

Management of Forests in India for Biological Diversity and Forest Productivity A New Perspective

WII-USDA Forest Service Collaborative Project
Grant No. FG-In-780 (In-FS-120)



Volume IV

Garo Hills Conservation Area (GCA)

Ashish Kumar
Atul K. Gupta
Bruce G. Marcot
Ajai Saxena
Santosh P. Singh
T.T.C. Marak



भारतीय वन्यजीव संस्थान
Wildlife Institute of India



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Project Overview

Background

The Wildlife Institute of India-U.S. Forest Service Collaborative Project entitled “Management of Forests for Biological Diversity and Forest Productivity – A New Perspective” was conceived in 1992 and formally approved by the Government of India in 1995. An Memorandum of Understanding was signed between the parties for this project under the Indo-US Scientific Collaboration on Science and Technology on November 24, 1995 with a sanctioned grant of Rs. 13,455,000 (USIF). The project evolved from the earlier collaboration of the US Forest Service (USFS) and the Wildlife Institute of India (WII) on a project in the Satpura Hills of Central India.

The project is first of its kind in India to address the primary mandate of forest managers in the country to sustain forest biodiversity. The National Forest Policy (NFP) of 1988 by recognizing the maintenance of biological diversity in forests as the principle mandate was materially different than the previous NFP passed in 1952. It is obvious that the traditional forest management approach had to undergo a major shift in emphasis and strategies. The shift in traditional training for budding foresters needed to be inseparable from changes that must happen in the field. Both were under review in India at the time of project initiation. This project was, thus, expected to play a significant role in demonstrating the integration of science and management in a planning process that establishes the complementary roles of protected areas and the large surrounding landscapes of managed forests in maintaining forest-based biological activity.

In view of the above, the principal aim of the project was to demonstrate an approach to achieving integration of concerns in India for biological diversity, forest based products, and their sustained flow in support of technological, economic and social benefits to urban and rural sector lifestyles. To accomplish this, the project set forth the following six objectives that addressed ecological assessment in “conservation areas” that included relatively undisturbed forest ecosystems, managed forests with current forestry interventions under a variety of harvest systems, and intervening matrix landscapes that support subsistence and related market based rural economies.

Project Objectives

- Assess, document, and map the kinds, extent and distribution of plant and animal diversity in selected “conservation areas” through rapid survey methods.
- Use existing status and habitat relationships information to set up baseline habitat relationships information system.
- From stand-to landscape-level perspectives, evaluate the impact of existing forestry practices and use of forest-based resources by local people, including methods of harvests and collection, fires, operation of varied concessions and rights on micro habitat elements, key habitats, species, communities, the overall forest productivity and diversity.
- Rapidly assess the social and economic systems of surrounding villages in terms of varied land use and forest resource dependency, including raising and grazing of domestic livestock, other vocations, skills, economy, and markets. These will be seen in relationship to forest systems. Threats to ecological harmony and economical status of people will be documented.
- Use modern ecological concepts to develop practical management tools and practices for bringing about harmony within and between forest and village systems through sustainable land use practices that make social and economic sense. Document problems and threat mitigation prescriptions, and develop site specific field guides to management.
- Conduct workshops and seminars to share experiences, disseminate knowledge, and begin the process of training scientists and managers.

Project Sites

The project was field based at four conservation areas (CA) that covered some 15,500 sq km of forested and nonforested matrix areas representing a variety of biogeographic patterns in wild plant and animal

communities, forestry practices, ethnic human societies and their forest based cultures, economics and tradition, and the range of administrative realities. Each of the CAs included select Protected Areas (PAs) – National Parks or Wildlife Sanctuaries; Managed Forests (MFs), and the intervening matrix of other Government, community or private lands so as to constitute a larger delineated landscape. The four CAs were the Anaimalai Conservation Area (ACA) in south India; Garo Hills Conservation Area in the north east India (GCA); Satpura Conservation Area (SCA) in Central India; and Terai Conservation Area (TCA) in the foothills of Himalaya and on the India-Nepal border.

Project Partners

The Project engaged in early 1996 five field researchers with varied backgrounds in Forestry and Life Sciences. They were given orientation training, then posted at the chosen CA with full logistical support from field line personnel at established field stations and camps. In addition, a Co-Investigator (CI) among the participating WII faculty and a counterpart USFS scientist were assigned to each CA. Besides the scientists and managers from WII and the USFS, senior decision-makers from the respective forest departments supported the team of personnel to conduct the work envisaged under the project. Accordingly, the Principal Chief Conservator of Forests and Chief Wildlife Wardens of the five States (Tamil Nadu, Meghalaya, Madhya Pradesh, Maharashtra, and Uttar Pradesh) fully supported the project. Further, the collaborating Institution i.e. the Indira Gandhi National Forest Academy (IGNFA) identified and pledged the services of two senior faculty members for the cause of the project, each of whom has been a line forest officer prior to their assignment at the IGNFA. In all, nearly 40 people from the WII, USFS, collaborating institutes, and the state forest departments were involved in project.

Project Planning Workshop

A Planning Workshop for the project was conducted at WII, Dehra Dun on June 10-12, 1996. The workshop objectives were to increase understanding of the overall project and to gain the support of the key stakeholders. The individual CA descriptions and the critical issues to be addressed were written for each CA. A specific action plan was to be developed for each CA along with the programme of work to accomplish the identified tasks over the project period.

Appropriate coordination structure, monitoring and evaluation efforts were identified. Mr. Tom Darden, Dr. Martin Prather and Mr. Elton Thomas representing the US Forest Service, Mr. G.K. Gupta and Mrs. Usha Kapur representing FERRO, New Delhi, participated in the workshop. The other participants included faculty from WII (17) and IGNEA (3), and managers from the field representing ACA (1), GCA (4), SCA (4) and TCA (1). The proceedings were prepared and provided to the participants and circulated to others separately. The Planning Workshop facilitated the development of a framework of actions during the project period and coordination mechanisms.

Project Approach

The work programme for the project was charted in the Planning Workshop, attended by representatives of all the partners in the project. It is worth mentioning that the wildlife science is of recent origin in India. There is excellent scientific information on plant and animal taxonomy but weak information on species-habitat relationships or species biology. There are no central databases, and retrieval of local information is not easy as automation in data bases is just beginning. One of the most important steps to be taken at the outset was to ascertain, collate, and review the kind and spread of information - maps, unpublished data, research publications, and working plans of agencies. Indents for maps and imageries were decided on the basis of what was available. The ACA, SCA, and TCA had the advantage of a few researchers having worked on some endangered vertebrates, plant communities, and human social systems. Except for GCA, the rest of the three sites had excellent documented forest management histories and current plans.

The project aimed at incorporating modern ecological concepts into a framework applied to CA-specific guides for managers that synthesized technical information and provided strategies for achieving synergy between ecology and forest based economies. Further, the project planned to incorporate project principles, guide books, and management strategies into a managerial training.

Field Work – The Data Realms

Broadly four data realms – ecological, socio-economic, management, and administrative (mechanism of programme delivery through multi-agencies) - were

visualized as critical components for each of the project sites. Sampling strategies were challenging since the project dealt with large landscapes. Established techniques were used to investigate the components under each of the realm appropriately:

- The **ecological** realm considered the status and distribution patterns of plants and animals. Those under special focus included plant species of economic and cultural importance, animals that are culturally important, and those plants and animals that are endangered, threatened, endemic and rare. Elements under threat of illegal exploitation were integral to the foregoing. Besides the species, plant communities of conservation importance, sensitive and key sites and systems were included.

Past and current forestry practices, including silvicultural systems and marking rules, were evaluated for their impact on forest composition and structure, including impacts on special and unique micro-habitats such as snags and logs. Fuel wood collection was integral. There was a much better understanding of silvicultural treatments and their broad impacts on vegetation dynamics than for the species, locations, ecology, productivity, sustainability, and harvest systems of non-timber forest produce. Medicinal plants were of special concern.

- The **socio-economic** realm investigated the relationships between the people and forest based resources. Local people were considered as key players in mitigation and sustainability. This realm has a fluid interface with the ecological data realm as people's interest and activities meld ecological and economic concerns. People's lifestyles and their influences both on the people themselves and on forest systems were also investigated through standard techniques *viz.*, questionnaires, household surveys, rapid assessment and micro planning.

Livestock rearing, grazing and the articulating influences, likewise fuel wood collection constitute very long-term pressures on the forests. Agricultural practices within enclave villages and among peripheral villages are directly related to the nature of pressures on the forests. For example, cropping pattern, crop-depredation by wild herbivores, livestock predation by wild carnivores,

injuries and death of humans as a result of encounters with wild animals were major issues of study. Poaching is another activity that has complex linkages. Mining, quarrying, collection of sand, use of water from streams and water holes were also included as a part of the information base development.

- The **management** realm included understanding and interpreting the impacts of infrastructure development (e.g. roads, fire lines, water holes, hides, etc) and current management practices.
- The **administrative** realm of information includes all management processes for conservation or human development of the region, thus includes multiple agencies and their programmes. The programme targets and dimensions can be varied – from local rural interest through activities of national interest. Information was collected on objectives, mechanisms of delivery, and the outputs of these socio-economic programmes of the Government and private sectors especially evolved for the inhabitants of villages in the forest.

Project Accomplishments

Generating ecological and land use maps to fit the project objectives was a necessity for all sites. Each CA stratified the area based on significant forest/vegetation/habitat types, and established a system of randomly placed transects to assess vegetation structure, composition, distribution, and frequencies of plants of conservation and economic importance. While tree and shrub communities were addressed in detail, the grass and herb communities were addressed in terms of key assemblages and sensitive sites, except in the TCA where tall riverine grasslands and upland dry grasslands constituted significant ecosystems.

Assessments were made on plots of varying sizes placed at regular intervals on the transects. Along with plants, distribution and abundance of larger vertebrates were recorded by indirect evidences with the plots and sightings along the transects. TCA also used a modified experimental design to assess grassland by testing established intervention practices of prescribed burning, harrowing, and grass cutting in different combinations across grass communities. GCA adopted a system of existing natural and man-made trails in an extremely challenging field situation.

Following were the major outputs:

- **Resource Maps** - The project has been able to generate resource maps for all the four sites using the remote sensing and GIS technologies. A spatial data base has been, thus, created for each CA incorporating different layers viz., drainage, administrative/management units, land use/land cover, vegetation, animal distribution, villages, and infrastructure.
- **Baseline Information** – The project has significantly contributed in providing a baseline information on the floral and faunal diversity, land use, historic development, socio-economic condition, wildlife – people conflict, etc. The project has also addressed different biotic pressure in each of the sites.
- **Wildlife Habitat Relationships (WHR)** – A large number of vertebrate species representing the four sites and those unique to each CA based on a species selection criteria were short-listed. The project provided a detailed description on each in each CA and in the overall WHR database.
- **Capacity Building** – The capacity building of the frontline staff was an integral component of the project. New training curricula in the training module for the Post-Graduate Diploma Course in Wildlife Management were formulated for the frontline staff of the forest departments, especially related to habitat assessment and habitat management. A new approach to planning integrated disparate management units (e.g., PAs, MFs, matrix) at hierarchical spatial scales ranging from the CA to the region. These approaches have also been appropriately incorporated in the continuing education courses for middle and senior level forest managers and planners. Changes are also brought about in the training module for wildlife management at the IGNFA. A new course is being developed for forest working plan officers that will be built upon the learning from the project. The chapters on assessment of biodiversity, wildlife and habitat management planning in the draft National Working Plan Code, 1999, were largely based on the learning emerging from this project.
- **Study Tour for the Indian Delegation** - A 13-member Indian delegation visited USA on a study tour from July 24, 1999 to August 7, 1999. The

delegation included five faculty members from the Institute and eight field managers representing the four project sites across five Indian States. The program was jointly prepared and coordinated by Mr. Tom L. Darden and Dr. Hal Salwasser of the USFS, with support by Dr. James R. Stevenson, US Foreign Agricultural Service. The group visited two important regions – the Southern Appalachian Region on the east coast and the Sierra Nevada Region in the State of California and Nevada on the west coast. Visits to different National Forests, wilderness areas and conservation areas were organized. The counterpart US scientists also joined the visiting group during their field visits to different areas and participated in the workshop and project review. In addition to the field visits to different demonstration areas, workshops were also organized at Asheville, NC and the Institute of Forest Genetics (IFG), Placerville, CA. Several resource persons from the USFS, US National Park Service, and the University of California, Davis were invited during the workshops/field visits to provide their technical inputs. The delegates also visited the Department of Forestry Science in University of California, Davis.

Making large-scale ecological assessments on hierarchical scales to address management were central to the study tour. The experience gained in the process was ploughed into the presentations and field demonstrations. The entire experience was extremely relevant to the emerging situation of planning in India and addressed the vital areas of training, research, monitoring, planning and management. Apart from the field visits, the visiting group was paced through different approaches to integrated forest management using the concept of large landscape/conservation areas. Emphasis was laid on different tools and methods for forest and wildlife inventories, habitat assessment, timber management, endangered species management, management of forest insects epidemics, wildlife habitat relationships, fires, recreations, visitor management, ecological monitoring and some significant research especially on the spotted owls in the Pacific Northwest. Several opportunities were also provided for cultural exchange. The visiting delegations also made presentations based on their field/research works on respective Indian sites and related the experience to the element of the study tour conducted.

- **Management Guide** - The project has ultimately provided a new way of thinking about managing for biodiversity at the landscape scale, by taking into account all types of lands, across multiple spatial scales for multiple wildlife species and resource management needs. The project has provided an insight for the conceptual framework, the scientific basis, specific procedures for analysis and operations, and evaluation of select demonstration areas, about how to integrate resource assessment and management for biodiversity at the landscape level.
- **Information Dissemination** – Right from the beginning the project has yielded a substantial information in the form of technical annual reports or specific compilations. The project has significantly contributed in developing a spatial database. The field managers have extensively used the information generated in the preparation/revision of management plans or planning other strategies/proposals. It is evident in the first management plan written for the Dudwa Tiger Reserve (De, 2001) and proposal for the establishment of an Elephant Reserve in the State of Meghalaya. Three Ph.D. dissertations are expected from the project. Researchers of the project have been making research presentations during the Annual Research Seminar organized by the Institute wherein a large number of field managers, scientists, decision-makers participate. The project plans to provide an electronic version of the report for its wider use by the scientific community as well as the field practitioners.

Organization of the Report

The final products of the project include a six volume management guide. The volumes have been produced in collaboration and intense interactions among four full time researchers, the US team of scientists, participating WII faculty, field managers of four project field sites and representative faculty from collaborating institution – IGNEA.

The Volume I addresses the conceptual and scientific basis of the approach, and would be of use to any manager or researcher entrusted with such an approach anywhere. Volume II is on wildlife habitat relationships and includes a framework for how to evaluate multiple wildlife species simultaneously, and

narrative summaries of life histories of 184 wildlife species selected to represent various criteria of rarity, endemism, management focus, habitat associations and others. Volumes III to VI are intensive case studies of four “Conservation Areas” selected across India to represent a great diversity of ecological conditions, CA histories, cultural situations, and management challenges.

Lessons Learned

The four conservation areas studied in this project differed markedly in ecological conditions, socio-economic situation, and management issues. Equally diverse were the arrays of key stressors on the native flora and fauna, and in the management opportunities for improving conditions for native plant and animal diversity and human communities. Many useful lessons have been learnt from the project, principally the need to think broadly across major landscape areas when managing for native species and communities. This includes the need to coordinate data, analyses and management across different land ownerships and allocations. Cumulative effects in buffer areas or zones of influence outside existing protected areas, or even along international borders, are also to be taken into account when developing site-specific management plans. Also, an integrated resource management approach at all spatial scales is seen as the best way to avoid conflicts in resource use and to plan for appropriate ways to conserve biodiversity in managed forests.

Specifically, following is a gist of overall guiding principles and lessons learned from this project :

- *Think* broadly across major landscape areas
- *Integrate* management plans across administrative boundaries and between forest and wildlife resource areas
- *Consider* cumulative effects of all activities
- *Think* in hierarchical spatial scales
- *Use* local knowledge and needs in the conservation strategy
- *Consider* a fuller array of flora and fauna
- *Consider* ecosystem and anthropogenic processes and the ecological roles of organisms

The study categorised stressors into five main groups: (1) stressors associated with resource consumption, (2) stressors associated with use of non-consumptive resource amenities, (3) stressors associated with transportation and habitation infrastructures, (4) stressors associated with effluents, and (5) stressors associated with other human activities having impact on the resources.

Specific management opportunities related to reducing or eliminating the occurrence and adverse effects of the various stressors listed above can be summarized across the four conservation areas are follows:

- Management opportunities and recommendations in managed forests
- Management opportunities and recommendations for identifying natural conditions and native biodiversity
- Management opportunities and recommendations in riparian areas
- Management opportunities and recommendations for roads and transportation systems
- Management opportunities and recommendations for tourism

- Management opportunities and recommendations for protecting rare and locally-distributed species and ecological communities
- Management opportunities and recommendations for conservation of wide-ranging species
- Management opportunities and recommendations on collection and poaching of species
- Management opportunities and recommendations on participation by local people
- Management opportunities and recommendations on research and monitoring

Further, basic ecological understanding also is necessary to modernise silvicultural systems by moving them from a focus simply on the production of wood and other human goods and services, to the production of both human and ecological goods and services by restoring or maintaining diversity and viable forest ecosystems. The transition from old to “new forestry” will be critical for integrating PAs and MFs to meet ecological goals described for conservation areas. The transition likely will require a period of adjustment of attitudes and experimentation with new methods, such as use of adaptive management approaches.

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Chapter 1

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Chapter 1

General Description : Landscape Preview

1.1 Introduction

Indian forests are home of ca. 15,000 flowering plant species, which is about 6% of the world's estimate (Haywood, 1985). The North-eastern India along with Himalayan region is a unique transitional zone amongst the Indian, the Indo-Malayan and the Indo-Chinese biogeographical zones as well as being the meeting point of the Himalayan region with the Peninsular India (Takhtajan, 1988). This region is important for conservation of biodiversity because of its high species diversity and high level of endemism. The region contains about 8000 species of flowering plants including several representatives of primitive or ancient angiosperms (Takhtajan, 1988). This region is constituted by seven

north-eastern states and is popularly known as 'seven sisters.' The total forest cover of this region is 164,043 sq km, which is 25% of the total forest cover of India (FSI, 1997). The forests can be broadly categorised into tropical evergreen, semi-evergreen and temperate forests (Champion & Seth 1968; Meher-Homji & Gadgil 1986).

However, the forests of northeast India are under tremendous pressure of exploitation. Studies have indicated that within a period of two years between 1995 to 1997, about 1,875 sq km of forest land were converted to crop land for shifting cultivation, whereas the natural regeneration was recorded over only 1,700 sq km of land (FSI, 1997) resulting in a net loss of

175 sq km of forest over a two-years period. Shifting cultivation, locally popular as *jhum* in the region is an age-old practice of raising crops by clearing and burning a forest patch. The field is abandoned after few years as the soil productivity decreases and fresh forest area is cleared again. Apart from shifting

India ranks sixth among the 12 mega biodiversity countries of the world (Maslekar, 2000). It contains two out of the 16 most important biodiversity hot spots of the world, namely Eastern Himalayas and Western Ghats. Currently available data place India at tenth position in world and fourth in Asia in terms of plant diversity. Based on the survey of 70% of the total geographical area of the country, 46,000 species of plants and 81,000 species of animals have been recorded (Sarat Babu and Arora, 1999).

cultivation, large-scale timber harvesting has been carried out in north-eastern India in the last few decades. Various pulp industries as well as local communities harvest bamboo forest, a seral community, for commercial purposes as well as for local use (Ramakrishnan, 1985; Ramakrishnan and Toky, 1983).

Meghalaya has a geographical area of 22,429

sq km, out of which 15,657 sq km (ca. 70%) is under forest cover (Figure 1.1). The Khasi, Jaintia and Garo hills, which constitute the state of Meghalaya, are known to harbour rich biodiversity. At present within Meghalaya, there are 2 National Parks, 3 Wildlife Sanctuaries, 23 Reserved Forests (RFs) or Managed Forests (MFs) and 5 Protected Forests owned by the State (SFD, 1995). Collectively, these protected areas (PAs) and managed forests cover only 4.7% of land, whereas remaining forests over 65% of land are mostly owned by tribal communities. The state-owned forests were constituted between 1883 and 1888 and have been managed systematically since then. The first working plan for state-owned forests in Meghalaya was prepared by Fisher in 1887 (1887-

1902), mainly to exploit Sal. The emphasis for exploitation of Sal and other timber trees of the managed forests was evident until the Working Plan of Islam (1956-57), which gradually shifted the focus of forest management to include protection of wildlife and other non-timber natural resources (Working Plan of Suchiang, 1975-76). The first wildlife sanctuary of Meghalaya, Siju Wildlife Sanctuary (SWS), was constituted in 1979, and the first national park of the state, Balpakram National Park (BNP), was declared only in 1986, by acquiring land from tribal communities, thus initiating a positive process for long term biodiversity conservation.

Situated in the western part of the State, the Garo Hills are spread over 8167 sq km. They also contain most of the existing PAs and RFs of the state. Out of a total of 5 PAs and 23 RFs in Meghalaya, 4 PAs and 15 RFs are located in Garo Hills (SFD, 1995). In the Garo Hills, *jhum* is used to grow cashew nuts, for latex processing, and growing and harvest of tea, pepper, cinnamon, bamboos, and other agricultural and forest products (Ramakrishnan, 1985). There are three revenue districts in Garo Hills viz. East Garo Hills (2,603 sq km), West Garo Hills (3,714 sq km) and South Garo Hills (1,850 sq km).

The South Garo Hills district was separated from West Garo Hills in 1992 and is the least exposed area to the government's developmental activities. As per the 1991 census, the total human population and density of the district was 77,073 and 42 persons/sq km, respectively which is also relatively half of that of Garo Hills as a whole. The study area viz the Garo Hills Conservation area (GCA), is spread over 2,450 sq km, covering most part of the South Garo Hills district and parts of East and West Garo Hills districts (Figure 1.2).

1.2 Conservation significance of landscape

The area is highly significant from biodiversity point of view with a high level of endemism of plants and animals. It also represents one of the densest populations of Asian elephants (*Elephas maximus*) as

compared to any other region of the subcontinent. Some of the remaining undisturbed or less impacted tracts of tropical evergreen and semi evergreen forests with a great diversity flora and fauna of Meghalaya State are within the GCA. Endemic plants such as pitcher plant (*Nepenthes khasiana*) and many citrus species have the best chance of survival in the region. Out of total 23 species of citrus in India, six (6) are available in the study area viz. *Citrus medica*, *C. macroptera*, *C. latipes*, *C. ichangensis*, *C. assamensis* and *C. indica*. All other except *C. medica* are in the wild and semi-wild state (Singh, 1981). About 90 species of Bamboo and 14 species of canes (Lakshmana, 1993) have been reported from North-east India of which 18 and five 5 are found in the study area, respectively.

The GCA forms a part of the catchment for the mighty Brahmaputra, the major river flowing through this region (Figure 1.3). Two rivers, namely Simsang and Mahadeo, originate from the central and southern hill ranges of GCA. The deep gorges, extensive limestone formations, caves and the Balpakram plateau (regarded as a holy place by the Garo tribes) are among the unique features of the GCA.

The native Garo tribals are highly dependent on forest resources such as timber, small wood, bamboo and a variety of Non-Timber Forest Produce (NTFPs) in support of their economy. Their traditional style of agriculture, the shifting cultivation or *jhumming* is a system that is heavily subsidized by nutrients accumulated in forest soils. Major conservation problems of the area include unsustainable landuse activities and the increasing people's dependency on forest resources. The community forests are being depleted rapidly due to shifting cultivation, unscientific logging, intensive extraction of NTFPs, and enlargement of settlements. Increasing incidence of *jhum* and shortening of *jhum* cycle are the main factors responsible for the loss of forest cover and significant reduction in agricultural outputs (Ramakrishnan, 1985; Ramakrishnan and Toky, 1983; Mishra and Ramakrishnan, 1982; and Kushwaha and Kuntz, 1993).

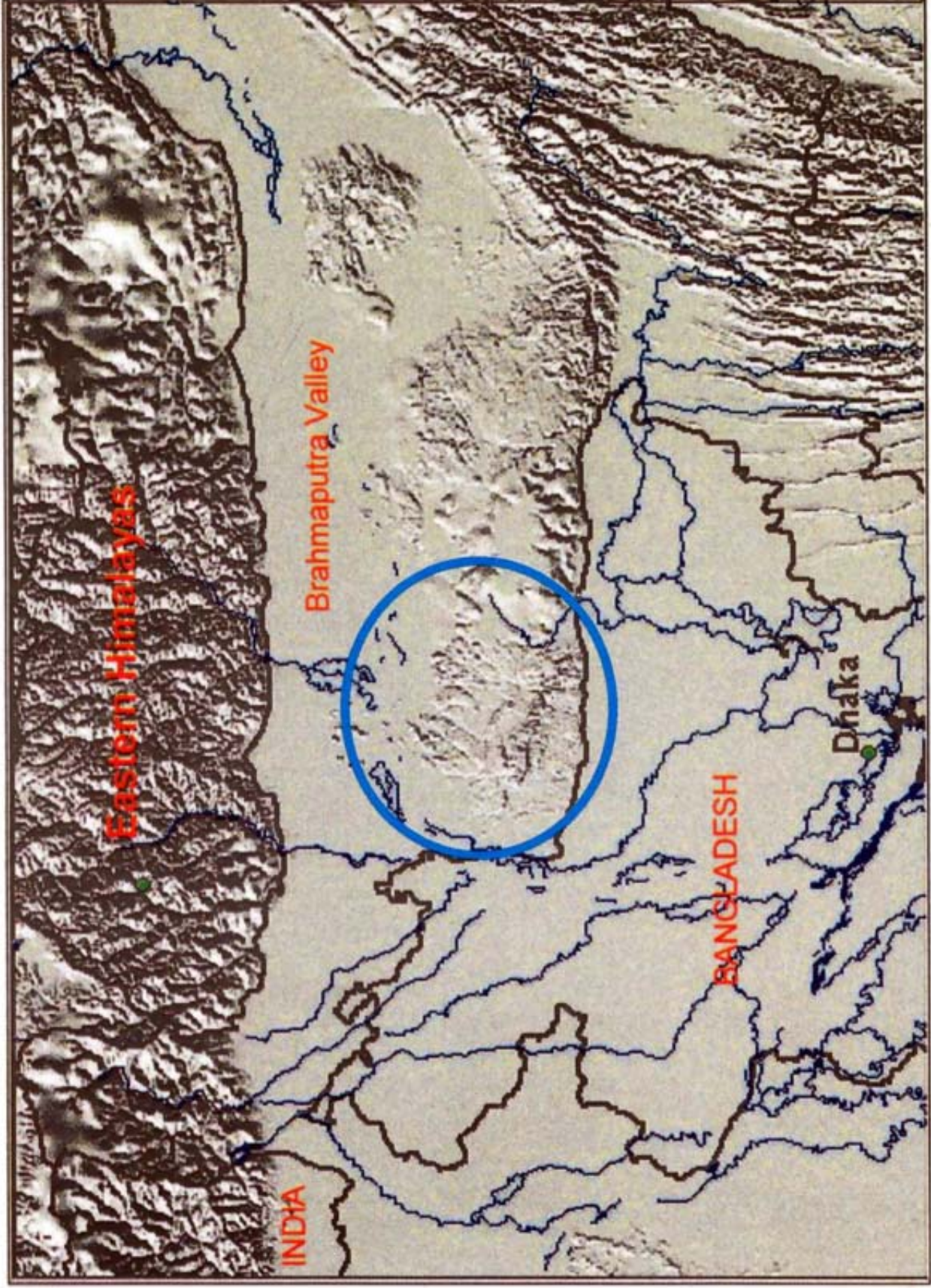


Figure 1.1 Garo Hills, Meghalaya

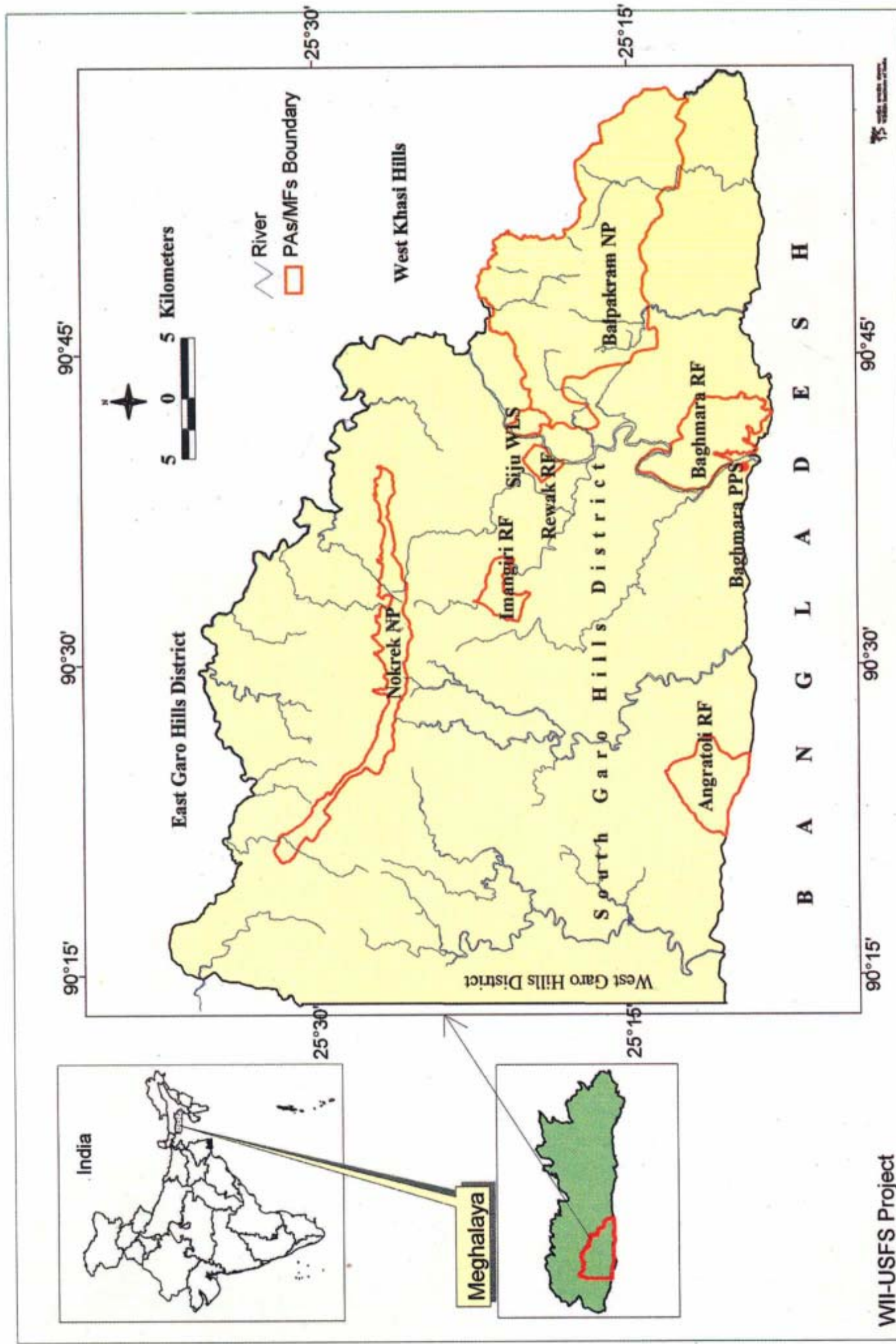


Figure 1.2 Location Map of GCA, Western Meghalaya



Figure 1.3 Unique position of GCA amongst 3 biogeographic realms

Considering all these factors, it is clear that the current trend in landuse practices might lead to irreparable loss of otherwise renewable natural resources such as productive soils leading to further loss of primary and old secondary forests, and associated biodiversity.

The existing network of primary and old secondary forests in GCA occurs in PAs, MFs, and community-owned lands as undisturbed forest patches including sacred groves. This network offers prospects of conserving the existing old-forest biodiversity of the region, and improving the overall conservation of wildlife and forests through proper landuse planning.

1.3 People and community

According to Sharma (1984) the ancestors of the present Garo tribes reached the north-eastern part of India during the Neolithic period beginning about 5,000 B.C. from their original homeland in southwest China. The Neolithic people were food producers and practised shifting cultivation. They lived in semi permanent settlements consisting of small agricultural communities and knew the art of making earthen vessels from clay. The Garo tribe is major ethnic community in the Garo Hills. Though they are known as 'Garo' they prefer to call themselves as Achiks or Achik mande (Achik means hills and mande means man). After the initial settlements in the area, Garos spread over the whole Garo Hills range and formed different groups or Aking (clans).

1.4 Area size

The landscape is situated in the south-eastern portion of the Garo Hills, Meghalaya. It covers the entire South Garo Hills district (area 1,850 sq km) and the part of East and West Garo Hills districts. The total geographical area of recognized landscape i.e. the Garo Hills Conservation Area (GCA) is 2,459 sq km. Government owned 4 PAs and 4 RFs make up for 362 sq km, while remaining (2,097 sq km) area of the GCA belongs to local community.

1.5 Location

The study area falls under biogeographic zone 9B

i.e. North-eastern India (Rodgers and Panwar, 1988) between 90°07' to 91° E longitudes and 25°02' to 25°32' N latitudes. The terrain is extremely rugged and undulating landscape of hill ranges mostly run from east to west with deep gorges and many streams flowing along the north-south gradient. In the east, the boundary of the GCA follows district boundary between South Garo Hills and West Khasi Hills. In the north, it follows the river Simsang and joins a road, which goes to Tura, in the northwest corner of the study area. The western boundary follows a road from Tura to Dalu. The southern boundary follows the hill ranges at international border between India and Bangladesh.

1.6 Landscape use pattern, management and resource dependence

Unique land holding patterns and traditional forestry practices distinguish GCA from other forested landscapes in India. About 85% of the land in GCA is still under the control of local communities and used extensively for shifting cultivation i.e. *jhumming*. The practice of shifting cultivation has created the mosaic of various land use categories and successional stages of vegetation. During the late 19th and early 20th centuries, British government acquired the land from local communities and created Reserved Forests (RFs). British managed about 10% forest land of the GCA and their interest was in providing timber by harvesting older forest stands having commercial trees. For this purpose the forestry plans were developed and continued until the 1970s.

The Meghalaya State government initiated wildlife management and protection measures in the late 20th century by acquiring 25% of the forestland from local Garo Hills communities or individuals and created protected areas viz. Siju Wildlife Sanctuary (SWS) in 1979, Balpakram National Park (BNP) in 1985, Nokrek National Park (NNP) in 1985 and Baghamara Pitcher Plant Sanctuary (BPPS). In recent years, the State Forest Department embarked on ecodevelopment activities in 1985 around BNP and NNP covering 101 and 33 villages, respectively (Table 1.1).

Table 1.1: Historical account of landscape use pattern in the study area

| Management priority | Activity/Task | Govt. official | Purpose |
|---------------------|-------------------------------------|-----------------------------------|--|
| Forest | Working Plan (1941-51) | M.C. Jacob, DFO | Commercial mainly timber production |
| | Working Plan (1956-57) | M.M. Islam, DFO | |
| | Working (1975-90) | F. Suchiang, DFO | |
| Wildlife | Wildlife Division, Meghalaya (1977) | SFD, Meghalaya | Wildlife Protection |
| | Siju WLS (1979) | SFD, Meghalaya | |
| | Wildlife Circle (1982) | SFD, Meghalaya | |
| | Balpakram & Nokrek NP (1986) | SFD, Meghalaya | |
| | Wildlife Division, Baghmara (1987) | SFD, Meghalaya | |
| Biodiversity | Preliminary Management Plan | J. Dutta, DFO | Biodiversity Conservation |
| | Management Plan | S.N. Sangma, ACF | |
| | Ecodevelopment | Ecodevelopment Society, Meghalaya | Ecodevelopment of 101 and 33 villages around BNP and NNP |

In GCA, the forest types were classified by Champion and Seth (1968) as Tropical Moist Evergreen Forest (TMEF), Tropical Semi-evergreen Forest (TSEF) and Tropical Moist Deciduous Forest (TMDF). The landscape consists of primary and secondary forest growth of above types, along with degraded land. Other vegetation types include grasslands, riparian forests, shola-type forest (Kumar & Rao, 1985), degraded land with bamboo (a seral stage) and scrub vegetation. The landscape supports one of the densest population of Asian elephants. Population density of the elephants is very high in Meghalaya with crude density of one elephant per 2 sq km. Balpakram National Park (BNP) and Baghamara Reserved Forests (BRF) linked with corridors of contiguous, closed-canopy forests are suitable habitats for the wide ranging elephants.

The BNP along with its adjoining forests provide habitats for the tiger (*Panthera tigris*), hoolock gibbon (*Hylobates hoolock*), clouded leopard (*Neofelis nebulosa*), Malayan giant squirrel (*Ratufa bicolor*), binturong

(*Arctictis binturong*), yellow throated marten (*Martes flavigula*), large Indian civet (*Viverra zibetha*), small Indian civet (*V. indica*), capped langur (*Trachypithecus pileatus*), Indian Bison (*Bos gaurus*) besides many other mammals and bird species. The two species of hornbills (*Buceros bicornis* and *Anthracoceros albirostris*) are widely distributed.

The native Garo tribes are culturally rich and some of their mythological sites are also located within the landscape. The GCA landscape is heavily influenced by human resource use activities, predominantly by *jhumming*. The land area affected by, and frequency of *jhumming* by local Garo tribes has greatly increased in recent decades concurrent with increasing human population. Illegal and legal export of timber and other forest products occurs in the region. Other resource use activities in GCA, which might have adverse effects on the old native forests of the region, are mining (coal and limestone), excessive collection of NTFP and the animal hunting.

1.7 Current administration

The current administration of GCA is similar to other seven districts of Meghalaya state. Being a new district, South Garo Hills district does not yet have a well-developed administrative infrastructure. A Deputy Commissioner (DC) heads the district administration and controls various administrative units. These units are called administrative branches *viz.* the general or establishment branch, the judicial branch, the revenue branch, the loan branch, the registration branch and other such branches in charge of supply, housing, elections, block development as well as the district selection committee.

In general, the hierarchy of district administration includes the Deputy Commissioner, Sub-Divisional Officer (SDO), Extra Assistant Commissioner (EAC), Deputy Director of Supply (DDS), Deputy Superintendent of Excise (DSE), Enforcement Inspector (EI), Inspector of Supply (IS) and District Transport Officer (DTO). The DC office is situated in Baghmara, the headquarters of South Garo Hills District .

1.7.1 Village administration

All the administrative powers related to the domestic matters of villagers and village community belongs to Nokmas. The Nokma in the given village is the head or chief from the dominant clan or group of clans. He presides over council *Melaa Saldonga* and decides all the issues and disputes. The Nokma deals with all the customary laws and affairs. The Nokma fixes the dates of festivals and observance, and arranges for community participation in festivities, sacrifices and other rituals connected with the community. However, following the creation of the class of officials, powers of Nokmas have been reduced, especially after their powers to try legal cases have been taken away from them (Simon, 1996).

1.7.2 District council administration

The Garo Hills District Council (GDC) came into being in 1952 under the provision of the Sixth Schedule to the Constitution of India, the Assam and the

Meghalaya (Constitution of District Councils Rules, 1951). At present, the jurisdiction of the GDC is over the entire geographical area of Garo Hills across the district boundaries.

An Executive Committee was constituted under the Autonomous District Rules headed by the Chief Executive Member. This body looks after the administration of the Garo Hills under the Chief Executive Member assisted by two Executive members. The major subjects assigned to the Council are: forests, civil works, taxation, revenue, judiciary, transport and education.

Forest management, education, revenue and tax collections are among those activities that have suffered considerably over the past few years. In case of forest management, the District Council appoints its own staffs that are to look after exploitation of forest resources. Revenue is derived from royalties on timber, bamboo, cane, reeds and minerals.

1.7.3 Forest administration (Wildlife)

The PAs and MFs comprising Ca. 15% area of GCA landscape are being managed and administered as per existing laws and policies of India under the State Government. Principal Chief Conservator of Forests (PCCF) heads the forest department. The Chief Wildlife Warden and a Conservator of Forests (Wildlife) are responsible for all the matters related to wildlife in the state. Four Divisional Forest officers stationed at Shillong, Jowai, Tura and Baghmara manage the forest and wildlife at district and local level within their jurisdiction. The portion of GCA near Tura peak and Nokrek area belongs to the East and West Garo Hills Division while rest to the Balpakram NP division. The organisation chart below provides a brief overview of man power engaged for wildlife management and conservation (of major portion of GCA) under Balpakarm NP division under the control of Divisional Forest Officer at Baghmara being the head quarters of South Garo Hills district (Table 1.2).

Table 1.2: Organisation chart of BNP Division, South Garo Hills (SFD, 1995)

| ACF | DFO (BNP) Baghmara | | | | Office staff |
|-----------|--|--|--|---|--|
| | Baghmara | Siju | Rongra | Mahadeo | |
| CE= 1 no. | Fr-1 = 3 nos. F Gd = 4 nos. G/W= 1 no. G/M =1 no. CE = 10 nos. | Fr-1 = 1 no. F Gd = 2 nos. G/W= 5 nos. B/M =1 no. CE = 12 nos. | Fr-1 = 4 nos. F Gd = 4 nos. G/W= 3 nos. G/M =3 nos. CE = 13 nos. | Fr-1 = 3 nos. F Gd = 6 nos. G/W= 2 nos. G/M =8 nos. O/C = 1 no. CE = 28 nos. | VAS = 1 no. A/C = 1 no. LDA =3 nos. RA= 2 nos. O/P = 1 no. D/R =1 no. O/C= 1 Driver =3 nos. CE =9 nos. |

DFO =Divisional Forest Officer
 BNP =Balpakram National Park
 ACF =Assistant Conservator Of Forests
 Fr-1 =Forester Grade 1
 F Gd =Forest Guard
 G/W=Game Watcher
 G/M =Gate Man

CE =Casual Employee
 B/M =Boat man
 O/C = Office Clerk
 VAS =Veterinary Assistant Surgeon
 A/C =Accountant
 O/P = Office Peon
 D/R = Draftsman

1.8 Forest management in Garo Hills

Unlike other states of India, most of the land in Meghalaya, including forests, is owned by the tribal communities. During the British rule, some of the land, which was under the ownership of Government was constituted as reserved forests covering 262.74 sq km (in Garo Hills) between 1883 to 1888. Systematic forest management was initiated in 1887. At that time, some of the reserved forests were given to contractors on lease. The earliest working plans for the Garo Hills were written by Fischer (1887-1902) and Combell (1886-87) for Dambu and Darugiri reserved forests. The first detailed working plan covering all reserved forests of Garo Hills was prepared by Sh. M.C. Jacob in 1940-41 for 10 years in which he prescribed five working circles (WC) based on the commercial value and silvicultural characteristics of the forests. The second detailed plan for all reserved forests was prepared by M.M. Islam (1956-57) after a detailed stock mapping and ground inventory. He constituted following four working circles:

- Sal selection WC
- Sal improvement WC
- Miscellaneous WC
- Ghugra WC

The Sal area of Angratoli and other RFs in East and West Garo Hills district were allotted to Sal conversion working circle with an objective to attain maximum sustained yield. The Ghugra overlapping working circle focused on *Schima wallichii* associated with Sal to be worked through the selection system. Taungya working circle was allotted to those areas which were under plantations and all the known areas of RFs were suitable for plantations. Sal improvement working circle was allotted to RFs-Rewak, Emangiri, Baghmara, Angratoli and Siju (Wildlife Sanctuary now) along with some other RFs of the Garo Hills with an objective to improve the condition and composition of Sal by silvicultural operations and to allow sustained supply of timber. All miscellaneous forests of various RFs were allotted to the Miscellaneous working circle with an objective of maximizing the sustained yield

and replacement of existing poor stock by the valuable species. The latest working plan for Garo Hills, prepared by Suchiang (1975-76) was in operation until 1990. The following six working circles were constituted in this Plan.

- Sal Selection WC (12.90 sq km)
- Sal Conversion WC (21.71 sq km)
- Plantation WC except Siju (91.71 sq km)
- Bamboo WC (20.77 sq km)
- Protection WC (4.79 sq km) and
- Ghugra (*Schima wallichii*) overlapping WC (Overlapping all reserves)

Forest plantations were also raised from time to time. The 'taungya' plantation in Garo Hills was established during 1905-1906 in which approximately 60 sq km of Sal, Teak and other commercially important tree species were raised. Extensive social forestry plantations of Sal, teak and Gamari covering 51 sq km were raised during 1986-90. Shuching's Working Plan also started the process of conservation and wildlife protection in Garo Hills, as illustrated in the following two objectives of the plan:

1. To protect in perpetuity, the precipitous slopes and catchment areas of rivers with a view to conserve soil and moisture.
2. Without disregard to the principles of the scientific forestry to conserve and improve the status of wildlife in these forests.

1.9 Physiographic condition

1.9.1 Geological history

The Garo Hills region is a part of the Meghalaya plateau. Rock types from most ancient to recent period occur in different locations of these hills. The oldest known rocks comprise the 'Archean Group' of about 3,600 million year of antiquity and occupy about 60% of the Garo Hills. Over these rocks, localised patches of rocks belonging to the 'Gondwana group' of some 350 million years old are also present. The sediments of the Tertiary age (65 million years old) occur around

Baghmara and many other localities in South Garo Hills. At the end of Miocene, continuous sedimentation over southern and western parts of the Garo Hills resulted in the uplifting of the Meghalaya plateau and the formation of Khasi Hills and Garo Hills.

1.9.2 Altitudinal range and the physiographic regions

Garo Hills can be divided into five physiographic regions on the basis of altitude (Momin, 1984), which are as follows:

1.9.2.1 Above 1,350 meters msl

This include the Nokrek peak and nearby areas. This region is regarded as wilderness.

1.9.2.2 Between 901-1,350 meters msl

This region lies in three pockets, i.e. a part of Nokrek, Chutmang and Balpakram hills. There is complete absence of human settlements. Mainly primary forests occur here.

1.9.2.3 Between 301-901 meters msl

This region lies in the central part of Garo Hills from which the Simsang river originates. There are very few human settlements due to poor accessibility

1.9.2.4 Between 151-300 meters msl

This region constitutes the inner parts of Garo Hills touching the Khasi Hills in the east and northeast. This tract forms the important catchments of almost all rivers and streams of the Garo Hills region. The area is hilly and covered with thick forests. This region is thinly populated and economically very weak.

1.9.2.4 Below 151 meters msl

This region includes all the fertile plains and river valleys from north-eastern Garo Hills to the north and northwest touching Assam, the southern and south-western part of the district bordering Bangladesh, and the Maheshkola area. Nearly half of the area of Garo Hills falls in this region. The valuable Sal and Teak forests/stands (very old plantations) cover the hill slopes.

1.9.3 Rivers and drainage pattern

The drainage system of the Garo Hills is divided directly by the central upland zone. This zone divide rivers which flow down to the south to the Surma valley of Bangladesh, from rivers which flow to the north to the Brahmaputra valley of Assam. The rivers in the Garo Hills generally are not navigable by large boats, but the Simsang, Ganol, Bugi or Bugoi and Dareng or Nitai rivers are used for some local navigation within the Garo Hills. Other important rivers of the Garo Hills include the Nareng, Rongdik, Chibe, Rongdi, Rongkol, Mahadeo, Maheshkola, Kanai, Nawa and Lengta. Important features of the few of these rivers are as follows

1.9.3.1 Simsang River

This south-flowing river flows through the centre of the GCA. It originates in the Tura range near the Nokrek peak and flows east then south until it emerges on the plains of Pargana Susang of Mymensing district in Bangladesh. It passes through the villages of Simsanggiri, Rongrenggiri, William Nagar, Nangalbibra, Do'bak Kol, Rongbinggiri, Siju, and Rewak and the Baghmara township. The important tributaries of the Simsang are the Rongkoi, Rompa, Ringdi, Rongdik, Chibok, and others. The upper course of this river is not navigable due to a high number of cataracts and numerous boulders. However, the lower course has many deep pools and falls, namely Mrik, Matma, Kon'chru Suk, Warisik, Bobra and Goka. Among these pools Kan'chru Suk is the deepest. This river is important for transportation of goods including smuggling of timber and other forest produce to Bangladesh in the monsoon when it is extremely difficult to monitor and halt such activities.

1.9.3.2 Dareng or Nitai River

The source of this south-flowing river is the southern side of Nokrek Range. It has many famous and deep pools such as Warima, Rong'ang and Bamon. Among these pools, the Bamon is the deepest. The tributaries of this river are Kakija, Daji and Rompa. Redingsi is the deepest pool in Kakija river.

1.9.3.3 Bugai River

This is locally known as the Bugi river and flows in a southward direction. It originates on the southern side of Nokrek. It also has the deep pools such as Nosari, Bandari and Warima.

1.9.3.4 Mahadeo River

The source of this river is near Balpakram Hills and it flows through a picturesque and very deep gorge in Balpakram National Park.

1.9.3.5 Maheshkola River

The source of this river is on the eastern side of Balpakram hills and it flows along the border between South Garo Hills and West Khasi Hills. There are a number of waterfalls along this river. Those with scenic beauty are Chibbok, Gongja, Renang, Imilchang and Dare.

1.9.4 Unique physiographic features

Physiographically, the Garo Hills represent a remnant of an ancient plateau of the Pre-Cambrian peninsular shield. This plateau forms a watershed between the Surma River valley of Bangladesh to the south and the Brahmaputra River valley to the north. Nokrek peak, which is situated on Tura ridge in the northeast portion of the GCA study area, has an elevation of 1,515m, and is the highest peak of the Garo Hills. Maheshkola Adugiri range divides the plateau of Khasi Hills and Garo Hills. The most salient features of the study area are the Tura range and the Simsang River valley. The Tura range runs west to east, extending from Tura town to Siju, a distance of 50 km. The Simsang River valley runs north to south and culminates into Bangladesh.

Balpakram National Park, which includes Balpakram Plateau, is the most famous place of the Garo Hills. The national park is located toward the end of the Tura Range near Maheshkola and Pindenggru hills. Balpakram means 'wind blows continuously' in the local Garo dialect, and Balpakram Plateau is regarded as the home of the spirits of the dead by the Garos. The Kailash hill locally known as Chutmang with an

altitude of 1,023 msl is the highest peak of not only the Balpakram area but the broader South Garo Hills district as well. Chutmang towers above most of the peaks in the vicinity. There are a number of places of interest in the GCA study area, which are important from cultural, traditional and historical points of view. These places also possess scenic beauty and hence are attractive to tourists. A few of these are as follows

1.9.4.1 Baghmara

South Garo Hills district is the recent district created in 1992-93 and the town of Baghmara is the district head quarters. It is an important commercial town situated on the east bank of the river Simsang and close to the international border with Bangladesh. The original name of this town was Konagittam, and its market place was known as Chimonganti.

A small wildlife sanctuary has been established in the middle of this town to conserve the highly endangered Khasi pitcher plant endemic to Meghalaya. The nearby Baghmara Reserved Forest is an important habitat for a number of wild animals as well as plant species.

1.9.4.2 Chigitchakgre

Chigitchakgre is located at about 33 km from Baghmara town near the upper reaches of the Rompa river. This place is famous for its beautiful location and a rock cave known as Te'teng kol. This cave is believed to be the abode of elves. A very imposing pathway leads northwards in the recesses of the cave. Rock formations resembling a cot and a large basket are unique features of the cave. These formations are believed by the Garos to be the belongings of the elves.

1.9.4.3 Nokrek peak

This is the highest peak of the area and thus, clearly visible. During the British rule, administrators of this area used to light bonfires in celebrations of important occasions, once, for example, at the end of the First World War. This place located at a relatively high elevation, has a unique microclimate. Apart from its

scenic beauty, it contains a rich floral and faunal diversity. In addition to the more common species of tropical forest ecosystems, many rare and endangered species are reportedly found here. This is an important habitat of the wild species of citrus, the *Citrus indica*, locally called as the me'mang narang. This species is believed to be the most primitive of its kind and the progenitor of the other citrus types. Nokrek peak is now within the Nokrek National Park under the control of the Divisional Forest Officer (DFO) East and West Garo Hills Division (Wildlife), Tura. The area of the wild citrus protection zone within Nokrek National Park is ca. 10 sq km.

1.9.4.4 Siju

Siju is situated on the bank of the Simsang River. Siju Wildlife Sanctuary (SWS) forms a important forest tract for the wildlife of the region. It is about 40 km in south east of Baghmara town. Simsang River is very wide and deep near Siju village providing a beautiful view of river and the surrounding mountain ranges. There are extensive limestone and coal deposits in the surroundings areas of Siju and some of these deposits are being actively surface-mined. The Siju area includes a deep limestone cave that provides habitat for bats, including Kelaart's Leaf-nosed Bat, *Hipposideros lankadiva* (specimens at Zoological Survey of India, Shillong).

No one has explored the end of the cave so far. The fish diversity and abundance in the river Simsang is considered significant and attracts large scale fishing. In winters, especially during December and January, traditional fishing in many deep pools is popular. During such times, traders from Meghalaya and the nearby state of Assam gather here to purchase fish which is believed to be the tastiest and therefore in high demand.

Siju is also famous for its cave locally known as 'Do.bak kol' meaning the cave (*kol*) of bats (*Do'bak*). Thousands of bats belonging to different species live in the cave, hence the name. The entrance of this cave is striking due to the presence of stalagmites

and stalactites of cylindrical and conical shapes. These, unfortunately, are being removed by visitors due to lack of protection measures and interpretive programme. Recently a road and a cemented footpath have been constructed from the market place to the entrance of cave. It has a great tourist potential, and utmost care is needed to maintain the integrity of the site.

1.9.4.5 Tura

Tura is the second biggest town of Meghalaya and is the district headquarters of West Garo Hills District. Earlier it was the district headquarters of the whole Garo Hills district since the beginning of British administration in 1867. The name Tura is a corruption of Dura, which is the original name of the Tura mountain range. The original name of Tura is Rong'noma, which means a forested place strewn with huge boulders. Tura peak (*ca.* 1200 m) is an attractive place for tourists. At present there is one Cinchona garden. From this peak, the plains of Bangladesh to the south and the Brahmaputra River to the north can be seen if the weather is clear. The setting sun provides an enchanting experience. Until recent times the Tura area provided excellent habitat for wild elephant and the tiger. The town has a mini-zoo run by the forest department.

1.9.4.6 Balpakram

Balpakram, the most important national park of the Meghalaya has assumed its name on virtue of its location at the centre of a plateau. A deep gorge cuts into the plateau to form a channel through which strong winds blow regularly from the south, hence the name 'Balpakram' which means "wind blows continuously across." The local belief is that anything carried by these winds, even the souls of the dead, come to rest here. It is believed that the spirits of the Garos must go to Balpakram after death. Balpakram plateau has several natural salt licks and thus is attractive to wild animals. There are a number of landmarks in and around this plateau. These are associated with various mythological and cultural values of local residents. Simon (1996) in the

"Gazetteer of India" for Garo Hills, has mentioned 29 such landmarks. Kumar and Rao (1985) have described the flora of Balpakram National Park following an intensive study. Following eight categories of tropical moist formation based on the classification given by Holdridge et. Al. (1971).

- a. Tropical moist evergreen forests
- b. Tropical semi-evergreen forests
- c. Tropical moist deciduous forests
- d. Secondary formations
- e. Shola types forests
- f. Riverine forests
- g. Grassland and Tree-Savannas and
- h. Bamboo forests

1.9.4.6.1 Tropical moist evergreen forests

These forests generally occurred in the interior hills of BNP. Most of these hills are inaccessible or very difficult to approach. Deep gorges in Balpakram, Pindengru, Naksalga, Nongchigoit, Chuntmang, Maram, Bytit and Penda lime stone areas with moderate slope are present. The limestone belt that spreads between Maheshkola on the border of Garo-Khasi Hills to Siju area also preserves the evergreen forests, which form the climatic climax. This belt is exposed over the ground in many places inside National Park and sanctuary as well as outside for example at Chimitab, Hangsapal, Chutmang hills, Rongsu and Goerapattar etc. Most of the land is unsuitable for shifting cultivation; hence micro-climate is maintained. These forests also support the growth of rare herbs, terrestrial orchids and ferns, etc. The periphery of these forests along steep slope form a very good habitat for endemic species of carnivorous Khasi Pitcher Plant.

The common species in these forests include *Acrocarpus fraxinifolius*, *Castanopsis species*, *Cynometra polyandra*, *Diospyros gobara*, *D. stricata*, *Dysoxylum binectariferum*, *D. kurzii*, *Elaeocarpus floribundus*, *Kayea floribunda*, *Engelhardia spicata*, *Walsura robusta*, *Mesua ferrea*, *Prkia roxburghii*, *Pterospermum acerifolium*, *Sapium baccatum*, *Ferniana colorata*, and

Schima wallichii, etc. Deciduous species like *Hibiscus macrophyllus* and *Tétrameles nudiflora* are present in forest openings and gaps. The middle canopy is composed of *Aquilaria agallocha*, *Antidesma acuminata*, *Garcinia cowa*, *Saraca asoca*, *Sterculia roxburghii*, and *Syzygium species*, etc. The lower canopy comprises of smaller trees like *Ficus species*, *Leea umbraculia*, *Saprosma ternata*, *Dracaena spicata*, *Ixora species*, and *Miliosa roxburghiana*. Vegetation of these forests is mixed without dominance of single species. Species belonging to families like Ebenaceae, Fagaceae, Lauraceae, Clusiaceae tend to predominate.

1.9.4.6.2 Tropical semi-evergreen (mixed evergreen) forests

These forests show the stratification with the predominance of evergreen species like *Castanopsis species*, *Mesua ferrea*, *Lithocarpus elegans*, and *Pterospermum lancaefolium*. Trees like *Mesua ferrea*, *Acrocarpus fraxinifolius*, *Albizia species*, *Careya arborea*, *Terminalia species*, *Sterculia species*, *Lagerstroemia parviflora*, and *Stereospermum chelonoides*, as top canopy tree species. In the semi-evergreen areas *Crateva nurvala*, *Maesa rementacea*, *Rhus javanica*, *Phoebe lanceolata*, *Styrax serrulatum*, *Ligustrum robustum*, *Capparis species*, and *Calliandra umbrosa*, etc. are some common middle canopy tree species.

1.9.4.6.3 The tropical deciduous forests

These are the sub-climax type and are man made. These forests occur on the border areas and gradual sloppy area of the park, where *jhumming* was practiced prior to the acquisition of land by state government. The important economic species of these forests are *Albizia lebeck*, *A. lucida*, *Dillenia pentagyna*, *Elaeocarpus floribundus*, *Erythrina stricata*, *Glochidion spp.*, *Gmelina arborea*, *Holarrhaena antidysentrica*, *Kydia calycina*, *Lagerstroemia spp.*, *Ochna integerrima*, *Salmalia malabarica*, *Schima wallichii*, *Sterculia villosa*, *Terminalia bellerica*, *Vitex glabra*, and *V. peduncularis*, etc. Second story is composed of *Aporusa dioica*, *Bredelia retusa*, *Croton joufra*, *C. roxburghii*, *Grewia*

microcos, *Glochidion lanceolarium*, *Mallotus philippinensis*, and *Rhus javanica* etc. These are very disturbed forests and *Bauhinia purpurea*, *Callicarpa arborea*, *Emblica officinalis*, *Grewia microcos*, *Kydia calycina*, *Macaranga denticulata* and other fast growing species are common.

1.9.4.6.4 The secondary forests

These are relatively less diverse with few common species like *Callicarpa arborea*, *Glochidion lanceolaria*, *Careya arborea*, *Phyllanthus emblica* along with some saplings of *Holarrhaena antidysentrica*, *Micromelon integrefolium*, *Lagerstroemia parvifloram*, *Macaranga denticulata*, *Syzygium species*, etc. Tropical moist deciduous forests that are man made and sub-climax type occur in old *jhum* fallows. Important tree species found in this type of forests are *Albizia lebeck*, *A. lucida*, *Dillenia pentagyna*, *Elaeocarpus floribundus*, *Erythrina stricta*, *Glochidion species*, *Gmelina arborea*, *Holarrhaena antidysentrica*, *Kydia calycina*, *Lagerstroemia species*, *Salmalia malabarica*, *Schima wallichii*, *Sterculia villosa*, *Terminalia bellerica*, *Vitex glabra*, *V. peduncularis*, *Aporusa dioica*, *Bredelia retusa*, *Grewia macrocos*, *Glochidion lanceolarium*, *Mallotus philippinensis*, and *Rhus javanica*, etc.

Several species of bamboo form thickets chiefly as secondary growth. The dominant bamboo species, which are mainly found on the degraded land in older *jhum* fallows, are *Bambusa species*, *Melocanna bambusifolia* and *Dendrocalamus hemiltonii*. A few palms like *Areca*, *Caryota*, *Pinanga* and *Didymosperma* are also conspicuous. Species of epiphytic orchids viz. *Aerides*, *Bulbophyllum*, *Dendrobium*, *Eria*, *Liparis*, *Pholidota*, *Thunia* and *Vanda* are seen in the evergreen forests. Ferns, liverworts and mosses, are seen on old tree trunks and stones, near water sources, and in shady places in the evergreen forests. *Artocarpus species* are common in the vicinity of villages and towns. In open moist localities and near water sources, herbs such as *Dictyospermum*, *Aneilema scaberrium*, *Burmaniam species*, *Coix species*, *Cyperus species*, *Oxalis corniculata*, *Anemone species*, and *Ericcaulon species* etc., can be seen.

1.9.4.6.5 Other vegetation types

Kumar and Rao (1985) have described the species composition of shola type forests; riverine forests; grassland and tree-savannas; and bamboo forests. Shola type forests occur around the Balpakram plateau. Important species are *Helicia nilagirica*, *Engelhardia spicata*, *Fermiana colorata*, *Pittosporum nepalense*, *Kayea floribunda*, and *Schima wallichii*. Riverine forest trees are small sized, much branched form ground level with a smooth bark. Species like *Syzygium polypetalum*, *Ficus pyriformis*, *F. squamosa* and *Homonoia riparia* are the common species growing in rocky and sandy areas. Grasslands and tree savannas are confined to the northern most portion of Balpakram NP at Rongcheng and Lumsorjong areas. The common species are *Alloteropsis semialata*, *Arundinella bengalensis*, *Centotheca lappacea*, *Cymbopogon khasianum*, *Imperata cylindrica*, *Ischaemum geobelli* and *Neyraudia reynandiana*. Other associated plants are *Grewia hirsuta*, *Curcuma species.*, *Costus speciosus*, etc. In wet rocky area grasses are dwarf and associated with *Urticularia*, *Eriocaulon*, *Drosera* species. In Savannas common tree species are *Dalbergia rimosa*, *D. stipulata*, *Dillenia pentagyna*, *Phyllanthus officinalis* and *Schima wallichii*. Bamboo forest occurs on 18-20 years old fallows on degraded soil and the common bamboo species are *Bambusa species*, *Melocanna babusifolia*, *Dendrocalamus hamiltonii* etc. Associated tree species are *Callicarpa arborea*, *Glochidion lanceolaria*, *Careya arborea*, etc. in gaps.

1.10 Weather and climate

November to February is the coldest period of the year. The Garo Hills receive rainfall from the north-

eastern monsoon in winter and from the south-eastern monsoon in summer. Records during 1931 to 1960 indicate that the mean minimum and mean maximum temperatures were 12.3 °C and 32.5 °C for the months of January and April, respectively. The total average annual rainfall was 3361.6 mm with 114.2 average numbers of rainy days and June being the wettest month with an average of 21.3 rainy days.

1.11 Summary

The GCA has great biological and ecological significance. The variety of fauna and flora in GCA still needs to be fully explored. The unique culture and tradition of local people have been attracted many historians, anthropologists, sociologists and economists. Though the GCA constitutes less than one-third of the Garo Hills and one-tenth of Meghalaya, it encompasses all four protected areas (mentioned above) of the Garo Hills, out of total of five in Meghalaya. This chapter gives an overview of the conservation significance of the GCA from biological and ecological points of views, and an historical background of the people and communities. It also briefly discusses the size, location and boundaries of the GCA, including its geological history and the physiography with a brief account on unique physiographic features. Five physiographic regions based on elevational boundaries have also been discussed, along with information on weather, climate and drainage pattern. The figures showing locations of Meghalaya, Garo Hills, GCA and the uniqueness of these areas have also been provided for further description.

Chapter 2

Vegetation: The tropical forest

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 - Primary Forest
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Top 10 most important species (rank-wise, based on IVI)

The successional changes

The Forest types as per Champion and Seth's classification

Tree species composition and diversity in Forested landscape

- a. Tropical moist evergreen Forests
- b. Tropical moist deciduous Forests
- c. Tropical semi-evergreen Forests

Phyto-sociological values of tree species

- a. Frequency
- b. Abundance and Density
- c. Importance Value Index (IVI)

2.8 Important Tree Species in GCA (Haridasan and Rao, 1985)

2.8 Landscape analysis

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Landscape structure

Potential Areas of Conservation Priorities (Viable Forest Patch)

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- a. Protected Areas
- b. Reserved forests
- c. Community owned lands

2.10.1 Connectivity among Existing PA Network

- a. Tropical Moist Evergreen Forest (TMEF)
- b. Tropical Semi-evergreen Forests (TSEF)
- c. Tropical moist Deciduous Forests (TMDF)
- d. Bamboo and young secondary Forests

2.10.2 Assessing effectiveness of existing PA network

2.11 Significance from management point of view

2.12 Summary

Chapter 2

Vegetation : The Tropical Forest

2.1 Introduction

The tropical forests are the most ancient, diverse, and ecologically complex of land communities (Lewin, 1986). Although, they cover only 7% of the earth surface, they sustain more than half of the planet's life forms (Myers, 1984). With only 2.4% of the total land area of the world, the known biological diversity of India contributes 8% to the known global biological diversity (Sarat Babu and Arora, 1999). The tropical forests among terrestrial systems possess a greater density of species as compared to others (Sarat Babu and Arora, 1999) and the tropical evergreen forests are considered to be the richest in terms of species diversity than those of other formations of Tropical forests (Khan et al., 1997). Laurance and Bierregaard (1997) broadly designated tropical forest nations into three categories: (1) nations that already have experienced a drastic loss of forest cover, (2) nations that have moderate amounts of tropical forest cover remaining but are experiencing rapid forest conversion, and (3) nations, in which tropical forests are being rapidly modified but which still retain large tracts of intact forests. In general, India belongs to the first category, but at least some states of northeastern Indian region belong to the second and third categories.

The forest cover of India is 637,300 sq km constituting 19.39% of the geographic area of country out of which 377,400 sq km (11.48%) is dense forest, 2,55,000 sq km (7.76%) open forest and 4,900 sq km (0.15%) mangroves (FSI, 1999). As per the information provided by Protected Area Database cell of Wildlife Institute of India, Dehra Dun (2001), there are 89 national parks and 484 wildlife sanctuaries with total areas of 37,158 sq km and 116,651 sq km, respectively.

“Whatever the origins of the forests or of man, it seems an absurdity to presume that the rain forests evolved through aeons only to meet their demise at man's hand. He who is neither a hunter-gatherer nor a biologist often only defiles and impoverishes the forest. Everyone should try to understand the rain forests, and appreciate their products, if possible without damage. But we can only understand the forests if we accept them as they are. No one can improve an undisturbed rain forest. It is a culmination point of creation, as precious, worthy, and sacred as any in the universe as we know it.”

-Jacobs (1981), p. 271

These together constitute 153,809 sq km and form 4.69% of the geographic area of the country. In addition, 11 biosphere reserves with the geographical area of 43,000 sq km partly overlap protected areas (FSI, 1999). The main areas of tropical forest are found in the Andaman and Nicobar Islands; the Western Ghats, which fringe the Arabian Sea coastline of peninsular

India; and the greater Assam region in the north-east, however, small remnants of rain forests are also found in Orissa state (WCMC, 2001). There are substantial differences in both the flora and fauna between three major rain forest regions (IUCN, 1986; Rodgers and Panwar, 1988). The tropical vegetation of northeast India embraces evergreen and semi-evergreen rain forests, moist deciduous monsoon forests, riparian forests, swamps and grasslands.

Evergreen rain forests are found in the Assam Valley, the foothills of the Eastern Himalayas and the lower parts of the Naga Hills, Meghalaya, Mizoram, and Manipur where the rainfall exceeds 2,300 mm per annum (WCMC, 2001).

The tropical forests in Meghalaya occur up to 1,200 m with an average annual rainfall of 1,000-2,500 mm (Haridasan and Rao, 1985). However a few tree species of lower subtropical forests are present at high altitude. The total forest cover of Meghalaya is 15,633 sq km, which is 69.70% of the total geographic area of the state out of which dense and open forest cover 5,925 sq km (38% of forest cover) and 9,708 sq km (62), respectively. Reserved Forests, Protected Forests and Unclassed Forests constitute 10.33%, 0.13% and 89.54% of the total forests, respectively. Flora of Meghalaya (Haridasan and Rao, 1985) mentioned about 1151 woody Dicotyledon plant species belonging to 552 genera and 119 families.

2.2 Landuse

Non-forest landuses are not as prevalent here as in other parts of the country. The industrial and mechanical advances have not spread its wing in the area and the environmental pollution is not a problem. Thus most of the non-forest land is being used for various domestic uses by society, however the coal mining and road construction are being initiated at few places around and at the boundaries of existing PAs and RFs in GCA.

The land in GCA can be grouped into three broad categories based on the legal status of land such as Protected Areas as National Parks and Sanctuaries; Managed forests in the form of Reserved Forests; and the Community or privately owned land. All together, these PAs and RFs covers 372 sq km land (15% of GCA) and are under the control of state government whereas the remaining about 85% land of GCA belongs to tribal councils and individuals termed as community land in present study. Such lands are being

used for agriculture, plantation, settlement and other non-forest landuses. Sudhakar and Singh (1993) studied the district-wise landuse of Meghalaya at 1:2,50,000 using visual satellite data (Table 2.1).

Table 2.1: Land use in Garo Hills during 1993 through remotely sensed data (in sq km)

| Land use classes | West Garo Hills | South Garo Hills | East Garo Hills |
|---|-----------------|------------------|-----------------|
| Tropical Semi-evergreen Forests | 481 | 292 | 454 |
| Tropical Moist/Dry Deciduous Forests | 1257 | 716 | 955 |
| Tropical Dry Deciduous and bamboo mix Forests | 317 | 177 | 110 |
| Degraded Forests | 656 | 111 | 360 |
| Grasslands | - | 29 | 35 |
| Agriculture/Non forest | 470 | 471 | 675 |
| Sandy area | 33 | 38 | 9 |
| Water bodies | 56 | 16 | 4 |
| Total | 3260 | 1850 | 2604 |

Source: Sudhakar and Singh (1993)

2.3 Forest Fragmentation

Fragmentation is defined as the anthropogenic isolation of forests and severing of connectivity among forest patches. For this study, fragmentation refers to such changes in native, old (>30 years old) tropical forests of the Garo Hills Conservation Area (GCA), the specific study area in and around South Garo Hills district in Garo Hills, Meghalaya, northeast India. In general, fragmentation can reduce the amount of core habitat (old forest within the center of forest patches away from edge influences) for wild animals. Fragmentation can lead to the loss of species in an area, resulting the local decline or extinction of several plant and animal species (Tilman et al., 1994 and Burkey, 1995). Fragmentation divides the larger contiguous forest patches into smaller ones, isolating

the remnants of original ecosystems (Hobbs et. Al, 1989). Forest habitat fragmentation often results from human activities (Hobbs et. al, 1989). In GCA, forest resources and land use with accompanying infrastructure developments such as urbanization and road networks, have created fragmented forests as mosaics of patches across the landscape.

Increasing human populations and demands for land and other forest resources have created a plethora of deleterious effects (Laurance and Bierregaard, 1997). The effects of deforestation include massive soil erosion, siltation of streams, destabilisation of watersheds, loss of sustainable forest uses, and threats to indigenous people (Poore 1979; Smith, 1981). One major consequence of large-scale forest loss may be habitat fragmentation. Collectively, the correlated process of habitat loss and fragmentation pose the greatest single threat to the planet's biological diversity (Wilcox and Murphy, 1985; Simberoff, 1986). The recent increase in jhumming, illegal felling and logging and other resource use activities has led to increased forest fragmentation and loss of old-forest (> 30 yrs old) habitat. The results suggest that highly fragmented patches are more prevalent in southwestern portion of the Garo Hills. Further, the results of fragmentation analysis were used as input to identify the potential wildlife corridors connecting the existing protected natural areas.

2.3.1 Loss of tropical forest cover

The tropical forests in northeast India are being cleared, logged, burned, fragmented, and the wildlife being over-hunted at a greater pace than ever. However, in some locations large tracts have still remained intact. Studies show that from 1995 to 1997, ca 1,875 sq km of tropical forest (ca 1.14% of northeast Indian forest) in northeast India was converted to cropland under jhumming, (Anon., 1997). This followed large scale timber harvesting during past few decades. Bamboo growth, a seral community, is harvested both for commercial purpose

(pulp industries) and local uses (Ramakrishnan, 1992; Ramakrishnan and Toky, 1983).

In 1999, the total forest cover of the seven states of northeast India was 163,799 sq km (c. 64% of the geographic area of the region) compared to 164,043 sq km in 1997 and 164,359 in 1995 (FSI, 1997, 1999). Shifting cultivation (jhumming) is the major landuse practice responsible for deforestation in the region. According to the National Commission on Agriculture, the practice of jhum has affected about 2.7 million ha of forest cover (i.e. 16 % of total forest cover) in northeast India (Anon., 1976; Negi, 1984). Other such estimates are 3.81 million ha by a Task Force on shifting cultivation (1983); 2.80 million ha by North-Eastern Council (1975) and 7.40 million ha by FAO (1975). The FAO estimate may be biased high because of the small-scale resolution of their analysis; the values of 2.7 to 2.8 million ha might be more accurate estimates. (Back citation from report of FSI, 1999)

The Garo Hills still harbour good forest cover compared with many other areas of northeast India. However, increasing human population pressure from 406,615 people in 1971 to 668,930 in 1991, and the resultant increase in area under shifting cultivation, has caused a large-scale conversion of primary forests (before jhum) into secondary forests (after jhum). A study on forest cover in Garo Hills has shown that the annual rate of forest recession was 4.5% between 1972-73 and 1977 (Negi, 1984). This study intensively estimated the forest recession for a small area between the latitude 25° 15' 25" to 25° 30' north and longitude 90° 15' to 90° 45'. It covered 1,394 sq km and includes the entire Tura ridge (Nokrek area), Rewak and Emangiri Reserved Forests, Siju area and the part of Baghamara RE. Total forest cover of area under the study was 515 sq km (37% of the study area) in 1972-73, which was reduced to 264 sq km (19% of the study area) in 1977. During this period, 251 sq km (18% of the study areas) of the forest

Table 2.2: Comparative areas in figures obtained from photo interpretation map *via a vis* landsat map

| Particulars | Forested land | | | Total |
|---|---------------|-----------|--------|-------|
| | Forested | Jhum land | Others | |
| From aerial photograph of year 1972-73. Area sq km | 515 | 784 | 95 | 1394 |
| Percentage | 37 | 56 | 7 | 100 |
| From Landsat imageries of Jan.1977. Area (sq km) | 264 | 1061 | 69 | 1394 |
| Percentage | 19 | 76 | 5 | 100 |
| Change in Area (sq km) | -251 | +277 | -26 | 0 |
| Change in Percentage | -18 | +20 | -2 | 0 |

cover has been lost due to shifting cultivation. Non-forest land increased from 879 sq km to 1,130 sq km (i.e. from 63 % to 81 % of the study area, respectively). Area under jhum increased from 784 sq km to 1,061 sq km (i.e. 56 % to 76 % of the study area). The rate of forest recession during 1973 to 1977 was 18 %, or 4.5 % per year (Table 2.2).

2.3.2 Soil and vegetation loss due to jhumming

Shri Momin, Joint Director, Soil and Water Conservation, Directorate of Meghalaya provided the following quantification of soil and vegetation.

2.3.2.1 Soil

- 41 MT soil per year
- 0.703 MT Organic compounds
- 146 g of Phosphatic fertility
- 15.58 Lakh tonnes of good rich soil for replacement if predictable @ Rs. 1,600 per Truck load X 1,94,750 truck loads = Rs. 3,11,60,000/- only
- 26,714 MT of Organic compounds to replace

by equivalent quantity of cow dung manure @ Rs. 3,000 per truck load X 3,340 trucks = Rs. 10,020,000 only.

- 5.55 MT of P_2O_5 , 34.96 MT of Single Super phosphate @ Rs. 15,000 per MT = Rs. 52,503 only
- 226 MT of K_2O = 443.30 MT Muriate of Potash @ @ Rs. 9,200 per MT = Rs. 4,07,836

Total for replacement of Soil = Rs. 326,218,710 only say 326 million.

2.3.2.2 Vegetation

First class timber 95,000 Cubic m = Rs. 95 million
@ Rs. 1,000 per cubic m

Firewood 4,56,000 MT = Rs. 91.2 million
@ say Rs. 2,00 per MT at MT/ha

Fibre species say at 0.1 MT/ha = Rs. 1.9 million
= 3,800 MT @ Rs. 500

Bamboo, say 0.5 MT/ha = Rs. 11.875 million
= 19,000 MT @ Rs. 625 per M

Broom stick, say 19,000 MT = 19 MT
@ 1,000 per MT

| | |
|--|--|
| Thatch grass, say 50 bundles/ ha @ Rs. One per bundle | = 1.9 Million |
| Cane, 15 Million running meters @ Rs. 1.50 per meters | = 2.25 Million |
| Loss of vegetation | =Rs. 22,31,25,000 |
| Adding the loss of Soil | =Rs. 32,62,18,710 |
| Total Loss due to jhum | =Rs. 54,93,43,710 say 549 million |
| Return from jhum (380 sq km plot) | = Rs. 8,63,51,580 say 86 million |
| Net loss due to jhum | = Rs. 462,992,130 say 462 million only |

This works out to Rs. 12,200 /ha/year

2.4 Goals of study

The study develops an understanding of existing Protected Area (PA) network, its conservation status and biodiversity values. Critical, and at the same time vulnerable landscape elements outside PAs and other significantly large patches of undisturbed primary forests, were identified and assessed from landscape point of view. The connectivity among existing PAs, managed forests and the critical unprotected areas was assessed to get an overall picture of existing landscape condition. Corridors, apart from providing suitable habitats to wildlife, are also very important in human society by providing transportation routes, several kinds of protection and harvestable resources (Forman and Godron, 1986). Extent and status of other land-uses were also examined. The study quantifies the impact of fragmentation of forest cover on biodiversity, especially tree species diversity of the area. The major goal of the present study is to provide knowledge, tools, and indicators for providing potential management guidelines for biological diversity conservation.

The chapter reviews the literature on tropical forests and earlier studies on assessment of the flora of Garo

Hills. The principal plants in forest ecosystem are trees, which are dominant over much of the land surface for thousands of years (Mishra, 1968); hence, the field study focuses intensively on the tree species diversity for sampling field data. Also the study identifies successional changes among tree communities in Primary vis-à-vis Secondary Forests of varying age classes.

2.5 Objectives

- i. Map and characterise the landscape of Garo Hills Conservation Area (GCA)
- ii. Assess current landscape level forest fragmentation in GCA
- iii. Assess the diversity pattern and communities by composition of characteristic tree species
- iv. Quantify secondary changes among tree community using Importance Value of tree species
- v. Assess current landscape level forest fragmentation in GCA and connectivity among existing protected natural areas
- vi. Provide potential management guidelines to preserve the natural resources and wild species of conservation significance

2.6 Methodology

The GCA was stratified into broad landuse and landcover classes after a reconnaissance field visit and reviewing the existing literature from various government and non-government agencies in Meghalaya. The stratified random sampling was employed to collect the field data on forest tree species. The data was analysed to get the phytosociological indicators and for community classification and finally to develop an aspatial database. The aspatial database along with spatial database developed through satellite data in combination with the secondary information were used to get the results, which were discussed with existing knowledge on the study area (Figure 2.1).

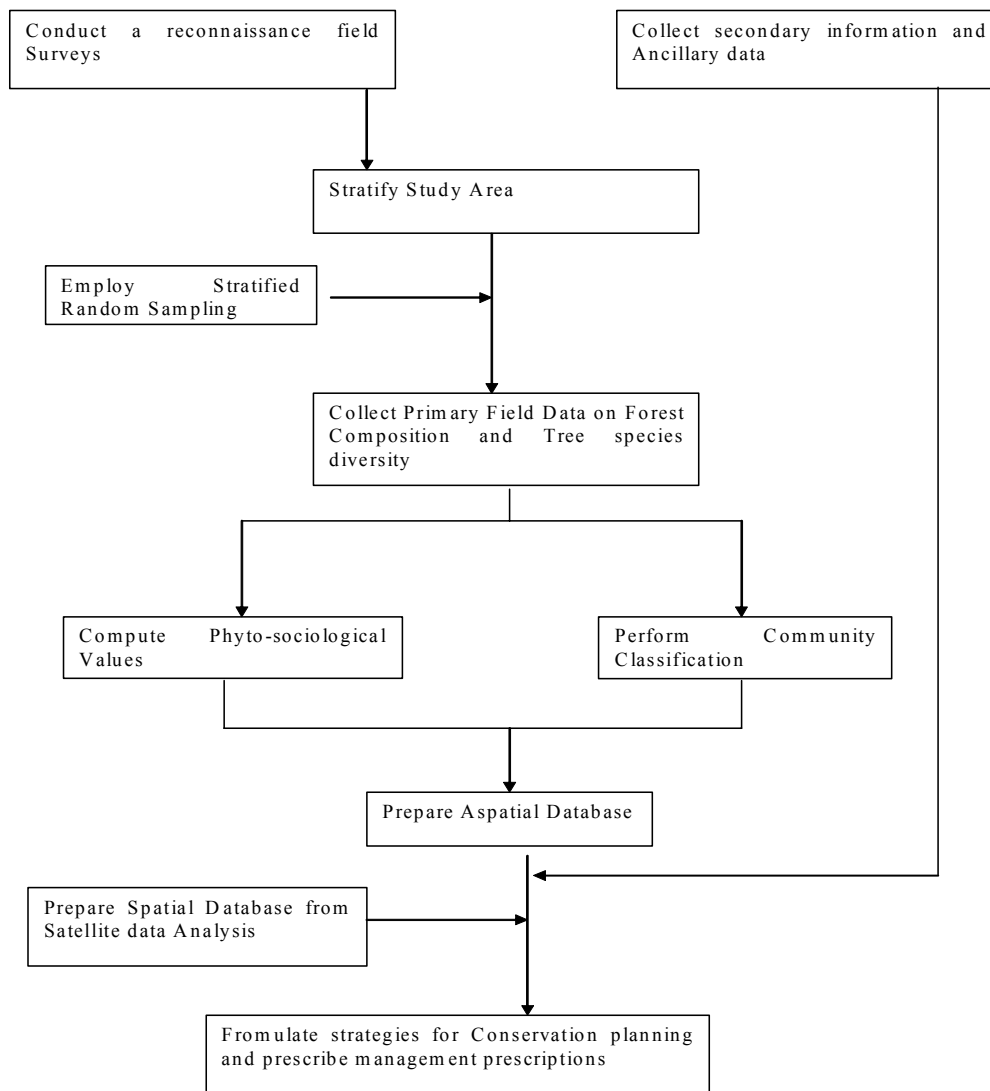


Figure 2.1: Flow diagram showing broad methodology

2.6.1 Identification and assessment of land-use categories

Identification of principal regional land use types is important for the study and analysis of landscape, since, these landuses act as the compartments of regional natural unit (RNU) or landscape (Haber, 1990). The first step of the study was to stratify the area and to assess the extent and status of various land-use categories. Land-uses were categorised as per the existing vegetation cover or land-use practices

and the legal status of the land. Following categories have been identified for this study.

