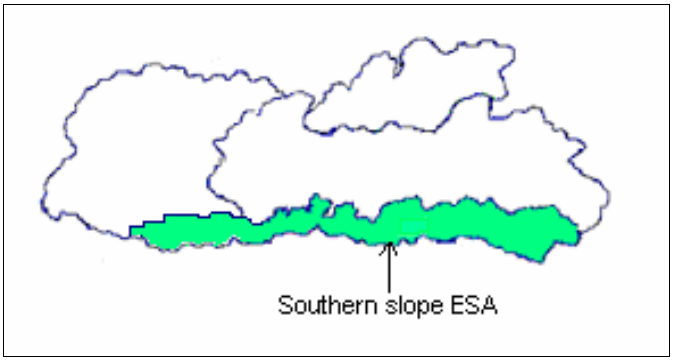


Figure- 10.1 Location of Southern slope ESA of the state

Threats: The natural environmental factors like steep slope and heavy rainfall prevalent in this zone itself contribute substantially to the degradation of land and vegetation of this area. Besides these factors, human activities like shifting cultivation, timber extraction, expansion of agriculture, quarrying, mining of lime stone and coal are ruining the ecology of the hill slope. On account of these activities and hilly terrain, a major portion of rain water is canalized through overland flow causing soil erosion. This has resulted in decreased soil fertility due to depletion of nutrients.

10.2 Coal mining areas

The state of Meghalaya is very rich in Tertiary Coal deposits, which are confined to the upper part of the tertiary rocks. Some prominent coalfields in the State are west Dadenggiri, Siju and Balpakram in the Garo Hills, Pyndengrei, Langrin, Mawlong-Shella and Laitryngew in the Khasi Hills and Bapung, Sutnga, Rymbai, Khliehriat, Jarain, Lakadong, etc. in the Jaintia Hills (Figure- 10.2). Extensive coal mining in Jaintia Hills District is leading to deforestation, pollution of water, soil and air and disturbance in natural geomorphology. As a result, vast area of the district has become devoid of natural vegetation and flora and fauna.

Threats: Mining of coal in the Jaiñtia Hills and Garo Hills districts of the state has caused massive damage to the landscape and biological communities. Due to unscientific mining, the coal bearing areas present a panorama of flat topped low hills, devoid of vegetation. The unfavorable habitat conditions prevailing in the coal mining areas have threatened the existence of rare and endemic species. At the same time rampant coal mining has adversely affected the quality of water of most rivers of the area. These rivers serve as important source for drinking and irrigation water and support a rich array of floral and faunal diversity. Due to deterioration of the water quality of these rivers there is serious implications on aquatic life, agricultural activity and availability of potable and irrigation water in the areas (Swer and Singh, 2005).

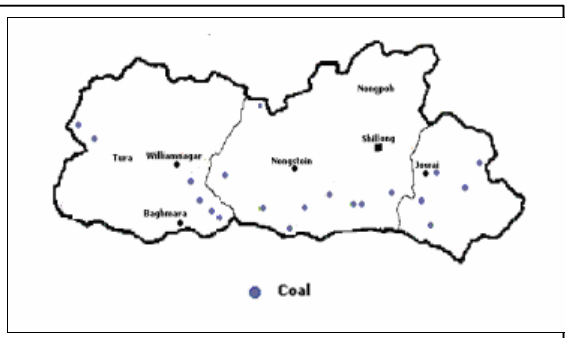


Figure- 10.2 Major Coal fields in Meghalaya

10.3 Biosphere Reserves and Wildlife Sanctuary

10.3.1 Nokrek Biosphere reserve

The Nokrek Biosphere Reserve established in 1988, is one of the 13 Biosphere Reserves so far notified in India and one of the 4 Biosphere Reserves of Northeast India. It is situated in the western part of the State and covers an area of about 80 sq. km. The reserve covers parts of three districts, East Garo Hills, West Garo Hills and South Garo Hills. Nokrek National Park with an area of 47.48 sq. km is the core zone of the reserve. This reserve is an important source of many perennial rivers. The important river systems originating from the area are Simsang, Ganol, Bugi, Dareng and the Rongdik.

