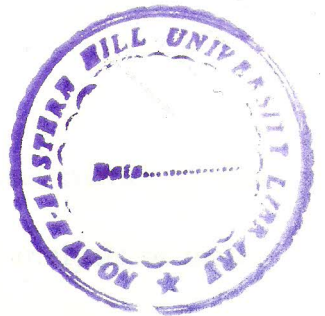


**STUDY OF DISTRIBUTION PATTERN AND
ECOLOGICAL ANALYSIS OF MAJOR FOREST
TYPES OF MEGHALAYA**



By

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CONTENTS

	Page No.
CHAPTER I. Introduction	...1 – 9
CHAPTER II. Study sites and Methodology	...10 – 20
CHAPTER III. Review of Literature	...21 – 32
CHAPTER IV. Forest Types of Meghalaya: their distribution, Climate and Soil	...33 - 46
CHAPTER V. Community structure of Subtropical Evergreen Forest	...47 - 65
^{VI} CHAPTER VI. Community structure of Subtropical Semi-evergreen Forest	...66 - 83
CHAPTER VII. Community structure of Subtropical Pine Forest	...84 - 98
CHAPTER VIII. General Discussion	...99 – 108
SUMMARY	...109 - 113
REFERENCES	...114 - 131
APPENDICES	...i - ii

CHAPTER I

INTRODUCTION

Forests cover an area of 3454 million ha (26.6%) of land surface (FAO 1997) on the Earth. Nearly 57% of the forest lay in developing countries, which for the most part are tropical and make up 58.9% of the total land area. They occur in three major climatic zones *viz.*, tropical, temperate and alpine zones of the earth. The tropical forests form almost a continuous belt along the equator. The temperate forests occur up to about 60° N and S latitudes (Evans 2001), while the boreal forest extend as a continuous vegetation belt of varying width across Eurasia and North America reaching up to 72° 30' N in Siberia (Archibold 1995). Deciduous forests are mostly confined in tropics, subtropics and lower latitudes of the temperate lands due to seasonality of cold and rainy periods.

Forests are renewable resources that contribute substantially to the social and economic development of the people. They preserve seed stock of plants and support large number of animals and microbes. Besides, they are effective sink of CO₂, which is steadily increasing at global level and contribute to the normal functioning of the biosphere. However, due to increasing pressure of human population and consumptive life style, the precious forest resources have been dwindling over the years. Forest is a national asset, and needs to be protected for the well being of the people. A thorough understanding of their

distribution, community structure and functioning is a prerequisite for evolving strategies for their scientific management and conservation.

Forests have distinctive characters that make them different from other terrestrial communities on the Earth. Forests have been classified primarily on the basis of physiognomy, floristic composition, community structure, and dynamics, physical environment and history.

An updated knowledge of the forest cover and land utilization pattern is an essential for a better scientific management of forest resources. Forest cover has largely stabilized in most industrialized countries, but deforestation continues in many developing countries. Between 1990 and 1995, the area of natural forests in developing countries decreased by an estimated 13.7 million ha per year, although this rate of loss appears to be slightly less than during the period 1980-1990. Utilization of forest resources beyond their productive potential has resulted in their quantitative and qualitative depletion. Deforestation also leads to depletion of soil nutrients, soil erosion and changes in local and global climate.

The forest cover of India is about 76.52 million ha. In terms of legal status, reserved, protected and unclassed forests constitute about 54.44%, 29.18% and 16.38%, respectively of the total recorded forest area. After independence, a large portion of forested area was diverted at an annual rate of 0.15 million ha to various non-forestry activities. After the enactment of Forest Conservation Act (Forest Conservation Act 1980), the forest diversions have

been considerably reduced and present rate of diversion is 16000 ha per year (FSI 1997).

Though the forest cover of India, as per Forest Survey of India Report (1999), is 19.2% of the total geographical area of which probably less than 1% of the total land area is covered by primary forest (Mani 1974). The forest cover of the northeast India including Sikkim is about 62.7% (1,64,359 square km) of the total geographical area (2,62,057 square km) of the region and about 5% of the total forest cover of the India, while this region covers only 7.97% area of the total geographical area of India (FSI 1999).

India is among the top twelve megadiversity countries in the world in terms of biodiversity. As a large tropical country, India ranks high in terms of Asian species richness. Dinerstein and Wikramanayake (1993) have reported about 15,000 plant species from India, which supports about 5-8% of the world's known flowering plant and animal species, a significant proportion of which is endemic (Gadgil and Meher-Homji 1986). Important regions of plant diversity in India are the Western Ghats, northeastern India, and Andman and Nicobar Islands (Nayar 1996). Biogeographers have recognised northeastern region of India as one of the most florally and faunally diverse regions since long time (Mani 1974).

Northeast India, an extension of the eastern Himalayan complex, is a "hot spot" of biodiversity. About 50 % species of the Indian flora is confined to this region (Rao and Hajra 1986). The varied physiography, soil and climatic

conditions of the region are responsible for the luxuriant growth of various types of forest. The landscape of the Meghalaya state lies in the northeastern Indian biogeographic zone (Rodger and Panwar 1988), and lays at the junction of Palearctic, Indo-Malayan and Indo-chienese biogeographic realm. The forest flora of the state is remarkable in two ways; firstly, it shows high degree of endemism and secondly, it consists of a number of taxonomic elements of neighbouring countries (Balakrishnan 1981-1983).

Kanjilal *et al.* (1934-40), Champion and Seth (1968), Balakrishnan (1981-83), Haridasan and Rao (1985-87), Rao and Hajara (1986), Chauhan and Singh (1992) and Tomar (1998) have classified the natural vegetation of Meghalaya. They have divided the vegetation into tropical evergreen forest, tropical semi-evergreen forest, subtropical broad-leaved hill forest, tropical moist deciduous forest, temperate forest, subtropical pine forest and grassland and savanna based on site condition and floristic composition. Major forests *viz.*, subtropical evergreen forest (11.9%), subtropical semi-evergreen forest (21.4%), and subtropical pine forest (7.6%) cover 40.9% of the total geographical area of the state.

The subtropical evergreen and semi-evergreen forests of Meghalaya cover large areas. Evergreen forest patches are confined to remote areas with complex terrain and are less influenced by humans. They include sacred groves and reserve forests. Subtropical pine forests of the state are secondary in nature, where further succession has been arrested due to complex interaction

of biotic and edaphic factors. These forests are mostly confined to higher reaches of Khasi and Jaintia hills and are highly fragmented. The impact of shifting cultivation is less in evergreen forests and greater in semi-evergreen forests as the former are not easily accessible while the latter are confined to less complex terrain.

During 1980-81, about 70% of the total geographical area of the state was under the forest cover; 18% area was covered with dense forest (canopy cover > 40%) and 52% with open forest (canopy cover 10-40%) (FSI 1995). Recent mapping of forest vegetation shows a 2% decline in the forest cover of the state (FSI 1997), and the major cause of this decline is shifting cultivation, which is still continuing unabated.

Recent developments in Remote Sensing technology and Geographical Information System allow us to address the problem of deforestation and biodiversity conservation at landscape level. The landscape approach include analyses of landcover, landuse change, estimation of deforestation rates and rates of forest fragmentation, modelling of deforestation, analysis of the consequences of landcover and landuse change on climate and distribution of biodiversity. It is also useful in analysis of the effectiveness of the protected area network in conserving biodiversity and conservation planning (Menon and Bawa 1997).

The landscape ecology approach departs from traditional approaches by focussing on the structure, function, and spatial patterns on landscape elements

and on changes in the landscape mosaic through time. Furthermore, this approach has numerous applications in conservation planning because the total area, patchiness, and connectivity of ecosystems and habitats, and their representation in the protected area network are all important for biodiversity conservation. Although Remote Sensing technology is readily available in India, but its use in landscape ecology and biodiversity conservation has been very limited. Spatial data from varieties of sources such as topographic maps, thematic maps, satellite imagery, and field studies can be incorporated into a GIS to examine the spatial and temporal patterns of landcover and landuse changes (FAO 1990, Liu *et al.* 1992, Menon and Bawa 1997).

The fate of biodiversity ultimately depends upon the existence and integrity of protected areas. Information about landscape changes can be integrated with data on spatial distribution of biodiversity and protected areas in order to devise effective conservation planning strategies. The last few years have witnessed an explosive growth in application of GIS and RS technologies to study changes in the landscape.

These technologies have been used in micro-level planning and sustainable forestry (Lakshmi and Dutta 1996), meso-scale analysis of forest (Lele 1998), estimation of forest resources (Vijaykumaran and Menon 1998), forest type classification and spatial dynamics of vegetation mapping and monitoring of land cover dynamics (Tomar 1998).

Satellite remote sensing has been used to map and classify land use and vegetation cover in various remote and inaccessible areas (Frank 1988, Lal *et al.* 1991, Millette *et al.* 1995). Vegetation mapping, a prime function of environmental remote sensing and often an important management priority, can also prove difficult in mountainous regions due to a lack of unique spectral reflectance/absorbance patterns across variations in cover types (Frank 1988). Digital terrain data, primarily elevation and aspects, has been used in combination with spectral data to classify vegetation in mountain environments (Frank and Thorn 1985, Frank 1988, Giles *et al.* 1994).

Fragmentation of the forests has serious ecological and environmental implications. Forest destruction and fragmentation increase vulnerability of the forest community to disturbances (Chen *et al.* 1992, Robinson *et al.* 1992, Matlack 1994) and lead to micro-environmental changes that drastically influence the forest under-storey (Kapos *et al.* 1995). After fragmentation, the remaining forest patches are surrounded by different vegetation/land-uses and an abrupt edge is created between forest and the surrounding vegetation (Saunders *et al.* 1991). These edges influence abundance and distribution of organisms across the landscape (Mills 1995, Murcia 1995).

Fragmentation is also considered as one of the major threats to biodiversity. It often causes depletion of biodiversity (Kareiva 1994), eliminates resource entirely (changing landscape composition) or rearranges resources into new configurations. In the Indo-Malayan realm of which the northeast India

is a part, degradation activities have altered the natural landscape to a great extent, resulting in mosaics of man-made and natural landscape with poor species composition.

The landscape of the state of Meghalaya has undergone heavy transformation in recent times. The major factors responsible for the change are developmental activities, shifting cultivation (jhum), urbanisation, commissioning of hydroelectric projects, mining and extraction of forest products. All these activities are responsible for wide-spread fragmentation of natural forests as is evident from the preponderance of small patches of both tropical and subtropical forests in fragmentation map of the state based on the IRS IB LISS II, 1995 imagery (Tomar 1998).

A number of earlier workers (Singh 1980, Khan *et al.* 1987, Barik 1992, Rao 1992, Arunachalam 1996, Tripathi *et al.* 1996, John 1998, Maithani *et al.* 1998, Tomar 1998) have studied different aspects of ecology of forest ecosystem of Meghalaya. However, a comprehensive macro-level study on the distribution pattern of the major forest types of the state and their ecological analyses are yet to be attempted. The present study was carried out with an aim to fill this gap using Remote Sensing technique and Geographical Information System.

The major objectives of the study were:

- To study the distribution pattern and area covered by three major forest types of the state of Meghalaya viz., subtropical evergreen, subtropical semi-evergreen and subtropical pine forests.
- To assess tree species richness of the above forest types.
- To study the vegetation and soil characteristics of the above forest types.
- To study the population structure and regeneration of important tree species of the above major forest types.

The present thesis based on an extensive field study and analysis of IRS ID LISS III imagery aims at fulfilling the above objectives. It comprises the following chapters.

Chapter I. Introduction

Chapter II. Review of literature

Chapter III. Study sites and Methodology

Chapter IV. Forest types of Meghalaya: their distribution, climate and soil

Chapter V. Community structure of subtropical evergreen forest

Chapter VI. Community structure of subtropical semi-evergreen forest

Chapter VII. Community structure of subtropical pine forest

Chapter VIII. General Discussion