2.6.1.1 As per the legal status of land, distribution and extent

Government owned land and Community owned land and private holdings.

2.6.1.2 As per the existing vegetation cover

Forest types, Distinctive plant communities;

successional stages of secondary forests; agriculture, plantations; and settlements.

2.6.2 Assessment of tree species diversity and secondary changes in vegetation

Stratified random sampling using belt transect method was employed for assessment of vegetation composition, structure and significant microhabitats. Belt transects of 1000 m X 10 m were laid to assess the tree communities in primary and secondary forests (Sykes & Horrills, 1977). Girth at breast height (gbh) of trees ≥ 30 cm gbh (Pelissier, 1998) within this belt was recorded. Menhinick index for species richness and Shannon's index for diversity were calculated based on the abundance value of plant species in different landuse categories (Ludwig and Reynolds, 1988). Community classification was done by clustering 35 sample plots.

2.6.2.1 Vegetation sampling and collection of field data

As the topography of GCA is extremely undulating and the dense tropical vegetation forest cover is almost impenetrable, establishing a straight line or belt transect was very difficult. Considering the man power and the time constraints, the existing footpaths/trails were used to lay belt transects in the Primary and Secondary Forests to collect tree data. A total of 35 belt transects were laid down in the existing Protected Areas, Managed Forests and the surrounding community owned land. The distribution of 35 belt transects in the Primary, Secondary and Sal Forests over government and non-government land is given in the Table 2.3.

2.6.2.2 Classification of tropical forests

Classification plays an important role in understanding the natural system, which might be viewed as reflection of those various processes that have lead to the observed arrangement of the objects. For example, in ecology this 'natural' system could be the end result of evolutionary process (Ludwig and Reynolds, 1988).

In case of forest tree communities, the classification process groups the numerous and variable tree species into few classes of similar species combination, which occur in the similar habitat conditions. The similar species combinations recur under similar habitat conditions, even in geographically quite separated location (Mueller-Dombois and Ellenberg, 1974).

Systematic classification of plant communities puts the numerous and variable plant communities into a comprehensive system, which is applicable to a limited geographical area at the regional scale as in the case of GCA. Certain groups of tree species were used as the criterion for classifying tropical forests of GCA. Cluster Analysis (CA), a polythetic, agglomerative classification model based on quantitative abundance data of tree species in sampling units i.e. belt transects was used to classify the forests. In a polythetic classification the similarity of any two sampling units is based on their overall similarity as measured by numerous variables, for example, species abundances, while in case of an agglomerative classification, individual sampling units are combined and recombined successively to form larger groups of sampling species. Clustering strategies, which are hierarchical, agglomerative and polythetic are the most commonly used by the ecologists (Ludwig and Reynolds, 1988).

2.6.2.3 Analysing for resemblance functions

Resemblance functions quantify the similarity or dissimilarity between two objects based on observations over a set of descriptors (Ludwig and Reynolds, 1988). The more similar samples are in species composition and quantity, the greater is their resemblance, that is, the closer their ecological distance. Here the objects of interest are one-hectare belt transects and the descriptors are the measures of species abundance. These resemblance functions involve a Q-mode analysis, that is, between sampling units of one hectare belt transects used in present study.

Table 2.3: Distribution of sample belt transects in the Primary and Secondary Forests of GCA

| Vegetation Land use | PF | SF | Sal Forest | Total |
|----------------------|-----------|-----------|------------|-----------|
| Protected Areas | 12 | 6 | NA | 18 |
| Reserved Forests | 9 | NA | 3 | 12 |
| Community owned land | 0 | 4 | 1 | 5 |
| | 21 | 10 | 4 | 35 |

Resemblance functions can be represented either by similarity coefficients or distance coefficients, of them the distance coefficients are more popular among community ecologists. Also in the view of Ludwig and Reynolds (1988), these are the most straightforward in concept and application for community classification. The similarity coefficient indices are based solely on presence and absence data. There are three groups of distance functions, which are based on abundance data viz. the E-group (Euclidean distance indices), the B-C group (represented by Bray-Curtis dissimilarity index), and the RE-group (the relative distance indices) The use of E-group distance indices have been of great heuristic view in ecology and the widespread popularity, but, there are various pitfalls in their use (Ludwig and Reynolds, 1988).

TWINSpan (TWo-way INdicator SPecies ANalysis) is also a popular method and commonly used. It actually classifies the objects in a similar way like cluster analysis. Gauch and Whittaker (1981) consider it useful but at the same time other techniques are complementary or superior. Minimum variance technique also known as Ward's method is one of the best to classify ecological communities and most commonly used by the ecologists (Ludwig and Reynolds, 1988).

2.6.3 Vegetation Analysis for Phyto-sociological values

2.6.3.1 Frequency

Frequency indicates the number of sampling units in which a species occurs (Mishra, 1968). It expresses the distribution or dispersion of various species in a community.

Frequency (F) = number of sampling units in which species occur/ total number of Sampling Units

$$\% \text{ Frequency} = F \times 100$$

All the species found were grouped into four classes (class interval 25%) based on the percentage frequency and the percentage frequency diagram was prepared (Mishra, 1968). The ranges between upper and lower limits of percent frequencies vary from 1 to 25%, 26 to 50%, 51 to 75%, 76 to 100%. The percentages of total number of species coming into each class were plotted on Y-axis against the frequency classes on X-axis. Frequency diagrams have been prepared for the entire data set as well as for different forest types identified through cluster classification technique viz. tropical moist evergreen forests, tropical semi-evergreen forests and the tropical moist deciduous forests.

2.6.3.2 Abundance and density

The abundance and density represents the numerical strength of species in the community (Mishra, 1968). Abundance is described as the number of individuals per sampling unit of occurrence and density as the number of individuals per sampling units.

- Abundance and density were calculated using following formulae
- Abundance (A) = Total number of individuals/ numbers of Sampling units of occurrence
- Density (D) = Total number of individuals/total numbers of Sampling units.

2.6.3.3 Basal area

Basal area refers to the ground actually penetrated by the stems, and is readily seen when the leaves and the stems are clipped at the ground surface (Hanson and Churchill, 1961; back cited in Mishra 1968). Basal area is one of the chief characters determining dominance of the community (Mishra, 1968). For present study, basal area was computed using girth of the tree stems at breast height (gbh) at 1.37 m above ground level. The shape of the stem was assumed cylindrical. The density of each species was multiplied with the corresponding basal area values to present the basal area of specific species per hectare.

2.6.3.4 Importance Value Index (IVI)

The concept of 'Importance Value Index (IVI)' has been developed for expressing the dominance and ecological success of any species, with a single value, (Mishra, 1968). This index utilises three characteristics, viz. relative frequency, relative density and relative dominance. The three characteristics were computed using frequency, density and basal area for all the species falling in all transects using following formulae (Phillip, 1959, back cited in Mishra 1968).

Relative Dominance = Total basal area of the species x 100 / Total basal area of all species

Relative Density = Number of individuals of the species x 100 / Number of individuals of all species

Relative frequency = Number of occurrences of the species x 100 / Number of occurrences of all the species.

IVI = Relative Dominance + Relative Density + Relative Frequency.

2.6.4 Analysis of successional changes in secondary forests

Secondary forest patches of distinct and varying age classes were identified through vegetation/landuse

map. Communities were assessed by composition of characteristic tree species. Secondary changes in tree communities were assessed by observing the appearance and disappearance of one or more species from different categories of secondary forests and compared to primary forests (Ramakrishnan and Toky, 1983). To quantify secondary changes, importance value of a species were taken into consideration (Zhang and Cao, 1995)

2.6.5 Landscape assessment

Protected areas boundaries within GCA were taken from the record of State Forest Department of Meghalaya. The Balpakram National Park (BNP) is situated at the southern portion of the study area and the Survey of India (SOI) toposheets for the most of its southern boundary region could not be assessed. Thus, the exact boundaries of the extended area of southern BNP could not be mapped for this reason. Hence, the extent of boundaries has been considered in relation to the initial 220 sq km. The other PAs and MFs boundaries have been digitized either from 1:50,000 SOI toposheets or other maps of varying scales (1: 1,00,000 to 1: 10,000) made available from the State Forest Department of Meghalaya. The data was further analysed in GIS domain.

The IRS-1D satellite LISS III digital data of February 1999 was used to generate maps of land use and vegetation classes. Remote Sensing data was analysed using GIS software ARC/INFO and ARCVIEW. Spatial and non-spatial attributes such as landscape elements, their physical attributes and vegetation characteristics were integrated into GIS domain for developing a spatial database of the study area.

2.6.5.1 Digital image processing (pre-classification)

The Supervised classification technique was used to categorise the vegetation and landuse categories in GCA. Prior to classification, the image rectification was undertaken to correct the image. This process provides a more realistic representation of the original

scene. The unsupervised classification was performed to get the broad vegetation and land use classes. The photographs of the available satellite data and unsupervised map were taken to the field and the limited ground check was performed to observe the ground control points for ground truthing. The final vegetation and land use map was prepared using supervised classification using ground control points observed and recorded with the help of field photographs as well as Survey of India toposheets during different field visits. To perform supervised classification, training areas were identified with the help of observed ground truth points and a numerical description of spectral attributes for vegetation and land use classes in the rectified image was developed. The training site polygons were delineated for different vegetation and land use categories. The row and column coordinates of the vertices for these polygons were used as the basis for extracting digital numbers as a sample to develop statistical description (mean vector and covariance matrix) of each training area. The training pattern for each land cover class was defined by analyzing 8-15 locations containing 15 to 25 pixels. The training sites are well distributed all over the scene.

Gaussian maximum likelihood classifier was employed to classify image based on sample training sets. This classifier quantitatively evaluates both the variance and covariance of the category spectral response patterns when classifying an unknown pixel. The statistical probability of a given pixel value being a number of a particular class was computed using mean vector and covariance matrix (Lillesand and Kiefer, 1994).

2.6.5.2 Post Classification Processing

The classified output i. e. vegetation and landuse map was smoothed to reduce noise. The odd pixels single or in pair within particular classes were considered as noise. A 3'3 pixel majority filter was applied to smoothen the classified image (Lillesand and Kiefer, 1994). The majority filter was applied

separately to forest and non-forest categories to avoid inter-merging of non-forest categories pixels with forest pixels and vice versa.

2.6.6 GIS analysis

The final image, i.e. the landuse landcover map (Figure 2.2) was then converted into a grid image with the grid size of 23.5'23.5 m (equals a pixel size) and then transformed to polygons to understand the patch characteristics of landscape. Some of the small inclusions of other classes have also been eliminated by both the smoothing process as well as the gridding and polygonisation processes, but such small inclusions are of negligible size i.e. 1104.50 sq m (equals two pixels of 23.5'23.5m each), which is very small for such a large landscape. Hence in the present study, the elimination of such small inclusions was considered as of no significance during analysis. The map with the boundaries of protected areas and managed forests, were then integrated with the output coverage. The resultant polygon attribute table contains patch identity of both the coverages, which was used for further analysis and interpretation.

2.6.6.1 Landscape composition and configuration

The landscape matrices viz. area, patch, nearest neighbour and core area matrices were computed to quantify landscape composition and configuration (McGarigal and Marks 1994) (Table 2.4).

2.6.6.2 Fragmentation analysis for critical wildlife habitats

Fragmentation is tendency of land cover (vegetation/land uses) in breaking down to smaller patches (Forman, 1995; and Frohn, 1998). Bio-CAP, a GIS based software developed by IIRS, Dehra Dun defined fragmentation as 'the number of forest and non-forest types patches per unit area'. Fragmentation is measured as the density of all types of patches (Romme, 1982; Roy and Tomar, 2001). Landscape analysis programme (LAP) in Bio_CAP using Borland C++ also provides a good measure of forest

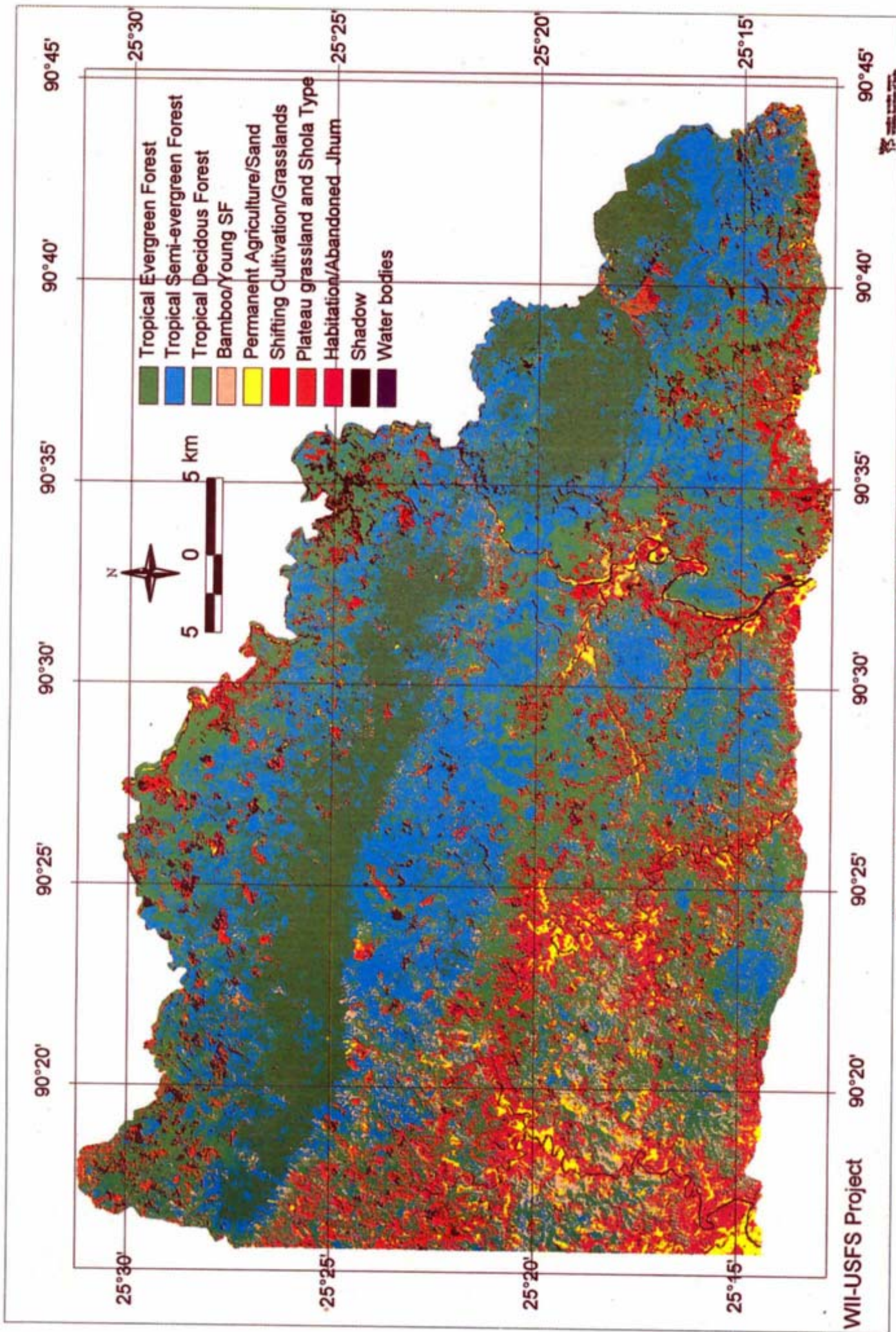


Figure 2.2 Landuse land cover map of GCA, Meghalaya

| | | | |
|-------------------|---|----------------------------|--|
| Area | To quantify Landscape composition | Patch, Class and Landscape | Area of patches under various landuse categories |
| Patch | To represent landscape configuration | Class and Landscape | No./density, the average size and variation in size of patches |
| Nearest neighbour | To quantify landscape configuration | Class and Landscape | Mean nearest neighbour distance and Nearest neighbour standard deviation of patch dispersion |
| Core Area | To represent available core habitat to wildlife | Patch, Class and Landscape | Area within a patch at specified edge distance from patch boundary |

fragmentation in which iteration of involving convolution of a specific size moved over a spatial data for deriving the number of forest patches under forest and non-forest categories.

$$F = \sum_{i=1}^n Di$$

Where Di is dissimilarity values for the ith boundary between adjacent cells and N is the number of boundaries between adjacent cells.

The vegetation/landuse type map was reclassified in two classes viz. Forest and Non-forest to assess fragmentation. A window of 250x250 m was convolved with the forest/non-forest map to derive the number of forest patches within the window. The iteration was repeated by moving the window through the entire forest/non-forest map. Outputs are in the form of fragmentation image (Figure 2.3) and the

normalised data of the patches per cell in the range of 0 to 10 (Table 2.5).

Table 2.5: Fragmentation value using Bio_CAP

| Fragmentation value | Re-classed value | Fragmentation level | Area (sq km) | |
|---------------------|------------------|---------------------|--------------|-----|
| 2 | 1 | Low | 897.70 | 174 |
| 3 | | | 844.61 | 2 |
| 5 | 2 | Medium | 402.08 | 504 |
| 6 | | | 102.33 | |
| 8 | 3 | High | 16.99 | 21 |
| 9 | | | 3.24 | |
| 10 | | | 0.49 | |
| 200 | 4 | Non-forest | 189.23 | 189 |

2.6.6.3 Potential areas of conservation priorities (Viable forest patches)

A patch with more geographical area does not mean that it is necessarily more suitable for wildlife. Near forest edges, the biotic and abiotic factors change dramatically (Kapos, 1989; Williams-Linera, 1990 a

and b; Laurance, 1991; Kapos et al., 1997; Malcolm, 1994; Turton and Freiburger, 1997, Didham, 1997) and show the actual and potential importance of edge effects (Murcia, 1995). Earlier, the perimeter length-to-area ratios (p/a ratios: Forman and Godron, 1986; Schonewald-Cox and Bayless, 1986; Buechner, 1987, Stamps et al., 1987) were used to quantify the edge effect in the forest fragments. The p/a ratio has been superseded by the Core-Area model of Laurance and Yensen (1991), which relies on quantifying the edge penetration distance in order to calculate the unaffected core area in a fragment of any given size or shape.

To understand the potential of wildlife habitats, Core Areas (CAs) were calculated for different forest patches. Core area is defined as the area within a patch beyond some specified edge distance or buffer width. Core area metrics reflect both landscape composition and landscape configuration (McGarigal and Marks 1994). Core area has been found to be a much better predictor of habitat quality than patch area for these forest interior specialists (Temple 1986). Unlike patch area, core area is affected by patch shape. Thus, while a patch may be large enough to support a given species, it still may not contain enough suitable core area to support the species (Figure 2.4).

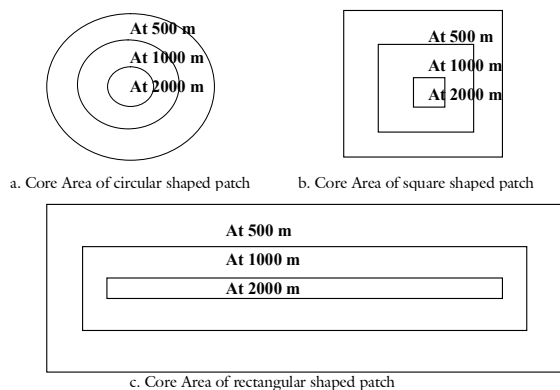


Figure 2.4: Core Area Concept (available core are in the patches of different shapes)

However, the standard size and extent of viable forest patches have been defined nowhere for tropical forests in northeast India. This always seems extremely difficult due to complexities of species and their

requirements. Core Areas were measured at edge distances of 250 m and 500 m among all the forest patches considering the views of various studies for assessing edge effects and microhabitat conditions at the varying interior edge distances, referred above. Core area indices mentioned above were computed at patch, class and landscape level.

2.6.6.4 Potential Areas for Wildlife Corridors

A wildlife corridor is defined as a linear two-dimensional landscape element that connects two or more patches of wildlife (animal) habitat that had been connected in historic times (Soule and Gilpin, 1991). The potential wildlife corridors were identified on the basis of fragmentation image outputs. The area within least fragmented classes was used to delineate corridors visually among existing protected areas and managed forests. The output image provided eight fragmentation categories, referred with the fragmentation value in Table 2.5. The count gives the number of pixels under particular fragmentation value. These Fragmentation values were then re-classed into four categories by combining 2 and 3 as 1; 5 and 6 as 2; 8, 9 and 10 as 3 and the 200 as 4. Re-classed fragmentation values of 1, 2 and 3 refer to the low, medium and high fragmentation areas, whereas 4 refers to the areas where no forest patch falls within the 250 m window *i.e.* belongs to non-forest land (Table 2.5). The pixels within the least fragmented categories in the community land connecting various Protected Areas and Managed Forests were separated by sketching the boundaries. These boundaries were considered as the boundaries of corridors. The boundaries of identified corridors were then integrated with vegetation/landuse cover map and the area calculations were done to understand the status of forest cover types within the corridors.

2.7 Results and discussion

2.7.1 Stratification of the GCA

On the basis of legal status of land, three landuse categories were designated as Protected Areas (PAs) comprising of National Parks and Wildlife Sanctuaries; Managed Forests (MFs) and Community owned private land. Two broad vegetation types *viz.* primary and secondary Forests along with the adjacent

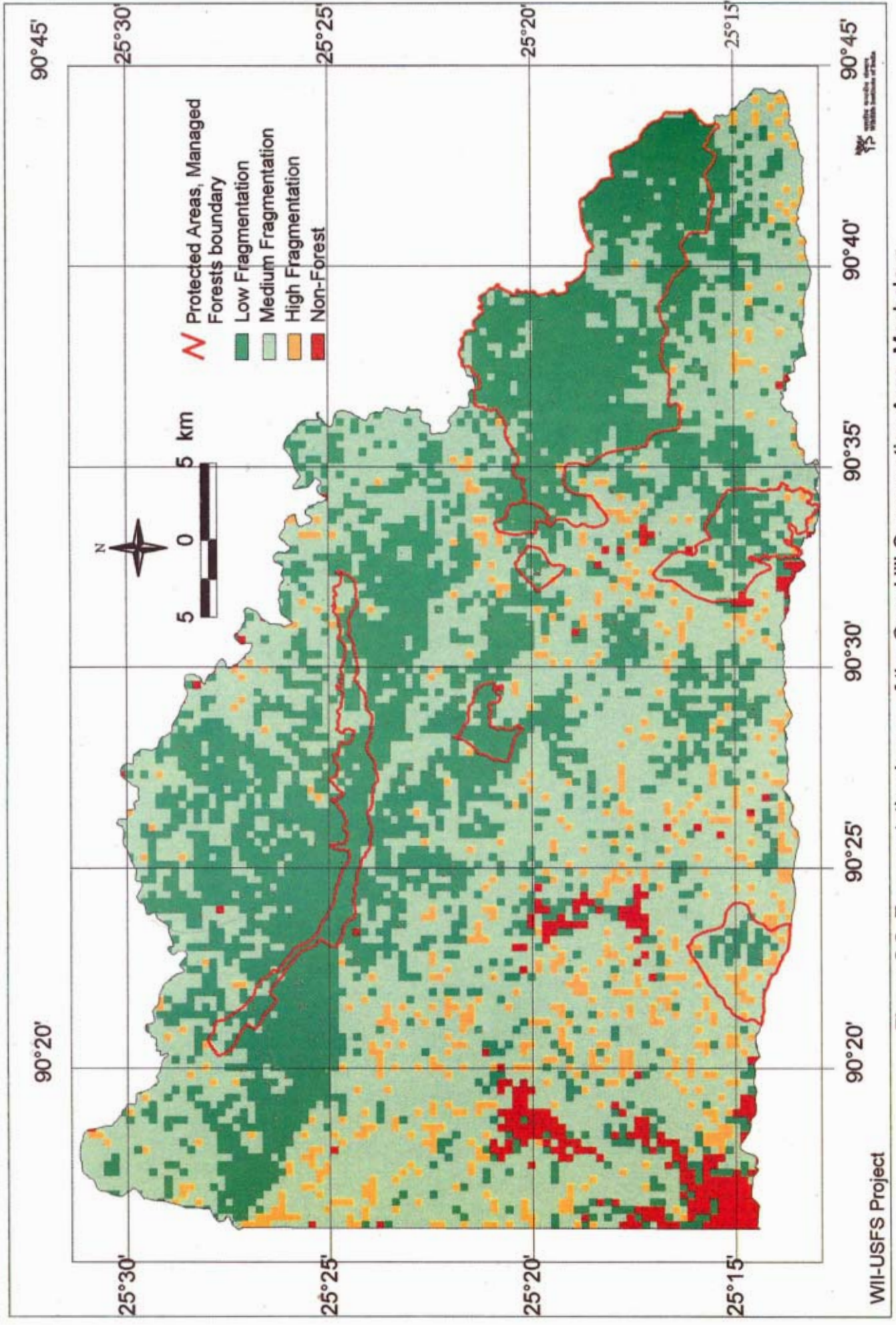


Figure 2.3 Fragmentation image of the Garo Hill Conservation Area, Meghalaya

degraded land have been found associated with these three major landuse classes. It was found that primary forests exist in all three landuse categories. The secondary forests; which have been formed due to the long history of shifting cultivation or *jhum* by the local communities were not found in Reserved Forests, mainly due to the fact that the Reserved Forests were created long time back during late nineteenth century. No clear felling was carried out in these forests except for few silvicultural treatments by the State Forest Department. However, some plantations of Sal (*Shorea robusta*) and the Teak (*Tectona grandis*) have been raised in certain pockets within the reserved forests also.

Secondary forests were further divided into tree sub-categories based on the age of different *jhum* fallows viz. SF1 (<15 years old), SF2 (15-30 years old) and SF3 (>30 years old *jhum* fallows). All the three sub-categories of secondary forests represent various stages of vegetation succession. While in the protected areas, mostly SF3 category is present, since all the existing Protected Areas in Garo Hills were created or acquired about one or two decade ago, and since then they have been accorded complete protection, therefore, the existence of first two categories viz. SF1 and SF2 in the Protected Areas is negligible. Balpakram Plateau due to its unique micro-habitat conditions is occupied by seasonal grasses and the characteristic Shola type forests in small pockets at the periphery of plateau. Few stunted trees can also be seen scattered over the plateau. These forests resemble the Shola forests of southern India and hence termed as Shola type (not Shola) forests.

Among non-forest categories, the prominent ones are current and abandoned *jhum* fields alongwith surrounding habitation and associated scrub land. In some valleys the land, which is flat and suitable for the cultivation, is being used for permanent agriculture by local people. Raising *bagans* (gardens for horticultural plants and cash crops) nearby their homes by local people is an age-old traditional practice. The important species are orange, cashew nut, pine apple, *gol mirch/kali mirch* (black pepper), mango and other fruits. Recently, the Social Forestry Division and the

Department of Soil and Water Conservation have started road-side plantations and the plantations of species of economic importance e.g. cashew nut, rubber, teak *etc.*, over community land.

2.7.2 Classification of tropical forests

The minimum variance technique of hierarchical clustering was used for grouping of 35 sites on the basis of tree species composition and their abundance values/ha. The results of the cluster analysis were summarized in the agglomeration schedule (Table 2.6), which contain the number of clusters being combined at each stage. The first line is stage 1, the 34-cluster solution. Plots 20 and 25 are combined at this stage, as shown in column labeled 'Cluster Combined'. The Phi-square value of distance measure between these two plots is given in the column labeled 'Coefficient'. The last column indicates at which stage another plot or cluster is combined with this one. At the fourth stage, plot 21 is merged with the plots 20 and 25 into a single cluster. The column entitled 'Stage Cluster 1st appear' indicates at which stage a cluster is first formed. For example, the entry of 1 at fourth stage indicates that the plot 20 was first involved in a merge in the previous step (stage 1). The last column of labeled 'Next Stage' shows the stage at which new cluster will merge with another cluster or plot, for example, from the last column of stage 4 it is clear that the new cluster (plot 20, 21 and 25) is next involved in a merge at stage 26 where the clusters (plots) combined with plots (Clusters) 13, 31, 33 and 35. Here small coefficients indicate that fairly homogeneous clusters are being merged. Large coefficients indicate that clusters containing quite dissimilar members are being combined. The actual value depends on the clustering methods and the distance measure used.

The information in the agglomeration schedule for 35 sample plots is displayed in the dendrogram (Figure 2.5), which is read from left to right. Vertical lines (dotted) denote joined clusters. The position of line on the scale indicates the distance at which clusters were joined. Since the distances are rescaled (Norusis, 1948) to fall in the range of 1 to 25, the largest distance 13.5 corresponds to the value of 25. The smallest

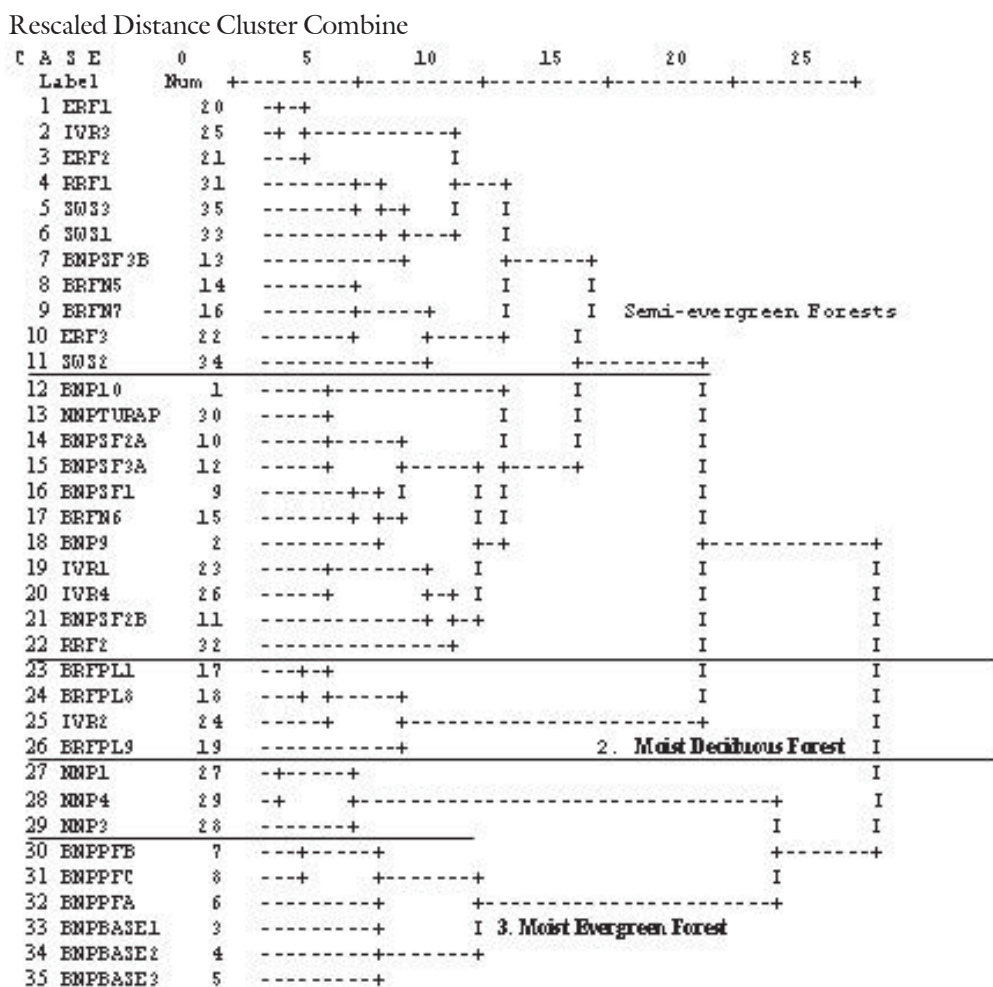
Table 2.6: Agglomeration Schedule

| Stage | Cluster Combined | | Coefficients | Stage Cluster First Appears | | Next Stage |
|-------|------------------|-----------|--------------|-----------------------------|-----------|------------|
| | Cluster 1 | Cluster 2 | | Cluster 1 | Cluster 2 | |
| 1 | 20 | 25 | .156 | 0 | 0 | 4 |
| 2 | 27 | 29 | .328 | 0 | 0 | 12 |
| 3 | 17 | 18 | .527 | 0 | 0 | 8 |
| 4 | 20 | 21 | .731 | 1 | 0 | 26 |
| 5 | 7 | 8 | .947 | 0 | 0 | 15 |
| 6 | 23 | 26 | 1.186 | 0 | 0 | 23 |
| 7 | 10 | 12 | 1.428 | 0 | 0 | 20 |
| 8 | 17 | 24 | 1.678 | 3 | 0 | 21 |
| 9 | 1 | 30 | 1.931 | 0 | 0 | 29 |
| 10 | 31 | 35 | 2.210 | 0 | 0 | 19 |
| 11 | 14 | 16 | 2.490 | 0 | 0 | 14 |
| 12 | 27 | 28 | 2.775 | 2 | 0 | 33 |
| 13 | 9 | 15 | 3.067 | 0 | 0 | 16 |
| 14 | 14 | 22 | 3.364 | 11 | 0 | 24 |
| 15 | 6 | 7 | 3.685 | 0 | 5 | 27 |
| 16 | 2 | 9 | 4.006 | 0 | 13 | 20 |
| 17 | 3 | 4 | 4.333 | 0 | 0 | 18 |
| 18 | 3 | 5 | 4.674 | 17 | 0 | 27 |
| 19 | 31 | 33 | 5.016 | 10 | 0 | 22 |
| 20 | 2 | 10 | 5.376 | 16 | 7 | 28 |
| 21 | 17 | 19 | 5.748 | 8 | 0 | 32 |
| 22 | 13 | 31 | 6.128 | 0 | 19 | 26 |
| 23 | 11 | 23 | 6.543 | 0 | 6 | 25 |
| 24 | 14 | 34 | 6.964 | 14 | 0 | 30 |
| 25 | 11 | 32 | 7.410 | 23 | 0 | 28 |
| 26 | 13 | 20 | 7.870 | 22 | 4 | 30 |
| 27 | 3 | 6 | 8.348 | 18 | 15 | 33 |
| 28 | 2 | 11 | 8.840 | 20 | 25 | 29 |
| 29 | 1 | 2 | 9.361 | 9 | 28 | 31 |
| 30 | 13 | 14 | 9.886 | 26 | 24 | 31 |
| 31 | 1 | 13 | 10.516 | 29 | 30 | 32 |
| 32 | 1 | 17 | 11.374 | 31 | 21 | 34 |
| 33 | 3 | 27 | 12.318 | 27 | 12 | 34 |
| 34 | 1 | 3 | 13.458 | 32 | 33 | 0 |

distance 0.16 corresponds to the value 1.

The groups obtained from the cluster analysis were hierarchically nested in a dendrogram chart (Figure 2.5), which results in three main groups/clusters. Two of these groups/clusters were further sub-divided into two sub-groups/sub-clusters in the next step of hierarchical clustering. Group 1 identified as Tropical semi-evergreen forests is a cluster of 22 plots. The 22 plots falling in this group are well distributed all over the study area. Seven of these plots are located

in and around Balpakram National Park, three in the Siju Wildlife Sanctuary, three in the Baghmara Reserved Forests, three in the Emangiri Reserved Forests, three over community land around Emangiri Reserved Forests, two in the Rewak reserved Forests and one at Tura peak reserve. The four plots form another cluster, represent the Moist deciduous forest. Three of these plots are located in Baghamara Reserved Forest and one on the community land around Emangiri Reserved Forest.



(Details of sample plots and Name of associations is given in Annexures 1,2 and 3. Also see annexures 4 and 5 for hierarchical cluster analysis of primary and secondary forests, respectively)

Figure 2.5: Dendrogram using Ward Method with Abundance

The cluster number 9 represent the Moist Evergreen Forests. Out of six in BNP, Three of these belong to middle altitude (400-600m above msl, near limestone area along across BNP road), three to lower altitude (100-200m, inside gorge at Mahadeo river). Out of three high altitude (>1,000m) plots from Nokrek, two were sampled inside Nokrek National Park and one from the adjoining hill on community old forests. All of these three plots are located at high altitude *i.e.* above 1,000m. Table 2.7 gives the possible equivalents of primary and secondary forests in terms of Champion and Seth's classification scheme.

2.7.3 The tropical forest and plant diversity

A total of 1062 plant species have been recorded during various field visits belonging to 154 families and 578 genera. The genus to species ratio (G/S ratio) for plant species is 1.84. The same ratio has been found for tree species. The G/S ratios for shrubs, herbs, climbers, bamboos, canes and ferns are 1.69, 1.53, 1.60, 1.55, 2.17, 2.67 and 1.12, respectively (Table 2.8).

Euphorbiaceae (33), Lauraceae (31), Moraceae (30) and Rubiaceae (26) are the families found with more than 25 species. There are 54 families with five or less than five species of which 23 are represented by single species (Figure 2.6). Number of species varies from six to 15 for other 19 families. *Ficus* with 21 species is the biggest genera. Other important genera

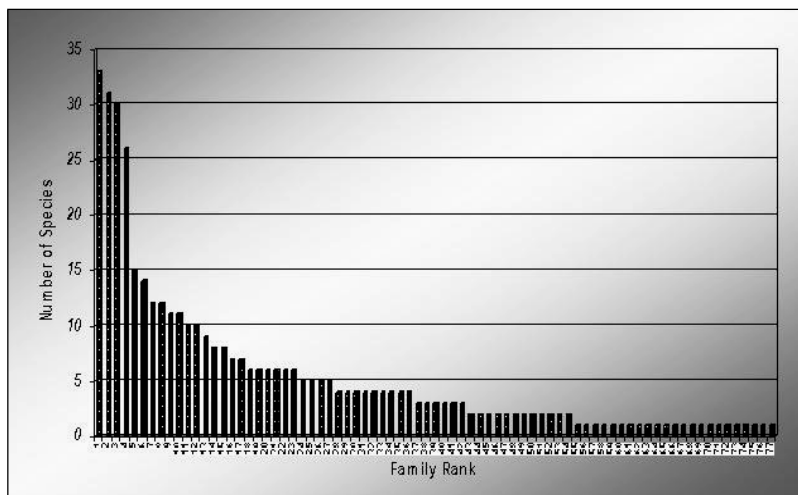


Figure 2.6: Distribution of species within plant families

Table 2.7: The possible Equivalents for Primary and Secondary Forests in GCA

| Forest Type | Primary/Secondary Forests |
|--------------------------------|--|
| Moist Evergreen | Primary Forests <i>Macaranga denticulata</i> (evergreen) at initial stages of succession. Small patches, about 8-10 years old <i>jhum</i> fallows. |
| Semi-evergreen | Primary and old secondary (more than 30 years old) at edges, riparian forests near gorge at Mahadeo river in BNP. In Siju WLS, Semi-evergreen nature is mainly due to presence of Sal patch in the middle of sanctuary |
| Moist Deciduous/ Sal Formation | Old Sal/Teak and young secondary forests at lower elevations |
| Bamboo forest | Bamboo and scrub vegetation including small grasslands |

are *Syzygium* (11), *Garcinia* (8), *Litsea* (7), *Albizia* (6), *Diospyros* (6) and *Premna* (6). There are 140 genera representing single species. Figures in parentheses indicate the number of species present (see annexures 6 and 7 for plant families).

A total of 187 tree species with gbh more than 30 cm were sampled using 35 one-hectare belt transects (1000 m x 10 m). Total 164 species were identified at specific or generic levels and 23 tree species could not be identified in the field in the herbarium section of WII, DehraDun. The unidentified 23

Table 2.8: The number of plant species in the tropical forests of GCA

| Plant group (TAXA) | Family | Genera | Species |
|--------------------|------------|------------|-------------|
| Trees | 71 | 224 | 411 |
| Shrubs | 51 | 137 | 231 |
| Herbs | 55 | 135 | 206 |
| Grasses | 1 | 25 | 40 |
| Climbers | 36 | 80 | 124 |
| Bamboos | 1 | 6 | 13 |
| Canes | 2 | 3 | 8 |
| Ferns | 16 | 26 | 29 |
| Total | 154 | 578 | 1062 |

species were not accounted for subsequent analysis, which were based using 164 identified species only. *Bignonia* sp., *Ilex* sp., *Mallotus* sp., *Drimycarpus* sp., *Artocarpus* sp. and *Carralia* sp. are very common and were recorded from 29, 20, 17, 16, 14 and 11 plots, respectively. Other important genera are *Grewia* (9), *Phoebe* (8), *Castanopsis* (7), *Polyalthia* (5), *Aporusa* (4), *Ardisia* (4), *Chukrasia* sp. (4), *Ficus* (4), *Boehmeria* (3), *Embllica* (3), *Citrus* (2), *Syzygium* (2) and *Bauhinia* (1). Figures in parentheses indicate the number of species in particular genus.

A total of 29,884 trees were sampled covering the basal area of 1975 sq m. The 10 most important tree species (rank wise) are *Shorea robusta*, *Schima wallichii*, *Castanopsis purpurella*, *Polyalthia simiamum*, *Syzygium cumini*, *Grewia microcos*, *Aporusa dioica*, *Dillenia pentagyna*, *Drimycarpus racemosus*, and *Eurya acuminata*. The species composition and other characteristics of Primary and Secondary Foersts are given in preceding paragraphs, However, in Sal Forest, *Shorea robusta*, *Glycosmis arborea*, *Schima wallichii*, *Artocarpus chaplasha*, *Syzygium cumini*, *Aporusa dioica*, *Vitex peduncularis*, *Sapium baccatum*, *Litsea monopelata*, and *Castanopsis purpurella* are the most important species. (See annexure 8 for details of vegetation characteristics of all forest types; also

see annexures 9 for tree species database and annexure 10 for details of all plants in GCA).

2.7.3 The primary and secondary forests

Various attempts have been made to understand the characteristics of the primary and secondary forests. Richards (1996) in the second edition of his classic book “The Tropical Rain Forest: an ecological study” gives the description of characteristics of several primary and secondary forests communities in the tropical countries of world. In GCA, the primary forests are generally confined to interior hills in the remote places. These are surrounded by the old secondary forests or sometimes with young secondary forests. The Sal formation along with young secondary growth forming moist deciduous forests occurs in patches and are very significant over the landscape at lower elevation.

In the primary and secondary forests of GCA, the numbers of tree species with gbh 30 cm or more are 162 and 132, respectively (Table 2.9). They belong to 54 and 53 species, respectively. Table 2.9 and figure 2.7 below describe the density and basal area characteristics of tree species in different types of formations.

Table 2.9: Vegetation characteristics in primary and secondary forests of GCA

| Vegetation characteristics | Primary Forests (N=21) | Secondary Forests (N=10) | Sal Foerests (N=4) |
|------------------------------------|------------------------|--------------------------|--------------------|
| No. of families | 54 | 53 | 39 |
| No. of species | 162 | 132 | 87 |
| No. of trees | 17139 | 9158 | 3547 |
| Basal Area (sq m) | 1330 | 428 | 217 |
| Species richness (Margalef Index) | 16.4 | 14.3 | 9.7 |
| Species richness (Menhinick index) | 1.23 | 1.38 | 1.03 |
| Species Diversity (Shannon index) | 4.27 | 3.78 | 2.43 |
| Evenness | 0.84 | 0.77 | 0.54 |

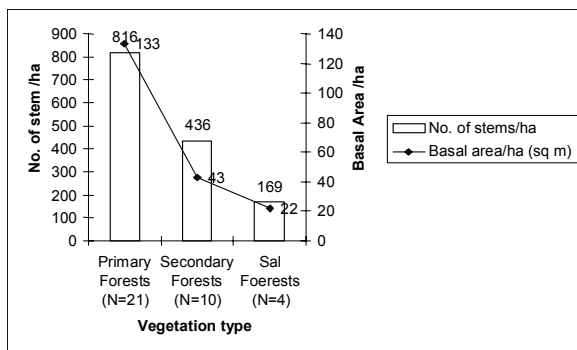


Figure 2.7: The no. of stems and basal area per hectare in GCA forests

2.7.4 Relationship between primary and secondary forests

The Garos clear fell the vast tracts under primary forest each year for practising *jhum*, the traditional practice. They prefer to do *jhumming* on land earlier occupied by dense primary forests. Because their organically rich soils support good crop returns to *jhumias*. Once, *jhumias* abandon the land after taking 2-3 years crop, the pioneer plant species occupy the bare land. Very dense and impenetrable growth of stem of a few species appears in first few years. The light-loving climbers (convolvulaceae, Cucurbitaceae and Dioscoreaceae) grow like a blanket over the young secondary growth. Under the thick blanket, the young branches die due to lack of light and the gap is created in place of dense cover. In the course of time the accumulated litter transformed into humus, giving the way to other species. If undisturbed, the succession proceeds: young forest gives the way to old secondary forest (Jacobs, 1981). Due to long life of trees, the changes take place gradually and difficult to observe without very concrete and long term efforts. The Budowski's table below provides the ecological characteristics of primary and various successional stages of secondary forests. The age of various communities observed by Budowski slightly differs as in GCA. The probable age of communities in GCA for pioneers, early secondary, late secondary and climax forest communities vary from 1-5 years, 8-12 years, 15-40 years and 60 years or more, respectively. The other characteristics can be presumed to be more or less similar with slight variation in the floristic

composition and dominant species (Table 2.10).

2.7.4.1 Primary forest

The primary forests are characterized by high number of plant and animal species. The number of tree species is also very high. The removal of primary forests creates the gap inside forests. The secondary forests grow in these gaps. The secondary forests play an important role for rehabilitation of land after clearing. These forests form the pool of fast growing trees with soft wood. A young secondary forest develops into a mature secondary forests and finally a primary forest with climax communities (Jacobs, 1988). In GCA these forests can be found from lowest to highest elevation (from about 100 to 1400 m above msl). The 10 most important tree species are *Polyalthia simiamum*, *Schima wallichii*, *Castanopsis purpurella*, *Syzygium cumini*, *Grewia microcos*, *Drimycarpus racemosus*, *Dillenia pentagyna*, *Cynometra polyandra*, *Aphanamixis polystachya*, and *Walsura tubulata*. Based on microclimatic differences, three distinct formations have been identified. These include

- High altitude formations (above 800 m), occur near Nokrek, Tura peak areas and in the high reaches of Chutmang hills near Balpakram. These formations are characterized by very humid, nearly wet microclimate, hence we call it **Wet evergreen Formations (WF)**. The 10 most important tree species are *Aphanamixis polystachya*, *Syzygium operculatum*, *Castanopsis sp.*, *Schima wallichii*, *Diospyros variegata*, *Castanopsis purpurella*, *Parapentapanax subcordatum*, *Garcinia cowa Roxb*, *Eurya acuminata*, and *Dillenia pentagyna*.
- The mid altitude formations (400n to 800 m) also support the vast tracts of dense primary forest cover, the major portion of which belongs to limestone areas, hence we called it **Limestone Formation (LM)**. The 10 most important tree species in LM are *Polyalthia simiamum*, *Walsura tubulata*, *Schima wallichii*, *Syzygium cumini*, *Cynometra polyandra*, *Grewia microcos*, *Shorea robusta*, *Drimycarpus racemosus*, *Castanopsis purpurella*, and *Sapium baccatum*.

- The low elevation primary forest patches are less humid, sometimes a few deciduous species mingle here, hence named as **Mixed evergreen Formation (MF)**. The 10 most important tree species are *Tectona grandis*, *Castanopsis purpurella*, *Canarium strictum*, *Polyalthia simiamum*,

Drimycarpus racemosus, *Grewia microcos*, *Dillenia pentagyna*, *Tetrameles nudiflora*, *Schima wallichii*, and *Shorea robusta*.

The details of vegetation characteristics is given in Figure 2.8 and Table 2.11.

Table 2.10: Budowski's table; Comparison between four successional stages, from Pioneer to mature primary forest, with special reference to the American tropics (Budowski 1965)

| Characteristics | Pioneer | Early Secondary | Late Secondary | Climax |
|------------------------------------|--|--|---|--|
| Age of communities observed, Years | 1-3 | 5-15 | 20-50 | More than 100 |
| Height, meters | 5-8 | 12-20 | 20-30, some reaching 50 | 30-45, some up to 60 |
| Number of woody species | Few, 1-5 | Few, 1-10 | 30-60 | Up to 100 or a little more |
| Floristic composition of dominants | Euphorbiaceae, <i>Cecropia</i> , <i>Ochroma</i> , <i>Trema</i> | <i>Ochroma</i> , <i>Cecropia</i> , <i>Trema</i> , <i>Heliocarpus</i> most frequent | Mixture, many Meliaceae, Bombacaceae, Tiliaceae | Mixture, except on edaphic association |
| Natural distribution of dominants | Very wide | Very wide | Wide, include drier regions | Usually restricted, endemics frequent |
| Number of strata | 1, very dense | 2, well differentiated | 3, increasingly difficult to discern with age | 4-5 difficult to discern |
| Upper canopy | Homogeneous, dense | Verticillate branching, thin horizontal crowns | Heterogeneous, includes very wide crowns | Many variable shapes of crowns |
| Lower stratum | Dense, tangled | Dense, large herbaceous species frequent | Relatively scarce, includes tolerant species | Scarce, with tolerant species |
| Growth | Very fast | Very fast | Dominants fast, others slow | Slow or very slow |

Contd...

Table 2.10 Contd...

| Characteristics | Pioneer | Early Secondary | Late Secondary | Climax |
|-------------------------------------|---------------------------------------|---------------------------------------|--|---|
| Life span, dominants | Very short, less than 10 years | Short, 10-25 years | Usually 40-100 years, some more | Very long, 100-1,000, some probably more |
| Tolerance to shade, dominants | Very intolerant | Very intolerant | Tolerant to juvenile stage, later intolerant | Tolerant, except in adult stage |
| Regeneration of dominants | Very scarce | Practically absent | Absent or abundant with large mortality in early years | Fairly abundant |
| Dissemination of seeds of dominants | Birds, bats, wind | Winds, birds, bats | Wind principally | Gravity, mammals, rodents, birds |
| Wood and stems, dominants | Very light, small diameters | Very light, diameters below 60 cm | Light to medium hard, some very large stems | Hard and heavy, include large stems |
| Size of seed, or fruits dispersed | Small | Small | Small to medium | Large |
| Viability of seeds | Long, latent in soil | Long, latent in soil | Small to medium | Short |
| Leaves of dominants | Evergreen | Evergreen | Many deciduous | Evergreen |
| Epiphytes | Absent | Few | Many in numbers, but few species | Many species and life forms |
| Vines | Abundant, herbaceous, but few species | Abundant, herbaceous, but few species | Abundant, but few of them large | Abundant, includes very large woody species |
| Shrubs | Many, but few species | Relatively abundant but few species | Few | Few in numbers but many species |
| Grasses | Abundant | Abundant or scarce | Scarce | Scarce |

Cecropia is from the Urticaceae, *Heliocarpus* from the Tiliaceae, *Trema* from the Ulmaceae

Table 2.11: Vegetation Characteristics in Primary Forests of GCA

| Vegetation characteristics | WF (N=4) | LF (N=9) | MF (N=8) |
|------------------------------------|----------|----------|----------|
| No. of families | 49 | 50 | 49 |
| No. of species | 125 | 130 | 134 |
| No. of trees | 3511 | 8155 | 5473 |
| Basal Area (sq m) | 472 | 451 | 407 |
| Species richness (Margalef Index) | 15.2 | 14.3 | 15.5 |
| Species richness (Menhinick index) | 2.11 | 1.44 | 1.81 |
| Species Diversity (Shannon index) | 3.93 | 3.92 | 4.07 |
| Evenness | 0.81 | 0.81 | 0.83 |

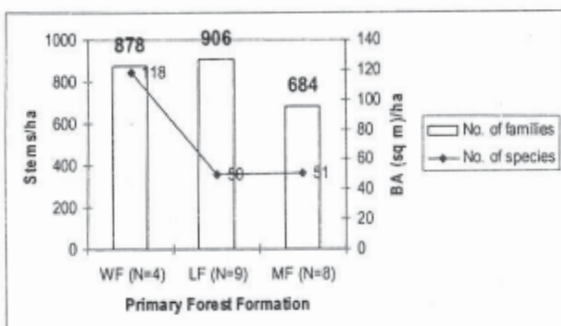


Figure 2.8: The stems and basal area per hectare in primary forest formations

2.7.4.2 Secondary Forest

Secondary forests occupy the major portion of area. These forests occur on lower elevation, moderate slopes with less rainfall. Most of these forests were produced either due to practice of shifting cultivation or the plantations supplemented by natural regeneration. Seasonal leaf shedding and recurrent

fires are the characteristics of these forests. Shifting cultivation or *jhumming* associated with human settlement along with recent infrastructure development and road building has resulted in large-scale conversion of natural forest. Secondary degraded forests with less plant diversity, inferior quality trees and invasion of weeds have occurred over a larger portion of the landscape. The 10 most important tree species in secondary forests are *Schima wallichii*, *Castanopsis purpurella*, *Shorea robusta*, *Macaranga denticulata*, *Grewia microcos*, *Syzygium cumini*, *Aporosa dioica*, *Eurya acuminata*, *Dillenia pentagyna*, and *Callicarpa arborea*. Table 2.12 and Figure 2.9 provide the details of vegetation characteristics in young, mature and old secondary forests. These forests are categorized on the basis of age of secondary growth, *i.e.*, below 15 years, 15-30 years and above 30 years old and named as SF1, SF2 and SF3, respectively.

Table 2.12: Vegetation Characteristics in Secondary Forests of GCA

| Successional stage | SF1 (N=3) | SF2 (N=4) | SF3 (N=3) |
|------------------------------------|-----------|-----------|-----------|
| No. of families | 43 | 40 | 46 |
| No. of species | 94 | 80 | 102 |
| No. of trees | 3547 | 9649 | 9572 |
| Basal Area (sq m) | 217 | 510 | 552 |
| Species richness (Margalef Index) | 11.9 | 10 | 12.2 |
| Species richness (Menhinick index) | 1.89 | 1.54 | 1.62 |
| Species Diversity (Shannon index) | 3.56 | 3.29 | 3.63 |
| Evenness | 0.78 | 0.75 | 0.79 |

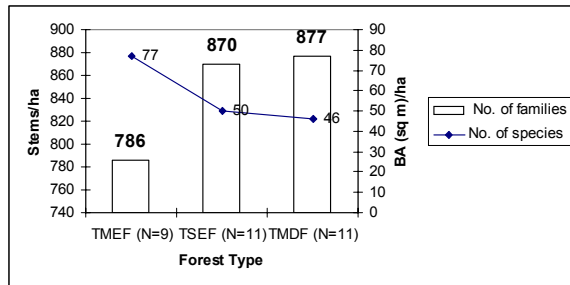


Figure 2.9: The stems and Basal Area per hectare in Secondary forests

Top 10 most important species (rank-wise, based on IVI).

2.7.4.2.1 Temporal succession

The succession in an ecosystem is often reflected by the secondary changes among tree communities, the major component of the landscape. The top most five important tree species of secondary forests in GCA include *Schima wallichii*, *Castanopsis purpurella*, *Shorea robusta*, *Macaranga denticulata*, and *Grewia microcos*. The species composition is changing with the age of secondary growth (Figure 2.10). The *Schima wallichii*, *Castanopsis purpurella* and *Macaranga denticulata* colonises first

among woody species on left over barren land. The first two remain amongst the important species during all the seral stages and its contribution is reduced much in the old climax stage, while the concentration of third one is reducing, as the secondary forest grows older. *Shorea robusta* is prominent in mature and old secondary forest stages. The *Grewia microcos* is very prominent in mature secondary forests (15-30 years old) and major source of food for variety of animals.

- In SF1, *Schima wallichii*, *Macaranga denticulata*, *Castanopsis purpurella*, *Syzygium cumini*, *Albizia odoratissima*, *Stereospermum chelonoides*, *Eurya acuminata*, *Persea villosa*, *Aporusa dioica*, and *Callicarpa arborea*
- In SF2, *Grewia microcos*, *Schima wallichii*, *Aporusa dioica*, *Macaranga denticulata*, *Castanopsis purpurella*, *Syzygium cumini*, *Terminalia bellirica*, *Shorea robusta*, *Holarrhena antidysenterica*, and *Callicarpa arborea*.
- In SF3, *Schima wallichii*, *Castanopsis purpurella*, *Shorea robusta*, *Eurya acuminata*, *Diospyros variegata*, *Dillenia pentagyna*, *Betula alnoides*, *Syzygium operculatum*, *Calophyllum polyanthum* and *Castanopsis* sp.

Now, let us look at the concentration of five top primary forest tree species in different successional stages. The top 5 species (rank wise) are *Polyalthia simiamum*, *Schima wallichii*, *Castanopsis purpurella*, *Syzygium cumini*, and *Grewia microcos*. The new species are *P. simiarum* and *S. cumini*. Unlike the higher IVI values, the prominent tree species have shown the low values of IVI in primary forest. It indicates the more evenness in primary forest composition as compared to that of secondary forest. (Figure 2.11).

2.7.4.2.2 Spatial succession

At the same time it is important to know the status of top five species in core of primary forest, which are undisturbed and have reached at the climatic climax, including the WE, LF and MF from low to high altitude. The most important species are *Polyalthia simiamum*, *Walsura tubulata*, *Syzygium operculatum*, *Michelia champaca*, and *Castanopsis purpurella*. The first two and the fourth one, which are dominant at mid or high altitude are absent from lower altitude. At lower altitude the *Syzygium operculatum*, and *Castanopsis purpurella* are predominant and their concentration is reducing at higher altitudes (Figure 2.12).

2.7.5 The Forest types as per Champion and Seth's classification

For overall comparison of results with studies already done the three broad forest types were identified through cluster analysis. These include the Tropical

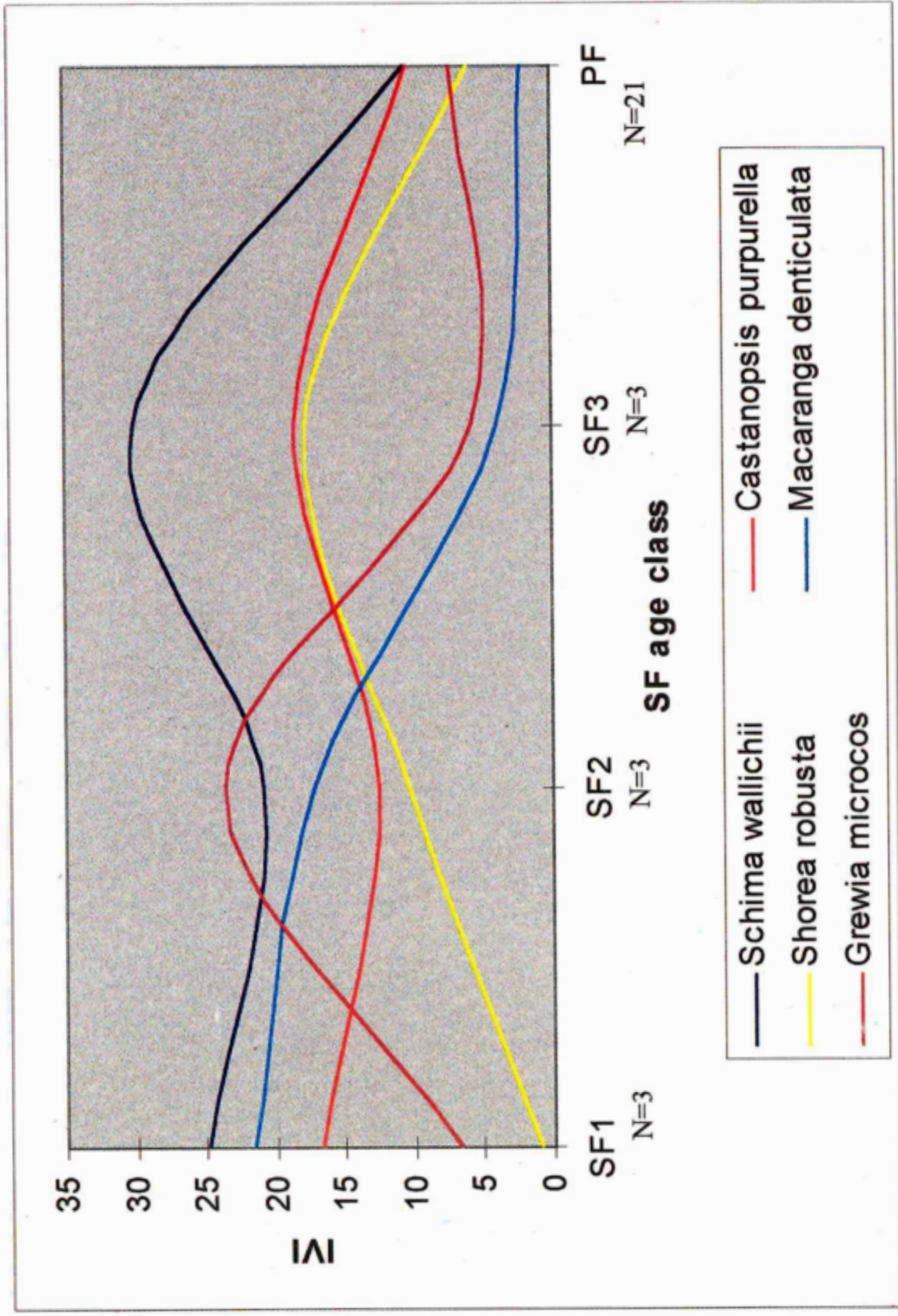


Figure 2.10: Changing species composition of top 5 Secondary forest tree species amongst seral stages

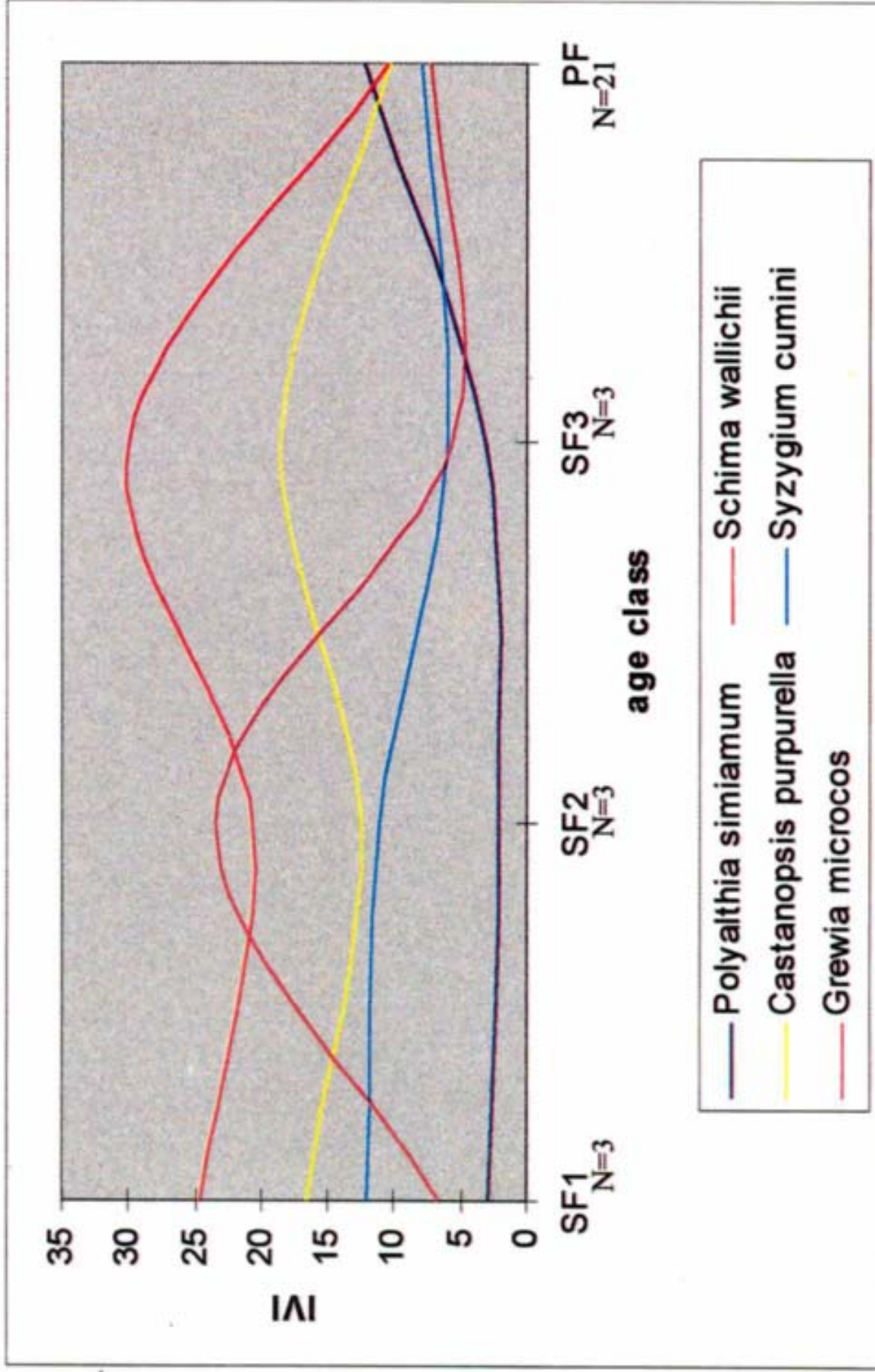


Figure 2.11: Changing species composition of top 5 Primary Forest tree species amongst seral stages

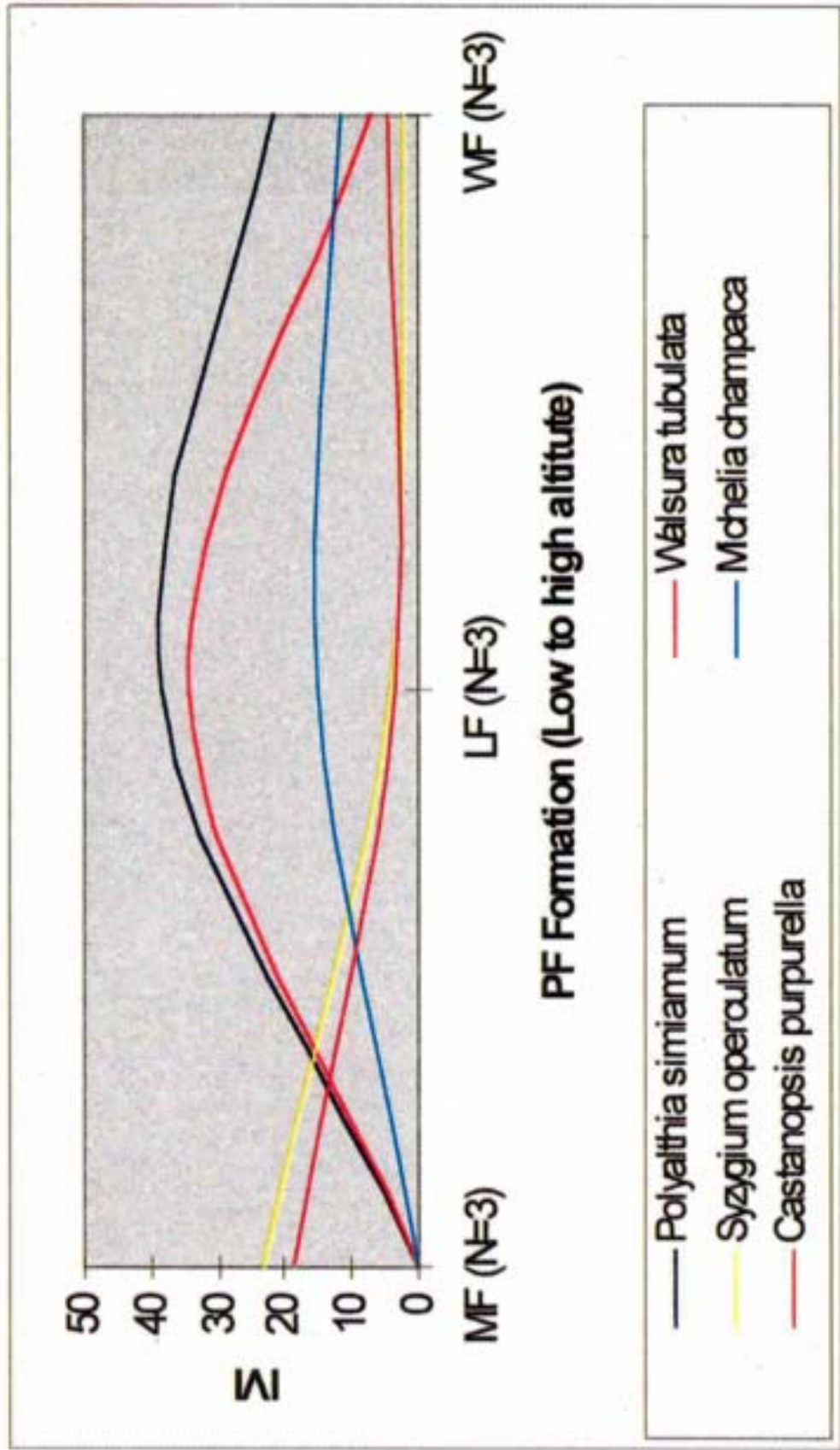


Figure 2.12: Changing species composition of top 5 core Primary Forest Formation tree species amongst PF Formations

Moist Evergreen Forest (TMEF), Tropical Semi Evergreen Forest (TSEF) and the Tropical Moist Deciduous Forests (TMDF). The number of samples in each category are 4, 9 and 8, respectively. The 10 most important tree species in these forest types are as follows:

- In TMEF, *Polyalthia simiamum*, *Walsura tubulata*, *Syzygium operculatum*, *Mesua ferrea*, *Castanopsis purpurella*, *Diospyros variegata*, *Castanopsis sp.*, *Aphanamixis polystachya*, *Michelia champaca*, and *Pterospermum lancifolium*.
- In TSEF, *Schima wallichii*, *Castanopsis purpurella*, *Shorea robusta*, *Macaranga denticulata*, *Dillenia pentagyna*, *Syzygium cumini*, *Tectona grandis*, *Grewia microcos*, *Aporusa dioica*, and *Eurya acuminata*.
- In TMDF, *Grewia microcos*, *Schima wallichii*, *Castanopsis purpurella*, *Shorea robusta*, *Syzygium cumini*, *Aporusa dioica*, *Dillenia pentagyna*, *Drimycarpus racemosus*, *Cynometra polyandra*, and *Sapium baccatum*

The detailed description is provided in preceding paragraphs. The vegetation characteristics of these forests have been summarised into Figure 2.13 and Table 2.13.

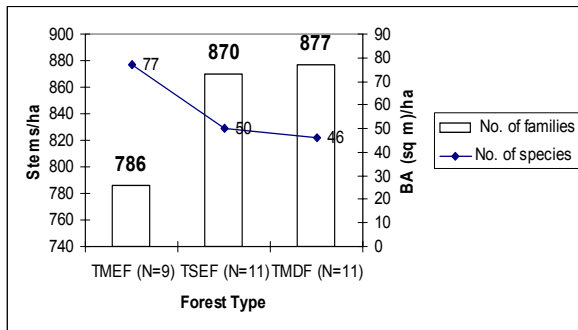


Figure 2.13: The stems and Basal Area per hectare in different forest types

Table 2.13: Vegetation Characteristics in Secondary Forests of GCA

| Forest type | TMEF (N=9) | TSEF (N=11) | TMDF (N=11) |
|------------------------------------|------------|-------------|-------------|
| No. of families | 50 | 51 | 50 |
| No. of species | 137 | 134 | 132 |
| No. of trees | 7076 | 9572 | 9649 |
| Basal Area (sq m) | 696 | 552 | 510 |
| Species richness (Margalef Index) | 15.3 | 14.5 | 14.3 |
| Species richness (Menhinick index) | 1.63 | 1.37 | 1.34 |
| Species Diversity (Shannon index) | 3.98 | 3.79 | 3.96 |
| Evenness | 0.81 | 0.77 | 0.81 |

2.7.6 Tree species composition and diversity in Forested landscape

The dense evergreen forests with compact canopy cover are confined to very steep slopes or in the unapproachable localities in interior hills. Whereas, tropical moist deciduous forests are generally found on the alluvial soil or well-drained soil on small hills at lower elevations along river courses. At present small and medium sized patches of these forests are surrounded either by habitations with increasing township and rural establishments or with other artificial landuse systems. The semi-evergreen forests were developed gradually with the course of time with increasing biotic pressure. Large gaps created through traditional *jbumming* provided chances of establishing deciduous species into large tropical moist evergreen forest patches. Major portion of semi-evergreen forests is present around the periphery of tropical moist evergreen forests. Even few smaller

patches exist within the intact large patches of evergreen forests.

2.7.6.1 Tropical moist evergreen Forests

Polyalthia simiarum-Walsura tubularis -Syzygium operculatum

These forests cover an area of 353 sq km *i.e.* 14.4% of the entire landscape, mainly confined to the Nokrek and Balpakram conservation blocks. These conservation blocks form the catchments of Simsang, Mahadeo and Maheshkola rivers in the northern, northeastern, eastern portions. Nokrek Conservation Block, situated over Nokrek ridge run eastwards from 'Tura peak' in upper northwest corner to the north of 'Siju Area' across river Simsang. The 'Nokrek Conservation Block' forms the upper and middle catchment of Simsang, the major river of study area. While 'Balpakram Conservation Block forms a catchment for Mahadeo and Maheshkola rivers. These conservation blocks are characterised by hilly terrain, steep slopes, moist and sometimes very moist habitat conditions. Average annual precipitation is higher as compared to the surrounding areas. Higher temperature throughout the year results in more humid conditions of wildlife habitats.

Few small patches of dense evergreen forests still exist near habitations. These patches can be seen in the south of Nokrek ridge near 'Emangiri area' and also near southern boundary of Balpakram National Park near 'Shooling area'. Unprotected areas near Chimitab, Nadankol and Shooling are example of tropical evergreen forests.

2.7.6.1.1 *Syzygium operculatum-Diospyros variegata-Castonopsis sp.*

These forests occur on the higher altitude (above 1,000 m) in very moist condition in Nokrek area. It also includes the species from very old (about 60 years) secondary forests, which resembles exactly the old primary forests. The important species are *Syzygium operculatum*, *Diospyros variegata*, *Castonopsis sp.*,

Castonopsis purpurella, *Aphanamixis polystachya*, *Calophyllum polyanthum*, *Casearia graveolens*, *Boehmeria sp.*, *Garcinia kydea* and *Betula alnoides*.

2.7.6.1.2 *Polyalthia simiarum-Walsura tubularis -Canarium strictum*

These forest occur at medium and lower altitude (between 100 to 700 m) inside Balpakram National Park. The limestone area forms the major habitat at the middle altitude. The important species of these forests are *Polyalthia simiarum*, *Walsura tubularis*, *Canarium strictum*, *Mesua ferrea*, *Michelia champaca*, *Tetrameles nudiflora*, *Drimycarpus racemosus*, *Cynometra polyandra*, *Pterospermum lancifolium* and *Sapium baccatum*.

2.7.6.2 Tropical moist deciduous Forests

Shorea robusta-Glycosmis arborea-Schima wallichii

Tropical moist deciduous forests are generally found on flat grounds or on very gentle slope of smaller hills. Majority of these forests occurs on community owned private land. These sites are easily approachable and being utilised for variety of landuse practices such as agriculture, horticulture, habitation, township, road network and infrastructure development etc. These forests cover an area of 703 sq km *i.e.* 28.6% of entire landscape and distributed all over the landscape in the form of non-contiguous smaller to medium sized patches of tropical deciduous forests.

2.7.6.3 Tropical semi-evergreen Forests

Schima wallichii-Castonopsis purpurella-Shorea robusta

The semi-evergreen forests are well distributed on the hilly portion of all over the landscape. These forests are highly fragmented due to increasing *jhum* practice. A large belt of semi-evergreen forests spread in the south of Nokrek Conservation unit, starting from Emangiri area to the Rewak area across the river Simsang in Siju area. These forests generally exist on the periphery of dense evergreen forests. A significant proportion of these forests exist in the reserved forests and community owned private land.

The semi-evergreen forests in the study area form upper catchment of Nareng, Bugi and Dareng rivers. Few patches in the central and southern portion of study area form the middle and lower catchment of river Simsang. These patches also form major catchment for Maheshkola river and other small rivers like Rompa and Rongdik, the main tributaries of Simsang-major river of study area.

2.7.6.3.1 *Grewia microcos-Schima wallichii-Castanopsis purpurella*

These Semi-evergreen forest have more deciduous species. The most important species are *Castanopsis purpurella*, *Shorea robusta*, *Syzygium cumini*, *Aporusa dioica*, *Dillenia pentagyna*, *Cynometra polyandra*, *Sapium baccatum* and *Polyalthia simiarum*.

2.7.6.3.2 *Schima wallichii-Castanopsis purpurella-Shorea robusta*

These semi-evergreen forests have more evergreen species. Species are *Schima wallichii*, *Castanopsis purpurella*, *Shorea robusta*, *Macaranga denticulata*, *Dillenia pentagyna*, *Syzygium cumini*, *Tectona grandis*, *Grewia microcos*, *Aporusa dioica* and *Eurya accuminata*.

2.7.7 Phyto-sociological values of tree species

2.7.7.1 Frequency

The four frequency classes *viz.* 1-25%, 26-50%, 51-75% and 76-100% were observed for assessing the distribution pattern of tree species, which indicate whether a species is very patchily distributed, or scattered, or moderately well distributed or very well distributed in the study area. The distribution pattern has been quantified (assessed) for the tree species in Tropical Moist Evergreen forests, Tropical Moist Deciduous Forests, Tropical Semi-evergreen Forests and then compared with the old tropical forest combining all of these three types.

The number of species is high in lower frequency classes and decreases towards the higher frequency

classes (Figure 2.14). The maximum number of species have been recorded in lower frequency classes of each category, for example, Tropical Moist Deciduous Forests (N=4) have 51% species, which are very patchily distributed *i.e.* belonging to the lowest frequency class (1-25%). This is followed by Tropical Semi-evergreen Forests (N=22) with 44% species of all, which are found in semi-evergreen forests and deciduous forests. Likewise, when all three forest types are combined into one category *i.e.* old tropical forests similar pattern was observed. The frequency diagram has been prepared for three forest types and the old forest growth (combining all three forest types). The frequency diagram represents the homogeneity or heterogeneity of a community as a floristic uniformity varies directly with the values for different frequency classes (Mishra, 1968).

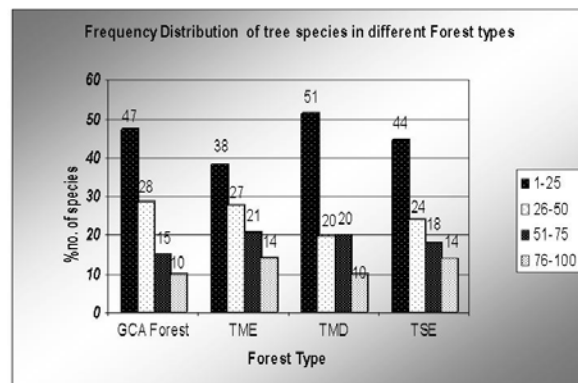


Figure 2.14 Frequency distribution of tree species in different forest types

The species those are well distributed (frequency >75%) have shown the lowest number of species in all types of forest categories. About 14% species have been recorded from both evergreen and deciduous forest types followed by 10% species in deciduous forests only. Overall, the old forests have 10% species that are well distributed all over the study area with >75% frequency value.

2.7.7.2 Abundance and Density

The abundance and density represents the numerical

strength of species in the community (Mishra, 1968). The abundance along with frequency gives an idea of the distribution pattern of the species while the density represents the number of individuals per unit area. The density and frequency taken together are of prime importance in determining the community structure and have a variety of uses far beyond those of other qualitative values (Oosting, 1958; back cited in Mishra, 1968). In GCA, the *Shorea robusta* is the most abundant species (abundance 158.5), has maximum density (97%), though the frequency is very less. *Castanopsis purpurella* and *Syzygium cumini* are well distributed in the study area with percentage frequency of 94.3 for each but low abundance and density. In case of evergreen forests, *Polyalthia simiarum* and *Walsura tubularis* are the most abundant. *S. operculatum* and *C. purpurella* have high frequency but low in abundance and density are quite low. *Shorea robusta* is the most abundant species in deciduous forests. The low frequency (11.4) could be due to low sample size (N=4). Next to *S. robusta* in lower density class *Glycosmis arborea* and *Aphanamixis polystachya* are the most abundant in semi-evergreen forests, though the density and frequency is very low (Figure 2.15).