The area of the national park as well as the entire ridge of Tura Range is very important from the conservation point of view because of its richness in floral and faunal diversity and more importantly, due to the fact that the area forms the primary catchments of all the major rivers and streams in the three districts of Garo Hills. Another special feature is the abundant natural occurrence of *Citrus sp*. mainly *Citrus indica*. Therefore, it constitutes an important gene pool for future hybridization programmes for evolving genetically improved varieties of *Citrus*. Nokrek Biosphere is also an unique area with a number of rare and endangered plants and animals. Some endemic floras confined to the area are Grand rasamala, White meranti, Lali, Chempaka and Wild lemon. The area also harbours many rare, endangered and endemic faunal species like hoolock gibbon, binturong, stump tailed macaque, pig tailed macaque, himalayan black bear, tiger, leopard, elephant, giant flying squirrel, etc.

Threats: Complex geological setting, peculiar land holding system and lack of infrastructure, unscientific extraction of coal in unorganized sector within the Biosphere Reserve is going on and posed a great threat to the well-being of the Reserve. Coal mining within the Biosphere Reserve started in the year 1985 at Darrangiri and is increasing day by day. At present coal is being extracted from 18 coal mining sites. The whole buffer area of the Biosphere Reserve is degraded and disturbed due to large scale coal mining, shifting cultivation and other human activities.

10.3.2 Nongkhyllem Wild Life Sanctuary

The Nongkhyllem Wild Life Sanctuary is located in the Ri-Bhoi District of Meghalaya adjoining to the Nongkhyllem Reserve Forest located between 91° 41′ E and 91° 51′ E longitude and 25° 50′ N and 25° 55′ N latitude. It covers an area of 29 sq. km.

The sanctuary is very rich in biodiversity. It is home of an immense variety of flora. There are more than 1000 taxa of vegetation in the Sanctuary and surrounding forests which make up an area of about 200 Sq. kms. The area is rich in fauna too, supporting many rare and endangered species. Out of the 141 or so species of mammals, birds, amphibians and reptiles listed in schedule-1 of the Wildlife Protection Act, about 30 are found in and around the Sanctuary. Globally endangered species found here are the Asian elephant, Himalayan black bear, Royal bengal tiger, Clouded leopard, Indian bison, etc. Some of the endangered species of birds found in the sanctuary are Swamp Partridge, Brown Hornbill, Rufous Necked Hornbill and Manipur Bush Quail (Bonney, 2004).

Threats: Shifting Cultivation (Jhumming) and clandestine exploitation of wood for commercial purposes, as well as for meeting basic requirements are some serious environmental threats to the Nongkhyllem Wild Life Sanctuary.

10.4 Sacred Groves

In Meghalaya, the scared groves are among the few least disturbed forest patches serving as the natural treasure house of biodiversity. They are scattered at different places in Khasi, Jaintia and Garo Hills being protected by the tribal. There are 79 sacred forests covering approximately 9000 ha. area with average size varying from 0.01 ha to 1200 ha (Tiwari et al., 1999). They are generally found below the hill brows and are considered to be the relic of the original forests. These sacred groves set aside and protected by village communities conserve a significant portion of local biodiversity. About 514 species belonging to 340 genera of 131 families are found in these groves. These forests also harbour a large number of endemic, rare and endangered plant as well as animal species. At least 50 rare and endangered plant species of Meghalaya are confined to these groves (Tiwari et al., 1998).

Protection and preservation of sacred groves has been associated with the religious beliefs and wisdom of the people residing in the adjoining areas. For instance, villagers are fully aware of the importance of sacred groves in providing perennial source of clean water and pure air to them. They also know that sacred groves help in reducing loss of top fertile soil layer from heavy rain. At some places beliefs are so strong that villagers fear to enter into groves except during ritual periods.

Threats: Sacred groves in Meghalaya are now increasingly coming under threat as the tribal way of life changes. The area under sacred groves is also shrinking and quite a few have been turned into degraded forests. The erosion of traditional values and deterioration of sacred groves in recent times is, however, a matter for concern.

10.5 Caves

The discovery of over one thousand caves in different parts of the state in the last one decade attracts tourists, cave explorers and adventurers from all over the world. Some well known caves in the Khasi Hills are like the Mawsmai cave, Krem Mawmluh, Krem Dam, Krem sohsympi etc. Some of these caves have got beautiful stalactites and stalagmites. In the Jaintia Hills also there are numerous caves which represent the rich cultural heritage of the people of that place. Krem Um-Lawan, The Rupasor Cave, Krem Kotsati, Krem Umshangktat, Krem Lashinng**,** Krem Sweep are some of the famous caves in the Jaintia Hills. Garo Hills also is no less important. Some of the beautiful caves in the Garo Hills are Tetengkol-Balwakol, Dobhakol Chibe Nala, Bok Bak Dobhakol and Siju-Dobkhakol (Anonymous, 2006). Out of these, the Siju caves situated on the bank of the Simsang river just below the village of Siju is of ecological importance.

Threats: The caves in the state are now facing the threat of disturbance and destruction due to various anthropogenic activities and lack of proper conservation. One of India`s longest cave systems, `Krem Kotsati Umlawan` is already facing destruction from limestone mining taking place in the area. The mining of coal in the `Shnongrim` Ridge, which is unique for having the largest concentration of caves in the state, is threatening existence of the caves in the area.

In addition to the above listed ESAs, many more such areas exist in the state and are facing various types of threats. Hence, there is an urgent need for their conservation and protection so that the forests of Meghalaya can sustainably contribute their goods and services for the human beings and also for other living beings and for the better environment.

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Chapter 11

Methodology, Primary survey, Data gaps and requirements etc.

11.1 Methodology

Forest and land resources support economy in many ways. They include products such as timber and NTFPs and services such as protection of soil loss, water supply, carbon sequestration, conservation of biodiversity etc. In natural resource accounting (NRA) all these environmental products and services of an area are quantified and valued and then adjusted in the GDP. In the present study of NRA of Meghalaya, we have quantified and valued the timber, NTFPs (bamboo, fuelwood, charcoal, cane, broomgrass, bayleaf, thatchgrass, lichen, torchwood, wildpepper, pine resin, amla and fodder) and services (prevention of soil loss, carbon sequestration, water supply) for Meghalaya. The methods for quantification and valuation are included in the respective chapter/section of the report.

11.2 Primary Survey

Primary survey was conducted to collect data on the types and quantity of forest products used and collected by the people of Meghalaya and its comparison with existing data based on secondary sources. Nine villages were selected from each of the three major forest types *i.e.*, Tropical evergreen forest, Sub-tropical pine forest and Semi evergreen forest. From the other two types of forest *viz.,* Bamboo forest and Moist deciduous forest which constitute only a small percentage of the geographical area, only 2 villages from each forest were selected for the survey. For the study, about 5% of the households were selected from the villages under each type of forest. Simultaneously data on price of various timber and NTFPs was also collected to be used for valuation of these products. Details of survey are included in Chapter 8. The Questionnaire used for survey is enclosed as Annexure C.

11.3 Data gaps and requirements

The data on quantity and valuation estimates for different timber and NTFPs is fragmentary and scattered in Meghalaya. For most of the NTFPs, there is no organized market outside the urban centres and several items are traded informally. As a result a wide variation in prices was found in primary survey.

There exist different classifications of forest in Meghalaya. Some data is available in one classification but not in others. As a result, it was found practically impossible to adapt a data set from one classification to other. Further, a big chunk of the forest and land in Meghalaya belongs to District Council or private parties and is rarely surveyed. Hence, available data is not complete and vary considerably from one source to other.

11.4 Further Studies

Meghalaya having varied landscape, geography, topography, climatic conditions and vegetation type will require specific studies for each component of goods and services in detail so that data gaps can be filled up.