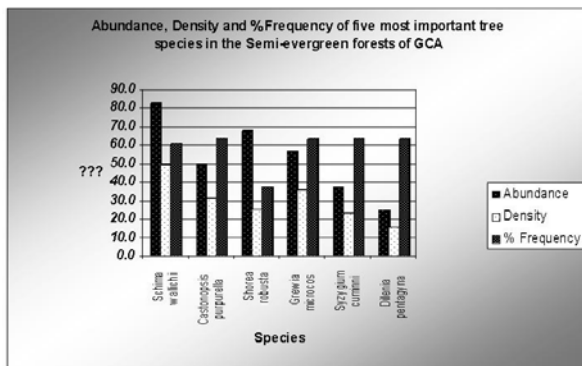


Figure 2.15 Abundance and Density and % frequencies

2.7.7.3 Importance Value Index (IVI)

All the species have been provided rank on the basis of IVI value and the above description is based on the IVI values of tree species.

2.7.8 Comparison with other tropical forests

The result of vegetation data analysis from present study is compared with those of other similar studies in tropical forests of India and other tropical countries (Table 2.14). The mean stand density and basal area are 861 stems per hectare and 57 sq m per hectare, respectively. Stand density of various plots is well within the range reported for other tropical forests, while the upper limit for per hectare basal area is comparatively higher. The highest basal area cover is 107 sq m /ha as reported by Parthasarathy (1986) for the Kalakad Reserved Forests in western Ghats. Singh and Singh (1981) reported the stand density of trees and shrubs (>10 cm gbh) at 1174 & 132 per ha (fenced area) and 936 & 554 per ha (unfenced), respectively, in the tropical dry deciduous forests of Varanasi (Uttar Pradesh, India). Singh et al. (1984) recorded the total basal cover ranging from 29 to 103 sq m/ha and the density from 622 to 709 stems per ha in the Silent Valley forest fo Kerala, India. Thorington et al.(1982) recorded 856 trees (of >60 cm gbh) in a five-hectare plot in the neotropical forests of Barro Colorado Island,. Parthasarathy (1986) reported that the stand density (20 cm gbh or more) ranged from 320 to 1260 stems per ha and the basal area from 18.3 to 107.4 sq m per ha in Kalakad Reserved Forests (KRF) of Tamil Nadu,. While in scrub forests same stood at 323 per ha and 19.2 sq m per ha. in KRF. Parthasarathy et al. (1992) recorded the stand density ranging from 574 to 915 trees/ha and the basal area from 55 to 95 sq m/ha in six 1.0 ha plots in the evergreen forests of KRF. Tree density in an equatorial forest ecosystem in Komgolo Island (Zaire) ranged from 443 to 553 per ha and the basal area from 10 to 45 sq m/ha (Mosango, 1991). Wide variations in the girth class, plot size and area considered for various studies in tropical regions of India and world do not allow a valid comparison.

Table 2.14: Vegetation characteristics of various forest ecosystems in India and other tropics

| Forest type | Location | Plot size (ha) | Girth size (cm) | Stand density (no./ha) | Basal area (sq m/ha) | Source |
|---|---|----------------|-----------------|------------------------|----------------------|------------------------------------|
| India | | | | | | |
| Evergreen Forest | Silent Valley, Kerala | - | >= 31.5 | 620-709 | 29-103 | Singh <i>et al.</i> (1984) |
| Tropical Forest: Scrub jungle to Wet Evergreen Forest | Kalakad RF, Western Ghats | 0.2 | >20 | 320-1260 | 18-107 | Parthasarathy (1986) |
| Tropical Wet Evergreen Forest | Kalakad RF, Western Ghats | 1.0 | >30 | 574-915 | 55-94 | Parthasarathy <i>et al.</i> (1992) |
| Evergreen Forests | Karnataka | 0.44 | | 466-1386 | 33-48 | Rai & Procter (1986) |
| Dry Tropical Forest | Vidhyan region | - | >30 | 294-559 | 7-23 | Jha & Singh (1990) |
| Dry Evergreen Forest | Marakkanam RF Coromandel coast | 0.3 | >=20 | 280 | 11 | Visalakshi (1995) |
| Dry Evergreen Forest | Puthupet Sacred Grove Coromandel coast | 0.2 | >=20 | 1130 | 36 | Vishalakshi (1995) |
| Tropical moist evergreen and deciduous forest | South Garo Hills and associated Nokrek area, Garo Hills (Western Meghalaya) | 1.0 | >=30 | 861 (430-1145) | 57 (12-162) | Current study |

Contd...

Table 2.14 Contd...

| Forest type | Location | Plot size (ha) | Girth size (cm) | Stand density (no./ha) | Basal area (sq m/ha) | Source |
|-------------------------------|----------------------------------|----------------|-----------------|------------------------|----------------------|---------------------------------|
| Other Tropical Forests | | | | | | |
| Tropical Rain Forest | Barro Colorado Island, Panama | 5 | 60.0 | 171 | - | Thorington <i>et al.</i> (1982) |
| Tropical | Barro Colorado Island, Panama | 50 | >62.8 | 152 | - | Hubbell & Foster (1983) |
| Tropical Rain Forest | Amazonia | 3 | 31.4 | 1420 | 28-68 | Campbell <i>et al.</i> (1986) |
| Equatorial Insular Forest | Eastern Carolline Island, Panama | 50 | >31.4 | 98-114 | 17 | Itow (1986) |
| Tropical Rain Forest | Jengka Reserve, Malaysia | 11 | 91 | 104 | 23 | Ho <i>et al.</i> (1987) |
| Tropical Rain Forest | Gunung Silam, Malaysia | 0.04 | 31.4 | 513-1596 | 23-46 | Procter <i>et al.</i> (1988) |
| Tropical Moist Forest | Singapore | 0.4 | >6.3 | 604 | - | Swan (1988) |
| Tropical rain Forest | Valcan Barva, Costa Rica | 6 | >31.4 | 391-617 | - | Heaney & Procter (1990) |
| Slope Forest | New Caledonia | 2.8 | >31.4 | 1533 | 49 | Jaffre & Veillon (1990) |
| Alluvium Forest | New Caledonia | 2.6 | 31.4 | 1183 | 47 | Jaffre & Veillon (1990) |
| Equatorial Forest | Kongo Island, Zaire | - | - | 440-553 | 10-45 | Mosango (1991) |
| Tropical Rain Forest | Amazonia | 3 | >31.4 | 1720 | 78 | Campbell <i>et al.</i> (1992) |

The Shannon-Weiner diversity indices computed for the tropical moist evergreen, moist deciduous and semi-evergreen forests of GCA are 4.03, 2.44 and 4.07, respectively. The very closer figures were found in the Silent valley, where the diversity of tree species were reported to be 4.15, 4.08 and 3.52 in riparian, mesic upland and less-mesic upland habitats, respectively (Singh et. al, 1984). The value closer to those of GCA's tropical forest have been reported for the tropical evergreen forests of the Kalakad RF (3.31 to 3.69) by Parthasarathy *et al.* (1992).

2.8 Important Tree Species in GCA (Haridasan and Rao, 1985)

2.8.1 *Aporosa dioica*

Vernacular name- Chamolja, Deciduous (D), 6-12m high

Euphorbiaceae, Flowers and Fruits (F&F): November-May

Bangladesh, Burma, and NE India, common in Meghalaya at lower elevations below 800m in deciduous and mixed dec. forest.

Associates: *Croton roxburghii*

2.8.2 *Diospyros variegata*

Bolgisem, (Evergreen), 10-20m high

Ebanaceae, F&F: April-December

Burma and NE India, Common in Meghalaya in tropical evergreen forests, often in open places, Tura, Khasi hills.

Diseases: the trees often malformed due to disease caused by witches broom.

3. *Michelia champaca*:

Bolnabat, (E), large (20-25m)

Magnoliaceae, F&F: May to April

50 Species in tropical Indo-Malayan region 12 in India, 8 in Meghalaya, few cultivated

Indo-Malayan, usually cultivated for fragrant flowers, cultivated as well as wild in foot hills, also in Tura

Uses: Wood durable, used in furnitures and building works.

2.8.4. *Schima wallichii*:

Boldok, (E), 15-50m large

Theaceae, Fruits and Flowers: February to April; January to February. (Following year)

16 genera and 500 species in tropics and subtropics, Mainly in Asia, 8/23 in India 6/13 in Meghalaya, Indo-Burma, Nepal, Bhutan, Bangladesh Eastern Himalaya NE India, throughout Meghalaya in all type of forests.

Uses: Plywood. Bark in allergic

2.8.5 *Styrax serrulatum*

5-15m

Styracaceae

12/190 in the tropical and temperate region 2/5 in India, 2/3 in Meghalaya 125 species in tropics/temperate 43 in India, 2 m high

Fruits and Flowers in March to December

Indo-Malayan, confined to East and NE India, Common in Meghalaya at lower elevations along forest margins and secondary forests.

Associates: *Friesodielsia forniculata*, *Milletia caudata*.

2.8.6. *Messua ferrea*

Karai, Khmde, large [upto 40m]

Clusiaceae: 35/400 (Genera/Species)

Largely confined to tropics, 6/22 in India 4/11 in Meghalaya. [3 species in world, 1 in Meghalaya]

Flowers and fruits in April to October.

Indo-malayan, confined to western ghats, and NE India; Important element in evergreen forests in Meghalaya, at lower elevation

Uses: Wood is very heavy and strong, used for construction proposals handles of agricultural equipment etc.

2.8.7 *Castanopsis purpurella*

Chako, large tree

Fagaceae: 8/500 in tropical/temperate region, except S. Africa, 5/40 in India, 4/13 in Meghalaya

Burma and NE India; very common in Meghalaya, forming canopy tree in associates with *C. tribularis*

2.8.8 *Castanopsis indica*

Fagaceae.

Large tree

Flowers and Fruits in february to December.

NE India and neighbouring countries: very common in Meghalaya, in evergreen forest through out the state.

2.8.9. *Tetra meleis nudiflora*

(D), tall upto 50m

Tetramelaceae: A monotypic family of Indo-Malayan region.

Flowers and Fruits in March to June.

Occur in open deciduous forests in Garo hills, associated with *Duabanga grandiflora*, *Gmelina arborea*, *Largerstroemia parviflora*, *wrightia tomen tosa*.

Uses: Wood is useful in match industries, Fast growing tree, easily distinguishable due to its towering size and noded branching.

2.8.10. *Cynometra polyandra*

Chherasu (E), large (upto 20m)

Caesalpiniaceae 152/2800 in tropics and sub-tropics, 23/80 India, 13/28 in Meghalaya (60 species in tropics, 6 in India and 1 in Meghalaya)

Flowers and Fruits in March to August.

Indo-malayan; confined to north-east India, common in tropical evergreen forests, associates with *Premna latifolia*, *Garcinia paniculata*, *Sarchochlamys*, *Pulcherrima*, *Schima wallichii*, *Mallotus*, *Lutra coccous*

Uses: Wood is useful for construction purpose plywood and charcoal.

2.8.11. *Trewia nudiflora*

Boldiktak, Bol-khap, (D), upto 20 m.

Euphorbiaceae Arugong.

A large cosmopolitan family 300/5000

61/336 in India, 30/90 in Meghalaya

(5 species in Indo-malayan region. 2 in India and 1 in Meghalaya)

Flowers and Fruits in January to September.

Indo-malayan; nearly through out in India; fairly common in Meghalaya in deciduous forests, particularly in along river and water courses, associated with *Aesculus assamicus*, *Vatica lanceaefolia*.

2.8.12. *Stereospermum chelonoides*

Bolsel middle to lofty trees upto 40m.

Bignoniaceae 20/37 in India, majority cultivated; 5

genera and 5 species in Meghalaya [25 species in Afro-Asia, 4 in India, 1 in Meghalaya].

Flowers and Fruits in April to March.

Indo-Burma, through out the greater part of India, very common in Meghalaya in tropical evergreen and deciduous forests (below 800m) associated with *Vitex species*, *Dillenia species*, *Oroxylum indicum*, etc.

Uses: Linear fruits, which persist nearly through out year; yield straight boled sturdy and durable timber.

2.8.13. *Glycosmis species:*

Rutaceae

150 genera/900 species in tropics and temperate region, largely in Asia, Africa and Australia, 24/86 in India 13/Ca.25 in Meghalaya

[50 species in tropics]

Flowers and Fruits through out the year

Indo-Burma; common; dense evergreen forest of Meghalaya, especially in Garo hills as an undergrowth in wet shady places.

2.8.14. *Callicarpa arborea*

Khimber, Makhanchi, Middle (upto 15m)

75/3000 in tropics and sub-tropics, 17/96 in India, 13/40 in Meghalaya.

[140 species in tropics and sub-tropics, 10 in India, 6 in Meghalaya]

Flowers and Fruits nearly throughout the year, (more during in April to September)

Indo-malaya; mostly in northern India, Abundant in Meghalaya at all elevations in secondary forest, usually associated with *Styrax serrulatum*.

2.8.15. *Grewia microcos:*

(D) Bolchibins, Borsubret (5-15m)

Tiliaceae: 50/450 in tropics and temperate 8/64 nearly through out India, 3/11 in Meghalaya.

(150 species in tropics, 42 in India, 6 in Meghalaya)

Flowers and Fruits in May to February.

Indo-malaya, through out the warmer part of India, in Meghalaya this species occurs in deciduous forests of lower ranges, associated with *Holarrhena antidysenterica*, *Careya arborea*, *Embica officinalis*, *Callicarpa arborea* etc.

Uses: Green to fruits purple.

2.8.16. *Persea villosa*

Namega tall (upto 25m)

Lauraaceae 47/1900 in tropics and sub-tropics 17/175 in india, 11/50 in Meghalaya.

(150 species in tropical Asia and America, 15 in India and 10 in Meghalaya)

Flowers and Fruits in January to May.

NE India and neighbouring countries; verry common in Meghalaya, particularly in tropical evergren and mixed deciduous forests; also in secondry forest at lower elevation, associated with *Stereospeesimum chelanooides*, *Artocarpus chaplasha*, *Castanopsis species*, etc.

2.9 Landscape analysis

2.9.1 Landscape composition and configuration

In present study, landscape is considered as a mosaic of different forest types (Champion and Seth, 1968), other vegetation types and non-forest landuses. Total extent of the landscape area is 2459 sq km. The GCA landscape consists of three forest types *viz.* Tropical Moist Evergreen Forest (TMEF), Tropical Semi-evergreen Forest (TSEF) and Tropical Moist Deciduous Forest (TMDF), other categories include the Grassland, Shola type forest (Holdridge *et al*,1971; and Kumar & Rao, 1985) and degraded land with bamboo growth-a seral stage of succession and the scrub vegetation. The forest patches either in isolation or along with bamboo brakes and grassland form the habitats for number of wild animals.

General habitat conditions are assessed at broad scale, considering entire landscape as a unit and at the same time it is subdivided in to different sub-units based on the boundaries of existing protected areas and managed forests, the existing administrative units to conserve and manage wildlife. The four PAs and four RFs covering 362 sq km (495 sq km, if new extension of BNP is also considered) land, are being managed by the state government, while the rest of 2097 sq

km (1967 sq km after extension of BNP) belongs to the local community. The exact boundaries of extended Balpakram National Park are not available (as the area falls in the restricted area zone due to its proximity with the International border) and the mapping work has not been done. Hence, in present study, the extent of Balpakram National Park is considered as per the initial boundaries *i.e.* area of 220 sq km. The TMEF, TSEF and TMDF, all together constitute the 72% of landscape. Only 28 percent land comes under non-forest category, which includes the Bamboo growth also (Figure 2.16).

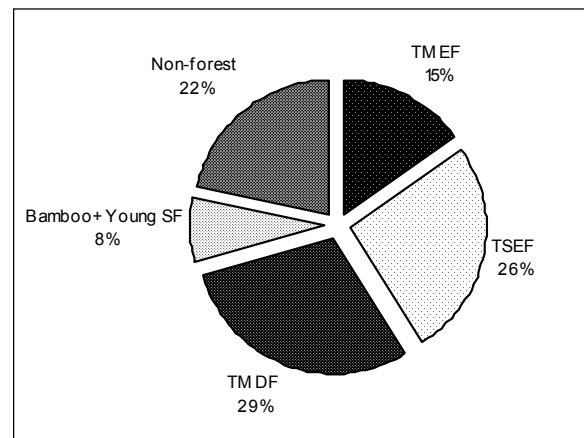


Figure 2.16: Landscape composition (% area)

The forest landuse categories have been described in details in next few paragraphs. However, among the non-forest landuse categories, human habitation along with associated scrubland and habitation occupies about one-tenth (234 sq km) of the total land, which is followed by area under shifting cultivation (175 sq km) and bamboo patches, which have been merged with the young age secondary forests for satellite data processing. Tropical Moist Evergreen, Semi-evergreen and Moist Deciduous Forests cover 68% of the landscape. The tropical moist deciduous forests covered an area of 703 sq km, which is 41.8% of total forest cover, followed by tropical semi-evergreen forest (624 sq km). Tropical evergreen forests constitute 353 sq km (Table 2.15).

Table 2.15: Vegetation/landuse classes in different land ownership categories (sq km)

| Landuse/Forest types | Community Land (CL) | % of CL | PAs | % of PAs | RFs | % of RFs | Total | % of total |
|---------------------------------|---------------------|------------|------------|------------|-----------|------------|-------------|------------|
| Evergreen Forest | 212 | 10 | 141 | 51 | 0 | 0 | 353 | 14 |
| Semi-Evergreen Forest | 500 | 24 | 89 | 32 | 35 | 39 | 624 | 25 |
| Deciduous Forest | 640 | 31 | 26 | 9 | 37 | 41 | 703 | 29 |
| Plateau Grassland | 0 | 0 | 3 | 1 | 0 | 0 | 3 | 0 |
| Bamboo + Young secondary forest | 175 | 8 | 4 | 1 | 6 | 7 | 184 | 7 |
| Permanent Agriculture | 93 | 4 | 1 | 0 | 2 | 2 | 96 | 4 |
| Shifting Cultivation | 166 | 8 | 5 | 2 | 4 | 5 | 175 | 7 |
| Habitation/scrub/abandoned jhum | 228 | 11 | 3 | 1 | 4 | 4 | 234 | 10 |
| Water bodies | 4 | 0 | 0 | 0 | 1 | 1 | 5 | 0 |
| Shadow | 75 | 4 | 5 | 2 | 1 | 2 | 81 | 3 |
| Total | 2092 | 100 | 276 | 100 | 90 | 100 | 2459 | 100 |

Landscape analysis of satellite data revealed that the major portion of landscape belongs to the semi evergreen and deciduous first cover along with other vegetation categories. Tables 2.16 and 2.17 below describe the landscape composition and configuration.

2.9.2 Potential areas of conservation priorities (Viable forest patch)

The Core Area (CA) can be defined as the area within a patch beyond some specified edge distance or buffer width (McGarigal and Marks 1994). Processed vegetation and land use cover map of study area is a mosaic of large number of patches of varying sizes and shapes. The shape of the patch might also play an important role (Patton, 1975; Covich, 1976; Marcot and Meretsky, 1983; Forman and Godron, 1986) in determining the effective area for potential wildlife use, depending on the species of wildlife and its sensitivity to, or tolerance of, edge conditions.

Various studies have shown the impact of edge effect on microclimatic conditions, such as measurable microclimatic changes are generally limited to a zone within 15-60 m of forest edge (Kapos, 1989; Williams-Linera, 1990b; Kapos *et al.*, 1997; Turton and Freiburger, 1997). For many physical phenomena, a reasonable assumption for the maximum penetration for edge effect is about 100 m (Didham, 1997). However, some physical edge effect phenomena, such as wind disturbance, can occur over larger spatial scale (200-500 m: Laurance 1991). Some animals such as certain insects, birds, and small mammals, are “edge advisor,” often becoming uncommon within 50-100 m of forest edges (Quintela 1985; Lynam, 1995 and Laurance, 1997).

The study of edge effects is still in its infancy, and the precautionary principle dictates that estimates of the maximum penetration of edge effects into forests

Table 2.16. Landscape composition in the tropical forests of GCA.

| Landuse classes/Forest types | No. of patches | Total area (sq km) | Mean of Area (sq km) | Largest patch size (sq km) | Standard deviation |
|---------------------------------|----------------|--------------------|----------------------|----------------------------|--------------------|
| Evergreen Forest | 6420 | 353 | 0.055 | 179.693 | 2.4425 |
| Semi-Evergreen Forest | 44429 | 703 | 0.0158 | 41.3392 | 0.305 |
| Deciduous Forest | 21163 | 624 | 0.0295 | 112.622 | 0.8938 |
| Plateau Grassland | 68 | 3 | 0.0407 | 1.7716 | 0.2172 |
| Bamboo + Young secondary forest | 56127 | 184 | 0.0033 | 1.4243 | 0.0177 |
| Permanent Agriculture | 10200 | 96 | 0.0094 | 4.0839 | 0.0585 |
| Shifting Cultivation | 49780 | 175 | 0.0035 | 0.8935 | 0.0117 |
| Habitation/scrub/abandoned jhum | 27050 | 234 | 0.0087 | 12.9481 | 0.1261 |
| Water bodies | 2168 | 5 | 0.0023 | 0.4954 | 0.0139 |
| Shadow | 10572 | 81 | 0.0077 | 1.7611 | 0.0286 |
| Total | 227977 | 2459 | | | |

Table 2.17: Nearest Neighbour distance in various forest types and landuse categories

| Forest type | Min (m) | Max (km) | Standard Deviation (km) | Mean (km) |
|---------------------|---------|----------|-------------------------|-----------|
| Evergreen | 50 | 82 | 19 | 30 |
| Semi-Evergreen | 56 | 85 | 15 | 38 |
| Deciduous | 50 | 85 | 15 | 29 |
| Bamboo | 71 | 84 | 16 | 25 |
| <i>Jhum</i> patches | 35 | 86 | 15 | 28 |
| Agriculture | 50 | 85 | 16 | 26 |

should be doubled for management purposes (Laurance and Bierregaard, 1997). The Core Areas were measured to project the status of forest patches forming critical wildlife habitats particularly for wildlife that seem to be closely associated with forest interior-patch conditions and that are sensitive to forest edge conditions *e.g.* Hoolock gibbons, Flying squirrels, Peacock pheasants, and Malayan giant squirrels are few among the interior species observed in the GCA.

The number of Core Areas along with patch sizes at the edge-distances of 500m 1000m and 2000m have been given in table 2.17.

A total of 2,236 forest patches (Table 2.18) with the available collective core area of 561 sq km were found at the edge distance buffer width of 250 m (Table 2.18 and figure 2.17). When the edge distance was increased to 500 m, the number of forest patches and core area are 644 and 292 sq km (Figure 2.18).

Table 2.18: Core Area (sq km) at specified distances from edge in different forest types

| Forest type | Core Area at 500 m | | Core Area at 1000 m | | Core Area at 2000 m | |
|-----------------|--------------------|------|---------------------|------|---------------------|------|
| | No. | Area | No. | Area | No. | Area |
| Evergreen | 55 | 214 | 23 | 143 | 8 | 68 |
| Semi-evergreen | 313 | 203 | 110 | 54 | 12 | 3 |
| Moist Deciduous | 618 | 150 | 102 | 16 | 1 | 0.2 |

Table 2.19: Distribution of Core Area at the specified edge distances in the interior of old growth forest patches

| Size Class | No. of CA | Area (sq km) | % Area | No. of CA | Area (sq km) | % Area |
|--------------|---------------------------|--------------|--------|---------------------------|--------------|--------|
| | CA at 250 m edge distance | | | CA at 500 m edge distance | | |
| <1 ha | 1430 | 4.39 | 0.78 | 285 | 1.13 | 0.39 |
| 1-5 ha | 494 | 11.21 | 2.00 | 165 | 3.97 | 1.36 |
| >5-10 ha | 126 | 8.83 | 1.57 | 63 | 4.43 | 1.52 |
| >10-50 ha | 134 | 28.91 | 5.15 | 103 | 21.34 | 7.33 |
| >50-100 ha | 28 | 20.87 | 3.72 | 11 | 7.05 | 2.42 |
| 1-5 sq km | 16 | 31.08 | 5.53 | 10 | 19.07 | 6.55 |
| >5-10 sq km | 3 | 19.59 | 3.49 | 3 | 21.46 | 7.36 |
| >10-50 sq km | 3 | 41.47 | 7.39 | 2 | 55.93 | 19.20 |
| >50 sq km | 2 | 395.14 | 70.37 | 2 | 156.96 | 53.87 |
| Total | 2236 | 561.49 | 100.00 | 644 | 291.34 | 100.00 |

2.9.3 Potential wildlife corridors

Corridors can play an important role in the dispersal of some biota as well as facilitating the gene flow between the populations, thus, increasing the heterozygosity within taxa and biodiversity of the region (Norton and Nix, 1991). Remotely sensed data is useful in identification and mapping of forest corridors (Gulinck *et al.*, 1991). Satellite data provides the first order information for analyzing the structure of forest corridors. The legally designated protected wildlife habitats (PAs and MFs) in GCA are scattered. The community owned land contains extensive forest cover. At many places, this forest cover forms contiguous forest tract with low fragmentation value

(Table 2.4). The low fragmentation areas were identified and analysed for the patch characteristics of potential wildlife corridors (Figure 2.19). The re-classed fragmentation image was used to delineate seven major corridors that seem to link the most PAs and MFs. Total area under seven corridors is 274 sq km, of which 253 *i.e.* 92.1 % has forest cover. Out of 252.82 sq km, TMEF, TSEF and TMDF constitute 23.1 %, 54.0 % and 22.9 %, respectively (Tables 2.20 and 2.21).

BNP is well connected with NNP (in the northwest), RRF (in the west) and BRP (in the southwest) and the area of each of these potential wildlife habitat

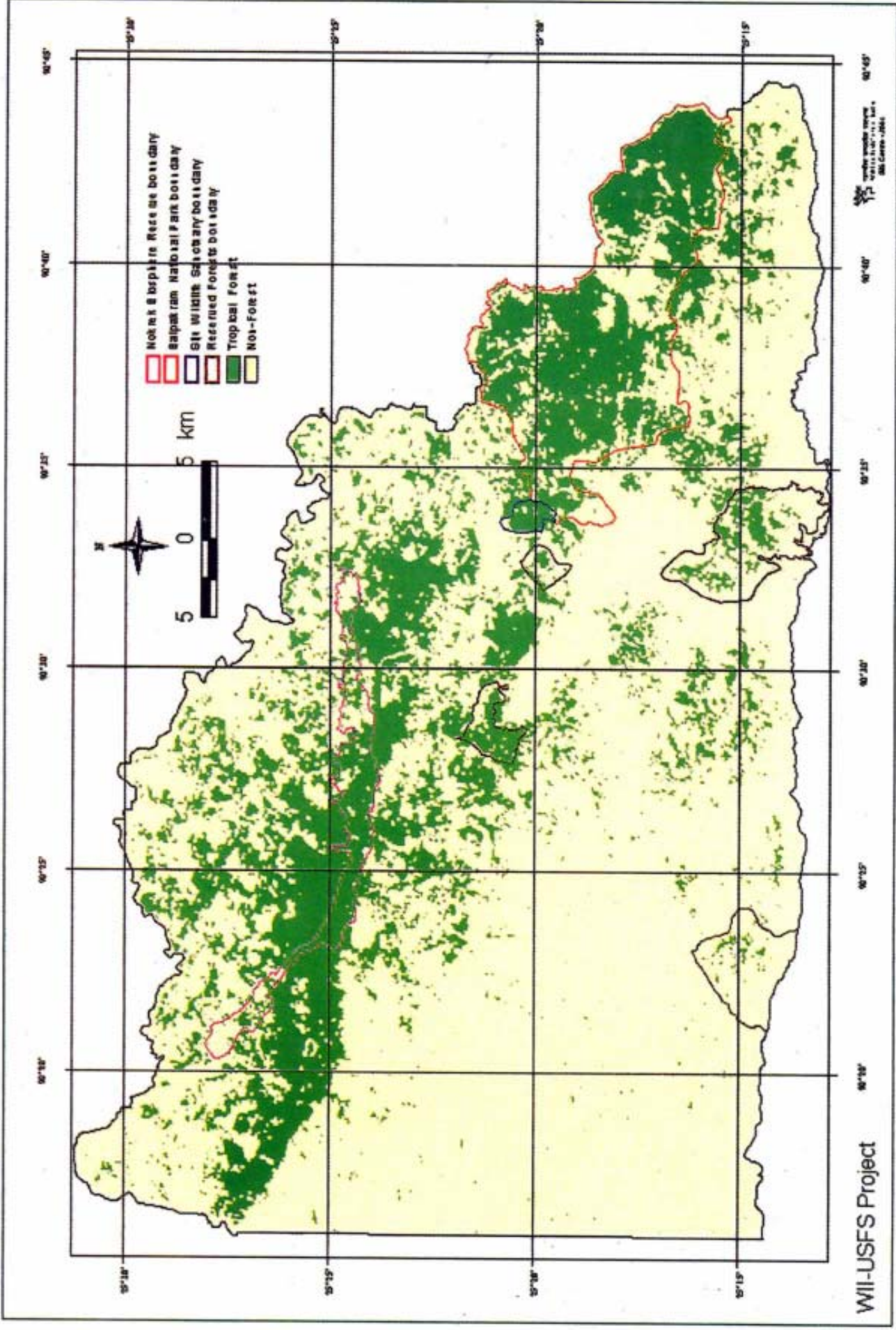


Figure 2.17 Core area at 250 m edge distance from boundary of forest patches in GCA

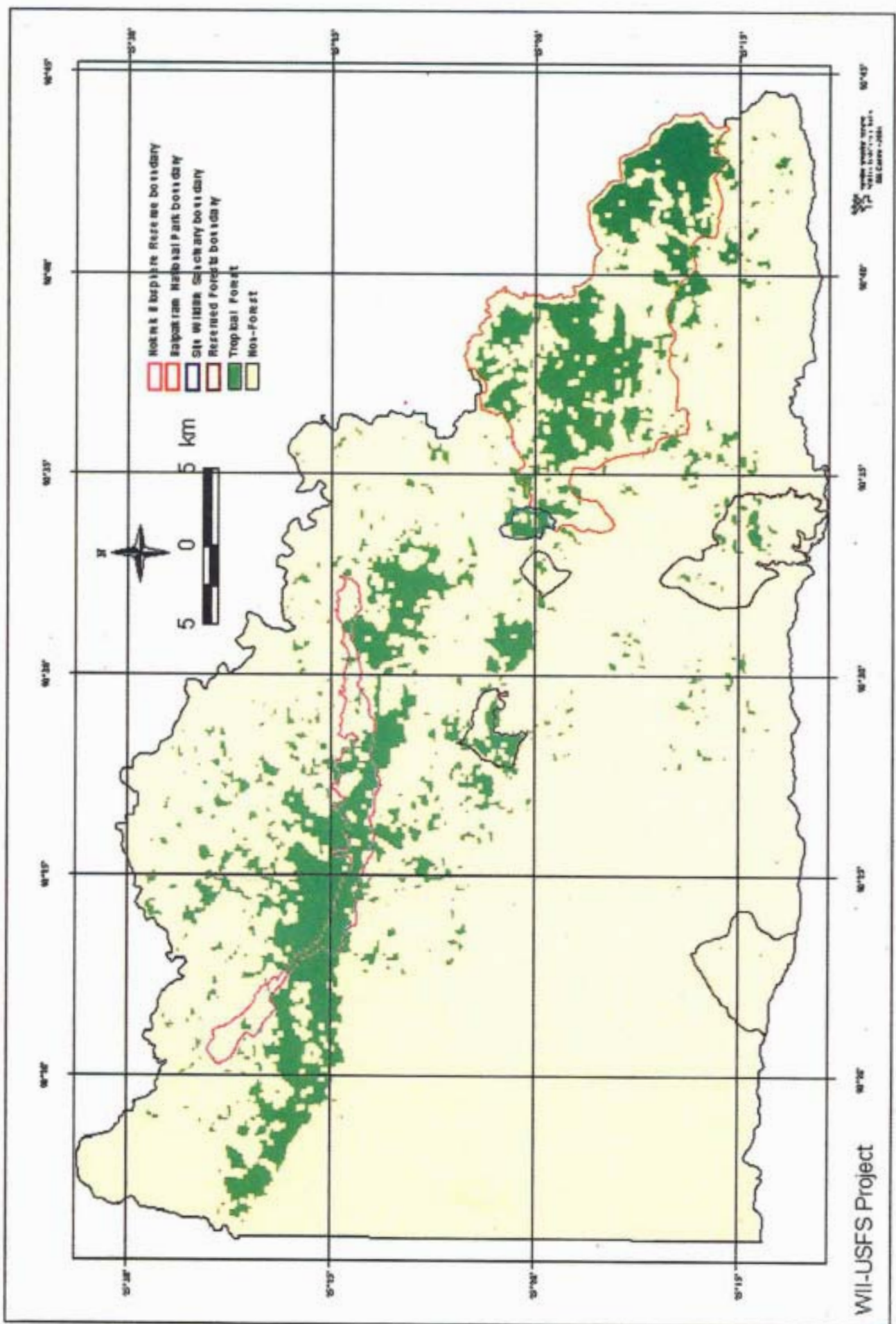
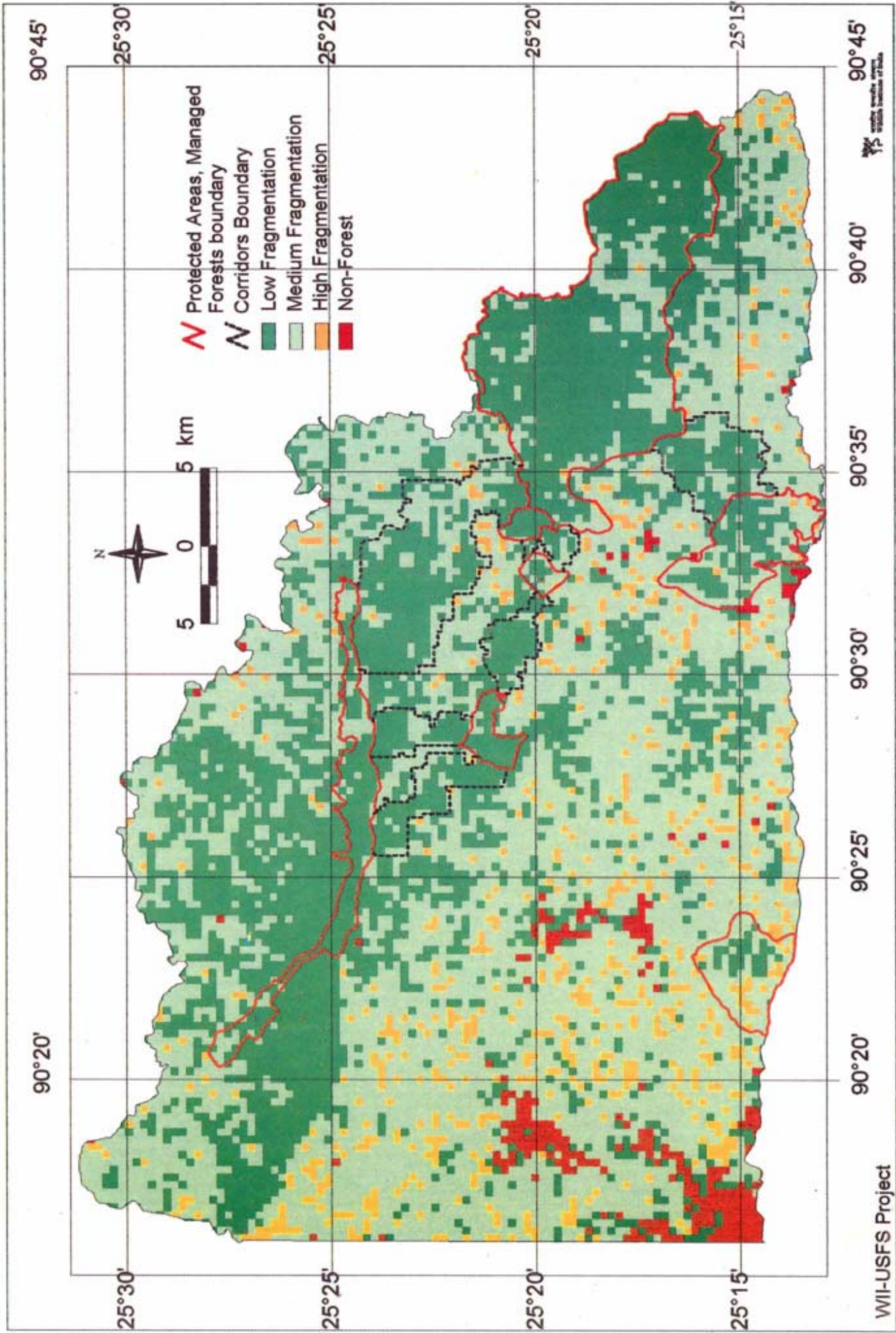


Figure 2.18 Core area at 500 m edge distance from boundary of forest patches in GCA



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Figure 2.19 Potential wildlife corridors connecting existing PAs and MFs in GCA

Table 2.20: Forest and non-forest in the identified corridors

| Corridor No. | Corridors | Forest Area (sq km) | Non-forest Area (sq km) | Grand Total |
|--------------|--------------|---------------------|-------------------------|---------------|
| 1 | BNP/SWS-NNP3 | 166.65 | 14.46 | 181.11 |
| 2 | BNP-BRF | 30.04 | 3.21 | 33.24 |
| 3 | ERF-NNP1 | 21.60 | 1.67 | 23.28 |
| 4 | ERF-NNP2 | 14.93 | 0.67 | 15.59 |
| 5 | RRF-ERF | 14.30 | 0.68 | 14.99 |
| 6 | BNP/SWS-RRF | 4.48 | 0.83 | 5.32 |
| 7 | SWS-RRF | 0.82 | 0.13 | 0.95 |
| | Total | 252.82 | 21.65 | 274.48 |

Table 2.21: Distribution of different forest types in the identified corridors

| Corridors | TEF Area (sq km) | TSEF Area (sq km) | TMDF Area (sq km) | Total Area (sq km) |
|--------------|------------------|-------------------|-------------------|--------------------|
| BNP/SWS-NNP3 | 49.76 | 82.38 | 34.52 | 166.65 |
| BNP-BRF | 0.61 | 19.10 | 10.34 | 30.04 |
| ERF-NNP1 | 0.74 | 17.29 | 3.58 | 21.60 |
| ERF-NNP2 | 7.16 | 6.92 | 0.85 | 14.93 |
| RRF-ERF | 0.21 | 9.84 | 4.26 | 14.30 |
| BNP/SWS-RRF | 0.00 | 0.47 | 4.01 | 4.48 |
| SWS-RRF | 0.00 | 0.46 | 0.36 | 0.82 |
| Total | 58.47 | 136.45 | 57.91 | 252.82 |

corridors was worked out. First two corridors also connect the adjoining SWS with NNP and RRF, respectively. The smallest corridor with an area of 0.95 sq km connects SWS and RRF, with existing forest cover of 0.82 sq km. A corridor between RRF and ERF connects the two conservation blocks i.e. Nokrek and Balpakram Conservation blocks. The area of this corridor is 15 sq km, of which 95.40 % is under forest cover. NNP has been linked with ERF with two corridors, covering an area of 23 sq km and 16 sq km, respectively. These two corridors

contain 22 sq km (92.8 %) and 15 sq km (95.8 %) forest covers, respectively.

Williams and Johnsingh (1996) had earlier identified three elephant corridors in the GCA based on a short term field survey. These corridors were named as Siju-Rewak, BNP-Baghmara and Emangiri-Nokrek covering the area of 8 sq km, 31 sq km and 48 sq km, respectively. The seven corridors identified in the present study encompass three earlier identified corridors.

2.10 Protected Area Network

The forests, under the State Forest Department control are being managed as Protected Areas (PAs) and Managed Forests (RFs). The protected area network in GCA includes three PAs: Balpakram National Park (BNP-220 sq km), Nokrek National Park (NNP-47.48 sq km), Siju Wildlife Sanctuary (SWS-5.18 sq km), and the four Managed Forests include Reserved Forests (RFs) viz. Baghmara RF (BRF-44.29 sq km); Angratoli RF (ARF-30.10 sq km), Rewak RF (RRF-6.47 sq km), and Emangiri RF (ERF-8.29 sq km). All Protected Areas and Managed Forests except the ARF are well connected with each other through forest cover over community land. Although, the connecting forest has not yet been officially notified as corridors. There is a historic corridor between ARF and the Nokrek range, which is no longer in use for elephant movement. In some cases, e.g. Nokrek NP and Siju WLS, the administrative boundaries are not compatible with the ecological units in terms of habitat requirements of wild animals. Nokrek National Park is situated over Tura ridge as a linear belt, and the major portion of large contiguous dense forest lies outside the boundaries of the park.

2.10.1 Protected areas

The state government has recently created PAs in GCA by acquiring community owned forest land from local community. The Balpakram National Park was created in 1986 by acquiring 220 sq km of community land, followed by the addition of another 133 sq km of tribal land. Further, an additional 142 sq km of land is being proposed for acquisition to extend the area of park to a total 495 sq km.

Tura range situated at the northwest portion of the GCA has been recognised and protected as an important watershed by its indigenous people since the beginning of the 20th century. The area of Nokrek Ridge was declared as a national park in 1995. The Nokrek National Park includes the area at high altitude of ridge and forms the core of Nokrek Biosphere Reserve. The state government has preserved the whole mountain range as a Citrus Gene Sanctuary as the unusual and endemic citrus fruit trees grow in this area, which is known as *me'mang narang* in local dialect. Siju Wildlife Sanctuary, managed since 1883

as a reserved forest, was constituted as a sanctuary in 1979. Baghmara Pitcher Plant Sanctuary was created in 1984 in the middle of the Baghmara town to conserve the endemic Pitcher plant (*Nepenthes khasiana*) population. The Primary forests make up for major portion of the Protected Areas, whereas *jhum* fallows contain secondary forests (Pradeep and Bhogen 1997).

2.10.2 Reserved forests

The three reserved forests namely BRF, RRF and ERF were created at the start of the 20th century and since then they are being managed by the State Forest Department. Young secondary forests do not occur in these RFs since no *jhum* has been practised here for a long period (Forests resulting from *jhum* practiced a very long time ago are effectively considered as primary forests.) However, few plantations of *Shorea robusta* and *Tectona grandis* have been raised in these RFs during the 1930s. Therefore, mainly two categories of successional stages are found in these reserved forests, viz., the primary forests and old plantations. Also, the state government, after attaining statehood in 1972, has raised small plantations of cashew nut and rubber inside the reserved forests as well as outside the notified forest areas.

2.10.3 Community owned lands

Most of the remaining area, other than PAs and RFs, is managed by the 'Garo Hills District Council (GDC). The actual control at village level, however, remains with the Nokma or village community head. A major portion of the rural population depends upon the *jhumming* product for their livelihood. *Jhumming* is an integral part of their lifestyle and is intimately and deeply tied to the Garo's traditions, rituals, rites, and even language. In no small way, *jhum* defines the Garos as a people. Each *Aking* (village or group of small villages) has its own land for *jhumming* which is further distributed among families of that particular Aking by the Nokma. In case of any social or legal dispute, the Nokma's decision is final and binding on the villagers. The Nokma has authority to allot a particular land to a family for *jhumming* purpose. However, in some Garo villages such as Rongpha, near Mahadeo, the families select their own *jhum*

sites and the Nokma mostly is on hand to settle any disputes.

In the past, when population pressure was comparatively low, *Jhumias* (families practicing *jhumming*) used to return at an old *jhum* site after a gap of 20 to 30 years. Such fallow periods used to allow many elements of primary forest to return to the site, for the soil to regain its productivity, and for the latent primary-forest seed bank in the soil to become replenished. However, now-a-days, *jhum* cycle is reduced to just five to six years or even less; in some areas of northwestern GCA south of Tura the *jhum* cycle is only 1-3 years. This has had the devastating effect of loss of old-forest cover, loss of soil productivity, erosion of soil cover, leaching of vital soil nutrients, reduction and loss of old-forest associated biodiversity, and decline in agricultural yield. In recent times, some permanent or settled agriculture plots have been established, especially in valleys where water is available for irrigation, but these are the exceptions more than the rule. Some plantations have also been raised.

The GCA is, in effect, a complex mosaic of current and abandoned *jhum* fields, secondary forests, plantations, settlements, and primary forest patches. The area still has many patches of little disturbed or undisturbed primary forests, valuable wildlife corridors, water catchments and sites of biological interest.

2.10.4 Connectivity among Existing PA Network

The National Parks, Sanctuaries and the Reserved Forests in the GCA are scattered patches of varying size and shapes. Primary forests or older secondary forests cover the major portion of these PAs and RFs. Balpakram NP being the largest one (220 sq km) is very important from biodiversity conservation point of view (Kumar and Rao, 1985). Siju WS, at the northern boundary of Balpakram NP form a *de facto* part of the national park by sharing common boundary at some places. Rewak RF and BRF are the nearest neighbours of Balpakram NP with the nearest edge to edge distance of 1,563 m and 4,609 m, respectively. Angratoli RF is the farthest at a distance of 26,645 m from BNP (Table 2.22). Nokrek NP is situated in the northwest of Balpakram NP at the distance of 10,081 m. Emangiri RF is the closest neighbour of Nokrek NP at a distance of 5,599 m. Angratoli RF is the most distant as compared with other PAs and RFs and has the least probability of connectivity with other PAs and RFs (Table 2.25).

Existing protected area network in GCA cover only 15% of the entire landscape (2458.63 sq km). Forest area covers 68.35 % of study area. Total forest cover over community land is 1351.93 sq km. It means that 55.99% forest cover lies outside existing PA/RF boundaries, and is subjected to rapidly increasing resource use activities. The TMEE, TSEE, and TMDF cover 212.39 sq km, 499.54 sq km and 640 sq km

Table 2.22: Minimum edge-to-edge distance (in meters) among various Protected and Managed forests in GCA

| | BNP | NNP | SWS | BRF | ARF | ERF | RRF |
|--------------|-------|-------|-------|-------|-------|------|-----|
| Balpakram NP | 0 | | | | | | |
| Nokrek NP | 12418 | 0 | | | | | |
| Siju WLS | 0 | 10081 | 0 | | | | |
| Baghmara RF | 4609 | 19674 | 7667 | 0 | | | |
| Angratoli RF | 26645 | 21784 | 28038 | 19819 | 0 | | |
| Emangiri RF | 10980 | 5599 | 9906 | 13210 | 19661 | 0 | |
| Rewak RF | 1563 | 10801 | 847 | 5904 | 24263 | 6586 | 0 |

area, respectively. Out of 183.96 sq km land under bamboo growth, 174.55 belong to the community land (Tables 2.23 and 2.24).

Polyalthia simiarum, *Ficus species*, *Xylosma longifolium*, etc. Smaller trees of third storey consist of *Oriocnide integrefolia*, *Ficus lamponga*, *F. clavata*, *Miliusa roxburghiana*, *Boemeria hemiltonii*, *Antidesma bunius*,

Table 2.23: Forest types vs. land stewardship (ownership) in GCA

| Land Ownership | Forest Types | | | | | |
|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| | TMEF (Sq km) | % of TMEF | TSEF (Sq km) | % of TSEF | TMDF (Sq km) | % of TMDF |
| Community Land | 212.39 | 60.13 | 499.54 | 80.04 | 640.00 | 91.04 |
| Balpakram NP | 114.57 | 32.43 | 72.07 | 11.55 | 21.03 | 2.99 |
| Nokrek NP | 26.17 | 7.41 | 13.66 | 2.19 | 3.63 | 0.52 |
| Siju WLS | 0.00 | 0.00 | 3.55 | 0.57 | 1.39 | 0.20 |
| Baghmara RF | 0.08 | 0.02 | 15.48 | 2.48 | 18.80 | 2.67 |
| Angratoli RF | 0.01 | 0.00 | 10.32 | 1.65 | 13.16 | 1.87 |
| Emangiri RF | 0.01 | 0.00 | 7.21 | 1.16 | 2.84 | 0.40 |
| Rewak RF | 0.00 | 0.00 | 2.30 | 0.37 | 2.14 | 0.30 |
| Total | 353.23 | 100.00 | 624.13 | 100.00 | 703.00 | 100.00 |

2.10.4.1 Tropical moist evergreen forest (TMEF)

The Tropical moist evergreen forests represent least disturbed primary forests in the interior hills of the study area. These forest patches mainly confine to Tura ridge and around the gorge at Mahadeo River in Balpakram National Park. These forests cover an area of 353 sq km *i.e.* 14.4% of the entire landscape. The largest patch of 180 sq km is situated over the Tura ridge and extends from northwest corner of GCA to the north of Rewak area near the eastern boundary of GCA. BNP and NNP have 115 and 26 sq km area, respectively (Table 2.24). These forests form a closed canopy forest and are very rich in species diversity.

The top canopy consists of giant trees like *Castanopsis tribuloides*, *C. indica*, *Mesua ferrea*, *Schima wallichii*, *Bischofia javanica*, *Jantolis hookerii*, *Dysoxylum species*, *Cynometra polyandra*, *Acrocarpus fraxinifolius* and *Xerospermum glabratum* etc. Few deciduous tree species like *Tetrameles nudiflora* and *Firminia colorata* etc. also occur in these forests. Second storey is formed by tall but thin boled tree species like *Antidesma accuminata*, *Phoebe attenuata*, *Persia gamblei*, *Garcinia pedunculata*, *Vitex glabrata*, *Premna bracteata*, *Ficus racemosa*, *Diospyros variegata*, *Mangifera sylvatica*,

Ixora subsessilis, *Prismatomeris tetrandra*, *Saprosma ternatum* etc. Important shrub species are *Draecana elliptica*, *Leea edgeworthii*, *Canthium augustifolium*, *Lasianthus hookerii*, *Tabernaemontana divaricata*, *Hyptianthera stricata* etc. Acanthaceous herbs and some emergent ferns are found on forest floor covered by thick layer of humus and litter.

Lianas and large woody climbers of these forests include the species like *Hodgsonia macrocarpa*, *Beaumontia grandiflora*, *Gnetum scandens*, *Ventilago madrasputna*,

Table 2.24: Size class wise distribution of forest patches

| Size class | No. of patches | Area (sq km) | % Area |
|--------------|----------------|----------------|--------|
| 0.5-1 ha | 21543 | 147.44 | 6.64 |
| 1-10 ha | 18684 | 483.20 | 21.76 |
| 10-50 ha | 1572 | 312.55 | 14.07 |
| 50-100 ha | 185 | 128.26 | 5.78 |
| 1-10 sq km | 151 | 426.44 | 19.20 |
| 10-50 sq km | 20 | 360.91 | 16.25 |
| > 50 sq km | 3 | 361.92 | 16.30 |
| Total | 42158 | 2220.72 | |

Table 2.25: Size class wise distribution of Tropical Moist Evergreen Forest patches

| Size class | No. of patches | Area (sq km) | % Area |
|--------------|----------------|---------------|--------|
| 0.5-1 ha | 906 | 6.23 | 1.80 |
| 1-10 ha | 873 | 22.70 | 6.56 |
| 10-50 ha | 77 | 15.91 | 4.60 |
| 50-100 ha | 5 | 3.09 | 0.89 |
| 1-10 sq km | 7 | 15.69 | 4.53 |
| 10-50 sq km | 1 | 33.16 | 9.58 |
| > 50 sq km | 2 | 249.30 | 72.03 |
| Total | 1871 | 346.08 | |

Cayratia pedata, *Chonemorpha fragrans*, *Phanera nervosa*, *P. khasiana*, *Shefflera venulosa*, *Trechelospermum auritum*, *Combratum roxburghii*, *Entada purscatta*, etc. Among epiphytes, many species of orchids and ferns are prominent in these forests. Important species are *Dendrobium sp.*, *Pholidota sp.*, *Aerides sp.*, *Eria sp.*, *Coelogyne sp.*, *Cymbidium sp.* etc. Common ferns include the species like *Aeschenanthes species*, *Hoya species*, *Agapetes species*, *Hymenopogon species*, *Agrostemma species*, etc. *Ficus* trees in these forests start their life as epiphytes but later on establishes connection with ground and strangle host to death. On the other hand weak plants *Raphidophora decursiva*, *R. lancefolia*, *Piper sp.* grow robust from ground clasping and covering the trunk of trees.

2.10.4.2 Tropical semi-evergreen forests (TSEF)

These forests cover 624 sq km (25.4 %) of land. The largest patch covered 113 sq km land extending along the southern side of Tura ridge. The majority of semi-evergreen forest type patches occur in the community owned private land and covered 500 sq km. These forests are mainly confined to the periphery of large contiguous patches of dense tropical moist evergreen forests. BNP and NNP, respectively, have 72 and 14 sq km of semi-evergreen forests (Table 2.26).

2.10.4.3 Tropical moist deciduous forests (TMDF)

The major portion of these forests occur in the areas affected by the human activities, especially *jhumming*. These forests cover an area of 703 sq km (28.6%).

Table 2.26: Size class wise distribution of Tropical Semi-evergreen Forest patches

| Size class | No. of patches | Area (sq km) | % Area |
|--------------|----------------|---------------|--------|
| 0.5-1 ha | 2560 | 17.60 | 2.92 |
| 1-10 ha | 2572 | 71.25 | 11.84 |
| 10-50 ha | 293 | 60.49 | 10.05 |
| 50-100 ha | 45 | 31.12 | 5.17 |
| 1-10 sq km | 43 | 121.25 | 20.14 |
| 10-50 sq km | 11 | 187.54 | 31.16 |
| > 50 sq km | 1 | 112.62 | 18.71 |
| Total | 5525 | 601.88 | |

The largest patch has an area of 41sq km. These forests naturally occur in the alluvial plains and comprise of Sal forests most of which are confined within the boundaries of the existing PA network. The community land has the major portion of TMDF, 640 sq km i.e. 91% of total TMDF (Table 2.27). The tropical moist deciduous forests in community land have resulted gradually due to exploitation of natural forests by local communities.

Table 2.27: Size class wise distribution of Tropical Moist Deciduous forest patches

| Size class | No. of patches | Area (sq km) | % Area |
|--------------|----------------|---------------|--------|
| 0.5-1 ha | 3950 | 27.00 | 4.10 |
| 1-10 ha | 4049 | 109.95 | 16.71 |
| 10-50 ha | 522 | 109.31 | 16.61 |
| 50-100 ha | 88 | 61.96 | 9.41 |
| 1-10 sq km | 76 | 222.65 | 33.83 |
| 10-50 sq km | 7 | 127.26 | 19.34 |
| > 50 sq km | 0 | 0.00 | 0.00 |
| Total | 8692 | 658.12 | |

2.10.4.4 Bamboo and young secondary Forests

These seral communities have developed through the course of time either naturally over rocky plateau or by clearing of primary forests by man. The tree-savannas occur, especially in Balpakram area, with tall grass species like *Saccharum*, *Phragmites*, *Arundo* etc. A few scattered trees are *Helicia nilagirica*,

Engelhardia colebrookiana, *Emblica officinalis* etc. grow scattered here and there. Bamboo forests usually develop in the *jhum* fallows. Common bamboo species are *Dendrocalamus hamiltonii*, *D. gigantea*, *Bamboosa bambos*, *Chimanobambusa khasiana*, *Melocanna bambusoides*, etc. Bamboos also grow in the canopy gaps of primary and older secondary forests around Siju, Rongra and Balpakram areas.

2.10.5 Assessing effectiveness of existing PA network

Existing protected area network in GCA cover only 15% of the entire landscape (2458.63 sq km). Forest area covers 68.35 % of study area. Total forest cover over community land is 1351.93 sq km. It means that 55.99% forest cover lies outside existing PA/RF boundaries, and is subjected to rapidly increasing resource use activities. The TMEF, TSEF, and TMDF cover 212.39 sq km, 499.54 sq km and 640 sq km area, respectively. Out of 183.96 sq km land under bamboo growth, 174.55 belong to the community land (Tables 2.28 and 2.29).

2.11 Significance from management point of view

The GCA harbours good forest wealth with large contiguous patches of old forest growth. Most of the forest tracts in the interior hills are almost inaccessible and hence, still remain intact although *jhum* agriculture is proceeding in areas of primary forests adjacent to Balpakram National Park. Existing protected area

Table 2.28: Distribution Forest types in different land ownership categories

| Land Ownership | TMEF (sq km) | TSEF (sq km) | TMDF (sq km) | Non-forest (sq km) | Total (sq km) |
|----------------|---------------|---------------|--------------|--------------------|---------------|
| Community Land | 212.39 | 499.54 | 640 | 174.55 | 2092 |
| PAs | 140.74 | 89.28 | 26.05 | 3.53 | 276 |
| RFs | 0.1 | 35.31 | 36.94 | 5.88 | 90 |
| Total | 353.23 | 624.13 | 703 | 183.96 | 2459 |

Table 2.28: Percentage area of Different Forest Types in different land ownership categories

| Land Ownership | TMEF (%) | TSEF % | TMDF (%) | Non-forest (%) | Total (%) |
|----------------|----------|--------|----------|----------------|-----------|
| Community Land | 60.13 | 80.04 | 91.04 | 94.88 | 85.10 |
| PAs | 39.84 | 14.30 | 3.71 | 1.92 | 11.25 |
| RFs | 0.03 | 5.66 | 5.25 | 3.20 | 3.65 |

network in GCA cover only 15% of the entire landscape (2,459 sq km). Forest area covers 68.4 % of the landscape. Total forest cover over community land is 1,352 sq km. It means that 56% forest cover lies outside existing PA/MF boundaries, and is subjected to rapidly increasing resource use activities. The older forests in GCA, comprise of TMEF, TSEF, and TMDF cover 212 sq km, 500 sq km and 640 sq km area, respectively and harbour a variety of flora and fauna (Kumar and Rao, 1985; Anon., 1995). The recent increase in *jhumming*, illegal felling and logging and other resource use activities has led to increased forest fragmentation and loss of old-forest (> 30 yrs old) habitat.

The result suggests that 1,742 sq km (71%) area is under low fragmentation. Total 525 sq km land is under moderate or high fragmentation. These are more prevalent in southwestern portion of Garo Hills. Loss of large sized forest tracts might adversely affect wildlife closely associated with forest interior conditions, such as tiger, hollock gibbons, flying squirrels, Malayan giant squirrel, large Indian civet, peacock pheasants and others; however, effects on these species from old-forest habitat loss and fragmentation, incursion of *jhum* lands, and associated forest edges has not been studied in this region.

Fortunately, substantial portions of the remaining old forest cover is currently protected with, and connected among, Protected Areas and Managed Forests. We identified seven corridors of old forest as possible

dispersal or population connectivity habitats for wildlife, that currently connect the larger extant forest patches. These corridors collectively cover 274 sq km of community owned land of which 253 sq km is in older ages of TMEF, TSEF and TMDF. The corridors could be managed as actual or *de facto* wildlife sanctuaries, the purpose being to protect the old forest stands from excessive *jhum* and to protect wildlife from excessive hunting. The forests inside the proposed corridors harbour good wealth of flora as well as fauna (unpublished data) and thus should be protected and monitored from conservation point of view. It is proposed that the State Government of Meghalaya through its State Forest Department should conduct studies to prepare preliminary inventories of various plant and animal taxa and population status of important vertebrate and invertebrate species prior to taking any decision regarding wildlife conservation and management in the Garo Hills, Meghalaya.

2.12 Summary

The land in GCA can be grouped into three broad categories based on the legal status of land such as Protected Areas as National Parks and Sanctuaries; Managed forests in the form of Reserved Forests; and the Community or privately owned land. All together, these PAs and RFs covers 372 sq km land (15% of GCA) and are under the control of state government whereas the remaining about 85% land of GCA belongs to tribal councils and individuals termed as community land in present study. Such lands are being used for agriculture, plantation, settlement and other non-forest landuses.

The older secondary growth provides very crucial habitat elements to the variety of wild animals. The distinct age-growths of secondary forests and the primary forests have been discussed and compared with the Budowski's table, which provides the ecological characteristics of primary and various successional stages of secondary forests.

The numbers of tree species with gbh 30 cm or more are 162 (N=21) in the primary forest and 132 (N=10) in the secondary forests of GCA. The numbers of species in young (< 15 years old named as SF1, N=3), mature (10-30 years old, SF2, N=4) and Old (> 30 years old, N=3) secondary forests are 94, 80 and 102, respectively. The species composition and other vegetation characteristics of these forest growths have also been discussed. The Secondary degraded forests with less plant diversity, inferior quality trees and invasion of weeds have occurred over a larger portion of the landscape. The few characteristic trees are *Bauhinia variegata*, *Emblia officinalis*, *Careya arborea*, *Callicarpa arborea*, *Glochidion species* etc. *Eupatorium odoratum*, *Mikania micratha* comprises the bulk of weeds.

The forest growths of various age classes are characterized by evergreen and deciduous tree species in varying proportions. The distinct tree communities as separated through a cluster analysis were named as the tropical moist evergreen, tropical semi-evergreen and tropical moist deciduous forests based on the proportion of evergreen or deciduous elements, that is, tree species following the Champion and Seth's legendary classification of Indian forests into 'Forest Types'. These forest types *viz.* Tropical Moist Evergreen Forest (TMEF), Tropical Semi-Evergreen Forest (TSEF) and Tropical Moist Deciduous Forest (TMDF) comprise 353, 624 and 703 sq km of forest cover, which is 14%, 25% and 29% of landscape, respectively.

A total of 411 tree species have been recorded which belong to 71 families and 224 genera. Euphorbiaceae (33), Lauraceae (31), Moraceae (30) and Rubiaceae (26) are the families found with more than 25 species. There are 54 families with five or less than five species of which 23 are represented by single species. Out of total 187 tree species (gbh more than 30 cm) were sampled using 35 one-hectare belt transects (10m x 1000m) and 164 have been retained after sorting the species. *Bignonia sp.*, *Ilex sp.*, *Mallotus sp.*, *Drimycarpus*

sp., *Artocarpus sp.* and *Carralia sp.* are among the most common tree species.

The results of vegetation data analyses from present study are compared with those of other similar studies in tropical forests of India and other tropical countries. The Shannon-Weiner diversity indices computed for the tropical moist evergreen, moist deciduous and semi-evergreen forests of GCA are 4.03, 2.44 and 4.07, respectively. Stratified random sampling using belt transect method was employed for assessment of vegetation composition, structure, secondary changes in tree communities and significant microhabitats. Species associations (formations) in three forest types were identified through cluster analysis using ward's method and phi-square distance measure. Also, the 35 samples, each covering one-hectare land, were grouped into three forest types based on the predominance of evergreen and deciduous elements. Frequency, abundance, density, basal area per hectare and importance value index (IVI) were computed for different forest types and discussed in the context of assessing effectiveness of the existing protected area network and status of conservation status in the study area. Secondary changes in tree communities were assessed by observing the appearance and disappearance of one or more species from different categories of secondary forests as compared to primary forests.

The landuse landcover map of the GCA prepared during the present study was used to analyse and understand the landscape structure. The several landscape metrics *viz.* area, patch, nearest neighbour and core area metrics were computed to quantify landscape composition and configuration (McGarigal and Marks 1994). Fragmentation image was used to draw potential wildlife corridors linking protected natural areas and managed forests of GCA. The result suggests that 1,742 sq km (71%) area is under low fragmentation. Total 525 sq km land is under moderate or high fragmentation. The Core Area metrics were computed to identify potential wildlife habitats. A total of 2,236 forest patches with the available collective core area of 561 sq km were found at the edge distance buffer width of 250 m, which were reduced to 644 patches (291 sq km) when the edge distance was increased to 500 m. The mean distance was the maximum for tropical semi-evergreen forests (38 km) and lowest for bamboo (25 km) patches. The seven major corridors that seem to link the most PAs and MFs were identified in GCA. The total area under these corridors is 274 sq km, of which 253 *i.e.* 92.1 % has forest cover. Existing protected area network in GCA cover only 15% of the entire landscape (2459 sq km). Forest area covers 68.35 % of study area. Total forest cover over community land is 1351.93 sq km. It means that 55.99% forest cover lies outside existing PA/RF boundaries, and is subjected to rapidly increasing resource use activities.

Chapter 3

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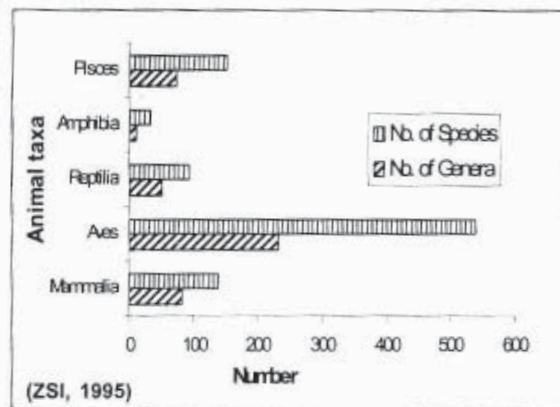
Chapter 3

Fauna

3.1 Introduction

The Meghalaya harbouring 5,538 animal species contributes significantly in the faunal diversity of India (ZSI, 1995). It is quite rich as far as the numbers of vertebrate and invertebrate species are compared with other regions of India, which are in the ratio of 5:1. Among invertebrates 4,580 species belonging to 2,094 genera have been recorded from the state. Though the geographical area of Meghalaya is less than one percent (1%) of India, it harbours more than 35% mammals and 50% birds of India. A total of 958 species (451 genera) of vertebrates have been recorded from Meghalaya (See

Box). The recorded number of species of reptilia, amphibia, and pisces are 94 (51), 33 (11) and 152 (74), respectively (Numbers in parentheses indicate the number of genera).



The three districts of Garo Hills viz. East Garo Hills, West Garo Hills and South Garo Hills, covering about one third portion of Meghalaya exhibit rich faunal diversity with 859 vertebrate species. There are 85 mammal species (61% of Meghalaya) in

Garo Hills. Insectivores, primates (apes and monkeys), canids, felids, bovids, viverrids, chiropters and rodents count 4, 8, 3, 7, 5, 4, 17 and 20, respectively (Table 3.1). There are 62, 14, 124 and 79 species of reptiles, amphibians, fish and butterfly, respectively in the Garo Hills (Table 3.2).

Table 3.1: Number of species belonging to various mammal taxa in Garo Hills

| Mammal group | Species |
|---|-----------|
| Mammals | 85 |
| Insectivores | 4 |
| Primate species (Apes & Monkeys) | 8 |
| Canidae (Wild Dogs <i>etc.</i>) | 3 |
| Felid species (Cats) | 7 |
| Bovids species (Hoofed animals) | 5 |
| Viverridae species (Civets) | 4 |
| Chiropters (Bats) | 17 |
| Rodents (Squirrel, Giant squirrel & rats) | 20 |

Source: 1. Fauna of Meghalaya, ZSI, 1995

Table 3.2: Number of species belonging to various animal taxa in Garo Hills

| Animal group | Species |
|----------------|---------|
| Birds | (423) |
| Reptiles | (62) |
| <i>Turtles</i> | 10 |
| <i>Snakes</i> | 28 (36) |
| <i>Lizards</i> | 18 |
| Amphibians | (14) |
| Fish | 124 |
| Butterflies | (79) |

Sources: 1. Fauna of Meghalaya, ZSI, 1995 and 2. Ghosh (1985) for figures in parentheses

The earliest detailed faunal assessment in Garo Hills was done for Siju cave by Kemp and Chopra (1924), who studied the animals and the cavernicolous (or cave adaptations) of animal life and provided the species account under different taxa in the cave (Table 3.3).

Table 3.3: Fauna of Siju Cave

| S. No. | Taxa | No. of Species |
|--------|-----------------------|----------------|
| 1 | Mammals | 5 |
| 2 | Fish | 8 |
| 3 | Molluscs | 2 |
| 4 | Decapods | 3 |
| 5 | Isopod Crustaceans | 4 |
| 6 | Myriapods Crustaceans | 6 |
| 7 | Orthopteran insects | 10 |
| 8 | Rhyncota | 4 |

Source: Ghosh, 1985

Balpakram area has been regarded as the most diverse in Garo Hills (Ghosh and Biswas, 1977). Ghosh (1985) has quoted the Balpakram as an index to the faunal resources of the entire Garo Hills. A faunal survey was attempted within the proposed Balpakram wildlife sanctuary during 1976 (Ghosh 1985) covering 125 sq Km. The five species of primates viz. hollock gibbon (*Bunopithecus hoolock*), Rhesus macaque (*Macaca mulatta*), Assamese macaque (*Macaca assamensis*), Capped langur (*Trachypithecus pileatus*) and slow loris (*Nycticebus coucang*) were recorded in the sanctuary. Among the carnivores, tiger (*Panthera tigris*), leopard (*Panthera pardus*), jungle cat (*Felis chaus*), leopard cat (*Felis bengalensis*), wild dog (*Cuon alpinus*), large Indian civet (*Viverra zibetha*), hog-badger (*Arctonyx collaris*), yellow throated marten (*Martes flavigula*), Himalayan black bear (*Selenarctos thibetanus*) and jackals (*Canis auceus*) were recorded. Besides primates and carnivores, other

species recorded were Indian bison (*Bos gaurus*), goral (*Nemorhaedus goral*), elephant (*Elephas maximus*), barking deer (*Muntiacus muntjak*), sambar (*Cervus unicolor*), porcupine (*Hystrix indica*) and Indian hare (*Lepus nigricollis*).

The report of Elephant census in the proposed Balpakram Wildlife Sanctuary of that time (1981) by the State Forest Department of Meghalaya, provides the approximate number and broad habitats of 20 important mammal species (approximate number of nine bird species (Tables 3.5). The evergreen forests in the interior hills, limestone area and around plateau grassland are the major habitat for wild animals (Kumar and Rao, 1985). The Balpakram National Park forms the excellent habitat for elephant, hoolock, capped langur, sambhar and barking deer.

The plant species like *Arundinella bengalensis*, *Neyraudia reymendiana*, *Calamus spp.*, leaves and fruits of *Trema orientalis*, *Bauhinia purpurea*, *Rhus javanica*, *Dillenia indica*, *D. pentagyna*, *Artocarpus chaplasha*, *Sterculia roxburghii*, *Stereospermum chelonoides* and *Litsea polyantha* along with many species of wild banana and bamboo are the major food items for elephants. Elephants visit nearby villages and *jhum* fields also during dry season in search of food. The *Jhum* and cash crops like tapioca, sweet potato, pineapple, banana and other cultivated plants are the preferred food of elephants. A considerable damage is done to *jhum* fields and horticultural *bagans*, whenever an Elephant herd raids any village.

Sambhar and barking deer prefer thick undergrowth and sometimes also seen in open areas, in *jhum* fields and on roadsides. The fruits of *Dillenia indica*, *Olea dentata*, *Emblica officinalis*, *Semicarpus anacardium*, *Spondius pinnata*, *Terminalia bellirica*, *T. chebula*, *Vitex peduncularis*, *Solanum sp.* and Convolvulaceae climbers in wild along with Sweet potato, and some crop plants in the *Jhums* are the preferred food item of sambhar and barking deer (Kumar and Rao, 1985).

Table 3.4: Common wild mammals in proposed Balpakram Wildlife Sanctuary during 1981 census

| Species | Common Name | Habitat | Approx. No. |
|---------------------------------|-----------------------|---|-------------|
| <i>Elephas maximus</i> | Asian Elephant | Evergreen Forest | 860 |
| <i>Panthera tigris</i> | Tiger | Evergreen forest in Lime stone area | 10 |
| <i>Panthera pardus</i> | Leopard | Dense evergreen forest | 7 |
| <i>Neofelis nebulosa</i> | Clouded leopard | Dense evergreen forest | 1 |
| <i>Felis bengalensis</i> | Leopard cat | Dense evergreen forest | 4 |
| <i>Felis Temmincki</i> | Jungle cat | Evergreen forest | 6 |
| <i>Bos gaurus</i> | India bison | Pocket of evergreen forest near grassland | 54 |
| <i>Bibos species</i> | Mithun | Pocket of evergreen forest near grassland | 24 |
| <i>Bubalus bubalis</i> | Wild buffalo | Pocket of evergreen forest near grassland | 2 |
| <i>Trachypithecus pileatus</i> | Capped Langur | Evergreen forest | 193 |
| <i>Bunopithecus hoolock</i> | Hoolock gibbon | Evergreen forest | 102 |
| <i>Selenarctas thibetanns</i> | Himalayan balack bear | Evergreen forest | 19 |
| <i>Sus scrofa</i> | Wild pig | Evergreen forest | 102 |
| <i>Cervus unicolor</i> | Sambar | All types of forest | 79 |
| <i>Muntiacus muntjak</i> | Barking deer | All types of forest | 172 |
| <i>Cuon alpinus</i> | Wild dog (Dhole) | Evergreen forest | 15 |
| <i>Capricornis sumatraensis</i> | Serow (Greatantelope) | Evergreen forest | 23 |
| <i>Nycticebus coucang</i> | Slow loris | Evergreen forest | 2 |
| <i>Petaurista candidatus</i> | Flying squirrel | Evergreen forest | 21 |
| <i>Ratufa indica</i> | Giant squirrel | Evergreen forest | 4 |

Source: Kumar and Rao, 1985

Table 3.5: Approximate Nos. of few common birds seen in the proposed Balpakram National Park

| Species | Common name | Approx. No. |
|----------------------------------|------------------------|-------------|
| <i>Anthracoeros Malabaricus</i> | Oriental pied hornbill | 169 |
| <i>Bubo zeylonensis</i> | Brown fish Owl | 140 |
| <i>Chalcophaps indica</i> | Emerald dove | 46 |
| <i>Coturnix coturnix</i> | Common Quail | 4 |
| <i>Falco jugger</i> | Lagger Falcon | 30 |
| <i>Gallus gallus</i> | Red jungle fowl | 226 |
| <i>Gracula religiosa</i> | Hill myna | 27 |
| <i>Oriolus oriolus</i> | Golden oriole | 35 |
| <i>Polyplectron bicalcaratum</i> | Grey Peacock pheasant | 85 |

Source: Kumar and Rao, 1981

Large herbivores like Indian bison and wild buffalo are confined to Balphakram plateau, covered by grasslands. They visit the nearby evergreen and mixed evergreen patches of undisturbed forests also. The grass species consumed by these animals are *Alloteropsis semialata*, *Arundinella bengalensis*, *Centotheca lappacea*, *Cymbopogon khasianum*, *Echinochloa colonum* and *Ischaemum geobelli*.

Hoolock gibbons are mostly confined to undisturbed evergreen forest, with tall canopied trees. They generally eat fleshy fruits of *Ficus*, *Spondius pinnata*, *Garcinia cowa*, *Terminalia bellirica* and *T. chebula*. Alfred and Sati (1990) recorded the hoolocks in deciduous forests also.

3.2 Group overviews

3.2.1 Mammals

Of the mammals, Malayan shrew, Indian flying fox, slow loris, rhesus monkey, hoolock gibbon, Himalayan black bear, Yellow throated marten, hog-badger, large Indian civet, crab eating mongoose, tiger, leopard, clouded leopard, wild boar, etc. present an array of diversified animals adapted to peculiar habitat conditions, which are offered by the GCA (see annexure 11 for details of mammals).

3.2.1.1 Tiger

The population estimates for tiger were carried out throughout the state during 1992-93 by the State Forest Department of Meghalaya. The census area covered 9,676 sq km area in the state (43% of Meghalaya), of which 42%, 16%, 35% and 6% belong to East/West Garo Hills, South Garo Hills, Khasi hills and Jaintia Hills districts, respectively. Accordingly, the population estimate for tiger in the Meghalaya was 63, of which 34 (54% of the tiger population of

Meghalaya) were present in the Garo Hills. Though the South Garo Hills included only 16% of census area about 27% of tigers were reported from this district (Table 3.6).

Table 3.6: Census figure of Tiger (1993)

| District | Number | | Census Area (sq km) | |
|--------------------------|-----------|-----|---------------------|-----|
| East and West Garo Hills | 17 | 27% | 4,094 | 42% |
| South Garo Hills | 17 | 27% | 1,596 | 16% |
| Khasi Hills | 22 | 35% | 3,406 | 35% |
| Jaintia Hills | 7 | 11% | 580 | 6% |
| Total | 63 | | 9,676 | |

Source: SFD, Meghalaya, 1993

Hoolock gibbon

Alfred and Sati (1990) surveyed 200 localities (5,075 sq km) of West and South Garo Hills districts and recorded gibbon groups and individuals in 32 localities (812 sq km). They identified 2 family groups and four floating individuals over 1395 ha of actual forest area. Out of total 130 (126 in groups+ 4 floating individuals) individuals 67% were adult, male or females (> 7years), while the sub-adults (4-7 years), juveniles (2-4 years) and infants (< 2 years) were 6%, 12% and 15%, respectively (Table 3.7).

The group size varied from two to six. Of these, 50% (63 individuals) were found in the group of three, followed by 31% (13 individuals) in the group of two. Only one group had been seen with six individuals (Table 3.8). the group and individual densities were three groups and nine individuals per sq km in surveyed area.

Table 3.7: Population status of Gibbons in West and South Garo Hills districts

| Particulars | | Figures | | % of total individuals (N=126) | |
|------------------------|-----------|---|----|--------------------------------|-------|
| No. of localities | | 32 | | --- | |
| Area surveyed (sq km) | | 812 | | --- | |
| Territory size (sq km) | | 14 | | --- | |
| Number of groups | | 42 | | --- | |
| Number of individuals | Adult | Male | 42 | 85 | 33.33 |
| | | Female | 43 | | 33.33 |
| | Sub-adult | Male | 6 | 11 | 3.97 |
| | | Female | 5 | | 2.38 |
| Juvenile | | 15 | | 11.91 | |
| Infants | | 19 | | 15.08 | |
| Total | | 130 (126 + 4 floating individuals) | | | |

Source: Alfred and Sati, 1990

Alfred and Sati (1990) compared their study with other studies in India and Bangladesh. Territory ranges for various family groups varied from 14 ha to 55 ha, whereas a study in Tripura (India) showed the territory size of 300-400 ha. (Table 3.9), however the average group size of 3 ± 0.3 was constant in all studies.

The area of 32 localities varied from 3 to 415 sq km, whereas the forested area ranged from 14 to 277 ha. Out of 200 localities studied, gibbons were found in 32 localities only. Approximately 75% of the gibbon population was found near village sacred forests, where the cultivated fruit trees like mango, jackfruit, orange and guava were grown. Though, other 168 localities had the similar vegetation type and for most of these localities the local villagers had confirmed the existence of gibbons during late seventies and early eighties.

Table 3.8: Hoolock gibbon group counts

| Group size | Frequency | No. of individuals |
|--------------|-----------|--------------------|
| 6 | 1 | 6 |
| 5 | 3 | 15 |
| 4 | 4 | 16 |
| 3 | 21 | 63 |
| 2 | 13 | 26 |
| Total | 42 | 126 |

(Source: Alfred and Sati, 1990)

The 32 localities where gibbons survived were surrounded by the forested hills with enough space for new gibbon colonies. While other 168 localities did not have continuous dense forest canopy. Hazarika (1988) had recorded that 550 sq km forest area in Meghalaya was deforested each year due to shifting cultivation. So the population of gibbons in the state was under great threat and required the immediate attention for proper conservation strategies in those 32 localities (Alfred and Sati, 1990). Now, after about more than 10 years, it's time to re-inspect the gibbon population in those 32 localities for assessing the existing status of gibbons in the Garo Hills, so that the proper conservation strategies for protecting gibbons and their habitats can be worked out timely, in the region.

Table 3.9: Territory size and density of Hoolock gibbons compared with other studies

| Location | Assam (India) | Tripura (India) | Sylhet (Bangla Desh) | West Garo Hills (India) |
|------------------------------|------------------|--------------------|--------------------------|----------------------------|
| Area Surveyed (sq km) | 8 | 11 | 162 | 812 |
| Territory Range size (ha) | 18-30 | 300-400 | 3.2 | 14-55 |
| | Mean | 22 | 300 | 31 |
| No. of Groups | 7 | 6 | 6 | 42 |
| Total Gibbons | 26 | 16 | 21 | 130 |
| Av. Group size | 3.4 | 3.2 | 3.5 | 3 |
| Group per sq km | 2.2 | 0.55 | 4.4 | 3.01 |
| Gibbons per sq km | 7.55 | 1.45 | 5.25 | 9.03 |
| Authority | Tilson (1979) | Mukharjee (1982) | Gittins & Tilson, (1984) | Alfred & Sati (1990) |

Source: Alfred and Sati, 1990

3.2.1.3 Elephant

A total of 2,872 elephants were recorded in the Meghalaya during 1992-93 Census, of which 1,850 elephants were found in the Garo Hills. Out of these 2,872 elephants, 1,460 individuals were recorded through direct sighting and 390 were estimated on the basis of indirect evidences (Table 3.10). The population estimate for elephant in the South Garo Hills district was 910 whereas 591 elephants were estimated in the Balpakram National Park alone during 1993 (SFD, 1995). However, Kumar and Rao (1985) quoted 860 individuals in Balpakram National Park based on the census data from State Forest Department during 1981 (Table 3.4).

Out of total 1460, solitary and maljuria elephants were 20 and 8, respectively. Males, females and unsexed (sex unidentified) were 313, 518 and 601, respectively, among the rest of 1,432 individuals. Adults, sub-adults and calves in the Garo Hills are 716 (195 males, 432

Table 3.10: Census figure for Elephants (1993 Census)

| District | Meghalaya | Garo Hills |
|--------------------------|--------------|--------------|
| Direct sighting | | |
| Garo Hills | 1,460 | 1,460 |
| Khasi Hills | 742 | |
| Jaintia Hills | 20 | |
| Total | 2,222 | 1,460 |
| Indirect sighting | | |
| | 650 | 390 |
| Total | 2,872 | 1,850 |

Source: SFD, Meghalaya, 1993

females and 189 unidentified), 401 (109 males, 84 females and 208 unidentified) and 215 (9 males, 2 females and 204 unidentified) respectively (Table 3.11).