Annexure- A Some wild edible plants used by the Khasis and Garos of Meghalaya in Northeast India

Plant	Family	Vernacular name (Tribe)	Parts of the plant used	Method of use	Season of Availability
Adhatoda vasica Nees	Acanthaceae	Devglameh (k)	L, Fl	Cooked as vegetable	March – April
Alocasia indica Schott	Araceae	Kimchit-nokam (G)	P	Cooked as vegetable	May – November
Amaranthus gangeticus L.	Amaranthaceae	Chantili (G)	L,S	Cooked as vegetable	June – October
Antidesma diandrum Roth	Euphorbiaceae	Aburok-arabok (G)	Fr	Eaten raw	April – June
Azadirachta indica Juss.	Meliaceae	Neemu (G)	L, S	Cooked as vegetable	April – May
Baccaurea sapida Lour.	Euphorbiaceae	Soh-ramdieng (K); Dojuka (G)	Fr	Eaten raw	April – August
Bauhinia purpurea L.	Caesalpiniaceae	Muyung-laphang (K); Megong (G)	L, Fl	Cooked as vegetable	April – May
Begonia roxburghii A.DC.	Begoniaceae	Kimchare (G)	L, S	Cooked with dry fish	January – may
Calamus acanthospathus Griff.	Araceae	Rie (G)	S	Vegetable; pounded, fermented, extracted and then sun dried for off-season use	June – July
Castanopsis indica A. DC.	Fagaceae	Chhakku-khokrak (G)	Fr	Eaten raw	October – December
Colocasia affinis Schott	Araceae	Goneusu (G)	RT	Cooked with dry fish	July – December
C. esculenta Schott	Araceae	Matchitangong (G)	RT	Cooked as vegetable	July – December
Corchorus capsularis L.	Tiliaceae	Mehku (G)	L	Cooked as vegetable	July – September
Crinum prtense Herb.	Amaryllidaceae	Amaltchu (G)	RT	Cooked as vegetable	March – April
Dendrocalamus hamiltonii Nees & Arn.	Poaceae	Banh (G)	S	As of *Calamus acanthospathus*	June – October
Desmodium triflorium DC.	Fabaceae	Memang-mong-ara-bak (G)	L	Cooked preferably mixed with dry fish	March – April
Dillenia indica L.	Dilleniaceae	Agachi (G); dieng-soh-karbam (K)	Fr	Unripened fruits are cooked with dry fish	April – June
Elaeagnus latifolia L.	Elaeagnaceae	Soh-sang (K); Chhokhua (G)	Fr	Eaten raw	April – May
Eryngium foetidum L.	Apiaceae	Etucha-bellock, dhania-patta (G)	L	Cooked as vegetable	Round the year
Ficus hispida L.	Moraceae	Thamusa (G)	Fr	Unripened fruits cooked as vegetable, ripe ones eaten raw	June – September
Garcinia pedunculata G. Don	Guttiferaceae	Soh-danei (K); Thizou (G)	Fr	Eaten raw	October – July
Hibiscus pungens Roxb.	Malvaceae	Kaldha (G)	L	Cooked as vegetable	June – August
Homalomena aromatica Schott	Araceae	Kimchit-nokam (G)	P	Cooked as vegetable	May – November
Ipomaea racemosa Roth	Convolvulaceae	Setre-budu (G)	RT	Cooked as vegetable, also consumed boiled	October – December
Ixora subsessilis Wall.	Rubiaceae	Sang-rura (G)	L, Fl, S	Cooked preferably mixed with dry fish	April – May

Mallotus philippinensis Muell.	Euphorbiaceae	Bol-khing-khang (G)	Fr	Unripe fruits cooked as vegetable	April – June
Malvastrum tricuspidatum A. Gray	Malvaceae	Sam-zalik (G)	Seeds, Bark	Seeds are cooked as vegetable, also used as condiment	October – January
Monochoria hastata Solms	Pontederiaceae	Garopoksi, gachli (G)	P	Cooked with dry fish	October – December
Moringa pterygosperma Gaertn.	Moringaceae	Sajna (G); rodina (K)	L, Fl, Fr	Cooked with dry fish	April – May
Myrica nagi Thunb.	Myricaceae	Soh-phi (K)	Fr	Eaten raw	March – April
Oxyspora paniculata DC.	Melastomataceae	Long-tang (K)	Fr	Eaten raw	August – September
Pedicularis carnosa Wall.	Scrophulariaceae	Sam-dipo (G); sam-thapar (K)	L, RT	Leaves are cooked as vegetable preferably mixed with dry fish	May – October
Peperomia pellucida H. B. & K.	Piperaceae	Bithe (G)	L	Cooked as vegetable	Round the year
Phlogacanthus thyrsiflorus Nees	Acanthaceae	Verua-kainchait (G)	L, Fr	Cooked with fish and meat	February – July
Phrynium capitatum Wild.	Zingiberaceae	Balgato (G)	RT	Cooked as vegetable	July – September
Phyllanthus emblica L.	Euphorbiaceae	Bon-bakeri (G)	Fr	Fruits eaten raw, also mixed with curry	April – June
P. parvifolius Ham.	Euphorbiaceae	Ja-la-mat-kha (K); Memang-ambri (G)	Fr	As above	April – June
Piper malamiris L.	Piperaceae	Dubili (G)	L	Leaves chewed as substitute of betel; leaf also cooked as vegetable	Round the year
Plectranthus incanus Link	Lamiaceae	Chichithoni (G)	L	Cooked as vegetable	February – March
Portulaca oleracea L.	Portulacaceae	Stilchi (G)	L, S	Cooked as vegetable	March – April
Psychotria denticulata Wall.	Rubiaceae	Sonopincyl (G)	L	Cooked as vegetable	Round the year
Rhynchotechum ellipticum A.DC.	Gesneriaceae	Re-gong (G)	L	Cooked with dry fish	December – February
R. vestitum (DC.) Hk. & f.	Gesneriaceae	Re-gong-chu (G)	L	Cooked as vegetable mixed with sodium bicarbonate	December – February
Strobilanthes coloratus T. Anders.	Acanthaceae	Samoong (G); sam-si-phara (K)	L	Cooked as vegetable	February – July
Zanthoxylum khasianum Hk. f.	Rutaceae	Sumet-chheng (G); Soh-umiuw (K)	L	Cooked as vegetable	Round the year

Fl– flower; Fr– fruit; L– leaves; P– petiole; RT– root and tuber; S– shoot. Vernacular name: K- Khasi; G- Garo