Table 3.11: Elephant Population structure in Garo Hills (1993)

| Elephant group | Male | | Female | Unsexed | Total |
|-------------------|--------|------------|------------|------------|--------------|
| | Tusker | Makna | | | |
| Adult | 164 | 31 | 432 | 189 | 716 |
| Sub-adult | 96 | 13 | 84 | 208 | 401 |
| Calf | | 9 | 2 | 204 | 215 |
| Total | | 313 | 518 | 601 | 1,432 |
| Solitary | 18 | 2 | | | 28 |
| | | 20 | | | |
| Maljuria | 6 | 2 | | | |
| | | 8 | | | |
| Total | | | | | 1,460 |
| Indirect Sighting | | | | | 390 |

Source: SFD, Meghalaya, 1993

According to Gogoi and Chowdhary (1982) the proposed Balpakram wildlife sanctuary (292 sq km) and its buffer zone (292 sq km) harboured 580 (including three solitary individuals) and 280 elephants, respectively (Table 3.12). The ratios among adult, sub-adult and calf in Total Census Area and the

Table 3.12: Elephant population in proposed Balpakram Wildlife Sanctuary and its surroundings

| Population structure | Proposed Balpakram WLS | Buffer zone | Total Census Area |
|----------------------|------------------------|-------------|-------------------|
| Adult | 296+3 solitary | 115 | 471 |
| Sub-adult | 178 | 58 | 236 |
| Calf | 103 | 47 | 150 |
| Total | 577+3=580 | 280 | 860 |

Source: Gogoi and Chowdhary, 1982

proposed Balpakram Sanctuary are 3.14: 1.57: 1 and 2.87: 1.73: 1, respectively.

The entire population of elephants in Garo Hills has been over only 5,909 sq km area (72% of the entire Garo Hills). Of this, about 2,636 sq km land is under private forest (307 elephants), whereas the rest of 1,153 individuals were found over other 3,273 sq km area including government owned forests in the form of Protected Areas and Reserved Forests and their adjoining forest land (Table 3.13).

3.2.1.3.1 The elephant mortality

IUCN's Species Survival Commission's Asian Elephant Specialist Group, during year 2000 estimated a population of *c.* 35,000 to 51,000 Asian elephants in world; *c.* 19,100 to 29,450 in India and *c.* 7,200 to 11,300 in Northeast India (IUCN, 2000). The elephant population in the North East region of India

Table 3.13: Elephant bearing areas in the Garo Hills

| Name of the forests | Location | Approximate area of Forests (sq. km.) | No. of Elephants |
|---|-----------------------------|---------------------------------------|------------------|
| Government owned Forests and adjoining forest land | | | |
| Balphakram NP | South GH | 538 | 591 |
| Nokrek NP | West GH and part of East GH | 516 | 161 |
| Rewak-Emangiri RF | South GH | 657 | 172 |
| Angratoli RF | South GH | 307 | 98 |
| Dibru Hills RF | West GH | 180 | 27 |
| Songsak RF | East GH | 434 | 51 |
| Dambu-Darugiri RF | East GH | 398 | 17 |
| Dhima-Rajasimla-Ildek RF | East GH | 243 | 36 |
| Total | | 3273 | 1153 |
| Purely unclassified Private Forests | | | |
| Rongchugre-Chesingre RF | South GH | 1069 | 87 |
| Moranga RF | South GH | 279 | 4 |
| Rangira-Damalgre RF | West GH | 586 | 83 |
| Kherapeara-Dana-Adugre- Rongmagre | West GH | 702 | 133 |
| Total | | 2636 | 307 |
| GRAND TOTAL | | 5909 | 1460 |

Source: SFD, Meghalaya, 1993

inhabits a very wide area and so it is difficult to protect the entire elephant ranges, given meager resource available. The latest estimate of elephant populations in Meghalaya is 1,840 (Marak, 1998).

A few years ago, when the large population of elephants in Meghalaya became a problem for people, the government had to take the action to control the elephant population. A total of 256 elephants were

captured from different districts of Meghalaya during 1977 to 1981, of which 60% (152 elephants) were captured from Garo Hills only (Table 3.14). Maximum elephants (69) were captured during 1979-80. A total of 76 elephants were shot dead in Garo Hills under Elephant Control Scheme during 1970 and 1976. Most of them (63) were eliminated during 1971 and 1972 (Table 3.15).

Table 3.14: Capture statement for elephants of Meghalaya

| Financial year | East Garo Hills | West and South Garo Hills | Total | East Khasi Hills | West Khasi Hills | Jayantia Hills | Grand Total |
|----------------|-----------------|---------------------------|------------|------------------|------------------|----------------|-------------|
| 1977-78 | | | | | 24 | | 24 |
| 1978-79 | 11 | 34 | 45 | | 15 | | 60 |
| 1979-80 | 42 | 27 | 69 | 11 | 14 | | 94 |
| 1980-81 | 21 | 17 | 38 | 34 | 6 | | 78 |
| Total | 74 | 78 | 152 | 45 | 59 | | 256 |

Source: SFD, Meghalaya, 1993

Table 3.15: Statement of elephant eliminated and captured in Garo Hills, Meghalaya

| Year of Elimination | Shot under Elephant control Scheme | | Shot as proclaimed rogue | | | Shot by poachers | | Death due to unknown causes | | Death due to epidemic | | |
|---------------------|------------------------------------|-----------|--------------------------|----------|----------|------------------|----------|-----------------------------|----------|-----------------------|----|----|
| | Tu/Ga | Ma | Tu | Ma | Fe | Tu | Ma | Tu | Ma | Tu | Ma | Fe |
| 1970 | 29 | 12 | 15 | | | | | | | | | |
| 1971 | 11 | 11 | 1 | | | | | | 1 | | | |
| 1972 | 3 | 4 | | | | | | | | | | |
| 1973 | | | | | | | | | | | | |
| 1974 | 1 | 1 | | 1 | | | | | | | | |
| 1975 | 1 | 1 | | 1 | | 2 | | | | | | |
| 1976 | 2 | | 1 | | 1 | | | | | 1 | | |
| 1977 | | | | | | | | | | | | |
| 1978 | | | | | | | | | | | | |
| 1979 | | | | | | | | | 1 | | | |
| 1980 | | | | 1 | | 1 | 1 | | | | | |
| 1981 | | | | | | | | | 1 | | | |
| Total | 47 | 29 | 17 | 3 | 1 | 3 | 1 | | 3 | 1 | | |

Source: SFD, Meghalaya, 1993

Note: Tu: Tusker, Ga: Ganesh, Ma: Makna and Fe: Female

According to IUCN's Species Survival Commission's Asian Elephant Specialist Group (WWE, 1996), "the population of elephants in Garo Hills i.e. West Meghalaya is probably the most threatened population of its size throughout the entire range of the Asian elephant". During 1993 elephant census in Garo Hills the estimated population of elephants was 1850 (SFD, 1993). Now as per latest census records the Garo Hills region supports about 71% of elephant population of Meghalaya with 1306 individuals (Marak, 1998). There is decline of about 30% of animals during this period. Marak (1998) has reported death of 46 elephants due to natural and unnatural causes during 1994 to 1999, of which poaching accounted for 46% cases.

A record of 54 elephant deaths was collected from the offices of Divisional Forest Officers of Balpakram National Park (BNP) division, Baghmara (25 cases) and the East and West Garo hills (EWGH) Division, Tura (29 cases). Though the area under jurisdiction of BNP division is very less as compared to the East and West Garo Hills Division, the high mortality of elephants per unit area recorded in the former is due to high density of elephants in this area. The five census zones (Figure 3.1) viz. GH/XVII, GH/XVIII, GH/XIX, GH/XX and GH/XXI under BNP division have recorded 650 elephants out of total 1306 estimated in 23 census zones in entire Garo hills (Marak, 1998). The elephant population estimated in these five zones during 1993 census was 763. It means a loss of 113 elephants (about 15% of initial population in 1993) during five years period i.e. between 1993 and 1998. However, the sixth zone (GH/XVI) under BNP division has shown the drastic decline in Elephant population and the number of elephants has decreased from 78 in 1993 to 10 in 1998 i.e. decline of about 87% during five years period.

3.2.1.3.2 Elephant deaths in South Garo hills district

BNP division has been reported for total 25 death cases for a period between October 1994 and April 1999, 16 and 7 of which were males and females, respectively. The information about sex of two individuals was not available, but one of them was suspected as being female.

The natural and unnatural deaths among these 25 elephants were 8 and 17, respectively. All deaths due to causes other than poaching were referred as Natural deaths here regardless of age of the dead one. The causes of natural deaths include diseases (3 cases), forest fire (1 case), accident (3 cases) and normal old age death (1 case). See annexures 12 and 13 for details.

3.2.1.3.3 Natural deaths

The diseases took toll of three elephants. A four months old infant male died due to starvation and dehydration near Jodigittam under Siju range. One 2 years old female was died due to unknown disease Asrophic sanities (?) near Panda area under Baghamara range, while another sub-adult female (16 years old) died due to chronic infection in respiratory system near Jodigittam under Siju range. One female sub-adult (10 years) was entrapped in the forest fire near Dagal stream (Angratoli). Forest department collected two small tusks weighing 250 gm from the dead body of this elephant. An inexperienced young male (4 years old) felt down from a 62 ft. high cliff while moving on narrow path on a steep hill slope near Ropwari, Thaidang under Rongra range having two small tusks weighing 280 gm. Likewise an elephant (age and sex unknown-probably female) felt down from a high cliff near Rewak. One 22 years old departmental female died accidentally of asphyxia due to drowning in Kanai River (near the place where departmental elephants are being kept) under Mahadeo range. Only one case of normal death of a 55 years old male elephant is reported due to normal weakness in old age.

3.2.1.3.4 Unnatural deaths

A total of 17 unnatural deaths were reported under BNP division, 16 of which were cases of poaching. Villagers near Badri Rongdong aking had killed one elephant for self-defense. Three adult female elephants (ages 42 years, 45 years and unknown) were killed by poachers. These three killings might have been done accidentally. Out of total 13 cases of poaching, only one was sub-adult, seven were adults and age of five were not recorded. The sub-adult male tusker (10 years) was killed near Gingsning stream, Gulpani under Rongra Range during

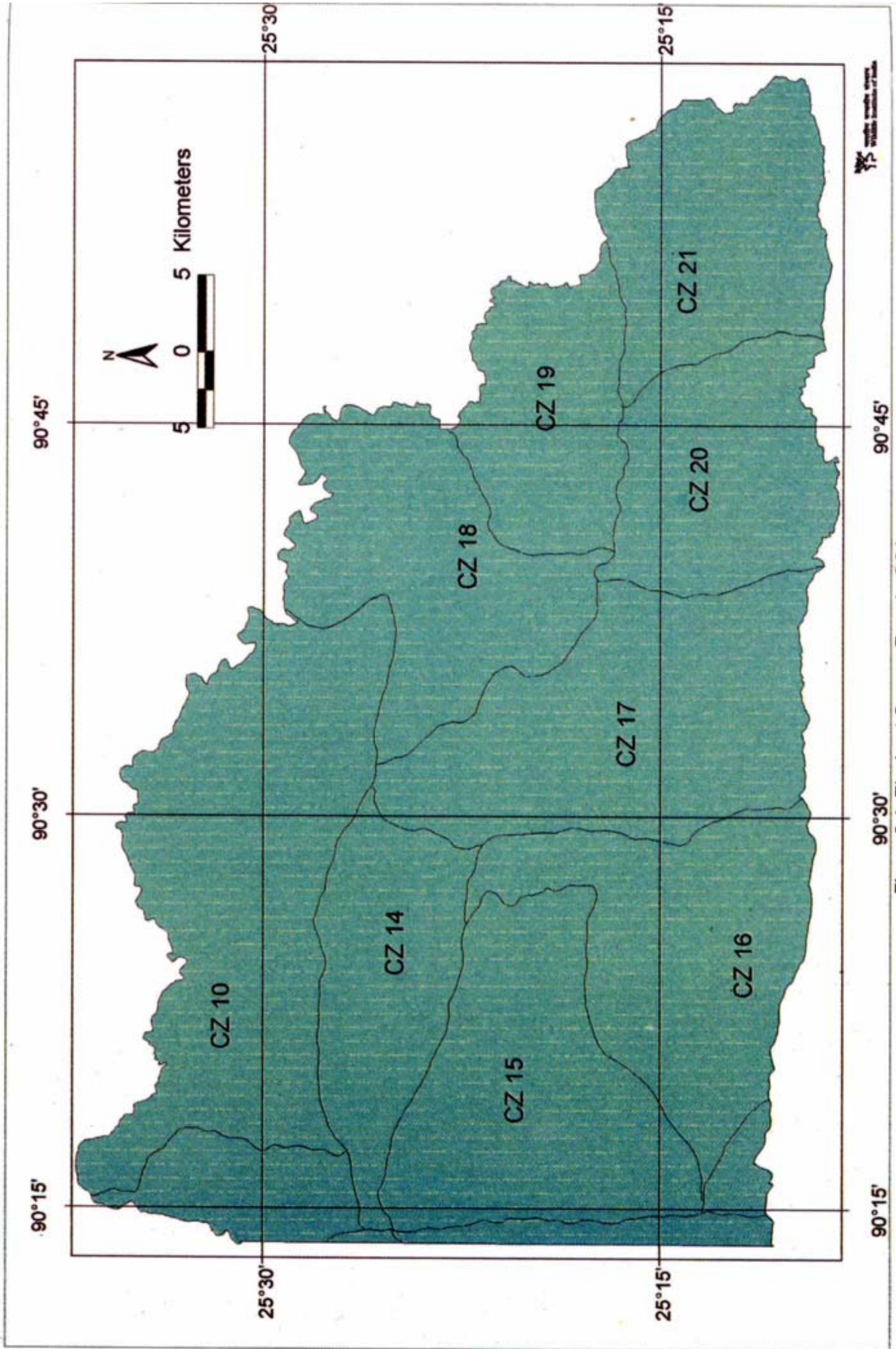


Figure 3.1 Elephant Census Zone in GCA

December 1994. Seven adult males at different places in Rongra, Siju, Angratoli and Mahadeo in South Garo Hills. In all cases except two under Rongra range (28 Oct. '94 and 13 Jul.'95), tusks were being taken away by poachers. Out of total 16 cases of poaching, 10 were in Rongra range.

3.2.1.3.5 Model elephant-habitat relationship

Meghalaya is one of the most famous elephant areas in the northeast. The main conservation problems here is the lack of management of all but the reserved forests, which make up to only 3.18% of the total forests area. Due to the large-scale indiscriminate shifting cultivation, the large animals habitats are becoming fragmented. The problem is worse in west Meghalaya (Garo Hills). The only protected areas are Siju Wildlife sanctuary, The Balpakram National Park, the Nokrek National Park and the Nongkhylliem Sanctuary (East Khasi Hills), which are inadequate for the elephant protection.

In the South Garo Hills District and Norkrek area of western Meghalaya, statistical analyses suggest very low elephant densities and greatest declines of elephants in areas with >10% bamboo and secondary forest (6-10 years old) and >10% scrub and abandoned jhum fields (old fallow jhum 3-6 years old). Elephant densities are highest, and declines are the least, in areas with >25% semi-evergreen forest (old secondary forests 15-30+ years old). Data on elephant sign (use) in the field generally support these findings, with selection by elephants (i.e., use significantly exceeding availability) for native semi-evergreen forest, and lack of selection (use significantly less than availability) for deciduous forests (including sal forest, teak, and cashew plantations) and for scrub and abandoned jhum fields. To maintain elephant populations in the South Garo Hills District and Nokrek area, we suggest official delineation of 7 elephant habitat corridors that we mapped as having low degree of fragmentation of forest cover and a high proportion of contiguous, semi-evergreen and evergreen forest cover (Marcot et. al, 2002).

Authors conducted a statistical analysis to determine the major landscape correlates of elephant densities and

elephant population changes in the Garo Hills of Meghalaya from two elephant census periods of 1993 and 1998. Census results reported by State forestry officials suggest a 30 percent decline in elephant numbers between census periods. In the Garo Hills, crude densities were 0.30 elephant / sq km in 1993 and 0.21 / sq km in 1998. Density in 1998 was significantly and negatively correlated with proportion of land in current jhum (slash-and burn shifting cultivation), abandoned jhum, and density of villages. Linear regression modeling also suggested significant influence on elephant density from percent cover in deciduous forest (positive influence), percent cover in high terrain complexity (positive), and village density (negative). Analyses suggest higher elephant densities occurred in elephant census zones with: at least 4% of the landscape in deciduous forest cover; less than 30% of the landscape in current jhum and abandoned jhum; less than 5% of the landscape in current jhum alone; less than 20% of the landscape in high forest patchiness (caused by jhum); and village density less than about 0.4 / sq km. These values can be used as testable management hypotheses for guiding conservation or restoration of habitat conditions for elephant conservation in the Garo Hills (Marcot et. al, submitted).

3.2.2 Birds

This area could be regarded as one of the unique habitats for a large number of bird species and it would be no wonder that it has attracted the attention of earlier ornithologists even in the nineteenth century; work of Goodwin Austin on the birds of Khasi and North Cachar Hills, continued to be published from 1870 to 1892. Salim Ali's Hill Birds and Birds of Eastern Himalayas could be regarded as guide to avian fauna of the region. A list of some important bird species is presented in Annexure 14.

3.2.3 Reptiles

Reptiles include a number of many diverse forms like Chelonians (tortoises/turtles), Lacertilia (lizards), serpents or Ophidians (snakes). A total of 62 species of reptiles, including 8 species of turtles and tortoises, 18 species of lizards and 36 species of snakes are reported

from the Garo Hill regions and GCA is also represented by most of such species.

3.2.4 Fishes

The fishes constitute yet another major resource of Garo Hills, and a study conducted over seven years revealed as many as 62 species from streams, rivers and waterbodies of the area including the much elusive so-called Electric-eel which occur in Ganai and Simsang rivers.

3.2.5 Amphibians

These include salamanders, newts, frogs and toads. Out of total 40 species reported in entire Northeaster region, the Garo Hills region has 14 species including some of the endemic species. The Garo Hill Webbed footed tree toad is restricted to this region in its distribution. The limbless amphibian and interesting *Hyla* spp are other remarkable possession of the region.

The following species of anurans are of special “conservation” interest in GCA (Pillai *et al*, 1989).

- Garo Hills Tree-Toad, *Pedostibes kempi* Boulenger (family Bufonidae); Rare & endangered. Collected from Tura area of Garo Hills in 1919 - extremely rare. Expert tree climber, eats ants from tree trunks.
- *Bufoides meghalayana* (family Bufonidae), endemic genus to Meghalaya.
- *Leptobrachium hasselti* (family Pelobatidae), endemic to Khasi Hills.
- *Hyla annectens* (family Hylidae), occurs in forests of Meghalaya. Calls loudly from tree canopy. Endemic to Meghalaya.

3.2.6 Invertebrates

Of the invertebrates, insects constitute the most prominent faunal component. Other major invertebrate component are Annelids, Molluscs, and Arachnids. The insects are a diverse group consisting of Diptera, Coleoptera, Orthoptera, Isoptera and Dermaptera. It is said that almost 60% of the total aphid fauna in India is represented in the Northeastern region and of

these many are represented in the Garo Hills (ZSI). The dung beetles also act as the single largest natural group of scavenger-insects in this region (Biswas, S., PhD dissertation, Calcutta University). Of all the insect fauna, butterflies are the most attractive and diverse. A list of some important butterfly species in the region has been given in annexure 15 the document.

3.3 Wildlife Issues, concerns and implications

This is covered specifically for key wildlife faunal species when the said species is described either in the preceding paragraphs or under species profile in Volume II on ‘Wildlife Habitat Relationship’.

3.4 Methodology

3.4.1 Wildlife habitat relationship

Present study attempts to develop wildlife habitat relationship in GCA for selected animal species. It broadly looks into the bird habitat relationship, mammal habitat relationship, mammal tree relationship and the elephant habitat relationship.

3.4.2 Mammal tree relationship

A list of 150 tree species (Annexure 16) with their local names prepared during vegetation survey was used to conduct interview of local forest guards, foresters and permanently resident people. The mammal species like elephant, hoolock gibbon, macaques (including rhesus, Assamese, stump-tailed and pig-tailed macaques), slow loris, capped langur, tiger, deers (including sambar and barking deer), Indian bison, Serow, Himalayan black bear, bats in general, wild pig, yellow throated martin, squirrels (Malayan giant squirrel, hoary-bellied himalayan squirrels and orangebellied Himalayan squirrels), civets (large, small and Himalayan palm civets) and porcupine were inquired for their food tree preferences. For each animal species (or group of species like macaques, deer and bats and civets) all of the 150 tree species from list were announced one by one and the reply of local forest staff and the resident people were recorded and discussed. Once the forest staff and other locally resident people jointly agreed to consider any tree species

as a food item, its body part was recorded. Following abbreviations were used to indicate the body parts of trees.

- B = Bark
- F = Fruit
- Fl = Flower
- S = Shoots
- Y = Yound
- Blank = Either not used or information not available

The local name of wild animals and broad habitats along with local distribution of species in GCA was also recorded using experience and knowledge of local people.

3.4.3 Mammal habitat relationship

Local forest guards, foresters and permanently resident people were interviewed. The mammal species like elephant, hoolock gibbon, macaques (including rhesus, Assamese, stump-tailed and pig-tailed macaques), slow loris, capped langur, tiger, deers (including sambar and barking deer), Indian bison, Serow, Himalayan black bear, bats in general, wild pig, yellow throated martin, squirrels (Malayan giant squirrel, hoary-bellied himalayan squirrels and orange bellied Himalayan squirrels), civets (large, small and Himalayan palm civets) and porcupine were inquired for their local distribution and the preferred habitats.

3.4.4 Bird habitat relationship

Manoj and Jaypal provided the checklist of 184 birds in various kind of habitats in GCA. They have collected the information during 1996-97. The data was analysed to get the habitat relationship of selected 110 bird species.

3.5 Results and discussion

3.5.1 Wildlife habitat relationship

The entire northeastern India except few Protected Areas in Arunachal Pradesh and Assam are not explored for scientific researches on the wildlife (plants and animals both). The ecological studies have never been conducted in most of areas in northeastern India. Garo

Hills too, is the least explored as far as the ecological studies of plant and animals are concerned. In the present study, attempts have been made to collate whatever information was available with the State Forest Department of Meghalaya, local forest staff, scientific tourists, local resident people, local Non Government Organisations in combination with the experience of field researcher and field assistant during stay in Garo Hills.

3.5.2 Mammal tree relationship in GCA

Trees in the forest are the most important component and are the integral part of wildlife habitats. Local environmental and anthropogenic factors prevailing in the area affect the distribution of various tree species. Most of the tree species respond to their environment and also decide the kind of vegetation in their surroundings, in other words trees contribute significantly to make an area as a habitat for the wildlife by providing food, shelter and cover to many of the wild animals. The distribution of various tree species in different forest types and habitats has already been described in the Chapter 2. Though the shrubs, herbs and other forms of plant life provide food to mammals, but trees are vital to the mammals since they provide shelter, cover and fulfil other requirements along with food.

Out of total 150 tree species only 56 species are being used by these species (Table 3.16). Macaques (including Rhesus, Assamese, Pig-tailed and Stump-tailed macaques), slow loris, serow and deers (including sambar and barking deer) have wide range of food preferences for tree species by consuming various body parts of 28, 27, 25 and 25 tree species, respectively out of 56 selected food tree species (Table 3.17). Squirrels, hoolock and capped langur followed them, which are feeding on 21, 20 and 20 tree species, respectively.

Grewia microcos, *Artocarpus chama*, *Syzygium cumini*, *Lapisanthus rubiginosa*, *Artocarpus gomezianus*, *Ficus semicordata* and *Lannea grandis* are the most preferred tree species. 10 or more than 10 of the 15 wildlife species

Table 3.16: Number of tree species being used as food item by wild animals

| Mammal Species | No. of tree species used |
|----------------------------------|--------------------------|
| Macaques | 28 |
| Slow loris | 27 |
| Sambar and Barking deer | 25 |
| Serow | 25 |
| Squirrels | 21 |
| Hoolock gibbon | 20 |
| Capped Langur | 20 |
| Asian Elephant | 18 |
| Indian Bison | 18 |
| Wild pig | 12 |
| Himalayan yellow throated Martin | 12 |
| Himalayan black bear | 11 |
| Bats | 11 |
| Civets | 6 |
| Porcupine | 5 |

surveyed, are consuming fruits, leaves, flowers, or bark of these tree species. *Grewia microcos* is the common food source for all 15 mammals species. The fruits of this tree species are also being preferred by many other mammals and bird species in GCA. Interview suggested that there are 16 tree species, which are being consumed by single animal species; 6 by 2 animal species and 6 by 3 animal species (Table 3.17).

3.5.3 Mammal habitat relationship

3.5.3.1 Tiger

Local name: Matcha.

Prey species are Sambar, Barking deer, Wild pig, India Bison, Wild pig, Hare, Goat, Hen (fowl), Langur, hoolock, Macaques *etc.*

Local distribution in and around BNP: Balpakram area, Sinaru area, Agal-chongoppa in the way of Rongcheng from Balpakram plateau, Pindengru,

Maogipeng, Penda, Marakabari, Pusul chiring, Deoban area, Dogep chiring, Teptepa area, Ailatoli area, Maheshkola, Bellibari, Narangbari, Sochet chiring, Rongdi-bisik, Nowa chiring, Ronsu-agal, Chutmang, Ampangiri, Hatitia, Passgaon, Bonbera, Nadankol, Atambing, Rongsu, Rewak.

Habitat: Dense Primary Forest, Bamboo forest, Also Grassland

3.5.3.2 Macaques

Local names: Rhesus (Makri-chiran), Assamese (Makri-ugong), Stump-tailed (Makri-dalgappa) & Pig-tailed Macaques.

Local distribution: Rhesus macaque all over the GCA. Assamese macaque is more difficult to see but said to be abundant in undisturbed areas. Stump-tailed and pig-tailed are very rare in GCA, mainly confined to interior of BNP.

Habitat: Rhesus macaques found in every type of forest and nearby villages, usually found in a large group playing nearby river plains in valleys. Assamese macaque can be seen in dense forests in limestone area. Stump-tailed and pig-tailed macaques prefer undisturbed primary forest (Mainly Evergreen and sometimes Semi-evergreen forests), very rarely comes nearby habitation and open areas.

3.5.3.3 Slow loris

Local name: Gilwe

Local distribution in and around BNP: Hatitia, Teptepa, Kanai, Rompa, Rongmenchiring, Passgaon, Ranthangri, Rongcheng, Siju, Rewak, Rongsu, Chimitab, Maheshkola, Shooling, Pindengru, Maogipeng, Chutmang

Habitat: It comes in 3-4 years old *jhum* fallows, dense Primary Forest and Riparian Forests.

3.5.3.4 Serow

Local name: Matrong

Local distribution in and around BNP: Rompa Dare (Dare mean gorge), Chidokthak Dare, Hamdangi Dare, Kundulgop Dare, Rongdibisek Dare, Nowa Dare,

Table 3.17: Tree species and their body parts used as food items by selected wildlife

| Sl. No. | Botanical name | Wild Animal Code (See Table 3.16 for description) | | | | | | | | | | | | | | | |
|---------|-------------------------------|---|-------------|-----|-----|----|----------|-----|-----|---|----|----|----|----|----|----|-------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Total |
| 1 | <i>Grewia microcos</i> | B | F | F,L | F,L | F | YL | L | F,L | F | F | F | F | F | F | F | 15 |
| 2 | <i>Artocarpus chama</i> | | F | F | F | F | F,L | F,L | F,L | F | F | F | F | F | | F | 13 |
| 3 | <i>Syzygium cumini</i> | | F | | F,L | F | F | | F | F | F | F | F | F | F | F | 12 |
| 4 | <i>Lepisanthes rubiginosa</i> | | F | F | F,L | F | L | F,L | L | | F | | F | F | | F | 11 |
| 5 | <i>Artocarpus gomezianus</i> | B,L | | F | | F | F | L | L | F | | F | F | F | | | 10 |
| 6 | <i>Ficus semicordata</i> | B,L | | F | | F | L | L | L | F | | F | | F | F | | 10 |
| 7 | <i>Lankea grandis</i> | | F | F,L | F,L | F | L | | F,L | F | | F | F | F | | | 10 |
| 8 | <i>Bursera serrata</i> | B,L | F | F | | F | F,L | L | F | | F | F | F | | | | 9 |
| 9 | <i>Dillenia pentagyna</i> | | F | F | L | F | F,L | F,L | F,L | | F | F | | | | | 9 |
| 10 | <i>Ficus subulata</i> | B,L | | | F,L | | F,L | L | F,L | F | | F | F | | F | | 9 |
| 11 | <i>Garcinia lancifolia</i> | | F | F | F | F | F | | F | | | F | F | | F | | 9 |
| 12 | <i>Ilex umbellulata</i> | | F | F | F,L | F | | | F | F | F | | F | | | | 8 |
| 13 | <i>Syzygium balsameum</i> | B,L,F | | F | | | F,L | F,L | L | F | | F | | F | | | 8 |
| 14 | <i>Alangium chinense</i> | | F | F | F | F | | | | | F | | F | F | | | 7 |
| 15 | <i>Bauhinia stipularis</i> | | YL, F Fl | | F,L | Fl | L,Fl | F,L | F,L | | | | | | | | 7 |
| 16 | <i>Garcinia kydia</i> | | F | F | | F | F | F,L | | F | | F | | F | | | 7 |
| 17 | <i>Macaranga indica</i> | | F | F | F,L | | L | | | F | | F | | F | | | 6 |
| 18 | <i>Mangifera indica</i> | F | | F | | F | | | | F | | F | | F | | | 6 |
| 19 | <i>Mangifera sylvatica</i> | F | | F | | F | | | | F | | F | | F | | | 6 |
| 20 | <i>Trema orientalis</i> | B,L | | F | L | | L | L | L | | | | | | | | 6 |
| 21 | <i>Callicarpa arborea</i> | | F | F | F,L | | L | | | F | | | | | | | 5 |
| 22 | <i>Flacourtia jangomas</i> | | F | F | F | F | | | | | | F | | | | | 5 |
| 23 | <i>Abrus precatorius</i> | | | F | | | F,L | F,L | F,L | | | | | | | | 4 |
| 24 | <i>Ficus foveolata</i> | | | | | | L | F,L | L | | | | F | | | | 4 |
| 25 | <i>Garcinia tinctoria</i> | B,L | F | F | | F | | | | | | | | | | | 4 |
| 26 | <i>Gmelina arborea</i> | | | | L | | F, YLF,L | F,L | | | | | | | | | 4 |
| 27 | <i>Morinda augustifolia</i> | | F | F | F | F | | | | | | | | | | | 4 |
| 28 | <i>Pterigota alata</i> | B,L | | | F | F | | F,L | | | | | | | | | 4 |
| 29 | <i>Aporusa dioica</i> | | | | F | F | | | | | | | F | | | | 3 |

Contd...

Table 3.17 Contd...

| Sl. No. | Botanical name | Wild Animal Code (See Table 3.16 for description) | | | | | | | | | | | | | | | Total |
|---------|------------------------------------|---|----|------|-----|----|------|-----|----|----|----|----|----|----|----|----|-------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| 30 | <i>Emblica officinalis</i> | | | | | | F,YL | F | | | | | F | | | 3 | |
| 31 | <i>Eurya accuminata</i> | | F | | F | | | F | | | | | | | | 3 | |
| 32 | <i>Maesa sarmentosa</i> | | F | F | | | | L | | | | | | | | 3 | |
| 33 | <i>Syzygium operculatum</i> | | | F,YL | | F | | | | | F | | | | | 3 | |
| 34 | <i>Wendlandia excelsa</i> | | | | | | L | L | L | | | | | | | 3 | |
| 35 | <i>Bridelia retusa</i> | | | F | | | | F,L | | | | | | | | 2 | |
| 36 | <i>Croton joufera</i> | | | | F,L | | | | | | | | F | | | 2 | |
| 37 | <i>Hodgsonia macrocarpa</i> | F | | | | | | F,L | | | | | | | | 2 | |
| 38 | <i>Holarrhena antidiysenterica</i> | | | | L | | L | | | | | | | | | 2 | |
| 39 | <i>Pterospermum acerifolium</i> | B | | F | | | | | | | | | | | | 2 | |
| 40 | <i>Vitex peduncularis</i> | | | | | | B,L | | | F | | | | | | 2 | |
| 41 | <i>Aesculus assamica</i> | | | | L | | | | | | | | | | | 1 | |
| 42 | <i>Albizia chinensis</i> | | | | L | | | | | | | | | | | 1 | |
| 43 | <i>Albizia odoratissima</i> | | | | L | | | | | | | | | | | 1 | |
| 44 | <i>Anthocephalus chinensis</i> | | | | | | | | | | | | | F | | 1 | |
| 45 | <i>Aristolochia tagala</i> | | | | F | | | | | | | | | | | 1 | |
| 46 | <i>Bridelia monoica</i> | | F | | | | | | | | | | | | | 1 | |
| 47 | <i>Careya arborea</i> | | | | | | | L | | | | | | | | 1 | |
| 48 | <i>Dalbergia paniculata</i> | | | | L | | | | | | | | | | | 1 | |
| 49 | <i>Elaeocarpus rugosus</i> | B,L | | | | | | | | | | | | | | 1 | |
| 50 | <i>Erythrina stricta</i> | B | | | | | | | | | | | | | | 1 | |
| 51 | <i>Glochidion sphaerogynum</i> | | | | | | | | | | | | F | | | 1 | |
| 52 | <i>Mallotus roxburghianus</i> | B,L | | | | | | | | | | | | | | 1 | |
| 53 | <i>Ostodes paniculata</i> | | | | | | | | | | | | F | | | 1 | |
| 54 | <i>Polyalthia simiarum</i> | | | F | | | | | | | | | | | | 1 | |
| 55 | <i>Pterospermum lancifolium</i> | B,L | | | | | | | | | | | | | | 1 | |
| 56 | <i>Tetrameles nudiflora</i> | B | | | | | | | | | | | | | | 1 | |
| | Total | 28 | 27 | 25 | 25 | 21 | 20 | 20 | 18 | 18 | 12 | 12 | 11 | 11 | 6 | 5 | |

Maogapeng Dare, Sprichiring Dare, Ranthangsora chiring Dare, Deoban Dare, Kanai Dare, Chutmang Dare. Very rare.

Habitat: Thickly wooded boulders strewn gorges in hilly terrain.

3.5.3.5 Sambar and Barking deer

Local names: Sambar (Matchok) and Barking deer (Balgitchak)

Local distribution: All over GCA.

Habitat: Visit new *jhums* and cultivated fields frequently, grassland and all types of forests except the forests in limestone area.

3.5.3.6 Hoolock gibbon

Local Name: Huro, Group size varies from 2-6 (This observation confirm the findings of Alfred and Sati, 1990).

Local distribution in and around BNP: Rokpa chiring/ Rompa chiring, Hamdangi chiring, Narang chiring, Nongal gat, Kundulgop, Rongchun area, Penda area, Pindengru, Nawa chiring, Chutmang, Rongcheng, Rongsu, Chimitab, Shooling, Siju, Rewak, Balpakram area, Maheshkola, Bellibari area, Kanai-Rongtherasrea area, Rongra area, Taidang area, Kunchung area, Dambuk-Jongkol area, Teptepa.

Habitat: Undisturbed old Primary Forest with close canopy trees. Sometimes seen nearby the villages in the interiors.

3.5.3.7 Squirrels

Local name: Math (Malayan giant squirrel, Hoarybellied Himalayan squirrel and orangebellied squirrel)

Local distribution in and around BNP: Rompa-bisek, Limestone area, Deoban, Kundulgop, Rongcheng, Nowa area, Chimitab, Siju and Shooling area.

Habitat: Higher reaches of tall trees in denser forests, very rarely on ground.

3.5.3.8 Capped langur

Local name: Rangol

Local distribution in and around BNP: Rompa chiring, Hamdangi chiring, Ronthersea, Pindengru, Narang chiring, Maogipeng, Narangbari area, chimitab, Taidang, Nowa, Rongcheng, Kundulgop, Rangthangsora, chiring, Deoban area, Kala Paharh (Paharh means Hill), area, Rongsu area, Penda area, Maheshkola, Shooling, Siju, Kanai, Marakabari, Dogep chiring, Teptepa, Chutmang.

Habitat: Undisturbed primary forests with dense coanopied trees.

3.5.3.9 Indian bison

Local name: Matle

Local distribution in and around BNP: Balpakram, Sochet chiring, Atambing, Pindengru, Nowa chiring, Maogipeng, Penda area (mainly during May-June), Hamdangi area, Roncheng, Chimitab.

Habitat: Grasslands, Bamboo area, Secondary Forests in the interior of BNP.

3.5.3.10 Elephant

Local Name: Mongma

Local distribution in and around BNP: Kanai, Rongra, Siju, Gaobari, Teptepa, Pindengru, Balpakram, Rongcheng nowa, Narang chiring, Kundulgop, Deoban, Rangthangsora chiring, Dogeo chiring, Shooling, Chimitab, and Chutmang.

Habitat: Primary Forests. Visit Secondary Forests and habitation during Jan-Feb. Occurs on hill slopes, valleys. During Jan-Feb occur along streams for water.

3.5.3.11 Himalayan yellow throated martin

Local name: Gredong

Local distribution in and around BNP: New Rongmenchiring, Kundulgop, Deoban, Rompa chiring, Rongcheng, Nowa area, Chutmang, Rongsu, Siju, Shooling, Narangbari, Hamdangi, Pindengru,

Narang chiring.

Habitat: Occurs on trees mainly.

3.5.3.12 Wild pig

Local name: Wak-burung

Local distribution: All over study area.

Habitat: In the surroundings of limestone area nearby habitation, very old Secondary Forests. Visits *Jhum* fields regularly.

3.5.3.13 Bats

Local name: Dobak

Local distribution in and around BNP: Nongalgat, Rompa dare, Kundulgop, Rongthrasea Dare, Siju Dobak-kol, Nowa Dare, Rongdi-bisek Dare, Maogipeng Dare, Chutmang, Rangthansora Dare, Kanai Dare, Deoban Dare, Spruchiring Dare, Chidokthak Dare.

Habitat: Caves, trees near caves, Ficus trees. Sometimes found on abandoned man-made structures like Ceiling of bridges, culverts and old buildings.

3.5.3.14 Himalayan black bear

Local name: Makbil-bak (To avoid dung on its route, it walks on soil and prefers land covered with grasses for walking)

Local distribution in and around BNP: Rokpa chiring area, Rongtherasea, Hamdangi, Deoban area, Kundulgop, NBalpakram plateau, Nowa area, Roncheng, Chimitab, Chutmang, Kunchung, Maogapeng, Rangthansora, Rompa, Kanai.

Habitat: Old *Jhum* fallows, limestone area in dense evergreen forests, visit new *jhum* areas for paddy, potato and Tapioca. Also feed s on rotten meat of dead animals, Honey and Insects. During rains build bed on tree branches and leaves to sleep.

3.5.3.15 Porcupine

Local name: Okchigipu

Local distribution in and around BNP: Rompa ading,

Hatitia, Dulbeta, Teptepa, Ranthagsora, Chimitab, Deoban, Kundulgop, Balpakram plateau, Maheshkola, Atambing, Siju, Rongsu, Rongcheng, Nowa, Ampangiri, Rewak.

Habitat: Small holes in rocks, Burrows in soil.

3.5.3.16 Civets

Local name: Matchuri (Also feeds on small bird, fowl, fish, dry fish)

Local distribution in and around BNP: Hatitaia, Rompa, Kanai, Teptepa, Rangthansora, Passgaon, Balpakram plaeau, Rongcheng, Maogapeng, Chimitab, Rongsu, Siju, Rongra, Shooling, Deoban, Kundulgop, Chinaru.

Habitat: Primary and Secondary Forests. Usually seen nearby habitation and roadsides during evening time.

3.5.4 Bird habitat relationship

Manoj and Jayapal (Personal Communication) provided a checklist of 184 bird species from Balpakram National Park and its surrounding areas. Out of total 184 bird species, the habitats of 110 bird species have also been recorded. There are 26 species, which are restricted to only primary forests, though a total of 51 species are using the primary forest habitat. These species are very critical from conservation point of view, since the conversion of old primary forests to the secondary forest greatly reduces the available habitat of these specialist species. A total of 55 bird species have been found associated with the secondary forests, of which 18 are restricted to the Secondary forests only. Seondary forests form an important habitats for these bird species. Out of 36 birds recorded from *jhum* areas, 10 are completely restricted to *jhum* patches only (Table 3.18). Out of 36 bird species recorded from Balpakram plateau 10 species (table 3.18) were not seen anywhere else in GCA.

Table 3.18: Habitats of selected bird species in and around Balpakram National Park

| Sl. No. | Common Name | Species | Primary Forest | Secondary Forest | Jhum Areas | Balpakram Plateau |
|---------|--------------------------------|---------------------------------|----------------|------------------|------------|-------------------|
| 1 | Red Jungle Fowl | <i>Gallus gallus</i> | 1 | 1 | 1 | 1 |
| 2 | Brown shrike | <i>Lanius cristatus</i> | | 1 | 1 | 1 |
| 3 | Red whiskered bulbul | <i>Pycnonotus jocosus</i> | | 1 | 1 | 1 |
| 4 | Red vented bulbul | <i>Pycnonotus cafer</i> | | 1 | 1 | 1 |
| 5 | Yellow browed leaf warbler | <i>Phylloscopus inornatus</i> | 1 | 1 | | 1 |
| 6 | Grey headed flycatcher warbler | <i>Seicercus xanthoschistos</i> | 1 | 1 | | 1 |
| 7 | Franklin's wren warbler | <i>Prinia hodgsoni</i> | | 1 | 1 | 1 |
| 8 | Yellow backed sunbird | <i>Aethopyga siparaja</i> | 1 | 1 | | 1 |
| 9 | White-eye | <i>Zosterops palpebrosus</i> | 1 | 1 | | 1 |
| 10 | Sparrow Hawk | <i>Accipiter nisus</i> | | 1 | | 1 |
| 11 | Kestrel Falco | <i>Falco tinnunculus</i> | | | 1 | 1 |
| 12 | Kaleej Pheasant | <i>Lophura leucomelana</i> | 1 | 1 | | |
| 13 | Thickbilled green pigeon | <i>Treron curvirostra</i> | 1 | 1 | | |
| 14 | Rufous turtle dove | <i>Streptopelia orientalis</i> | | | 1 | 1 |
| 15 | Emerald dove | <i>Chalcophaps indica</i> | 1 | 1 | | |
| 16 | Lorikeet | <i>Loriculus vernalis</i> | 1 | 1 | | |
| 17 | Common hawk cuckoo | <i>Cuculus varius</i> | | 1 | | 1 |
| 18 | Coucal | <i>Centropus sinensis</i> | | 1 | 1 | |
| 19 | Palm swift | <i>Cypsiurus parvus</i> | | | 1 | 1 |
| 20 | Great hill barbet | <i>Megalaima virens</i> | 1 | 1 | | |
| 21 | Large green barbet | <i>Megalaima zeylonica</i> | 1 | 1 | | |
| 22 | Golden oriole | <i>Oriolus oriolus</i> | | 1 | | 1 |
| 23 | Maroon oriole | <i>Oriolus trailii</i> | 1 | 1 | | |
| 24 | Blackheaded oriole | <i>Oriolus xanthornus</i> | 1 | 1 | | |
| 25 | Greybacked shrike | <i>Lanius tephronotus</i> | | | 1 | 1 |

Contd...

Table 3.18 contd...

| Sl. No. | Common Name | Species | Primary Forest | Secondary Forest | Jhum Areas | Balpakram Plateau |
|---------|------------------------------|-----------------------------------|----------------|------------------|------------|-------------------|
| 26 | Grey drongo | <i>Dicrurus leucophaeus</i> | | 1 | | 1 |
| 27 | Bronzed drongo | <i>Dicrurus aeneus</i> | 1 | 1 | | |
| 28 | Lesser rackettailed drongo | <i>Dicrurus remifer</i> | 1 | 1 | | |
| 29 | Greater rackettailed drongo | <i>Dicrurus paradiseus</i> | 1 | 1 | | |
| 30 | Ashy swallow shrike | <i>Artamus fuscus</i> | | | 1 | 1 |
| 31 | Greyheaded myna | <i>Sturnus malabaricus</i> | | 1 | | 1 |
| 32 | Pied flycatcher shrike | <i>Hemipus picatus</i> | | 1 | | 1 |
| 33 | Scarlet minivet | <i>Pericrocotus flammeus</i> | 1 | 1 | | |
| 34 | Common iora | <i>Aegithinia tiphia</i> | 1 | 1 | | |
| 35 | Goldmantled chloropsis | <i>Chloropsis cochinchinensis</i> | | 1 | | 1 |
| 36 | Olive bulbul | <i>Hypsipetes viridescens</i> | 1 | 1 | | |
| 37 | Brown eared bulbul | <i>Hypsipetes flavalus</i> | 1 | 1 | | |
| 38 | Spotted babbler | <i>Pellorneum ruficeps</i> | 1 | 1 | | |
| 39 | Slatyheaded scimitar babbler | <i>Pomatorhinus horsfieldii</i> | 1 | 1 | | |
| 40 | Nepal babbler | <i>Alcippe nipalensis</i> | 1 | | | 1 |
| 41 | Greyheaded flycatcher | <i>Culicicapa ceylonensis</i> | 1 | 1 | | |
| 42 | Blyth's reed wabbler | <i>Acrocephalus dumetorum</i> | | | 1 | 1 |
| 43 | Dull green leaf warbler | <i>Phylloscopus trochiloides</i> | 1 | 1 | | |
| 44 | Dark grey bush chat | <i>Saxicola ferrea</i> | | | 1 | 1 |
| 45 | Indian tree pipit | <i>Anthus hodgsoni</i> | | | 1 | 1 |
| 46 | Purple sunbird | <i>Nectarinia asiatica</i> | | 1 | | 1 |
| 47 | Crested serpent eagle | <i>Spilornis cheela</i> | | | | 1 |
| 48 | Buzzard spp | <i>Buteo spp</i> | | | | 1 |
| 49 | Blackcrested Baza | <i>Aviceda leuphotes</i> | | | 1 | |

Contd...

Table 3.18 contd...

| Sl. No. | Common Name | Species | Primary Forest | Secondary Forest | Jhum Areas | Balpakram Plateau |
|---------|----------------------------|---|----------------|------------------|------------|-------------------|
| 50 | Short-Toed Eagle | <i>Circaetus gallicus</i> | | | | 1 |
| 51 | Oriental hobby | <i>Falco severus</i> | | | 1 | |
| 52 | Lesser Kestrel | <i>Falco naumannii</i> | | | 1 | |
| 53 | Peacock Pheasant | <i>Polyplectron bicalcaratum</i> | 1 | | | |
| 54 | Indian cuckoo | <i>Cuculus micropterus</i> | | 1 | | |
| 55 | Drongo cuckoo | <i>Surniculus lugubris</i> | 1 | | | |
| 56 | Large green billed malkoha | <i>Rhopodytes tristis</i> | 1 | | | |
| 57 | Longtailed nightjar | <i>Caprimulgus macrurus</i> | | 1 | | |
| 58 | Red headed trogon | <i>Harpactes erythrocephalus</i> | 1 | | | |
| 59 | Himalayan swiftlet | <i>Collocalia brevirostris</i> | | | | 1 |
| 60 | Whitebreasted kingfisher | <i>Halcyon smyrnensis</i> | | | | 1 |
| 61 | Chestnut headed bee-eater | <i>Merops leschenaultii</i> | | 1 | | |
| 62 | Indian roller | <i>Coracias benghalensis</i> | | | | 1 |
| 63 | Indian pied hornbill | <i>Anthracoceros coronatus</i> | 1 | | | |
| 64 | Bluethroated barbet | <i>Megalaima asiatica</i> | | 1 | | |
| 65 | Speckled piculet | <i>Picumnus innominatus</i> | 1 | | | |
| 66 | Rufous piculet | <i>Sasia ochrasia</i> | | 1 | | |
| 67 | Rufous woodpecker | <i>Micropternus brachyurus</i> | 1 | | | |
| 68 | Longtailed broadbill | <i>Psarisomus lunatus</i> ?? <i>dalhousiae</i> | 1 | | | |
| 69 | Swallow | <i>Hirundo rustica</i> | | | | 1 |
| 70 | Sand Martin | <i>Riparia riparia</i> | | | | 1 |
| 71 | Refousbacked shrike | <i>Lanius schach tricolor</i> | | 1 | | |
| 72 | Hill myna | <i>Gracula religiosa</i> | 1 | | | |

Contd...

Table 3.18 contd...

| Sl. No. | Common Name | Species | Primary Forest | Secondary Forest | Jhnm Areas | Balpakram Plateau |
|---------|----------------------------------|------------------------------------|----------------|------------------|------------|-------------------|
| 73 | Large wood shrike | <i>Tephrodornis virgatus</i> | | 1 | | |
| 74 | Large cuckoo shrike | <i>Coracina novaehollandie</i> | | 1 | | |
| 75 | Smaller grey cuckoo shrike | <i>Coracina melaschistos</i> | | 1 | | |
| 76 | Longtailed minivet | <i>Pericrocotus ethologus</i> | | 1 | | |
| 77 | Goldfronted chloropsis | <i>Chloropsis aurifrons</i> | 1 | | | |
| 78 | Orange bellied chloropsis | <i>Chloropsis hardwickii</i> | 1 | | | |
| 79 | Fairy bluebird | <i>Irene puella</i> | 1 | | | |
| 80 | Finchbilled bulbul | <i>Spizixos canifrons</i> | 1 | | | |
| 81 | Blackheaded yellow bulbul | <i>Pycnonotus melanicterus</i> | 1 | | | |
| 82 | Black bulbul | <i>Hypsipetes madagascariensis</i> | 1 | | | |
| 83 | Whitethroated bulbul | <i>Crimiger flaveolus</i> | 1 | | | |
| 84 | Redfronted babbler | <i>Stachris ruficeps</i> | | | 1 | |
| 85 | Blackchinned babbler | <i>Stachyris pyrrhops</i> | | 1 | | |
| 86 | Yellow breasted babbler | <i>Macronous gularis</i> | | | 1 | |
| 87 | Redcapped babbler | <i>Timalia pileata</i> | | | 1 | |
| 88 | Necklace laughing thrush | <i>Garrulax moniligers</i> | | 1 | | |
| 89 | Blackgorgetted laughing thrush | <i>Garrulax pectoralis</i> | | 1 | | |
| 90 | Blackcapped sibia | <i>Heterophasia capistrata</i> | 1 | | | |
| 91 | Little pied flycatcher | <i>Ficedula westermanni</i> | | 1 | | |
| 92 | Redbreasted flycatcher | <i>Ficedula parva</i> | | | 1 | |
| 93 | Pygmy blue flycatcher | <i>Muscicapella hodgsonii</i> | | | | 1 |
| 94 | Bluethroated flycatcher | <i>Cyornis rubeculoides</i> | 1 | | | |
| 95 | Whitethroated fantail flycatcher | <i>Rhipidura albicollis</i> | | 1 | | |

Contd...

Table 3.18 contd...

| Sl. No. | Common Name | Species | Primary Forest | Secondary Forest | Jhum Areas | Balpakram Plateau |
|---------|-----------------------------|----------------------------------|----------------|------------------|------------|-------------------|
| 96 | Blacknaped blue flycatcher | <i>Hypothymis azurea</i> | | | | 1 |
| 97 | Large billed leaf warbler | <i>Phylloscopus magnirostris</i> | 1 | | | |
| 98 | Large crowned leaf warbler | <i>Phylloscopus coronatus</i> | 1 | | | |
| 99 | Allied flycatcher wabler | <i>Seicercus affinis</i> | | 1 | | |
| 100 | Sultat tit | <i>Melanochlora sultanea</i> | 1 | | | |
| 101 | Scarlet backed flowerpecker | <i>Dicaeum cruentatum</i> | 1 | | | |
| 102 | Rubycheek | <i>Anthreptes singalensis</i> | 1 | | | |
| 103 | Nepal yellowbacked sunbird | <i>Aethopyga nipalensis</i> | | 1 | | |
| 104 | Little spider hunter | <i>Arachnothera longirostris</i> | 1 | | | |
| 105 | Streaked spider hunter | <i>Arachnothera magna</i> | 1 | | | |
| 106 | Blackbreasted sunbird | <i>Aethopyga saturata</i> | 1 | | | |
| 107 | Tree sparrow | <i>Passer montanus</i> | | 1 | | |
| 108 | House sparrow | <i>Passer domesticus</i> | | | 1 | |
| 109 | Whitebacked munia | <i>Lonchura striata</i> | | | 1 | |
| 110 | Spotted munia | <i>Lonchura punctulata</i> | | | 1 | |
| | Total | | 51 | 55 | 24 | 36 |

Source : Manoj and Jaypal (Personal communication)

3.6 Summary

The study of fauna is based on the secondary information available from various published and unpublished research papers, official documents, elephant census results, work of local NGOs, interviewing individuals and several visiting researchers. Among government agencies the regional head-quarter of Zoological Survey of India, Shillong has done the intensive studies for inventorying the faunal resources of Garo Hills. However, the

information on the ecological aspect of animals is lacking in GCA. Out of total 958 species of vertebrate animal species in Meghalaya more than 600 are present in the Garo Hills. Common wild mammals and few bird species along with their approximate number of individuals in the Balpakram National Park (then proposed Balpakram WLS) have been mentioned on the basis of 1981 census report by State Forest Department. The chapter briefly discusses the surveys and population estimates of Tiger, Elephant

and Hollock gibbons. The Elephant mortality in GCA, largely Sough Garo Hills have been discussed based on the figures available from BNP division. Further the elephant-habitat relationship model has been suggested for the Garo Hills. The local villagers and frontline field staff were interviewed to develop relationship between common wild mammals and the associated tree species in their habitats. The results suggest that the *Grewia microcos*, *Artocarpus chama*, *Syzygium cumini*, *Lapisanthus rubiginosa*, *Artocarpus gomezianus*, *Ficus semicordata* and *Lannea grandis* are the most preferred tree species. *Grewia microcos* is the

common food source for all 15 mammals species. The fruits of this tree species are also being preferred by many other mammals and bird species in GCA. Out of total 184 bird species, the habitats of 110 bird species have also been recorded. There are 26 bird species which are restricted to only primary forests, though a total of 51 species are using the primary forest habitat. Secondary forests form an important habitats for these bird species. Out of 36 birds recorded from *jhum* areas, 10 are completely restricted to *jhum* patches only. Out of 36 bird species recorded from Balpakram plateau 10 species were not seen anywhere else in GCA.



Chapter 4

Social and Economics

Population Influx

Population trend in Garo Hills

Table 4.2: Percent Increase in Population

Sex Ratio

4.1 The existing situation in zone of influence (ZI) in GCA

4.1.1 The Location, extent, boundaries and natural attributes of ZI

 ZI at 2 km distance

 Forest and Non-forest types

 ZI at 5 km distance

4.1.2 Villages inside and outside the PAs. Ethnic identities, traditions, customs, relationships between distinct group of people, relationship with forests

 Ethnic identities

 Growth of Tribal Communities

 Family Nucleation

 Individual Ownership

4.2 The state of people's economy: Vocations, landuse, use of forest and non-forest based resources by people and seasonal patterns

4.2.1 Vocations

 Economic Trends (Simon, 1996)

 Livelihood Pattern

 Standard of Living

 Family Budget

 Employment Situation

 Employment formation scheme

 Planning and community development

 Community development

4.2.2 Agricultural Customs and needs of Populations

4.2.3 Forest and non-forest resources

 Use of Non-forest resources:

 Agricultural & Allied products

 Horticultural & Cash crop products

 Seasonal pattern in the collection of NTFP from the forests of community land

 Root

 Flower

4.3 Implications of the landuse and resource dependency for the conservation of PA

Implications of landuse

 Implications of resource dependency

 Wants of the Population

 Hunting

4.4 Forest management practices and their implications on people

 Informal forestry practices by the local people

4.5 The development programmes and conservation issues

4.5.1 Evaluation of government and non-government programmes for development-implications for CA and people within.

The Ecodevelopment Society

4.6 Interplay of market forces and their impact on subsistence economy of local people

Market and Marketable Produce

4.7 Summary of problems faced by people that affect CA management (forest and agricultural areas)

a. Park Management vs. local people

b. Animal vs. local people Summary

Chapter 4

Social and Economics

Those hills were the Garo Hills and so were the people there. The Garo tribes form the dominant community in GCA. The Garo society is matrilineal and consists of five exogamous groups or clans. Each clan again divided into many sub-clans, called *Maharies*, related on the mother's side. Each *Mahari* lives in a particular area of its own, called *Aking*, under the authority of *Nokma*, the husband of the inheriting daughter of the oldest family of *Aking*. The

British constituted the 'Garowana' (now Garo Hills) as a separate administrative unit during 1866 and a headquarter was set up at Tura. Since then direct administration was introduced in the Garo Hills and British started collecting revenue and enforcing law and order over local people. When British took commands of Garo Hills administration during 1867, the hill community was so wild and violent (as mentioned in the opening paragraph of chapter) that the blood shedding in nearby plain areas was a common routine. So the Garos had got the evil reputation of headhunters. Later, the British authorities invited the American Baptist Mission to develop education among the Garos.

Before the beginning of Missionary education, Bengla and the Garo were the medium of the instructions in all the school, and the Bengali script was used for teaching the Garo language. Around 1901, Bengla was finally dropped from the lower primary courses of studies and made elective in advance stage. The script was also changed in favour of roman. The Government gave a grant of Rs. 1000 (Rupees One thousand) only for the printing of books in Roman script.

- P. C Kar (1975), pp. xiv.

Though the Garos dominate but are not the only aboriginal tribe in Garo hills. The other tribes such

as the Hajongs, Koches, Rabhas, Dalus and Banais constitute the native minority population. Among non-tribal the Bengalese (including Muslims), Nepalese, and the other plains people were settled in Garo Hills district since the British period. The Garos got the benefit of a first start in respect of education and modernisation whereas the other native groups were neglected both by British authorities and the Mission.

In 1807, four times within a few days the Garos rushed from their hills, plundered two official headquarters, fired several hamlets, and left the headless corpses of twenty seven men and women on the ground. A month later an armed band attacked a large within two miles of a strong police force, inhumanly killed four women, and carried off a man whom they probably tortured later in the hills.

- Carey (1919), 11

A literacy gap, backed by religious difference, arose between the Garo and the non-Garo tribes. Besides the historical, social and ethnic reasons, the unrest in Garo Hills, especially in post-independence period (after 1947), has been predominantly due to disparities in economic development and the uneven distribution of material benefits between the people of the hills and the plains. There has also appeared a growing economic gap between the greater mass of the illiterate hillmen (of the traditional society) and a very small middle class of the literate hillmen in the post-independence period. The benefits of development expenditure go largely to the latter. Outside contractors and traders by virtue of their ability and wealth have been able to control the economic benefits, many a time avoiding tensions through a partnership with literate hill men. A majority of the tribal population is still in the abject poverty, practicing *jhum* cultivation and maintaining a bare subsistence level of living.

- P. C Kar (1975), pp. xix

Population influx

The Garo Hills were sparsely populated at the time the British came. According to Hunter, population of the Garo Hills was 80,000 in 1872; there was hardly any immigration and the hills were mostly populated by the Garos. Population went on increasing rapidly after that. In 1901 Garos were 74% of total population. It became 78% in 1951 and 85% in 1961 and 78.81% in 1971 (Table 4.1).

Table 4.1: Decennial growth rate of population

| Year | Population (in 100,000) | | | Decennial growth (%) | | |
|------|-------------------------|-----------|-------------|----------------------|-----------|-------------|
| | India | Meghalaya | Garro Hills | India | Meghalaya | Garro Hills |
| 1901 | 238.39 | 3.41 | 1.38 | - | - | - |
| 1911 | 252.09 | 3.94 | 1.59 | 5.75 | 15.71 | 14.94 |
| 1921 | 251.23 | 4.22 | 1.79 | 0.31 | 7.21 | 12.71 |
| 1931 | 278.97 | 4.81 | 1.91 | 11 | 13.83 | 6.57 |
| 1941 | 318.66 | 5.56 | 2.24 | 14.2 | 11.59 | 17.11 |
| 1951 | 361.08 | 6.06 | 2.42 | 13.3 | 8.97 | 8.28 |
| 1961 | 439.24 | 7.69 | 3.67 | 21.5 | 27.03 | 26.91 |
| 1971 | 548.16 | 10.12 | 4.07 | 24.8 | 31.5 | 32 |
| 1981 | 6851.9 | 13.36 | 5.06 | 25 | 32.04 | 27.33 |
| 1991 | 8439.3 | 17.6 | 6.66 | 23.5 | 31.8 | 31.62 |

Sources: 1. Census of India, 2. Basic statistic of North-Eastern Region and 3. Statistical Hand Book Meghalaya

Table 4.2: Percent increase in population

| Period | India | Meghalaya | Garro Hills |
|-----------|--------|-----------|-------------|
| 1901-1951 | 54.46 | 77.77 | 75.3 |
| 1951-1991 | 133.79 | 190.42 | 175.2 |

Variation in the growth rate of population in Garo Hills during the Pre and Post-Independence period can be noted from the following figures (Table 4.2).

In the first phase it took 50 years to double the population while in the second phase it took only 30 years to double the population. If the present trend of the population growth continues, the population of the Garo Hills will double during the next 18 to 20 years, as compared with the country as a whole, which takes 30 to 35 years to double the population.

Sex Ratio

Table 4.3 gives the sex ratio in the Garo Hills. Prior to 1951 there is a gradual decline in the sex ratio in the Garo Hills and also in Meghalaya. In the Garo Hills, sex ratio increased in 1941 from 959 to 975,

which was even higher than the 1901 figures (This could also be an error and actual figures may have been 957). After 1941 there was again decline in the sex ratio. 1981 figures indicate that in the West Garo Hills sex ratio is higher than East Garo Hills and in Meghalaya as a whole. Decline in sex ratio can be attributed to (i) Growth of urban centers (ii) Influx of male population from outside. The trend in urban and rural areas is similar when the population of male and female of the rural and urban areas is analyzed.

Table 4.3: Sex ratio (1901-1981)

| Year | 1901 | 1911 | 1921 | 1931 | 1941 | 1951 | 1961 | 1971 | 1981 | |
|---------------------------------|------|------|------|------|------|------|------|------|------|-----|
| East and West Garo Hills | | | | | | | | | | |
| Rural | 974 | 956 | 959 | 959 | 975 | 951 | 960 | 950 | 939 | 964 |
| Urban | 974 | 956 | 959 | 959 | 975 | 951 | 992 | 958 | 945 | 973 |
| Meghalaya | - | - | - | - | - | - | 639 | 779 | 772 | 890 |

4.1 The existing situation in zone of influence (ZI) in GCA

The ZI in the present study represents the land within a specified distance from the periphery of existing

protected natural areas and the managed forests, spread over the surrounding community or privately owned land in GCA. The 2 km and 5 km were considered as the specified distance to represent two ZIs. The GCA with the geographical area of 2,459 sq km covers the entire South Garo Hills district (area 1,850 sq km) and the eastern and southern portions of West Garo Hills and East Garo Hills districts, respectively. The South Garo Hills district is divided into three administrative units called as Community Development Blocks (CDB) viz. Chokpot CDB, Baghamara CDB and Rongra CDB. As far as the GCA is concerned, it encompasses the three CDBs of South Garo Hills district and also touches the parts of Dalu and Rongram CDBs in West Garo Hills and Samanda CDB in East Garo Hills district.

As per the survey by Directorate of Soil Conservation (1995) the total of 14,127 (covering almost 50% of existing population of GCA) families from 1,087 villages are engaged in the *jhumming* with an average of 5.16 members per family with 0.28 to 0.8 ha area under *jhum* per family (Table 4.4). On an average, a total of 10,432 ha land is *jhummed* per year.

collection of NTFPs, plantations by department of Forest and Soil & Water Conservation, Meghalaya. Grazing pressure is almost negligible due to low cattle population (Personal observation). The land belongs either to local community or individuals and is being controlled by local *nokmas* or District Council. The people for their day-to-day needs are utilizing the land and forest in this area. Since the area is thinly populated around the Parks' boundaries, the pressure of resource exploitation is minimum as compared to other regions of the country. Four PAs namely Balpakram National Park (BNP), Nokrek National Park, Siju WLS (SWS) and Baghamara Pitcher Plant Sanctuary (BPPS) are situated in the complex mosaic with varying landuse activities being practised in the surroundings, for example, BPPS is located in the middle of Baghamara town at very steep slope, whereas other PAs are surrounded either by current and abandoned *jhum* fields with secondary growth or human habitations along with their crop/*jhum* fields. The patches of old primary forests still exist in few remote locations such as Thaidang, Chimitab, Shooling, Kalu-Rongcheng, Rongsu and Hangsapal etc. around BNP and Mandalgiri, Ampangiri, Bandigiri etc. around NNP. BNP shares the common boundary with SWLS in

Table 4.4: Demographic composition of villages in Six CDBs
(* indicates Average no. of *Jhumia* families in surveyed villages)

| Name of CDB | Total Villages (No.) | Total Families (No.) | Total <i>Jhumia</i> Families (No.) | <i>Jhummed</i> area per family (ha) | Total area under <i>jhum</i> | Average persons per family |
|--------------|----------------------|----------------------|------------------------------------|-------------------------------------|------------------------------|----------------------------|
| Chokpot | 343 | 5519 | 2991 | 0.80 | 2393 | 5 |
| Baghamara | 147 | 5100 | 763 | 0.72 | 549 | 5 |
| Rongra | 107 | 2001 | 989 | 0.28 | 277 | 5 |
| Dalu | 257 | 8834 | 3681 | 0.72 | 2650 | 5 |
| Rongram | 233 | 8526 | 5703 | 0.80 | 4562 | 5.8 |
| Smanda | NA | NA | NA (35)* | 0.73 | | 5.18 |
| Total | 1087 | 29980 | 14127 | 0.675 | 10432 | 5.16 |

Source: Directorate of Soil Conservation Department, Meghalaya (1995)

Apart from *jhumming*, other major factors influencing the ZI include the permanent agriculture at valley plains, horticultural fields (*bagan*) & Cash crops,

north and considered as single unit for analysis purpose.

4.1.1 The Location, extent, boundaries and natural attributes of ZI

Protected Areas do not have any village inside, thus the ZI is restricted to outside PAs and RFs. The zone of influence has been considered at two specified distances, viz. 2 km and 5 km from the PA/RF boundary representing forest and non-forest landuses under each ZI, which indirectly represents the pressure from outside the park.

4.1.1.1 ZI at 2 km distance

At 2 km distance, excepting ARF, all other PAs/MFs still had most area within ZI containing forested areas (secondary forests, deciduous, and evergreen forests) than non-forest areas. Even in case of combined ZI for three PAs, the forested areas were more represented in the ZI than non-forested areas. The most redeeming feature of ZI at 2 km distance is the low proportions of agricultural, *jhum* and scrubland areas suggesting that biotic pressures within the ZI at 2 km shall not be very high (Tables 4.5, 4.6 and annexure 17).

The ZI of BNP, SWS, and RRF overlapped when ZI was considered at 2 km distance. Therefore, a combined ZI has been taken in to consideration (Figure 4.1 and Table 4.6).

4.1.1.2 ZI at 5 km distance

In case of ZI taken at 5 km distance from boundaries, there was an overlap among the ZIs of the Balpakram NP, Nokrek NP, Siju WLS, Baghamara RF, Imangiri RF and Rewak RF. The combined zone of influence was marked and boundaries of combined ZI have been taken into consideration (Figure 4.1 and table 4.7). The non-forested areas are much less compared to the forested areas even with 5 km ZI for individual PAs and MFs. In some cases (ARF, BRF, BNP, and SWS), however, the area under *jhum* is quite substantial. The BNP and SWS, with ca. 130 sq km area under evergreen and semi-evergreen forests has most forested and less biotic influence in ZI. For combined PAs and MFs almost 80% of the area under ZI is covered with either deciduous, semi-evergreen, or evergreen forests (Table 4.7, 4.8 and annexure 18).

Table 4.5: Area (sq km) under different forest and non-forest types in the zone of Influence for different PAs/RFs at 2 km distance from boundaries

| Forest and Non-forest types | ARF | BRF | IRF | RRF | BNP | SWS | NNP |
|--------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Bamboo/Secondary forest (6-10 years) | 6 | 19 | 22 | 13 | 48 | | 24 |
| Deciduous forests | 16 | 8 | 1 | 2 | 36 | | 3 |
| Semievergreen forest | 3 | 10 | 1 | 2 | 4 | | 52 |
| Waterbodies | 0 | 8 | 3 | 9 | 8 | | 7 |
| Evergreen forest | 0 | 3 | 17 | 3 | 3 | | 5 |
| Permanent Agriculture | 2 | 7 | 0 | 1 | 7 | | 2 |
| Shifting Cultivation/grasslands | 4 | 1 | 1 | 0 | 9 | | 78 |
| Shadow | 1 | 0 | 0 | 1 | 3 | | 1 |
| Scrub/Abandoned <i>jhum</i> fields | 7 | 5 | 0 | 0 | 1 | | 0 |
| Plateau grassland | 0 | 0 | 0 | 0 | 0 | | 0 |

Table 4.6: Area under different forest and non-forest types in the zone of Influence (2 km) for combined BNP, SWS and RRF

| Forest and Non-forest types | No. of Patches | Total Area |
|--------------------------------------|----------------|------------|
| Bamboo/Secondary forest (6-10 years) | 3139 | 8 |
| Deciduous forests | 2493 | 42 |
| Semievergreen forest | 1534 | 52 |
| Waterbodies | 154 | 1 |
| Evergreen forest | 946 | 9 |
| Permanent Agriculture | 464 | 4 |
| Shifting Cultivation/grasslands | 2409 | 9 |
| Shadow | 723 | 5 |
| Scrub/Abandoned <i>jhum</i> fields | 883 | 5 |
| Plateau grassland | 2 | 0 |
| Unclassified | 1 | 71 |
| Total | 12747 | 134 |

Table 4.7: Area (sq km) under different forest and non-forest types in the zone of Influence (5 km)

| Forest and Non-forest types | ARF | BRF | IRF | RRF | BNPSWS | NNP |
|--------------------------------------|------------|------------|------------|------------|------------|------------|
| Bamboo/Secondary forest (6-10 years) | 17 | 15 | 52 | 41 | 19 | 14 |
| Deciduous forests | 47 | 50 | 66 | 40 | 93 | 76 |
| Semievergreen forest | 10 | 38 | 0 | 1 | 108 | 152 |
| Waterbodies | 0 | 1 | 12 | 8 | 1 | 0 |
| Evergreen forest | 0 | 1 | 1 | 6 | 21 | 155 |
| Permanent Agriculture | 8 | 12 | 10 | 9 | 9 | 2 |
| Shifting Cultivation/ grasslands | 10 | 18 | 3 | 3 | 23 | 20 |
| Shadow | 3 | 6 | 6 | 6 | 12 | 14 |
| Scrub/Abandoned jhum fields | 25 | 19 | 0 | 0 | 12 | 7 |
| Plateau grassland | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 119 | 160 | 150 | 114 | 298 | 441 |

Table 4.8: Area under different forest and non-forest types in the zone of Influence (5 km) for combined BNP, NNP, SWS, BRF, IRF and RRF

| Forest and Non-forest types | No. of Patches | Total Area |
|--------------------------------------|----------------|------------|
| Bamboo/Secondary forest (6-10 years) | 20289 | 49 |
| Deciduous forests | 15723 | 248 |
| Semievergreen forest | 8713 | 327 |
| Waterbodies | 769 | 2 |
| Evergreen forest | 3891 | 178 |
| Permanent Agriculture | 2859 | 21 |
| Shifting Cultivation/ grasslands | 16906 | 66 |
| Shadow | 4001 | 31 |
| Scrub/Abandoned jhum fields | 6973 | 37 |
| Plateau grassland | 2 | 0 |
| Total | 80126 | 959 |
| Unclassified | 7 | 204 |

4.1.2 Villages inside and outside the PAs. (Ethnic identities, traditions, customs, relationships between distinct group of people, relationship with forests Villages inside and outside the PAs)

There is no village inside PAs. A List of 72 villages within 10 km from boundary of BNP is given in annexure 19. The Eco-development Society of Meghalaya had identified 101 and 33 villages around BNP and NNP, respectively for implementing its eco-developmental schemes. All of these villages are dominated by Garos. However, a total of 25 Forest Villages are within the boundaries of RFs in Garo Hills. The Southern range in Garo Hills having the maximum six villages (Table 4.9), all of which along with Angratoli beat belongs to the GCA. These villages were earlier set up on the line of ‘forest-villages’ with a view to have ready employment in times of need and the amount of work put in by the villagers was compensated in terms of their land revenues paid to the State Forest Department. In addition, the villagers also enjoyed the rights and privileges of collection of firewood and thatch grass from the reserves. Currently, these villages are no more forest villages and are more or less revenue paying villages only and the villagers do not enjoy the rights and privileges for collection of NTFPs.

The exact number of villages around reserved forests is not known, but three out of the four reserved forests are located on or very near to highway and are inhabited heavily in their surroundings. Emangiri Reserved Forest is a little far from the highway in the southeast of NNP, but surrounded by bigger Garo villages.

4.1.2.1 Ethnic identities

The population inhabiting the areas near PAs and Reserved Forests is predominantly Garos. There are also a small number of Rabhas, Hajong and Kochs. The Hajongs practice wet rice permanent cultivation. The Kochs and Rabhas are sections of the Bodo race like Garos and appear to be off-shoots of Garos. Their original habitation seems to have been the northern slopes of the Garo hills with cultivation areas in valley plains. ‘GARO’ is a term generally used by other communities to refer to a particular group of people commonly known as the ‘Garos’ whose population is

Table 4.9: Reserved Forest Villages in Garo Hills, Meghalaya

| S. No. | Name of range/beat | Name of the forest villages |
|--------|--------------------|--|
| 1. | Rongrenggiri range | Chidikgiri and Rongmalgiri |
| 2. | Darugiri range | Darugiri, Dambu and Rongjeng |
| 3. | Danadubi range | Dangkhong, Chisimapal, Tengasot, Bolmedang and Nag |
| 4. | Kharkutta range | Kharkutta, Rajasimla, Adokgiri |
| 5. | Southern range | Emangiri, Rewak, Baghmara, Mahota, Bhabanipur and Rangajhora |
| 6. | Angratoli beat | Kondok, Telikali, Rakipara |
| 7. | Hollaidanga beat | Hollaidanga, Paham, and Sorakpara |

concentrated in Garo Hills district, and whose population also formed one of the racial elements in the basic population of north-east India including West Bengal and Bangladesh.

4.1.2.2 Growth of tribal communities

Table 4.10 gives the population of tribal communities in Meghalaya. The tribal communities in the Garo Hills are represented by Garo, Khasi, Hajong, Koch, Kuki, Mizo, Naga, Rabha and Bodo. In addition to these there are other tribal communities in the Garo Hills, but their population is significantly low.

Most of the areas of Garo Hill district are inhabited by the Garos. It comprised of a number of independent cluster of villages, such cluster forming an Aking land. According to the different dialects, different practices of socio-political, cultural and religious beliefs, the areas of the district were divided among the sub-tribes.

Table 4.10: Growth of Tribal Communities

| | Population | | | Decennial Growth | | Percentage | | |
|---------------|----------------|------------------|------------------|------------------|-----------|------------|------------|------------|
| | 1961 | 1971 | 1981 | 1971 | 1981 | 1961 | 1971 | 1981 |
| Garo | 254,784 | 411,532 | 405,449 | 62.5 | -1.47 | 33.1 | 40.6 | 30.3 |
| Hajong | 22,652 | 23,978 | 24,331 | 5.85 | 1.46 | 2.94 | 2.3 | 1.8 |
| Khasi-Jaintia | 352,031 | 468,499 | 628,104 | 33.1 | 34.1 | 45.7 | 46.3 | 47 |
| Other-Tribes | 9694 | 10918 | 15,921 | 0.01 | 45.8 | 1.25 | 1 | 1.1 |
| Other | 130,219 | 96772 | 262,014 | 170 | 170 | 16.9 | 9.5 | 19.6 |
| Total | 769,380 | 1,011,699 | 1,335,819 | 31.5 | 32 | 100 | 100 | 100 |

Source : Based on Census of India

Though the main features of their traditional political setup, social institutions, marriage systems, inheritance of properties and religion and beliefs are common. It is observed that these units were isolated from one another. They have developed their own separate patterns of political, social, cultural and religious institutions. The song, dances and music are mostly associated with traditional religion functions and ceremonies. Such important ceremonial function among Dual sub-tribes is 'Mangona Ceremony'. A certain conception of punishment and reward hereafter is not wanting in their beliefs, for sin in one life affects the form of incarnation in the next.

- The lowest form of reincarnation is that in the shape of insects and plants.
- The next higher is in the shape of animals and birds,
- The highest is that in human form and,
- The greatest reward for the virtuous life is to be reborn into the same motherhood as before.

4.1.2.3 Village Site

Hunter (Back cited in Sangma, 1995) noted that the boundaries between the villages were settled or supposed to have been settled from time immemorial. How is it that villages of a *jhumia* society came to have geographical delimitation. Playfair noted that earlier Garo villages were of larger size of two to three hundred houses.

4.1.2.4 Family Nucleation

Family nucleation is already an observable phenomenon among the traditional Garos. Majumdar (Back cited in Sangma, 1995) noted it in a *jhumia* village which seeks supplementary income in wage labour. Even a *nokrom* was found to be living separately from his father-in-law. This is the direct result of dwindling *jhumia* economy. This being reinforced by opportunities of income where individual rather than communal action needed. Nucleation is inevitable.

4.1.2.5 Individual ownership

Communal ownership is ideal. But it can be preserved in a traditional society only through co-operativisation, which has not succeeded much in our country. This does not appear to be very strong among the Garos.

4.2 The state of people's economy: (Vocations, landuse, use of forest and non-forest based resources by people and seasonal patterns)

4.2.1 Vocations

The main vocation of the people in the GCA is agriculture especially shifting cultivation (*jhumming*). About 49% of the total families in the GCA practise shifting cultivation (Table 4.4), thus covering an area of about 10,431 hectares under *jhum*. Other vocations, which constitute a very small portion of their *jhum*-based economy, include the livestock rearing, fishery, seri-culture, weaving and other small-scale industries.

Analyses of data on socio-economic aspects indicated that the local communities have a well-structured system and the most of the families were of medium size (5-8) and average number of working members ranges between 2 to 6 (Table 4.11). The well-knit tribal communities are economically largely dependent on the natural forest resources; forest land for shifting cultivation; collection of NTFPs and need of timber for construction and other uses. The agricultural produce included paddy, cotton, turmeric, tapioca, ginger and vegetables. While horticulture is being

of economic activity and 238,457 were classified as non-workers, the ratio being 5:7. Comparative figures for the state of Meghalaya as a whole were 446,828 workers to 564,871 non-workers or approximately 11:44. This is an indication of poor economic conditions of the Garo Hills district. The figures in table 4.13 give the percentage distribution of workers and non-workers between rural and urban areas of the district under different work classes.

Table 4.11: Demographic Composition of Villages around BNP

| Parameters Family groups | No. of Families (Population) | Average No. of working members | Per family land holding in ha | |
|--------------------------------|------------------------------------|--------------------------------------|----------------------------------|---------|
| | | | <i>Jhumming</i> | Orchard |
| Small (1-4 ind.) | 20 (66) | 2 | 0.62 | 1.07 |
| Medium (5-8 ind.) | 37 (231) | 3 | 0.82 | 0.99 |
| Large (>8 ind.) | 7 (69) | 6 | 0.68 | 1.29 |

gradually developed within the home gardens, especially in larger villages, it indicated a change from shifting cultivation to more settled form of agriculture. The horticulture and cash crops grown were betel nut, betel leaves, bay leaves, pineapple, banana, rubber, cashew nut, mango, orange *etc.* Apart from this, piggery, duckary and poultry were the other activities of the tribes. The non timber forest produce included collection of fuel wood, broom grass, thatch grass, bamboo, agar wood, cane, wild fruits and tubers, medicinal plants, fish and other wild animals.

4.2.2 Livelihood pattern

As per 1971 census, the population of the then single district of Garo hills was divided into two categories, namely workers and non-workers. The working population was further subdivided into nine categories given in the table 4.12.

Out of the total population of 406,615 persons in the original district, 168,158 were engaged in some kind

Cultivators and agricultural labourers comprised about 90% of the total number of workers in the district. Out of 152,070 persons, 90% lived in the rural area and 0.11 in the urban area. The next higher percentage of workers in the rural and urban areas falls in class 5 (household

and other household industries), it being the 1.15% in the rural area and 0.16% in urban areas. The minimum number of people in employment, both in rural and urban areas is in class 6 (construction). In the class No. 9 (other services), the proportion of workers in rural and urban areas was about 5:2 (Simon 1996).

4.2.3 Standard of living

From a reputation of being headhunters in nineteenth century the Garo community has long been transformed into a well-developed society as in any other leading state of India, though the economic status is comparatively poor. To understand the general economic condition of the people, it is useful to know the standards of living of various groups in society. The two common factors, which determine the standard of living of people, are total income that a family earns and the total expenditure that it incurs for maintaining a living. According to the report on

Table 4.12: Male and female populations engaged in various professional categories in Garo Hills

| S. No. | Category of workers | Rural | | Urban | | Total | | Grand Total | Percentage |
|--------|--|----------------|----------------|--------------|--------------|----------------|----------------|----------------|------------|
| | | Male | Female | Male | Female | Male | Female | | |
| 1 | Cultivators | 86,131 | 55,376 | 106 | 61 | 86,237 | 55,437 | 141,674 | 33.84 |
| 2 | Agricultural Labourers | 7515 | 2856 | 24 | 1 | 7539 | 2857 | 10396 | 2.54 |
| 3 | Livestock,Forestry, hunting and plantations, orchards, and allied activities | 618 | 57 | 32 | | 650 | 57 | 707 | 0.17 |
| 4 | Mining and quarrying etc. | 10 | | | | 10 | | 10 | 0 |
| 5a | Household Industries | 1024 | 480 | 53 | 23 | 1077 | 503 | 1580 | 0.39 |
| 5b | Other than household industry | 387 | 50 | 193 | 3 | 580 | 53 | 633 | 0.16 |
| 6 | Construction | 259 | 9 | 181 | 2 | 440 | 11 | 451 | 0.11 |
| 7 | Trade and Commerce | 1726 | 70 | 714 | 32 | 2440 | 102 | 2542 | 0.63 |
| 8 | Transport, Storage and communications | 370 | 8 | 101 | 6 | 471 | 14 | 485 | 0.12 |
| 9 | Other Services | 6400 | 504 | 2477 | 298 | 8877 | 803 | 9680 | 2.38 |
| 10 | Non-Workers | 95,353 | 131,922 | 4824 | 6358 | 100,177 | 138,280 | 238,457 | 58.64 |
| | Total population | 199,793 | 191,333 | 8,705 | 6,784 | 208,498 | 198,117 | 406,615 | 100 |

Source: Simon, 1996

Table 4.13: Population engaged in various professional categories in Garo Hills

| S. No. | Category of workers | Percentage | | |
|--------|--|--------------|--------------|-------------|
| | | District | Rural | Urban |
| 1 | Cultivators | 34.84 | 34.84 | 0.04 |
| 2 | Agricultural Labourers | 2.56 | 2.56 | 0 |
| 3 | Livestock,Forestry, hunting and plantations, orchards, and allied activities | 0.17 | 0.17 | 0 |
| 4 | Mining and quarrying etc. | 0 | 0 | 0 |
| 5a | Household Industries | 0.39 | 9.37 | 0.02 |
| 5b | Other than household industry | 0.16 | 0.1 | 0.06 |
| 6 | Construction | 0.11 | 0.06 | 0.05 |
| 7 | Trade and Commerce | 0.63 | 0.44 | 0.19 |
| 8 | Transport, Storage and communications | 0.12 | 0.09 | 0.03 |
| 9 | Other Services | 2.38 | 1.69 | 0.69 |
| | Total | 41.36 | 40.27 | 1.08 |
| 10 | Non-Workers | 58.64 | 55.89 | 2.75 |
| | Total | 100 | 96.16 | 3.84 |

Source: Simon, 1996

Socio-Economic Survey of the Garo Hills District conducted by the Directorate of Economics, Statistics and Evaluation for 1970, the pattern reveals that the total monthly expenditure incurred on food by an average rural family was 74.21% in the hills region and 72.94% in the plains region of Garo Hills. About 16.28% was spent on non-food items in the hills region and 16.13% in the plains region, these included beverages, betel nut and leaf, tobacco, fuel & light and toilet articles *etc.* The balance 9.51% in hill regions and 10.93% in plain regions was spent on

miscellaneous articles, such as clothing, sports and amusement, education, furniture, ornaments, medicine, ceremonials, repairs and maintenance of dwelling houses, litigation, domestic servants, travelling *etc.* The high percentage of expenditure on items like clothing, housing, education, *etc.*, indicates a low standard of living in an average rural family. The consumption expenditure pattern (percentage) on principal items is given in the table 4.14 (Simon 1996).

Table 4.14: Average monthly expenditure on various items and percentage of total expenditure

| S. No. | Items | Hills region | | | | Plains region | | | |
|--------|-----------------------------------|---------------|------------|---------------|------------|---------------|------------|---------------|------------|
| | | Border | | Non-Border | | Border | | Non-Border | |
| | | Rs. | % | Rs. | % | Rs. | % | Rs. | % |
| I | Food items | 146.34 | 75.77 | 116.93 | 70.32 | 163.61 | 70.32 | 129.94 | 73.96 |
| II | Non-food items | | | | | | | | |
| A | Beverages | 2.28 | 1.18 | 1.54 | 0.93 | 2.60 | 1.39 | 2.36 | 1.02 |
| B | Betal nut & leaf | 3.64 | 1.89 | 0.84 | 0.50 | 2.91 | 1.55 | 2.44 | 1.06 |
| C | Tobacco | 4.68 | 2.42 | 11.94 | 7.18 | 4.31 | 2.30 | 4.61 | 1.99 |
| D | Drugs and intoxicants | 1.76 | 0.91 | 4.91 | 2.951 | 2.32 | 1.24 | 5.10 | 2.21 |
| E | Toilet articles | 3.61 | 1.87 | 1.72 | 1.04 | 3.24 | 1.73 | 3.47 | 1.50 |
| F | Fuel and light | 11.69 | 6.05 | 10.84 | 6.52 | 11.30 | 6.02 | 17.95 | 7.76 |
| G | Others | 1.55 | 0.80 | 2.13 | 1.28 | 0.92 | 0.49 | 4.07 | 1.76 |
| | | 29.21 | 15.12 | 33.92 | 20.40 | 27.60 | 14.72 | 40.00 | 17.30 |
| III | Miscellaneous | | | | | | | | |
| A | Clothing, bedding, footwear, etc. | 8.11 | 4.20 | 5.04 | 3.03 | 6.90 | 3.68 | 8.94 | 3.86 |
| B | Sports, amusements, etc. | 0.05 | 0.02 | 3.03 | 0.01 | -- | | | |
| C | Education | 0.71 | 0.37 | 0.01 | 0.16 | .14 | 0.08 | 1.19 | 0.51 |
| D | Sundry goods | 0.01 | 0.01 | 0.08 | 0.01 | .04 | 0.02 | 0.06 | 0.03 |
| E | Ornaments | 0.19 | 0.10 | 0.38 | 0.08 | .07 | 0.04 | 0.16 | 0.07 |
| F | Medical aid | 0.85 | 0.44 | 0.81 | 0.38 | 0.60 | 0.32 | 2.23 | 0.97 |
| G | Ceremonials | 1.01 | 0.52 | 1.55 | 0.81 | 1.99 | 1.06 | 0.25 | 0.11 |
| H | Construction, repairs, etc. | 1.28 | 0.66 | 1.01 | 1.55 | 3.12 | 1.66 | 6.45 | 2.79 |
| I | Domestic help | | | | | | | | |
| J | Travelling | 1.08 | 0.56 | 2.24 | 1.01 | 1.30 | 0.69 | 3.75 | 1.62 |
| K | Others | 4.31 | 2.23 | 9.28 | 2.24 | 4.02 | 2.14 | 4.87 | 2.11 |
| | | 17.60 | 9.11 | 100 | 9.28 | 18.18 | 9.69 | 27.90 | 12.07 |
| | Total | 193.15 | 100 | 166.29 | 100 | 187.57 | 100 | 231.21 | 100 |

4.2.4 Family Budget

The Table 4.15 below gives the family budget of an average family per month in the rural areas of Garo Hills.

Table 4.15: The family budget of an average rural family (Simon, 1996)

| FAMILY BUDGET HEAD | Hill region | | Plains region | | District |
|--|---------------|-------------------|---------------|-------------------|---------------|
| | <i>Border</i> | <i>Non-border</i> | <i>Border</i> | <i>Non-border</i> | |
| Gross income | 198.39 | 171.97 | 191.4 | 288.9 | 189.52 |
| Outlay | 11.32 | 11.65 | 15.78 | 25.68 | 12.36 |
| Net income | 187.07 | 160.32 | 175.62 | 263.22 | 177.36 |
| Expenditure | 193.15 | 166.29 | 187.57 | 231.21 | 175.69 |
| Food items | 146.34 | 116.93 | 141.79 | 163.31 | 129.94 |
| non-food items | 29.21 | 33.92 | 27.6 | 40 | 28.52 |
| Miscellaneous | 17.6 | 15.44 | 18.18 | 27.9 | 17.23 |
| Total expenditure | 193.15 | 166.29 | 187.57 | 231.21 | 175.69 |
| Difference between the total expenditure and Net income | -6.08 | -5.97 | -11.95 | +32.01 | +1.67 |

Source: A report of Socio-economic survey of Garo Hills district, 1970

4.2.5 Employment situation

Agriculture is the main occupation of the people living in the Garo Hills. According to the 1971 census there were 152,070 cultivators. The agricultural labourers in the old undivided Garo Hills district show an increase from year to year indicating a favourable scope for employment not only to men but also to women. The total number of applicants in employment between 1974 and 1981 in both districts was 360. Most of the jobs sought by the candidates were white-collar jobs in government offices. During the same period the monthly average number of

employees who used the Employment Exchanges were 10 in west Garo Hills and 3 in East Garo Hills.

4.2.6 Employment formation scheme

The main objective of this scheme was to collect employment data both from Public and Private Sector Establishments located within the jurisdiction of the Employment Exchanges. The scheme was introduced after the establishment of the original exchange. The following statement of Employment Market Information Scheme shows the changes in the volume of employment in both the sectors during the period from 1st January 1973 up to 31st December 1982 (Table 4.16).

4.2.7 Planning and community development

The Government of India set up the Planning Department with the main objective for bringing about a well-balanced growth of the different sectors of the under-developed economy. Three 5-year plan periods have been covered

since the inception of state (1972). Prior to that, the Government of Assam was responsible for the development of hill districts, including the Garo Hills. From the start, government had been giving top priority to the development of Transport & Communication followed by Agriculture, Education, and Health & Industries.

4.2.8 Community development

The implementation of the Community Development Programme involves the combined efforts of the government and the local people for improving the

Table 4.16: Employment formation schemes in Garo Hills

| Industrial division | No. of establishments (31st December 1972 onwards) | No. of Employees |
|--------------------------------------|--|-------------------------|
| Agriculture | 17 | 855 |
| Mining and quarrying | 1 | 31 |
| Manufacturing | 4 | 50 |
| Construction | 10 | 851 |
| Electricity | 2 | 395 |
| Water supply | | |
| Public health | 4 | 122 |
| Trade and commerce | 1 | 10 |
| Transport, storage and communication | 2 | 357 |
| Other services | 119 | 6,777 |
| Total | 160 | 9,448 |

economy of rural community. The first Community Development Block was inaugurated in the district in 1953. This was the Resubelpara Development Block opened on 1st October 1953, followed by the Dalu Development Block opened on 1st April 1954. More blocks have been opened after 1954 and as of 1981, the districts are being covered by 13 Community Development Block. The important schemes taken up by the community Development Block are Agriculture, Communication, Animal Husbandry & Veterinary, Health & Sanitation, Education & Social Welfare, Industries and Cooperation. These C.D. Blocks also administer the all-normal rural works and other rural development programmes as the Integrated Rural Development Programme (IRDP) and the National Rural Employment Programme (NREP) and Rural Godowns, and programmes respecting Public Cooperation and Nutrition.

4.2.9 Agricultural customs and needs of Populations

The main agriculture is practiced through *jhumming*. In this a plot of the land is selected on the hillside and rice crop is planted in April at the commencement of the rains. Shortly afterwards the seeds of vegetables, cotton, pepper and pulses are sown in the same clearing and each crop is reaped in rotation as it comes to maturity. Miscellaneous crops include the potatoes, *arhar*, ginger and turmeric and other plants for rearing of lac insects. In the second year only rice is grown and after two years of cultivation the clearing is abandoned and allowed to lie fallow for about five to seven years. The sole implement of agriculture is a short Dao fixed in a long handle with which jungle is cleared (Suchiang, 1975).

4.2.10 Forest and non-forest resources

4.2.10.1 Use of forest resources

Villagers for their sustenance use varieties of forest and non-forest resources. The uses of these resources vary both in quantity and periods of use depending upon different seasons. Main forest based resources includes: Fuel wood; Broom grass; Thatch grass; Bamboo; Agar wood; Cinnamon leave; Bark of *Persia villosa*; Medicinal plants; Cane; Fish; Wild Fruits; Wild Tubers; Wild Animals

Among the various uses from above forestry resources, the most common are the food plants. A study by Biswas and Bhuyan (1986) identified some food plants of Garo Hills. They mentioned that the forests are an important source of food particularly for the tribal population, which depends substantially on the edible products of the forests. It had been found that plants and vegetables eaten by the people living in the forest are sometimes included in the list of famine foods. It was also reported that during the period of drought and when a supply of good cultivated vegetable and crop is not procurable, various forest

products are utilized, *e.g.*, rice is substituted by the content of yams (*Dioscorea alata*, *D. pentaphylla* and *D. bulbifera*). The tuberous crops are cheap source of calories and valuable source of vitamins and minerals with low protein content (Deb, 1975), the cultivation of Dioscoreas in the locality is common whose tubers are collected and grown in their crop fields and gardens. Manihot (*Manihot esculenta*) is one of the widely grown root crops in the region and it furnishes the basic food next to yams and paddy. In the folklore of Garos the importance of Manihot is well versed by

the words, which mean in English: “I could live without rice but not without Manihot”. The vegetables mostly consist of young bamboo shoots (*Bambusa balcooa* and *Dendrocalamus hamiltonii*). Other commonly used are inflorescences of banana (both wild and cultivated) and leaves of various species *e.g* *Zanthoxylum oxyphyllum*, *Bauhinia* spp, *Corchorus* and *Amaranthus* spp. *etc.* A comprehensive systematic enumeration is provided below for 28 species together with their local names, important characters and parts used (Table 4.17).

Table 4.17: Some useful tree plant species in GCA

| Species Name | Local name | Habit | Parts used | Use |
|----------------------------------|--------------|-------|-------------------------------------|--|
| <i>Dillenia pentagyna</i> | Agachi | T | Young tender leaves and flower buds | Eaten raw or cooked |
| <i>Corchorus olitorius</i> | Me-kha | US | Young shoots | Eaten as pot-herb |
| <i>Zanthoxylum oxyphyllum</i> | Me-chang | S | Young shoots and leaves | Eaten raw or cooked |
| <i>Bauhinia malabarica</i> | Phak-Phakil | T | Young tender leaves | Eaten as vegetable |
| <i>B. purpurea</i> | Phak-Phakil | T | Young tender leaves | Eaten as vegetable |
| <i>Momordica cochinchinensis</i> | Khang Kelong | C | Fruits | Eaten as vegetable |
| <i>Eryngium foetidum</i> | Phut Masala | H | Leaves | Flavouring rice and curries |
| <i>Solanum indicum</i> | Kimka | S | Unripe fruits | Employed in the preparation of curries, chutneys and preserves |
| <i>Stereospermum personatum</i> | Bol-sel | T | Young tender leaves | Eaten as vegetable |
| <i>Premna latifolia</i> | Dukh-me | T | Young tender leaves | Eaten in curries |
| <i>Amaranthus gangeticus</i> | Sandli | H | Stems and leaves | Eaten as pot-herb |
| <i>A. spinosus</i> | Sandli | H | Stems and leaves | Eaten as pot-herb |

Contd....

Table 4.17 Contd....

| Species Name | Local name | Habit | Parts used | Use |
|---------------------------------|-----------------|-------|----------------------------------|--|
| <i>A. viridis</i> | Sandli | S | Tender tops | Eaten as vegetable |
| <i>Manihot esculenta</i> | Ta'belchu | S | Tubers | Liquour 'Hardy' |
| <i>Artocarpus heterophyllus</i> | T'brong | T | Fruits, Seeds | Seeds are roasted and eaten as vegetable. Unripe fruit is also used as vegetable |
| <i>Artocarpus chaplasha</i> | Chram | T | Fruits | When ripe. |
| <i>Costus speciosus</i> | | H | Leafy stems, Rhizomes | Used as vegetable |
| <i>Musa spp.</i> | Terik rechu | S | Inflorescence with tender bracts | Made into curries with black pepper and salt |
| <i>Dioscorea alata</i> | Ta Jong | | Tubers | Extensively exploited during famine |
| <i>Dioscorea bulbifera</i> | Ta Torak | | Tubers & bulbils | Used as famine food |
| <i>Dioscorea pentaphylla</i> | Ta Steng | | Tubers | Used as vegetable |
| <i>Dioscorea hamiltonii</i> | | | Tubers | Used as vegetable |
| <i>Dioscorea trinervia</i> | | | Tubers | Used as vegetable |
| <i>Dioscorea esculenta</i> | Ta Torak | | Tubers | Used as vegetable |
| <i>Amorphophyllus bulbifera</i> | Chongrura | H | Petiole & Peduncle | Boiled and eaten with salt & chillies by extremely poor people |
| <i>Bambusa balbooa</i> | Wamna, Boluka | | Young shoots | Largely eaten as vegetables during rainy season |
| <i>Dendrocalamus hamiltonii</i> | Mia, Kaku, Wa'a | | Young shoots | Eaten as vegetable |
| <i>Echinochloa frumentacea</i> | | | Grains (millet) | Used in place of rice. |

4.2.10.2 Use of non-forest resources:

These are of two types.

4.2.10.2.1 Agricultural & allied products:

Paddy; Cotton; Turmeric; Ginger; Tapioca; Vegetables; Pig rearing; Poultry

4.2.10.2.2 Horticultural & cash crop products:

Betal nut; Betal leaf; Pineapple; Banana; Jack fruit;

Mango; Orange; Rubber; Cashew nut.

4.10.2.3 Seasonal pattern in the collection of NTFP from the forests of community land

Fuel wood: Every family in Garo villages collect the fuel wood regularly during dry season and store it for the use during rainy season. Each lady in the family roughly collects one basket (12-15 Kg) daily during

October to April, mainly for self-use; very rarely for commercial purposes.

Broom Grass: This is mainly during January and February. On an average, a group of families (3-5 persons) collect 80-100 Kg per day. It is being sold to the local contractors (mainly Marwaries) @ Rs. 2 (Two) per Kg.

Thatch Grass: About 10% families of the villages are involved in the collection of NTFP. Collection is being done during January and February, which is being sold @ Rs. 2 (Two) per bundle (One bundle is 1-1.5 Kg) in the local markets.

Bamboo: About 10% families of the villages are involved in Bamboo extraction, which is done mainly in rainy season and immediately supplied to Bangladesh along with the flow of river Simsang. It is sold @ 1 (One) Taka per Bamboo (Taka is the Currency of Bangladesh, more or less equals the Indian Rupee).

Agar wood: Bark of Agar tree (Old name *Aquilaria agallocha*, New name *Aquilaria malaccensis*) is removed and Hardwood and softwood cut into small pieces and sold @ Rs 30 (Thirty only) per Kg. One mature tree produces c. 50-60 Kg on an average.

Tree Bark: For medicinal purposes.

- Boldukaki (*Litsea sebifera*) The dried bark is sold @ Rs. 4 (Four only) per Kg while fresh bark is sold @ Rs. 2 (Two only).
- Nameaga (*Persia villosa*), sold @ Rs. 4 (Four only) per Kg for dried bark and Rs. 2 (Two only) for Fresh bark.
- Kiring (*Oroxylum indicum*), sold @ Rs. 6 (Six only) per Kg for dried bark and Rs. 4 (Four only) for Fresh bark.
- Mixture of crushed bark of Tegatchu (*Mangifera indica*), Ambre (Old name *Emblica officinalis*, New name *Phyllanthus emblica*), Gimbal (*Careya arborea*), Artak (*Terminalia citrina*) is used to control Dysentery. It is collected in minor quantity for self-use. Commercially exploitation is not reported.

Root

- Makkal (Vernacular name in Garo dialect), a climber crushed into powder and mixed in water body to kill fish. A quantity of 2-3 Kg of powder is enough to kill all the fish of a small pond.
- Thagachak (Vernacular name in Garo dialect), boiled timber of this species is used as food.

Flower

- The flower of a shrub Elliot (*Phlogacanthus thyrsiflorous*) are used as vegetable
- The flowers of a tree locally known as Tekring or Ambi-lathong (*Burserra serrata*) are used as vegetable/Pickle. The fruits of this species also consumed.

Fruit: The raw fruits of following tree species are used as vegetables and the ripen ones eaten as such.

- Chrum (*Artocarpus chaplasha*),
- Armu (*Artocarpus gomezianus*),
- Micheng (*Zanthoxylum rhetsa*),
- Olmak (*Sterculia villosa*), and
- Banana fruit *Musa species*).

Leaves: The leaves of following species are used either as culinary or plates for serving meals.

- Megong (*Bauhinia stipularis*)
- Tejpatta (*Cinnamomum tamala*)
- Chhagro (*Macaranga denticulate*)
- Mao (*Hibiscus macrophyllus*)
- Agatchi (*Dillenia pentagyna*)
- Banana (*Musa species*)
- Gimbal (*Careya arborea*).

New shoots of Bamboo & Canes are used as food.

Coal: Coal deposits near Balpakram National Park are extracted @ 80-100 Kg per family per day.

Cane: Cane is used for making furniture and other handicraft items like

- Chair and Table. Chair sold in the local markets @ Rs. 150 (One hundred fifty) only per piece & Table @ Rs. 250 (Two hundred fifty) only per piece.
- Stool (*Morah*) is sold @ Rs. 80 (Eighty) only per piece.

- Almirah/Book shelf is sold @ Rs. 400 (Four hundred only) per piece.
- Sup, which is made of canes and used for removing husk from cereals/pulses before cooking, is @ Rs. 50 (Fifty) only per piece.
- Mats are sold @ Rs. 125 (One hundred twenty five) only per piece.
- Baskets are sold @ Rs. 20- 40 (Twenty to Forty) only per piece (depending upon size).

A list of 150 tree species (Annexure 3.5) with their local names prepared during vegetation survey was used conducting interview of local forest guards, foresters and permanently resident people to get the information on the use of different body parts of selected tree species. A total of 108 tree species were found to be used by local people either as food source (33 tree species) or medicine (20) or timber (54) or fuelwood (98) or boat construction material (43). There are numerous uses of trees and other plant species, but present survey was restricted to these five categories of key cultural functions. Two species *Dillenia pentagyna* and *Terminalia citrina* were found to be the most versatile species. Most of these species are used as fuelwood (Table 4.18).

4.3 Implications of the landuse and resource dependency for the conservation of PA

4.3.1 Implications of landuse

Since the main landuse pattern is for the shifting cultivation, the major implications of this landuse pattern relates to the forest loss leading to the forest fragmentation and habitat degradation. *Jhum* varies from 3-15 years, which was observed by Medhi (1984) quoting that erosion due to *jhumming*, cultivation in hilly plains, and construction result in the wastage of 33-201, 40-50 and 18 tons of soil per hectare per annum. A case study by Dutta (1982) showed the loss of 19 million tons of soil annually in Garo Hills (see annexures 20 and 21 for detailed landuse in South Garo hills and various Community Development Blocks).

4.3.2 Implications of resource dependency

The resource dependency of the people in the GCA is for the land as such and other natural forestry resources including NTFPs and wild animals leading

to hunting and poaching.

4.3.3 Wants of the population

As described in the preceding paragraphs, the common requirements of the local villagers from forestry resources are for bamboos, firewood, timber for house construction as well as agricultural implements *etc.* Whenever they can afford people use house posts, beams, rafters *etc.*, which are made of Sal timber. The roofing material is collected from their own *Jhum* lands. As they have got only a few heads of cattle, demand for grazing is very limited. The demand for forest produce from other communities like Rabhas, Hajongs *etc.* are limited and they collect the produce from the unclassified state forests.

4.3.4 Hunting

During the fieldwork some local people were interviewed to know the status and methods of hunting in the GCA. Basically, the Garos are hunter by nature. "Whatever moves is being eaten" many of the people declare this fact very proudly. They eat wild animals ranging from big elephants to small rats/bats, birds and even tiny insects including grasshopper. They have developed many indigenous devices during the course of society development. *Agrip*, *Doja*, *Jaga*, *Suchikang*, *Khelkha* and *Baging* are few examples of the traditional traps used for capturing and killing animals like myna, barking deer, hare, jackals, sambhar and elephant *etc.* These killing trap designs and operation requires a fair degree of skill, *e.g.* A device locally known as *Suchikang* (*Khelkha*) is used to capture and kill elephants. It is constructed using strong pointed iron rods. *Doja* is a small house (room), which is made to collect and store paddy. Sometimes it is also used to capture barking deers and small animals. *Agrip* prepared through poles, is used to capture small animals such as barking deer. *Baging* is used to capture hare, jackal and wild pig. Animal's neck or leg is trapped very strongly, sometimes animal die in the trap.

4.4 Forest management practices and their implications on people

Of the total GCA area only 15% fall within PAs or MFs and the remaining 85% is with the local communities. After the 1998 ruling of the Honourable

Table 4.18: Key Cultural Functions of important tree species

(Number '1' in cell indicate the use of species for particular purpose while blank means either species is not used or use is unknown to project staff)

| S. No. | Species | Botanical name | Edible | Medicine | Timber | Fuelwood | Boat |
|--------|-----------------|---|--------|----------|--------|----------|------|
| 1 | Agatchi | <i>Dillenia pentagyna</i> | 1 | 1 | 1 | 1 | 1 |
| 2 | Artak | <i>Terminalia citrina</i> | 1 | 1 | 1 | 1 | 1 |
| 3 | Chrum | <i>Artocarpus chaplasha</i> | 1 | | 1 | 1 | 1 |
| 4 | Kimbol/Makanchi | <i>Callicarpa arborea</i> | 1 | | 1 | 1 | 1 |
| 5 | Gambil/Dambil | <i>Careya arborea</i> | | 1 | 1 | 1 | 1 |
| 6 | Bolbret | <i>Cedrela toona</i> | 1 | | 1 | 1 | 1 |
| 7 | Chambu Sirsang | <i>Eugenia aquca</i> | 1 | | 1 | 1 | 1 |
| 8 | Aruwak | <i>Garcinia tinctoria</i> | 1 | 1 | 1 | 1 | |
| 9 | Tebe | <i>Hodgsonia macrocarpa</i> | 1 | | 1 | 1 | 1 |
| 10 | Bolbet | <i>Litsea monopelata</i> | 1 | | 1 | 1 | 1 |
| 11 | Tegatchu | <i>Mangifera indica</i> | 1 | | 1 | 1 | 1 |
| 12 | Tegatchu | <i>Mangifera sylvatica</i> | 1 | | 1 | 1 | 1 |
| 13 | Aburispil | <i>Micromelon pubescens</i> | 1 | 1 | 1 | 1 | |
| 14 | Te'brong | <i>Syzygium balsameum</i> | 1 | | 1 | 1 | 1 |
| 15 | Dodikimsong | <i>Actinodaphne obovata</i> | | | 1 | 1 | 1 |
| 16 | Bolribu | <i>Aesculus assamica</i> | | | 1 | 1 | 1 |
| 17 | Chandana | <i>Ailanthus grandis</i> | | | 1 | 1 | 1 |
| 18 | Shishu | <i>Albizia lebbek</i> | | | 1 | 1 | 1 |
| 19 | Khilbe | <i>Albizia odoratissima</i> | | | 1 | 1 | 1 |
| 20 | Bolapal | <i>Aphanamixis polystachya</i> | | | 1 | 1 | 1 |
| 21 | Armu/Arimu | <i>Artocarpus gomezianus</i> | 1 | 1 | | 1 | |
| 22 | Gakkal | <i>Betula alnoides</i> | | | 1 | 1 | 1 |
| 23 | Dongram | <i>Canarium strictum</i> | | | 1 | 1 | 1 |
| 24 | Chako Chiring | <i>Castonopsis hystrix</i> | | | 1 | 1 | 1 |
| 25 | Chako | <i>Castonopsis purpurella</i> | | | 1 | 1 | 1 |
| 26 | Teja Bifa | <i>Cinnamomum bejolghota</i> | | | 1 | 1 | 1 |
| 27 | Rongrip | <i>Cynometra polyandra</i> | | | 1 | 1 | 1 |
| 28 | Bolasin | <i>Disoxylum hamiltonii</i> | | 1 | 1 | | 1 |
| 29 | Bolchim | <i>Duabunga grandiflora</i> | | | 1 | 1 | 1 |
| 30 | Ambre | <i>Emblica officinalis/ Phyllanthus emblica</i> | 1 | 1 | | 1 | |
| 31 | Bokta | <i>Ferminiana colorata</i> | | | 1 | 1 | 1 |
| 32 | Bolchiring | <i>Glochidion velutinum</i> | | 1 | | 1 | 1 |
| 33 | Gambari | <i>Gmelina arborea</i> | | | 1 | 1 | 1 |
| 34 | Mugasalgro | <i>Heteropanax fragrans</i> | | | 1 | 1 | 1 |
| 35 | Bolong | <i>Kaeya floribunda</i> | | | 1 | 1 | 1 |
| 36 | Bolanchi | <i>Knema limifolia</i> | | 1 | 1 | 1 | |

Contd...

Table 4.18 Contd...

| S. No. | Species | Botanical name | Edible | Medicine | Timber | Fuelwood | Boat |
|--------|------------------------|--|--------|----------|--------|----------|------|
| 37 | Kimde | <i>Mesua ferrea</i> | | | 1 | 1 | 1 |
| 38 | Champa | <i>Michelia champaca</i> | | | 1 | 1 | 1 |
| 39 | Solwa | <i>Polaquim polyanthum</i> | | | 1 | 1 | 1 |
| 40 | Adingok | <i>Pterospermum acerifolium</i> | | | 1 | 1 | 1 |
| 41 | Adambit/Laisa | <i>Pterospermum lancefolium</i> | | | 1 | 1 | 1 |
| 42 | Boldak | <i>Schima wallichii</i> | | | 1 | 1 | 1 |
| 43 | Bolsal | <i>Shorea robusta</i> | | | 1 | 1 | 1 |
| 44 | Churi | <i>Terminalia bellirica</i> | 1 | 1 | | 1 | |
| 45 | Bolbok | <i>Tetrameles nudiflora</i> | | | 1 | 1 | 1 |
| 46 | Khrenti/Kranchi | <i>Walsura arborea</i> | | | 1 | 1 | 1 |
| 47 | Kitma/Sabong | <i>Abrus precatoius</i> | 1 | | | 1 | |
| 48 | Bolpha | <i>Albizia chinensis</i> | | | | 1 | 1 |
| 49 | Kadam | <i>Anthocephalus kadamba/ A. chinensis</i> | | | 1 | 1 | |
| 50 | Megong | <i>Bauhinia purpurea</i> | 1 | | | 1 | |
| 51 | Ambilatong | <i>Bursera serrata</i> | | 1 | | 1 | |
| 52 | Matmi | <i>Croton joufera</i> | 1 | | | 1 | |
| 53 | Bolmendu | <i>Dalbergia paniculata</i> | | | 1 | | 1 |
| 54 | Gap | <i>Diospyros embryopteris</i> | 1 | | | 1 | |
| 55 | Ankispak | <i>Elaeocarpus rugosus</i> | | | 1 | 1 | |
| 56 | Chamisi | <i>Eurya accuminata</i> | | | 1 | 1 | |
| 57 | Goerangsang | <i>Ficus foveolata</i> | 1 | | | 1 | |
| 58 | Aminsep | <i>Ficus semicordata</i> | 1 | | | 1 | |
| 59 | Dengaduti | <i>Garcinia kydea</i> | 1 | | | 1 | |
| 60 | Boljagro | <i>Glochidion sphaerogynum</i> | | | 1 | 1 | |
| 61 | Bolchubret/ Damsuri | <i>Grewia microcos</i> | 1 | | | 1 | |
| 62 | Bolibu | <i>Gynocardia odorata</i> | | | 1 | 1 | |
| 63 | Mao | <i>Hibiscus macrophyllus</i> | | | 1 | 1 | |
| 64 | Ajakari/Bolasari | <i>lagerstroemia speciosa</i> | | | 1 | 1 | |
| 65 | Gawigran | <i>Lapisanthus rubiginosa</i> | 1 | | | 1 | |
| 66 | Boldukaki | <i>Litsea sebifera</i> | | 1 | | 1 | |
| 67 | Rimikgital | <i>Macaranga indica</i> | | 1 | | 1 | |
| 68 | Kiring | <i>Oroxylum indicum</i> | 1 | 1 | | | |
| 69 | Nameaga | <i>Persia villosa</i> | | 1 | | 1 | |
| 70 | Bolgisim | <i>Polyalthia simiarum</i> | | | 1 | 1 | |
| 71 | Dokimi | <i>Premna latifolia</i> | 1 | | | 1 | |
| 72 | Changsim/ Cherasu | <i>Sapium baccatum</i> | | | | 1 | 1 |

Contd...

Table 4.18 Contd...

| S. No. | Species | Botanical name | Edible | Medicine | Timber | Fuelwood | Boat |
|--------|--------------------------|----------------------------------|-----------|-----------|-----------|-----------|-----------|
| 73 | Kimkol | <i>Saraca indica</i> | 1 | | | 1 | |
| 74 | Chambu | <i>Syzygium cumini</i> | 1 | | | 1 | |
| 75 | Pakram | <i>Trema orientalis</i> | 1 | | | 1 | |
| 76 | Bolka | <i>Trewia nudiflora</i> | | 1 | 1 | | |
| 77 | Rangri | <i>Vitex peduncularis</i> | | | 1 | 1 | |
| 78 | Garadek | <i>Wendlandia excelsa</i> | 1 | | | 1 | |
| 79 | Boljalik | <i>Actinodaphne augustifolia</i> | | | | 1 | |
| 80 | Rengokmi | <i>Alangium chinense</i> | | | | 1 | |
| 81 | Bolapu | <i>Albizia stipulata</i> | | | | 1 | |
| 82 | Sokchon | <i>Alstonia scholaris</i> | | 1 | | | |
| 83 | Chamolja | <i>Aporusa dioica</i> | | | | 1 | |
| 84 | Terimu | <i>Aristolochia tagala</i> | | | | 1 | |
| 85 | Bolchhu | <i>Bombax ceiba</i> | | | 1 | | |
| 86 | Kasi | <i>Bredelia retusa</i> | | | | 1 | |
| 87 | Kasi Dupret | <i>Bredelia stipularis</i> | | | | 1 | |
| 88 | Sinaru | <i>Cassia fistula</i> | | 1 | | | |
| 89 | Tejpatta | <i>Cinnamomum tamala</i> | 1 | | | | |
| 90 | Tewak | <i>Ficus hispida</i> | 1 | | | | |
| 91 | Chigambil | <i>Garuga pinnata</i> | | | | 1 | |
| 92 | Bolgolmatra/ Matalwe | <i>Holarrhena antidysentrica</i> | | | | 1 | |
| 93 | Bolchenda | <i>Ilex embedioides</i> | | | | 1 | |
| 94 | Boltajong | <i>Ilex umbellulata</i> | | | | 1 | |
| 95 | Boldubok | <i>Kydia calycina</i> | | | | 1 | |
| 96 | Sidai | <i>Lagerstroemia parviflora</i> | | | | 1 | |
| 97 | Bolgreng | <i>Ligustrum robustum</i> | | | | 1 | |
| 98 | Chagro/Bolajak | <i>Macaranga denticulata</i> | | | | 1 | |
| 99 | Mangritchok | <i>Maesa sarmentosa</i> | | | | 1 | |
| 100 | Boltatu | <i>Mallotus roxburghianus</i> | | | | 1 | |
| 101 | Matchamikong | <i>Mallotus tetracoccus</i> | | | | 1 | |
| 102 | Kilkira | <i>Oriocnoides integrefolia</i> | | | | 1 | |
| 103 | Charapak | <i>Pterigota alata</i> | | | | 1 | |
| 104 | Bolmising/ Bolmicheng | <i>Rhus accuminata</i> | | 1 | | | |
| 105 | Chengsu | <i>Sterculia colorata</i> | | | | 1 | |
| 106 | Olmak | <i>Sterculia villosa</i> | | | | 1 | |
| 107 | Bandikuri | <i>Vitex glabrata</i> | | | | 1 | |
| 108 | Bolkingrak | <i>Walsura tubularis</i> | | | | 1 | |
| | Total | | 33 | 20 | 54 | 98 | 43 |

Supreme Court, there has not been any working in the RFs. As such PAs are governed by the provision of WL (P) Act, wherein limited scope exists for forest working only to improve the habitats as a part of Wildlife Management Plan.

Reserved Forests areas within GCA were covered under last Working Plan of 1975, which was in operation until 1990. According to this plan, forest management was effected through the creation and management of five working circles: Sal Working Circle (WC), Plantation WC, Bamboo WC, Protection WC, and Ghugra (*Gmelina arborea*) overlapping WC. Forest management practices till 1990 also included raising of 'taungya' plantations mainly of *Tectona grandis* and *Shorea robusta*, and extensive social forestry plantations using above two species, besides *Gmelina arborea*.

The most notable aspect of latest Working Plan was that it advocated for such management practices that could help in the overall wildlife conservation. Such forest management practices aimed at conserving and improving the status of wildlife in RFs without, of course, compromising with the principles of the scientific forestry. Since 1990, there has not been any forestry management practice mentioning either inside the RFs or PAs.

Informal forestry practices by the local people

The Garos are closely related with the forests, since the forests are fulfilling most of their day-to-day needs. They are very much concerned with the loss of forest resources. They have experienced that during the years the water availability has been reduced to a critical level. Many villages have moved from the top of hills to down near river recently (personal observation). They understand that the loss of forest cover has been increased by many folds now a days and this is the major reason of disturbed monsoon pattern and declining water resources. The rural community in the Garo Hills has its own way of conserving the water resources by keeping some forest tracts as a village reserve. As regards the forest management practices inside the community owned areas, the main emphasis has been on the strict protection of the 'Village Community Reserves' in

the midst of *jhum* areas. The sizes of these reserves vary between 2-5 ha or sometimes exceeding 10 ha depending upon the availability of forested land that is important from water catchment's point of view. Such examples exist near Nokrek, Balpakram, Baghmara and Emangiri area.

4.5 The development programmes and conservation issues

Dutta (1984) discussed various schemes initiated by the Soil Conservation Department of the Government of Meghalaya and found the significant social changes caused by these economic innovations. These schemes included:

1. The *Jhum* Control Scheme
2. General Land Development Schemes
 - Terracing
 - Erosion Control Work
 - Afforestation Scheme (Table 4.19)
 - Water Conservation and Distribution work
 - Urban Area Conservation work
3. Watershed Management scheme.

4.5.1 Evaluation of government and non-government programmes for development-implications for CA and people within

The three-tier administration of the Garo Hills consists of Deputy Commissioner at the district level, District Councils at the Autonomous district councils, and Nokmas at the village levels. Various activities pertaining to different departments are performed and governed at these three levels with the addition of the participation from different non-government societies and Cooperative societies at all these levels.

The Deputy Commissioner who is assisted by different lower ranking staff carries on the district administration. The District Council administration is carried on by the Executive Commissioner the headed by the Chief Executive Officer. The major subjects assigned to the council are Forests, Civil Wworks, Taxation, Revenue, Judicial, Transport and Education. The development programmes are undertaken at above three levels of administration by different departments; Agriculture department, Animal Husbandry and Veterinary Department,

Table 4.19: Plantation chart under social division south Garo Hills, Baghmara (All the plantation will be handed over back to Nokma after 10 years.)

Teak, Gamari were planted instead of fuel wood & fodder by keeping preference of villagers for teak & Gamari.

| Sl. No. | Year of Creation | Name of Centre | Area (Ha) |
|---------|------------------|--------------------|-------------|
| 1 | 1988-1989 | Rongsepgiri | 100 |
| 2 | 1990-1991 | Goka | 100 |
| 3 | 1990-1991 | Jaksongram | 80 |
| 4 | 1991-1992 | Balkai-1 | 25 |
| 5 | 1991-1992 | Balkai-2 | 100 |
| 6 | 1992-1993 | Eringiri | 50 |
| 7 | 1992-1993 | Beta | 100 |
| 8 | 1992-1993 | Eringiri | 50 |
| 9 | 1992-1993 | Eringiri | 28 |
| 10 | 1993-1994 | Rewak-1 | 50 |
| 11 | 1993-1994 | Dilsingre | 70 |
| 12 | 1993-1994 | Jadugiri | 100 |
| 13 | 1993-1994 | Magua Aobagre | 40 |
| 14 | 1994-1995 | Chorengpara | 80 |
| 15 | 1994-1995 | Doragiri | 40 |
| 16 | 1994-1995 | Kapasipara | 27 |
| 17 | 1994-1995 | Rewak-11 | 13 |
| 18 | 1994-1995 | Dilsingiri-11 | 40 |
| 19 | 1995-1996 | Chorengpara | 75 |
| 20 | 1995-1996 | Rongsopgre | 50 |
| 21 | 1995-1996 | Mangkengre | 23 |
| 22 | 1995-1996 | Gaobari | 52 |
| 23 | 1996-1997 | Atisia | 45 |
| 24 | 1996-1997 | Mindikgre | 05 |
| 25 | 1996-1997 | Gaijangre | 25 |
| 26 | 1996-1997 | Chonggni | 35 |
| 27 | 1996-1997 | Gaobari-11 | 05 |
| 28 | 1996-1997 | Jaksongram-11 | 35 |
| 29 | 1996-1997 | Mindikgre | 25 |
| 30 | 1996-1997 | Bandapara | 11 |
| 31 | 1996-1997 | Alokpang-1 | 35 |
| 32 | 1996-1997 | Alokpang-11 | 24 |
| 33 | 1996-1997 | Masighat-1 | 16 |
| 34 | 1996-1997 | Masighat-11 | 04 |
| | | Grand Total | 1558 |

SFD. 1995

Cooperative Department, Education, Information and Publicity Department, Public Health Engineering Department, Social Welfare Department Soil Conservation Department, Cooperative Department, etc.

All the above departments have the common goal of adopting an overall strategy with the objective of achieving a higher output through such programmes, which can be identified feasible for implementation and accepted by the traditional communities within their culture and traditions.

A special mention of the Cooperative Department should be made here since this department through its various societies helping implementation of the programmes of other line-departments at the ground level with the active involvement of local people both at the planning and implementation stages. The main duty of the Cooperative Department is to organize and register various types of societies and, in addition, to audit the funds and generally oversee the affairs of registered cooperative societies whose responsibility is to foster economic development of weaker sections of the society. Few of such societies are as follows:

- i. Service Cooperative society
- ii. Fishery cooperative society
- iii. Thrift Cooperative Society
- iv. Horticulture Society
- v. Sub-area Marketing Society
- vi. Handloom Weavers Society
- vii. Housing Cooperative Society
- viii. Canes and Bamboo Industries Cooperative Society
- ix. Dairy Farming Cooperative Society
- x. Women Multipurpose Crop Society
- xi. Ecodevelopment Society

4.5.2 The ecodevelopment society

The Ecodevelopment Society is the one that was constituted in 1985 (alongside BNP and NNP) with the basic aim to ensure compatibility between the protected areas and their surroundings, which were identified as Special Areas for Eco-Development (SAEDs) aiming at undertaking of conservation oriented development programmes. The Society

covers 33 villages in the surrounds of the Nokrek NP, the villages covered by the Rongra Development Block in the West Garo Hills and the villages in the surrounds of the Balpakram NP as well as the Siju WLS in Garo Hills. Main objectives of this society are given in box.

- To meet the basic needs of the people in the surrounding villages of the National Parks.
- To improve their economic condition as a whole through improved agricultural practices and facilities and where possible development of some cottage resources.
- To educate them as to the importance of conservation and to train them as custodians of forest resources.
- To generate more employment facilities so that the people can become self-supporting making them a part of the viable socio-economic group of society.
- To rehabilitate the villagers who have been translocated from the core areas of the NPs and take up schemes for their economic development.
- To take up schemes for providing with alternative sources of forest produce to remove people's dependency for the same on the biodiversity rich areas.
- To build up the confidence of these backward tribal people by making them feel that they are part of the mainstream of development activities, for their own benefits and prosperity of the area for its biodiversity values.

To achieve the specific objectives, following development works are taken up by the society in the project area:

- Land Development
- Flow Irrigation
- Horticulture Development
- School Buildings
- Drinking water
- Afforestation
- Roads and foot paths
- Handloom Development
- Rehabilitation

In spite of all above mentioned efforts including the fact that to ensure speedy development the tribal development blocks also came into existence, the pace of economic development has been very slow: mainly due to communication bottle-neck, soil erosion and loss of fertility, among other reasons.

However, the most significant changes with the adoption of programmes of different line departments have been a shift from barter- economy to monetary-economy, a shift from *jhumming* to settled cultivation with the help of *jhum* control schemes, general land development schemes with the components of terracing erosion schemes with the components of terracing erosion control work, afforestation schemes, water conservation and distribution works, Water Conservation Scheme of the Social Conservation Department, and relying more on horticulture and cash crops. This has raised the economic welfare of some of the tribal societies thereby reducing their dependency on the forestry and wildlife resources. The shift as wage earning labourers has also caused for their migration to outside areas, which has disintegrated the communal mode of livelihood satellite family set-up. The growth of population and markets inspired many families to set up their own business leading to removal of dependency on the natural forestry and wildlife resources.

State level and district level coordination committees coordinate the developmental activities of various departments to ensure that the benefits flow to the desired target people.

4.6 Interplay of market forces and their impact on subsistence economy of local people

Garos were not much of traders. They came to the *hats* (weekly markets) to barter their produce for their needs, which indeed were few in the past. Playfair (1998) mentioned *marwari* to be engaged in cotton trade. The British introduced restriction on the traders in the Hills. After independence trade came to be highly regulated. But the system of license, contract and sub-contract, seems not to have succeeded in protecting the people from exploitation. Kar (1975) noted the practice of non-tribal carrying on trade & contracts in the name of tribal. We have come to know

of advances being made for cotton, cash crops and horticultural produces at a price determined at the time of making the advance. Professional moneylenders do not operate in the Garo villages but loans come from licensed traders and their agents.

Gambling, hitherto unknown among Garo communities is coming up strongly now-a-days. Kar (1975) noted decline of traditional customs of mutual help in time of need, collective action, labour exchange etc. Rise in wage labour is distinct. We need a systematic examination of the impact of monetisation on the life of the Garos. They may not be in an advanced stage of exploitation yet and may be protected by adoption of appropriate corrective measures even now.

4.6.1 Market and marketable produce

The RFs of Garo hills were the main source of revenue for the state Forest Department. Railway department was the main buyer of the timber from these RFs. The same is not practised now-a-days, since the green felling is stopped in the hilly regions of north east India.

Market - The most important centers of the consumption of the produce were Rongjuli, Damara, Krishnai, Tura, Mendipather, Dalu, Mankchar, Goalpara, Dhubri etc. in Assam. There was only one depot of Mendipather, from where the supply of sleepers to railways was made. The sale of other timber was conducted through sale of forest coupes to contactors. All drift and seized material are/were sold by auction. A list of 137 weekly markets is given in annexure 4.5.

4.7 Summary of problems faced by people that affect CA management (forest and agricultural areas)

The local Garo community owns about 85% of the total land in GCA with almost dense forest cover that meet most of their requirements. However, rapidly increasing population and its demands for forest resources has created some pressure on the government forests during recent years. The people are entering inside park for collecting broom grass, thatch grass, agarwood and other NTFPs.

4.7.1 Park Management vs. local people

Park management imposes several restrictions to the local people regarding entry inside and use of forest resources. The Garo people believe that the entire land and natural resources in the Garo Hills belongs to Garos only, but the existing legislations on wildlife and forests do not allow the local people to utilise the resources of their own land. In some cases the land has been purchased by the government, but the people want to take it back. For example, the Nokma who has sold the land around Balpakram area was very much annoyed when he discovered that the land is rich in coal mines. Also there is possibility of getting ore mines of valuable Uranium inside the existing boundaries of Balpakram National Park. The fact has also been confirmed by a scientist of Geological Survey of India (Shillong) who has found the presence of specific extant species as well as fossils of extinct species of trees/plants, which usually occur at or near such sites (Personal Communication). This is one of the greatest economic losses for any stakeholder in GCA.

4.7.2 Animal vs. local people

Wild animals sometimes directly come in to the contact of local people. The food crops grown in the valley plains and *jhumms* usually attract the wild animals. They also compete for the drinking water at many places. The main wild animals competing with human include elephants, Sambar, Barking deer, Wild pig and rats. These animals raid the agricultural crops regularly and cause considerable damage to the crops. However, the big cats, for example, tigers and leopards lift the cattle and fowls of villagers. The hundreds of cases regarding animal depredation and cattle lifting have been reported each year in GCA. The society is basically non-vegetarian hence, the requirement of milk and milk products is negligible, and therefore, the cattle population is very limited in GCA. The community land is able to provide enough food for cattle and other domestic animals. Rarely the domestic animals come in contact to wild animals excepting carnivores that lift the cattle and other domestic animals from villages. So the chances of spreading contagious diseases are very less among wild animals, and vice versa.

Summary

The socio-economic condition of Garo Hills has changes rapidly during twentieth century. Earlier the Garos were very wild and violent. Latter, as the education and awareness spread among community, the social status of Garos improved. They still practice *jhum* for their sustenance in rural areas in absence of any other alternate measures. The *jhum* agriculture is one the major reasons for degrading forest cover in Garo Hills. On an average, a total of 10,432 ha land is *jhummed* per year. However, the patches of old primary forests still exist in the remote locations deep inside the interior hills such as Thaidang, Chimitab, Shooling, Kalu-Rongcheng, Rongsu and Hangsapal *etc.* around BNP and Mandalgiri, Ampangiri, Bandigiri *etc.* around NNP.

The important schemes taken up by the community Development Block are Agriculture, Communication, Animal Husbandry & Veterinary, Health & Sanitation, Education & Social Welfare, Industries and Cooperation. These C.D. Blocks also administer the all-normal rural works and other rural development programmes as the Integrated Rural Development Programme (IRDP) and the National Rural Employment Programme (NREP) and Rural Godowns, and programmes respecting Public Cooperation and Nutrition.

The zone of influence has been considered at two specified distances, *viz.* 2 km and 5 km from the PA/RF boundary representing forest and non-forest landuses under each ZI, which indirectly represents the pressure from outside the park at 2 km distance, the proportions of agricultural, *jhum* and scrubland is very low, which indicate that biotic pressures within the ZI at 2 km shall not be very high. The PAs don't

have any village inside. There are few villages around the BNP and NNP, of which 134 are brought under the schemes of Eco-development Society of Meghalaya formed in 1985 when these PAs were created. However, there are 25 forest villages in Garo Hills of which 8 belongs to the GCA.

Along with Garos, there are also a small number of Rabhas, Hagong and Kochs tribal communities. The Hajongs practise wet rice permanent cultivation. The Kochs and Rabhas are sections of the Bodo race like Garos and appear to be off-shoots of Garos. The Garo community has a well-structured system and the most of the families were of medium size (5-8) and average number of working members ranges between 2 to 6. The 28 wild food plants used by Garos are provided with their local names, important characters and parts used. The seasonal pattern in the collection of NTFP from the forests of community land have also been discussed based on the questionnaire surveys of households. A total of 108 tree species were found to be used by local people either as food source (33 tree species) or medicine (20) or timber (54) or fuelwood (98) or boat construction material (43).

The total monthly expenditure incurred on food by an average rural family was 74.21% in the hills region and 72.94% in the plains region of Garo Hills. The high percentage of expenditure on items like clothing, housing, and education, *etc.*, indicates a low standard of living in an average rural family. As regards the forest management practices inside the community owned areas, the main emphasis has been on the strict protection of the 'Village Community Reserves' in the midst of *jhum* areas. Such examples exist near Nokrek, Balpakram, Baghmara and Emangiri area.

Chapter 5

Conclusions and management implications

5.1 Key issues and opportunities identified in the analysis

5.1.1 Keystressors

5.2 Application of findings at appropriate scales: toward a landscape-scale biodiversity conservation strategy for GCA

5.2.1 Conservation of specific sites

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5.2.4 Consideration for Garo Beliefs

5.2.5 Other management recommendations and implementation mechanisms

5.3 Overview and summary

Chapter 5

Conclusions and Management Implications

5.1 Key issues and opportunities identified in the analysis

Several conditions with the GCA pose special challenges to successfully conserving biodiversity and providing for human use of resources over the long term:

- the widespread use of shifting cultivation, the practice of which by the Garos is consuming more forest land annually and being conducted on increasingly shorter cycles, thereby sacrificing local biodiversity of native forests;
- proximity to Bangladesh and the host of special problems this imposes, including legal (and illegal) export of forest resources across the border;
- the isolation of the Garo peoples from major centers of economy and trade;
- ongoing insurgency and presence of military and police forces; and
- inadequate basic infrastructure (roads, etc.) needing development for transportation and exchange of goods and services to outside the region.

Other social conditions within the Garo villages and communities posing special challenges include the potential decline in interest in traditional agricultural practices, and increases in social unrest, among especially the young males. As well, the majority of the land base within GCA is non-government and consists of community or village forests and agricultural areas. The GCA is about 2,548 square kilometers; about 15 per cent of this is in protected areas and reserved forest, and about 85 per cent is in

non-government (village and clan) ownership. (The percentage in government lands, however, is greater than the approximately 2.3 per cent of the total geographical area of the state.)

“The message that comes through very clearly is that although many technologies may be viable otherwise, unless the technology is appropriately integrated in the social and the cultural context, it may not find acceptance and may not be able to become established.”
- Ramakrishnan (1992), p. 371

Overall, these challenges pose significant hurdles to successfully redirecting land allocations, guiding agricultural practices (especially regarding reducing impacts of shifting cultivation, and potentially increasing use of

permanent agricultural plots to offset the shifting cultivation), diversifying the economic base for the villages, protecting culturally and ecologically important sites, reducing social unrest, and providing a promising future of long-term sustainable use of forests and their resources for people of the region. It is not expected that the current project will solve these problems. Instead, it will help to understand them better and provide a more scientific basis for building a comprehensive solution yet to come.

The current project has provided major advances in information and technology as a basis for such solutions. As of the start of this project, there were no overall maps of the GCA, including maps of vegetation cover, *jhum* locations, or topography. Some general vegetation mapping work had been published on Balpakram NP but this is only a small portion of the overall GCA. National defense and security directives imposes restrictions to access of their maps, aerial photos, or satellite images of the border area near Bangladesh. The project has now provided vegetation map coverage of much of the GCA (Kumar *et al.* 2000).

We have provided some information on selected species of GCA, but there continues to be very scant data available on the distribution and ecology of most plants and animals of the area; not much field work had previously been done. Zoological Survey of India (ZSI) and Botanical Survey of India (BSI) can provide little more than catalogues of species by specific location. This is certainly very valuable information, but it provides only a start for more ecologically-based species studies. Much basic work remains to be done to catalogue wildlife-habitat relationships, for example, and the ecological roles in the ecosystems played by the sundry plants and invertebrates of the region. Our work is a beginning.

5.1.1 Key stressors

The major stressor in the GCA affecting conservation of wildlife and their habitats is the increasing anthropogenic conversion of mature, primary forests to *jhum* land and, at best, to early successional forest stages of only a few years age. Probably no one stressor than *jhum* has had a more extensive influence on loss of old forest habitat and associated wildlife, both plants and animals. Obviously, wildlife associated with young *jhum* lands are benefiting from this conversion, but for the most part these are not species of conservation concern.

Other stressors directly and adversely affecting wildlife and their habitats include: direct hunting and poaching of animals; excessive and, in some cases, illegal extraction of some forest products; mining, road construction, presence of international border, ongoing insurgency, poaching excessive fishing, excessive collection of non-timber forest products, and lack of infrastructure developments. These stressors

likely are acting in concert with *jhum* cultivation to cause even greater local threats to some wildlife.

Stressors to wildlife habitat also affect plant species, plant diversity, and diversity of vegetation communities. These too are part of the concern for overall biodiversity conservation (Rao and Haridasan 1981, Murti 1986, Khan et al. 1997). Awasthi (1999) noted that Meghalaya (including the Garo Hills and GCA area) is the richest botanical region in India, and that several issues are affecting the continued conservation of plant diversity there:

- Extraction of plants for local use
- Commercial exploitation of medicinal and ornamental plants
- Effect of eroding traditions on lack of protection of sacred groves
- Development activities
- Shifting agriculture (*jhum*)
- Problems of forest management
- Mining

They also identified the needs for additional floristic studies and inter-institutional linkages to aid successful conservation.

5.1.2 Key findings: Species, habitats, substrates, processes of most importance or under greatest threat

It is clear that the old, primary forests that once covered much of the GCA have been greatly reduced and confined mostly to various protected areas and land allocations having forest protection. Old, primary forests now likely constitute less than 14% of the GCA¹. Wildlife closely associated with old forests

¹ The percentage of landcover under old, primary forest could not be assessed very accurately. It was about 14% (271 sq km out of total 1940 sq km land of GCA) during the initial phases (1997-98) of image processing during the study. As per the latest landuse landcover map, the tropical moist evergreen forest, which is about 353 sq km, can be considered as old primary forests; it also accounts for about 14% of the landscape (out of total 2548 sq km of GCA). However, the actual dense forests as mapped by FSI and IIRS (Dehra Dun) lying beyond the boundaries of these evergreen forests should also be considered as the primary forests. Thus, at best, about one-fifth the portion of GCA in the interior hills is under the old, primary forest.

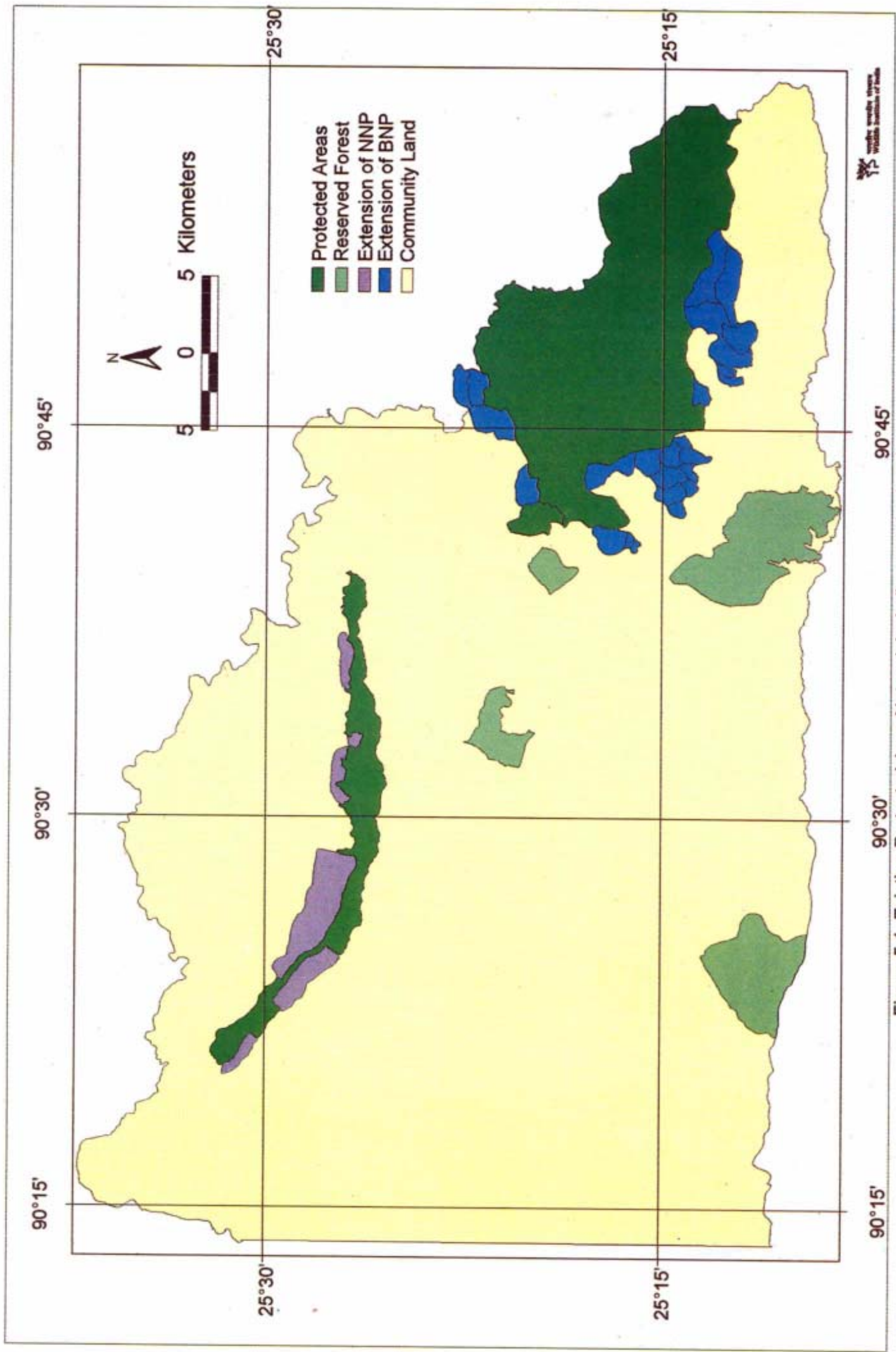


Figure 5.1 : Existing Protected Area Network including acquired and proposed extension in GCA

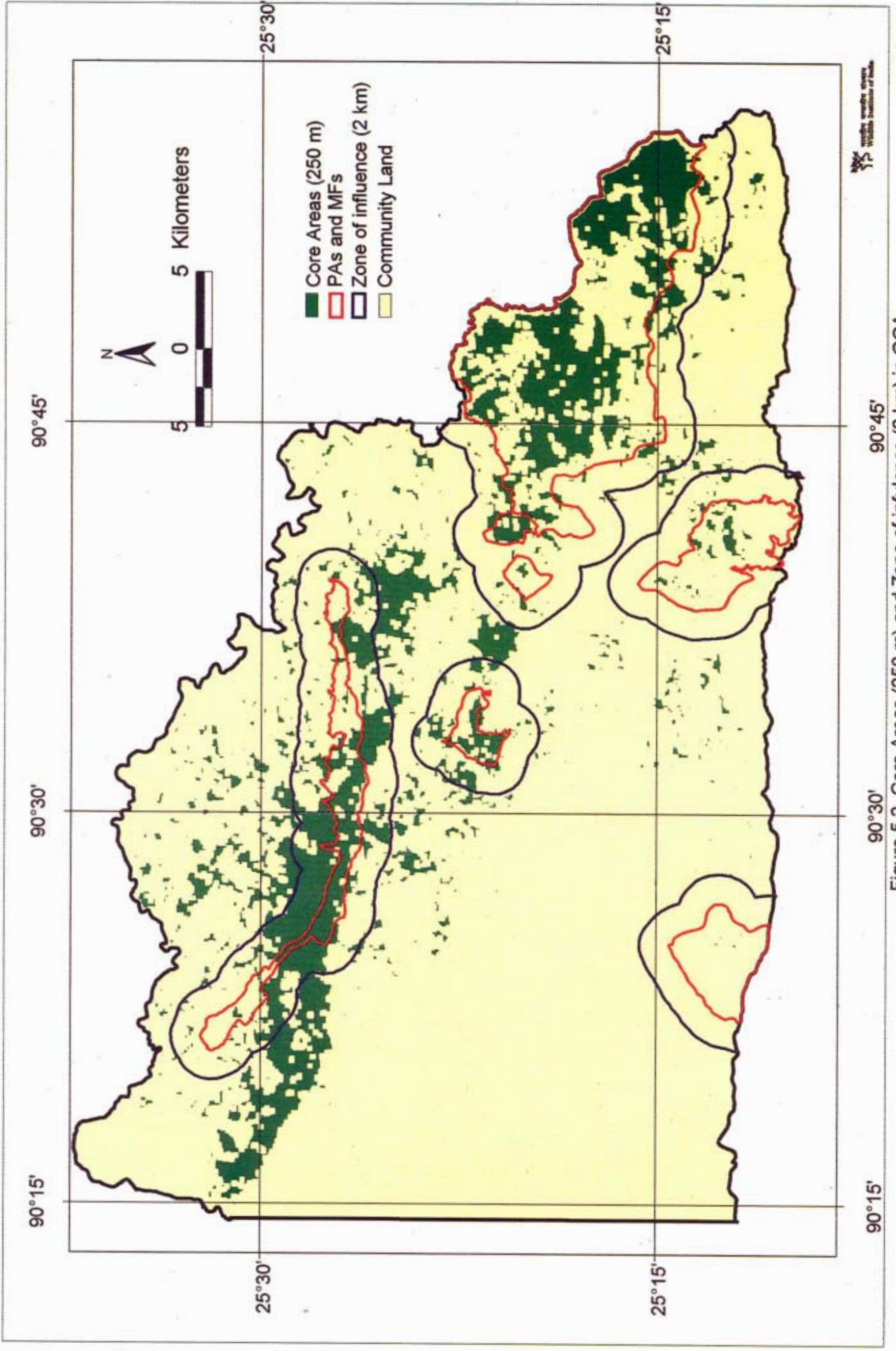


Figure 5.2 Core Areas (250 m) and Zone of influence (2 km) in GCA

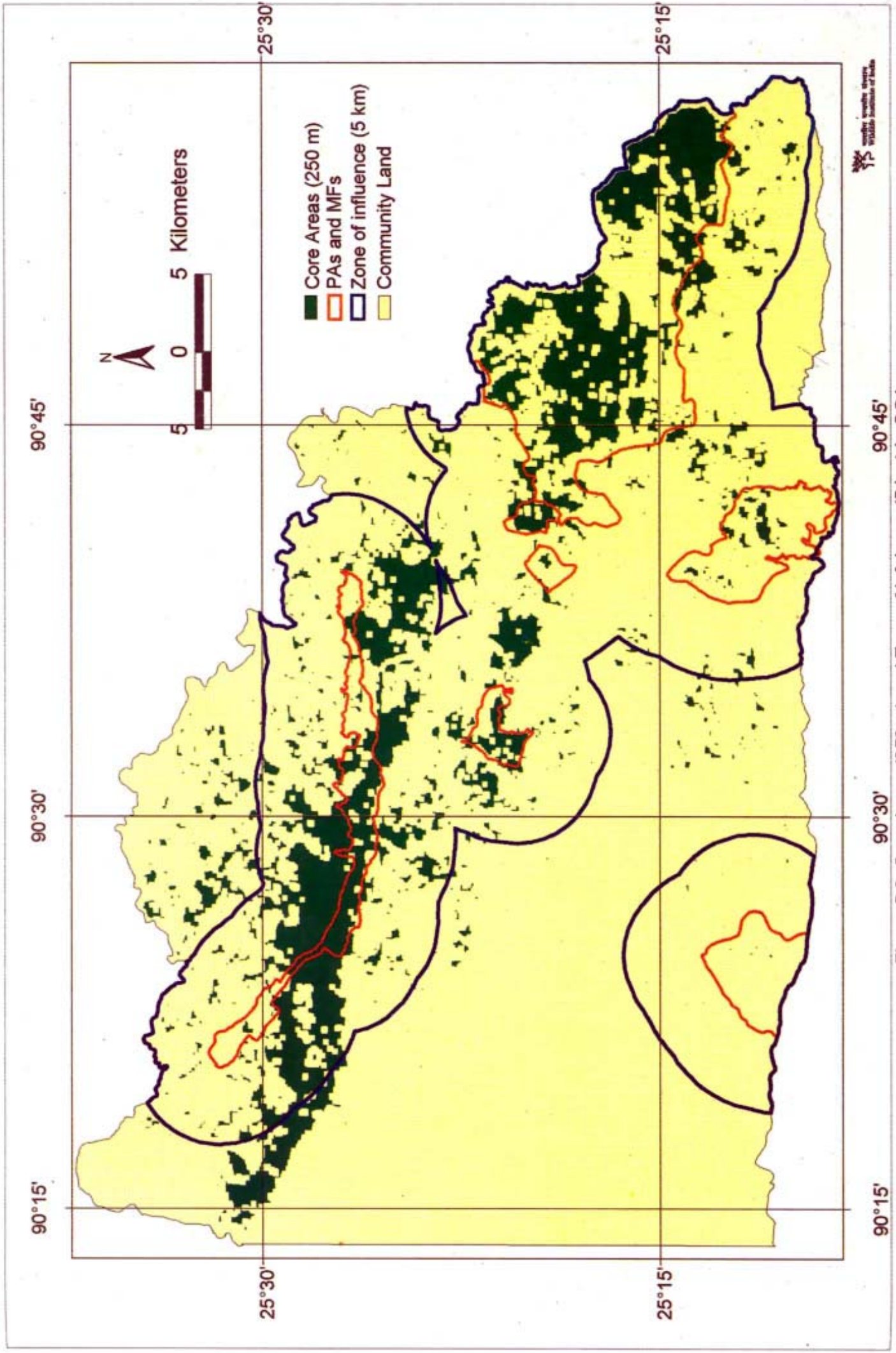


Figure 5.3 Core Areas (250 m) and Zone of influence (5 km) in GCA

with contiguous canopy cover include slow loris, hoolock gibbon, capped langur, pigtailed macaque, stumptailed macaque, squirrels, and others; these have likely suffered reductions in distribution and numbers in GCA over historic times from alteration of their habitat to younger forests with discontinuous canopy cover, and to non-forest agriculture conditions.

However, it is not *jhum* agriculture per se that is to blame for this reduction, but rather the increasing intensity of its application across the landscape of GCA. *Jhum* agriculture is central to the social structure, beliefs, and even language of the Garos. When applied with appropriate fallow periods (especially 20 years or longer), *jhum* agriculture has the potential of providing for both older forest communities as well as for the agricultural needs of the local peoples, at different stages of growth of the vegetation on the same site. It is the great reduction in the fallow period that has truncated forest growth cycles and the loss of older forests and their wildlife.

The good news is that GCA still contains most of the pieces of biodiversity from which older forest communities could be restored. The pieces include the irreplaceable species, particularly the old-forest obligates and local endemics, as well as the ecological functions of the fuller faunal community that collectively serve to keep forest ecosystems intact and productive. Even several rare plant species (*Chirita hamosa*, *Gastrodia exilis*, *Polygala tricholopha*, *Haematocarpus thompsoni*, and *Acrocarpus fraxinifolius*) thought to be eliminated from Meghalaya were rediscovered after 50-100 years (Khan et al. 1997). One exception is the apparent complete extirpation of mouse deer (or Indian chevrotain, *Tragulus meminna*) from GCA, possibly due to overhunting and habitat loss due to *jhumming*. This lesson should be heeded; with proper guidance on *jhum* allocation and fallow periods, in specific areas, much of the old-forest community can likely be restored at least in selected sites of highest conservation interest and importance.

5.2 Application of findings at appropriate scales: Toward a landscape-scale biodiversity conservation strategy for GCA

A landscape-scale approach to evaluating and conserving biodiversity entails understanding broader ecological, social, and economic context of an area of interest. In the case of the Garo Hills, it is obvious that (1) GCA holds far greater forest cover, and is less densely inhabited by people, than adjacent land outside the GCA boundary within the Garo and also Khasi Hills; and (2) the protected areas within the GCA - namely Balpakram NP, Siju WLS, Nokrek National Park and Biosphere Reserve, and the reserved forests - are real biodiversity gems of global significance.

Forest cover in the GCA can increase in only two ways: (1) land acquisition by government, and (2) ecodevelopment work projects for the fringe forest dwellers, by which to decrease their reliance on, and exploitation of, the forests. Social forestry activities are present in the community lands, so it may be possible to increase ecodevelopment projects for the economic sake of the people and for the conservation of forests. As for land acquisition by government, Nokrek National Park (now a biosphere reserve) and Balpakaram National Park were initially purchased fully from the local communities, clans, and families, to conserve the watersheds for them.

5.2.1 Conservation of specific sites

The national parks and sanctuary are likely the last habitats for some of the rarities and endemic wildlife species of the area, especially Hoolock gibbon, capped langur, pigtailed and stumptailed macaque, slow loris, great Indian and pied hornbills, and other species. They also provide primary habitat and refuges for elephant and big cats as well as other carnivores.

Among the important wildlife habitats needing more formal protection are sacred groves having older forest cover. Even sacred groves of the smallest size, just a few hectares or less, provide valuable habitats with fruiting trees, cavity trees, canopies for cover, and

other habitat values (Tiwari et al. 1999). Some 133 plant species are restricted to sacred groves of Meghalaya, and of these, 96 are endemic to Meghalaya (Khan et al. 1997).

The intact and least fragmented area occupied nearly 70 per cent of the landscape. A total numbers of 2,236 and 644 forest patches with the total available core area of 561 sq km and 291 sq km were found at the specified edge distances or buffer width of 250 m and 500 m, respectively. Seven potential wildlife corridors were delineated by mapping the least fragmented forest patches those link the protected areas with the smaller fragments of managed forests. The analysis revealed that nearly one-fifth of the landscape was covered by old primary forests, which are mainly composed of the Tropical Moist Evergreen Forest (TMEF) patches. The vegetation patterns were discussed in four different forest types *viz.* Moist Evergreen, Semi-evergreen, Moist Deciduous and Sal Formation and the effect of shifting cultivation under three successional stages *viz.* young (up to 15 years), mature (15 to 30 years) and old (more than 30 years) forests. A total of 1062 angiosperms belonging to 578 genera and 154 families were identified during several field visits between year 1997 to 2000. This included 411 tree species belonging to 224 genera and 71 families.

The Importance Value Indices of 162 tree species sampled in 35 one-hectare plots were computed. Also, the study developed a few elephant-habitat relationship models using population estimates of the State Forest Department for the years 1993 and 1998 of Asian elephants.

5.2.2 Wildlife habitat corridors

Corridors are essential for habitat contiguity and facilitation of gene flow between the populations. With the use of GIS based technology it is possible to identify and analyse the low and high fragmentation values of potential corridors areas. Potential wildlife habitat corridors were identified based on predominance of primary or older cover of evergreen, semi-evergreen, and deciduous forests, the older age

classes of which are increasingly scarce resources in GCA. Major findings included identification of seven potential elephant habitat corridors consisted largely of unfragmented native forests linking most of the existing protected areas. Out of 274 sq km area in seven corridors, about 92% are rich in forest and serve to interconnect BNP, NNP, RRF and BRE. Siju WLS is also well-connected with NNP and RRF through corridors. However, the corridors need formal designation and protection or they likely will soon suffer the same fate as other old forests of the area that have been converted to young *jhum*. Details on these corridors are given in chapter 2.

5.2.3 Management of specific substrates in forest management and *jhum* activities

In GCA, *jhum* has substantially reduced the original extent of old forests and their associated vegetation elements. As possible, it would benefit old-forest associated wildlife if such elements were restored and conserved during *jhum* activities and during any forest management activities.

The kinds of substrates and vegetation elements (of old forests or otherwise) that could be provided, either through use of permanent buffers between *jhum* plots or with extended *jhum* rotation cycles, can be described according to the habitat requirements of wildlife species of interest. Such information can be found as the categories of habitat elements of biological origin in the wildlife-habitat relationships matrixes (see Volume II). For GCA, these include the following elements, with a few examples of associated wildlife species that use the elements for breeding, feeding, or other functions:

- **Snags** – greater racket-tailed drongo, verditer flycatcher, dollarbird, peregrine falcon, stork-billed kingfisher
- **Snag recruits (dying trees, live trees with dead portions)** – white-rumped vulture, grey-headed fish-eagle, vernal hanging parrot
- **Hollow trees, chimney trees (living or dead)** – pigtail macaque, barking deer, brown hawk owl

- **Tree cavities (natural or created)** – slow loris, leopard, tiger, streak-throated woodpecker
- **Large old trees (living)** – white-throated fantail, red-headed vulture, small Indian civet
- **Trees with fluting boles and buttresses** – little spiderhunter, greater racket-tailed drongo, red junglefowl
- **Down wood** – painted francolin, red junglefowl, Indian porcupine, barking deer, Manipur bush quail
- **Litter and duff** – spotted deer, gaur, sambar, Tickell's blue flycatcher
- **Litter in streams** – lesser whistling duck, pintail snipe
- **Lianas** – little spiderhunter, spotted deer, gaur, green imperial pigeon
- **Fruit-bearing shrubs** – spotted deer, gaur, sambar, wild pig, peafowl
- **Fruit-bearing trees** – barking deer, pigtail macaque, stump-tail macaque
- **Epiphyte patches** – vernal hanging parrot, hoolock gibbon

Many other species use each of these elements in addition to the species listed above.

Because the first stage of *jhum* agriculture entails slashing and clearing a plot of major woody cover and then burning the slash, it may be possible to retain some of the old-forest vegetation elements only in small patches or along the edges of *jhum* plots. Indeed, as topography permits, buffer strips of old-forest cover could be permanently retained along the edges of some *jhum* plots. In other selected locations, old-forest vegetation elements can be restored or conserved by extending the fallow period between *jhum* clearing from the current short 2-5 years to 20-30 years.

5.2.4 Consideration for Garo beliefs

To help ensure successful conservation of sites and species outside government-managed protected areas and reserved forests, consideration needs to be made to Garo beliefs and traditions. The value of sacred groves to both Garo beliefs and as plant and animal habitat was discussed above.

Additionally, the Garos also have a wonderfully rich heritage in which specific locations, plants, and animals have important religious, mythological, and medicinal significance (Marak 1996). For example, the rare Khasi pitcher plant *Nepenthes khasiana* is called *Memang Koksi* by the Garos, meaning “fishing creel of the Spirits,” and is used by native physicians ostensibly to cure leprosy. And the Balpakram area, which contains critical habitat for this plant, is also revered, among other things, as the birthplace of *do•de* or the peacock (Marak 1996).

In *Jadoreng* — the folk medicine and the traditional, animistic, religious beliefs of the Garos — numerous species of plants and animals are used for many of the rituals and rites (Sangma 1993). Sangma lists dozens of plant and animal species from which medicinal ingredients are extracted for traditional folk medicine.

Such “key cultural functions” of habitats and organisms, some of which are annotated in the WHR species accounts, can be used to help advance their conservation. The Garos would likely be more apt to help protect sites, habitats, forest groves, and organisms if it meant protecting their culture as well. The problem is there, however, of disappearing traditions and cultural beliefs among the Garos.

5.2.5 Other management recommendations and implementation mechanisms

To exemplify the new ideas for conservation generated from this study, several demonstrations could be developed. These would serve to showcase some potential solutions to the problems of sustaining forest resource use in the area.

The demonstration or pilot projects could address some of the following needs:

- adjusting existing *jhum* practices to better provide for soil conservation, for ecological consideration, and for specific habitat conditions or elements for wildlife conservation; examples might include leaving key forest vegetation elements within and between *jhums* for wildlife use, preserving trees

laden with orchid epiphytes, providing habitat for small animals having key ecological functions such as pollination of plants, preserving particularly old or large trees and trees with hollows for owls and other wildlife, etc.

- supplementing or replacing harmful *jhum* cultivation with permanent family agriculture, irrigated agriculture, etc.
- better valuating timber and nontimber forest products and conditions in terms of marketing, market accessibility, and pricing of products and services (e.g., ecotourism guides)
- meeting the existing and any newly recommended directives for environmental conservation during *jhum* cultivation
- diversifying the economic base of Garo villages
- providing jobs or incentives to young males for alternate sources of earning methods, or for engaging in alternative productive economic pursuits for their families and clans.

Potential demonstration projects designed to conserve or restore old-forest conditions for wildlife are listed in annexure 22.

There is accelerating human population pressure on the non-protected forests and *jhum* cultivation lands within the GCA. Conservation of critical environments in new PAs, and of key habitat elements outside the PAs, should proceed post haste if there is any chance of success. Perhaps local organizations can be engaged or encouraged to help monitor and control *jhum* activity.

One such organization is ADRA, a native Garo tribe non-government organization (NGO) that self-monitors illegal cutting in the GCA. Implementation of the demonstration projects for GCA might be successful if also supported by other local groups such as the Ecodevelopment Society of Meghalaya (established in 1985). Other NGOs can also play useful roles. The Association for Protection of Environment and Endangered Species (APEES) have already helped conduct surveys that might be useful for identifying sites for potential conservation focus.

The Supreme Court Ruling of 15 January 1998 directed that at least 10% of forest cover in the state shall be in protected areas. From this, IFS has proposed that all reserved (managed) forests in Khasi Hills and Jaintia Hills Districts are to be totally protected, and will recommend the same for the Garo Hills Division. The Ruling also mandates identifying ecologically sensitive areas by consultation with recognized expert groups (mentioning Wildlife Institute of India among others), and to ensure they are totally excluded from exploitation.

Also, upcoming amendments to the Wildlife Protection Act will provide for some degree of conservation measures on lands currently outside government control, including on some community reserve lands. Such authority may ultimately be useful for controlling further degradation of sacred groves and other patches of primary forest and old secondary forest scattered outside protected areas and reserved forests of the GCA. Indeed, sacred groves should be added to the array of PAs (Khan *et al.* 1997) in GCA.

Any forest wildlife habitat conservation project in the GCA is inevitably linked to, and affected by, the social and economic conditions of the Garos. For example, if land is to be withdrawn from community *jhum* and used to add onto, say, Balpakram National Park, some recompense may be needed.

But it is a long way from Balpakram to viable and consistent economic markets in big cities such as Tura, Shillong, and especially Guwahati, Assam. From Balpakram it is 177 kilometers to Tura and then another 220 kilometers to Guwahati. Transporting goods over that distance, as exports or imports, means that their value must be consistently high and, likewise, their local extraction should be ecologically sustainable. The government is helping support road development, an essential part of any transportation system; this is a start.

Obviously, the Garos themselves must be an integral part of any conservation action resulting from this study. Their livelihood and vitality should be enhanced

by such actions taken to protect or restore forest biodiversity in the GCA. This can be done. In one example, the Forest Department has identified sacred groves in the Garo Hills outside the protected areas. Such groves often are important bastions of old forest stands and their wildlife denizens, and can be protected from incursion by formally recognizing their value and conservation. This would also provide for important sacred sites for the Garos, so that both people and wildlife win with such a strategy.

But the sword can be double-edged. To open the area to outside economic transportation, and perhaps also to ecodevelopment or eventually ecotourism, may inadvertently cause further degradation of the forests and resources so worthy of protection. As the opening quote to this chapter suggested, only by encouraging *local and intimate* participation, ownership, and especially responsibility, with due rewards given, can conservation of forest resources of GCA succeed.

5.3 Overview and summary

The GCA is a mix of various matrices, each of which is occupying a unique niche and playing a definite role thus affecting the over-all conservation of the biodiversity of the region. If allowed to function independently, these matrices might even nullify the positive effects of other matrices with no net result. Therefore, a proper and judicious coordination in the causes and effects of these matrices is what a unique challenge confronting the managers at the GCA.

The most severe challenge is to transform the deep rooted traditional *jhum*-base economy — which at its present, accelerated rate is neither economically nor ecologically viable – into that of a permanent-plot agriculture-base economy. The fact that of the total GCA area about 75% is in non-government ownership (village and clan) makes this task of transformation daunting. This transformation, along with a lengthening of the fallow period between *jhum* cycles on given plots, is identified as a must for any effective launching of conservation planning since all the key issues and opportunities identified in GCA revolves around this (see Chapter –5 of Vol. IV on GCA).

Linked very closely with this key stressor are other resultant stressors, namely, proximity to the international border with Bangladesh; isolation of Garo people from the mainstream developmental processes; very strong orthodox traditional and cultural linkages with the natural forestry resources; and inadequate basic infrastructure, which are adding further to making measures towards upliftment of the economic conditions of the local people a futile exercise.

In spite of all the above negative traits, GCA holds on to most of the pieces of biodiversity from which older forest community could be restored. The pieces includes the irreplaceable species, particularly, the old-forest obligates and local endemics, as well as the ecological function of the fuller faunal community that collectively serve to keep forest eco-systems intact and productive. Much of the old-forest community can be restored, at least on the selected sites of the highest conservation importance, to begin with, through proper guidance on *jhum* allocation and fallow periods.

This study on GCA makes it obvious that this conservation area holds far greater forest cover, and is less densely inhabited by people than adjacent land outside the GCA boundary within the Garo and also Khasi Hills. The study also revealed that all the different PAs within the GCA are extremely rich in biodiversity and are of real biodiversity significance as these are likely to be the last habitats of some of the rare and endangered wild flora and fauna. Another most notable feature of this conservation area is the presence of viable corridor areas for migrating elephant populations, and during this study seven such corridors, linking various PAs together, were identified and evaluated.

Raising the economic condition of the local inhabitants has been identified as one of the most crucial steps towards biodiversity conservation in this area. For this besides addressing the problem of *jhum* cultivation as described earlier, concerted efforts for better valuating timber and non-timber forests and condition in terms of marketing, market accessibility, and pricing of products and services (e.g., Eco-tourism

guides), and attempting at diversifying the economic base of local people, had be taken up on priority basis.

The potential themes for demonstration area for the GCA have been identified as follows: 1) Additions to protected areas, 2) Protection of primary forests and mature forests in wildlife corridor habitat areas, and 3) Provision of elements of older secondary forests as wildlife habitat and for biodiversity conservation in heavily *jhummed* areas. The objective of the first theme is to demonstrate how to select specific sites for adding on to existing areas, including National Parks and Reserved Forests, and wildlife sanctuaries. It is proposed that these additions could be peripheral to the existing boundaries and part of buffer boundary system. The objective of the second theme pertains to maintaining forest habitat conditions in specific areas as migration and movement corridors for wildlife besides, identifying there as compatible forest use activities by local people with provisions of corridor habitats. The objective of the third demonstration theme is to provide for selected elements of forest habitat conditions within heavily *jhummed* landscapes to help conserve forest-associated wildlife with a minimal impact of agriculture.

An example of extending PAs is presented in Figure 5.1, which shows recent additions to Norkrek National Park (NNP) and Balpakram National Park (BNP). The extensions were designed to add to overall park area and to capture areas of older forest that would otherwise succumb to *jhum*. In the case of NNP, the area added provides additional habitat for the many endemic and rare plants of the region including *Citrus* spp. for which NNP was initially designated, as well as for hoolock gibbon, slow loris, and other rare or endemic wildlife species. In the case of BNP, the area added provides a needed buffer to *jhum*, which in recent years has been converting old forests nearly up to the

border of the park. Other additions to PAs and RFs of GCA can be delineated based our work analyzing core areas and least fragmented areas of native forests, especially old evergreen forests. Such additions may be made within zones of influence surrounding the PAs and RFs (see Figures 5.2 and 5.3).

An example of protecting primary forests and mature forests in wildlife corridor habitat areas was presented in Figure 2.19, Chapter 2 of this volume. We analyzed the degree of fragmentation of native forests in GCA and proposed a series of seven potential forest corridors. The corridors would serve as connective habitat for elephant and other wildlife species and would effective unite most of the PAs and RFs of GCA into a true wildlife habitat network. The habitat corridors would serve to help maintain contiguous wildlife populations that would otherwise be severed into smaller population segments that in turn would be far more susceptible to local extirpation from a variety of stressors.

Finally, three examples of providing for old-forest components and patches of older forest among community land and *jhum* landscape are as follows. The first example is the list of old-forest components listed in Section 5.2.3 above, which could be maintained or restored within or among *jhum* plots. The second example may be protection of larger patches of older evergreen forest existing as core areas as shown in Figures 5.2 and 5.3. The third example may be formal protection of sacred groves as PAs. Collectively, these three situations – old-forest components within and among *jhum* patches, protection of forest core areas, and protection of sacred groves – would go far in ensuring that some degree of old forests and their elements are restored or conserved throughout the mostly community-owned matrix lands of GCA.

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Annexure 1: Plot codes (alphabetically) along with short description (identity) of Plots

| Plot Id. | Description of Plot |
|-----------|---|
| BNP10 | Chutmang Hills at northwest boundary of BNP, about 10-12 km from Siju WLS. Primary forest at 800-900 m altitude |
| bnp9 | Young secondary forests at the northern boundary of BNP near village Rongsu, about 7-8 km from Siju WLS |
| BNPBase1 | Old Primary forest in the Mahadeo gorge in BNP mainly riverine forests and semievergreen forest |
| BNPBase2 | Old Primary forest in the Mahadeo gorge in BNP mainly riverine forests and semievergreen forest |
| BNPBase3 | Old Primary forest in the Mahadeo gorge in BNP mainly riverine forests and semievergreen forest |
| Bnppfa | Primary forest in the limestone area of BNP sometimes touches the edges with old secondary forest of deciduous nature |
| Bnppfb | Primary forest in the limestone area of BNP sometimes touches the edges with old secondary forest of deciduous nature |
| Bnppfc | Primary forest in the limestone area of BNP sometimes touches the edges with old secondary forest of deciduous nature |
| bnpsf1 | Secondary forest in BNP, below 10 years |
| bnpsf2a | Secondary forest in BNP, 10-20 years |
| bnpsf2b | Secondary forest in BNP, 10-20 years |
| bnpsf3a | Secondary forest in BNP, 20-30 years |
| bnpsf3b | Secondary forest in BNP, 20-30 years |
| brfn5 | Natural Forest at moist places in Baghmara Reserved forests surrounded by old Sal forest (Locally known as Sal Plantation) |
| brfn6 | Natural Forest at moist places in Baghmara Reserved forests surrounded by old Sal forest (Locally known as Sal Plantation) |
| brfn7 | Natural Forest at moist places in Baghmara Reserved forests surrounded by old Sal forest (Locally known as Sal Plantation) |
| brfpl1 | Sal Forest in alluvial soil and lower part of hills near Simsang river in Baghmara Reserved forests (Locally known as Sal Plantation) |
| brfpl8 | Sal Forest in alluvial soil and lower part of hills near Simsang river in Baghmara Reserved forests (Locally known as Sal Plantation) |
| brfpl9 | Sal Forest in alluvial soil and lower part of hills near Simsang river in Baghmara Reserved forests (Locally known as Sal Plantation) |
| erf1 | Old forest in side Emangiri Reserved Forest |
| erf2 | Old forest in side Emangiri Reserved Forest |
| erf3 | Old forest in side Emangiri Reserved Forest |
| ivr1 | Village reserve forest in the surrounding areas Emangiri Reserved Forest |
| ivr2 | Village reserve forest in the surrounding areas Emangiri Reserved Forest |
| ivr3 | Village reserve forest in the surrounding areas Emangiri Reserved Forest |
| ivr4 | Village reserve forest in the surrounding areas Emangiri Reserved Forest |
| nnp1 | Old, moist Primary forest at Nokrek ridge in the way of Nokrek Peak inside Nokrek National Park |
| nnp3 | 60 years old secondary forest (Looks like Primary forest), at neighbouring hills of Nokrek hills Outside Nokrek National Park |
| nnp4 | Old, moist Primary forest at Nokrek ridge in the way of Nokrek Peak inside Nokrek National Park |
| Nnpturape | Old, moist Primary forest at Tura Peak inside Tura reserve at the western most corner of Tura ridge, a very important catchment area. |
| RRF1 | Old forest in Rewak reserved forest nearby rivers |
| RRF2 | Old forest in Rewak reserved forest nearby rivers |
| sws1 | Semi-evergreen forest in Siju WLS |
| sws2 | Semi-evergreen forest with the higher proportion of deciduous trees near lake in Siju WLS |
| sws3 | Semi-evergreen forest in Siju WLS |

Annexure 2: Plot description

| Plot code | Association |
|-----------|--|
| BNP10 | <i>Schima wallichii</i> - <i>Polyalthia simiarum</i> - <i>Aphanamixis polystachya</i> |
| BNP9 | <i>Schima wallichii</i> - <i>Castonopsis purpurella</i> - <i>Callicarpa arborea</i> |
| BNPBASE1 | <i>Michelia champaca</i> - <i>Kaeya floribunda</i> - <i>Grewia microcos</i> |
| BNPBASE2 | <i>Tetrameles nudiflora</i> - <i>Polyalthia simiarum</i> - <i>Canarium strictum</i> |
| BNPBASE3 | <i>Polyalthia simiarum</i> - <i>Canarium strictum</i> - <i>Drimycarpus racemosus</i> |
| BNPPFA | <i>Polyalthia simiarum</i> - <i>Michelia champaca</i> - <i>Walsura tubularis</i> |
| BNPPFB | <i>Walsura tubularis</i> - <i>Polyalthia simiarum</i> - <i>Mesua ferrea</i> |
| BNPPFC | <i>Polyalthia simiarum</i> - <i>Walsura tubularis</i> - <i>Mesua ferrea</i> |
| BNPSF1 | <i>Castonopsis purpurella</i> - <i>Schima wallichii</i> - <i>Syzygium cuminni</i> |
| BNPSF2A | <i>Schima wallichii</i> - <i>Macaranga denticulate</i> - <i>Syzygium cuminni</i> |
| BNPSF2B | <i>Macaranga denticulate</i> - <i>Albizia odoratissima</i> - <i>Bignonia</i> sp. |
| BNPSF3A | <i>Grewia microcos</i> - <i>Aporusa dioica</i> - <i>Castonopsis purpurella</i> |
| BNPSF3B | <i>Grewia microcos</i> - <i>Aporusa dioica</i> - <i>Terminalia balerica</i> |
| BRFN5 | <i>Castonopsis purpurella</i> - <i>Grewia microcos</i> - <i>Cynometra polyandra</i> |
| BRFN6 | <i>Schima wallichii</i> - <i>Aporusa dioica</i> - <i>Castonopsis purpurella</i> |
| BRFN7 | <i>Castonopsis purpurella</i> - <i>Dillenia pentagyna</i> - <i>Celtis tetrandia</i> |
| BRFPL1 | <i>Shorea robusta</i> - <i>Artocarpus chaplasha</i> - <i>Aporusa dioica</i> |
| BRFPL8 | <i>Shorea robusta</i> - <i>Schima wallichii</i> - <i>Aporusa dioica</i> |
| BRFPL9 | <i>Shorea robusta</i> - <i>Glycosmis arborea</i> - <i>Tectona grandis</i> |
| ERF1 | <i>Schima wallichii</i> - <i>Shorea robusta</i> - <i>Syzygium cuminni</i> |
| ERF2 | <i>Schima wallichii</i> - <i>Lagerstroemia parviflora</i> - <i>Grewia microcos</i> |
| ERF3 | <i>Cynometra polyandra</i> - <i>Castonopsis purpurella</i> - <i>Sapium baccatum</i> |
| IVR1 | <i>Shorea robusta</i> - <i>Schima wallichii</i> - <i>Dillenia pentagyna</i> |
| IVR2 | <i>Schima wallichii</i> - <i>Sapium baccatum</i> - <i>Syzygium cuminni</i> |
| IVR3 | <i>Schima wallichii</i> - <i>Castonopsis purpurella</i> - <i>Shorea robusta</i> |
| IVR4 | <i>Schima wallichii</i> - <i>Macaranga denticulate</i> - <i>Shorea robusta</i> |
| NNP1 | <i>Syzygium operculatum</i> - <i>Aphanamixis polystachya</i> - <i>Castonopsis</i> sp. |
| NNP3 | <i>Diospyros variegata</i> - <i>Castonopsis purpurella</i> - <i>Calophyllum polyanthum</i> |
| NNP4 | <i>Diospyros variegata</i> - <i>Castonopsis</i> sp.- <i>Castonopsis purpurella</i> |
| NNPTURAP | <i>Castonopsis</i> sp.- <i>Schima wallichii</i> - <i>Aphanamixis polystachya</i> |
| RRF1 | <i>Shorea robusta</i> - <i>Dillenia pentagyna</i> - <i>Lagerstroemia parviflora</i> |
| RRF2 | <i>Tectona grandis</i> - <i>Shorea robusta</i> - <i>Tetrameles nudiflora</i> |
| SWS1 | <i>Schima wallichii</i> - <i>Grewia microcos</i> - <i>Persia villosa</i> |
| SWS2 | <i>Diospyros variegata</i> - <i>Tetrameles nudiflora</i> - <i>Cynometra polyandra</i> |
| SWS3 | <i>Shorea robusta</i> - <i>Aporusa dioica</i> - <i>Grewia microcos</i> |

Annexure 3: Vegetation characteristics (plot-wise) with averages of abundance, dominance and importance value (IV)

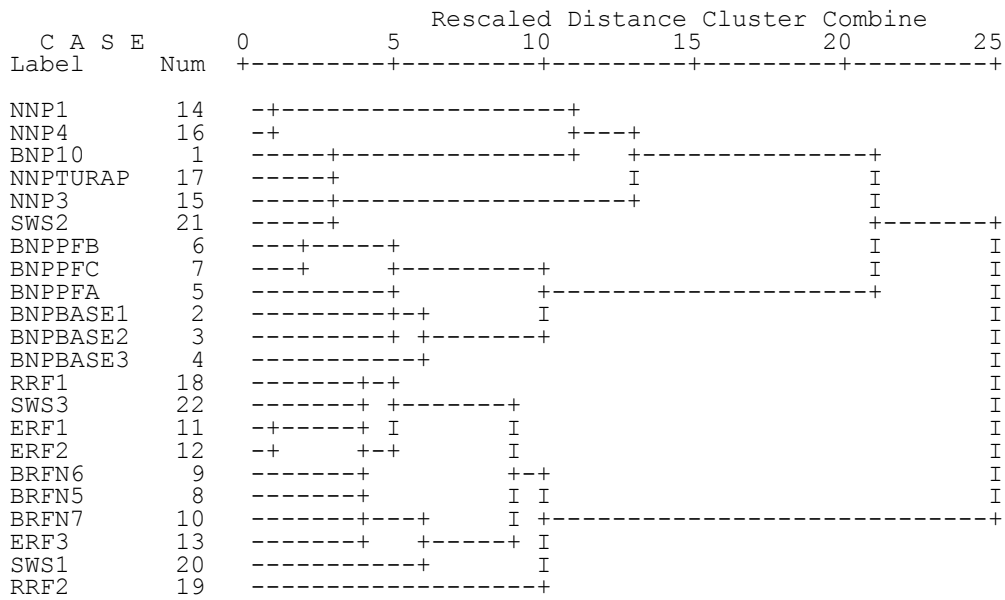
| Plot code | No. of species | No. of Individuals | Total Basal Area (sq m) | Average Abundance | Average Dominance | Average IV |
|------------------|----------------|--------------------|-------------------------|-------------------|-------------------|-------------|
| BNP10 | 83 | 921 | 162.08 | 1.20 | 1.20 | 2.41 |
| bnp9 | 57 | 967 | 33.14 | 1.75 | 1.75 | 3.51 |
| BNPBase1 | 63 | 430 | 29.93 | 1.59 | 1.59 | 3.17 |
| BNPBase2 | 73 | 492 | 73.32 | 1.37 | 1.37 | 2.74 |
| BNPBase3 | 74 | 491 | 114.98 | 1.35 | 1.35 | 2.70 |
| bnppfa | 68 | 755 | 40.55 | 1.47 | 1.47 | 2.94 |
| bnppfb | 56 | 1033 | 50.33 | 1.79 | 1.79 | 3.57 |
| bnppfc | 55 | 1145 | 44.75 | 1.82 | 1.82 | 3.64 |
| bnpsf1 | 49 | 620 | 12.02 | 2.04 | 2.04 | 4.08 |
| bnpsf2a | 74 | 1109 | 16.63 | 1.35 | 1.35 | 2.70 |
| bnpsf2b | 69 | 750 | 19.46 | 1.45 | 1.45 | 2.90 |
| bnpsf3a | 50 | 861 | 20.46 | 2.00 | 2.00 | 4.00 |
| bnpsf3b | 47 | 969 | 23.81 | 2.13 | 2.13 | 4.26 |
| brfn5 | 60 | 838 | 39.44 | 1.67 | 1.67 | 3.33 |
| brfn6 | 57 | 955 | 35.60 | 1.75 | 1.75 | 3.51 |
| brfn7 | 76 | 755 | 32.68 | 1.32 | 1.32 | 2.63 |
| brfpl1 | 39 | 953 | 39.02 | 2.56 | 2.56 | 5.13 |
| brfpl8 | 56 | 892 | 42.25 | 1.79 | 1.79 | 3.57 |
| brfpl9 | 27 | 727 | 74.43 | 3.70 | 3.70 | 7.41 |
| erf1 | 59 | 1005 | 54.61 | 1.69 | 1.69 | 3.39 |
| erf2 | 68 | 980 | 50.21 | 1.47 | 1.47 | 2.94 |
| erf3 | 68 | 833 | 69.51 | 1.47 | 1.47 | 2.94 |
| ivr1 | 45 | 1112 | 75.48 | 2.22 | 2.22 | 4.44 |
| ivr2 | 50 | 980 | 61.18 | 2.00 | 2.00 | 4.00 |
| ivr3 | 64 | 957 | 53.46 | 1.56 | 1.56 | 3.13 |
| ivr4 | 37 | 889 | 22.95 | 2.70 | 2.70 | 5.41 |
| nnp1 | 59 | 855 | 83.16 | 1.69 | 1.69 | 3.38 |
| nnp3 | 52 | 974 | 152.00 | 1.92 | 1.92 | 3.83 |
| nnp4 | 56 | 1023 | 117.56 | 1.77 | 1.77 | 3.54 |
| nnpturape | 90 | 715 | 110.57 | 1.10 | 1.09 | 2.19 |
| RRF1 | 88 | 894 | 44.44 | 1.14 | 1.14 | 2.27 |
| RRF2 | 69 | 702 | 45.38 | 1.45 | 1.45 | 2.90 |
| sws1 | 77 | 944 | 46.01 | 1.30 | 1.30 | 2.60 |
| sws2 | 59 | 802 | 38.98 | 1.69 | 1.69 | 3.39 |
| sws3 | 63 | 817 | 62.73 | 1.59 | 1.59 | 3.17 |
| All Plots | | 30145 | 1993.13 | 1.64 | 1.64 | 3.27 |

Annexure 4: Hierarchical Cluster analysis for primary forest sample plots

A. Agglomeration schedule

| Stage | Cluster Combined | | Coefficients | Stage Cluster First Appears | | Next Stage |
|-------|------------------|-----------|--------------|-----------------------------|-----------|------------|
| | Cluster 1 | Cluster 2 | | Cluster 1 | Cluster 2 | |
| 1 | 14 | 16 | .172 | 0 | 0 | 18 |
| 2 | 11 | 12 | .358 | 0 | 0 | 8 |
| 3 | 6 | 7 | .574 | 0 | 0 | 10 |
| 4 | 1 | 17 | .827 | 0 | 0 | 18 |
| 5 | 15 | 21 | 1.097 | 0 | 0 | 19 |
| 6 | 18 | 22 | 1.376 | 0 | 0 | 11 |
| 7 | 8 | 10 | 1.656 | 0 | 0 | 9 |
| 8 | 9 | 11 | 1.951 | 0 | 2 | 11 |
| 9 | 8 | 13 | 2.249 | 7 | 0 | 14 |
| 10 | 5 | 6 | 2.569 | 0 | 3 | 17 |
| 11 | 9 | 18 | 2.894 | 8 | 6 | 15 |
| 12 | 2 | 3 | 3.221 | 0 | 0 | 13 |
| 13 | 2 | 4 | 3.562 | 12 | 0 | 17 |
| 14 | 8 | 20 | 3.915 | 9 | 0 | 15 |
| 15 | 8 | 9 | 4.366 | 14 | 11 | 16 |
| 16 | 8 | 19 | 4.840 | 15 | 0 | 21 |
| 17 | 2 | 5 | 5.318 | 13 | 10 | 20 |
| 18 | 1 | 14 | 5.843 | 4 | 1 | 19 |
| 19 | 1 | 15 | 6.442 | 18 | 5 | 20 |
| 20 | 1 | 2 | 7.293 | 19 | 17 | 21 |
| 21 | 1 | 8 | 8.296 | 20 | 16 | 0 |

B. Dendrogram using Ward Method

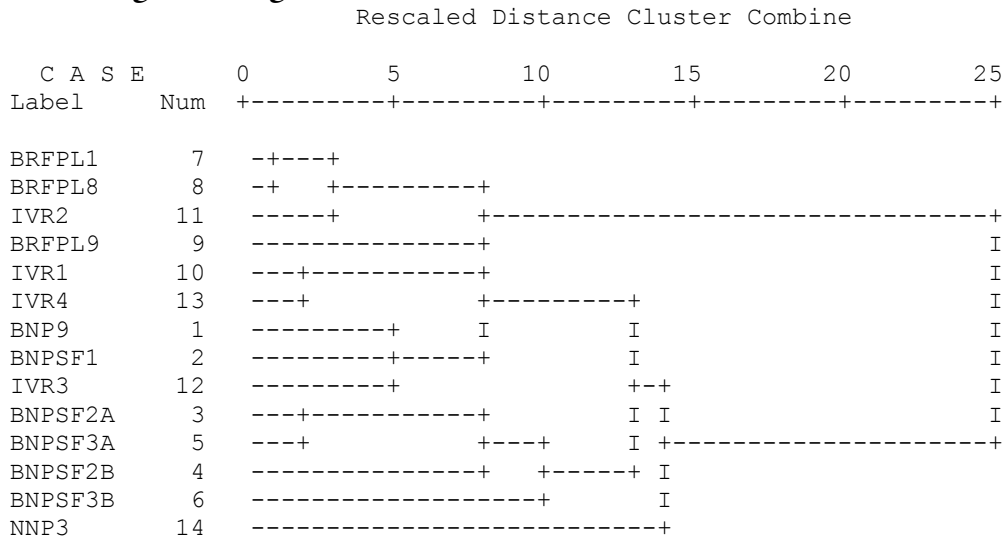


Annexure 5: Hierarchical Cluster analysis for secondary forest sample plots

A. Agglomeration schedule

| Stage | Cluster Combined | | Coefficients | Stage Cluster First Appears | | Next Stage |
|-------|------------------|-----------|--------------|-----------------------------|-----------|------------|
| | Cluster 1 | Cluster 2 | | Cluster 1 | Cluster 2 | |
| 1 | 7 | 8 | .199 | 0 | 0 | 4 |
| 2 | 10 | 13 | .438 | 0 | 0 | 8 |
| 3 | 3 | 5 | .679 | 0 | 0 | 9 |
| 4 | 7 | 11 | .930 | 1 | 0 | 7 |
| 5 | 1 | 2 | 1.228 | 0 | 0 | 6 |
| 6 | 1 | 12 | 1.530 | 5 | 0 | 8 |
| 7 | 7 | 9 | 1.902 | 4 | 0 | 13 |
| 8 | 1 | 10 | 2.280 | 6 | 2 | 11 |
| 9 | 3 | 4 | 2.668 | 3 | 0 | 10 |
| 10 | 3 | 6 | 3.092 | 9 | 0 | 11 |
| 11 | 1 | 3 | 3.601 | 8 | 10 | 12 |
| 12 | 1 | 14 | 4.135 | 11 | 0 | 13 |
| 13 | 1 | 7 | 4.940 | 12 | 7 | 0 |

B. Dendrogram using Ward Method



Annexure 6: Families of Dicotyledons in Meghalaya and their status

(Monocotyledons: 1. Aracaceae (Palmae) – 6 genera and 5 species; 2. Pandanaceae – 1/2 ; 3. Araceae – 1/2; 4. Dracaenaceae – 1/2 and 5. Poaceae – 5/8. Gymnosperms: 1. Gnetaceae – 1/2; Podocarpaceae – 1/1; Taxaceae – 1/1; Pinaceae – 1/1 and 5. Cycadaceae – 1/1)

| S. No. | Family | Genera World | Genera India | Genera Mghalaya | Species World | Species India | Species Mghalaya |
|--------|------------------|--------------|--------------|-----------------|---------------|---------------|------------------|
| 1 | Ranunculaceae | 35 | 20 | 6 | 1500 | 154 | 18 |
| 2 | Dilleniaceae | 10 | 3 | 2 | 400 | 12 | 4 |
| 3 | Magnoliaceae | 12 | 6 | 6 | 210 | 32 | 15 |
| 4 | Schisandraceae | 2 | 2 | 2 | 45 | 8 | 4 |
| 5 | Annonaceae | 80 | 20 | 13 | 850 | 95 | 26 |
| 6 | Menispermaceae | 80 | 17 | 7 | 400 | 42 | 11 |
| 7 | Berberidaceae | 4 | 3 | 2 | 575 | 68 | 3 |
| 8 | Lardizabalaceae | 7 | 3 | 2 | 35 | 5 | 3 |
| 9 | Capparaceae | 30 | 5 | 3 | 650 | 36 | 7 |
| 10 | Flacourtiaceae | 89 | 6 | 5 | 1250 | 24 | 10 |
| 11 | Pittosporaceae | 9 | 1 | 1 | 350 | 11 | 3 |
| 12 | Polygalaceae | 12 | 3 | 3 | 800 | 21 | 8 |
| 13 | Hypericaceae | 8 | 2 | 1 | 550 | 24 | 1 |
| 14 | Cluciaceae | 35 | 6 | 4 | 400 | 22 | 11 |
| 15 | Theaceae | 16 | 8 | 6 | 500 | 23 | 13 |
| 16 | Saurauiaceae | 1 | 1 | 1 | 300 | 6 | 5 |
| 17 | Dipterocarpeceae | 13 | 6 | 2 | 500 | 31 | 2 |
| 18 | Malvaceae | 75 | 17 | 6 | 1000 | 88 | 18 |
| 19 | Bombacaceae | 11 | 3 | 1 | ? | 3 | 1 |
| 20 | Sterculiaceae | 68 | 23 | 9 | 1600 | 75 | 15 |
| 21 | Tiliaceae | 50 | 8 | 3 | 450 | 64 | 11 |
| 22 | Eleaeocarpaceae | 13 | 3 | 2 | 300 | 21 | 12 |
| 23 | Ixonanthaceae | 1 | 1 | 1 | 10 | 3 | 1 |
| 24 | Erythrozyllaceae | 4 | 1 | 1 | 200 | 5 | 1 |
| 25 | Malpighiaceae | 65 | 2 | 2 | 1280 | 12 | 5 |
| 26 | Averrhoaceae | 1 | 1 | 1 | ? | 2 | 1 |
| 27 | Rutaceae | 150 | 24 | 13 | 900 | 86 | 25 |
| 28 | Simarombaceae | 30 | 6 | 3 | 200 | 12 | 4 |
| 29 | Ochnaceae | 21 | 2 | 1 | 400 | 8 | 1 |
| 30 | Burseraceae | 20 | 6 | 3 | 600 | 22 | 4 |
| 31 | Meliaceae | 50 | 16 | 11 | 800 | 66 | 16 |
| 32 | Olacaceae | 25 | 15 | 3 | 150 | 15 | 3 |
| 33 | Opiliceae | ? | ? | ? | ? | 4 | 1 |
| 34 | Icacinnaceae | 3 | 1 | 1 | 200 | 22 | 8 |
| 35 | Aquifoliaceae | 38 | 7 | 2 | 225 | 14 | 2 |
| 36 | Celastraceae | 45 | 10 | 7 | 500 | 65 | 15 |
| 37 | Rhamnaceae | 58 | 12 | 7 | 900 | 51 | 12 |
| 38 | Vitaceae | 12 | 8 | 6 | 700 | 61 | 26 |
| 39 | Leeaceae | 1 | 1 | 1 | 70 | 20 | 8 |
| 40 | Sapindaceae | 150 | 19 | 11 | 2000 | 50 | 14 |
| 41 | Aceraceae | 3 | 1 | 1 | 200 | 15 | 3 |

| S. No. | Family | Genera World | Genera India | Genera Mghalaya | Species World | Species India | Species Mghalaya |
|--------|------------------|--------------|--------------|-----------------|---------------|---------------|------------------|
| 42 | Staphylaceae | 5 | 2 | 1 | 60 | 5 | 2 |
| 43 | Sabiaceae | 4 | 2 | 2 | 200 | 19 | 6 |
| 44 | Auacrabaceae | 60 | 16 | 8 | 600 | 50 | 12 |
| 45 | Moringaceae | 1 | 1 | 1 | 12 | 2 | 1 |
| 46 | Connaraceae | 16 | 3 | 2 | 200 | 14 | 2 |
| 47 | Fabaceae | 482 | 100 | 42 | 1200 | 700 | 130 |
| 48 | Caesalpinaceae | 152 | 23 | 13 | 2800 | 80 | 28 |
| 49 | Mimosaceae | 15 | 15 | 10 | 2800 | 72 | 24 |
| 50 | Rosaceae | 100 | 30 | 18 | 2000 | 215 | 60 |
| 51 | Iteaceae | 2 | 2 | 2 | ? | 3 | 2 |
| 52 | Hamamelideaceae | 25 | 7 | 3 | 110 | 9 | 5 |
| 53 | Rhizophoraceae | 16 | 4 | 1 | 120 | 9 | 1 |
| 54 | Combretaceae | 18 | 6 | 2 | 500 | 32 | 11 |
| 55 | Myrtaceae | 100 | 10 | 7 | 3000 | 100 | 25 |
| 56 | Barringtoniaceae | 7 | 3 | 1 | ? | 8 | 1 |
| 57 | Melastomataceae | 240 | 11 | 6 | 3000 | 10 | 15 |
| 58 | Lythraceae | 25 | 8 | 1 | 550 | 58 | 6 |
| 59 | Sonneratiaceae | 2 | 2 | 1 | 9 | 4 | 1 |
| 60 | Crypteroniaceae | 1 | 1 | 1 | ? | 5 | 1 |
| 61 | Passifloraceae | 12 | 2 | 2 | 600 | 28 | 6 |
| 62 | Cucurbitaceae | 110 | 37 | 16 | 640 | 92 | 22 |
| 63 | Tetramelaceae | 1 | 1 | 1 | ? | ? | 1 |
| 64 | Araliaceae | 86 | 18 | 12 | 920 | 62 | 25 |
| 65 | Cornaceae | 20 | 8 | 5 | 125 | 17 | 6 |
| 66 | Caprifoliaceae | 16 | 6 | 3 | 400 | 67 | 11 |
| 67 | Rubiaceae | 500 | 77 | 36 | 6000 | 274 | 75 |
| 68 | Valerianaceae | 13 | 4 | 1 | 400 | 18 | 2 |
| 69 | Dipsacaceae | 10 | 5 | 1 | 160 | 18 | 1 |
| 70 | Asteraceae | 900 | 138 | 42 | 13000 | 708 | 86 |
| 71 | Campanulaceae | 35 | 8 | 3 | 780 | 48 | 7 |
| 72 | Lobeliaceae | 29 | 1 | 1 | 1150 | 22 | 4 |
| 73 | Ericaceae | 24 | 7 | 4 | 2000 | 100 | 7 |
| 74 | Vacciniaceae | 8 | 3 | 3 | 500 | 52 | 12 |
| 75 | Myrsinaceae | ? | 10 | 6 | 1000 | 208 | 26 |
| 76 | Sapotaceae | ? | 10 | 5 | 800 | 28 | 7 |
| 77 | Ebenaceae | 6 | 1 | 1 | 300 | 44 | 9 |
| 78 | Symplocaceae | ? | ? | ? | 300 | 40 | 9-10 |
| 79 | Styracaceae | 12 | 2 | 2 | 190 | 5 | 3 |
| 80 | Oleaceae | ? | ? | ? | 300 | 40 | 9 |
| 81 | Apocynaceae | 180 | 29 | 21 | 1500 | 60 | 29 |
| 82 | Asclepiadaceae | 130 | 39 | 22 | 2000 | 194 | 43 |
| 83 | Buddlejaceae | 8 | 1 | 1 | 150 | 11 | 2 |
| 84 | Loganiaceae | 24 | 6 | 6 | 600 | 39 | 10 |
| 85 | Boraginaceae | 100 | 35 | 6 | 2000 | 137 | 11 |
| 86 | Convolvulaceae | 120 | 20 | 11 | 1650 | 158 | 36 |

| S. No. | Family | Genera World | Genera India | Genera Mghalaya | Species World | Species India | Species Mghalaya |
|--------------|------------------|--------------|--------------|-----------------|---------------|---------------|------------------|
| 87 | Solanaceae | 90 | 25 | 10 | 2000 | 88 | 28 |
| 88 | Genseriaceae | 120 | 20 | 11 | 2000 | 110 | 33 |
| 89 | Bignoniaceae | ? | 20 | 5 | ? | 37 | 5 |
| 90 | Acanthaceae | 250 | 68 | 24 | 2500 | 337 | 77 |
| 91 | Verbenaceae | 75 | 17 | 13 | 3000 | 96 | 40 |
| 92 | Lamiaceae | 180 | 64 | 32 | 3500 | 380 | 55 |
| 93 | Polygonaceae | 40 | 8 | 4 | 800 | 100 | 25 |
| 94 | Nepenthaceae | 1 | 1 | 1 | 70 | 1 | 1 |
| 95 | Aristolochiaceae | 7 | 4 | 1 | 400 | 21 | 4 |
| 96 | Piperaceae | 8 | 2 | 2 | 3000 | 55 | 20 |
| 97 | Chloranthaceae | 5 | 2 | 1 | 65 | 3 | 2 |
| 98 | Myristicaceae | 16 | 3 | 2 | 380 | 13 | 4 |
| 99 | Lauraceae | 47 | 17 | 11 | 1900 | 175 | 50 |
| 100 | Hernandiaceae | 63 | 2 | 1 | 60 | 10 | 2 |
| 101 | Proteaceae | 60 | 4 | 3 | 1300 | 6 | 5 |
| 102 | Thymelaceae | 47 | 10 | 3 | 850 | 20 | 7 |
| 103 | Elaeagnaceae | 3 | 2 | 1 | 60 | 10 | 2 |
| 104 | Loranthaceae | 36 | 11 | 9 | 1300 | 50 | 15 |
| 105 | Santalaceae | 30 | 8 | 2 | 400 | 11 | 3 |
| 106 | Buxaceae | 5 | 2 | 1 | 50 | 5 | 1 |
| 107 | Euphosbiaceae | 300 | 61 | 38 | 5000 | 336 | 90 |
| 108 | Daphniphyllaceae | 1 | 1 | 1 | 24 | 4 | 1 |
| 109 | Vischofiaceae | 1 | 1 | 1 | ? | 1 | 1 |
| 110 | Ulmaceae | 15 | 5 | 5 | 200 | 18 | 7 |
| 111 | Cannabaceae | 2 | 2 | 1 | 3 | 2 | 1 |
| 112 | Moraceae | 75 | 9 | 8 | 1850 | 104 | 54 |
| 113 | Urticaceae | 45 | 21 | 15 | 550 | 114 | 35 |
| 114 | Juglandaceae | 8 | 2 | 1 | 68 | 4 | 2 |
| 115 | Myricaceae | 2 | 1 | 1 | 40 | 1 | 1 |
| 116 | Betulaceae | 2 | 2 | 2 | 54 | 6 | 2 |
| 117 | Fagaceae | 8 | 5 | 4 | 500 | 14 | 13 |
| 118 | Corylaceae | 4 | 2 | 1 | 50 | 5 | 1 |
| 119 | Salicaceae | 2 | 2 | 1 | 330 | 44 | 2 |
| Total | | 6500 | 1417 | 711 | 108630 | 7404 | 1723 |

Source: Haridasan and Rao, 1985

Annexure 7: Plant families in GCA

| S. No. | Family | Species |
|--------|------------------|---------|
| 1 | Acanthaceae | 25 |
| 2 | Adiantaceae | 2 |
| 3 | Alangiaceae | 3 |
| 4 | Amaranthaceae | 9 |
| 5 | Anacardiaceae | 13 |
| 6 | Angiopteridaceae | 1 |
| 7 | Annonaceae | 2 |
| 8 | Annonaceae | 14 |
| 9 | Apiaceae | 3 |
| 10 | Apocynaceae | 12 |
| 11 | Aquifoliaceae | 4 |
| 12 | Araceae | 7 |
| 13 | Araliaceae | 17 |
| 14 | Arecaceae | 14 |
| 15 | Aristolochiaceae | 2 |
| 16 | Asclepiadaceae | 12 |
| 17 | Asteraceae | 1 |
| 18 | Asteraceae | 43 |
| 19 | Athyriaceae | 1 |
| 20 | Averrhoaceae | 1 |
| 21 | Balsaminaceae | 1 |
| 22 | Bambusaceae | 15 |
| 23 | Barringtoniaceae | 1 |
| 24 | Begoniaceae | 3 |
| 25 | Betulaceae | 1 |
| 26 | Bignoniaceae | 5 |
| 27 | Bischofiaceae | 1 |
| 28 | Blechnaceae | 1 |
| 29 | Bombasaceae | 1 |
| 30 | Boraginaceae | 3 |
| 31 | Buddlejaceae | 1 |
| 32 | Burseraceae | 3 |
| 33 | Buxaceae | 1 |
| 34 | Caesalpinaceae | 1 |
| 35 | Caesalpiniaceae | 18 |
| 36 | Cannabinaceae | 1 |
| 37 | Capparidaceae | 5 |
| 38 | Caprifoliaceae | 1 |
| 39 | Caryophyllaceae | 1 |

| S. No. | Family | Species |
|--------|--------------------|---------|
| 40 | Celastraceae | 3 |
| 41 | Chenopodiaceae | 2 |
| 42 | Chloranthaceae | 1 |
| 43 | Clusiaceae | 14 |
| 44 | Combretaceae | 8 |
| 45 | Commelinaceae | 5 |
| 46 | Convolvulaceae | 17 |
| 47 | Crassulaceae | 1 |
| 48 | Crypteroniaceae | 1 |
| 49 | Cryptogrammataceae | 1 |
| 50 | Cucurbitaceae | 8 |
| 51 | Cupressaceae | 1 |
| 52 | Cuscutaceae | 2 |
| 53 | Cyatheaceae | 1 |
| 54 | Cyperaceae | 6 |
| 55 | Dilleniaceae | 4 |
| 56 | Dioscoreaceae | 3 |
| 57 | Dipterocarpaceae | 2 |
| 58 | Dracaenaceae | 2 |
| 59 | Ebenaceae | 6 |
| 60 | Ehretiaceae | 4 |
| 61 | Elaeagnaceae | 1 |
| 62 | Elaeocarpaceae | 7 |
| 63 | Ericaceae | 1 |
| 64 | Euphorbiaceae | 58 |
| 65 | Fabaceae | 55 |
| 66 | Fagaceae | 7 |
| 67 | Flacourtiaceae | 10 |
| 68 | Gesneriaceae | 4 |
| 69 | Gleicheniaceae | 1 |
| 70 | Gnetaceae | 2 |
| 71 | Hamamelidaceae | 1 |
| 72 | Hemionitidaceae | 1 |
| 73 | Hypericaceae | 1 |
| 74 | Juglandaceae | 4 |
| 75 | Labeliaceae | 1 |
| 76 | Lamiaceae | 16 |
| 77 | Lauraceae | 37 |
| 78 | Leeaceae | 7 |
| 79 | Loganiaceae | 3 |
| 80 | Loganiaceae | 1 |

| S. No. | Family | Species |
|--------|-----------------|---------|
| 81 | Loranthaceae | 7 |
| 82 | Lycopodiaceae | 1 |
| 83 | Lythraceae | 2 |
| 84 | Magnoliaceae | 6 |
| 85 | Malpighiaceae | 5 |
| 86 | Malvaceae | 8 |
| 87 | Martyniaceae | 1 |
| 88 | Melastomaceae | 3 |
| 89 | Melastomataceae | 3 |
| 90 | Meliaceae | 13 |
| 91 | Menispermaceae | 10 |
| 92 | Mimosaceae | 20 |
| 93 | Moraceae | 43 |
| 94 | Moringaceae | 1 |
| 95 | Musaceae | 1 |
| 96 | Myristicaceae | 5 |
| 97 | Myrsinaceae | 16 |
| 98 | Myrtaceae | 16 |
| 99 | Nepenthaceae | 1 |
| 100 | Nyctaginaceae | 1 |
| 101 | Nymphaeaceae | 1 |
| 102 | Ochnaceae | 1 |
| 103 | Oleaceae | 12 |
| 104 | Oleandraceae | 1 |
| 105 | Onagraceae | 2 |
| 106 | Orchidaceae | 6 |
| 107 | Oxalidaceae | 2 |
| 108 | Pandanaceae | 3 |
| 109 | Papaveraceae | 1 |
| 110 | Passifloraceae | 1 |
| 111 | Piperaceae | 5 |
| 112 | Pittosporaceae | 1 |
| 113 | Plagiogyriaceae | 1 |
| 114 | Plantaginaceae | 3 |
| 115 | Poaceae | 39 |
| 116 | Podocarpaceae | 2 |
| 117 | Polygalaceae | 5 |
| 118 | Polygonaceae | 6 |
| 119 | Polypodiaceae | 12 |
| 120 | Portulacaceae | 2 |
| 121 | Proteaceae | 4 |

| S. No. | Family | Species |
|--------|------------------|-------------|
| 122 | Pteridaceae | 2 |
| 123 | Ranunculaceae | 6 |
| 124 | Rhamnaceae | 6 |
| 125 | Rhizophoraceae | 1 |
| 126 | Rosaceae | 12 |
| 127 | Rubiaceae | 5 |
| 128 | Rubiaceae | 61 |
| 129 | Rutaceae | 23 |
| 130 | Sabiaceae | 3 |
| 131 | Sapindaceae | 6 |
| 132 | Sapotaceae | 2 |
| 133 | Saurauaceae | 4 |
| 134 | Schisandraceae | 1 |
| 135 | Schizaceae | 2 |
| 136 | Scrophulariaceae | 4 |
| 137 | Selaginellaceae | 1 |
| 138 | Simaroubaceae | 3 |
| 139 | Sinopteridaceae | 1 |
| 140 | Smilacaceae | 4 |
| 141 | Solanaceae | 11 |
| 142 | Sonneratiaceae | 1 |
| 143 | Staphyliaceae | 2 |
| 144 | Sterculiaceae | 11 |
| 145 | Symplocaceae | 5 |
| 146 | Taxaceae | 1 |
| 147 | Tetramelaceae | 1 |
| 148 | Theaceae | 4 |
| 149 | Thelypteridaceae | 1 |
| 150 | Thymelaeaceae | 1 |
| 151 | Thymeliaceae | 1 |
| 152 | Tiliaceae | 13 |
| 153 | Ulmaceae | 5 |
| 154 | Urticaceae | 18 |
| 155 | Utriculariaceae | 1 |
| 156 | Vacciniaceae | 2 |
| 157 | Verbenaceae | 31 |
| 158 | Violaceae | 2 |
| 159 | Vitaceae | 11 |
| 160 | Zingiberaceae | 9 |
| 161 | Zygophyllaceae | 1 |
| | Total | 1112 |

Annexure 8: Importance Value Indices (IVI) for top 20 tree species in various primary and secondary forest types

(Overall = all sample plots regardless of forest types; PF= Primary Forest; SF= Secondary Forest, WF= Wet evergreen Formation; LF= Limestone Formation; MF= Moist evergreen Formation; TMEF= Tropical Moist Evergreen Forest, TSEF= Tropical Semi-evergreen Forest and TMDF= Tropical Moist Deciduous Forest)

| Species rank | Forest type | Species | Relative Density | Relative dominance | Relative Frequency | IVI |
|--------------|-------------|--------------------------------|------------------|--------------------|--------------------|------|
| 1 | Overall | <i>Shorea robusta</i> | 9.0 | 9.1 | 0.8 | 19.0 |
| 2 | Overall | <i>Schima wallichii</i> | 6.5 | 6.8 | 1.4 | 14.7 |
| 3 | Overall | <i>Castanopsis purpurella</i> | 4.7 | 5.0 | 1.6 | 11.3 |
| 4 | Overall | <i>Polyalthia simiamum</i> | 3.6 | 3.8 | 1.4 | 8.7 |
| 5 | Overall | <i>Syzygium cumini</i> | 3.4 | 3.0 | 1.6 | 8.0 |
| 6 | Overall | <i>Grewia microcos</i> | 4.5 | 1.7 | 1.5 | 7.8 |
| 7 | Overall | <i>Aporusa dioica</i> | 3.8 | 1.2 | 1.4 | 6.4 |
| 8 | Overall | <i>Dillenia pentagyna</i> | 2.0 | 2.7 | 1.5 | 6.3 |
| 9 | Overall | <i>Drimycarpus racemosus</i> | 1.7 | 1.9 | 1.8 | 5.5 |
| 10 | Overall | <i>Eurya acuminata</i> | 2.2 | 1.7 | 1.4 | 5.2 |
| 11 | Overall | <i>Sapium baccatum</i> | 1.5 | 2.1 | 1.5 | 5.2 |
| 12 | Overall | <i>Diospyros variegata</i> | 2.0 | 2.4 | 0.7 | 5.1 |
| 13 | Overall | <i>Canarium strictum</i> | 1.3 | 2.3 | 1.3 | 4.9 |
| 14 | Overall | <i>Cynometra polyandra</i> | 1.4 | 2.0 | 1.4 | 4.7 |
| 15 | Overall | <i>Aphanamixis polystachya</i> | 1.3 | 2.3 | 1.0 | 4.6 |
| 16 | Overall | <i>Syzygium operculatum</i> | 1.3 | 2.6 | 0.6 | 4.4 |
| 17 | Overall | <i>Macaranga denticulata</i> | 2.6 | 0.7 | 1.1 | 4.4 |
| 18 | Overall | <i>Walsura tubulata</i> | 2.2 | 1.2 | 0.7 | 4.1 |
| 19 | Overall | <i>Castanopsis sp.</i> | 1.1 | 2.6 | 0.3 | 4.0 |
| 20 | Overall | <i>Vitex peduncularis</i> | 1.3 | 1.1 | 1.4 | 3.8 |
| 1 | PF | <i>Polyalthia simiamum</i> | 5.6 | 5.4 | 1.3 | 12.3 |
| 2 | PF | <i>Schima wallichii</i> | 4.0 | 5.2 | 1.3 | 10.4 |
| 3 | PF | <i>Castanopsis purpurella</i> | 4.2 | 4.6 | 1.5 | 10.3 |
| 4 | PF | <i>Syzygium cumini</i> | 3.2 | 3.1 | 1.5 | 7.8 |
| 5 | PF | <i>Grewia microcos</i> | 4.3 | 1.7 | 1.3 | 7.3 |
| 6 | PF | <i>Drimycarpus racemosus</i> | 2.7 | 2.6 | 2.0 | 7.3 |
| 7 | PF | <i>Dillenia pentagyna</i> | 2.3 | 3.1 | 1.5 | 6.9 |
| 8 | PF | <i>Cynometra polyandra</i> | 2.2 | 2.9 | 1.5 | 6.5 |
| 9 | PF | <i>Aphanamixis polystachya</i> | 2.1 | 3.2 | 1.1 | 6.5 |
| 10 | PF | <i>Walsura tubulata</i> | 3.9 | 1.7 | 0.9 | 6.4 |
| 11 | PF | <i>Canarium strictum</i> | 1.7 | 3.1 | 1.3 | 6.1 |
| 12 | PF | <i>Diospyros variegata</i> | 2.9 | 2.4 | 0.8 | 6.1 |
| 13 | PF | <i>Shorea robusta</i> | 2.5 | 2.9 | 0.7 | 6.0 |
| 14 | PF | <i>Aporusa dioica</i> | 3.2 | 1.1 | 1.3 | 5.6 |
| 15 | PF | <i>Sapium baccatum</i> | 1.8 | 2.2 | 1.5 | 5.5 |
| 16 | PF | <i>Syzygium operculatum</i> | 1.8 | 2.8 | 0.7 | 5.3 |
| 17 | PF | <i>Eurya acuminata</i> | 2.0 | 1.5 | 1.3 | 4.8 |
| 18 | PF | <i>Michelia champaca</i> | 1.5 | 2.5 | 0.7 | 4.7 |
| 19 | PF | <i>Tetrameles nudiflora</i> | 1.3 | 2.4 | 0.9 | 4.6 |
| 20 | PF | <i>Castanopsis sp.</i> | 1.4 | 2.8 | 0.4 | 4.6 |
| 1 | SF | <i>Schima wallichii</i> | 12.0 | 12.6 | 1.7 | 26.3 |
| 2 | SF | <i>Castanopsis purpurella</i> | 6.9 | 7.9 | 1.9 | 16.7 |
| 3 | SF | <i>Shorea robusta</i> | 5.0 | 7.2 | 0.8 | 12.9 |

| Species rank | Forest type | Species | Relative Density | Relative dominance | Relative Frequency | IVI |
|--------------|-------------|-----------------------------------|------------------|--------------------|--------------------|------|
| 4 | SF | <i>Macaranga denticulata</i> | 6.9 | 2.3 | 1.5 | 10.7 |
| 5 | SF | <i>Grewia microcos</i> | 6.3 | 2.3 | 1.7 | 10.3 |
| 6 | SF | <i>Syzygium cumini</i> | 3.7 | 2.7 | 1.7 | 8.1 |
| 7 | SF | <i>Aporosa dioica</i> | 4.7 | 1.6 | 1.7 | 8.1 |
| 8 | SF | <i>Eurya acuminata</i> | 3.2 | 3.1 | 1.7 | 8.0 |
| 9 | SF | <i>Dillenia pentagyna</i> | 2.2 | 2.5 | 1.7 | 6.4 |
| 10 | SF | <i>Callicarpa arborea</i> | 3.3 | 1.3 | 1.5 | 6.2 |
| 11 | SF | <i>Betula alnoides</i> | 1.0 | 2.9 | 1.5 | 5.4 |
| 12 | SF | <i>Diospyros variegata</i> | 1.2 | 3.4 | 0.6 | 5.2 |
| 13 | SF | <i>Vitex peduncularis</i> | 1.8 | 1.7 | 1.7 | 5.1 |
| 14 | SF | <i>Calophyllum polyanthum</i> | 1.0 | 3.2 | 0.4 | 4.6 |
| 15 | SF | <i>Sapium baccatum</i> | 1.2 | 1.9 | 1.5 | 4.6 |
| 16 | SF | <i>Stereospermum chelonoides</i> | 1.4 | 1.8 | 1.3 | 4.6 |
| 17 | SF | <i>Ilex umbellulata</i> | 1.7 | 1.1 | 1.7 | 4.5 |
| 18 | SF | <i>Lagerstroemia parviflora</i> | 1.7 | 1.5 | 1.3 | 4.5 |
| 19 | SF | <i>Persea villosa</i> | 2.0 | 1.0 | 1.5 | 4.5 |
| 20 | SF | <i>Syzygium operculatum</i> | 0.9 | 3.0 | 0.4 | 4.3 |
| 1 | WF | <i>Syzygium operculatum</i> | 10.6 | 10.9 | 1.8 | 23.3 |
| 2 | WF | <i>Diospyros variegata</i> | 9.2 | 8.2 | 1.8 | 19.3 |
| 3 | WF | <i>Castanopsis sp.</i> | 8.5 | 8.3 | 1.8 | 18.6 |
| 4 | WF | <i>Castanopsis purpurella</i> | 7.5 | 9.3 | 1.8 | 18.6 |
| 5 | WF | <i>Aphanamixis polystachya</i> | 6.0 | 4.7 | 1.8 | 12.5 |
| 6 | WF | <i>Calophyllum polyanthum</i> | 4.8 | 5.6 | 1.8 | 12.2 |
| 7 | WF | <i>Casearia glomerata</i> | 4.7 | 3.3 | 1.8 | 9.8 |
| 8 | WF | <i>Boehmeria hamiltoniana</i> | 3.1 | 4.4 | 1.8 | 9.4 |
| 9 | WF | <i>Garcinia cowa</i> | 3.8 | 2.7 | 1.8 | 8.3 |
| 10 | WF | <i>Betula alnoides</i> | 2.5 | 3.3 | 1.8 | 7.7 |
| 11 | WF | <i>Viburnum colebrookianum</i> | 3.0 | 2.8 | 1.8 | 7.6 |
| 12 | WF | <i>Eurya acuminata</i> | 2.9 | 2.8 | 1.8 | 7.5 |
| 13 | WF | <i>Parapentapanax subcordatum</i> | 2.6 | 3.0 | 1.8 | 7.3 |
| 14 | WF | <i>Saurauia nepaulensis</i> | 2.1 | 2.6 | 1.8 | 6.5 |
| 15 | WF | <i>Actinodaphne obovata</i> | 1.8 | 2.0 | 1.8 | 5.7 |
| 16 | WF | <i>Aesculus assamica</i> | 1.9 | 1.5 | 1.8 | 5.2 |
| 17 | WF | <i>Acronychia pedunculata</i> | 1.7 | 1.5 | 1.8 | 5.0 |
| 18 | WF | <i>Flacourtia jangomas</i> | 1.5 | 1.6 | 1.8 | 5.0 |
| 19 | WF | <i>Elaeocarpus aristatus</i> | 1.4 | 1.8 | 1.8 | 5.0 |
| 20 | WF | <i>Chikrassia tabularis</i> | 1.9 | 1.8 | 1.2 | 4.9 |
| 1 | LF | <i>Polyalthia simiamum</i> | 17.5 | 19.3 | 1.8 | 38.5 |
| 2 | LF | <i>Walsura tubulata</i> | 20.0 | 12.5 | 1.8 | 34.3 |
| 3 | LF | <i>Mesua ferrea</i> | 11.0 | 6.7 | 1.8 | 19.4 |
| 4 | LF | <i>Michelia champaca</i> | 3.8 | 9.6 | 1.8 | 15.2 |
| 5 | LF | <i>Pterospermum lancifolium</i> | 4.9 | 3.1 | 1.8 | 9.8 |
| 6 | LF | <i>Cynometra polyandra</i> | 2.1 | 4.2 | 1.8 | 8.1 |
| 7 | LF | <i>Drimycarpus racemosus</i> | 1.4 | 3.4 | 1.8 | 6.6 |
| 8 | LF | <i>Syzygium cumini</i> | 2.7 | 2.0 | 1.8 | 6.5 |
| 9 | LF | <i>Canarium strictum</i> | 1.6 | 2.5 | 1.8 | 5.8 |
| 10 | LF | <i>Betula alnoides</i> | 1.3 | 2.4 | 1.8 | 5.4 |
| 11 | LF | <i>Sapium baccatum</i> | 1.5 | 2.1 | 1.8 | 5.4 |

| Species rank | Forest type | Species | Relative Density | Relative dominance | Relative Frequency | IVI |
|--------------|-------------|----------------------------------|------------------|--------------------|--------------------|------|
| 12 | LF | <i>Trewia nudiflora</i> | 2.1 | 1.5 | 1.8 | 5.3 |
| 13 | LF | <i>Cinnamomum bejolghota</i> | 1.6 | 1.8 | 1.8 | 5.2 |
| 14 | LF | <i>Macaranga denticulata</i> | 2.4 | 0.9 | 1.8 | 5.1 |
| 15 | LF | <i>Saraca asoca</i> | 2.1 | 0.9 | 1.8 | 4.7 |
| 16 | LF | <i>Croton joufera</i> | 1.8 | 1.0 | 1.8 | 4.6 |
| 17 | LF | <i>Tetrameles nudiflora</i> | 0.6 | 2.1 | 1.8 | 4.5 |
| 18 | LF | <i>Syzygium operculatum</i> | 1.3 | 1.2 | 1.8 | 4.2 |
| 19 | LF | <i>Acronychia pedunculata</i> | 1.3 | 1.2 | 1.8 | 4.2 |
| 20 | LF | <i>Kayea floribunda</i> | 0.9 | 1.3 | 1.8 | 3.9 |
| 1 | MF | <i>Polyalthia simiamum</i> | 9.6 | 10.4 | 1.5 | 21.5 |
| 2 | MF | <i>Canarium strictum</i> | 4.8 | 12.8 | 1.5 | 19.1 |
| 3 | MF | <i>Tetrameles nudiflora</i> | 7.5 | 8.0 | 1.5 | 17.0 |
| 4 | MF | <i>Michelia champaca</i> | 6.2 | 3.9 | 1.5 | 11.5 |
| 5 | MF | <i>Drimycarpus racemosus</i> | 3.0 | 6.0 | 1.5 | 10.5 |
| 6 | MF | <i>Cynometra polyandra</i> | 3.2 | 3.9 | 1.5 | 8.6 |
| 7 | MF | <i>Sapium baccatum</i> | 2.9 | 2.6 | 1.5 | 7.1 |
| 8 | MF | <i>Walsura tubulata</i> | 3.7 | 1.6 | 1.5 | 6.9 |
| 9 | MF | <i>Walsura robusta</i> | 2.9 | 2.5 | 1.5 | 6.9 |
| 10 | MF | <i>Pterospermum lancifolium</i> | 3.4 | 1.7 | 1.0 | 6.1 |
| 11 | MF | <i>Eurya acuminata</i> | 2.4 | 2.2 | 1.5 | 6.1 |
| 12 | MF | <i>Dillenia pentagyna</i> | 2.2 | 1.8 | 1.5 | 5.5 |
| 13 | MF | <i>Duabanga grandiflora</i> | 2.0 | 1.5 | 1.5 | 5.0 |
| 14 | MF | <i>Aphanamixis polystachya</i> | 1.4 | 1.7 | 1.5 | 4.6 |
| 15 | MF | <i>Kayea floribunda</i> | 0.5 | 2.6 | 1.5 | 4.6 |
| 16 | MF | <i>Grewia microcos</i> | 3.4 | 0.6 | 0.5 | 4.5 |
| 17 | MF | <i>Pterospermum acerifolium</i> | 1.8 | 1.6 | 1.0 | 4.4 |
| 18 | MF | <i>Ligustrum robustum</i> | 1.0 | 1.9 | 1.5 | 4.4 |
| 19 | MF | <i>Castanopsis purpurella</i> | 1.8 | 1.1 | 1.5 | 4.4 |
| 20 | MF | <i>Schima wallichii</i> | 1.8 | 1.0 | 1.5 | 4.4 |
| 1 | TSEF | <i>Schima wallichii</i> | 13.0 | 14.6 | 1.7 | 29.4 |
| 2 | TSEF | <i>Castanopsis purpurella</i> | 6.1 | 4.7 | 1.7 | 12.4 |
| 3 | TSEF | <i>Shorea robusta</i> | 5.1 | 5.7 | 0.9 | 11.7 |
| 4 | TSEF | <i>Macaranga denticulata</i> | 6.7 | 2.0 | 1.5 | 10.2 |
| 5 | TSEF | <i>Dillenia pentagyna</i> | 2.7 | 4.7 | 1.7 | 9.1 |
| 6 | TSEF | <i>Syzygium cumini</i> | 4.1 | 3.1 | 1.7 | 8.9 |
| 7 | TSEF | <i>Tectona grandis</i> | 3.9 | 4.7 | 0.2 | 8.7 |
| 8 | TSEF | <i>Grewia microcos</i> | 4.5 | 1.7 | 1.7 | 7.9 |
| 9 | TSEF | <i>Aporosa dioica</i> | 4.3 | 1.2 | 1.7 | 7.2 |
| 10 | TSEF | <i>Eurya acuminata</i> | 3.0 | 2.1 | 1.7 | 6.7 |
| 11 | TSEF | <i>Aphanamixis polystachya</i> | 1.5 | 3.8 | 0.6 | 5.9 |
| 12 | TSEF | <i>Ilex umbellulata</i> | 2.2 | 2.1 | 1.5 | 5.8 |
| 13 | TSEF | <i>Callicarpa arborea</i> | 3.2 | 1.3 | 1.4 | 5.8 |
| 14 | TSEF | <i>Polyalthia simiamum</i> | 1.1 | 2.8 | 1.5 | 5.4 |
| 15 | TSEF | <i>Stereospermum chelonoides</i> | 1.6 | 2.3 | 1.4 | 5.2 |
| 16 | TSEF | <i>Castanopsis sp.</i> | 0.8 | 3.8 | 0.3 | 4.9 |
| 17 | TSEF | <i>Persea villosa</i> | 2.1 | 0.8 | 1.5 | 4.4 |
| 18 | TSEF | <i>Vitex peduncularis</i> | 1.4 | 1.0 | 1.7 | 4.2 |
| 19 | TSEF | <i>Lagerstroemia parviflora</i> | 1.6 | 1.1 | 1.2 | 3.9 |

| Species rank | Forest type | Species | Relative Density | Relative dominance | Relative Frequency | IVI |
|--------------|-------------|-----------------------------------|------------------|--------------------|--------------------|------|
| 20 | TSEF | <i>Terminalia bellirica</i> | 1.4 | 0.9 | 1.5 | 3.8 |
| 1 | TMDF | <i>Grewia microcos</i> | 8.4 | 4.2 | 1.6 | 14.1 |
| 2 | TMDF | <i>Schima wallichii</i> | 5.0 | 7.7 | 1.4 | 14.1 |
| 3 | TMDF | <i>Castanopsis purpurella</i> | 5.2 | 6.6 | 1.6 | 13.3 |
| 4 | TMDF | <i>Shorea robusta</i> | 4.0 | 7.4 | 1.0 | 12.5 |
| 5 | TMDF | <i>Syzygium cumini</i> | 4.3 | 5.9 | 1.6 | 11.8 |
| 6 | TMDF | <i>Aporosa dioica</i> | 5.2 | 2.5 | 1.4 | 9.1 |
| 7 | TMDF | <i>Dillenia pentagyna</i> | 2.9 | 4.4 | 1.6 | 8.8 |
| 8 | TMDF | <i>Drimycarpus racemosus</i> | 3.5 | 2.7 | 2.0 | 8.2 |
| 9 | TMDF | <i>Cynometra polyandra</i> | 2.7 | 4.0 | 1.4 | 8.1 |
| 10 | TMDF | <i>Sapium baccatum</i> | 2.3 | 3.8 | 1.4 | 7.5 |
| 11 | TMDF | <i>Polyalthia simiamum</i> | 3.1 | 2.1 | 1.4 | 6.6 |
| 12 | TMDF | <i>Diospyros variegata</i> | 3.0 | 2.1 | 1.1 | 6.2 |
| 13 | TMDF | <i>Vitex peduncularis</i> | 2.1 | 2.5 | 1.6 | 6.1 |
| 14 | TMDF | <i>Canarium strictum</i> | 1.9 | 2.5 | 1.6 | 6.0 |
| 15 | TMDF | <i>Lagerstroemia parviflora</i> | 2.7 | 2.2 | 1.0 | 5.8 |
| 16 | TMDF | <i>Holarrhena antidysenterica</i> | 2.6 | 1.3 | 1.3 | 5.2 |
| 17 | TMDF | <i>Eurya acuminata</i> | 2.4 | 1.4 | 1.3 | 5.1 |
| 18 | TMDF | <i>Lansea coromandelica</i> | 1.1 | 1.5 | 2.0 | 4.6 |
| 19 | TMDF | <i>Terminalia bellirica</i> | 1.3 | 1.9 | 1.3 | 4.5 |
| 20 | TMDF | <i>Croton joufera</i> | 2.0 | 0.9 | 1.4 | 4.3 |

Anexure 9: Tree species inventory and database

(c= Common, f= frequent, r= rare, pf= Primary forests, sf= Secondary Forests, ev= Evergreen Forests, dd= Moist deciduous forest, bmb= Bamboo growth, cult= Cultivation)

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|--|---------------|--------|---------------------|-----------------------|------|----------|------|--------|-----------------------------|-----------------|---|
| <i>Alangium chinense</i> (Lour.) Harms | Alangiaceae | 10 | c | sf, edge, roadside | | | | | | | Phagrang, Rangomi, Konkamari, rangokmi |
| <i>Alangium salvifolium</i> ? | Alangiaceae | | | | | | | | | | |
| <i>Anacardium occidentale</i> Linn. | Anacardiaceae | 10 | c | cultivation | 1 | | | | | | |
| <i>Drimycarpus racemosus</i> (Roxb.) Hk. f. | Anacardiaceae | 20 | o | ev | | | | 1 | Plancks, Flooring | | babari |
| <i>Lannea coromandelica</i> (Houtt.) Merr. | Anacardiaceae | L | c | dd, sf, open | | | | | | | Chigampa |
| <i>Mangifera indica</i> Linn. | Anacardiaceae | 25 | o | cultiv | | | | | | | |
| <i>Mangifera sylvatica</i> Roxb. | Anacardiaceae | L | | ev | | | | | | | |
| <i>Rhus acuminata</i> DC. | Anacardiaceae | 20 | f | open, edge | | | | | Itching, wax, Varnish | | bolmising/bo lmicheng |
| <i>Rhus javanica</i> Linn. | Anacardiaceae | 12 | | sf, open, edge | | 1 | | | Fish poison | | kitma |
| <i>Semecarpus anacardium</i> Linn. f. | Anacardiaceae | 15 | c | dd, sf | 1 | 1 | | | | | |
| <i>Spondias axillaris</i> Roxb. | Anacardiaceae | | f | ev, mixdd | | | | | | | |
| <i>Spondias pinnata</i> (Linn. f.) Kurz. | Anacardiaceae | 20 | c | dd | 1 | | | | | Barking deer | |
| <i>Alphonsea ventricosa</i> Hk. f. | Annonaceae | | | | 1 | | | | | | |
| <i>Milium roxburghiana</i> (Wall.) Hk. f. | Annonaceae | 6 | c | ev | | | | | | | |
| <i>Milium tomentosa</i> (Roxb.) Sinclair | Annonaceae | | | | | | | | | | |
| <i>Milium velutina</i> Hk. f. | Annonaceae | 13 | rare | Sal | | | | | | | Borsamphal |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|--|---------------|--------|---------------------|------------------|------|----------|------|--------|------------------|------------|----------------------|
| <i>Mitrephora tomentosa</i> Hk. f. & Th. | Annonaceae | 25 | | dd | | | | | | | |
| <i>Polyalthia jenkinsii</i> Benth. & Hk. f. | Annonaceae | 15 | c | ev | | | | | Pole | | |
| <i>Polyalthia siniamum</i> (Hk. f. & Th.) Hk. f. & Th. | Annonaceae | large | rare | ev | | | | | | | jigre |
| <i>Alstonia scholaris</i> (Linn.) R. Br. | Apocynaceae | 40 | f | dd, sf, edge | | 1 | | | | | Chokchong, Sockchong |
| <i>Holarrhena antidysenterica</i> (Roth) A. DC. | Apocynaceae | 10 | c | sf, dry sandy | | 1 | | | Decorative items | | bolgolmatra/matalwe |
| <i>Plumeria rubra</i> Linn. | Apocynaceae | | | cult | | | | | | | |
| <i>Thevetia peruviana</i> (Pers.) K. Schum. | Apocynaceae | 12 | c | sf, dd | | | | | | | koropi |
| <i>Wrightia arborea</i> (Dennst.) Mabblerley | Apocynaceae | 10 | | cult | | | | | | | Bolmatra |
| <i>Ilex embelioides</i> Hk. f. | Aquifoliaceae | S | r | | | | | | | | bolchhenda |
| <i>Ilex excelsa</i> (Wall.) Hk. f. | Aquifoliaceae | 20 | c | ev | | | | | | | |
| <i>Ilex fragilis</i> Hk. f. | Aquifoliaceae | 15 | r | | | | | | | | |
| <i>Ilex umbellulata</i> (Wall.) Loes. | Aquifoliaceae | 30 | c | | | | 1 | | | | boltajong |
| <i>Areca catechu</i> Willd. | Araceae | | | | | | | | | | |
| <i>Aralia thomsonii</i> Seem | Araliaceae | 5 | | pf, road cutting | | | | | | | |
| <i>Brassiopsis glomerulata</i> (Bl.) Regel | Araliaceae | L | f | ev | | | | | | | |
| <i>Heteropanax fragrans</i> (D. Don) Seem | Araliaceae | 20 | | ev, disturbed | | | | | | | mugasalgro |
| <i>Macropanax dispersum</i> (Bl.) O. Ktze. | Araliaceae | 10 | | broadleaved | | | | | | | jakrichu budu |
| <i>Macropanax undulatus</i> (Wall ex G. Don) Seem | Araliaceae | 15 | c | ev | | | | | | | samibrek |
| <i>Merillioanax japonicum</i> Seem | Araliaceae | S | | | | | | | | | tingsi |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|--|-------------------------|--------|---------------------|-----------------|------|----------|------|--------|-------------------|-------------------|---------------------|
| <i>Parapentapanax subcordatum</i> (G. Don) Hutch. | Araliaceae | 10 | c | rocky | | | | | | | Samibrak |
| <i>Schefflera hypoleuca</i> (Kurz.) Harms | Araliaceae | 15 | c | | | | | | | Bees-honey source | |
| <i>Schefflera wallichiana</i> (W. & A.) Harms | Araliaceae | S | c | ev | | | | | | | |
| <i>Trevesia palmata</i> (Roxb.) Vis. | Araliaceae | S | | ev, streamlets | 1 | 1 | | | | | Chinnathong |
| <i>Caryota urens</i> Linn. | Arecaceae | | f | | | | | | | | Pengaru/Bolbanji |
| <i>Licuala peltata</i> Roxb. | Arecaceae | | | | | | | | | | Ishok |
| <i>Phoenix humilis</i> Royle | Arecaceae | | | | | | | | | | |
| <i>Pinanga gracilis</i> Bl. | Arecaceae | | | | | | | | | | Thaming |
| <i>Vernonia arborea</i> Buch.-Ham. | Asteraceae | 20 | r | open | | | | | | | |
| <i>Vernonia volkameriifolia</i> DC. | Asteraceae | 6 | f | Dry areas | | | | | | | Gamba |
| <i>Averrhoa carambola</i> Linn. | Averrhoaceae | 10 | | sandy,cult,wild | | | | | | | Gamlinga |
| <i>Careya arborea</i> Roxb. | Barringtoniaceae | 20 | c | mixev | | 1 | | 1 | | | gambil/dambil |
| <i>Betula alnoides</i> Buch.-Ham. ex D. Don | Betulaceae | 30 | c | higher elevtn | | | | | | | Gakgil |
| <i>Jacaranda mimosifolia</i> D. Don | Bignoniaceae | 25 | c | cult | | | | | avenue tree | | |
| <i>Oroxylum indicum</i> (Linn.) Vent. | Bignoniaceae | 15 | c | dd | | 1 | | | Tanning, Dyeing | | Khiring |
| <i>Radermachera gigantea</i> (Bl.) Miq. | Bignoniaceae | 25 | r | | | | | | | | dugrak/nelata mejab |
| <i>Stereospermum chelonoides</i> (Linn. f.) DC. | Bignoniaceae | 40 | c | ev, dd | | | | 1 | | | Borsil |
| <i>Bischofia javanica</i> Bl. | Bischofiaceae | 25 | c | ev,mixev | | | | | | | Udum |
| <i>Salmalia malabarica</i> (DC.) Schott. & Endlicher | Bombacaceae/Bombacaceae | 75 | c | SecF | | | | | cordage match ply | | Bolchu |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|-----------------|--------|---------------------|------------------|------|----------|------|--------|------------------|--------------|----------------------|
| | | | | | | | | | cotton | | |
| <i>Cordia dichotoma</i> Forst. f. | Boraginaceae | M | r | dd | | | | | | | Bolsadu |
| <i>Cordia fragrantissima</i> Kurz. | Boraginaceae | | r | ev | | | | | | | |
| <i>Cordia grandis</i> Roxb. | Boraginaceae | 20 | f | rb | | | | | Adhesive | | Bolmitap |
| <i>Bursera serrata</i> Colebr. | Burseraceae | L | c | ev, mixed | | | | 1 | | | ambilatong, tekring |
| <i>Canarium strictum</i> Roxb. | Burseraceae | 40 | r | edge, ev, rb | | | | | Insect repellent | | dongkhreng |
| <i>Garuga pinnata</i> Roxb. | Burseraceae | L | c | dd, open | | | | 1 | Tannin, fodder | | Wakri, chigambil |
| <i>Acrocarpus fraxinifolius</i> Arn. ex Wt. | Caesalpiniaceae | 35 | f | dd | | | | | | | |
| <i>Bauhinia malabarica</i> Roxb. | Caesalpiniaceae | M | | | | | | | | | bakbakil, meo gngtak |
| <i>Bauhinia purpurea</i> Linn. | Caesalpiniaceae | 10 | c | dd, sf, edge | | 1 | | | | | Begongry |
| <i>Bauhinia retusa</i> Ham. | Caesalpiniaceae | | | | | | | | | | |
| <i>Bauhinia variegata</i> Linn. | Caesalpiniaceae | 8 | f | dd | | | | | | | |
| <i>Cassia fistula</i> Linn. | Caesalpiniaceae | 12 | c | plantation, wild | | | | | Tannin, fodder | Bears, goats | sinaru |
| <i>Cynometra polyandra</i> Roxb. | Caesalpiniaceae | 20 | c | ev | | | | 1 | Plywood, coal | | rongrip |
| <i>Delonix regia</i> (Boj.) Rafim. | Caesalpiniaceae | 29 | | cult | | | | | Avenue tree | | |
| <i>Saraca asoca</i> (Roxb.) de Wilde | Caesalpiniaceae | 15 | r | ev, rb, cult | | | | | | | Khimkol, Kimikol |
| <i>Crataeva nurvala</i> Buch.-Ham. | Capparidaceae | 30 | rare | ev | | | | | | | |
| <i>Crataeva religiosa</i> Forst. | Capparidaceae | 35 | | | | | | | | | |
| <i>Viburnum colebrookianum</i> Wall. ex DC. | Caprifoliaceae | 5 | c | | | | | | | | Bolmchok |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|-----------------|--------|---------------------|-----------------|------|----------|------|--------|-------------------------|----------------|-----------------|
| <i>Calophyllum polyanthum</i> Choisy | Clusiaceae | 15 | | pf | | | | 1 | | | Bolmindre |
| <i>Garcinia acuminata</i> Planch. & Triana | Clusiaceae | 20 | c | ev | | | | | | | |
| <i>Garcinia anomala</i> Planch. & Triana | Clusiaceae | 12 | | | | | | | | | Thechu |
| <i>Garcinia cowa</i> Roxb. ex DC. | Clusiaceae | 20 | c | ev mixed forest | | 1 | | | | Fruit elephant | Rangram |
| <i>Garcinia lancifolia</i> (G.Don) Roxb. | Clusiaceae | 10 | | ev | | | | | | | Thisra, tesaru |
| <i>Garcinia morella</i> Desr. | Clusiaceae | 15 | | ev | | | | | | | tizru |
| <i>Garcinia paniculata</i> (G.Don) Roxb. | Clusiaceae | 20 | | ev | 1 | | | | | 1 | aruwak chi |
| <i>Garcinia tinctoria</i> (DC.) W. F. Wight | Clusiaceae | 20 | c | ev | | | | | | | Arawak/Arak |
| <i>Garcinia xanthochymus</i> Hk. f. | Clusiaceae | medium | c | | | | | | | | |
| <i>Kayea floribunda</i> Wall. | Clusiaceae | 20 | c | ev | | | | 1 | bark itching | | bolong |
| <i>Mesua ferrea</i> Linn. | Clusiaceae | 40 | | ev | | | | 1 | Handles for agric. tool | | khimde/karai |
| <i>Microtropis discolor</i> (Wall.) Arn. | Clusiaceae | 15 | f | ev | | | | | | | |
| <i>Terminalia bellirica</i> (Gaertn.) Roxb. | Combretaceae | 40 | c | ev, dd | | | | | | | churi |
| <i>Terminalia chebula</i> Retz. | Combretaceae | 35 | f | | | 1 | | 1 | Tannin, agri tools | | |
| <i>Terminalia citrina</i> (Gaertn.) Flem. | Combretaceae | 30 | c | | | | | | | | artak |
| <i>Terminalia myriocarpa</i> Heurck & Muell.-Arg. | Combretaceae | 35 | c | ev | | | | | | | |
| <i>Crypteronia paniculata</i> Bl. | Crypteroniaceae | 25 | | | | | | | | | gingsep |
| <i>Dillenia indica</i> Linn. | Dilleniaceae | 25 | c | ev Riverbank | 1 | 1 | 0 | 0 | Souring agent | | agatchi/tediki |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|------------------|--------|---------------------|---------------|------|----------|------|--------|------------------------------|------------|------------------------|
| <i>Dillenia pentagyna</i> Roxb. | Dilleniaceae | 25 | c | dd | 0 | 0 | 1 | 1 | Wood-craft | Fruit | agatchi-badura |
| <i>Dillenia scabrella</i> (D. Don) Roxb. ex Wall. | Dilleniaceae | 35 | | dd | 1 | 0 | 0 | 1 | | Fruit | |
| <i>Shorea robusta</i> Gaertn. | Dipterocarpaceae | tall | c | dd | | | | 1 | | | bolsal/Borsal |
| <i>Vatica lanceaefolia</i> Bl. | Dipterocarpaceae | 10 | c | dd, riverbank | | | | | | | Khamkhor |
| <i>Diospyros kaki</i> Thumb. | Ebenaceae | 15 | f | open | | | | | | | |
| <i>Diospyros lancifolia</i> Roxb. | Ebenaceae | 15 | c | ev, rb | | | | | | | |
| <i>Diospyros malabarica</i> (Desr.) Kostel | Ebenaceae | 15 | f | | | 1 | | 1 | | | Gap |
| <i>Diospyros montana</i> Roxb. | Ebenaceae | 10 | f | sf, pf, edge | | | | | | | |
| <i>Diospyros toposia</i> Ham. | Ebenaceae | 15 | f | pf, ev | | | | | | | |
| <i>Diospyros variegata</i> Kurz | Ebenaceae | 20 | c | ev, open | | | | | | | bolgism |
| <i>Ebretia acuminata</i> R. Br. | Ehretiaceae | 20 | c | ev, open | | | | 1 | Fodder | | bolmitap |
| <i>Echinocarpus assamicus</i> Benth. | Elaeocarpaceae | 20 | c | riverbank | | | | | planks teaboxes | | Chuditro |
| <i>Elaeocarpus aristatus</i> Roxb. | Elaeocarpaceae | 40 | | | | | | | | | dura agong, gangama |
| <i>Elaeocarpus floribundus</i> Bl. | Elaeocarpaceae | 30 | | | | | | | | | |
| <i>Elaeocarpus lancifolius</i> Roxb. | Elaeocarpaceae | 15 | c | | 1 | | 1 | | Pole, tea chest, charcoal | 1 | |
| <i>Elaeocarpus rugosus</i> Roxb. | Elaeocarpaceae | 35 | c | | | | | 1 | Tea chest | | Ankisipak |
| <i>Elaeocarpus varuna</i> Ham. ex Mast. | Elaeocarpaceae | 25 | c | ev dd | | | | | | | kangma |
| <i>Alchornea tiliacifolia</i> Muell.-Arg. | Euphorbiaceae | 6 | c | Mix sal | | | | | | | |
| <i>Antidesma bunius</i> (Linn.) Spreng. | Euphorbiaceae | 15 | c | | | | | | | | |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|---------------|--------|---------------------|----------------|------|----------|------|--------|-------|------------|----------------------|
| <i>Antidesma nigricans</i> Tul. | Euphorbiaceae | S | f | bmb | | | | | | | |
| <i>Aporusa aurea</i> Hk. f. | Euphorbiaceae | 12 | f | dd,bmb | | | | | | | Chamolija |
| <i>Aporusa dioica</i> (Roxb.) Muell.-Arg. | Euphorbiaceae | 12 | c | dd,mixdd | | | | | | | Chamolija, Gasambi |
| <i>Aporusa oblonga</i> Muell.-Arg. | Euphorbiaceae | 12 | c | dd | | | | | | | |
| <i>Aporusa wallichii</i> Hk. f. | Euphorbiaceae | 20 | f | | | | | | | | Makrimangal |
| <i>Baccaurea ramiflora</i> Lour. | Euphorbiaceae | 12 | | wld, cult | 1 | | | | | | Dojka |
| <i>Bridelia monoica</i> (Lour.) Mess | Euphorbiaceae | 10 | c | dd | | | | | | | kasi dupret |
| <i>Bridelia retusa</i> (Linn.) Spreng | Euphorbiaceae | 15 | c | sal, mixdd | | | | | | | kasi |
| <i>Chaetocarpus castanocarpus</i> (Roxb.) Thw. | Euphorbiaceae | 15 | c | sandyriverbeds | | | | | | | |
| <i>Cleidion spiciflorum</i> (Burm.) Merr. | Euphorbiaceae | 20 | c | ev | | | | | | | |
| <i>Cleistanthus chartaceus</i> Muell.-Arg. | Euphorbiaceae | 10 | f | | | | | | | | |
| <i>Croton joufèra</i> Roxb. | Euphorbiaceae | M | c | dd, sal | | | | | posts | | Makeme, matmi, Matmi |
| <i>Croton roxburghii</i> Balak. | Euphorbiaceae | 15 | c | dd | | | | | | | |
| <i>Drypetes lancifolia</i> (Hk. f.) Pax et Hoffm. | Euphorbiaceae | | r | | | | | | | | |
| <i>Emblica officinalis</i> Gaertn. | Euphorbiaceae | 15 | c | sf,dd | 1 | 1 | | | | | |
| <i>Glochidion acuminatum</i> Muell.-Arg. | Euphorbiaceae | 15 | f | | | | | | | | |
| <i>Glochidion hirsutum</i> Muell.-Arg. | Euphorbiaceae | M | f | sal | | | | | | | |
| <i>Glochidion sphaerogynum</i> Kurz | Euphorbiaceae | 15 | c | sf,edge | | | | | | | boljagro |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|---------------|--------|---------------------|--------------|------|----------|------|--------|--------------------|------------|-----------------------------------|
| <i>Glochidion velutinum</i> Wt. | Euphorbiaceae | S | c | sf | | | | | | | bolchiring |
| <i>Hevea brasiliensis</i> Muell.-Arg. | Euphorbiaceae | | | plt | | | | | Rubber | | Rubber |
| <i>Macaranga denticulata</i> Muell.-Arg. | Euphorbiaceae | 20 | c | sf,jhum | | | 1 | | fodder | | bolajak, chhagro |
| <i>Macaranga indica</i> Wt. | Euphorbiaceae | 20 | f | ev | | | | | | | Reemigittal/ Chagro |
| <i>Mallotus albus</i> Muell.-Arg. | Euphorbiaceae | 15 | c | mixev | | | | | | | |
| <i>Mallotus leucocarpus</i> (Kurz) A. Shaw | Euphorbiaceae | 6 | f | ev | | | | | latex | | |
| <i>Mallotus philippinensis</i> (Lam.) Muell.-Arg. | Euphorbiaceae | 12 | o | dd | | | | | | | Shabikbol |
| <i>Mallotus roxburghianus</i> Muell.-Arg. | Euphorbiaceae | | | | | | | | | | boltatu |
| <i>Mallotus tetracoccus</i> (Roxb.) Kurz. | Euphorbiaceae | 15 | c | ev, mixev | | | | | | | Mat-hmikong |
| <i>Ostodes paniculata</i> Bl. | Euphorbiaceae | 20 | c | ev | | | | | | | Karikram/ Karikron/ Naikram, Tija |
| <i>Sapium baccatum</i> Roxb. | Euphorbiaceae | 35 | c | ev | | | | | ply | | changsim/ cherasu, bandudime |
| <i>Sapium eugeniaefolium</i> Ham. ex Hk. f. | Euphorbiaceae | 20 | | ev | | | | | | | Agong |
| <i>Trewia nudiflora</i> Linn. | Euphorbiaceae | 20 | c | dd,rb | | | | | | | Bolbok, bolkha |
| <i>Butea monosperma</i> (Lamk.) Ktz. | Fabaceae | | r | dd, sf, open | | | | | | | |
| <i>Dalbergia stipulacea</i> Roxb. | Fabaceae | 10 | c | sal | | | | | | | |
| <i>Derris robusta</i> (Roxb. ex DC.) Benth. | Fabaceae | 12 | c | ev, dd | | | | 1 | Agri tools, Fodder | | bolkakharu |
| <i>Erythrina stricta</i> Roxb. | Fabaceae | 30 | c | dd | | | | | | | Mandal |

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|--|----------------|--------|---------------------|--------------|------|----------|------|--------|-------|------------|--------------------------|
| <i>Erythrina suberosa</i> Roxb. | Fabaceae | | | | | | | | | | |
| <i>Milletia pycnidia</i> Wt. | Fabaceae | 15 | c | | | | | | | | Ruaning/ Nachimakal |
| <i>Castanopsis armata</i> Spach. | Fagaceae | M | c | ev,edges | | | | | | | |
| <i>Castanopsis indica</i> A. DC. | Fagaceae | L | c | ev | | | | | | | Chacko, chackochi |
| <i>Castanopsis kurzii</i> (Hance) Biswas | Fagaceae | | | | | | | | | | |
| <i>Castanopsis purpurella</i> (Miq.) Balak. | Fagaceae | L | c | ev,stream | | | | | | | chako |
| <i>Castanopsis tribuloides</i> (Sm.) DC. | Fagaceae | 30 | c | ev,stream | | | | | | | |
| <i>Lithocarpus elegans</i> (Bl.) Hatus ex Soep. | Fagaceae | L | c | lower elevtn | | | | | | | bolsimok |
| <i>Casearia glomerata</i> Roxb. | Flacourtiaceae | 20 | | mixev | | | | | | | Bolmithap/ Mangchotra |
| <i>Casearia kurzii</i> Cl. | Flacourtiaceae | 25 | f | ev | | | | | | Bird-fruit | |
| <i>Casearia zeylanica</i> (Gaert.) Thw. | Flacourtiaceae | 25 | | | | | | | | | Boldhijong |
| <i>Gynocardia odorata</i> R. Br. | Flacourtiaceae | 20 | c | ev,mixev | | | | | | | Bolibu |
| <i>Homalium bhamoense</i> Cubit et Sm. | Flacourtiaceae | | r | lower elevtn | | | | | | | |
| <i>Homalium schlichii</i> Kurz | Flacourtiaceae | 25 | r | | | | | | | | |
| <i>Xylosma controversum</i> Clos. | Flacourtiaceae | 10 | | sf | | | | | | | Darumek |
| <i>Xylosma longifolium</i> Clos. | Flacourtiaceae | 10 | | | | | | | | | palwang |
| <i>Exbucklandia populnea</i> (R. Br. ex Griff) | Hamamelidaceae | L | c | | | | | | | | |
| <i>Engelhardtia roxburghiana</i> Wall. | Juglandaceae | L | r | lower elevtn | | | | | | | Wakkil |
| <i>Engelhardtia spicata</i> Leschn. ex Bl. | Juglandaceae | | | | | | | | | | Wakri |

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|--|--------------|--------|---------------------|--------------------|------|----------|------|--------|---------------------|------------|---|
| <i>Engelhardtia spicata</i> var. <i>colebrookeana</i> (Wall.) Kds. & Val. Bijdr. | Juglandaceae | 35 | c | | | | | | | | |
| <i>Engelhardtia spicata</i> var. <i>spicata</i> | Juglandaceae | | | | | | | | | | |
| <i>Actinodaphne augustifolia</i> Nees | Lauraceae | 20 | c | | | | | | | | boljalik |
| <i>Actinodaphne obovata</i> (Nees) Bl. | Lauraceae | L | c | moistshady, ev | | | | | | | Dodi-kamchong, Boljalek, Boljalek jakme |
| <i>Beilschmiedia fagifolia</i> Nees | Lauraceae | 10 | r | ev | | | | | | | |
| <i>Beilschmiedia roxburghiana</i> Nees | Lauraceae | 10 | c | streambank | | | | | | | |
| <i>Cinnamomum bejolghota</i> (Buch.-Ham.) Sweet. | Lauraceae | 25 | c | ev, mixdd, streams | | | | | | | teta bebipa |
| <i>Cinnamomum glanduliferum</i> (Wall.) Meissn. | Lauraceae | 25 | c | | | | | | | | |
| <i>Cinnamomum glaucescens</i> (Nees) Meissn. | Lauraceae | L | c | | | | | 1 | | | dalchini, gansari |
| <i>Cinnamomum tamala</i> Fr. Nees | Lauraceae | 15 | c | sf, cult, | | | | | culinary-oil, spice | | Tejpata |
| <i>Cryptocarya amygdalina</i> Nees | Lauraceae | 20 | c | sal | | | | | | | |
| <i>Cryptocarya andersonii</i> King ex Hk. f. | Lauraceae | 25 | r | | | | | | | | bolong bolanchi/bolj adong/boldujong |
| <i>Lindera melastomacea</i> Benth. | Lauraceae | 10 | c | | | | | | | | |
| <i>Lindera nacusua</i> (D. Don) Merr. | Lauraceae | 8 | f | | | | | | | | |
| <i>Lindera pulcherrima</i> (Nees) Benth. | Lauraceae | 15 | c | | | | | | | | |
| <i>Litsea cubeba</i> (Lour.) Pers. | Lauraceae | 15 | c | sf | | | | | Odomos mos- | | Chengjil |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|--|-----------|--------|---------------------|-------------|------|----------|------|--------|-----------------------|------------|---------------------|
| | | | | | | | | | quitoe repellent | | |
| <i>Litsea glutinosa</i> | Lauraceae | | | | | | | | | | bolbet |
| <i>Litsea lancifolia</i> (Roxb. ex Nees) Wall. ex Hk. f. | Lauraceae | 8 | f | ev | | | | | | | |
| <i>Litsea meisneri</i> Hk. f. | Lauraceae | M | f | ev | | | | | | | |
| <i>Litsea monopelata</i> (Roxb.) Pers. | Lauraceae | | f | plt | | | | | Muga silkworm rearing | | bolbet |
| <i>Litsea salicifolia</i> (Roxb. ex Nees) Hk. f. | Lauraceae | 8 | c | | | | | | | | Chengjil |
| <i>Litsea sebifera</i> Pers. | Lauraceae | M | c | ev | | | | | | | Boldukaki |
| <i>Litsea tomentosa</i> Nees | Lauraceae | | | | | | | | | | Machurisphal |
| <i>Neocinnamomum caudatum</i> (Wall. ex Nees) Merr. | Lauraceae | 10 | f | | | | | | | | chammejam, samejang |
| <i>Neolitsea umbrosa</i> (Nees) Gamble | Lauraceae | M | | | | | | | | | Jinggil |
| <i>Persea odoratissima</i> (Nees) Koster. | Lauraceae | 15 | c | | | | | | | | |
| <i>Persea petiolaris</i> (Hk. f.) Deb. | Lauraceae | 25 | f | | | | | | | | |
| <i>Persea villosa</i> (Roxb.) Koster. | Lauraceae | 25 | c | ev,sf,mixdd | | 1 | | | | | Namiaga |
| <i>Phoebe attenuata</i> (Nees) Nees | Lauraceae | 25 | c | ev | | | | 1 | | | Pantakhas |
| <i>Phoebe cooperiana</i> U. N. Kanjilal | Lauraceae | 25 | r | dd | | | | | | | |
| <i>Phoebe goalparensis</i> | Lauraceae | | | | | | | 1 | planks | | Bolsudipet |
| <i>Phoebe lanceolata</i> (Nees) Nees | Lauraceae | 10 | c | ev,rb | | | | | | | |
| <i>Phoebe paniculata</i> Nees | Lauraceae | 20 | r | | | | | | | | |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|-----------------|--------|---------------------|------------------|------|----------|------|--------|--------------------|------------|----------------------------------|
| <i>Leea compactiflora</i> Kurz | Leeaceae | S | c | ev | | | | | | | |
| <i>Leea edgeworthii</i> Sant. | Leeaceae | S | c | dd, waste, mixev | | | | | | | |
| <i>Leea indica</i> (Burm. f.) Merr. | Leeaceae | S | c | dd,sf,edge | | | | | | | |
| <i>Fagraea ceilanica</i> Thumb. | Loganiaceae | 10 | r | dd | | | | | | | |
| <i>Lagerstroemia parviflora</i> Roxb. | Lythraceae | 35 | c | dd, mixdd | | | | | | | sidai |
| <i>Lagerstroemia speciosa</i> (Linn.) Pers. | Lythraceae | 15 | c | rb, edge, cult | | | | | | | Jalai/ Ajakari, bolasari |
| <i>Magnolia pterocarpa</i> Roxb. | Magnoliaceae | 15 | c | ev | | | | | | | |
| <i>Manglietia insignis</i> (Wall.) Bl. | Magnoliaceae | 20 | c | ev | | | | | | | dodikimsong |
| <i>Michelia champaca</i> Linn. | Magnoliaceae | 25 | c | ev | 0 | 0 | 0 | 1 | Flower fragrent | | champa |
| <i>Michelia doltsopa</i> DC. | Magnoliaceae | 20 | c | ev | | | | | | | |
| <i>Michelia oblonga</i> Wall. ex Hk. f. | Magnoliaceae | 40 | c | ev | | | | | | | Bewa-champe |
| <i>Talauma hodgsonii</i> Hk. f. & Th. | Magnoliaceae | 25 | | | | | | | | | |
| <i>Hibiscus macrophyllus</i> Roxb. ex Hornem. | Malvaceae | 25 | | ev dd | | | | | | | Mao/ Mao-Marli |
| <i>Kydia calycina</i> Roxb. | Malvaceae | 15 | c | | | | 1 | | Bark-Cordage Match | | boldubok |
| <i>Memecylon cerasiforme</i> Kurz | Melastomataceae | 15 | f | stream | | | | | | | |
| <i>Aglaia edulis</i> A. Gray | Meliaceae | L | c | ev | | | | | | | |
| <i>Aphanamixis polystachya</i> (Wall.) Parker | Meliaceae | 15 | c | ev | | | | | | | Matchurispil, Bolapal, bolsampal |
| <i>Aphanamixis wallichii</i> (King.) Haridasan et Rao | Meliaceae | 25 | c | ev | | | | 1 | Plancks | | |

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|--|------------|--------|---------------------|--------------|------|----------|------|--------|---------------------------|------------|------------------------|
| <i>Chikrassia tabularis</i> Anbr. Juss. | Meliaceae | 55 | | ev | | | | | | | Bolma |
| <i>Chisocheton paniculatus</i> (Roxb.) Hiern. | Meliaceae | 20 | c | ev, dd | | | | | | | Atur sphal, damni bol |
| <i>Dysoxylum alliarium</i> (Ham.) Balak. | Meliaceae | 25 | | | | | | | | | bolasin |
| <i>Dysoxylum binectariferum</i> Hk. f. et. Bedd. | Meliaceae | 30 | c | | | | | | | | Sambal |
| <i>Dysoxylum gobara</i> (Buch.-Ham.) Merr. | Meliaceae | 25 | c | ev | | | | 1 | Plancks | | |
| <i>Melia azedarach</i> Linn. | Meliaceae | medium | | cultiv | | | | | Avenue, shade tree | | |
| <i>Toona ciliata</i> Roem. | Meliaceae | 40 | c | dd, mixdd | | | | | | | bolbret |
| <i>Walsura robusta</i> Roxb. | Meliaceae | | c | ev, edge | | | | | | | khrenti/kranchi |
| <i>Walsura tubulata</i> Hiern | Meliaceae | 15 | r | | | | | | | | bolkingrak |
| <i>Acacia auriculiformis</i> A. Cuno. ex Benth. | Mimosaceae | | | | | | | | | | ikakshi |
| <i>Albizia chinensis</i> (Osbeck) Merr. | Mimosaceae | 25 | | | | | | | | | Bolpha, bolphu, bolapu |
| <i>Albizia lebbek</i> (Linn.) Benth. | Mimosaceae | L | f | dd, open | | | | 1 | | | shishu |
| <i>Albizia lucidior</i> (Stend.) Neilson ex Hara | Mimosaceae | 20 | c | ev,dd,rb | | | 1 | | Poles, support | | |
| <i>Albizia mollis</i> Boiv. | Mimosaceae | 20 | c | | | | | | | | |
| <i>Albizia odoratissima</i> (Linn. f.) Benth. | Mimosaceae | 25 | c | dd | | | | | | | khilbe |
| <i>Albizia procera</i> (Roxb.) Benth. | Mimosaceae | 25 | c | dd, sf, open | | | 1 | | Post, pillars, Agri tools | | |
| <i>Calliandra umbrosa</i> (Wall.) Benth. | Mimosaceae | 10 | c | sf | | | | | | | |
| <i>Parkia roxburghii</i> G. Don | Mimosaceae | | r | dd, mixev | | | | | Avenue tree | | |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|------------|--------|---------------------|----------------|------|----------|------|--------|---------------|------------|---------------------|
| <i>Pithecellobium heterophyllum</i> (Roxb.) Haridasan & Rao | Mimosaceae | 15 | c | dd, sf | | | | | | | bolmangal/mangal |
| <i>Pithecellobium monadelphum</i> (Roxb.) Koster. | Mimosaceae | M | f | ev, edge | | | | | | | Bolmangal, Bol-daru |
| <i>Artocarpus chaplasha</i> Roxb. | Moraceae | 50 | | | l | | | l | | | bolsrem/chrum |
| <i>Artocarpus gomezianus</i> ssp. <i>Gomezianus</i> Wall. ex Trecul | Moraceae | 35 | | | | | | | | | armu/arimu |
| <i>Artocarpus gomezianus</i> ssp. <i>zeylanicus</i> Wall. ex Trecul | Moraceae | | r | dd | l | | | l | | | Armu |
| <i>Artocarpus heterophyllum</i> Lamk. | Moraceae | L | o | cult,wild | l | | | | | | Schrumjakpa |
| <i>Broussonetia papyrifera</i> Vent | Moraceae | M | r | cult | | | | | | | |
| <i>Ficus altissima</i> Bl. | Moraceae | L | r | open area | | | | | | roosting | roost tree |
| <i>Ficus benghalensis</i> Linn. | Moraceae | L | f | bmb, others | | | | | Fodder, shade | | |
| <i>Ficus benjamina</i> Linn. | Moraceae | | r | cult | | | | | | | |
| <i>Ficus cyrtophylla</i> Wall. ex Miq. | Moraceae | 20 | c | ev | | | | | | | Sakap |
| <i>Ficus drupacea</i> Thumb. | Moraceae | L | f | ev | | | | | | | |
| <i>Ficus elastica</i> Roxb. ex Hornem. | Moraceae | L | f | ev, rb | | | | | | | |
| <i>Ficus fistulosa</i> Reinwtdt. | Moraceae | 10 | f | dd, streambank | | | | | | | |
| <i>Ficus gibbosa</i> Bl. | Moraceae | M | f | | | | | | | | |
| <i>Ficus glaberrima</i> Bl. | Moraceae | 25 | f | dd | | | | | | | |
| <i>Ficus heterophylla</i> Linn. f. | Moraceae | S | f | rb | | | | | | | Sakhap |
| <i>Ficus hirta</i> Vahl | Moraceae | S | c | stream, bmb | | | | | | | |
| <i>Ficus hispida</i> Linn. f. | Moraceae | S | c | stream | | | | | | | Sakhap, Sakhap, |

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|---|-------------|--------|---------------------|-------------------|------|----------|------|--------|------------------------------------|------------|-----------------|
| | | | | | | | | | | | Sakapap |
| <i>Ficus infectoria</i> Roxb. | Moraceae | M | f | | | | | | | | Sewla |
| <i>Ficus ischnopoda</i> Miq. | Moraceae | S | c | river, rocky area | | | | | | | |
| <i>Ficus lamponga</i> Miq. | Moraceae | 20 | f | dd, mixdd | | | | | | | bolmitap |
| <i>Ficus nervifolia</i> J. E. Sm. Var. <i>Trilepis</i> (King) Corn. | Moraceae | 20 | c | subtropical | | | | | | | |
| <i>Ficus nervosa</i> Heyne ex Roth | Moraceae | | c | ev | | | | | | | |
| <i>Ficus oligodon</i> Miq. | Moraceae | 12 | r | sev | | | | | | | |
| <i>Ficus religiosa</i> Linn. | Moraceae | L | o | planted | | | | | | | |
| <i>Ficus rumphii</i> Bl. | Moraceae | L | f | lower elevtn. | | | | | | | |
| <i>Ficus semicordata</i> | Moraceae | | | | | | | | | | aminsep |
| <i>Morus australis</i> Poir. | Moraceae | 10 | | cult, wild | | | | | silkworm | | |
| <i>Morus macroura</i> Miq. | Moraceae | 30 | c | dd, mix, cult | | | | | | | |
| <i>Streblus asper</i> Lour. | Moraceae | S | r | dry | | | | | | | Chewla, Sewla |
| <i>Streblus zeylanicus</i> Kurz | Moraceae | | | | | | | | | | |
| <i>Moringa oleifera</i> Lamk. | Moringaceae | M | c | cultiv, wild | 1 | | | | Gum, hedge poles, fodder, wrapping | | |
| <i>Ardisia colorata</i> Roxb. | Myrsinaceae | 10 | r | ev | | | | | | | Bolchimbai |
| <i>Ardisia floribunda</i> Wall. | Myrsinaceae | L/S | f | rb, edge | | | | | | | |
| <i>Ardisia paniculata</i> Roxb. | Myrsinaceae | 4 | o | dd, mixev | | | | | | | |

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|--|-------------|--------|---------------------|------------|------|----------|------|--------|-----------------|------------|-------------------------------|
| <i>Ardisia virens</i> Kurz | Myrsinaceae | S | f | ev, stream | | | | | | | |
| <i>Maesa indica</i> (Roxb.) Wall. | Myrsinaceae | 10 | c | shady | | | | | | | Bolakhatok |
| <i>Maesa ramentacea</i> Wall. | Myrsinaceae | 10 | c | sf, edge | | | | | Orna- mental | | |
| <i>Cleistocalyx operculatus</i> (Roxb.) Merr. & Perr. | Myrtaceae | 35 | c | dd, mixev | | | | | | | |
| <i>Eucalyptus tereticornis</i> Sm. | Myrtaceae | 40 | | cult | | 1 | | | | | |
| <i>Psidium guajava</i> Linn. | Myrtaceae | 10 | | cult | 1 | | | | | | |
| <i>Syzygium balsameum</i> (Wt.) Wall. ex AM. & SM. Cowan | Myrtaceae | 10 | f | edge, rb | | | | | | | Tebrong |
| <i>Syzygium cumini</i> (Linn.) Skeels | Myrtaceae | 35 | c | | 1 | | | | | | Cham- buisam |
| <i>Syzygium formosum</i> (Wall.) Mas. | Myrtaceae | 15 | f | ev, | | | | | | | Jambuisam, Cham- buisam |
| <i>Syzygium grandis</i> (Wt.) Wala. | Myrtaceae | 30 | r | | | | | | | | |
| <i>Syzygium kurzii</i> (Duthie) Balak. | Myrtaceae | 35 | c | ev, sev | | | | | | | |
| <i>Syzygium operculatum</i> (Roxb.) Wall | Myrtaceae | | | | | | | | | | chambu sirsang |
| <i>Syzygium polypetalum</i> (Wall. ex Wt.) Merr. & Perr. | Myrtaceae | M | f | rb | | | | | | | |
| <i>Syzygium praecoxum</i> (Roxb.) Haridasan et R. R. Rao | Myrtaceae | 35 | c | dd, mixdd | 1 | | 1 | | | | |
| <i>Syzygium ramosissimum</i> (Wall. ex Duthie) Balak. | Myrtaceae | 20 | c | ev | | | | | | | |
| <i>Syzygium sizigioides</i> (Miq.) Merr. & Perr. | Myrtaceae | 35 | c | | | | | | | | chambi |
| <i>Syzygium tetragonum</i> (Wt.) Kurz | Myrtaceae | 25 | c | | | | | | | | |
| <i>Ochna integerrima</i> (Lour.) Merr. | Ochnaceae | 10 | r | | | | | | Avenue tree | | bambi |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|----------------|--------|---------------------|--------------|------|----------|------|--------|-------|------------|-----------------------|
| <i>Chionanthus macrophylla</i> Bl. | Oleaceae | 25 | c | ev | | | | | | | |
| <i>Ligustrum indicum</i> (Lour.) Merr. | Oleaceae | 15 | f | ev, edge | | | | | | | |
| <i>Ligustrum robustum</i> (Roxb.) Bl. | Oleaceae | 15 | c | | | | | | | | bolgreng |
| <i>Olea dentata</i> Wall. ex DC. | Oleaceae | 20 | c | ev, mixev | | | | | | | |
| <i>Olea dioica</i> Roxb. | Oleaceae | 10 | f | ev | | | | | | | |
| <i>Pandanus foetidus</i> Roxb. | Pandanaceae | | | | | | | | | | |
| <i>Pandanus odoratissimus</i> (Lamk.) Linn. | Pandanaceae | | | | | | | | | | Mema anarus |
| <i>Pittosporum nepaulense</i> (DC.) Rehd. & Wils. | Pittosporaceae | 15 | c | | | | | | | | |
| <i>Podocarpus latifolia</i> Wall. | Podocarpaceae | L | | | | | | | | | Wam |
| <i>Podocarpus neerifolia</i> D. Don | Podocarpaceae | 20 | | | | | | 1 | | | durama shillongkit |
| <i>Xanthophyllum flavescens</i> Roxb. | Polygalaceae | 40 | rare | ev | | | | 1 | | | RARE |
| <i>Grevillea robusta</i> A. Cunn. | Proteaceae | L | | cult | 1 | | | | | | |
| <i>Helicia excelsa</i> Bl. | Proteaceae | M | r | | | | | | | | |
| <i>Helicia nilagirica</i> Bedd. | Proteaceae | 12 | | | | | | | | | |
| <i>Helicia robusta</i> Wall ex Benn. | Proteaceae | 15 | f | | | | | | | | |
| <i>Rhamnus nepalensis</i> (Wall.) Laws. | Rhamnaceae | S | | sf,open | | | | | | Birds | |
| <i>Zizyphus rugosa</i> Lamk. | Rhamnaceae | 10 | c | open | | | | | | | Unki/Tesenki Ankat |
| <i>Carallia brachiata</i> (Lour.) Merr. | Rhizophoraceae | 15 | c | ev, rb, edge | 1 | | | 1 | | | Suksunaring |
| <i>Eriobotrya bengalensis</i> Hk. f. | Rosaceae | 25 | f | ev | | | | 1 | | | |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|-----------|--------|---------------------|------------------|------|----------|------|--------|--------------------|------------|-----------------|
| <i>Anthocephalus chinensis</i> (Lam.) A. Rich. ex Walp. | Rubiaceae | 35 | c | | | | | | Match, plancks | | kadam |
| <i>Canthium dicoccum</i> (Gaert.) T. & T. | Rubiaceae | 20 | f | ev | | | | | | | |
| <i>Canthium glabrum</i> Bl. | Rubiaceae | 20 | r | dd | | | | | | | |
| <i>Catunaregam spinosa</i> (Thumb.) Tiruv | Rubiaceae | | | | | | | | | | Burma bushu |
| <i>Catunaregam uliginosa</i> (Retz.) Siv. | Rubiaceae | | | | | | | | | | Agrenda/agreng |
| <i>Cinchona ledgeriana</i> Moons. ex Trim. | Rubiaceae | 10 | | cult | | 1 | | | | | |
| <i>Gardenia campanulata</i> Roxb. | Rubiaceae | 8 | r | | 1 | | | | | | Rangak |
| <i>Haldina cordifolia</i> | Rubiaceae | 35 | r | | | | | | | | sandang |
| <i>Hymenodictyon flaccidum</i> Wall. | Rubiaceae | 30 | f | ev, mixdd, rocky | | | | | fodder | | |
| <i>Hymenodictyon excelsum</i> Wall. | Rubiaceae | 30 | f | | | | | | | | |
| <i>Hyptianthera stricta</i> (Willd.) W. & A. | Rubiaceae | 10 | c | ev | | | | | | | |
| <i>Ixora undulata</i> Roxb. | Rubiaceae | 10 | c | | | | | | | | |
| <i>Mitragyna rotundifolia</i> (Roxb.) O. Ktz. | Rubiaceae | 15 | f | | | | | | | | |
| <i>Naucllea griffithii</i> Hav. | Rubiaceae | 35 | f | ev | | | | | | | |
| <i>Pavetta indica</i> Linn. | Rubiaceae | 8 | c | ev | | | | | Orna-mental | | |
| <i>Prismatomeris tetrandra</i> (Roxb.) K. Schum. | Rubiaceae | 5 | c | ev | | 1 | | | Horticulture plant | | |
| <i>Randia griffithii</i> Hk. f. | Rubiaceae | 8 | o | edge | | | | | | | Bnp |
| <i>Randia wallichii</i> Hk. f. | Rubiaceae | 25 | f | ev | | | | | | | Rubiaceae |
| <i>Saprosma ternatum</i> Hk. f. | Rubiaceae | 12 | c | ev, dd, bmb | | | | | | | Durapasim |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|-----------|--------|---------------------|----------|------|----------|------|--------|-------------|------------|--|
| <i>Tarenna asiatica</i> (Linn.) Sant. & Merch. | Rubiaceae | 5 | f | | | | | | | | Rubiaceae |
| <i>Tricalysia singularis</i> K. Schum. | Rubiaceae | 30 | c | mixdd | | | | | | | Boljakong |
| <i>Wendlandia glabrata</i> DC. | Rubiaceae | S | f | | | | | | | | |
| <i>Wendlandia grandis</i> Cowan | Rubiaceae | 15 | c | ev, sf | | | | | | | Bolbrak |
| <i>Wendlandia paniculata</i> DC. | Rubiaceae | 3 | f | gorges | | | | | | | Rubiaceae |
| <i>Wendlandia tinctoria</i> (Roxb.) DC. | Rubiaceae | 6 | c | sf, edge | | | | | | | Garadak |
| <i>Xeromphis spinosa</i> (Thunb.) Keay | Rubiaceae | S | f | sf, edge | | | | | Fish poison | | Burma bushu |
| <i>Acronychia pedunculata</i> (Linn.) Miq. | Rutaceae | | | | | | | | | | Bolmapa/ agon/ pantabol/ bolgreng/ bolmapa |
| <i>Aegle marmelos</i> (Linn.) Correa | Rutaceae | large | rare | cultiv | | | | | | | |
| <i>Atalantia monophylla</i> Corr. | Rutaceae | small | | | | | | | | | |
| <i>Citrus medica</i> Linn. | Rutaceae | | | | | | | | | | |
| <i>Evodia glabrifolia</i> Champ. | Rutaceae | 25 | | | | | | | | | |
| <i>Glycosmis arborea</i> (Roxb.) DC. | Rutaceae | 5 | | | | | | | | | sampal |
| <i>Glycosmis cymosa</i> (Kurz.) Narayanswamy | Rutaceae | | | | | | | | | | |
| <i>Micromelem integerrimum</i> (Roxb.) Wt. & Arn. | Rutaceae | small | | | | 1 | | | | | |
| <i>Murraya paniculata</i> (Linn.) Jack. | Rutaceae | small | | | | | | | | | Mukaka-mprat |
| <i>Zanthoxylum hamiltonianum</i> Wall. | Rutaceae | L | | | | | | | Fish poison | | Didiplok |
| <i>Zanthoxylum rhetsa</i> (Roxb.) DC. | Rutaceae | 30 | | ev, | | | | | | | bolmicheng |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|--|----------------|--------|---------------------|--------------------|------|----------|------|--------|----------------------------|------------|-----------------------------|
| <i>Meliosma arnottiana</i> (Wt.) Walp | Sabiaceae | 15 | r | | | | | | | | |
| <i>Meliosma simplicifolia</i> (Roxb.) Walp | Sabiaceae | 15 | c | ev, sf | | | | | | | |
| <i>Aesculus assamica</i> Griff. | Sapindaceae | M | c | dd, rb | | | | | | | Rewok, bol- r ibu, renot |
| <i>Aphania rubra</i> (Roxb.) Radlk. | Sapindaceae | 8 | | mixev, rivulets | 1 | | | | Tools, Walking stick | | |
| <i>Dimocarpus longan</i> Lour. | Sapindaceae | M | | | | | | | | | Samfalbol |
| <i>Lepisanthes rubiginosa</i> (Roxb.) Leenb. | Sapindaceae | | o | | 1 | | | | | | gawigran |
| <i>Palaquium polyanthum</i> (Wall. ex DC.) Engl. | Sapotaceae | 20 | r | | | | | | | | solwa |
| <i>Sarcosperma arboreum</i> Cl. | Sapotaceae | 25 | c | ev, | | | | 1 | | | |
| <i>Saurauia cerea</i> Griff. ex Dyer. | Saurauiaceae | 15 | | | | | | | | | |
| <i>Saurauia nepaulensis</i> DC. | Saurauiaceae | 10 | | sf, edge | 1 | | | | | | Adambak |
| <i>Saurauia panduana</i> Wall. | Saurauiaceae | 10 | | | | | | | | | Dingsning |
| <i>Saurauia roxburghii</i> Wall. | Saurauiaceae | 12 | | edge, dsiturbed | | | | | | | |
| <i>Ailanthus excelsa</i> Roxb. | Simaroubaceae | | | Pltd | | | | | | | |
| <i>Ailanthus integrifolia</i> Lamk. | Simaroubaceae | 50 | | ev | | | | | | | chandana |
| <i>Picrasma javanica</i> Bl. | Simaroubaceae | 20 | c | ev | | 1 | | | | | |
| <i>Duabanga grandiflora</i> (Roxb. ex DC.) Walp. | Sonneratiaceae | 30 | c | rb | | | | | Plywood | | Achim, Bolchhim |
| <i>Turpinia nepalensis</i> Wall. ex W. & A. | Staphyliaceae | S | f | ev | | | | | | | |
| <i>Turpinia pomifera</i> (Roxb.) DC. | Staphyliaceae | 20 | c | | | | | | | | |
| <i>Firmiana colorata</i> (Roxb.) R. Br. | Sterculiaceae | 50 | c | dd | | | | | | | Bokta/ Wagam |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|---------------|--------|---------------------|--------------|------|----------|------|--------|------------------------|------------|-------------------------------------|
| <i>Heritiera acuminata</i> Wall. | Sterculiaceae | medium | | | | | | | | | |
| <i>Pterospermum acerifolium</i> Willd. | Sterculiaceae | 40 | c | dd | | | | 1 | planks tea-chest match | | adingok, aisa |
| <i>Pterospermum lancifolium</i> DC. | Sterculiaceae | 20 | | ev dd | | | | | | | Laisa, Gakkilwatriu, adambit, laisa |
| <i>Pterygota alata</i> (Roxb.) R. Br. | Sterculiaceae | 100 | rare | | 1 | | | 1 | Bark-Cordage | | Charupak/Mi-bol |
| <i>Sterculia colorata</i> Roxb. | Sterculiaceae | 15 | | | | | | | | | senksu/waljem |
| <i>Sterculia hamiltonii</i> (O. Ktze.) Adelb. | Sterculiaceae | small | | ev | | | | | | | Dombokgiri |
| <i>Sterculia villosa</i> Roxb. | Sterculiaceae | lofty | c | dd | 1 | | 1 | | Ply Rope | | Olmak/Uderi/Umale |
| <i>Styrax serrulatum</i> Roxb. | Styracaceae | 15 | c | sf, edge | | | | | | | |
| <i>Symplocos javanica</i> (Bl.) Kurz | Symplocaceae | 15 | f | ev, rb | | | | | | | |
| <i>Symplocos laurina</i> (Retz.) Wall. ex Rehd. & Wils. | Symplocaceae | 15 | c | ev, dd, edge | | | | | | | |
| <i>Symplocos lucida</i> (Thumb.) S. & Z. | Symplocaceae | 20 | c | pf | | | | | | | |
| <i>Symplocos racemosa</i> Roxb. | Symplocaceae | 15 | c | ev, edge | | | | | | | bolsudupet, bolimitap |
| <i>Symplocos sumuntia</i> Buch.-Ham. ex D. Don | Symplocaceae | 15 | f | dd, sal | | | | | | | duragong |
| <i>Cephalotaxus griffithii</i> Hk. f. | Taxaceae | M | | | | | | | | | shillongkit |
| <i>Tetrameles nudiflora</i> R. Br. | Tetramelaceae | 50 | | open,dd | | | | | Match | | Merakhas, awek, bolbok |
| <i>Eurya acuminata</i> DC. | Theaceae | small | c | ev dd | | | 1 | | | | Chamisi |
| <i>Schima khasiana</i> Dyer. | Theaceae | 20 | | | | | | | | | |
| <i>Schima wallichii</i> (DC) Korth. | Theaceae | 50 | | | | | | | Ply | | boldak |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|--|--------------|--------|---------------------|-------------------|------|----------|------|--------|--------------------------------------|------------|----------------------------------|
| <i>Aquilaria malaccensis</i> Lamk. | Thymeliaceae | 25 | f | ev | | | | | Aloe or eagle wood, wood for incense | | Agalbol |
| <i>Grewia disperma</i> Roth. | Tiliaceae | 15 | c | ev | | | | | | | bolmengo |
| <i>Grewia elastica</i> Royle | Tiliaceae | 30 | c | dd | | | | | | | Borkhentor |
| <i>Grewia microcos</i> Linn. | Tiliaceae | 15 | c | dd | | | | | | | Bolsubret/ Bolchibin |
| <i>Grewia multiflora</i> Juss. | Tiliaceae | small | | | | | | | | | |
| <i>Celtis tetrandia</i> Roxb. | Ulmaceae | 30 | f | dd | | | | | | | bolgitchak |
| <i>Celtis timorensis</i> Spanogb. | Ulmaceae | 30 | c | ev | | | | | | | |
| <i>Holoptelea integrifolia</i> (Roxb.) Planch. | Ulmaceae | | r | | | | | | | | |
| <i>Trema orientalis</i> (Linn.) Bl. | Ulmaceae | 10 | f | open, edge | | | | | | | Bhukran/Pakram |
| <i>Ulmus lanceifolia</i> Roxb. | Ulmaceae | 30 | r | | | | | | | | wakru/bolsue |
| <i>Boehmeria hamiltoniana</i> Wedd. | Urticaceae | | | waterfall-courses | | | | | | | Andhampuri |
| <i>Boehmeria macrophylla</i> D. Don | Urticaceae | | | | | | | | | | |
| <i>Debregeasia longifolia</i> (Burm. f.) Wedd. | Urticaceae | S | c | ev, edges | | | | | | | Andhampuri |
| <i>Debregeasia wallichiana</i> (Wedd.) Wedd. | Urticaceae | | f | ev | | | | | | | |
| <i>Oreocnide frutescens</i> (Thunb.) Miq. | Urticaceae | | c | higher elevtn | | | | | | | |
| <i>Oreocnide integrifolia</i> (Gaud.) Miq. | Urticaceae | | c | lower elevtn | | | | | | | Kilkra, Dingsing |
| <i>Sarcochlamys pulcherrima</i> Gaud. | Urticaceae | S | c | ev | | | | | | | |
| <i>Callicarpa arborea</i> Roxb. | Verbenaceae | 15 | c | sf, dd | | | | | | | Makhanche, Kimbil, Makanji |

| Scientific name | Family | Ht (m) | Conservation status | Habitat | Food | Medicine | Fuel | Timber | Other | Animal use | Vernacular name |
|---|-------------|--------|---------------------|------------|------|----------|------|--------|-------|------------|-------------------------|
| <i>Callicarpa vestita</i> Wall. ex Cl. | Verbenaceae | 15 | o | sf | | | | | | | |
| <i>Gmelina arborea</i> Roxb. | Verbenaceae | 30 | c | dd, sf | 1 | | | 1 | | | bolgipok, gambari |
| <i>Premna barbata</i> Wall. ex Sch. | Verbenaceae | 20 | f | | | | | | | | |
| <i>Premna bengalensis</i> Cl. | Verbenaceae | 20 | f | dd, stream | | | | | | | |
| <i>Premna bracteata</i> Wall. ex Cl. | Verbenaceae | 10 | r | ev | | | | | | | Wakmibol |
| <i>Premna latifolia</i> Roxb. | Verbenaceae | 15 | c | ev, dd | | | | | | | dokimi |
| <i>Premna mucronata</i> Roxb. | Verbenaceae | 15 | c | dd, ev | | | | | | | |
| <i>Premna racemosa</i> Wall. ex Sch. | Verbenaceae | 8 | | ev | | | | | | | |
| <i>Tectona grandis</i> Linn. f. | Verbenaceae | 30 | | pltd | | | | 1 | | | segun/teak |
| <i>Vitex altissima</i> Linn. f. | Verbenaceae | 40 | f | dd | | | | | | | |
| <i>Vitex glabrata</i> R. Br. | Verbenaceae | 25 | c | dd, open | | | | 1 | | | Bandukri |
| <i>Vitex negundo</i> Linn. | Verbenaceae | 10 | f | cult | | 1 | | | Hedge | | |
| <i>Vitex peduncularis</i> Wall. ex Sch. | Verbenaceae | 35 | c | dd, sf | | | | 1 | pole | | Trangri, Rangri, Ramgri |
| <i>Vitex pinnata</i> Linn. | Verbenaceae | 35 | c | dd, mixdd | | | | | | | bhodia |

Annexure 10: Inventory of Shrubs, herbs, climbers, Bamboo and Canes

(C= Climber, F=Fern, G=Grass, H=Herbs, S= Shrub, SB=Bamboo and SC= Cane, BNP= Balpakram NP, NNP, Nokrek NP, S= Siju area, B & BAG= Baghmara area, TP= Tura peak area, A=Angiosperm, GM=Gymnosperm)

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|----------------|-------|------|--|--|
| <i>Abrus precatorius L.</i> | Fabaceae | C | A | NNP,S,TP | kitma/sabong |
| <i>Acacia caesia (L.) Willd.</i> | Mimosaceae | C | A | BAG, BNP | |
| <i>Acacia oxyphylla Grab. ex Craib.</i> | Mimosaceae | C | A | NNP | |
| <i>Acacia pennata (L.) Willd.</i> | Mimosaceae | C | A | NNP,TP,S,BN P,B | |
| <i>Acacia pruinescens Kurz.</i> | Mimosaceae | C | A | TP,S | |
| <i>Acacia sinuata (Lour.) Merrill.</i> | Mimosaceae | C | A | BNP,B,NNP, | |
| <i>Adenia trilobata (Roxb.) Engl.</i> | Passifloraceae | C | A | | |
| <i>Ampelocissus latifolia Planch.</i> | Vitaceae | C | A | | |
| <i>Anoectochilus elatus Lindl.</i> | Orchidaceae | C | A | | |
| <i>Argyreia capitata Arn. ex Choisy</i> | Convolvulaceae | C | A | | |
| <i>Argyreia nervosa (Burm.f.) Boj.</i> | Convolvulaceae | C | A | | |
| <i>Artabotrys caudatus Wall. ex Hk.f. & T.</i> | Annonaceae | C | A | | |
| <i>Aspidopteris elliptica A. Juss.</i> | Malpighiaceae | C | A | Tura peak | Rawatip budu |
| <i>Aspidopteris indica (Roxb.) Hochr.</i> | Malpighiaceae | C | A | | |
| <i>Aspidopteris wallichii Hk.f.</i> | Malpighiaceae | C | A | Nokrek | |
| <i>Atylosia scarabaeoides Benth.</i> | Fabaceae | C | A | | samplingram |
| <i>Atylosia sp.</i> | Fabaceae | C | A | | |
| <i>Bridelia pubescens Kurz.</i> | Euphorbiaceae | C | A | BNP | Mangrachok/ thebaloa, kasibiprk |
| <i>Butea minor Buch.-Ham. ex Baker</i> | Fabaceae | C | A | Baghmara | Maribudu |
| <i>Butea parviflora Roxb.</i> | Fabaceae | C | A | | Maru |
| <i>Byttneria grandifolia DC.</i> | Sterculiaceae | C | A | Tura | |
| <i>Byttneria pilosa Roxb.</i> | Sterculiaceae | C | A | BNP | Dusipri |
| <i>Caesalpinia cucullata Roxb.</i> | Caesalpinaceae | C | A | Tura peak, Baghmara, Nokrek, BNP | Mangojaskal, Mangogaskal, Manihot esculenta |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|----------------|-------|------|--|---------------------------|
| <i>Cayratia japonica</i> (Thunb.) Gagnep. | Vitaceae | C | A | BNP, Baghmara, Nokrek, Tripto Siju | Moibanga |
| <i>Cayratia pedata</i> (Lour.) Gagnep. | Vitaceae | C | A | Nokrek | |
| <i>Cayratia</i> sp. | Vitaceae | C | A | Nokrek, Tripto Siju, Tura peak | Amangal budu, Dutret budu |
| <i>Cayratia trifolia</i> (L.) Domin. | Vitaceae | C | A | | |
| <i>Celastrus paniculatus</i> Willd. | Celastraceae | C | A | Tura peak | |
| <i>Ceropegia longifolia</i> Wall. | Asclepiadaceae | C | A | | |
| <i>Chonemorpha fragrans</i> (Moon) Alst. | Apocynaceae | C | A | | |
| <i>Cocculus orbiculatus</i> (L.) DC. | Menispermaceae | C | A | NNP, B | |
| <i>Combretum punctatum</i> subsp. <i>squamosum</i> Bl. | Combretaceae | C | A | | |
| <i>Cryptolepis buchmanii</i> R. & S. | Asclepiadaceae | C | A | | |
| <i>Cryptolepis sinensis</i> (Lour.) Merr. | Asclepiadaceae | C | A | Tripto Siju, Tura peak | |
| <i>Dalbergia rimosa</i> Roxb. | Fabaceae | C | A | | Ghot |
| <i>Dalbergia volubilis</i> Roxb. | Fabaceae | C | A | BNP, Tura peak, Baghmara, Nokrek, Trip to Siju | Fulvung, Fukung |
| <i>Derris marginata</i> (Roxb.) Benth. | Fabaceae | C | A | | |
| <i>Derris scandens</i> (Roxb.) Benth. | Fabaceae | C | A | Nokrek, BNP | |
| <i>Derris trifoliata</i> Lour. | Fabaceae | C | A | Nokrek | |
| <i>Desmos longiflorus</i> (Roxb.) Safford. | Annonaceae | C | A | | |
| <i>Dioscorea alata</i> L. | Dioscoreaceae | C | A | BNP | |
| <i>Dioscorea bulbifera</i> L. | Dioscoreaceae | C | A | Nokrek, Baghmara, BNP | Bariumambhing |
| <i>Dioscorea pentaphylla</i> L. | Dioscoreaceae | C | A | Tura peak, Tripto Siju | |
| <i>Diplocyclos palmatus</i> (L.) Jeffrey. | Cucurbitaceae | C | A | | |
| <i>Entada pursaetha</i> DC. | Mimosaceae | C | A | Baghmara | Gilla |
| <i>Erycibe albiflora</i> Hall.f | Convolvulaceae | C | A | | |
| <i>Erycibe paniculata</i> Roxb. | Convolvulaceae | C | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|-----------------|-------|------|---|-----------------------------|
| <i>Fissistigma bicolor</i> (Roxb.) Merr. | Annonaceae | C | A | | |
| <i>Fissistigma rubiginosa</i> (A. DC.) Merr. | Annonaceae | C | A | | |
| <i>Fissistigma wallichii</i> (Hk. f. & Th.) Merr. | Annonaceae | C | A | Tura, BNP | |
| <i>Freisodielsia forniculata</i> (Roxb.) Das | Annonaceae | C | A | | Dumakhal |
| <i>Gnetum montanum</i> Markgraf. | Gnetaceae | C | GM | BNP | |
| <i>Gnetum scandens</i> Roxb. | Gnetaceae | C | GM | Baghmara | Domittam |
| <i>Gongronema nepalense</i> (Wall.) Decne. | Asclepiadaceae | C | A | Baghmara, Nokrek | |
| <i>Gouania tiliaefolia</i> Lamk. | Rhamnaceae | C | A | Tura peak, BNP, Baghmara | Silkring soda budu, Dumigog |
| <i>Hemidesmus</i> sp. | Asclepiadaceae | C | A | Nokrek, Tura peak | |
| <i>Hodgsonia macrocarpa</i> (Bl.) Cogn. | Cucurbitaceae | C | A | | tebe |
| <i>Ichnocarpus frutescens</i> (L.) R. Br. | Apocynaceae | C | A | Baghmara, BNP, Nokrek, Tripto Siju, Tura peak | Dumisok budu, Nimonia budu |
| <i>Ipomoea macrantha</i> R. & S. | Convolvulaceae | C | A | | |
| <i>Jasminum azoricum</i> L. | Oleaceae | C | A | Nokrek | |
| <i>Kadsura heteroclita</i> (Roxb.) Craib. | Schisandraceae | C | A | | |
| <i>Lasiobema scandens</i> var. <i>borsfieldii</i> (Watt. ex Prain) de Wit. | Caesalpiniaceae | C | A | | Rare |
| <i>Luffa aegyptiaca</i> Mill. | Cucurbitaceae | C | A | | |
| <i>Lygodium flexuosum</i> (L.) Sw. | Schizaeaceae | C | P | | Ruwatap |
| <i>Lygodium japonicum</i> (Thunb.) Sw. | Schizaeaceae | C | P | | |
| <i>Merremia umbellata</i> (L.) Hall. f. | Convolvulaceae | C | A | | |
| <i>Merremia vitifolia</i> (Burm. f.) Hall. f. | Convolvulaceae | C | A | Tura peak, BNP, Baghmara, Tripto Siju | pannabudu |
| <i>Mikania micrantha</i> Kunth. | Asteraceae | C | A | BNP, Nokrek, Baghmara, Tripto Siju | |
| <i>Milletia pachycarpa</i> Benth. | Fabaceae | C | A | BNP | Mungal |
| <i>Mimosa himalayana</i> Gamble | Mimosaceae | C | A | Tripto Siju | |
| <i>Momordica dioica</i> Roxb. ex Willd. | Cucurbitaceae | C | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|-----------------|-------|------|---|-----------------|
| <i>Mucuna bracteata</i> DC. | Fabaceae | C | A | | |
| <i>Mucuna imbricata</i> DC. | Fabaceae | C | A | BNP | |
| <i>Mucuna pruriens</i> (L.)DC. | Fabaceae | C | A | Tripto Siju, BNP, Baghmara | Maribudu |
| <i>Mukia maderaspatana</i> (L.)M.Roem. | Cucurbitaceae | C | A | | |
| <i>Naravelia zeylanica</i> DC. | Ranunculaceae | C | A | | |
| <i>Paederia scandens</i> (Lour)Merr. | Rubiaceae | C | A | Nokrek | Bhasm |
| <i>Pericampylus glaucus</i> (Lamk.)Merr. | Menispermaceae | C | A | | |
| <i>Phanera khasiana</i> (Baker)Thoth. | Caesalpiniaceae | C | A | Baghmara, Nokrek | |
| <i>Phanera nervosa</i> Benth. | Caesalpiniaceae | C | A | Nokrek | |
| <i>Premna scandens</i> Roxb. | Verbenaceae | C | A | | |
| <i>Pueraria phasioloides</i> (Roxb.)Benth. | Fabaceae | C | A | BNP | |
| <i>Pueraria wallichii</i> DC. | Fabaceae | C | A | | |
| <i>Raphidophora decursiva</i> Schott. | Araceae | C | A | Nokrek, Tura peak, BNP, Baghmara | Samnguachi |
| <i>Raphidophora lancifolia</i> Schott. | Araceae | C | A | BNP, Nokrek | |
| <i>Rhynchosia viscosa</i> DC. | Fabaceae | C | A | Nokrek | Songichak |
| <i>Rubus khasianus</i> Cordot. | Rosaceae | C | A | Nokrek | |
| <i>Rubus rosifolius</i> Sm. | Rosaceae | C | A | Nokrek | |
| <i>Rubus rugosus</i> Sm. | Rosaceae | C | A | Nokrek | |
| <i>Sabia lanceolata</i> Colebr. | Sabiaceae | C | A | Nokrek | |
| <i>Schefflera venulosa</i> Harms. | Araliaceae | C | A | | jenggil |
| <i>Senecio scandens</i> Buch.-Ham ex D.Don | Asteraceae | C | A | | |
| <i>Smilax aspera</i> L. | Smilacaceae | C | A | BNP, Nokrek, Tripto Siju, Tura peak, Baghmara | Kimbaru budu |
| <i>Smilax macrophylla</i> Roxb. | Smilacaceae | C | A | | |
| <i>Smilax</i> sp | Smilacaceae | C | A | | |
| <i>Smilax zeylanica</i> L. | Smilacaceae | C | A | Nokrek | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|----------------|-------|------|----------------------------------|-------------------------------|
| <i>Solena heterophylla</i> Lour. | Cucurbitaceae | C | A | Baghmara | |
| <i>Sphenodesma pentandra</i> Jacq. | Verbenaceae | C | A | | |
| <i>Stephania glandulifera</i> Miers. | Menispermaceae | C | A | Baghmara, BNP | Dodom budu |
| <i>Stephania japonica</i> (Thunb.) Miers. | Menispermaceae | C | A | | |
| <i>Strychnos quintuplinervis</i> A.W.Hill | Loganiaceae | C | A | BNP | |
| <i>Strychnos wallichiana</i> Benth. | Loganiaceae | C | A | Baghmara | |
| <i>Tellosma pallida</i> (Roxb.) Craib. | Asclepiadaceae | C | A | Tripto Siju | |
| <i>Tetracera sarmentosa</i> (L.) Vahl. | Dilleniaceae | C | A | BNP | Agachibudu |
| <i>Tetrastigma leucostaphylum</i> (Dennst.) Balak. | Vitaceae | C | A | Nokrek | |
| <i>Tetrastigma obovatum</i> (Laws) Gagnep | Vitaceae | C | A | Baghmara, Nokrek, Tura peak | |
| <i>Tetrastigma rumicispermum</i> (Laws.) Plantch. | Vitaceae | C | A | Baghmara | Galwaringbudu |
| <i>Tetrastigma serrulatum</i> (Roxb.) Planch. | Vitaceae | C | A | | Endenic |
| <i>Tetrastigma thomsonianum</i> Planch. | Vitaceae | C | A | Nokrek | |
| <i>Thladiantha colorata</i> Cogn. | Cucurbitaceae | C | A | | samarang |
| <i>Thunbergia coccinea</i> Wall. | Acanthaceae | C | A | NNK | |
| <i>Thunbergia grandiflora</i> Roxb. | Acanthaceae | C | A | BNP, Baghmara | Varambhak-budu, Kakubudu |
| <i>Tiliacora acuminata</i> (Lamk.) Hk.f. & Th. | Menispermaceae | C | A | Baghmara, BNP, Nokrek, Tura peak | Mukum budu |
| <i>Tinospora cordifolia</i> Miers. | Menispermaceae | C | A | Tura peak | Warambatbudu |
| <i>Tinospora sinensis</i> (Lour.) Merr. | Menispermaceae | C | A | Baghmara, BNP, Nokrek | Solsola budu/maribudu |
| <i>Toddalia asiatica</i> (L.) Lamk. | Rutaceae | C | A | Nokrek, BNP, Tura peak | Mangojaskal budu, Nachimakkal |
| <i>Trichosanthes tricuspidata</i> Lour. | Cucurbitaceae | C | A | | |
| <i>Uncaria macrophyllus</i> Wall. | Rubiaceae | C | A | Tura peak, Nokrek | Dojosing |
| <i>Uncaria sessilifructus</i> Roxb. | Rubiaceae | C | A | | mangojaskil |
| <i>Uvaria lurida</i> Hk.f. & Th. | Annonaceae | C | A | | |
| <i>Vallisneria spiralis</i> (L.) O.Ktze. | Apocynaceae | C | A | Baghmara, Nokrek, Tura peak | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|---------------------|-------|------|------------------------------------|-----------------|
| <i>Ventilago madraspatana Gaertn.</i> | Rhamnaceae | C | A | Nokrek | |
| <i>Zanthoxylum khasianum Hk.f.</i> | Rutaceae | C | A | Nokrek | Gradek |
| <i>Zizyphus oenoplia (L.)Müll.</i> | Rhamnaceae | C | A | Nokrek | |
| <i>Adiantum caudatum L.</i> | Adiantaceae | F | P | | |
| <i>Adiantum lunulatum Burm.f.</i> | Adiantaceae | F | P | | |
| <i>Aglaomorpha coronans (Wall. ex Mett.)Copel.</i> | Polypodiaceae | F | P | | |
| <i>Angiopteris evecta (G.Forst.)Hoffm.</i> | Angiopteridaceae | F | P | BNP,NNP,B | |
| <i>Arthromeris lehmanni (Mett.)Ching</i> | Polypodiaceae | F | P | | |
| <i>Arthromeris wallichana (Spreng.)Ching</i> | Polypodiaceae | F | P | Tura peak | |
| <i>Blechnum orientale L.</i> | Blechnaceae | F | P | | |
| <i>Cheilanthes farinosa (Forsk.)Kaulf.</i> | Sinopteridaceae | F | P | Nokrek | |
| <i>Colysis hemionitidea Presl.</i> | Polypodiaceae | F | P | | |
| <i>Coniogramme sp.</i> | Hemionitidaceae | F | P | Baghmara | |
| <i>Cyathea sp.</i> | Cyatheaceae | F | P | | |
| <i>Cyclosorus megaphylla</i> | Thelypteridaceae | F | P | | |
| <i>Dichranopteris liniaris Holtum</i> | Gleicheniaceae | F | P | Baghmara | |
| <i>Diplazium esculentum (Retz.)Sw.</i> | Athyriaceae | F | P | | |
| <i>Drymoglossum heterophyllum (L.)Trimen.</i> | Polypodiaceae | F | P | | |
| <i>Lenmaphyllum sp.</i> | Polypodiaceae | F | P | | |
| <i>Lepisorus soridus (C.Chr.)Ching.</i> | Polypodiaceae | F | P | Baghmara, BNP, Nokrek, Tripto Siju | |
| <i>Leptochilus nitidum</i> | Polypodiaceae | F | P | | |
| <i>Lycopodium sp.</i> | Lycopodiaceae | F | P | | |
| <i>Microsorium normale (Roxb.)Copel</i> | Polypodiaceae | F | P | | |
| <i>Nephrolepis cordifolia (L.)C.Presl.</i> | Oleandraceae | F | P | | |
| <i>Onychium saliculosum (Desv.)C.Chr.</i> | Cryptogrammatacaeae | F | P | | |
| <i>Plagiogyria communis Ching.</i> | Plagiogyriaceae | F | P | Nokrek | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|-----------------|-------|------|-------------------------------------|-----------------|
| <i>Pleopeltis excavatus</i> | Polypodiaceae | F | P | BNP | |
| <i>Polypodium argutum</i> (Wall. ex Hooker) Ching | Polypodiaceae | F | P | Nokrek | |
| <i>Pteris biaurita</i> L. | Pteridaceae | F | P | | |
| <i>Pteris</i> sp. | Pteridaceae | F | P | Nokrek | |
| <i>Pyrossia</i> sp. | Polypodiaceae | F | P | | |
| <i>Selaginella</i> sp. | Selaginellaceae | F | P | BNP, Nokrek, Tripto Siju, Tura peak | Sarat |
| <i>Apluda mutica</i> Hack. | Poaceae | G | A | BNP, Nokrek, Tura peak | |
| <i>Arundo donax</i> L. | Poaceae | G | A | Baghmara, BNP | |
| <i>Brachiaria distachya</i> Stapf. | Poaceae | G | A | Baghmara | |
| <i>Capillipedium assimile</i> (Steud.) A. Camus | Poaceae | G | A | Nokrek, Tura peak | |
| <i>Chrysopogon serrulatus</i> Trin. | Poaceae | G | A | Baghmara, Nokrek, Tripto Siju | |
| <i>Cynodon dactylon</i> Pers. | Poaceae | G | A | Baghmara, Tripto Siju, Tura peak | |
| <i>Cyrtococcum accrescens</i> Stapf. | Poaceae | G | A | Baghmara, BNP, Tripto Siju, Nokrek | |
| <i>Cyrtococcum oxyphyllum</i> Stapf. | Poaceae | G | A | Tura peak | |
| <i>Dactyloctenium aegyptium</i> Willd. | Poaceae | G | A | Baghmara | |
| <i>Digitaria setigera</i> R. & S. | Poaceae | G | A | BNP, Nokrek | |
| <i>Digitaria stricta</i> Roth. | Poaceae | G | A | Baghmara, Nokrek | |
| <i>Eleusine coracana</i> Gaertn. | Poaceae | G | A | Nokrek | |
| <i>Eleusine indica</i> Gaertn. | Poaceae | G | A | BNP | |
| <i>Eragrostiella bifaria</i> (Vahl.) Bor. | Poaceae | G | A | BNP | |
| <i>Eragrostis atrovirens</i> Lange. | Poaceae | G | A | Nokrek | |
| <i>Eragrostis pilosa</i> Beauv. | Poaceae | G | A | Baghmara, BNP | |
| <i>Eragrostis tenella</i> R. & S. | Poaceae | G | A | | |
| <i>Eragrostis unioides</i> Nees. | Poaceae | G | A | Baghmara, Nokrek | Memong rongchu |
| <i>Eulaliopsis binata</i> (Retz.) C.E. Hubbard | Poaceae | G | A | Baghmara, BNP | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|---------------|-------|------|---|-----------------|
| <i>Hackelochloa granularis</i> (L.) O.Ktze. | Poaceae | G | A | | |
| <i>Imperata cylindrica</i> (L.) Raeus. | Poaceae | G | A | Nokrek, Baghmara, Tripto Siju | Ambhang |
| <i>Oplismenus burmanii</i> Beauv. | Poaceae | G | A | Baghmara, BNP, Nokrek, Tripto Siju, Tura peak | |
| <i>Oplismenus compositus</i> Beauv. | Poaceae | G | A | BNP, Nokrek, Tripto Siju, Tura peak | |
| <i>Panicum auritum</i> Presl. | Poaceae | G | A | | |
| <i>Panicum notatum</i> Retz. | Poaceae | G | A | Tura peak | |
| <i>Paspalidium flavidum</i> (Retz.) A. Camus | Poaceae | G | A | BNP | |
| <i>Paspalum conjugatum</i> Berg. | Poaceae | G | A | | |
| <i>Paspalum scorbiculatum</i> L. | Poaceae | G | A | | |
| <i>Saccharum arundinaceum</i> Retz. | Poaceae | G | A | | |
| <i>Saccharum munja</i> Roxb. | Poaceae | G | A | Tripto Siju | Galda |
| <i>Saccharum spontaneum</i> L. | Poaceae | G | A | Nokrek, Tripto Siju, Baghmara | |
| <i>Saccharum benghalensis</i> Ham. | Poaceae | G | A | Nokrek | |
| <i>Setaria glauca</i> Beauv. | Poaceae | G | A | Nokrek | |
| <i>Setaria paniculifera</i> (Steud.) Fourn. | Poaceae | G | A | Baghmara, BNP, Nokrek, Tura peak | Saman |
| <i>Setaria verticillata</i> (L.) P.Beauv. | Poaceae | G | A | Tura peak, Nokrek | |
| <i>Sporobolus diander</i> Beauv. | Poaceae | G | A | BNP | |
| <i>Sporobolus indicus</i> var. <i>purpureosuffusus</i> (Obwi) Koyama | Poaceae | G | A | Nokrek | |
| <i>Themeda quadrivalvis</i> (L.) O.Kuntze. | Poaceae | G | A | Baghmara, BNP | |
| <i>Themeda villosa</i> (Poir.) A. Camus | Poaceae | G | A | | |
| <i>Thysanolaena maxima</i> (Roxb.) O.Kuntze | Poaceae | G | A | BNP, Nokrek, Tripto Siju | |
| <i>Abelmoschus moschatus</i> Medik. | Malvaceae | H | A | NNP, BNP, S | Meemang galda |
| <i>Abrus fruticulosus</i> W. & A. | Fabaceae | H | A | BNP | |
| <i>Acalypha ciliata</i> Forsk. | Euphorbiaceae | H | A | NNP | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|------------------|-------|------|---|---------------------------|
| <i>Achyranthes aspera</i> L. | Amaranthaceae | H | A | Nokrek, Tripto Siju, BAG, NNP | |
| <i>Achyranthes bidentata</i> Bl. | Amaranthaceae | H | A | Baghmara, BNP, Tura peak | |
| <i>Acorus calamus</i> L. | Araceae | H | A | Nokrek | |
| <i>Aerides</i> sp. | Orchidaceae | H | A | Baghmara, BNP | |
| <i>Aerva</i> sp. | Amaranthaceae | H | A | BNP, NNP, SIJ U, TURA | |
| <i>Aeschynomene indica</i> L. | Fabaceae | H | A | | |
| <i>Ageratum conyzoides</i> L. | Asteraceae | H | A | Baghmara, BNP, Tura peak, Tripto Siju, Norkek | Sangwang |
| <i>Ajuja bracteosa</i> Wall. | Lamiaceae | H | A | Baghmara | |
| <i>Alternanthera pungens</i> HBK | Amaranthaceae | H | A | Baghmara, BNP, NNK | |
| <i>Alternanthera sessilis</i> Br. | Amaranthaceae | H | A | Baghmara, BNP, NNK | |
| <i>Amaranthus spinosus</i> L. | Amaranthaceae | H | A | | |
| <i>Amaranthus viridis</i> L. | Amaranthaceae | H | A | BNP | Jada bushu |
| <i>Anaphalis adnata</i> Wall. ex DC. | Asteraceae | H | A | Tura peak | |
| <i>Anisomeles indica</i> (L.) O.Ktze. | Lamiaceae | H | A | Nokrek | |
| <i>Anisomeles ovata</i> R.Br. | Lamiaceae | H | A | Nokrek | Sipin |
| <i>Argemone mexicana</i> L. | Papaveraceae | H | A | Tripto Siju | |
| <i>Aristolochia</i> sp. | Aristolochiaceae | H | A | Baghmara, BNP, Nokrek, Tura peak | Noritbudu, Tematchinarang |
| <i>Aristolochia tagala</i> Cham. | Aristolochiaceae | H | A | | terimu |
| <i>Asclepias curassavica</i> L. | Asclepiadaceae | H | A | Nokrek | |
| <i>Bacopa procumbens</i> (Mill.) Green | Scrophulariaceae | H | A | Baghmara | |
| <i>Barleria cristata</i> L. | Acanthaceae | H | A | BNP, NNK, TURA, S, B | |
| <i>Begonia picta</i> Sm. | Begoniaceae | H | A | BNP | mebishi |
| <i>Begonia rubro-vinea</i> Hook. | Begoniaceae | H | A | | |
| <i>Begonia</i> sp. | Begoniaceae | H | A | Nokrek | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|-----------------|-------|------|----------------------------------|-----------------|
| <i>Bidens bitternata</i> Merrill. ☉Scheriff. | Asteraceae | H | A | Tura peak | |
| <i>Bidens pilosa</i> L. | Asteraceae | H | A | BNP, Nokrek | |
| <i>Blumea densiflora</i> DC. | Asteraceae | H | A | | |
| <i>Blumea lacera</i> DC. | Asteraceae | H | A | | |
| <i>Blumea lacera</i> var. <i>blumei</i> DC. | Asteraceae | H | A | | |
| <i>Blumea oxyodonta</i> DC. | Asteraceae | H | A | Tripto Siju | |
| <i>Blumea procera</i> DC. | Asteraceae | H | A | | |
| <i>Blumea riparia</i> DC. | Asteraceae | H | A | | |
| <i>Blumeopsis flava</i> (DC)Gagnep. | Asteraceae | H | A | | |
| <i>Boerhavia diffusa</i> L. | Nyctaginaceae | H | A | Tura peak | |
| <i>Borreria articularis</i> (L.f.)F.N.Will. | Rubiaceae | H | A | Nokrek, Tura peak | |
| <i>Borreria pusila</i> (Wall.)DC. | Rubiaceae | H | A | Nokrek | |
| <i>Borreria pusila</i> DC. | Rubiaceae | H | A | BNP | |
| <i>Bryophyllum calycinum</i> Salisb. | Crassulaceae | H | A | BNP | |
| <i>Cannabis sativa</i> L. | Cannabinaceae | H | A | Nokrek | |
| <i>Carex</i> sp. | Cyperaceae | H | A | Baghmara, Nokrek | |
| <i>Carex</i> sp. | Cyperaceae | H | A | Nokrek, Tripto Siju, Tura peak | |
| <i>Cassia occidentalis</i> L. | Caesalpiniaceae | H | A | BNP | |
| <i>Cassia tora</i> L. | Caesalpiniaceae | H | A | Baghmara, BNP | |
| <i>Catheranthus roseus</i> (L.)G.Don. | Apocynaceae | H | A | Baghmara, Tripto Siju | |
| <i>Celosia argentea</i> L. | Amaranthaceae | H | A | BNP,NNP,SIJ U,TURA | |
| <i>Centella asiatica</i> (L.)Urban. | Apiaceae | H | A | Baghmara, BNP, Tura peak, Nokrek | |
| <i>Chenopodium ambrosioides</i> L. | Chenopodiaceae | H | A | | |
| <i>Chenopodium murale</i> L. | Chenopodiaceae | H | A | Baghmara | |
| <i>Chirita hamosa</i> R.Br. | Gesneriaceae | H | A | | |
| <i>Cirsium involucreatum</i> DC. var. <i>horridum</i> (Hk.f.)Balak. | Asteraceae | H | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|----------------|-------|------|---|-----------------|
| <i>Cissampelos pareira L.</i> | Menispermaceae | H | A | Baghmara, BNP, Nokrek, Tripto Siju, Tura peak | mormibudu |
| <i>Cissus discolor Bl.</i> | Vitaceae | H | A | BNP | |
| <i>Coelogyne sp.</i> | Orchidaceae | H | A | BNP, Baghmara, Nokrek, Tura peak | |
| <i>Colocasia sp.</i> | Araceae | H | A | Nokrek, BNP | |
| <i>Commelina benghalensis L.</i> | Commelinaceae | H | A | Baghmara, Tura peak | |
| <i>Commelina longifolia Spreng.</i> | Commelinaceae | H | A | Nokrek, Tura peak | |
| <i>Commelina suffruticosa Bl.</i> | Commelinaceae | H | A | Baghmara, BNP, Tura peak | |
| <i>Corchorus acutangulus Lamk.</i> | Tiliaceae | H | A | BNP | |
| <i>Costus speciosus Sm.</i> | Zingiberaceae | H | A | BNP, Tura peak | |
| <i>Cotula hemisphaerica Wall.</i> | Asteraceae | H | A | BNP | |
| <i>Crassocephalum crepidioides (Benth.) Moore</i> | Asteraceae | H | A | | |
| <i>Crotalaria juncea L.</i> | Fabaceae | H | A | | |
| <i>Crotalaria sericea Retz.</i> | Fabaceae | H | A | | |
| <i>Crotalaria sessiliflora L.</i> | Fabaceae | H | A | Nokrek | Matchasingsam |
| <i>Curcuma psuedomontana Grab.</i> | Zingiberaceae | H | A | BNP | |
| <i>Curcuma sp.</i> | Zingiberaceae | H | A | BNP | |
| <i>Curcuma zedoaria Roxb.</i> | Zingiberaceae | H | A | BNP | |
| <i>Cuscuta reflexa Roxb.</i> | Cuscutaceae | H | A | Tripto Siju, Baghmara | |
| <i>Cyanotis cristata Sch.f.</i> | Commelinaceae | H | A | BNP, B, NNP | |
| <i>Cyclea bicristata (Griff.) Diels.</i> | Menispermaceae | H | A | BNP, Bagmara | |
| <i>Cyperus compressus L.</i> | Cyperaceae | H | A | Nokrek | |
| <i>Cyperus kyllingia Endl.</i> | Cyperaceae | H | A | | |
| <i>Cyperus triceps Endl.</i> | Cyperaceae | H | A | | |
| <i>Deeringia amaranthoides (Lamk.) Merrill.</i> | Amaranthaceae | H | A | NNP | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|----------------|-------|------|--------------------------|------------------------|
| <i>Dendrobium aphyllum</i> (Roxb.) Fischer. | Orchidaceae | H | A | | |
| <i>Dendrobium</i> sp. | Orchidaceae | H | A | Baghmara, BNP, Nokrek | |
| <i>Desmodium gangeticum</i> DC. | Fabaceae | H | A | Baghmara, Nokrek | |
| <i>Desmodium gyrans</i> DC. | Fabaceae | H | A | | |
| <i>Desmodium pulchellum</i> (L.) Benth. | Fabaceae | H | A | Nokrek | |
| <i>Desmodium</i> sp. | Fabaceae | H | A | BNP, Nokrek | Erimittal, Samplingkap |
| <i>Desmodium triflorum</i> DC. | Fabaceae | H | A | Tripto Siju | |
| <i>Desmodium velutinum</i> (Willd.) DC. | Fabaceae | H | A | Nokrek | |
| <i>Dicliptera bupleuroides</i> Nees. | Acanthaceae | H | A | Baghmara, Trip to Siju | |
| <i>Duchesnea indica</i> (Andr.) Focke. | Rosaceae | H | A | | |
| <i>Eclipta prostrata</i> L. | Asteraceae | H | A | | |
| <i>Elephantopus scaber</i> L. | Asteraceae | H | A | Trip to Siju | |
| <i>Elsholtzia flava</i> Benth. | Lamiaceae | H | A | | |
| <i>Emilia sonchifolia</i> (L.) DC. | Asteraceae | H | A | | |
| <i>Epilobium</i> sp. | Onagraceae | H | A | | |
| <i>Erigeron bonariensis</i> L. | Asteraceae | H | A | Nokrek, Tura peak | |
| <i>Erigeron karvinskianus</i> DC. | Asteraceae | H | A | | |
| <i>Eupatorium adenophorum</i> Spreng. | Asteraceae | H | A | Nokrek, Trip to Siju | |
| <i>Eupatorium odoratum</i> L. | Asteraceae | H | A | Baghmara, BNP, Tura peak | |
| <i>Euphorbia hirta</i> L. | Euphorbiaceae | H | A | BNP, Baghmara, Tura peak | Mamluk |
| <i>Euphorbia prostrata</i> Orteg. | Euphorbiaceae | H | A | Baghmara | |
| <i>Evolvulus nummularius</i> L. | Convolvulaceae | H | A | | |
| <i>Fimbristylis dichotoma</i> Vahl. | Cyperaceae | H | A | BNP | |
| <i>Galinsoga parviflora</i> Cav. | Asteraceae | H | A | | |
| <i>Galium elegans</i> Wall. | Rubiaceae | H | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|----------------|-------|------|----------------------------------|-------------------|
| <i>Gnaphalium polycaulon Pers.</i> | Asteraceae | H | A | Baghmara, Nokrek | |
| <i>Gomphrena globosa L.</i> | Amaranthaceae | H | A | BNP, NNP, SIJ U, TURA | |
| <i>Hedychium coronarium Koen.</i> | Zingiberaceae | H | A | NNP | |
| <i>Hedychium sp.</i> | Zingiberaceae | H | A | Baghmara, Nokrek, Tura peak, BNP | Gongaga, Gong |
| <i>Hedychium spicatum Ham.</i> | Zingiberaceae | H | A | | |
| <i>Hedyotis corymbosa (L.) Lamk.</i> | Rubiaceae | H | A | | |
| <i>Hedyotis scandens D. Don</i> | Rubiaceae | H | A | BNP, Baghmara, Nokrek, Tura peak | Mariram |
| <i>Heliotropium supinum L.</i> | Boraginaceae | H | A | Baghmara | Mecnangare |
| <i>Horsfieldia amygdalina (Wall.) Warb.</i> | Myristicaceae | H | A | BNP | |
| <i>Horsfieldia kingii (Hk.f.) Warb.</i> | Myristicaceae | H | A | Trip to Siju | |
| <i>Hydrocotyle sybthorpioides Lamk.</i> | Apiaceae | H | A | Nokrek, Tura peak | |
| <i>Hygrophila auriculata (Sch.) Heine</i> | Acanthaceae | H | A | NNK, BAG | |
| <i>Impatiens chinensis L.</i> | Balsaminaceae | H | A | | dupketipul chhota |
| <i>Indigofera linifolia Retz.</i> | Fabaceae | H | A | | |
| <i>Ipomoea alba L.</i> | Convolvulaceae | H | A | BNP | |
| <i>Ipomoea batatas (L.) Lamk.</i> | Convolvulaceae | H | A | | |
| <i>Ipomoea nil (L.) Roth.</i> | Convolvulaceae | H | A | | |
| <i>Ipomoea pes-tigridis L.</i> | Convolvulaceae | H | A | Trip to Siju | |
| <i>Ipomoea purpurea (L.) Roth.</i> | Convolvulaceae | H | A | | |
| <i>Ipomoea quamoclit L.</i> | Convolvulaceae | H | A | | gatepul |
| <i>Knoxia sp.</i> | Rubiaceae | H | A | | |
| <i>Lepidagathis cristata Willd.</i> | Acanthaceae | H | A | BNP, Baghmara, Nokrek | Sampathu |
| <i>Lepidagathis incurva D. Don.</i> | Acanthaceae | H | A | Tura peak | |
| <i>Leucas aspera Spreng.</i> | Lamiaceae | H | A | Baghmara | |
| <i>Leucas cephalotes Spreng.</i> | Lamiaceae | H | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|------------------|-------|------|--|------------------|
| <i>Leucas mollissima</i> Wall. | Lamiaceae | H | A | Nokrek | Machejasman |
| <i>Lindenbergia indica</i> (L.) O.Ktze. | Scrophulariaceae | H | | | |
| <i>Lindernia ciliaris</i> (Colsm.) Penn. | Scrophulariaceae | H | A | | |
| <i>Lindernia cordifolia</i> (Colsm.) Merr. | Scrophulariaceae | H | | | |
| <i>Lobelia nicotianifolia</i> R. & S. | Lobeliaceae | H | A | | |
| <i>Ludwigia octovalvis</i> (Jacq.) Raven. | Onagraceae | H | A | Baghmara | |
| <i>Martynia annua</i> L. | Martyniaceae | H | A | Baghmara | |
| <i>Mimosa pudica</i> L. | Mimosaceae | H | A | Baghmara | |
| <i>Mosla dianthera</i> Maxim. | Lamiaceae | H | A | Nokrek | |
| <i>Murdannia nudiflora</i> (L.) Brenan. | Commelinaceae | H | A | S, NNP | |
| <i>Musa superba</i> Roxb. | Musaceae | H | A | Tura peak, Nokrek | Leabenchi tiring |
| <i>Neanotis oxyphylla</i> (G. Don.) Hk. f. | Rubiaceae | H | A | Baghmara, BNP | |
| <i>Nelsonia canescens</i> Nees. | Acanthaceae | H | A | Bag, nnk | |
| <i>Nelumbo nucifera</i> L. | Nymphaeaceae | H | A | Baghmara | |
| <i>Nepeta</i> sp. | Lamiaceae | H | A | Nokrek | Phanet |
| <i>Nicotiana tabacum</i> L. | Solanaceae | H | A | | |
| <i>Oberonia</i> sp. | Orchidaceae | H | A | Tura peak | |
| <i>Oxalis corniculata</i> L. | Oxalidaceae | H | A | Baghmara, BNP, Nokrek, Tura peak | |
| <i>Oxalis debilis</i> H.B.K. var. <i>corymbosa</i> (DC.) Lourt. | Oxalidaceae | H | A | Nokrek | |
| <i>Parthenium hysterophorus</i> L. | Asteraceae | H | A | | |
| <i>Phyla nudiflora</i> (L.) Green. | Verbenaceae | H | A | Baghmara | |
| <i>Phyllanthus retusus</i> Dennst. | Euphorbiaceae | H | A | | |
| <i>Phyllanthus</i> sp. | Euphorbiaceae | H | A | | |
| <i>Phyllanthus urinaria</i> L. | Euphorbiaceae | H | A | Nokrek | |
| <i>Physalis minima</i> L. | Solanaceae | H | A | | |
| <i>Pilea</i> sp. | Urticaceae | H | A | Baghmara, Tura peak, | Kakuchi |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|----------------|-------|------|-----------------------------|--------------------------------------|
| | | | | Nokrek | |
| <i>Pimpinella Sp.</i> | Apiaceae | H | A | Nokrek | Kathamasia |
| <i>Piper griffithii DC.</i> | Piperaceae | H | A | Nokrek | Asira |
| <i>Piper mullesua D.Don.</i> | Piperaceae | H | A | Nokrek | |
| <i>Piper nigrum L.</i> | Piperaceae | H | A | Tripto Siju | |
| <i>Piper pedicellosum Wall.</i> | Piperaceae | H | A | | |
| <i>Piper pectuloides Roxb.</i> | Piperaceae | H | A | BNP, Nokrek, Baghmara | Machipan |
| <i>Plantago erosa Wall.</i> | Plantaginaceae | H | A | NOK | |
| <i>Plantago major L.</i> | Plantaginaceae | H | A | Tura peak | |
| <i>Plantago sp.</i> | Plantaginaceae | H | A | Nokrek | |
| <i>Polygala glomerata Lour.</i> | Polygalaceae | H | A | | |
| <i>Polygala persicariaefolia DC.</i> | Polygalaceae | H | A | Nokrek | |
| <i>Polygala sibirica L.</i> | Polygalaceae | H | A | | |
| <i>Polygonum sp.</i> | Polygonaceae | H | A | Tura peak, BNP | Mukuchling/ Achuak, Mukuchlang |
| <i>Polygonum barbatum L.</i> | Polygonaceae | H | A | Baghmara | |
| <i>Polygonum chinense L.</i> | Polygonaceae | H | A | Nokrek, Tura peak | Actiak |
| <i>Polygonum hydropiper L.</i> | Polygonaceae | H | A | Baghmara, Nokrek | |
| <i>Polygonum runcinatum Ham.</i> | Polygonaceae | H | A | Nokrek | |
| <i>Portulaca grandiflora Hook.</i> | Portulacaceae | H | A | BNP | |
| <i>Portulaca pilosa L.</i> | Portulacaceae | H | A | BNP, Nokrek | |
| <i>Pothos scandens L.</i> | Araceae | H | A | BNP | |
| <i>Pothos sp.</i> | Araceae | H | A | Baghmara, Nokrek, Tura peak | |
| <i>Pouzolzia pentandra Benn.</i> | Urticaceae | H | A | Baghmara, Nokrek | |
| <i>Pseudognaphalium leuteo-album Gillard. & Burt.</i> | Asteraceae | H | A | | |
| <i>Ranunculus arvensis L.</i> | Ranunculaceae | H | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|------------------|-------|------|--|------------------------|
| <i>Ranunculus sceleratus</i> L. | Ranunculaceae | H | A | | |
| <i>Rhynchosglossum obliquum</i> Bl. | Gesneriaceae | H | A | | |
| <i>Richardsonia pilosa</i> H.B. & K. | Rubiaceae | H | A | | |
| <i>Rubia cordifolia</i> L. | Rubiaceae | H | A | | |
| <i>Ruellia tweediana</i> (Nees.) Griseb. | Acanthaceae | H | A | Baghmara, Nokrek | |
| <i>Rumex nepalensis</i> Spreng | Polygonaceae | H | A | | |
| <i>Rungia pectinata</i> Nees. | Acanthaceae | H | A | Baghmara, BNP, Tura peak, Nokrek, Tripto Siju | |
| <i>Rungia repens</i> Nees. | Acanthaceae | H | A | BNP, Nokrek | |
| <i>Scoparia dulcis</i> L. | Scrophulariaceae | H | A | BNP, Baghmara, Nokrek, Tripto Siju, Tura peak | Sokpisis |
| <i>Siegesbeckia orientalis</i> L. | Asteraceae | H | A | | |
| <i>Silene alba</i> (Mill.) Krause | Caryophyllaceae | H | A | Baghmara | |
| <i>Smithia blanda</i> Wall. | Fabaceae | H | A | | |
| <i>Solanum nigrum</i> L. | Solanaceae | H | A | Tura peak | Chitop |
| <i>Solanum surattense</i> Burm.f. | Solanaceae | H | A | Tripto Siju | |
| <i>Sonchus asper</i> (L.) Hill | Asteraceae | H | A | Nokrek | |
| <i>Sonchus oleraceus</i> L. | Asteraceae | H | A | | |
| <i>Spilanthes acmella</i> Jacq. | Asteraceae | H | A | Baghmara, Nokrek | Dogipiapa |
| <i>Synedrella nodiflora</i> (Lour.) Gaert. | Asteraceae | H | A | | Asteraceae |
| <i>Thalictrum</i> sp. | Ranunculaceae | H | A | | |
| <i>Tribulus terrestris</i> L. | Zygophyllaceae | H | A | Baghmara, Tripto Siju, Nokrek, Tura peak | |
| <i>Tridax procumbens</i> L. | Asteraceae | H | A | | Asteraceae |
| <i>Uraria crinita</i> Desv. | Fabaceae | H | A | | sambabrek/same brak |
| <i>Utricularia striatula</i> Sm. | Utriculariaceae | H | A | Baghmara | |
| <i>Vernonia cinerea</i> (L.) Less. | Asteraceae | H | A | Baghmara, Nokrek, Tripto | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|---------------|-------|------|---|------------------------|
| | | | | Siju, Tura peak | |
| <i>Viola betonicifolia</i> Sm. | Violaceae | H | A | Nokrek | |
| <i>Viola serpens</i> Wall. | Violaceae | H | A | Nokrek | |
| <i>Youngia japonica</i> (L.)DC. | Asteraceae | H | A | Baghmara | |
| <i>Zingiber officinale</i> Rosc. | Zingiberaceae | H | A | Baghmara | Richum |
| <i>Zingiber</i> sp. | Zingiberaceae | H | A | Tura peak | |
| <i>Abroma angusta</i> Linn.f. | Sterculiaceae | S | A | TP,NNP | |
| <i>Adhathoda zeylanica</i> Medik. | Acanthaceae | S | A | BNP | |
| <i>Aeschmanthera gossypina</i> Nees | Acanthaceae | S | A | BNP, NNK, Tura, Bag | |
| <i>Aeschynanthus grandiflora</i> Spreng. | Gesneriaceae | S | A | | |
| <i>Aeschynanthus superba</i> Cl. | Gesneriaceae | S | A | | |
| <i>Agapetes variegata</i> G.Don. | Vacciniaceae | S | A | | |
| <i>Allophylus distachys</i> Radlk. | Sapindaceae | S | A | Nokrek | |
| <i>Allophylus villosus</i> Bl. | Sapindaceae | S | A | | |
| <i>Amblyanthus glandulosus</i> (Roxb.)D.C. | Myrsinaceae | S | A | | |
| <i>Antidesma acidum</i> Retz. | Euphorbiaceae | S | A | Nokrek | Bolsudiket |
| <i>Antidesma acuminatum</i> Wall | Euphorbiaceae | S | A | | |
| <i>Aralia armata</i> Seem. | Araliaceae | S | A | | |
| <i>Aralia dasyphylla</i> Miq. | Araliaceae | S | A | Nokrek | samibra |
| <i>Aralia</i> sp. | Araliaceae | S | A | NNP | Mangchotra ?, Rangi |
| <i>Ardisia crispa</i> (Thumb.)DC. | Myrsinaceae | S | A | tura | |
| <i>Ardisia griffithii</i> Cl. | Myrsinaceae | S | A | | semarang/chengr ong |
| <i>Ardisia pedunculosa</i> Wall. | Myrsinaceae | S | A | Nokrek | nagari |
| <i>Ardisia</i> sp. | Myrsinaceae | S | A | BNP, Baghmara, Nokrek, Tura peak, Tripto Siju | Chengmagong, Nagri |
| <i>Ardisia thomsonii</i> (Cl.)Mez. | Myrsinaceae | S | A | | Khumbrit |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|-----------------|-------|------|--|--|
| <i>Artemisia nilagirica (Cl.)Pamp.</i> | Asteraceae | S | A | Nokrek, Tura peak | khilbijak, Simbusam |
| <i>Artemisia parviflora Roxb.</i> | Asteraceae | S | A | | |
| <i>Artemisia sp.</i> | Asteraceae | S | A | Tripto Siju | |
| <i>Baliospermum calycinum Muell.-Arg.</i> | Euphorbiaceae | S | A | | |
| <i>Boehmeria glomerulifera Miq.</i> | Urticaceae | S | A | Nokrek | |
| <i>Boehmeria platyphylla D.Don.</i> | Urticaceae | S | A | Tura peak, Baghmara, Nokrek, Tripto Siju | |
| <i>Boehmeria sp.</i> | Urticaceae | S | A | | agilda |
| <i>Breynia retusa (Denmst)Alst.</i> | Euphorbiaceae | S | A | Tripto Siju | Marikron |
| <i>Bridelia stipularis Bl.</i> | Euphorbiaceae | S | A | BNP, Tura peak, Baghmara | Kasipret-budu/Khasidubret, Kasidupret, |
| <i>Buddleja asiatica Lour.</i> | Buddlejaceae | S | A | Nokrek | |
| <i>Callicarpa macrophylla Vahl.</i> | Verbenaceae | S | A | Nokrek, Tripto Siju, Tura peak | |
| <i>Callicarpa rubella Lindl.</i> | Verbenaceae | S | A | | |
| <i>Calotropis gigantea (L.)Dryand</i> | Asclepiadaceae | S | A | | |
| <i>Canthium angustifolium Roxb.</i> | Rubiaceae | S | A | | Rubiaceae |
| <i>Canthium parviflorum Roxb.</i> | Rubiaceae | S | A | | Rubiaceae |
| <i>Capparis acutifolia Sw.</i> | Capparidaceae | S | A | | |
| <i>Capparis assamica Hk.f. & Th.</i> | Capparidaceae | S | A | BNP | |
| <i>Caryopteris wallichiana Schau.</i> | Verbenaceae | S | A | Nokrek | |
| <i>Cassia alata L.</i> | Caesalpiniaceae | S | A | | |
| <i>Cestrum nocturnum L.</i> | Solanaceae | S | A | | |
| <i>Chasalia ophioxylodes (Wall.)Craib.</i> | Rubiaceae | S | A | | |
| <i>Chloranthus elatior R.Br.</i> | Chloranthaceae | S | A | | |
| <i>Citrus hystrix DC.</i> | Rutaceae | S | A | Nokrek | |
| <i>Citrus sp.</i> | Rutaceae | S | A | | bolnarang |
| <i>Clausena heptaphylla W.&A.</i> | Rutaceae | S | A | Nokrek | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|---------------|-------|------|---|--|
| <i>Clematis gouriana</i> DC. | Ranunculaceae | S | A | Nokrek | |
| <i>Clematis laureiriana</i> DC. | Ranunculaceae | S | A | Nokrek | |
| <i>Clerodendrum bracteatum</i> Wall. ex Walp. | Verbenaceae | S | A | Baghmara | |
| <i>Clerodendrum colebrookianum</i> Walp. | Verbenaceae | S | A | Nokrek, Tura peak | |
| <i>Clerodendrum serratum</i> (L.) Moon. | Verbenaceae | S | A | Tripto Siju | |
| <i>Clerodendrum viscosum</i> Vent. | Verbenaceae | S | A | | |
| <i>Clerodendrum wallichii</i> Merr. | Verbenaceae | S | A | BNP, Tura peak | |
| <i>Coffea bengalensis</i> Roxb. | Rubiaceae | S | A | BNP, Tura peak | |
| <i>Combretum acuminatum</i> Roxb. | Combretaceae | S | A | BNP, Baghmara, Nokrek, Tripto Siju | Ketkechi-udu |
| <i>Combretum flagocarpum</i> Cl. | Combretaceae | S | A | Baghmara, Nokrek, Tura peak | |
| <i>Combretum roxburghii</i> Spreng. | Combretaceae | S | A | BNP/ Nokrek, Baghmara, Tripto Siju | Dugrak-budu |
| <i>Crotalaria alata</i> Ham. | Fabaceae | S | A | | |
| <i>Croton caudatus</i> Geisel. | Euphorbiaceae | S | A | Tura peak | Matchpu, Bolmisakbudu, gulbis, samstap |
| <i>Croton</i> sp. | Euphorbiaceae | S | A | | |
| <i>Cudrania cochinchinensis</i> (Lour) Kudo-Mas. | Moraceae | S | A | Nokrek, BNP | Burma bushu |
| <i>Cudrania fruticosa</i> Wt. ex Kurz. | Moraceae | S | A | Nokrek | |
| <i>Dalbergia mimosoides</i> Franch. | Fabaceae | S | A | BNP, Baghmara, Tura peak, Nokrek | Dumitam |
| <i>Dalbergia pinnata</i> (Lour.) Prain. | Fabaceae | S | A | Baghmara, BNP | |
| <i>Daphne involucrata</i> Wall. | Thymeliaceae | S | A | | |
| <i>Datura stramonium</i> L. | Solanaceae | S | A | | |
| <i>Dendrocnide sinuata</i> (Bl.) Chew. | Urticaceae | S | A | BNP | Gilmath |
| <i>Dendrophthoe falcata</i> (L.f.) Etting. | Loranthaceae | S | A | Tripto Siju | |
| <i>Desmodium heterocarpon</i> (L.) DC. | Fabaceae | S | A | Baghmara | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|----------------|-------|------|-----------------------------|-----------------|
| <i>Desmodium laxiflorum</i> DC. | Fabaceae | S | A | Tura peak | |
| <i>Desmodium motorium</i> DC. | Fabaceae | S | A | | |
| <i>Desmodium triquetrum</i> (L.)DC. | Fabaceae | S | A | Nokrek, Tripto Siju | |
| <i>Didymosperma nana</i> H.Wal. & DC. | Arecaceae | S | A | | |
| <i>Difflugosa colorata</i> (Nees.) Bremek. | Acanthaceae | S | A | NNK, TURA, BAG | |
| <i>Dracaena elliptica</i> Thunb. | Dracaenaceae | S | A | BNP, Bagmara | |
| <i>Dracaena spicata</i> Roxb. | Dracaenaceae | S | A | BNP, Baghmara | Lalai |
| <i>Elaeagnus conferta</i> Roxb. | Elaeagnaceae | S | A | Tura peak | Sukua |
| <i>Elsholtzia blanda</i> Benth. | Lamiaceae | S | A | BNP | |
| <i>Embelia floribunda</i> Wall. | Myrsinaceae | S | A | Nokrek | |
| <i>Embelia ribes</i> Burm.f. | Myrsinaceae | S | A | | |
| <i>Embelia</i> sp. | Myrsinaceae | S | A | | ambre rongtong |
| <i>Eranthemum pulchellum</i> Andr. | Acanthaceae | S | A | Bag, Siju | |
| <i>Euonymus theifolius</i> Wall. ex Laws. | Celastraceae | S | A | | |
| <i>Euphorbia royleana</i> Boiss | Euphorbiaceae | S | A | BNP, Tura peak | |
| <i>Eurya japonica</i> Thunb. | Theaceae | S | A | | |
| <i>Ficus crininervia</i> Miq. | Moraceae | S | A | | |
| <i>Ficus foveolata</i> Wall. ex Miq. | Moraceae | S | A | BNP, Bagmara, Nokrek, Tura | goerangsang |
| <i>Ficus sarmentosa</i> Ham. ex J.E. SH. | Moraceae | S | A | | |
| <i>Ficus scandens</i> Roxb. | Moraceae | S | A | Nokrek, Tura peak | |
| <i>Ficus squamosa</i> Roxb. | Moraceae | S | A | Siju | |
| <i>Ficus subulata</i> Bl. | Moraceae | S | A | | tewak |
| <i>Ficus urophylla</i> Wall. ex King. | Moraceae | S | A | | |
| <i>Flacourtia indica</i> (Hk.f.) Warb. | Flacourtiaceae | S | A | Tura peak | Darukik bima |
| <i>Flacourtia jangomas</i> (Lour.) Rae. | Flacourtiaceae | S | A | | darichik |
| <i>Flemingia latifolia</i> Benth. | Fabaceae | S | A | Baghmara, Nokrek, Tura peak | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|----------------|-------|------|---------------------------------------|---------------------------------|
| <i>Flemingia macrophylla</i> (Willd.) Prain. | Fabaceae | S | A | Nokrek | Bolmichi |
| <i>Flemingia strobilifera</i> (L.) R.Br. | Fabaceae | S | A | | |
| <i>Gaultheria fragrantissima</i> Wall. | Ericaceae | S | A | | |
| <i>Girardinia palmata</i> (Forsk.) Gaud. | Urticaceae | S | A | Tura peak | |
| <i>Glycosmis pentaphylla</i> Hk.f. | Rutaceae | S | A | BNP, Tripto Siju, Tura peak, Baghmara | Nemangchinachi |
| <i>Goldfussia echinata</i> Haridasan et Rao | Acanthaceae | S | A | Nokrek, Tura peak | |
| <i>Goniothalamus sesquipedalis</i> (Wall.) Hk.f. & Th. | Annonaceae | S | A | BNP, Nokrek | |
| <i>Grewia abutilifolia</i> Vent. ex Juss. | Tiliaceae | S | A | BNP, Nokrek, Tura peak | Arengakimi, Bolmengo, Bolsubret |
| <i>Grewia hirsuta</i> Vahl. | Tiliaceae | S | A | Nokrek | |
| <i>Grewia sapida</i> Roxb. | Tiliaceae | S | A | BNP | |
| <i>Grewia</i> sp. | Tiliaceae | S | A | Tripto Siju | Pakram |
| <i>Grewia</i> sp. | Tiliaceae | S | A | | bolmengo |
| <i>Hedyotis uncinella</i> Hk.f. & Arn. | Rubiaceae | S | A | | |
| <i>Helixanthera ligustrina</i> (Wall.) Dans. | Loranthaceae | S | A | | |
| <i>Hibiscus rosa-sinensis</i> L. | Malvaceae | S | A | | |
| <i>Hibiscus surattensis</i> L. | Malvaceae | S | A | Tripto Siju | |
| <i>Himalrandia tetrasperma</i> (Roxb.) Yam. | Rubiaceae | S | A | | |
| <i>Hiptage acuminata</i> Wall. ex Hk.f. | Malpighiaceae | S | A | | |
| <i>Hiptage bengalensis</i> (L.) Kurz. | Malpighiaceae | S | A | Nokrek, Baghmara, BNP, Tripto Siju | Kochabudu |
| <i>Holmskioldia sanguinea</i> Retz. | Verbenaceae | S | A | Tura peak/BNP | Misinachil |
| <i>Homonoia riparia</i> Lour. | Euphorbiaceae | S | A | BNP | |
| <i>Hoya fusca</i> Wall. | Asclepiadaceae | S | A | Nokrek | |
| <i>Hoya lanceolata</i> Wall. ex D.Don. | Asclepiadaceae | S | A | BNP, Baghmara, Tura peak | Pattarchila |
| <i>Hoya lobbii</i> Hk.f. | Asclepiadaceae | S | A | Nokrek | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|----------------|-------|------|-------------------------------|-----------------|
| <i>Hypericum uralum</i> Buch.-Ham. ex D.Don. | Hypericaceae | S | A | | |
| <i>Hyptis suaveolens</i> (L.)Poir. | Lamiaceae | S | A | Baghmara, BNP, Tripto Siju | Panat |
| <i>Indigofera atropurpurea</i> Ham. | Fabaceae | S | A | | |
| <i>Indigofera dosua</i> Ham. | Fabaceae | S | A | | |
| <i>Indigofera pulchella</i> Roxb. | Fabaceae | S | A | | |
| <i>Inula cappa</i> (Buch.-Ham. ex D.Don.)DC. | Asteraceae | S | A | Nokrek | |
| <i>Inula eupatorioides</i> DC. | Asteraceae | S | A | | |
| <i>Ipomoea fistulosa</i> Mart. ex Choisy | Convolvulaceae | S | A | Baghmara | |
| <i>Ixora acuminata</i> Roxb. | Rubiaceae | S | A | Baghmara, Nokrek, Tripto Siju | |
| <i>Ixora nigricans</i> W.&A. | Rubiaceae | S | A | | |
| <i>Jasminum amplexicaule</i> Buch.-Ham. ex G.Don. | Oleaceae | S | A | | |
| <i>Jasminum humile</i> L. | Oleaceae | S | A | Nokrek | |
| <i>Jasminum lanceolaria</i> Roxb. | Oleaceae | S | A | Nokrek | Digrak |
| <i>Jasminum multiflorum</i> (Burm.f.)Andrews | Oleaceae | S | A | Nokrek, Tura peak | |
| <i>Jasminum nervosum</i> Lour. | Oleaceae | S | A | | |
| <i>Jasminum subglandulosum</i> Kurz. | Oleaceae | S | A | Nokrek | |
| <i>Jatropha curcas</i> L. | Euphorbiaceae | S | A | Tripto Siju | |
| <i>Lantana camara</i> L. | Verbenaceae | S | A | Tura peak | |
| <i>Lantana indica</i> Roxb. | Verbenaceae | S | A | | |
| <i>Lasianthus biermanii</i> King. ex Hk.f. | Rubiaceae | S | A | Nokrek | |
| <i>Lasianthus lucidus</i> Bl. | Rubiaceae | S | A | | |
| <i>Lasianthus tubiferus</i> Hk.f. | Rubiaceae | S | A | | |
| <i>Leea alata</i> Edgew. | Leeaceae | S | A | BNP | Tipakrong |
| <i>Leea asiatica</i> (L.)Ridsdale | Leeaceae | S | A | Baghmara | |
| <i>Leea crispa</i> L. | Leeaceae | S | A | BNP, Nokrek, Tura peak | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|-----------------|-------|------|--|-----------------|
| <i>Leea crispa</i> L. | Leeaceae | S | A | Baghmara | |
| <i>Lepidagathis hyalina</i> Nees. | Acanthaceae | S | A | BNP,NNK | |
| <i>Loranthus gracilifolius</i> Schult. | Loranthaceae | S | A | Baghmara, Nokrek | pothekme |
| <i>Loranthus scurrula</i> L. | Loranthaceae | S | A | | |
| <i>Macrosolan cochinchinensis</i> (Lour.) Van Tiegh. | Loranthaceae | S | A | | |
| <i>Maesa montana</i> DC. | Myrsinaceae | S | A | | |
| <i>Maoutia puya</i> Wedd. | Urticaceae | S | A | | |
| <i>Maytenus bookeri</i> Loes. | Celastraceae | S | A | | |
| <i>Melastoma malabathricum</i> L. | Melastomataceae | S | A | | |
| <i>Morinda augustifolia</i> Roxb. | Rubiaceae | S | A | | chenong |
| <i>Morinda umbellata</i> L. | Rubiaceae | S | A | | |
| <i>Munronia pinnata</i> (Wall.) Harms. | Meliaceae | S | A | | |
| <i>Murraya koenigii</i> (L.) Spreng. | Rutaceae | S | A | Baghmara, BNP, Tripto Siju, Tura peak, Nokrek | Machlipuma |
| <i>Mussaenda corymbosa</i> Roxb. | Rubiaceae | S | A | | |
| <i>Mussaenda roxburghii</i> Hk.f. | Rubiaceae | S | A | | amanget budu |
| <i>Mycetia longifolia</i> (Wall.) O.Kuntze | Rubiaceae | S | A | Baghmara | |
| <i>Nepenthes khasiana</i> Hk.f. | Nepenthaceae | S | A | | memang kokhi |
| <i>Osbeckia nutans</i> Triana | Melastomataceae | S | A | Baghmara | |
| <i>Osbeckia rostrata</i> D.Don | Melastomataceae | S | A | BNP, Nokrek | |
| <i>Oxyspora cernua</i> (Roxb.) Triana | Melastomataceae | S | A | | Rare |
| <i>Paramignya micrantha</i> Kurz. | Rutaceae | S | A | | endemic |
| <i>Paramignya scandens</i> (Griff.) Craib. | Rutaceae | S | A | Nokrek | |
| <i>Pavetta tomentosa</i> Roxb. ex Sm. | Rubiaceae | S | A | | |
| <i>Phlogacanthus thyrsoflorus</i> (Roxb.) Nees | Acanthaceae | S | A | Baghmara, BNP, Tripto Siju, Tura peak | |
| <i>Phlogacanthus tubiflorus</i> Nees. | Acanthaceae | S | A | Nokrek | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|----------------|-------|------|------------------------|-----------------|
| <i>Phoenix acaulis</i> Ham. | Arecaceae | S | A | Baghmara, Nokrek | |
| <i>Phyllanthus glaucus</i> Wall. ex Muell.-Arg. | Euphorbiaceae | S | A | BNP | |
| <i>Plectranthus ternifolius</i> D.Don. | Lamiaceae | S | A | | |
| <i>Pogostemon amaranthoides</i> Benth. | Lamiaceae | S | A | BNP | Samaki |
| <i>Pogostemon benghalensis</i> (Burm.f.) Kuntze | Lamiaceae | S | A | BNP | |
| <i>Pogostemon parviflorus</i> Benth. | Lamiaceae | S | A | | |
| <i>Pouzolzia sanguinea</i> Merr. | Urticaceae | S | A | BNP, Tura peak | |
| <i>Pseudaecbmanthera glutinosa</i> (Nees.) Bremek. | Acanthaceae | S | A | BNP, NNK, | |
| <i>Pseuderanthemum indicum</i> A.M. & J.M. Cowan | Acanthaceae | S | A | NNK, TURA | |
| <i>Psychotria denticulata</i> Wall. | Rubiaceae | S | A | | ranggal kigol |
| <i>Psychotria erratica</i> Hk.f. | Rubiaceae | S | A | | |
| <i>Psychotria monticola</i> Kurz. | Rubiaceae | S | A | Baghmara, Tura peak | |
| <i>Psychotria</i> sp. | Rubiaceae | S | A | Nokrek | |
| <i>Psychotria simplicifolia</i> Kurz. | Rubiaceae | S | A | | |
| <i>Pteracanthus griffithianus</i> Bremek. | Acanthaceae | S | A | BNP | |
| <i>Randia longiflora</i> Lamk. | Rubiaceae | S | A | | |
| <i>Randia spinosa</i> (Thunb.) Poir. | Rubiaceae | S | A | | |
| <i>Ricinus communis</i> L.. | Euphorbiaceae | S | A | Baghmara | |
| <i>Rivea hypocrateriformis</i> Choisy | Convolvulaceae | S | A | Tripto Siju, Tura peak | |
| <i>Rivea ornata</i> Chois. | Convolvulaceae | S | A | Nokrek | Machebudu |
| <i>Rosa clinophylla</i> Thory | Rosaceae | S | A | | |
| <i>Rosa moschata</i> Herrm. | Rosaceae | S | A | | |
| <i>Rotula aquatica</i> Lour. | Ehretiaceae | S | A | | |
| <i>Rubus alceifolius</i> Poir. | Rosaceae | S | A | Nokrek | |
| <i>Rubus ellipticus</i> Sm. | Rosaceae | S | A | Nokrek, Tura peak | Dukhisimpak |
| <i>Rubus hexagynus</i> Roxb. | Rosaceae | S | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|---------------|-------|------|---|--------------------------------------|
| <i>Rubus niveus</i> Thunb. | Rosaceae | S | A | | thinki |
| <i>Rubus</i> sp. | Rosaceae | S | A | BNP | Nachig-wagam |
| <i>Sarcococca saligna</i> (D. Don.) Muell.-Arg. | Buxaceae | S | A | | |
| <i>Schefflera</i> sp | Araliaceae | S | A | Nokrek, Tura peak | |
| <i>Securinega virosa</i> (Roxb. ex Willd.) Baill. | Euphorbiaceae | S | A | BNP, Baghmara, Nokrek, Tripto Siju, Tura peak | Namikron/ Dumikron |
| <i>Sida acuta</i> Burm.f. | Malvaceae | S | A | Baghmara, BNP, Tura peak | |
| <i>Sida rhombifolia</i> L. | Malvaceae | S | A | Baghmara | |
| <i>Solanum erianthum</i> D. Don | Solanaceae | S | A | Nokrek | Khimkaru |
| <i>Solanum myriacanthum</i> Dunal | Solanaceae | S | A | | |
| <i>Solanum torvum</i> Sw. | Solanaceae | S | A | Nokrek | |
| <i>Solanum violaceum</i> Ort. | Solanaceae | S | A | Nokrek, Tripto Siju, Tura peak | |
| <i>Stachytarpheta dichotoma</i> Vahl. | Verbenaceae | S | A | Nokrek, Tura peak | |
| <i>Stachytarpheta jamaicensis</i> (L.) Vahl. | Verbenaceae | S | A | Baghmara | |
| <i>Stixis suaveolens</i> (Roxb.) Bail. | Capparidaceae | S | A | Nokrek | Marochibudu |
| <i>Strobilanthes neilgherrensis</i> T. Anders | Acanthaceae | S | A | Nokrek | |
| <i>Syzygium cuneatum</i> (Duthie) Balak. | Myrtaceae | S | A | | RARA |
| <i>Tabernaemontana divaricata</i> (L.) R.Br. | Apocynaceae | S | A | BNP, Nokrek, Tura peak, Baghmara | Mikakimpret, Kimdotchi, Mikkakimpret |
| <i>Taxillus vestitus</i> (Wall.) Dans. | Loranthaceae | S | A | | |
| <i>Tephrosia candida</i> (Roxb.) DC. | Fabaceae | S | A | | |
| <i>Tephrosia purpurea</i> Pers. | Fabaceae | S | A | | |
| <i>Tithonia diversifolia</i> A. Gray. | Asteraceae | S | A | Tura peak | |
| <i>Tournefortia viridiflora</i> Wall. | Boraginaceae | S | A | | |
| <i>Trachelospermum lucidum</i> (D. Don.) H. Sch. | Apocynaceae | S | A | | |
| <i>Trigonostemon semperflorens</i> (Roxb.) Muell.-Arg. | Euphorbiaceae | S | A | | Artak |
| <i>Triumfetta pilosa</i> Roth. | Tiliaceae | S | A | Baghmara, Nokrek | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|--|--------------|-------|------|------------------------------------|-----------------|
| <i>Triumfetta rhomboidea</i> Jacq. | Tiliaceae | S | A | Baghmara, BNP, Nokrek, Tripto Siju | Samptri |
| <i>Triumfetta tomentosa</i> Bojer. | Tiliaceae | S | A | Nokrek, BNP | Samndhi |
| <i>Tupidanthus calyptratus</i> Hk.f. & Tb. | Araliaceae | S | A | | |
| <i>Uraria picata</i> Desv. | Fabaceae | S | A | Baghmara | |
| <i>Urena lobata</i> L. | Malvaceae | S | A | Tura peak, Nokrek, BNP, Baghmara | Samdhi |
| <i>Urtica dioica</i> L. | Urticaceae | S | A | Nokrek | |
| <i>Urtica parviflora</i> Roxb. | Urticaceae | S | A | Nokrek | |
| <i>Vaccinium dunalianum</i> Wt. | Vacciniaceae | S | A | | |
| <i>Vaccinium vacciniaceum</i> (Roxb.) Sleum. | Vacciniaceae | S | A | Nokrek | |
| <i>Vernonia scandens</i> DC. | Asteraceae | S | A | Nokrek | |
| <i>Viscum nepalense</i> Spreng. | Loranthaceae | S | A | | |
| <i>Wallichia densiflora</i> Mart. | Arecaceae | S | A | | |
| <i>Zizyphus mauritiana</i> Lamk. | Rhamnaceae | S | A | Baghmara | |
| <i>Arundinaria hirsuta</i> Munro | Bambusaceae | SB | A | | |
| <i>Bambusa arundinacea</i> Willd. | Bambusaceae | SB | A | | |
| <i>Bambusa balcooa</i> Roxb. | Bambusaceae | SB | A | | |
| <i>Bambusa nutans</i> Wall. | Bambusaceae | SB | A | Baghmara | |
| <i>Bambusa pallida</i> Munro | Bambusaceae | SB | A | | wago |
| <i>Bambusa tulda</i> Roxb. | Bambusaceae | SB | A | BNP | |
| <i>Bambusa vulgaris</i> Schrad. | Bambusaceae | SB | A | Baghmara | |
| <i>Cephalostachyum latifolium</i> Munro. | Bambusaceae | SB | A | Baghmara | |
| <i>Dendrocalamus hamiltonii</i> Nees. et Arn. ex Munro | Bambusaceae | SB | A | Tripto Siju | |
| <i>Dendrocalamus strictus</i> Nees. | Bambusaceae | SB | A | BNP, Baghmara | Wadro |
| <i>Melocanna baccifera</i> Skeels | Bambusaceae | SB | A | | |
| <i>Schizostachyum capitatum</i> (Munro) Majumdar | Bambusaceae | SB | A | | |

| Plant species | Family | Habit | Div. | Locality | Vernacular name |
|---|-------------|-------|------|-----------------------------|-----------------|
| <i>Schizostachyum dullooa</i> (Gamble)Majumdar | Bambusaceae | SB | A | | |
| <i>Calamus erectus</i> Roxb. | Arecaceae | SC | A | BNP, Nokrek, Tura peak | Rima |
| <i>Calamus erectus</i> var <i>macrocarpa</i> Roxb. | Arecaceae | SC | A | | |
| <i>Calamus floribundus</i> Griff. | Arecaceae | SC | A | | |
| <i>Calamus gracilis</i> Roxb. | Arecaceae | SC | A | Darugiri | |
| <i>Calamus</i> sp. | Arecaceae | SC | A | BNP | |
| <i>Calamus</i> sp. | Arecaceae | SC | A | BNP, Baghmara, Nokrek | Jaling |
| <i>Daemonorops jenkinsianus</i> Mart. | Arecaceae | SC | A | Baghmara | |
| <i>Derris cuneifolia</i> Benth. | Fabaceae | SC | A | Tura peak | |

Annexure 11: Mammalian distribution

| Order | GCA | Garo Hills | Meghalaya |
|--------------|------------|-------------------|------------------|
| Insectivora | | 4 | 9 |
| Scandentia | | 1 | 2 |
| Chiroptera | 4 | 14 | 39 |
| Primates | 3 | 5 | 8 |
| Pholidota | | 1 | 1 |
| Carnivora | 12 | 19 | 29 |
| Proboscidae | 6 | 8 | 11 |
| Logomorpha | 1 | 1 | 1 |
| Rodenta | 9 | 18 | 38 |

Annexure 12: Elephant death cases reported in Balpakram National Park division, South Garo Hills, Meghalaya

| S. No. | Date | Sex | Age (Years) | Place | Cause | Natural/ Unnatural | No. of Tusks & weight | Remark |
|--------|-----------------|-----------------------|-------------|---------------------------------------|--|-----------------------|--------------------------|---------------------------------------|
| 1 | 941028 | Male Tusker | 40 | Chenggini, Rongra | Electrocution | UN | 2 (30 kg) | |
| 2 | 941226 | Male calf | 1/3 | Jodigittam, Siju | Starvation and dehydration | N | | |
| 3 | 9412dd | Male Tusker Sub-adult | 10 | Gingsning stream, Gulpani Rongra | Bullet injury | UN | | Tusk missing |
| 4 | 950404 | Female Sub-adult | 10 | Dagal stream, Angratoli | Forest fire | N | 2 (250 g) | Tusks with Forest Department) |
| 5 | 950407 | Male calf | 4 | Ropwari, Thaidang, Rongra | Fell down from 62 ft. high cliff while moving on narrow path | N | 2 (280 g) | |
| 6 | 950411 | Female elephant | 42 | Dambukgittam, Siju | Poaching, most probably fired upon | UN | | No tusk |
| 7 | 9504dd – 9507dd | Male Tusker | 45 | Daldam stream, Angratoti | Speared with sharp weapons | UN | | Tusk missing |
| 8 | 950713 | Male Tusker | 45 | Dambuk jongkol, Matchok soram, Rongra | Bullet injury | UN | 1 (15 kg) | |
| 9 | 9507dd-9509dd | Male | NA | Wagekona, Rongra | Electrocution | UN | | Case detected on 950912, Tusk missing |
| 10 | 9507dd-9509dd | Female | NA | Wagekona, Rongra | Electrocution | UN | | Case detected on 950912 |
| 11 | 9507dd-9509dd | Male | NA | Wagekona, Rongra | Electrocution | UN | | Case detected on 950912, Tusk missing |
| 12 | 9507dd-9509dd | Male | NA | Wagekona, Rongra | Electrocution | UN | | Case detected on 950912, Tusk missing |
| 13 | 951001 | Female | 45 | Siju | by some miscreants | UN | | |
| 14 | 960409 | Male | 50 | Rongsu-agal, Rongra | Bullet injury on head | UN | | No action |

| S. No. | Date | Sex | Age (Years) | Place | Cause | Natural/ Unnatural | No. of Tusks & weight | Remark |
|--------|--------|-------------------------|-------------|------------------------|--|-----------------------|--------------------------|--|
| 15 | 961015 | NA (probably female) | NA | Rewak | Accidentally fall from high cliff | N | | No action |
| 16 | 970511 | NA | NA | Artika, Siju | Poaching | UN | | |
| 17 | 970512 | Male | NA | Rongsil stream | Poaching | UN | | |
| 18 | 971117 | Male | 35 | Himdangi area, Mahadeo | Poaching | UN | | |
| 19 | 980125 | Male | 11 | Badri Rongdong gittam | Accidental, killed for self defense | UN | | |
| 20 | 980207 | Female infant | 2 | Panda, Baghmara | Disease (Asrophic sinitis ???) | N | | |
| 21 | 980218 | Male tusker | 35 | Gaonbari, Rongra | Poaching | UN | | |
| 22 | 980404 | Male tusker | 35 | Rongra range | Poaching, injury on head | UN | | |
| 23 | 980502 | Female | 16 | Jadigittam, Siju | Cronic infection of respiratory system | N | | |
| 24 | 980922 | Female | 22 | Kanai, Mahadeo | Due to asphyxia by drowning accidentally | N | | Departmental elephant (Hiralmati) |
| 25 | 990424 | Male | 55 | Dambuk atong, Rongra | Normal weakness due to old age | | | Elephant died 24 months ago, Post-mortem on 970510 |

(Source: SFD 2000)
available

Note: N: Natural death, UN: Un-natural death and NA: Information not

Annexure 13: Elephant death cases reported in East and West Garo Hills division, Tura, Meghalaya

| S. No. | Date | Sex | Age Class | Place | Cause | Natural/ Unnatural | No. of Tusks & weight | Remark |
|--------|-------------------|----------|-----------|------------------------|---|-----------------------|-----------------------------|--------|
| 1 | 910310 | M | A | EGH | Anthrax | N/UN | | |
| 2 | 910718 | M | Y | WGH | NA | NA | | |
| 3 | 930512 | M | SA | EGH | NA | NA | | |
| 4 | 940510 | M Tusker | A | EGH | Poaching | UN | | |
| 5 | 941028 | F | A | EGH | NA | NA | | |
| 6 | 941126 | M | Y | EGH | Poaching | UN | | |
| 7 | 94mmdd- 95mmdd | NA | NA | EGH | NA | NA | | |
| 8 | 94mmdd- 95mmdd | F | A | EGH | NA | NA | | |
| 9 | 94mmdd 5mmdd | M | A | WGH | Anemia and peritonitis due to gun shot | UN | | |
| 10 | 950331 | M Makna | A | WGH | Septicaemica due to spear bound on neck | UN | | |
| 11 | 950331 | M Tusker | A | WGH | NA | NA | | |
| 12 | 951121 | NA | NA | WGH | NA | NA | | |
| 13 | 9510dd | NA | NA | EGH | Poaching | UN | | |
| 14 | 960316 | M | NA | ? Tujingiri | NA | NA | | |
| 15 | 9607dd | NA | Y | ? Baljek songgittam | NA | NA | | |
| 16 | 9607dd | M Tusker | A | EGH | NA | NA | | |
| 17 | 9706dd | F | A | EGH | NA | NA | | |

| S. No. | Date | Sex | Age Class | Place | Cause | Natural/ Unnatural | No. of Tusks & weight | Remark |
|--------|--------|----------|-----------|------------------------------------|--|-----------------------|-----------------------------|--------|
| 18 | 970727 | F | A | ? Chibongiri (near PWD road) | NA | NA | | |
| 19 | 970819 | M Tusker | A | ? Chiringpara | NA | NA | | |
| 20 | 970717 | F | A | ? Daramihas | NA | NA | | |
| 21 | 970830 | F | A | ? Daramchas | NA | NA | | |
| 22 | 971010 | F | A | WGH | NA | NA | | |
| 23 | 990607 | F | A | ? Kendrikona (Chaliapati) | Due to acute pneumonia | N/UN | | |
| 24 | 971122 | M | A | WGH | Poaching, Head chopped with axe | UN | | |
| 25 | 970404 | F | A | ? Romba- adingiri | Accidently felt down into deep gorge | UN | | |
| 26 | 980724 | F | A | ? Prolongiri area | NA | NA | | |
| 27 | 980913 | M | A | WGH | NA | NA | | |
| 28 | 990204 | M | A | WGH | NA | NA | | |
| 29 | 990204 | F | A | WGH | NA | NA | | |

(Source: SFD 2000)

Note: N: Natural death, UN: Un-natural death and NA: Information not

available

Annexure 14: Checklist of few bird species from Balpakram National Park and surroundings (Manoj and Jayapal, personal Communication). Asterisk indicates that species is included in bird habitat relationship analysis.

| S . No. | Common Name | Species | Family |
|---------|----------------------------|----------------------------------|-------------------|
| 1 | Darter | <i>Anhinga rufa</i> | Phalacrocoracidae |
| 2 | Pond Heron | <i>Ardeola grayii</i> | Ardiedae |
| 3 | Little Egret | <i>Egretta garzetta</i> | Ardiedae |
| 4 | Cattle Egret | <i>Bubulcus ibis</i> | Ardiedae |
| 5 | Common Teal | <i>Anas crecca</i> | Anatidae |
| 6 | Lesser Whistling Teal | <i>Dendrocygna javanica</i> | Anatidae |
| 7 | Common Merganser | <i>Mergus merganser</i> | Anatidae |
| 8 | * Sparrow Hawk | <i>Accipiter nisus</i> | Accipitridae |
| 9 | * Crested serpent eagle | <i>Spilornis cheela</i> | Accipitridae |
| 10 | * Buzzard spp | <i>Buteo spp</i> | Accipitridae |
| 11 | * Blackcrested Baza | <i>Aviceda leuphotes</i> | Accipitridae |
| 12 | * Short-Toed Eagle | <i>Circaetus gallicus</i> | Accipitridae |
| 13 | Crested Hawk Eagle | <i>Spizaetus cirrhatus</i> | Accipitridae |
| 14 | Bonnelli's Hawk Eagle | <i>Hieraaetus fasciatus</i> | Accipitridae |
| 15 | Black winged Kite | <i>Elanus caeruleus</i> | Accipitridae |
| 16 | Shikra (?) | <i>Accipiter badius</i> | Accipitridae |
| 17 | Black Eagle | <i>Ictinaetus malayensis</i> | Accipitridae |
| 18 | * Oriental hobby | <i>Falco severus</i> | Falconidae |
| 19 | * Kestrel Falco | <i>Falco tinnunculus</i> | Falconidae |
| 20 | * Lesser Kestrel | <i>Falco naumanni</i> | Falconidae |
| 21 | * Red Jungle Fowl | <i>Gallus gallus</i> | Phasianidae |
| 22 | * Kaleej Pheasant | <i>Lophura leucomelana</i> | Phasianidae |
| 23 | * Peacock Pheasant | <i>Polyplectron bicalcaratum</i> | Phasianidae |
| 24 | White breasted waterhen | <i>Amaurornis phoenicurus</i> | Rallidae |
| 25 | * Thickbilled green pigeon | <i>Treron curvirostra</i> | Columbidae |
| 26 | * Rufous turtle dove | <i>Streptopelia orientalis</i> | Columbidae |
| 27 | * Emerald dove | <i>Chalcophaps indica</i> | Columbidae |

| S. No. | Common Name | Species | Family |
|--------|--------------------------------|-----------------------------------|---------------|
| 28 | Red turtle dove | <i>Streptopelia tranquebarica</i> | Columbidae |
| 29 | Spotted dove | <i>Streptopelia chinensis</i> | Columbidae |
| 30 | * Lorikeet | <i>Loriculus vernalis</i> | Psittacidae |
| 31 | Red breasted parakeet | <i>Psittacula alexandri</i> | Psittacidae |
| 32 | * Indian cuckoo | <i>Cuculus micropterus</i> | Coculidae |
| 33 | * Common hawk cuckoo | <i>Cuculus varius</i> | Coculidae |
| 34 | Emerald cuckoo | <i>Chalcites maculatus</i> | Coculidae |
| 35 | * Drongo cuckoo | <i>Surniculus lugubris</i> | Coculidae |
| 36 | Pied crested cuckoo | <i>Clamator jacobinus</i> | Coculidae |
| 37 | * Coucal | <i>Centropus sinensis</i> | Coculidae |
| 38 | Lesser coucal | <i>Centropus bengalensis</i> | Coculidae |
| 39 | * Large green billed malkoha | <i>Rhopodytes tristis</i> | Coculidae |
| 40 | Barred owlet | <i>Glaucidium cuculoides</i> | Strigidae |
| 41 | * Longtailed nightjar | <i>Caprimulgus macrurus</i> | Caprimulgidae |
| 42 | * Red headed trogon | <i>Harpactes erythrocephalus</i> | Trogonidae |
| 43 | * Palm swift | <i>Cypsiurus parvus</i> | Apodidae |
| 44 | * Himalayan swiftlet | <i>Collocalia brevirostris</i> | Apodidae |
| 45 | * Whitebreasted kingfisher | <i>Halcyon smyrnensis</i> | Alcedinidae |
| 46 | Himalayan pied kingfisher | <i>Ceryle lugubris</i> | Alcedinidae |
| 47 | Blyth's /great blue kingfisher | <i>Alcedo hercules</i> | Alcedinidae |
| 48 | Common kingfisher | <i>Alcedo atthis</i> | Alcedinidae |
| 49 | Hoopoe | <i>Upupa epops</i> | Upupidae |
| 50 | * Chestnut headed bee-eater | <i>Merops leschenaultii</i> | Meropidae |
| 51 | Green bee-eater | <i>Merops orientalis</i> | Meropidae |
| 52 | Blue bearded bee-eater | <i>Nyctyornis athertoni</i> | Meropidae |
| 53 | * Indian roller | <i>Coracias benghalensis</i> | Coraciidae |
| 54 | * Indian pied hornbill | <i>Anthracoceros coronatus</i> | Bucrotidae |
| 55 | Great pied hornbill | <i>Buceros bicornis</i> | Bucrotidae |
| 56 | * Great hill barbet | <i>Megalaima virens</i> | Capitonidae |

| S. No. | Common Name | Species | Family |
|--------|-------------------------------------|--|--------------|
| 57 | * Large green barbet | <i>Megalaima zeylonica</i> | Capitonidae |
| 58 | Lineated barbet | <i>Megalaima lineata</i> | Capitonidae |
| 59 | * Bluethroated barbet | <i>Megalaima asiatica</i> | Capitonidae |
| 60 | Blue eared barbet | <i>Megalaima australis</i> | Capitonidae |
| 61 | Crimson breasted barbet | <i>Megalaima haemacephala</i> | Capitonidae |
| 62 | * Speckled piculet | <i>Picumnus innominatus</i> | Picidae |
| 63 | * Rufous piculet | <i>Sasia ochrasia</i> | Picidae |
| 64 | * Rufous woodpecker | <i>Microptermus brachyurus</i> | Picidae |
| 65 | Blacknaped green woodpecker | <i>Picus canus</i> | Picidae |
| 66 | Golden backed three-toed woodpecker | <i>Dinopium shorii</i> | Picidae |
| 67 | Larger goldenbacked woodpecker | <i>Chrysocolaptes lucidus</i> | Picidae |
| 68 | Falvous breasted pied woodpecker | <i>Dendrocopos macei</i> | Picidae |
| 69 | Greycrowned pygmy woodpecker | <i>Dendrocopos canicapillus</i> | Picidae |
| 70 | Large yellow naped woodpecker | <i>Picus flavinucha</i> | Picidae |
| 71 | Small yellow naped woodpecker | <i>Picus chlorolophus</i> | Picidae |
| 72 | Redeared bay wood pecker | <i>Blythipicus pyrrhotis</i> | Picidae |
| 73 | * Longtailed broadbill | <i>Psarismus lunatus</i> ?? <i>dalhousiae</i> | Eurylamidae |
| 74 | * Golden oriole | <i>Oriolus oriolus</i> | Oriolidae |
| 75 | Blacknaped oriole | <i>Oriolus chinensis</i> | Oriolidae |
| 76 | * Maroon oriole | <i>Oriolus trailii</i> | Oriolidae |
| 77 | * Blackheaded oriole | <i>Oriolus xanthornus</i> | Oriolidae |
| 78 | * Swallow | <i>Hirundo rustica</i> | Hirundinidae |
| 79 | * Sand Martin | <i>Riparia riparia</i> | Hirundinidae |
| 80 | * Greybacked shrike | <i>Lanius tephronotus</i> | Laniidae |
| 81 | * Rufousbacked shrike | <i>Lanius schach tricolor</i> | Laniidae |
| 82 | * Brown shrike | <i>Lanius cristatus</i> | Laniidae |
| 83 | * Grey drongo | <i>Dicrurus leucophaeus</i> | Dicruridae |
| 84 | Black drongo | <i>Dicrurus adsimilis</i> | Dicruridae |

| S. No. | Common Name | Species | Family |
|--------|-------------------------------|-----------------------------------|---------------|
| 85 | * Bronzed drongo | <i>Dicrurus aeneus</i> | Dicruridae |
| 86 | * Lesser rackettailed drongo | <i>Dicrurus remifer</i> | Dicruridae |
| 87 | * Greater rackettailed drongo | <i>Dicrurus paradiseus</i> | Dicruridae |
| 88 | Haircrested drongo | <i>Dicrurus hottentottus</i> | Dicruridae |
| 89 | * Ashy swallow shrike | <i>Artamus fuscus</i> | Artamidae |
| 90 | * Hill myna | <i>Gracula religiosa</i> | Sturnidae |
| 91 | * Greyheaded myna | <i>Sturnus malabaricus</i> | Sturnidae |
| 92 | Brahminy myna | <i>Sturnus pagodarum</i> | Sturnidae |
| 93 | Pied myna | <i>Sturnus contra</i> | Sturnidae |
| 94 | Jungle myna | <i>Acridotheres fuscus</i> | Sturnidae |
| 95 | Common myna | <i>Acridotheres tristis</i> | Sturnidae |
| 96 | Jungle crow | <i>Corvus macrorhynchos</i> | Corvidae |
| 97 | Green magpie | <i>Cissa chinensis</i> | Corvidae |
| 98 | Indian tree pie | <i>Dendrocitta vagabunda</i> | Corvidae |
| 99 | Himalayan tree pie | <i>Dendrocitta formosae</i> | Corvidae |
| 100 | * Pied flycatcher shrike | <i>Hemipus picatus</i> | Campephagidae |
| 101 | * Large wood shrike | <i>Tephrodornis virgatus</i> | Campephagidae |
| 102 | * Large cuckoo shrike | <i>Coracina novaehollandiae</i> | Campephagidae |
| 103 | * Smaller grey cuckoo shrike | <i>Coracina melaschistos</i> | Campephagidae |
| 104 | * Scarlet minivet | <i>Pericrocotus flammeus</i> | Campephagidae |
| 105 | * Longtailed minivet | <i>Pericrocotus ethologus</i> | Campephagidae |
| 106 | * Small minivet | <i>Pericrocotus cinnamomeus</i> | Campephagidae |
| 107 | * Common iora | <i>Aegithinia tiphia</i> | Irenidae |
| 108 | * Goldfronted chloropsis | <i>Chloropsis aurifrons</i> | Irenidae |
| 109 | * Orange bellied chloropsis | <i>Chloropsis hardwickii</i> | Irenidae |
| 110 | * Goldmantled chloropsis | <i>Chloropsis cochinchinensis</i> | Irenidae |
| 111 | * Fairy bluebird | <i>Irene puella</i> | Irenidae |
| 112 | * Finchbilled bulbul | <i>Spizixos canifrons</i> | Pycnonotidae |
| 113 | * Blackheaded yellow bulbul | <i>Pycnonotus melanicterus</i> | Pycnonotidae |

| S . No. | Common Name | Species | Family |
|---------|----------------------------------|------------------------------------|--------------|
| 114 | * Red whiskered bulbul | <i>Pycnonotus jocosus</i> | Pycnonotidae |
| 115 | * Red vented bulbul | <i>Pycnonotus cafer</i> | Pycnonotidae |
| 116 | * Olive bulbul | <i>Hypsipetes viridiscens</i> ?? | Pycnonotidae |
| 117 | Rufous bellied bulbul (?) | <i>Hypsipetes mclellandi</i> | Pycnonotidae |
| 118 | * Black bulbul | <i>Hypsipetes madagascariensis</i> | Pycnonotidae |
| 119 | * Brown eared bulbul | <i>Hypsipetes flavalus</i> | Pycnonotidae |
| 120 | * Whitethroated bulbul | <i>Criniger flaveolus</i> | Pycnonotidae |
| 121 | * Spotted babbler | <i>Stachyris ruficeps</i> | Muscicapidae |
| 122 | * Slatyheaded scimitar babbler | <i>Pomatorhinus horsfieldii</i> | Muscicapidae |
| 123 | * Redfronted babbler | <i>Pallorneum ruficeps</i> | Muscicapidae |
| 124 | * Blackchinned babbler ? | <i>Stachyris pyrrhops</i> | Muscicapidae |
| 125 | Jungle babbler | <i>Turdoides striatus</i> | Muscicapidae |
| 126 | * yellow breasted babbler | <i>Macronous gularis</i> | Muscicapidae |
| 127 | * Redcapped babbler | <i>Timalia pileata</i> | Muscicapidae |
| 128 | * Necklace laughing thrush | <i>Garrulax moniliger</i> | Muscicapidae |
| 129 | * Blackgorgetted laughing thrush | <i>Garrulax pectoralis</i> | Muscicapidae |
| 130 | Whitcrested laughing thrush | <i>Garrulax leucolophus</i> | Muscicapidae |
| 131 | * Nepal babbler | <i>Alcippe nipalensis</i> | Muscicapidae |
| 132 | * Blackcapped sibia | <i>Heterophasia capistrata</i> | Muscicapidae |
| 133 | Chestnutbacked sibia | <i>Heterophasia annectens</i> | Muscicapidae |
| 134 | Black redstart | <i>Phoenicurus ochrurus</i> | Muscicapidae |
| 135 | Plumbeous redstart | <i>Rhyacornis fuliginosus</i> | Muscicapidae |
| 136 | Whitecapped redstart | <i>Chaimorornis leucocephalus</i> | Muscicapidae |
| 137 | Stone chat | <i>Saxicola torquata</i> | Muscicapidae |
| 138 | Magpie robin | <i>Copsychus saularis</i> | Muscicapidae |
| 139 | Shama | <i>Copsychus malabaricus</i> | Muscicapidae |
| 140 | * Little pied flycatcher | <i>Ficedula westermanni</i> | Muscicapidae |
| 141 | * Redbreasted flycatcher | <i>Ficedula parva</i> | Muscicapidae |
| 142 | * Pygmy blue flycatcher | <i>Muscicapella hodgsonii</i> | Muscicapidae |

| S . No. | Common Name | Species | Family |
|---------|------------------------------------|----------------------------------|--------------|
| 143 | * Bluethroated flycatcher | <i>Cyornis rubeculoides</i> | Muscicapidae |
| 144 | * Greyheaded flycatcher | <i>Culicicapa ceylonensis</i> | Muscicapidae |
| 145 | * Whitethroated fantail flycatcher | <i>Rhipidura albicollis</i> | Muscicapidae |
| 146 | * Blacknaped blue flycatcher | <i>Hypothymis azurea</i> | Muscicapidae |
| 147 | * Blyth's reed wabblers | <i>Acrocephalus dumetorum</i> | Muscicapidae |
| 148 | * Dull green leaf warbler | <i>Phylloscopus trochiloides</i> | Muscicapidae |
| 149 | * Yellow browed leaf warbler | <i>Phylloscopus inornatus</i> | Muscicapidae |
| 150 | * Large billed leaf warbler | <i>Phylloscopus magnirostris</i> | Muscicapidae |
| 151 | * Large crowned leaf warbler | <i>Phylloscopus coronatus</i> | Muscicapidae |
| 152 | * Grey headed flycatcher warbler | <i>Seicercus xanthoschistos</i> | Muscicapidae |
| 153 | * Allied flycatcher wabler | <i>Seicercus affinis</i> | Muscicapidae |
| 154 | Blackbacked forktail | <i>Enicurus immaculatus</i> | Muscicapidae |
| 155 | Little forktail | <i>Enicurus scouleri</i> | Muscicapidae |
| 156 | Leschenault's forktail | <i>Enicurus lesbaultii</i> | Muscicapidae |
| 157 | Blue whistling thrush | <i>Myophonus caeruleus</i> | Muscicapidae |
| 158 | Blue rock thrush | <i>Monticola solitarius</i> | Muscicapidae |
| 159 | Orange headed ground thrush | <i>Zoothera citrina</i> | Muscicapidae |
| 160 | Large brownthrush | <i>Zoothera monticola</i> | Muscicapidae |
| 161 | * Dark grey bush chat | <i>Saxicola ferrea</i> | Muscicapidae |
| 162 | * Franklin's wren warbler | <i>Prinia hodgsoni</i> | Muscicapidae |
| 163 | Ashy wren wabler | <i>Prinia socialis</i> | Muscicapidae |
| 164 | Plain wren wabler | <i>Prinia subflava</i> | Muscicapidae |
| 165 | Black-necked tailorbird | <i>Orthotomus atrogularis</i> | Muscicapidae |
| 166 | * Sultat tit | <i>Melanochlora sultanea</i> | Paridae |
| 167 | Velvet fronted nuthatch | <i>Sitta frontalis</i> | Sittidae |
| 168 | * Indian tree pipit | <i>Anthus hodgsoni</i> | Motacillidae |
| 169 | White wagtail | <i>Motacilla alba</i> | Motacillidae |
| 170 | Forest wagtail | <i>Motacilla indica</i> | Motacillidae |
| 171 | * Scarlet backed flowerpecker | <i>Dicaeum cruentatum</i> | Dicaeidae |

| S . No. | Common Name | Species | Family |
|------------|------------------------------|----------------------------------|---------------|
| 172 | * Rubycheck | <i>Anthreptesingalensis</i> | Nectariniidae |
| 173 | * Purple sunbird | <i>Nectarinia asiatica</i> | Nectariniidae |
| 174 | * Nepal yellowbacked sunbird | <i>Aethopyga nipalensis</i> | Nectariniidae |
| 175 | * Yellow backed sunbird | <i>Aethopyga siparaja</i> | Nectariniidae |
| 176 | * Little spider hunter | <i>Arachnothera longirostris</i> | Nectariniidae |
| 177 | * Streaked spider hunter | <i>Arachnothera magna</i> | Nectariniidae |
| 178 | * Blackbreasted sunbird | <i>Aethopyga saturata</i> | Nectariniidae |
| 179 | * White-eye | <i>Zosterops palpebrosus</i> | Zosteropidae |
| 180 | * Tree sparrow | <i>Passer montanus</i> | Ploceidae |
| 181 | * House sparrow | <i>Passer domesticus</i> | Ploceidae |
| 182 | * Whitebacked munia | <i>Lonchura striata</i> | Ploceidae |
| 183 | * spotted munia | <i>Lonchura punctulata</i> | Ploceidae |
| 184 | Chestnut bunting | <i>Emberiza rutila</i> | Emberizidae |

Annexure 15: List of Butterflies in GCA (1998)

| S. No | Species | Family | Common Name | Location |
|-------|---------------------------------|--------------|--------------------------|---------------------------------------|
| 1 | <i>Danus genutia</i> | Danaidae | The common tiger | Mahadeo |
| 2 | <i>Danus chrysippus</i> | Danaidae | The plain tiger | Mahadeo |
| 3 | <i>Euploecore</i> | Danaidae | The common India crow | Mahadeo |
| 4 | <i>Melanitis ledaismene</i> | Satyridae | The common evening brown | Mahadeo, Baghamara Road, Angratoli RF |
| 5 | <i>Argynnis spp.</i> | Nymphalidae | | Mahadeo |
| 6 | <i>Neptis spp.</i> | Nymphalidae | | Angratoli RF |
| 7 | <i>Precis atlites</i> | Nymphalidae | The grey pancy | BNP, Angratoli RF |
| 8 | <i>Precis lemonias</i> | Nymphalidae | The lemon pency | Mahadeo, Siju, Baghamara RF |
| 9 | <i>Papilio helenus</i> | Papilionidae | The red Helen | Baghamara-Siju-Tura Road side |
| 10 | <i>Papilio polytesromulus ?</i> | Papilionidae | The common mormon | Mahadeo. Siju, Baghamara Road side |
| 11 | <i>Papilio chaon ?</i> | Papilionidae | The yellow Helen | Baghamara-Tura Road side |
| 12 | <i>Troides Helena</i> | Papilionidae | The common birdwing | Baghamara-Tura Road side |
| 13 | <i>Catopsilia crocale</i> | Papilionidae | The common emigrant | Mahadeo, Baghamara-Tura Road side |
| 14 | <i>Eurema spp.</i> | Papilionidae | | Mahadeo, Baghamara-Tura Road side |
| 15 | <i>Ixias pyrene</i> | Pieridae | The yellow orange tip | Angratoli RF, |
| 16 | <i>Pelopidas mathias ?</i> | Hesperiidae | The small banded swift | Tura Road side |
| 17 | <i>Udaspes folus ?</i> | Hesperiidae | The grass Demons | Tura Road side |
| 18 | <i>Issoria sinha ?</i> | Hesperiidae | The Vagrent | Baghamara Road side |

Annexure 16: List of tree species (sorted by local names) interviewed as a food item for wildlife in GCA.

[The same list is used to carry out the survey on utilisation of tree species by local people. Here, the # sign after Botanical name of species indicates the use of species by wildlife. Other species either not used or information is not available]

| S. No. | Botanical name | Common name |
|--------|-------------------------------------|---------------------------------------|
| 1 | <i>Micromelum integerrimum</i> | Aburispil |
| 2 | <i>Duabunga grandiflora</i> | Achim/bolchhim |
| 3 | <i>Saurauia nepaulensis</i> | Adambak |
| 4 | <i>Pterospermum acerifolium</i> # | Adingok |
| 5 | <i>Aquilaria agallocha</i> | Agalbol |
| 6 | <i>Dillenia pentagyna</i> # | Agatchi |
| 7 | <i>Sapium euginiaefolium</i> | Agong |
| 8 | <i>Randia uliginosa</i> | Agrenda/agreng |
| 9 | <i>Lagerstroemia speciosa</i> | Ajakari/bolasari |
| 10 | <i>Bursera serrata</i> # | Ambilatong/tekring |
| 11 | <i>Embllica officinalis</i> # | Ambre |
| 12 | <i>Ficus semicordata</i> # | Aminsep |
| 13 | <i>Elaeocarpus rugosus</i> # | Ankisipak |
| 14 | <i>Artocarpus gomezianus</i> # | Armu/arimu |
| 15 | <i>Terminalia citrina</i> | Artak |
| 16 | <i>Garcinia tinctoria</i> # | Aruwak |
| 17 | <i>Drimycarpus racemosus</i> | Babari |
| 18 | <i>Meliosma simplicifolia</i> | Babari jaksram |
| 19 | <i>Bauhinia malabarica</i> | Bakbakil/megongtak |
| 20 | <i>Vitex glabrata</i> | Bandikuri |
| 21 | <i>Vitex pubescens</i> | Bhodia |
| 22 | <i>Firmiana colorata</i> | Bokta |
| 23 | <i>Macaranga denticulata</i> | Bolajak/chhagro |
| 24 | <i>Knema linifolia</i> | Bolanchi |
| 25 | <i>Aphanamixis polystachya</i> | Bolapal/bolsampal |
| 26 | <i>Albizia stipulata</i> | Bolapu |
| 27 | <i>Litsea monopelata</i> | Bolbet |
| 28 | <i>Tetrameles nudiflora</i> # | Bolbok/awek |
| 29 | <i>Toona ciliata</i> | Bolbret |
| 30 | <i>Ilex embelioides</i> | Bolchhenda |
| 31 | <i>Bombax ceiba</i> | Bolchhu |
| 32 | <i>Glochidion velutinum</i> | Bolchiring |
| 33 | <i>Schima wallichii</i> | Boldak |
| 34 | <i>Pithecellobium monodelphum</i> | Boldaru |
| 35 | <i>Kydia calycina</i> | Boldubok |
| 36 | <i>Lanea grandis</i> # | Bole agru/jiga/dome |
| 37 | <i>Polyalthia simiarum</i> # | Bolgisim |
| 38 | <i>Celtis tetrandia</i> | Bolgitchak |
| 39 | <i>Holarrhena antidysenterica</i> # | Bolgolmatra/matalwe/bolmatra/matmande |

| S. No. | Botanical name | Common name |
|--------|-------------------------------------|-------------------------------------|
| 40 | <i>Ligustrum robustum</i> | Bolgreng |
| 41 | <i>Gynocardia odorata</i> | Bolibu |
| 42 | <i>Glochidion sphaerogynum</i> # | Boljagro |
| 43 | <i>Actinodaphne augustifolia</i> | Boljalik |
| 44 | <i>Derris robusta</i> | Bolkakharu |
| 45 | <i>Trewia nudiflora</i> | Bolkha/bolklap |
| 46 | <i>Rhus succedanea</i> | Bolkhat-thi |
| 47 | <i>Walsura tubularis</i> | Bolkingrak |
| 48 | <i>Pithecellobium heterophyllum</i> | Bolmangal/mangal |
| 49 | <i>Acronychia pedunculata</i> | Bolmapu |
| 50 | <i>Dalbergia paniculata</i> # | Bolmendu |
| 51 | <i>Calophyllum polyanthum</i> | Bolmendu |
| 52 | <i>Croton caudatus</i> | Bolmisak |
| 53 | <i>Rhus accuminata</i> | Bolmising/bolmicheng |
| 54 | <i>Ficus lamponga</i> | Bolmitap |
| 55 | <i>Kaeya floribunda</i> | Bolong |
| 56 | <i>Cryptocarya andersonii</i> | Bolong bolanchi/boljadong/boldujong |
| 57 | <i>Albizia chinensis</i> # | Bolphu |
| 58 | <i>Aesculus assamica</i> # | Bolribu/renot |
| 59 | <i>Shorea robusta</i> | Bolsal |
| 60 | <i>Grewia microcos</i> # | Bolsubret/damsuri |
| 61 | <i>Ilex umbellulata</i> # | Boltajong |
| 62 | <i>Mallotus roxburghianus</i> # | Boltatu |
| 63 | <i>Castanopsis purpurella</i> | Chako |
| 64 | <i>Castanopsis hystrix</i> | Chako chiring |
| 65 | <i>Syzygium cumini</i> # | Chambu |
| 66 | <i>Syzygium operculatum</i> # | Chambu sirsang |
| 67 | <i>Eurya accuminata</i> # | Chamisi |
| 68 | <i>Neocinnamomum caudatum</i> | Chammejam |
| 69 | <i>Aporosa dioica</i> # | Chamolja/Chamsia |
| 70 | <i>Michelia champaca</i> | Champa |
| 71 | <i>Ailanthus integrifolia</i> | Chandana |
| 72 | <i>Sapium baccatum</i> | Changsim/cherasu |
| 73 | <i>Pterigota alata</i> # | Charapak |
| 74 | <i>Morinda augustifolia</i> # | Chegong |
| 75 | <i>Garuga pinnata</i> | Chigambil |
| 76 | <i>Lannea coromandelica</i> | Chigampa |
| 77 | <i>Artocarpus chama</i> # | Chrum/bolsrem |
| 78 | <i>Terminalia bellirica</i> | Churi/cherore |
| 79 | <i>Flacourtia jangomas</i> # | Darichik |
| 80 | <i>Garcinia kydia</i> # | Dengaduti |
| 81 | <i>Oreocnoide integrifolia</i> | Dingsning/kilkira |
| 82 | <i>Actinodaphne obovata</i> | Dodikimsong |
| 83 | <i>Premna latifolia</i> | Dokimi |

| S. No. | Botanical name | Common name |
|--------|-----------------------------------|--------------------|
| 84 | <i>Canarium strictum</i> | Dongkhreng/dongram |
| 85 | <i>Elaeocarpus aristatus</i> | Dura agong/gangma |
| 86 | <i>Podocarpus neerifolia</i> | Durama shillongkit |
| 87 | <i>Betula alnoides</i> | Gakkal |
| 88 | <i>Gmelina arborea</i> # | Gambari |
| 89 | <i>Careya arborea</i> # | Gambil/dambil |
| 90 | <i>Cinnamomum glaucescens</i> | Gansari |
| 91 | <i>Diospyros embryopteris</i> | Gap |
| 92 | <i>Wendlandia excelsa</i> # | Garadek |
| 93 | <i>Lepisanthes rubiginosa</i> # | Gawigran |
| 94 | <i>Ficus foveolata</i> # | Goerangsang |
| 95 | <i>Glycosmis arborea</i> | Jalwai |
| 96 | <i>Schefflera venulosa</i> | Jengjil |
| 97 | <i>Anthocephalus chinensis</i> # | Kadam |
| 98 | <i>Ostodes paniculata</i> # | Karekgran |
| 99 | <i>Bridelia retusa</i> # | Kasi |
| 100 | <i>Bridelia monoica</i> # | Kasi dupret |
| 101 | <i>Albizia odoratissima</i> # | Khilbe |
| 102 | <i>Mesua ferrea</i> | Khimde |
| 103 | <i>Walsura arborea</i> | Khrenti/kranchi |
| 104 | <i>Oroxylum indicum</i> | Kiring |
| 105 | <i>Abrus precatorius</i> # | Kitma/sabong |
| 106 | <i>Litsea sebifera</i> | Laham/boldukaki |
| 107 | <i>Pterospermum lancifolium</i> # | Laisa/adambit |
| 108 | <i>Callicarpa arborea</i> # | Makanchi/kimbal |
| 109 | <i>Erythrina stricta</i> # | Mandal |
| 110 | <i>Casearia graveolens</i> | Mangjotra |
| 111 | <i>Maesa sarmentosa</i> # | Mangritchok |
| 112 | <i>Hibiscus macrophyllus</i> | Mao |
| 113 | <i>Mallotus tetracoccus</i> | Matchmikong |
| 114 | <i>Croton joufera</i> # | Matmi |
| 115 | <i>Bauhinia stipularis</i> # | Megong |
| 116 | <i>Heteropanax fragrans</i> | Mugasalgro |
| 117 | <i>Toddalia asiatica</i> | Nache makkal |
| 118 | <i>Persea villosa</i> | Nameaga |
| 119 | <i>Sterculia villosa</i> | Olmak |
| 120 | <i>Trema orientalis</i> # | Pakram |
| 121 | <i>Xylosma longifolium</i> | Palwang |
| 122 | <i>Vitex peduncularis</i> # | Rangri |
| 123 | <i>Alangium chinense</i> # | Rengokmi |
| 124 | <i>Macaranga indica</i> # | Rimikgital |
| 125 | <i>Cynometra polyandra</i> | Rongrip |
| 126 | <i>Ficus heterophylla</i> | Sakap |
| 127 | <i>Ficus hispida</i> | Sakapak |

| S. No. | Botanical name | Common name |
|--------|-----------------------------------|---------------|
| 128 | <i>Parapentapanax subcordatum</i> | SamibreK |
| 129 | <i>Haldina cordifolia</i> | Sandang |
| 130 | <i>Tectona grandis</i> | Segun/teak |
| 131 | <i>Sterculia colorata</i> | Senksu/waljem |
| 132 | <i>Ficus infectoria</i> | Sewla |
| 133 | <i>Albizia lebbek</i> | Shishu |
| 134 | <i>Lagerstroemia parviflora</i> | Sidai |
| 135 | <i>Lithocarpus elegans</i> | Simok |
| 136 | <i>Cassia fistula</i> | Sinaru |
| 137 | <i>Alstonia scholaris</i> | Sokchon |
| 138 | <i>Polaquium polyanthum</i> | Solwa |
| 139 | <i>Hodgsonia macrocarpa</i> # | Tebe |
| 140 | <i>Syzygium balsameum</i> # | Tebrong |
| 141 | <i>Dillenia indica</i> | Tediki |
| 142 | <i>Cinnamomum bejolghota</i> | Teja bifa |
| 143 | <i>Cinnamomum tamala</i> | Tejpatta |
| 144 | <i>Aristolochia tagala</i> # | Terimu |
| 145 | <i>Garcinia lancifolia</i> # | Tesaru |
| 146 | <i>Ficus subulata</i> # | Tewak |
| 147 | <i>Mangifera indica</i> # | Thegatchu |
| 148 | <i>Mangifera sylvatica</i> # | Thegatchu |
| 149 | <i>Bischofia javanica</i> | Udari/udim |
| 150 | <i>Ulmus lancifolia</i> | Wakru/bolsue |

Annexure 17: Number of patches of different forest and non-forest types in the zone of Influence for different PAs/RFs at 2 km distance from boundaries

| Forest and Non-forest types | Class Code | ARF | BRF | IRF | RRF | BNPSWS | NNP |
|--------------------------------------|------------|-------------|-------------|-------------|-------------|--------------|--------------|
| Bamboo/Secondary forest (6-10 years) | 1 | 1738 | 1777 | 781 | 849 | 2632 | 2331 |
| Deciduous forests | 2 | 1186 | 1622 | 646 | 576 | 2141 | 2411 |
| Semievergreen forest | 3 | 567 | 382 | 234 | 233 | 1371 | 1979 |
| Waterbodies | 4 | 36 | 153 | 11 | 52 | 124 | 6 |
| Evergreen forest | 5 | 11 | 28 | 44 | 21 | 920 | 919 |
| Permanent Agriculture | 6 | 467 | 466 | 65 | 119 | 369 | 265 |
| Shifting Cultivation/ grasslands | 7 | 1631 | 2059 | 770 | 695 | 2014 | 1883 |
| Shadow | 8 | 223 | 426 | 112 | 160 | 634 | 463 |
| Scrub/Abandoned jhum fields | 9 | 1046 | 1168 | 291 | 275 | 691 | 575 |
| Plateau grassland | 10 | 0 | 0 | 0 | 0 | 3 | 0 |
| Unclassified | 0 | 1 | 5 | 0 | 0 | 1 | 0 |
| Total | 55 | 6906 | 8086 | 2954 | 2980 | 10900 | 10832 |

Annexure 18: Number of patches of different forest and non-forest types in the zone of Influence (5km)

| Forest and Non-forest types | Class Code | ARF | BRF | IRF | RRF | BNPSWS | NNP |
|--------------------------------------|------------|--------------|--------------|-------------|-------------|--------------|--------------|
| Bamboo/Secondary forest (6-10 years) | 1 | 4321 | 4766 | 2238 | 2200 | 7710 | 6612 |
| Deciduous forests | 2 | 3188 | 3752 | 1118 | 1225 | 5363 | 6158 |
| Semievergreen forest | 3 | 1275 | 1054 | 15 | 166 | 2976 | 4223 |
| Waterbodies | 4 | 102 | 279 | 370 | 324 | 376 | 204 |
| Evergreen forest | 5 | 27 | 219 | 325 | 624 | 1586 | 2047 |
| Permanent Agriculture | 6 | 1067 | 1056 | 2756 | 2595 | 1103 | 701 |
| Shifting Cultivation/ grasslands | 7 | 3938 | 4533 | 389 | 537 | 5981 | 5496 |
| Shadow | 8 | 583 | 822 | 1148 | 1154 | 1616 | 1569 |
| Scrub/Abandoned jhum fields | 9 | 2532 | 2495 | | | 2187 | 1915 |
| Plateau grassland | 10 | 0 | 0 | 0 | 0 | 3 | 0 |
| Total | | 17033 | 18976 | 8359 | 8825 | 28901 | 28925 |

Annexure 19: List 72 of villages within 10 kms of Balpakram NP

| | |
|---------------|-----------------|
| Ailatoli | Kasarisora |
| Alokpang | Kosi |
| Amonggri | Kunchung |
| Ampanggre | Maduawe |
| Babanipur | Mahadeo |
| Badimbari | Malengma |
| Baghmara | Meata |
| Balkal | Mongmabel |
| Batlaban | Nadangkol |
| Bilda | Nengsara |
| Bilkona | New Rompa |
| Bolbokgri | Nokat |
| Bonbera | Panda |
| Champa | Pasgao |
| Chandrasuk | Rangri |
| Chenggni | Rangsora |
| Chimitap | Rangtanggri |
| Dalenggittim | Rangtangsora |
| Dambuk Aga | Rewak |
| Dambuk Apal | Rongara |
| Dambuk Atong | Rongcheng |
| DambukJongkol | Rongjol |
| Galasora | Rongmin Chiring |
| Gaobari | Rongrengpal |
| Ghandhigri | Rongruasim |
| Goka | Rongsuagal |
| Gonggrot | Rongwak |
| Gulpani | Sanbana |
| Halwa Atong | Seelpang |
| Hangsapat | Siju |
| Hatisia | Sooling |
| Imbloka | Teptepa |
| Inolgiri | Thaidang |
| Kalu | Toklekbari |
| Kanai | Wachalchiring |
| Karukol | Wagekona |

Source: BNP Division, Baghmara, 1997

Annexure 20: Land utilisation (for agriculture) in various community development blocks of GCA

| S. No. | Landuse in South Garo Hills during 1995-96 | Chokpot | Baghmara | Rongra | Total |
|--------|--|---------|----------|--------|---------|
| 1 | Reporting area | 705 | 558 | 587 | 1850 |
| 2 | Forest | 339.5 | 271.61 | 389.76 | 1001.87 |
| 3 | Not available for cultivation | | | | |
| 3A | Area under non-agriculture | 17.87 | 16.52 | 9.12 | 43.51 |
| 3B | Barren and uncultivable land | 14.02 | 14.85 | 25.19 | 54.06 |
| 4 | Other uncultivated land | | | | |
| 4A | Permanent pasture and other grazing land | | | | NA |
| 4B | Land under miscellaneous trees and grasses | 24.34 | 24.47 | 21.05 | 69.86 |
| 4C | Cultivable waste land | 117.55 | 90.97 | 40.06 | 248.58 |
| 5 | Falooow lands | | | | |
| 5A | Fallow land other than current fallows | 91.5 | 50.01 | 64.73 | 206.24 |
| 5B | Current fallows | 18.12 | 15.58 | 9.97 | 43.67 |
| 6 | Net area sown | 82.1 | 73.99 | 27.12 | 183.21 |
| 7 | Area sown more than once | 19.93 | 17.86 | 6.2 | 43.99 |
| 8 | Total cropped area | 102.03 | 91.85 | 33.32 | 227.2 |

Source: Directorate of Economics and Statistics, Meghalaya and District Office at Baghamara

Annexure 21: Landuse in South Garo Hills

| S. No. | Landuse | 1993-94 | 1994-95 | 1995-96 |
|--------|---|----------|---------|---------|
| 1 | Reporting area | 1850 | 1850 | 1850 |
| 2 | Forest | 10001.14 | 1001.01 | 1001.87 |
| 3 | Not available for cultivation | 97.49 | | |
| 3A | Area under non-agriculture | | 43.43 | 43.51 |
| 3B | Barren and uncultivable land | | 54.06 | 54.06 |
| 4 | Other uncultivated land excluding fallow land | 318.42 | | |
| 4A | Permanent pasture and other grazing land | | NA | NA |
| 4B | Land under miscellaneous trees and grasses | | 69.88 | 69.86 |
| 4C | Cultivable waste land | | 248.65 | 248.58 |
| 5 | Fallow lands | 249.99 | | |
| 5A | Fallow land other than current fallows | | 206.3 | 206.24 |
| 5B | Current fallows | | 43.59 | 43.67 |
| 6 | Net area sown | 182.96 | 182.03 | 183.21 |
| 7 | Area sown more than once | 43.9 | 43.93 | 43.99 |
| 8 | Total cropped area | 226.86 | 227.01 | 227.2 |

Reporting area excludes the area under Municipality and Town committee

Annexure 22: Potential demonstration projects for the the Garo Hills Conservation Area (GCA) in western Meghalaya. These are potential projects that could be implemented as small demonstrations to illustrate specific measures and approaches for conserving old forest or important wildlife habitats in GCA.

BACKGROUND

The Garo Hills Conservation Area (GCA) assessment may result in identifying forest biodiversity conservation needs for the area. These needs can be expanded into tests in demonstration areas within the GCA. This document presents ideas on three possible demonstration areas for the GCA following the current project.

DEMONSTRATION AREA THEMES

Three potential themes for demonstration area for the GCA are: (1) Additions to protected areas, (2) Protection of primary forests and mature forests in wildlife corridor habitat areas, and (3) Provision of elements of older secondary forests as wildlife habitat and for biodiversity conservation in heavily jhummed areas.

For each of these three themes, a small portion of the GCA can be selected to demonstrate how results from the overall GCA Assessment can be used at finer scales. Each theme focuses on a very different environmental condition and management focus within the GCA, with the overall aim of contributing to long-term conservation of wildlife habitat and biodiversity within the area as a whole.

GCA DEMONSTRATION I THEME: ADDITIONS TO PROTECTED AREAS AS BUFFERS

Objective: The objective is to demonstrate how to select specific sites for adding onto existing protected areas, including national parks, reserved forests, and wildlife sanctuaries. Additions can be peripheral to the existing boundaries and can be part of a buffer boundary system..

Problem: The existing protected areas of GCA do not seem to be established according to biosphere reserve designs with sanctum sanctorum core areas and surrounding partial-use buffer areas. Older forests adjacent to existing protected areas are being incurred for jhum cultivation and resource extraction with no specific guidelines to ensure the integrity of the protected areas.

Demonstration tasks: Identify, through the vegetation mapping of GCA, areas of older forest adjacent or very near to existing protected area boundaries. Identify such areas that are also undergoing undue incursion for jhum agriculture, and where habitat values for wildlife conservation are high. Then, allocate selected, specific forest sites as the start of an additional buffer area around the protected area. Identify the set of activities that can continue or be permitted within the site that would also provide for the older-forest habitat conditions, such as selected nontimber forest product use.

Products: The following products may result from this activity: [1] a map of older-forest zones adjacent to existing protected area boundaries that may serve as buffer areas; [2] a set of management guidelines for activities permissible within such buffer areas that would protect habitat values; [3] a list of habitat and wildlife values that would be conserved over time by institution of this approach. A further product might include a list of other priority areas for possible consideration.

GCA DEMONSTRATION II THEME: CONSERVATION OF PRIMARY AND MATURE FORESTS AND KEY HABITAT ELEMENTS FOR WILDLIFE CORRIDORS

Objective: This objective pertains to maintaining forest habitat conditions in specific areas as migration and movement corridors for wildlife. As well, specific forest use activities by local peoples may be identified as compatible with provision of corridor habitats.

Problem: More and more, the intensity of forest use is increasing in areas traditionally used as corridors by wildlife, especially elephant and other large species associated with older forest conditions such as dense tall tree canopies. If continued at the present pattern and pace, this will doubtless lead to further conflicts, including

elephant-man altercations. Loss of wildlife corridor habitat also will lead to isolation of wildlife populations into smaller, disconnected centres. Such smaller wildlife population “islands” then have far higher risk of local extinction from many types of events. Also, linkages of specific habitat elements across the landscape can help maintain viability of many types of wildlife.

Demonstration tasks: A demonstration project focused on conserving primary and mature forests and key habitat elements for wildlife corridors would first identify areas that currently serve as wildlife movement corridors, and, second, provide specific guidelines for the kinds of resource use activities by local peoples that would be compatible with maintaining the habitat values of such corridor areas for wildlife. Wildlife included in this task are principally elephant, and also other species associated with older forest conditions, such as hoolock, slow loris, other arboreal species of primates and squirrels, and other species of older forest conditions.

Products: [1] A general map of known or suspected wildlife corridors in the Garo Hills; [2] a specific map of particular sites that contribute to one of the corridors for the demonstration activity; [3] a list of the habitat conditions to provide within the corridor, such as forest canopy contiguity and density, occurrence of snags or down wood, occurrence of specific forage and food types and sources, and corridor width and area; and [4] a list of forest resource-use activities that are compatible with maintaining these habitat conditions. Compatible forest resource-activities may specify the type, intensity, and frequency of extraction of nontimber forest products, the desirability or undesirability of man-set fires, the level of grazing, and other actions and uses.

As with the Demonstration I objectives, above, the aim is to help provide for rationale and compatible human use of forest resources, not to blindly exclude all uses and incursions which would be unnecessary and impossible to accomplish.

**GCA DEMONSTRATION III THEME:
PROVISION OF OLDER SECONDARY FOREST HABITAT ELEMENTS IN HEAVILY
JHUMMED AREAS**

Objective: The objective of this theme is to provide for selected elements of forest habitat conditions within heavily jhummed landscapes to help conserve forest-associated wildlife with a minimal impact on agriculture.

Problem: Accelerated use of forest land in the Garo Hills for jhum agriculture has led to a severe shortage of old forest habitats and specific elements of old forests. Such forest habitat elements include large mature trees, local canopy clumps of older trees, standing dead trees, down trees, and key fruit- and seed-bearing shrubs and trees as wildlife food sources, all of which are used by many species of wildlife species. The loss of such habitat elements has meant that a large portion of the forest wildlife fauna has been severely reduced or eliminated from large areas of the Garo Hills. In turn, this makes conservation of such wildlife populations only within the few protected areas of the region difficult to impossible.

Demonstration tasks: A demonstration project can entail identifying a few specific forest plots within heavily jhummed landscapes; listing the set of forest habitat elements for conservation focus; developing operating guidelines for jhum activities that would help protect or create such habitat elements; carrying out such activities in a few selected sites; and monitoring results.

Illustrating the potential for permanent plot agroforestry is an important part of this theme. Accomplishing this will entail selecting specific demonstration sites which can be developed for intensive and ongoing agricultural and timber tree interplanting. The demonstration site may entail terracing to help stave off soil erosion, ease access for site and crop management, and ease interim treatment activities. The purpose is to demonstrate alternatives to the short-cycle jhum activities, that will permit some jhum sites to lay fallow for longer than 8-10 years by which some mature forest conditions as habitat for wildlife can regenerate.

Products: Products for this demonstration theme can include: [1] a list of the habitat elements and associated wildlife species; [2] jhum operating guidelines or activities to protect or create the habitat elements, such as extending the jhum fallow period; [3] an evaluation of the efficacy of the operations and how well they provide for the habitat elements in the field. Monitoring may include evaluating economic and ecological results, including agricultural crop production, tree and timber crop growth, and reduction in soil erosion and retention of productive soils.