Annexure- B Some Wild Medicinal Plants used by the Khasis and Garos of Meghalaya

Plant	Family	Vernacular Name (tribe)	Condition treated and method of use
Abroma angusta L.	Sterculiaceae	Bon-khopai (G)	Oil obtained from endosperm is consumed orally (2 teaspoonful 3 times a day) in fever and early stages of cold. For ringworm and scabies it is applied externally.
Acanthus leucostachyus Wall.	Acanthaceae	Sam-sikal	Decoction of leaves mixed with the extract of tuber of *Allium* sp. and leaves of *Thumbergia* sp. is applied externally for swelling, fever, toothache.
Aristolochia cathcartii Hk. f. & T.	Aristolochiaceae	Baro-hirkhut (G)	Extract of rhizome consumed (1 tsp. every 4 hours) orally relieves stomach pain. In hydrocoel it is rubbed on testes.
Artemisia vulgaris L.	Asteraceae	Sak-suk (G)	For headache fresh leaves are pounded with roots of *Capparis assamica*. Extract is applied on forehead in headache and put into nose to stop bleeding.
Asparagus racemosus Wild.	Liliaceae	Sam-riching (G)	For fever extract of roots is consumed orally
Bonnaya reptans Spreng.	Scrophulariaceae	Sam-reng-chick (G); Neing-lik (K)	For snakebite decoction of leaves and roots is consumed orally (1 tablespoonful after every 2 hours), also rubbed on bitten place.
Calotropis gigantea Br.	Asclepiadaceae	Akom-aring (G)	For malaria extract of fresh leaves is consumed orally (1 teaspoonful 3 times a day).
Canscora andrographioides Griff.	Gentianaceae	Sak-sre (G)	Paste made of roots and leaves is applied on cuts and wounds. In skin diseases the extract is applied externally.
Capparis assamica Hk. f. & T.	Capparaceae	Mantori (G)	For headache and general body pain the extract of dried leaves and roots mixed together with fresh leaves of *Artemisia vulgaris* is consumed orally (1 teaspoonful twice a day).
Costus speciosus Sm.	Zingiberaceae	Karami (G)	For fever decoction of roots is consumed orally.
Crepis fuscipappa Benth.	Asteraceae	Pan-bihar (G)	Extract of fresh leaves is used as ear drop (2-3 drops 3 to 4 times a day).
Curcuma aromatica Salisb.	Zingiberaceae	Tikegopl (G)	In gastric troubles green leaves are chewed raw. For asthma, tuberculosis, blood impurity decoction of tubers, leaves and stem is consumed orally.
Deeringia amaranthoides (Lamk.) Merr.	Amaranthaceae	Sam-sanum (G)	For fever, headache, nose bleeding, dysentery paste of young fresh leaves is applied on forehead.
Desmodium laxiflorum DC.	Fabaceae	Mari (G)	Aqueous extract of roots and tubers is consumed orally (1 tablespoonful thrice daily).
Disporum calcaratum D.Don	Liliaceae	Tike-jakriting (G)	Aqueous extract of tubers is used. For sore eyes it is used as eye drop, 2-3, 3-4 times a day, for venereal diseases.
Dracaena ensifolia Wall.	Liliaceae	Milam (G)	For cold, malaria, rheumatism, kidney troubles decoction of roots and leaves is taken orally.
Elephantopus scaber L.	Asteraceae	Samskal (G); kombatskurt sriang (K)	Aqueous extract consumed orally to induce abortion, also to treat urinary disorders. Used as contraceptive.
Garcinia cowa Roxb.	Guttiferaceae	Tekra-rengran (G)	Aqueous extract of the bark is sprayed in the surroundings of the houses as pesticide; sprinkled in water as mosquito larvicide.

Geodorum purpurerum Br.	Zingiberaceae	Metea-bas (G)	For malaria and whooping cough leaves and tubers ground, paste is applied on forehead.
Globba clarkei Baker	Zingiberaceae	Dike-holdiram (G)	For "run down condition" aqueous extract of leaves and roots is consumed orally (1 tablespoonful before food).
Hedyotis scandens Roxb.	Rubiaceae	Sam-reting (G); meidi (K)	For cough, cold, decoction of dried leaves is taken.
Homalomena aromatica Schott	Araceae	Roathi (G)	Swelling, pimples, skin sores, decoction of rhizomes is applied externally.
Hydrocotyle javanica Thunb.	Apiaceae	Mana-muni (G)	For cough, cold, fever dried leaves mixed with the fresh leaves of *Oenanthe stolonifera* are pounded and extracted. Extract is taken orally.
Ipomoea uniflora Roem. & Schult.	Convolvulaceae	--	For cholera, dysentery, vomiting aqueous extract is consumed orally (1 tablespoonful twice a day).
Itea chinensis Hk. & Arn.	Saxifragaceae	Dieng (K); myllons (G)	For skin diseases decoction of leaves is applied externally.
Ixora acuminata Roxb.	Rubiaceae	Saoltua (G)	For irregular menstrual cycle aqueous extract of leaves and flowers is consumed orally; used also for blood purification.
Jasminum lanceolaria Roxb.	Oleaceae	Pipli (G)	For ringworm extract of leaves and roots is applied externally, used only in case of children.
Justicia gendarussa L. f.	Acanthaceae	Dija-gipe, dochenpok (G)	For body pain decoction of leaves is drunk.
Lasia spinosa Thw.	Araceae	Timulana (G)	For poisoning decoction of rhizomes mixed with sugar is consumed orally.
Melia composite Willd.	Meliaceae	Sural (G)	For gastric problem, aqueous extract, after boiling is taken orally.
Molineria recurvata Herb.	Hypoxidaceae	Rekosi (G)	For dysentery, diarrhoea, fresh leaves and tuber ground to paste taken orally mixed with urine of a heifer.
Mycetia longifolia (Wall.) O. Ktz.	Rubiaceae	Janthro (G)	For fever or "body heat" extract of leaves and roots applied on forehead for cooling effect. Practiced only during summer.
Oenanthe stolonifera Wall.	Apiaceae	Bopo-goli-teng (G)	For stomach pain, constipation, extract of fresh leaves is taken orally.
O. nudicaulis Roxb.	Rubiaceae	Chenong-ri (G)	For general debility extract of leaves is taken orally.
Ophiorrhiza intermedius D. Don	Liliaceae	Ticea-ohik (G)	For vomiting extract of leaves is taken orally, used only for children, 4 – 6 months old.
Ophiorrhiza subcapitata Wall.	Rubiaceae	Samachik (G)	Decoction of roots and leaves mixed with honey taken orally for fever, sore throat, tonsils. Decoction alone mixed with water is used as wash for facial blemishes.
Parabaena sagittaria Miers	Menispermaceae	Chiongbombuelu (G)	For skin diseases extract of roots is applied externally.
Phlogacanthus tubiflorus Nees	Acanthaceae	Sam-rongtek (G)	For fever extract of fresh young leaves is drunk.
Pilea lancifolia Hk. f.	Urticaceae	Sam-rongtek (G)	For fever decoction of leaves is administered orally to children. Also antidandruff.

Plumbago zeylanica Linn.	Plumbaginaceae	Agea (G)	For general debility in children a piece of root is tied on the neck.
Pogostemon parviflorus Benth.	Lamiaceae	Sam-sanum (G)	Extract of fresh leaves is consumed orally for headache. Also used as eye drop and to remove foreign particles from the eye.
Polygonum chinense L.	Polygonaceae	Samitchang (G); jaseh (K)	For urinary disorders aqueous extract of roots and the leaves of *Hedyotis scandens* is consumed orally.
*Pothos kunstleri*Hk. f.	Araceae	Garore (G)	For toxicity extract of fresh leaves and stem is taken orally.
Pouzolzia indica Gaud.	Urticaceae	Fakrum (G); miensa-miyo (K)	For urinary and spleen disorders decoction of roots and leaves is taken orally.
Raphidophora hookeri D.	Araceae	Dhukentri (G)	For snake and dog bite paste of leaves and roots extracted. Extract is taken orally; paste is applied on injury.
Rhus semialata Murr.	Anacardiaceae	Khitma (G); dieng-soh-sma (K)	For stomach pain, intestinal worm infestation decoction of fruits is taken orally.
Rubus moluccanus L.	Rosaceae	Thekhi-sembok (G); soh-nybbah (K)	Paste of roots applied on cuts for blood clotting and to prevent swelling.
Smilax prolifera Roxb.	Liliaceae	Narang-wa (G)	For hydrocoel hot poultice of roots is used. Aqueous extract of leaves and roots, and of banana flowers consumed orally for labor pain and to facilitate delivery.
Sonerila maculate Roxb.	Melastomataceae	Pak-soaga (G)	
Spilanthes acmella L.	Asteraceae	Sam-atching (G)	For infant fever fresh leaves mixed with mustard oil are made into paste which is applied as poultice on forehead.
Strobilanthes scaber Nees	Acanthaceae	Sam-siphra, kimchat (G)	For body itching extract of young leaves is applied externally.
Symplocos racemosa Roxb.	Symplocaceae	Boligpok (G)	For indigestion and impaired blood circulation decoction of bark is consumed orally.
Tacca laevis Roxb.	Taccaceae	Colbera (G)	For neck and body pain tubers are boiled mixed with honey and bark of *Shorea assamica* made into powder. Decoction is taken orally.
Terminalia chebula Retz.	Combretaceae	Artak, saluka (G)	For diarrhoea, stomach pain, spleen disorders decoction of dry fruits is taken.
Thunbergia coccinea Wall.	Acanthaceae	Kakku-budu (G)	For bone fracture, leaves, with leaves and roots of *Acanthus leucostachyus* , are pounded and applied as poultice.
Uraria crinita Desv.	Fabaceae	Sam-gichhok (G); dieng-kha-rik-phlang (K)	For mouth pain young leaves are chewed raw.
Urena lobata L.	Malvaceae	Samtha-kkhari (G); soh-byrthil (K)	For swelling, bone fracture paste of fresh leaves is applied.
Viola diffusa Ging.	Violaceae	Ducherek (G)	Roots and leaves are ground to paste. A thin layer of paste placed on belly and forehead for headache, and typhoid fever. For indigestion and constipation aqueous extract is taken orally.
Vinca rosea L.	Apocynaceae	Pimacho (G)	Nodes are pounded. Pulp, after mixing with cow dung, is applied to cuts and wounds.

Vernacular name: K- Khasi G- Garo

Annexure-C Questionnaire used for Primary Survey

NORTH-EASTERN HILL UNIVERSITY
CENTRE FOR ENVIRONMENTAL STUDIES, NEHU CAMPUS, UMSHING, SHILLONG – 793 022 (Meghalaya)

Name of the project: Environmental Accounting of Natural Resources of Meghalaya: Phase- I- Land and Forest Resources.
Funding Agency: Ministry of Statistics and Programme Implementation, Govt. of India, New Delhi
Date of data collection:
Village level:

1. Location:
Name of the village: District: Nearest town: Nearest market:

2. No. of Household at present: **No. of Household 10 years back:**

3. Population at present:

4. Types of Forest available:
(a) Government, Private, Community. (b) Evergreen, Deciduous, Natural, Plantation.

5. Forest
(a) Area (b) Dominant species

6. Socio-economic data:
(a) Predominant occupation
(i)Agriculture (ii) Non-agriculture

(b) Income range monthly (% HH)
(i) High (above Rs. 5000/-) (ii) Middle (Rs. 3000-5000/-) (iii) Low (below Rs.3000/-)

(c) Literacy (No. of persons)
(i) Above matriculation (ii) Matriculation (iii) Below Matriculation

(d) Amenities/ Infrastructures
(i) Road – Pucca/ Kaccha (ii) School – Primary/ Upper Primary / Secondary/ Colleges
(iii)Health Centre – (iv)Water Supply -

NORTH-EASTERN HILL UNIVERSITY
CENTRE FOR ENVIRONMENTAL STUDIES, NEHU CAMPUS, UMSHING, SHILLONG – 793 022 (Meghalaya)

Household level:
Owner's name: Occupation: No. of family members: Own a forest land: yes/No

1. Forest Products

Products	Unit	Source	Use	Quantity collected per day/week (kg/q/MT)	Time spent in collection (hr)	Current price (Rs.)	Sold (kg/q/MT)	Consumed (kg/q/MT)	Seasonality	Distance traveled for collection	Quantity required per annum
a. Timber (sp) i. ii.											
b. Fuelwood (sp) i. ii.											
c. NTFPs											
i. Bamboo											
ii. Cane/rattan											
iii. Broomgrass											
iv. Charcoal											
v. Fodder											
vi. Thatch grass											
vii. Packing leaf											
viii. Edible product											
a. Food item i. Wild fruits & berries ii. Nuts iii. Vegetables iv. Honey v. Bamboo shoot vi. Mushrooms											
b. Medicinal Plants i. ii.											
b. Spices and Condiments i. Tezpatta ii. Dal Chini iii. Litsia bark iv. Lichens											

Remarks: