



**Biodiversity Governance for  
Managing  
Endemic and Threatened Medicinal Plants  
in India - A Geoinformatic Approach**

With Special Reference to  
Kalakad Mundanthurai Tiger Reserve,  
Southern Western Ghats of Tamil Nadu, India

**Dr. Manoj Kumar Sarkar, I.E.S.,**

*Published By*

**NATIONAL BIODIVERSITY AUTHORITY  
INDIA**

**Second Edition :**

**"Biodiversity Governance for Managing Endemic and Threatened Medicinal Plants in India - A Geoinformatic Approach"**

Published by :

National Biodiversity Authority  
Government of India  
5th Floor, TICEL BIO Park  
Taramani, Chennai – 600 013.  
<http://www.nbaindia.in>

This Book was prepared by carving out the important and relevant information from the book titled "*Management Strategies for Endemic and Threatened Medicinal Plants in India – A Geoinformatic Approach*" (First Edition) published by Department of Environment, Government of Tamil Nadu, Chennai to make easy access to the content of the book by readers specially the policy makers, field executives, environment lovers and local people.

The views, ideas and opinions expressed in the report are purely those of the author and not that of the organization he represents. All care has been taken to acknowledge the information used in this report. Any inadvertent error is unintentional.

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Year of publication : October 2012

Number text pages : 1-202

Number of Copies : 1000

ISBN : 978-81-923927-0-7

Price : Free distribution in serving the Nation

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**First Edition :**

*Trees of Tamil Nadu Series....*

**"Management Strategies for Endemic and Threatened Medicinal Plants in India – A Geoinformatic Approach"**

Year of publication : March 2012

Number text pages : 1-596

Price : Free distribution in serving the Nation

Published by

Department of Environment,  
Government of Tamil Nadu

---

Design & Printed by

Ace Data Prinexcel Private Limited  
Coimbatore – 641 004, Tamil Nadu, INDIA.  
Phone : +91 422 256 1500  
Website : [www.acedata-india.net](http://www.acedata-india.net)

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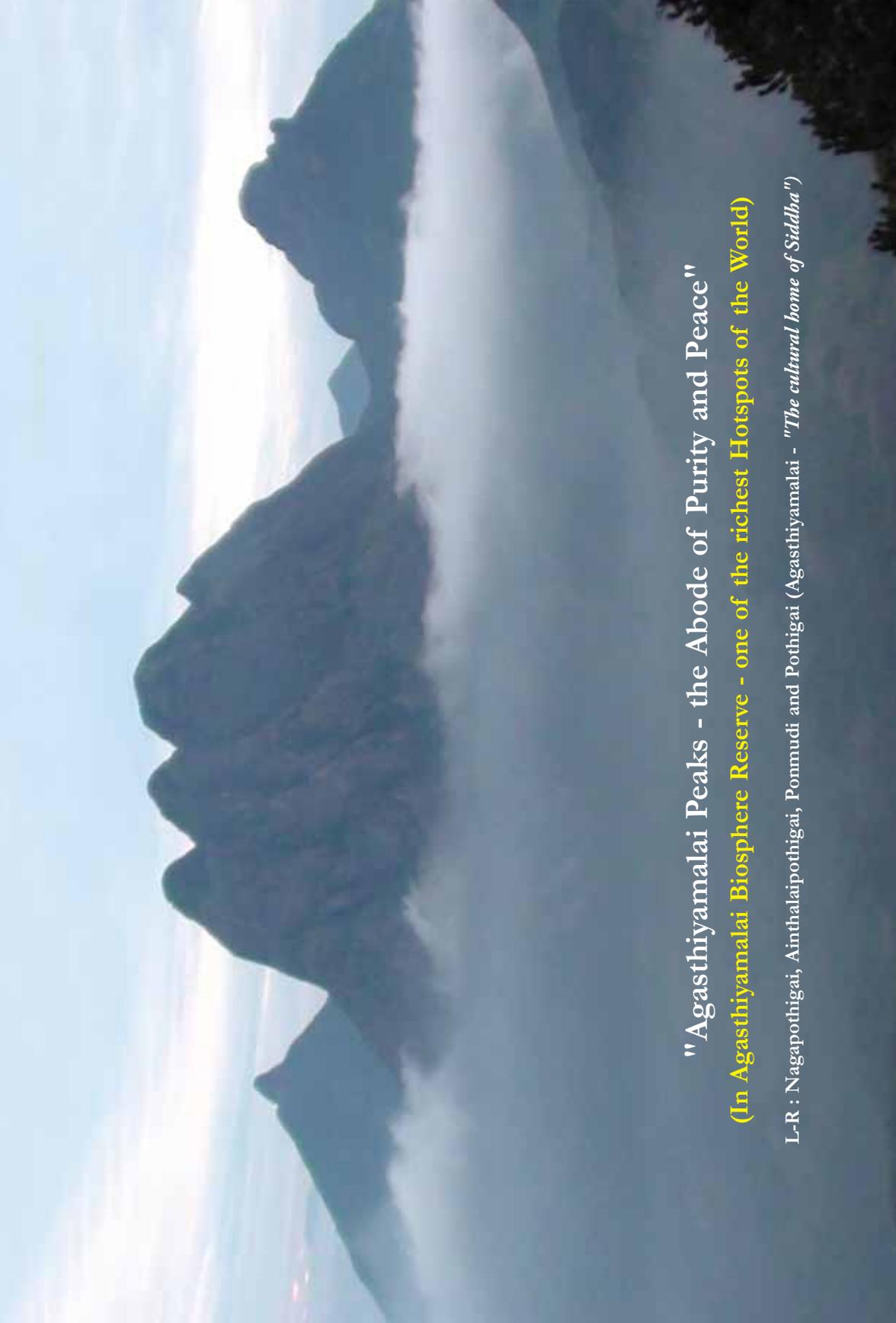
“To all green, growing, flowering ones  
of this beautiful planet,  
who embody the universal creative healing energy,  
and with each moment,  
humbly assume the grand task  
of transforming light into life,  
and who patiently bear  
the crude assaults and insults of our  
misguided ignorance,  
all in the dream of awakening.

Without their conscious, living presence,  
nothing,  
no breath nor food,  
no life,  
no delight,  
None of our earthly endeavors would be possible.”

*Michael Tierra*

“I salute this selfless living kingdom of plants with  
all my humility & take this endeavor in  
conserving, protecting & propagating them to  
receive their  
unleashed wisdom & auspicious  
healing energy for all.”

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**डॉ. बालकृष्ण पिसुपाटी**  
अध्यक्ष  
*Dr. Balakrishna Pisupati*  
Chairman

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September, 2012

## FOREWORD

Conservation, sustainable management and sharing of benefits from biodiversity as well as ecosystem goods and services underpin the rationale of global and national attention in recent years on environment and sustainable development. Medicinal Plants occupy an important niche within the biological reserve platform because of multiple benefits they offer from securing health to economic empowerment to trade regimes.

In India, various Ministries and Government agencies have focussed on medicinal plant related issues ranging from Ministry of Health and Family Welfare to Ministry of Environment & Forests. The focus of much of their actions is on conservation, human health and management. Recent analysis and studies have clearly indicated that the core challenge to securing our biological resources in the country is that of governance.

In a recent publication brought out by the National Biodiversity Authority (NBA) on biodiversity governance, it is argued that we need a multi-disciplinary, over-arching and inclusive approach to managing our biological resources. In continuation of this discourse, I was very pleased to come across the comprehensive work of Dr. Manoj Kumar Sarkar, IFS of Tamil Nadu Forest Department on ways and means to achieve better management practices of medicinal plants using a geoinformatics approach based on governance rules and principles.

Recognising the need to further disseminate this interesting and comprehensive work, NBA has decided to support bringing out this abridged version of the full publication for use by conservationists, forest and environment department personnel, policy makers and local people so that the management of endemic and threatened medicinal plants is based on science-policy interface. I am very certain that this publication will fill a knowledge gap in the country with reference to policy-practice link.

With India hosting the eleventh meeting of Conference of Parties to the Convention on Biological Diversity (CBD-COP 11) in 2012, wherein we are taking charge of steering global agenda on biodiversity, this publication, I am sure, will provide us with a voice to translate governance debates to actions on the ground.

(BALAKRISHNA PISUPATI)  
Chairman

National Biodiversity Authority, Govt. of India

## PREFACE TO THE SECOND EDITION

Six months have passed since the First edition of book titled “*Management Strategies for Endemic and Threatened Plants in India – A Geoinformatic Approach*” published by the Department of Environment, Government of Tamil Nadu, Chennai in March 2012. The book, containing the research findings over a decade, was distributed to the Government departments, Academic institutions, Centres of excellence, Forest and Environment Departments etc. within and outside the country. Within a short period of circulation, many laudable comments poured in from various sections of people. Comments like ‘*it is a masterpiece of work*’, ‘*a monumental work*’, ‘*a hallmark*’ - ‘*Magnum opus*’ etc. were made. At the same time, it is also commented that the book is not very handy for field personnel as the weight of the book is more and also the font size is smaller.

Further it was also opined that if an abridged version of the book containing salient issues can be brought out, it will be helpful for the field personnel and also for the policy makers, environmentalists and local people. An opportunity in the form of a brief presentation in Conference of Parties (CoP -11) to the Convention on Biological Diversity to be held at Hyderabad during October 2012 came my way. The Chairman, National Biodiversity Authority, Govt. of India was kind enough to state that “recognizing the need to further disseminate this interesting and comprehensive work, NBA has decided to support bringing out an abridged version of the full publication for use by conservationists, forest and environment department personnel, policy makers and local people so that the management of endemic and threatened medicinal plants is based on science-policy interface and am very certain that this publication will fill a knowledge gap in the country with reference to policy-practice link” Hence the printing of the abridged version of this book.

This document treads in a multidisciplinary path incorporating and synthesizing information from a variety of interrelated subjects like biodiversity with taxonomy and ecological input, geo-informatics, phytochemistry, public policy and management to serve as a reference point for the endemic and threatened medicinal plants, whilst endeavouring to provide a road map for conservation of plants.

The study has identified problems and prospects of medicinal plant sector in the country and accordingly prescribed necessary management strategies to overcome the same in a comprehensive manner based on detailed field survey as a pilot study. Although the study is representing KMTR in Tamil Nadu, the proposed model of conservation would hold good for the entire country, of course with minor modifications based on site specific issues of individual States. I am sure that it would help in framing Government policies and their implementation for conserving and managing sustainably the MPs of the country.

This is an abridged version of the Original book with special objective to reach the policy makers, personnel of forest and environment department for field trips, conservationists and local people. Therefore, additional information like detailed references and appendices provided in first edition are not accommodated here in this book.

Bringing out this scientific document is considered as an opportunity to learn intimately the floral resources including medicinal plants of the country in general and KMTR in particular to protect, conserve and augment them ensuring sustainable benefit flow for the people of this country. I have enjoyed the journey of carrying out this work. The information given here in this book, if can bring some positive change in the system in protecting the imperilled plants and if people at large are benefited, I shall feel rewarded.



**Manoj Kumar Sarkar**

## ACKNOWLEDGEMENT

I express my earnest gratitude to Dr. Balakrishna Pisupati, Chairman, National Biodiversity Authority, Government of India, for providing the opportunity to publish this book to have easy access, wide circulation to facilitate effective policy formulation and biodiversity governance for evolving appropriate management strategies of Medicinal plant resources of the country.

I am grateful to Shri C.V. Sankar, I.A.S., Principal Secretary to Government, Environment and Forests Department, Shri Gautam Dey, I.F.S., Principal Chief Conservator of Forests and Head of Forest Force, Tamil Nadu for inspiring me to reach the logical conclusion of the findings of the research work as documented in the book.

I am thankful to Shri C. Achalender Reddy, I.F.S., Secretary, National Biodiversity Authority, and Shri T.S. Srinivasamurthy, I.F.S., Chief Conservator of Forests, Chennai for their continuous encouragement and support. I am thankful to Dr. Aruna Basu Sarcar, I.F.S., Chief Conservator of Forests, Tiruchirapalli and Dr. Rekha R. Warriar, Scientist, Institute of Forest Genetics and Tree Breeding, Coimbatore for their help in editing the document.

I am grateful to Prof. M.S. Swaminathan, Chairman, M.S. Swaminathan Research Foundation and Member of Parliament (Rajya Sabha); Shri S. Kondas and Shri S. John Joseph, Former Principal Chief Conservators of Forests, Tamil Nadu; Shri D.K. Ved Advisor, I-AIM-FRLHT, Bangalore; Shri M.R. Rajagopalan, Managing Trustee, Gandhi Gram Trust, Dindigul; Shri Anoop Badhwa, Inspector General of Forests, Ministry of Environment & Forests, Govt. of India; Shri A. Selvaraj I.R.A.S, Financial Advisor and Chief Accounts Officer, Ministry of Railways, Govt. of India; Dr. R. Gopalan, Former Scientist, Botanical Survey of India, Coimbatore; Shri Asad R. Rahmani, Director, Bombay Natural History Society; Sr. M. Christie M.C. Secretary General, Missionaries of Charity, Kolkata; Smt. Sunita Narain, Centre for Science and Environment, New Delhi and many others for their kind comments about First edition of the book.

I acknowledge the excellent services of management and all the staff of Ace Data Prinexcel Private Ltd, Coimbatore for printing this book in the shortest possible time. I specially acknowledge the services of Thiru D. Kalimuthu - who compiled the entire book with full dedication and Thiru T. Mohanraj for his persistent support. My special thanks are due for V. Sekar, S. Gokula Kannan and S. Ramesh.

1<sup>st</sup> October 2012

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**Manoj Kumar Sarkar**

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Endemic and Threatened Medicinal Plants in India  
- A Geoinformatic Approach**

with Special Reference to KMTR, Southern Western Ghats of Tamil Nadu, India

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*“Why worry if tigers and rhinos and few plant species are wiped out?*

*An environment in which animals and plants become extinct is not safe for  
human beings either”.*

**- Indira Gandhi**

# Chapter – I

## Introduction

A group of plants, which serve as healers and health rejuvenators, are known as Medicinal Plants (MPs). Any part / parts of these plants which are used by any of the Indian traditional system of medicine like Ayurveda, Unani, Siddha, Tibetan, the rich and diverse folk medical tradition, Western Biomedical system (Allopathy) or Homeopathy are termed “medicinal plants” in this study.

*‘The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems’* (UN, 1992)<sup>1</sup>. Such diversity is the basis of human survival and well-being since biodiversity offers a range of goods and services for the people. It is estimated that 70-80% people worldwide rely chiefly on traditional, largely herbal, medicine to meet their primary health care needs (Farmsworth *et al.*, 1991)<sup>2</sup>. This diversity is fast disappearing from this Earth putting everyone at risk.

The International Union for Conservation of Nature and Natural Resources (IUCN) has indicated that nearly 12.5% of known flowering plants of the World suffer from different degrees of threats. A similar proportion (12.5%) of the 8,000 Medicinal Plant species as threatened category is found in India and this works out to about 1,000 Medicinal Plant species which suffer from various degrees of threat. 112 such plants are from the southern part of India in which Tamil Nadu has the main share. Of all these, about 201 endemic plants of the country need immediate management intervention to save these rare genetic resources from permanent loss. The Wildlife (Protection) Act, 1972 covers only six plant species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list covers eleven plant species and Ministry of Commerce and Trade (Govt. of India) notified 29 floral

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1 UN (United Nations). 1992. *Convention on Biological Diversity*. Report of the United Nation’s Conference on Environment and Development, Rio de Janeiro.

2 Farmsworth, N.R. and D.D Sejarito. 1991. ‘Global Importance of Medicinal Plants’. in O. Akerele, V. Heywood and H.Synge (Eds), *The Conservation of Medicinal Plants*, Cambridge University Press, pp 25-51 : Shengji, Pei, 2001, ‘Ethnobotanical Approaches of Traditional Medicine Studies : Some Experiences from Asia, Pharmaceutical Botany, Vol 39, pp.74-79. Cambridge, UK.

species of Indian plants including the above six and eleven plants. Therefore, we need to relook at the existing policy framework regarding the protection assurance to the floral species of the country.

Biodiversity governance can be defined as *'the manner in which stakeholders participate effectively in policy setting and decision making that is based on rule of law, is transparent, and is based on equity and accountability in order to ensure that the strategic vision of conserving biodiversity and ecosystems, using them sustainably, and sharing of the benefits are enforced at the national, regional and global levels for current and future uses'*. (Pisupati, 2012)<sup>3</sup>.

In case of biodiversity management of medicinal plants in the country, a big void could be observed while core characteristics of biodiversity governance are compared with the existing system of trading, harvesting, utility and overall management practices of these precious resources of the country. None of the core characteristics of the biodiversity governance could find place in existing management system of this resource. Stakeholders participation in policy setting and decision making is absent, legal frameworks are not in place to protect the endemic and imperilled plant species which provide life saving drugs to the people., non transparency is the hallmark in trading of medicinal plants in land, the question of equity and accountability is far from reality. The strategic vision of conserving biodiversity and ecosystems, using MPs sustainably, and sharing of the benefits of MPs to the stakeholders have not even been thought of except a few sporadic examples. All these anomalies were focused and management strategies required for Endemic Threatened Medicinal Plants (ETMPs) in India are discussed following a specific system of methodology along with clear recommendation and action plan in last chapter of the book.

The original book (First Edition) and this booklet is intended to reach the users involved in the field, policy makers of the country and also the elites who convert the broad policy into practical steps to implement these in field. Be it conservation of medicinal plants, biodiversity, or eco development, or even application of advance technology in decision making and planning by geo informatics, there is lack of written document in the form of an authentic handbook to provide readymade information to the practitioners who toil in the field to undertake protection and conservation measures of imperilled plants and flora in general. I attempted to fill up this gap with my earnest efforts of a decade by offering this document as service to the Nation. In spite of my best efforts, it is possible that there may be some shortcomings / errors in this booklet inadvertently. If these are intimated, I shall improve upon this book in future.

3 Balakrishna Pisupati 2012 *Biodiversity Governance, Lessons for International Environment Governance*: Chairman, National Biodiversity Authority, Chennai.

## Chapter – II

# Background and Context

The concepts of biodiversity and sustainable management of natural resources of forests became a global concern during 1980's and 90's and globalization has triggered an upsurge in the production of plant based medicines and herbal products. More than seventy percent of the people worldwide rely chiefly on traditional, largely herbal medicine to meet their primary health care needs. India, being a tropical country with favourable phytogeographical prerequisites for plant growth, has rich floral diversity with estimated 45,000 plant species and over a sixth of them have medicinal value. Traditional herbal medicine has been practiced in India and China since ancient times. India is also one of the world's leading exporters of medicinal plants (MPs) and herbal products, second only to China. The international market of herbal products is estimated to be US \$ 62 billion and this is poised to grow to US \$ 5 trillion by the year 2050 (Tewari, 2000)<sup>4</sup>. India is one of the mega-biodiversity countries in the world. With over 50,000 herbal formulations, an industrial turnover of Rs. 4200 crores per annum, and a projected annual growth rate of 20-30%, the MP related health sector is poised to take off. Despite its advantageous position, its share of the US\$ 62 billion global market is less than half a percent.

The reasons for this situation are not far to seek. Only about 15 % of MPs are cultivated while more than 85 % of MPs used by Indian industry is collected from the wild/forests and other natural habitat (Gupta, 1993<sup>5</sup>; FRLHT, 1997<sup>6</sup>; 2001<sup>7</sup>) mostly of Government owned land besides a marginal extent may be of private enterprises.

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4 Tewari D.N. 2000. *Report of the Task Force on Conservation & Sustainable use of Medicinal Plants*, Planning Commission, Government of India, New Delhi.

5 Gupta, R. 1993. Conservation and Utilisation of Indian Medicinal Plants; *Indian Journal of Plant Genetic Resources*, 131.

6 Anon. 1997. *Guidelines for National Policy and Conservation Programmes and the key role of Forestry Sector in commencing India's Medicinal Plants*; - A Technical Report, Foundation for Revitalisation of Local Health Traditions Medicinal Plants of India; Bangalore.

7 Anon. 2001. *Forestry Sector in Conserving India's Medicinal plants*, Foundation for Revitalization of Local Health Traditions, Bangalore.

Although trade in MPs in India has doubled since globalization, unsustainable and unscientific harvesting for commercial uses completely controlled by the informal sector with large traders operating from port towns and important cities is practised. The increases in trade resulting in indiscriminate harvesting and export have put a large number of India's MPs under the threat of extinction. The resource custodian has no material stake in the trade, either in terms of revenue, or even in terms of surveillance of what is exported from the forest / other wild areas (Sarcar, 2005)<sup>8</sup>.

Further, analysis of the working plan operations (prescriptions of work to be carried out in any forest division/District for next ten years) in forestry sector since 1900 shows that tree species of commercial value and fuel wood have received far more importance in management endeavours by the concerned authorities than other lower habits like shrubs, herbs, climbers, grasses, *etc.*, which account for 66% of floral composition of forests and include many species of great medicinal that commercial value.

It is a matter of concern that when a large number of species of MPs suffer from various degrees of threats with genetic loss for ever, still there are no policy formulation / reforms in this sector of integrated phyto - resource management in the country. In the absence of such species specific laws or policies for plants, indiscriminately collected MPs from any unit area from wild / forests could neither be identified (physically or by biochemical tests in forensic lab due to lack of skill, expertise and policies) nor booked outside the forest boundary under any offence, as it is not legally supported by the court of law. (Sarcar, 2005)<sup>9</sup>

The management of flora (including MPs) needs to be prioritized and dealt with site specific geographic information of their natural habitats. Precise point-location data on microclimate, topography and soil, in association with geographical distribution of threatened medicinal plant species in the phyto-sociological layout will lead to the exact locality information of the concerned taxa, their population status, the factors limiting their distributions, and also the factors leading to local and biological extinction and critical habitats.

Addressing the needs, after recognising each of the various Stakeholders of medicinal plants in the country requires a holistic approach for overall development of this sector. Unfortunately, there are no integrated national policies on herbal medicines, their source of origin, inventories and collection procedure; cultivation practices, monitoring of production; uses by the

8 Sarcar, Manoj Kumar. 2005. A Framework for Strategic Management of Medicinal Plants *Indian Institute of Management, Bangalore; Management Review*, December 2005,17-30.

9 *ibid*

consumers and traditional practitioners; prices, sale pattern, marketing and their monitoring and finally total surveillance on MPs and herbal products being exported from this country unabated. The protection, conservation and overall management of threatened MPs need support of various kinds like inventory of resources and ascertaining their species specific threat status, effective regulations, institutional mechanism and strong legislative support, as well as the participation of all stakeholders with systematic short term and long term planning in place.

Therefore, what is urgently required is to facilitate the resource custodians, policy planners, drug regulators, health administrators and professionals including traditional and modern practitioners to regulate the market and ensure consumer safety along with conservation and sustainable use of MPs with appropriate National Policy in place (Sarcar 2005<sup>10</sup>; Singh 2006)<sup>11</sup>.

## 2.1. Medicinal Plant Resource Base in the Country

India being one of the Mega Biodiversity countries of the world possesses rich plant diversity with an estimated 45,000 species (nearly 20 % of global species) of which about 8,000 are known for their medicinal uses. Of these around 960 MP species are used by the contemporary trade and Ayurvedic industry. Considering the global trends at which these plant species are getting threatened, it is being anticipated that more than 1,000 species of Indian medicinal plants may undergo various degrees of threat within the next ten years. More than 75% of the Indian plant resources remain unexplored for their potential value in ethno medicinal and in other systems.

### 2.1.1. Database of Medicinal Plants Species Usage across Medical Systems

The MPs database currently has 7,319 botanical names, and each botanical name bears one or more tags of medical systems ranging from Folk to Ayurveda, Siddha, etc. The botanical names, enlisted according to the medical system as well as the overlap across such systems, are reflected in Table 2.1 as follows :

---

10 ibid

11 Singh, Harbir (2006). *Prospects and Challenges for Harnessing Opportunities in Medicinal Plants Sector in India*, 2/2 Law, Environment and Development Journal (2006), p. 196, available at <http://www.leadjournal.or/content06196.pdf>

**Table 2.1 - Cross tabulation on the count of Medicinal Plants Usage**

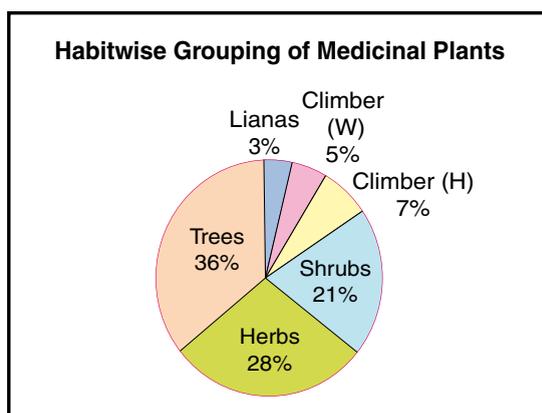
	AYURVEDA	FOLK	HOMEO	MODERN	SIDHA	TIBETAN	UNANI
AYURVEDA	2351	900	189	80	1028	341	880
FOLK	900	5137	164	86	971	235	573
HOMEO	189	164	506	100	167	77	173
MODERN	80	86	100	204	65	25	75
SIDHA	1028	971	167	65	1785	277	641
TIBETAN	341	235	77	25	277	350	275
UNANI	880	573	173	75	641	275	979

(Source : FRLHT)<sup>12</sup>

(The shaded figures give the count of plants used in each of the seven systems of medicine and the remaining ones represent the count of plants common across two of these)

### 2.1.2. Habit wise grouping details of MPs

The MP species belong to a wide range of habits/life forms from lofty trees, medium sized and small trees, shrubs and under shrubs, liana, woody climbers and twiners as well as perennial herbs. Habit wise analysis of MP species shows that nearly one third of these botanical entities are trees and the remaining two third (66%) consists of shrubs, woody climbers, herbs and twiners. **(Figure - 2.1)** However, we do not have systematic documentation of these lower habits which comprises 66% of forest composition.

**Figure 2.1 - Habit Wise Grouping Details of Medicinal Plants**

(Source : Amruth, August 1997, FRLHT)<sup>13</sup>

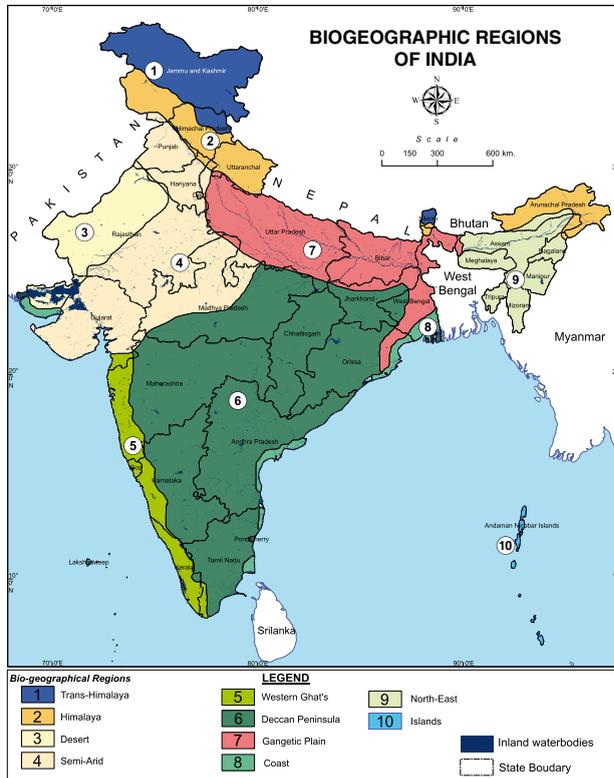
12 Ravikumar K. and D.K. Ved. 2000. *100 Red- Listed Medicinal Plants of Conservation Concern in Southern India*, Foundation for Revitalisation of Local Health Traditions (FRLHT), Bangalore.

13 Amruth, August 1997. *Foundation for Revitalisation of Local Health Traditions Medicinal Plants of India*; Bangalore.

### 2.1.3. General distribution pattern of MPs across Natural bio-geographical zones and Major forest types

Champion and Seth made revised classification of Indian forests into 16 major forest types and more than 200 subtypes (Champion & Seth, 1968)<sup>14</sup>. Further India's land surface has been grouped into ten distinct bio-geographic zones (**Figure - 2.2**) and these are further divided into 25 biotic provinces (Rodgers W.A. & Panwar H.S. 1988)<sup>15</sup>. The diversity of India's flora, as also the MP species, which form a sub-set of this flora, is spread across different bio-geographic zones of the country. The forest areas of these bio-geographic zones/provinces are overlapping in this 16 major forest types, and subtypes. To have a broad picture of MP diversity occurring in different bio geographic regions and forest types of this country an information table (Table 2.2) is furnished below.

**Figure 2.2 - Natural bio-geographical zones of India**



14 Champion, H.G., and S.K. Seth. 1968. *A Revised Survey of the Forest Types of India*. Govt. of India Press, Delhi. 404.

15 Rodgers W.A and Panwar H.S 1988. *Bio-Geographic Zones of India*, Wildlife Institute of India, DehraDun, India.

Table 2. 2 - Information Table on the count of MPs in Bio-geographic zones / Forest Types

Sl. No.	Bio-geographic zones (Rodgers & Panwar, 1988)	Sub - Bio-geographic zones	Corresponding Major Forest Types (Champion & Smet, 1968),	Approx. No. of MPs	Example of a few characteristic MPs of each Region
1	" <u>Trans Himalayan</u> " (1)	Cold desert like condition	Sub Alpine & Alpine Forest. (14,15 & 16)	700	<i>Ephedra Gerardiana</i> Wall., <i>Hippophae rhamnoides</i> L., <i>Arnebia euchroma</i> (Royle) John.
2	" <u>Himalayan</u> " (2)	North West Himalaya (2A), West Himalaya (2B), Central Himalaya (2C), East Himalaya (2D).	Himalayan Moist – Temperate Forest (12) Himalayan Dry Temperate Forest (13) Sub Tropical Dry Evergreen Forest (10) Sub Tropical Pine Forest (9) Montane Wet Temperate Forest (11)	1,700 1,200	<i>Aconitum heterophyllum</i> Wall. Ex Royle, <i>Ferula Jaeschkeana</i> Vatke, <i>Saussurea costus</i> (Balc.) Lipsd. (Syn. <i>S. lappa</i> C.B. Clarke) <i>Nardostachys grandiflora</i> DC., <i>Toxus wallichiana</i> Zucc., <i>Rhododendron anthopogon</i> D. Don, <i>Panax pseudoginseng</i> Wall.
3	" <u>Desert</u> " (3)	Kutch (3A), Thar (3B).	Tropical Thorn Forest (6)	500	<i>Convolvulus microphyllus</i> Seib ex Spreng., <i>Tecomella undulata</i> (Sm.) Seem, <i>Citrullus colocynthis</i> (L.) Schrader, <i>Cressa cretica</i> L.
4	" <u>Semi-Arid</u> " (4)	Punjab (4A), Gujarat – Rajwar (4B).	Tropical Dry Deciduous Forest (5)	1,000	<i>Commiphora wightii</i> (A.) Bhandari, <i>Caesalpinia bonduc</i> (L.) Roxb., <i>Balanites aegyptiaca</i> (L.) Delile, <i>Tribulus rajasthanensis</i> Bhandari & Sharma.
5	" <u>Western Ghats</u> " (5)	Malabar coast (5A), Western Ghats Mountains (5B).	Tropical Wet Evergreen Forest (1) Tropical Semi-Evergreen Forest (2) Tropical Moist Deciduous Forest (3)	2,000	<i>Myristica malabarica</i> Lam., <i>Garcinia indica</i> (Dup.) Choisy, <i>Uleria salicifolia</i> Bedd., <i>Vateria indica</i> L.

Sl. No.	Bio-geographic zones (Rodgers & Panwar, 1988)	Sub - Bio-geographic zones	Corresponding Major Forest Types (Champion & Smet, 1968),	Approx. No. of MPs	Example of a few characteristic MPs of each Region
6	" <u>Deccan Peninsula</u> " (6)	<u>Deccan Plateau South</u> (6A) <u>Central Plateau</u> (6B), <u>Eastern Plateau</u> (6C), <u>Chhota Nagpur</u> (6D), <u>Central Highlands</u> (6E).	Tropical Moist Deciduous Forest (3) Tropical Dry Deciduous Forest (5) Tropical Thorn Forest (6)	3,000	<i>Pterocarpus santalinus</i> L.f., <i>Decalepis hamiltonii</i> Wight & Arn., <i>Terminalia pallida</i> Brandis, <i>Shorea tumbuggaia</i> Roxb.
7	" <u>Gangetic Plain</u> " (7)	<u>Upper Gangetic Plain</u> (7A), <u>Lower Gangetic Plain</u> (7B).	Tropical Moist Deciduous Forest (3) Tropical Dry Deciduous Forest (5)	1,000	<i>Holarthra pubescens</i> (Buch - Ham.) Wallich ex DC., <i>Mallotus philippensis</i> (Lam.) Muell. - Arg., <i>Pluchea lanceolata</i> C.B. Clarke, <i>Peganum harmala</i> L.
8	" <u>Coasts</u> " (8)	<u>West Coast</u> (8A), <u>East Coast</u> (8B).	Littoral and Swamp Forest (4)	500	<i>Rhizophora mucronata</i> Lam., <i>Acanthus ilicifolius</i> L., <i>Avicennia marina</i> Vierh., <i>Sonnerati acaseolaris</i> (L.) Engl
9	" <u>North-East India</u> " (9)	<u>Brahmaputra Valley</u> (9A), <u>Assam Hills</u> (9B).	Tropical Wet Evergreen Forest (1) Tropical Semi-Evergreen Forest (2) Tropical Moist Deciduous Forest (3)	2,000	<i>Aquilaria malaccensis</i> Lam., <i>Smilax glabra</i> Roxb., <i>Ambroma augusta</i> (L.) L.f., <i>Hydnocarpus kurzii</i> (King) Warb.
10	" <u>Islands</u> " (10)	<u>Andaman Islands</u> (10A), <u>Nicobar Islands</u> (10B), <u>Lakshadweep Islands</u> (10C).	Andaman and Nicobar Islands (7)	1,000	<i>Calophyllum inophyllum</i> L., <i>Adenanthera pavonina</i> L., <i>Barringtonia asiatica</i> (L.) Kurz, <i>Aisandra butyracea</i> (Roxb.) Baehni

### 2.1.4. The Floristic Diversity and Endemism of Plants in India

Endemism encompasses taxonomic units of any rank or taxa which occur in a biogeographically confined area usually isolated by geographical, ecological or temporal barriers. (Nayar, 1996)<sup>16</sup>. Tables 2.3 and 2.4 give an overview of the endemism in India.

**Table 2. 3 Floristic Diversity and Endemism of Plants in India**

Number of Flowering Plants	Number of Endemics	Percentage of Endemism
17,500	5,725	33.5%

**Table 2. 4 – Three Mega Centers and Endemic Plants of India**

Sl. No	Region	Endemic Species
i	Eastern Himalaya	1,808
ii	Western Ghats	1,500
ii	Western Himalaya	1,195

- 5,725 flowering plant species are endemic to India (147 genera distributed over 47 families) that accounts for 33.5 percent of Indian flowering plants.
- 3,471 species are found in the Himalaya.
- 2,015 species in Peninsular India.
- 239 in the Andaman and Nicobar Islands.

### 2.1.5 India's Position of Threatened Plant Species

**Table 2.5 – Status of Threatened Vascular Plants in India**

India Total Vascular Plants	Ex	Ex/E	E	V	R	I	Total No. Threatened Plants	No. of Species	% of Threatened Plants
Families – 47									
Genera >147									
Species – 17,500									
(Flowering Plants)	19	41	152	102	251	690	1236	17,500	7-10

(Kerry and Harriet, 1998)<sup>17</sup>

Ex - Extinct; Ex/E - Extinct/Endangered; E - Endangered; V - Vulnerable; R - Rare; I - Indeterminate

<sup>16</sup> Nayar, M.P. 1996. "Hotspots" of Endemic Plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, Kerala.

<sup>17</sup> Kerry S. and Harriet J. ed. 1998. 1997 IUCN Red List of Threatened Plants IUCN – The World Conservation Union.

### 2.1.6. Medicinal Plant species of Conservation Concern

Availability of many plant species particularly of endemic origin of trees, shrubs, herbs etc. which provide life saving drugs to the people are declining very fast over the recent past. Of 622 taxa of Indian plants recorded in the Red Data Book of Indian Plants (Nayar and Shastri, 1987, 1988 & 1990)<sup>18</sup> more than 80 have known medicinal uses. Rapid threat assessment exercises carried out by FRLHT indicated a list of 265 wild medicinal plant species as threatened (based on IUCN Red list criteria and categories). The IUCN has indicated that nearly 12.5% of known flowering plants of the world suffer from different degrees of threats. A similar proportion (12.5%) to the 8,000 Medicinal Plant species as threatened category is found in India and this works out to about 1,000 Medicinal Plant species which suffer from various degrees of threats.

The Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora has notified eleven Indian medicinal plant species in its schedules in 1998 and the Government of India has recommended restriction on export of 29 species including this eleven of CITES list and six species existing in Schedule VI of WPA 1972 which are believed to be threatened in the wild.

The major threats to the MPs are unsustainable and unscientific harvesting for commercial utilizations, habitat fragmentation and degradation and habitat loss. These factors have significantly contributed to the decline in population of plant species particularly the endemic medicinal plants. Therefore, these wild endemic medicinal plant species of conservation concern need immediate appropriate management intervention.

#### 2.1.6.1. Red Listed Medicinal Plants of Southern India

Threat assessment exercise (carried out for Southern and Northern India, as per latest IUCN Red List categories) have brought to notice around 172 species of medicinal plants that are under various degrees of threats. The habit wise Red listed MPs of Southern India are shown in **Table – 2.6**.

18 Nayar, M.P. and A.R.K. Sastry. (Eds.) 1987, 1988, 1990 *Red Data Book of Indian Plants. Vol. 1, 2, 3* Botanical Survey of India, Calcutta.

**Table 2.6 - Habit wise Red Listed Medicinal Plants of Southern India**

Habit	VU	EN	CR	LRnt	EX	EW	TOTAL
Herb	10	5	6	3	1	1	26
Shrub	1	4	3	3	-	-	11
Tree	28	11	5	6	2	-	52
Climber	6	5	3	1	-	-	15
Liana	4	2	1	1	-	-	8
Total	49	27	18	14	3	1	112

Different degrees of threat- namely VU - Vulnerable; En - Endangered, CR - Critically Endangered; LRnt – Lower Risk – near threatened; EX- Extinct; EW – Extinct in Wild.

### 2.1.6.2. Study on Floristic Diversity, Endemic and Threatened Medicinal plant species in KMTR

Of the 4,000 species of flowering plants, (27% of the Indian flora) in Western Ghats, nearly 1,106 species are found to occur in KMTR (based on stratified random sampling conducted). Out of the 1,106 vascular plants reported in this area, around 772 species are recorded as MPs used in Ayurveda, Folk, Siddha, Tibetan, Unani, Homeopathy and Modern systems. Of this as many as 189 endemic species of angiosperms have been identified from this region (Nayar, 1996)<sup>19</sup>. The present study indicates that in Western Ghats and other Peninsular India, 122 endemic and threatened medicinal plant species are distributed while 58 are global endemics (endemic and threatened medicinal plants) confined to KMTR. The remaining 24 and 5 MPs are from other parts (Central and Northern) of Western Ghats and Peninsular India respectively. The other 35 are globally distributed (Table -2.7).

**Table 2.7 - Centres of endemism of Threatened Medicinal Plants recorded in quadrats**

Categories	Plants			Centres of floristic Endemism														
				WG										Others				
	MP	NMP	Endemic & Threatened	SWG										Others	Peninsular India		Global	Grand Total
				KMTR	S	SC	SCN	SN	C	N	CN	Sub Total	Nn. & Cn. WG		EG	WG, P1		
MP	772	--	122	7	34	8	8	-	-	1	-	58	24	2	3	35	122	
NMP		334	42	-	38	4	-	-	-	-	-	42	-	-	-	-	42	
Total	1106		164	7	72	12	8	-	-	1	-	100	24	2	3	35	164	

MP - Medicinal Plants, NMP – Non Medicinal Plants, KMTR - Kalakad Mundanthurai Tiger Reserve, S - SWG south, SC - SWG South central, SCN - SWG South, Central, North; C - SWG Central, N – SWG North, CN – SWG Central North, EG – Eastern Ghats, WGPI – Western Ghats and Peninsular India, WG – Western Ghats, SWG – Southern Ghats, G - Global, WG EG - Western Ghats and Eastern Ghats. Endemic & Threatened; PI - Peninsular India

19 ibid

### 2.1.7. Further Study on Growing Parameters of Plants, Conservation Development Model, Species Recovery Plan, Policy Lacunae

Thematic maps of various phytogeographic parameters for plant growth in the study area have been prepared with common geo reference and finally Summary Table of abiotic factors of individual ETMPs along with their ecological situations elaborated so that further rehabilitation work for the species can be taken up by the custodian and also similar work can be taken up for other species too.

Creation of a Conservation Development Model and Action Plan, a real need of the hour has been suggested for selected species. A conservation development model for prioritizing the management prescriptions for MPs along with Taxon Data sheet of sixteen ETMPs with species specific Recovery Plans is also provided. Finally the causes for decline of the medicinal plants to reach their threshold point of threatened conditions were found out especially for these select ETMPs.

Species specific recovery plans of twelve selected ETMPs of the area have been discussed with sufficient coloured illustrations and prescribed for future course of action by the custodian. Mapping of *Floristic species richness*, *Medicinal plant species richness*, *Hotspots of ETMPs* and finally *Zonation of conservation values* based on field survey and analysis is a novel study that can be applied for all areas of natural forests/wild areas for resource planning. Modelling for Strategic Management and Conservation by prioritization of threatened MPs of any unit area as generated in this study will have much application value to develop protocol for similar purposes for any given area.

The findings of this study is placed primarily before the custodian stakeholders of medicinal plants (with special attention to the endemic and threatened ones) which suffer from different degrees of threats and need immediate attention from the Policy makers and natural resource managers. As the appropriate policies are not in place even after the economic liberalization in 90's and its consequent effect of the upsurge in production of medicinal plants and herbal products and while a large number of medicinal plants suffer from various degrees of threats, the existing policy frame work regarding protection assurance of the floral species of the country needs to be relooked at. Because of this vacuum at policy level, the trade remains opaque and completely controlled by the informal sector. Besides, the executives in field meant to protect and conserve these plant resources are not in a position to take any appropriate legal action against the persons involved in illegal collection and destructive harvesting as it is not legally supported in the court of law.

Specific policy lacunae in the system has been provided by analyzing the i) role of existing legal provisions and polices in protecting medicinal plants; ii) protection assurance status of flora in comparison to fauna and iii) the historical perspective of policies and Acts formulated over the last 120 years in forestry, which clearly spell out the shortcomings as well as the paradigm shift required in the management strategy for medicinal plants. Further, overall summary in the sector has been drawn through the SWOT analysis and furnished.

Specific recommendations for Policy formulation, extension of legal provisions for conservation and sustainable utilization of medicinal plants were developed based on the findings of this study. Finally, a list of 201 Threatened Medicinal plants have been proposed for inclusion as *Plant Schedules* in The Wildlife (Protection) Act, 1972 or in the Biological Diversity Act, 2002 based on CAMP workshops conducted by various prime institutes in this field like FRLHT, Bangalore; Zoo Outreach Organization, Coimbatore; Forest Department, Uttar Pradesh, Lucknow and my own field study. This list of proposed *Plant Schedule* is supplemented with 193 photographs collected from various sources in addition to my own photographs with the single objective to provide comprehensive information to the users at one reference. The findings provide necessary input for the Policy makers to evolve conservation strategies, formulate negative list of MPs from the threatened groups of plants so that these can be well protected using appropriate *Plant Schedule*.

A *Recommendation Tree* and *Action Plan* for conservation and sustainable use of medicinal plants with all related issues so that this can be applied by the custodian as well other stakeholders in the field for protecting and conserving these resources is provided as last chapter. The study has identified the problems and prospects of medicinal plant sector in the country and accordingly prescribed necessary management strategies to overcome the same in a comprehensive manner based on detailed field survey as a pilot study. Although the study is representing KMTR in Tamil Nadu, the proposed model of conservation would hold good for the entire country, of course with minor modifications based on site specific issues of individual States.

## Chapter – III

# Kalakad Mundanthurai Tiger Reserve (KMTR) - The Study Area

Kalakad Mundanthurai Tiger Reserve or KMTR-- the 17th Tiger Reserve in India was established in 1988. The reserve is located at the Southern end of the Western Ghats in Tirunelveli and Kanyakumari districts of Tamil Nadu. The total area of the reserve is 895.39 km<sup>2</sup> and lies between latitudes 8°21'27" to 8°53'02" North and between longitudes 77°10'10" to 77°34'28" East. (**Map : 3.1** - on Front Inner Wrapper)

### 3.1. Western Ghats and KMTR

The Western Ghats form a practically unbroken relief dominating the Western coast of the Indian Peninsula for almost 1,600 km. They extend from the mouth of the river Tapti (21°N) to the tip of South India (about 8°N) the only major break in the chain being the Palghat Gap (Pascal, 1988)<sup>20</sup>. The Western Ghats may be divided into three major regions namely

- 1) Northern Western Ghats (River Tapti to Goa),
- 2) Central Western Ghats (Goa -River Kalinadi to Coorg) and
- 3) Southern Western Ghats (South of Coorg to Tirunelveli hill complex).

KMTR is located at the South portion of the Southern Western Ghats (SWG) in the Districts of Tirunelveli and Kanyakumari. The various parts and the major centres of floristic endemism of Western Ghats and KMTR- the Study Area are shown in **Map - 3.2 A, B, C and D**. A brief description of each part of Western Ghats is given below:

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20 Pascal J.P. 1988. *Wet Evergreen forests of the Western Ghats of India*; Ecology, structure, floristic composition and succession. Institut Francais de Pondicherry.



### **3.1.1. Northern Western Ghats (River Tapti to Goa)**

The most homogeneous aspect of the Ghats is to be found in this region hugging the coast for almost 600 km. Here they correspond to the Western edge of the vast plateau formed by the basaltic outpourings of the Deccan Trap. The term ‘Ghats’ i.e steps of a stair case dawn from here. Its elevation is generally between 700 to 1,000 m except peaks like Kalsubai (1,646 m) and the Mahabaleshwar (1,438 m). The coastal zone called Konkan, is narrow and about 50 to 60 km wide.

### **3.1.2. Central Western Ghats (Goa - River Kalinadi to Coorg)**

The Ghats lose their graded appearance and form a steep barrier whose height varies between 700 to 1,000 m upto 14°N, rise suddenly at Kodachadri (1,343 m) and fall to about 600 m at Agumbe. From Kudremukh (1,892 m) upto the Palghat Gap the edge of the plateau is very often higher than 1,000 m. The coastal region after Coorg known as Malabar, is not more than 30 km wide upto the latitude of Kozhikode. From here it widens out to about 60 km till the Palghat Gap.

### **3.1.3. Southern Western Ghats (South of Coorg to Tirunelveli hill complex consisting of Nilgiri, Anamalai, Palni, Malabar, Travancore, Tirunelveli hill complex):**

The Southern Western Ghats (SWG) may be further divided into three sub regions namely North, Central and South Southern Western Ghats (**Map - 3.2 B**) as follows:

#### **3.1.3.1. Northern part of Southern Western Ghats**

Towards 11°30' N, the Western Ghats rise abruptly in the Nilgiri Horst where they join the Eastern Ghats. The Nilgiri mountains constitute an elevated plateau attaining a maximum height of 2,637 m at Dodda Betta. The Western Ghats are interrupted by the Palghat Gap which is about 30 km wide and they reappear abruptly as the Anaimalai-Palni block whose high plateau attain a height of 2,695 m in the Anaimudi peak, the highest point in South India.

#### **3.1.3.2. Central part of Southern Western Ghats**

The Ghats display further changes here. They form an elevated plateau slanting towards the West, the Periyar plateau. The eastern part of this plateau forms the Elamalai range, better known as the Cardamom Hills. This Central range attains its peak at Devar Malai (1,922 m) and terminates in the East by a cliff about 1,000 m high. From this, the SW-NE oriented Varushanad massif is detached and continued by the Aundipatti, which together with the Palni hills embraces the Kambam Valley.

### 3.1.3.3. Southern part of Southern Western Ghats and KMTR

South of Devar Malai, at about 9° N, the Ghats are once again interrupted by the narrow Shencottah Pass (160 m). From here they continue as a narrow ridge with steep slopes to the West as well as to the East, until about 20 km before Cape Comorin (Kanyakumari). This last bit is very rugged and its highest peak is the Agasthiyamalai (1,869 m). Three regions may be distinguished here as Agasthiyamalai proper, Mahendragiri to the South and the Tirunelveli hills on the Eastern slopes. The coastal zone (30-50 km wide) constituting Travancore is made up of convex shaped hills with rounded summits. KMTR is located at this Southern part of the Southern Western Ghats.

## 3.2. KMTR

The Reserve covers most of the part of Tirunelveli hills, Agasthiyamalai proper, and Mahendragiri to the South except a small portion from Courtalam to Shencottah pass in the North which comes under Tirunelveli Forest Division and small portion of Kanyakumari District in Tamil Nadu and part of Trivananthapuram District of Kerala in the South. The Location map and the Base map of the study area is shown in **Map - 3.3**.

### 3.2.1. Constitution

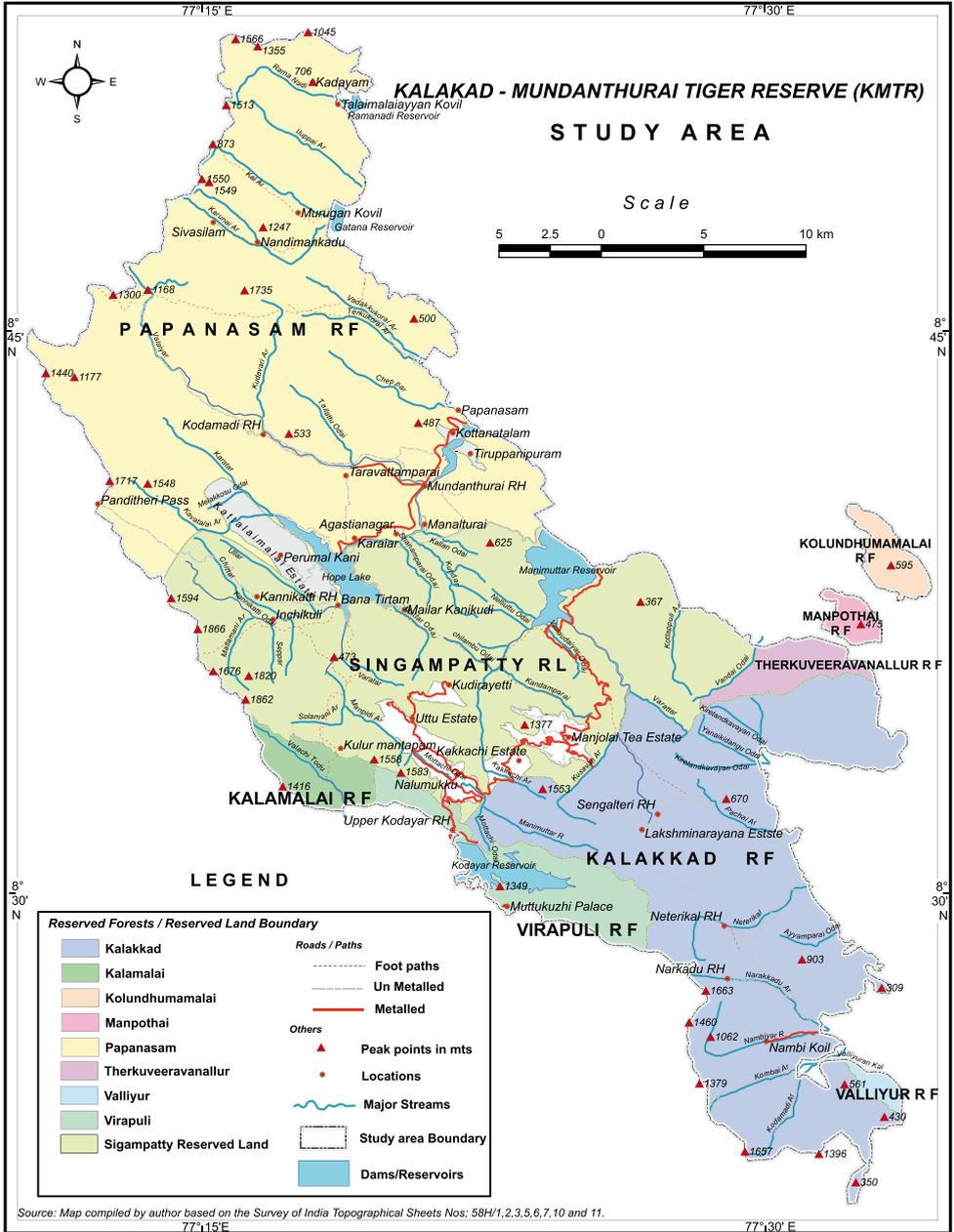
KMTR includes two adjacent Sanctuaries namely Kalakad Sanctuary and Mundanthurai Sanctuary in Tirunelveli District. It also includes part of Kilamalai and Veerapuli Reserved Forests of Kanyakumari Sanctuary. All these three Conservation Units are under the unified administration of KMTR. KMTR also includes nonsanctuary RFs to the extent of 2,705.69 ha. It covers seven territorial ranges, Kalakad and Thirukurungudi Ranges forms part of Kalakad Sanctuary, Upper Kodayar Range forms part of Kanyakumari Sanctuary, Kadayam, Papanasam, Mundanthurai and Ambasamudram Ranges forms part of Mundanthurai Sanctuary. KMTR includes four Eco-development Ranges namely Thirukurungudi, Ambasamudram, Papanasam and Kalakad. Kadayam Territorial Range also implements Eco-development programme.

### 3.2.2. Selection of the Study Area

Kalakad Mundanthurai Tiger Reserve (KMTR), Southern Western Ghats of Tamil Nadu, India, one of the protected areas in Agasthiyamalai, a Biodiversity Hotspot of global significance (Nayar, 1996)<sup>21</sup> and also noted for many important medicinal plants of endemic, ethnic value that are red listed has been selected as the study area. In fact, Agasthiyamalai is honoured as the “Cultural home of Siddha”.

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21 *ibid*



Map - 3.3 : Base Map of the Study Area

### 3.2.3. Legal Status of lands

**Table 3.2 – Reserved Forests, Reserved land and their extent**

Reserved Forests / Land	Year of Notification	Area (in ha)
Papanasam RF	1883	33,768.00
Kalakad RF	1883	22,358.47
Therkuveeravanallur RF	1890	1,289.82
Kolundumamalai RF	1890	622.88
Manpothai RF	1898	502.58
Veerapuli RF	1903	5,942.00
Valliyur RF	1904	290.41
Kilamalai RF	1929	1,786.00
<b>Subtotal of RFs</b>		<b>66,560.16</b>
Singampatty RL	1978	22,979.20
<b>Grand total of RFs and RL</b>		<b>89,539.36</b>

### 3.2.4. Abiotic factors operating in forests

Various abiotic factors such as geology, elevation, slope, rainfall, temperature, drainage networks and drainage density, geomorphology, soils, watershed, operate in the study area and that has resulted with specific forest types, forest canopy density.

### 3.2.5. Organisation and Administration

The forest cover in Tamil Nadu is about 23,635 km<sup>2</sup> which comes to 18.16% of the total geographical area (FSI, 2011)<sup>22</sup>. This resource is managed by 9,012 personnel having the composition of natural resource managers, planners and decision makers on one hand and executives and protection staff in the field on the other hand at three management levels. In Tamil Nadu protection of endangered species is highlighted through two initiatives viz. the protected area strategy through Indian Wildlife (Protection) Act 1972, its Amendment Act, 2006 and the development of its forest practices code through Tamil Nadu Forest Code and Tamil Nadu Forest Manual.

#### 3.2.5.1. Organizational Structure and Working in KMTR

KMTR - the study area comes under the jurisdiction of Tamil Nadu Forest Department. KMTR forms a compact and contiguous unit of about 895.39 km<sup>2</sup> and managed by 140 personnel. The Reserve is mainly governed by the Field Director - the Chief Executive Officer of KMTR along with three managers under him namely Deputy Director Ambasamudram, Deputy Director Kalakad and the Eco Development Officer. The Field Director is the overall controlling authority of the entire KMTR for protection, development and also for its future plan. The Field Director works directly under the Chief Wildlife Warden of the Tamil Nadu State and the Principal Chief Conservator

<sup>22</sup> Anon. Status Report 2011. Forest Survey of India, Government of India, Dehra Dun.

of Forests, Tamil Nadu. The policies / legal-acts / rules are applied in KMTR by the elites and protection staff.

### 3.2.6. Existing Policies, Legal Acts and Rules

The major policies, legal Acts and rules which control and govern the protection and conservation of the flora and fauna in Tamil Nadu including KMTR are listed chronologically.

1. 1882 - Madras Forest Act.
2. 1894 - National Forest Policy.
3. 1927 - Indian Forest Act.
4. 1946 - Tamil Nadu Preservation of Private Forest Rules.
5. 1949 - The Tamil Nadu Preservation of Private Forest Act.
6. 1952 - National Forest Policy.
7. 1955 - The Tamil Nadu Hill Areas (Preservation of Trees) Act.
8. 1957 - Tamil Nadu Hill Areas (Preservation of Trees) Rules.
9. 1967 - Tamil Nadu Sandalwood Transit Rules.
10. 1968 - Tamil Nadu Timber Transit Rules.
11. 1970 - Tamil Nadu Sandalwood Possession Rules.
12. 1972 - The Wildlife (Protection) Act.
13. 1980 - Forest (Conservation) Act.
14. 1982 - Tamil Nadu Prevention of Dangerous Activities of Bootleggers, Drug Offenders, Forest Offenders, Goondas, Immoral Traffic Offenders and Slum Grabbers Act, (commonly called Goondas Act).
15. 1982 - Tamil Nadu Timber (Movement Control) Order.
16. 1986 - The Environment (Protection) Act.
17. 1988 - National Forest Policy.
18. 1988 - Tamil Nadu Maintenance of Accounts in Respect of Scheduled Timber for Industrial or Commercial Purposes Rules.
19. 1991 - Forest (Conservation) Rules.
20. 1991 - Tamil Nadu Wildlife (Transit) Rules.
21. 1994 - Tamil Nadu Rosewood Tree (Conservation) Act
22. 1995 Directives of the Honourable Supreme Court in W.P. No. 202/1995 banning felling of Trees from Natural Forest irrespective of status of land.
23. 2002 - Biological Diversity Act.
24. 2002 - The Export Import Policy, 2002-2007.
25. 2004 - Biological Diversity Rules.
26. 2006 - The Wildlife (Protection) Amendment Act.

দাও ফিরে সে অরণ্য, লও এ নগর,  
লও যত লৌহ লৌষ্ট কাষ্ঠ ও প্রস্তর  
হে নবসভ্যতা। হে নিষ্ঠুর সর্বগ্রাসী,  
দাও সেই তপোবন পূণ্যচ্ছায়ারাশি,

‘চৈতালি’

*“Oh the Cruel Omnivorous Neocivilization!  
take back Thy Iron, Stone, Timber, Bricks and Cities,  
restore that Pristine Forest and Sanctuary  
- the Shelter for Eternity”.*

‘Chaitali’

- Rabindranath Tagore

# Chapter – IV

## Methodology Adopted

Field survey using nested Quadrat Method; application of Geoinformatics using modern tools such as Satellite Remote Sensing, GIS and GPS; application of phytochemical analysis by Gas Chromatograph and Stakeholders Analysis of medicinal plants were carried out as Methodology for this book as given in **Figure No. 4.1 and 4.2** - Integrated Methodology to make this study more holistic.

**Figure 4.1 - Methodology**

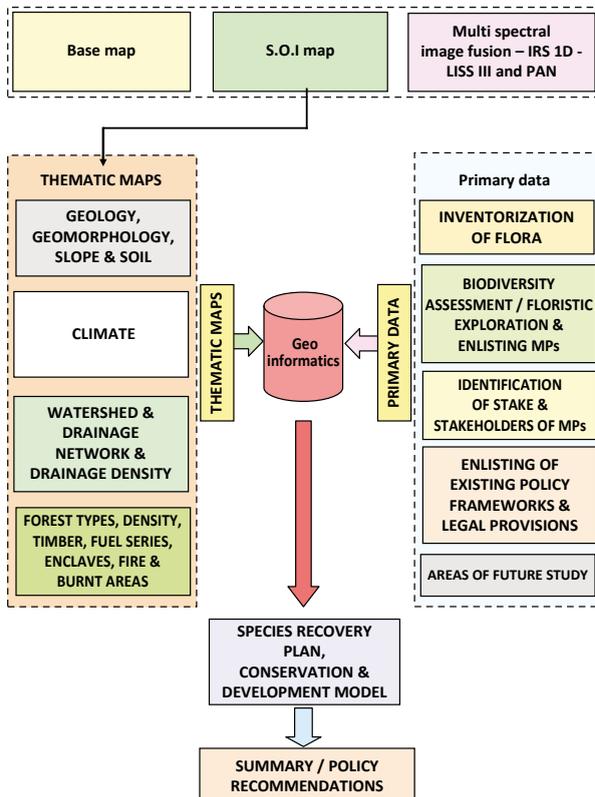
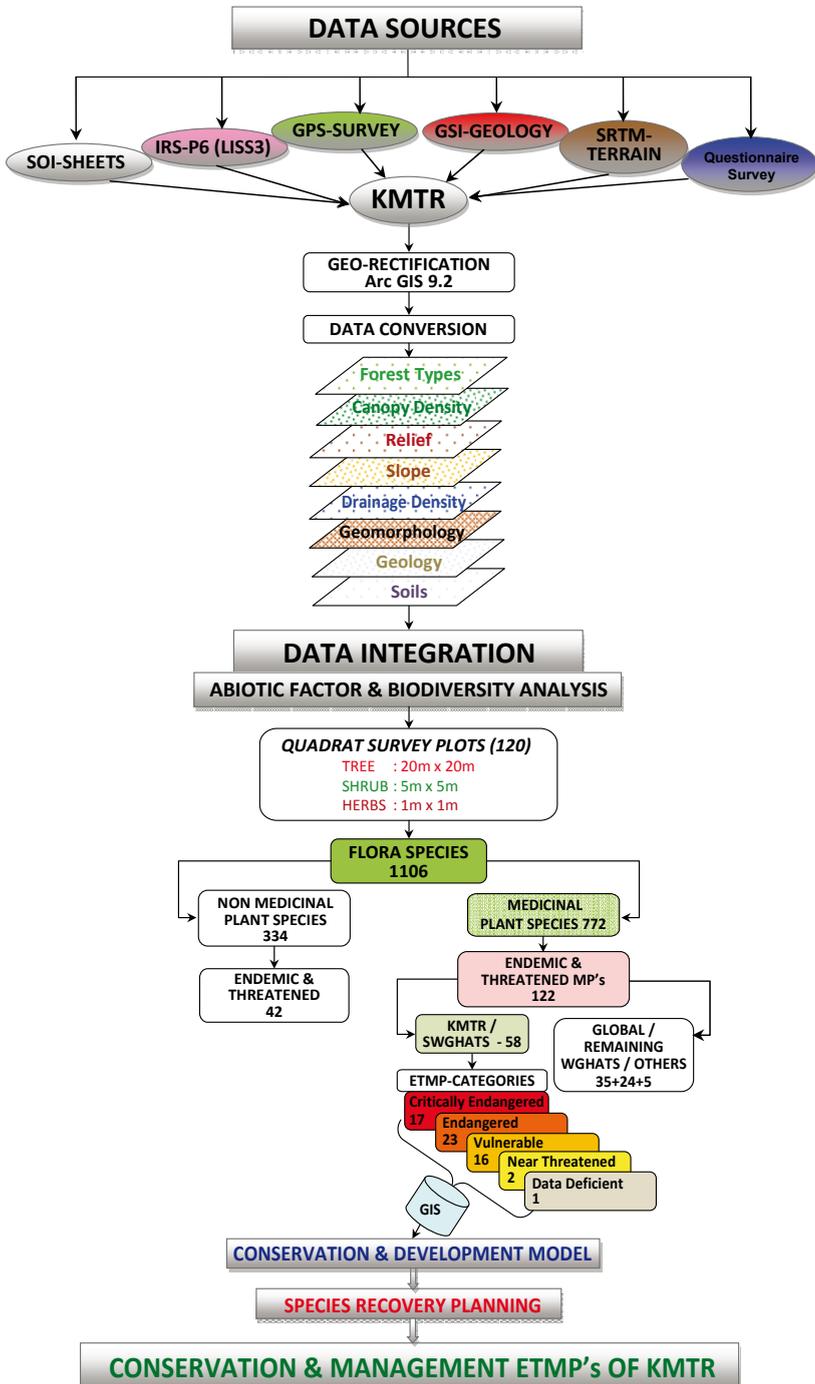
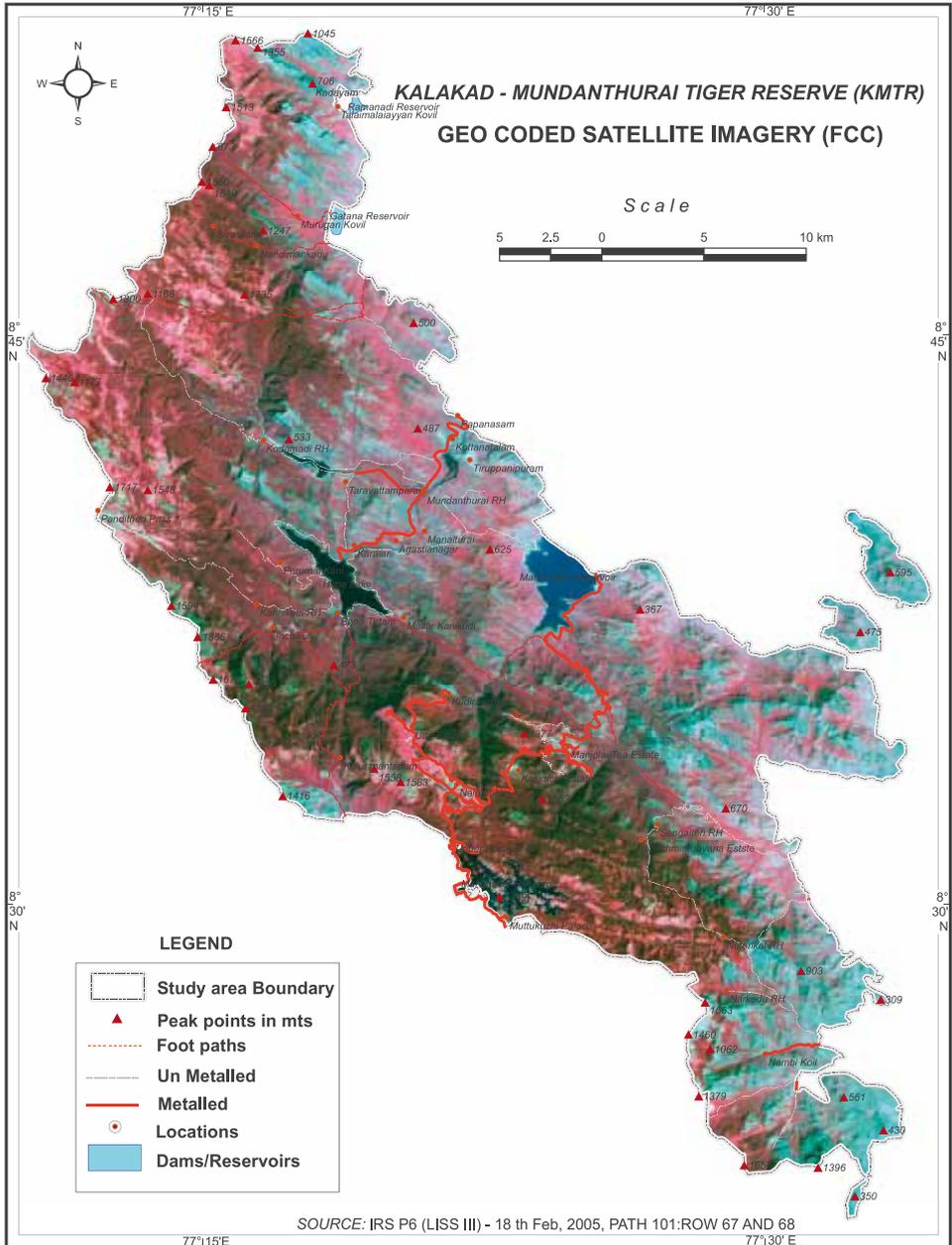


Figure 4.2 - Integrated Methodology



### 4.1. Satellite data

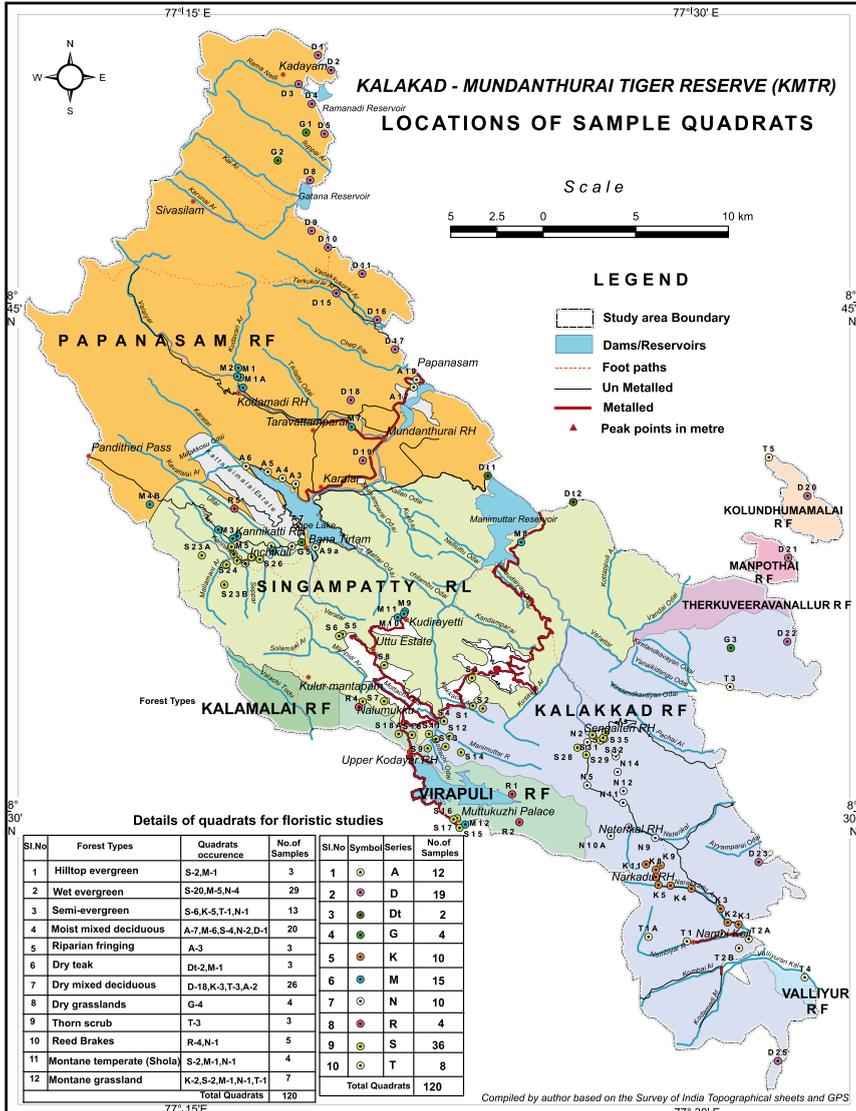
Satellite imagery, IRS – P/6 LISS III FCC hard and soft copies of 18<sup>th</sup> February 2005 of path, 101 and row 67 and 68 were used (**Map – 4.1**)



**Map - 4.1 : Geocoded Satellite imagery (FCC of bands 2, 3, and 4)**

### 4.2. Sampling Design

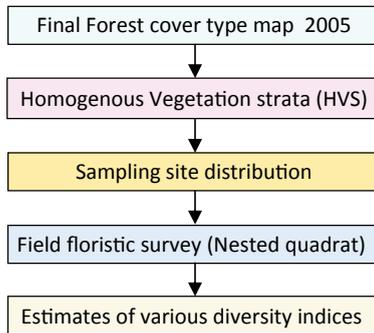
Intensive field study was carried out following nested quadrat technique (20m x 20m). The geo-coordinates of all 120 plots were recorded by GPS marking (**Map – 4.2**). A total of 4.8 ha area was sampled and all tree species above 15 cm GBH were enumerated and their girth measured. Shrubs (less than 15 cm at GBH) were enumerated in 5 m x 5 m quadrats and herbs were enumerated in 1 m x 1 m quadrats within all the plots.



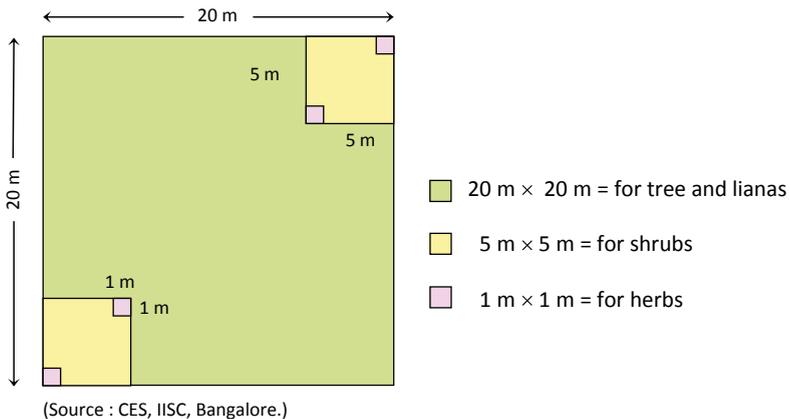
Map - 4.2 : Locations of sample quadrats for floristic studies

The species were identified in field and unidentified specimens were collected and herbarium prepared using standard procedures and identified at Rapinat Herbarium, Tiruchirappalli (RHT) and Madras Herbarium at Coimbatore (MH). For multi-stemmed trees, girth of the boles was measured and basal area calculated separately and summed up and the buttressed trees girth was measured just above the buttress. The methodology followed to carry out floristic diversity analysis is also explained in the **Figure – 4.3** and the dimensions of the nested quadrat are given in **Figure – 4.4**.

**Figure 4.3 - Paradigm for field floristic survey for plant diversity analysis**



**Figure - 4.4 Dimension of Quadrat for Field Survey**



### 4.3. Floristic diversity analysis

The following diversity indices were calculated for the recorded species

In the present study following diversity indices were calculated.

1. **Frequency** : (Magurran, 1988)<sup>23</sup> in percentage (%)

$$F (\%) = \frac{\text{Total number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}}$$

2. **Density** : (Magurran, 1988)

$$D = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats studied}}$$

Density is the number expressed in unit area – per hectare

3. **Abundance** : (Magurran, 1988) Abundance is the number of individuals in a given area.

$$Ab = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats in which the species occurred}}$$

4. **Basal area** : Basal Area is an area of the tree trunk at Breast Height.

$$BA = \frac{C^2}{4\pi} \text{ where } C \text{ is circumference at Breast Height}$$

5. **Relative frequency** : (Balslev *et al.*, 1987)<sup>24</sup>

$$RF = \frac{\text{Frequency of a species}}{\text{Sum of frequency of all the species}} \times 100$$

6. **Relative density** : (Balslev *et al.*, 1987) Relative Species Density is the total number of individuals of a species expressed as proportion (or percentage) of the total number of Individuals of all species.

$$RD = \frac{\text{Density of a species}}{\text{Sum of Density of all the species}} \times 100$$

7. **Relative basal area** : (Balslev *et al.*, 1987)

$$RBA = \frac{\text{Basal area of a species}}{\text{Sum of Basal area of all the species}} \times 100$$

8. **Importance Value Index** : (IVI) Importance Value Index gives an overall estimate of the influence or importance of a plant species in the community.

$$IVI = \text{Relative Frequency (RF)} + \text{Relative Density (RD)} + \text{Relative Basal Area (RBA)}$$

23 Magurran, A.E. 1988. *Ecological diversity and its measurement*. Princeton university pres. New Jersey.

24 Balslev, H., J. Luteyn, B. Ollgaard and L.B. Holm-Nielsen. 1987. Composition and structure of adjacent unflooded and floodplain forest in Amazonian Ecuador. *Opera Botanica*, 92, 37 – 57.

**9. Shannon's Index :** (Shannon and Weiner, 1963)<sup>25</sup>

Shannon's index is a quantitative measure of habitat diversity. The equation is :  $H = -\sum (p_i \ln p_i)$  or  $H' = \sum p_i \log p_i$

The term  $p_i$  is the decimal ratio of individuals of a species to the total number of individuals overall. The S-W Index is used to measure habitat quality. High diversity means that there is a high degree of uncertainty in predicting the next organism we will see in the ecosystem. A low S-W Index means a high degree of certainty in predicting the next organism.

**10. Simpson's Diversity Index :** (Balslev *et al.*, 1987)

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. Simpson's Diversity Index is a measure of diversity which takes into account both richness and evenness.

**Simpson's Diversity Indices (D) can be calculated as**

$$D = \sum (n / N)^2$$

$n$  = the total number of organisms of a particular species,

$N$  = the total number of organisms of all species,

Value of **D** ranges between 0 and 1, with this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of **D**, the lower the diversity.

Or **Simpson's Diversity Indices**  $1 = \sum p_i^2$

$$p_i = \frac{\text{Number of individuals of the species}}{\text{Total number of individuals}} \times 100$$

**11. Rarity (R) :** One or two individuals in the concerned forest types are considered as rare

$$\%R = \frac{\text{Number of rare species}}{\text{Total Number of species}} \times 100$$

**12. Abundance to Frequency ratio (A/F%)**

The Abundance to Frequency ratio to understand the distribution patterns *i.e.*, <0.025 (regular), 0.025 - 0.05 (random) and >0.05 (contiguous).

25 Shannon and Weiner. 1963. *General Ecology*, 4th Edition, WCB McGraw-Hill, New York.

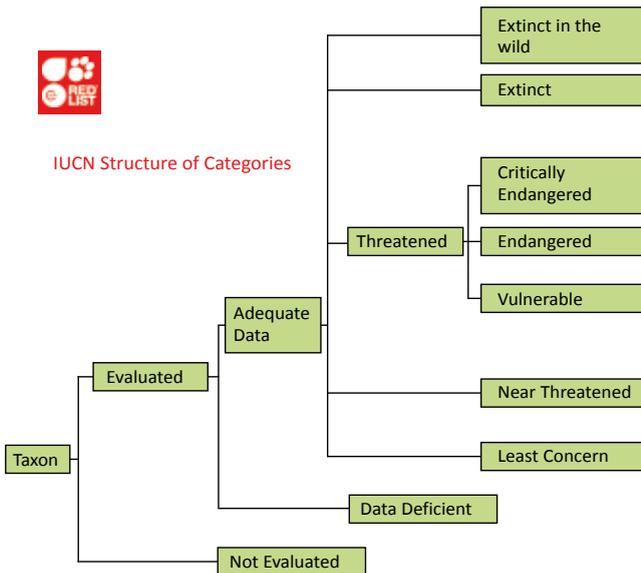
### 13. Species Richness

The Species Richness map was tied using Margalef (1958)<sup>26</sup> diversity index as studied by Ravan and Roy (1997)<sup>27</sup>. It is given by Margalef (Mg) Index :  $d = (S - 1) / \log N$ , where  $d$  is the richness index,  $S$  is the number of species, and  $N$  is the number of individuals.

#### 4.4. Short listing of Endemic and Threatened Medicinal Plant species

The Structure of the IUCN Red List categories (IUCN, 2001)<sup>28</sup> is shown in **Figure - 4.5**. Short listing of Endemic and Threatened Medicinal Plant species of the study area i.e., KMTR from the total inventory of the floral species is shown in **Figure - 4.6** in two segments by applying a logically conclusive selection method. First four sets of the segment are made to select the threatened plant species from KMTR to be studied in detail and the remaining three sets of the other halves are made to evolve the Management strategies for such short listed species by making a Conservation Management Model.

**Figure - 4.5 Structure of the IUCN Red List categories (IUCN, 2001)**

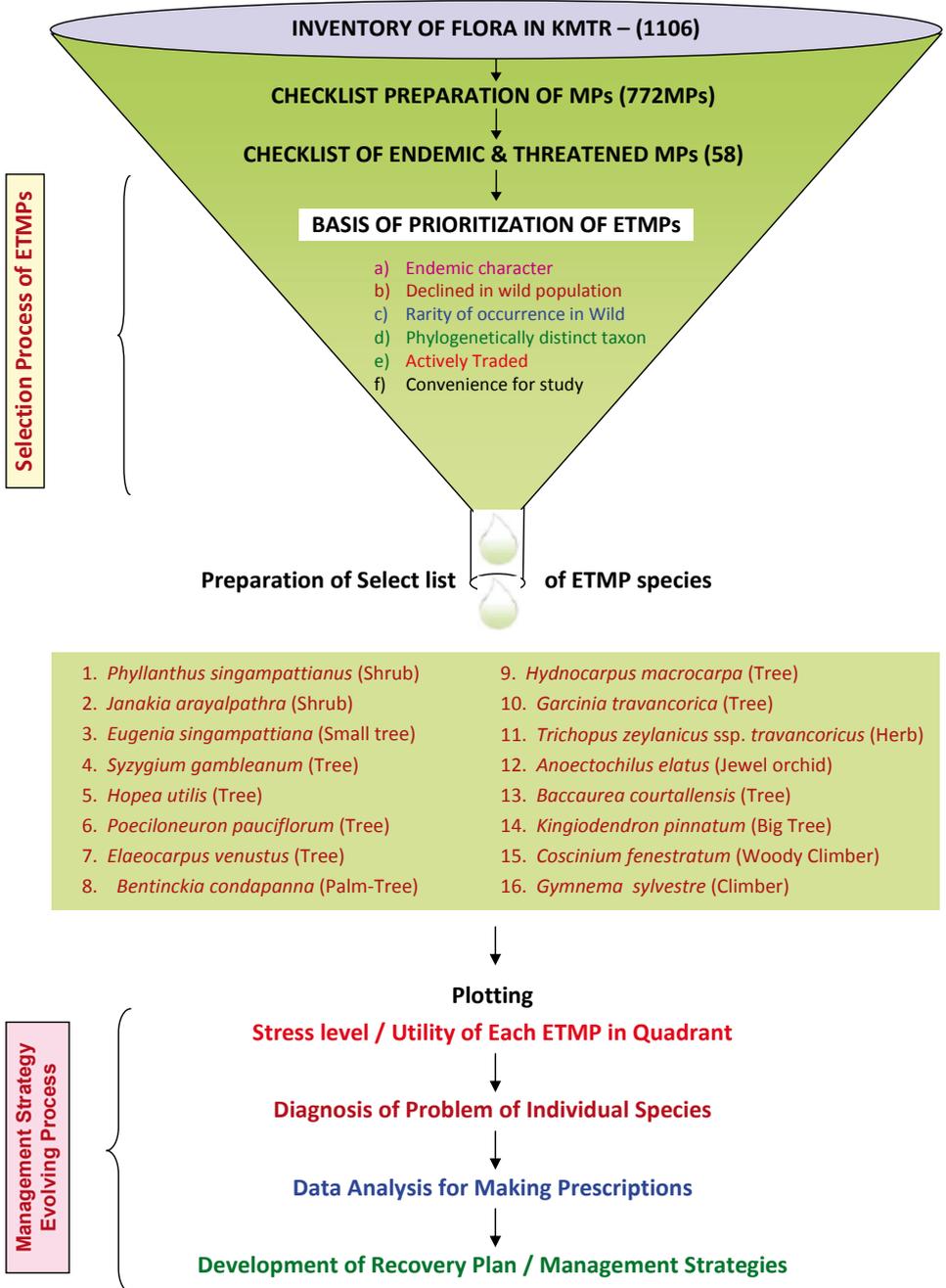


26 Margalef, R. 1958. *Information theory in ecology*. Gen. System 3 : 36-71.

27 Ravan, A and P.S. Roy. 1997. Satellite remote sensing for ecological analysis of forested landscape. *Plant Ecology* 1 : 1-13.

28 IUCN (International Union for Conservation of Nature and Natural Resources). 2001. *IUCN Red List Categories, version 3.1*, prepared by the IUCN Species Survival Commission. Gland, Switzerland.

Figure - 4.6 Short listing of Endemic and Threatened MP species of the study area



#### 4.5. Development of Methodology to select plant species to evolve Conservation / Management Strategy

To find out the stress level of each Medicinal Plant *Trade / Utility* and *Threat Status* are plotted in a quadrant to diagnose the actual problem of individual plant for developing business development plan for conservation and sustainable use of Medicinal plants (Sanjib Phansalkar, 2001)<sup>29</sup> Based on the findings from the plotting, a conservation model was planned to for selected species for evolving Recovery plan / Management Strategies.

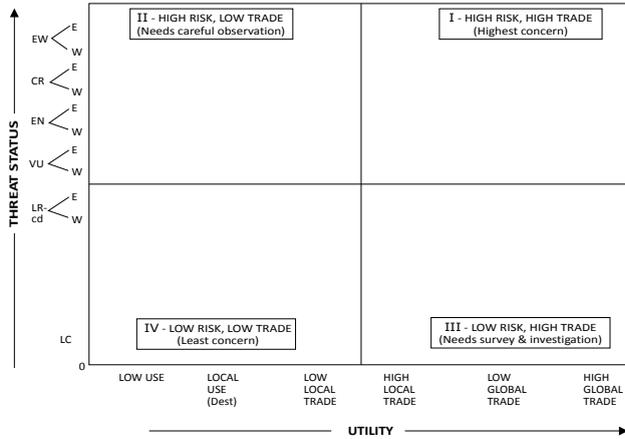
A quadrant is developed with the X-axis showing the status of a specific medicinal plant in *Trade utility* and the Y-axis indicating the present *threat status* of the same medicinal plant. For any specific area for which such a management plan is planned, we shortlist the medicinal plant from the field survey / list of flora of the area. Further, we shortlist the medicinal plants under different degrees of threat categories as per the IUCN guidelines. For a particular threat species both the *utility level* and its *threat status* are plotted in the quadrant based on the degree of utility and threat status. Likewise all the medicinal plants of the area can be plotted in the quadrant. Based on this plotting we can find out the group of plants as found in four categories namely (Figure - 4.7).

- A) Top left – **High risk - Low Utility value**
- B) Bottom left – **Low risk - Low Utility**
- C) Top right – **High risk - High Utility**
- D) Bottom right – **Low risk - High Utility**

Based on the location of a particular species where it got plotted, prescription or Recovery Planning / Strategy Plan are done for all the selected ETMP species.

<sup>29</sup> Sanjib Phansalkar. 2001. *Preparing Business Development plan for medicinal conservation areas and medicinal plant Development Areas* established by State Forest Department of Tamil Nadu, Karnataka & the FRLHT.

**Figure 4.7 – Model Showing the Priority Analysis for a Few Selected M Ps in KMTR**



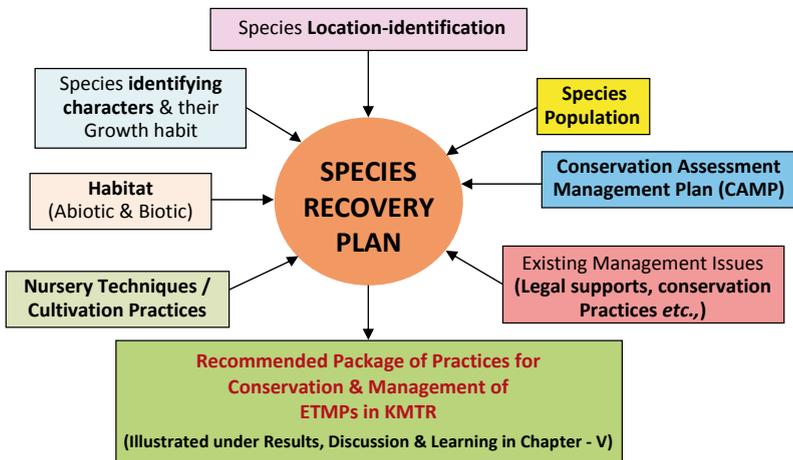
EW = Extinct in Wild; EN = Endangered; Vu = Vulnerable; LR-cd = Low Risk –conservation dependent, LC = Least Concern

### 4.6. Species Specific Recovery Plan for Selected Threatened Medicinal Plants

These recovery plans take into account all the factors that led to the present threat status of that species. **Figure - 4.8** shows the various factors considered in the present study and a subsequent operation plan.

Species specific recovery plan and management recommendations for selected endemic and threatened medicinal plants of the study area are prepared and elaborated under Results, Discussion and Learning in Chapter - V.

**Figure 4.8 - Species Specific Recovery Plan**



#### 4.7. Phytochemical Analysis by Gas Chromatograph - Mass detector (GC-MS)Method

GC-MS was used for analyzing the biochemical properties that can be used for ethnobotanic purpose for three critically endangered plant species namely *Phyllanthus singampattianus* (Sebastine & A.N. Henry) Kumari & Chandrab.; *Janakia arayalpathra* J. Joseph & V. Chand. and *Syzygium nesianum* Arn. as pilot study at Indian Institute of Crop Processing Technology, (IICPT) Thanjavur, Tamil Nadu (Sarcar, 2009).<sup>30</sup>

#### 4.8 Data collection by Questionnaire Survey from different groups of Stakeholder

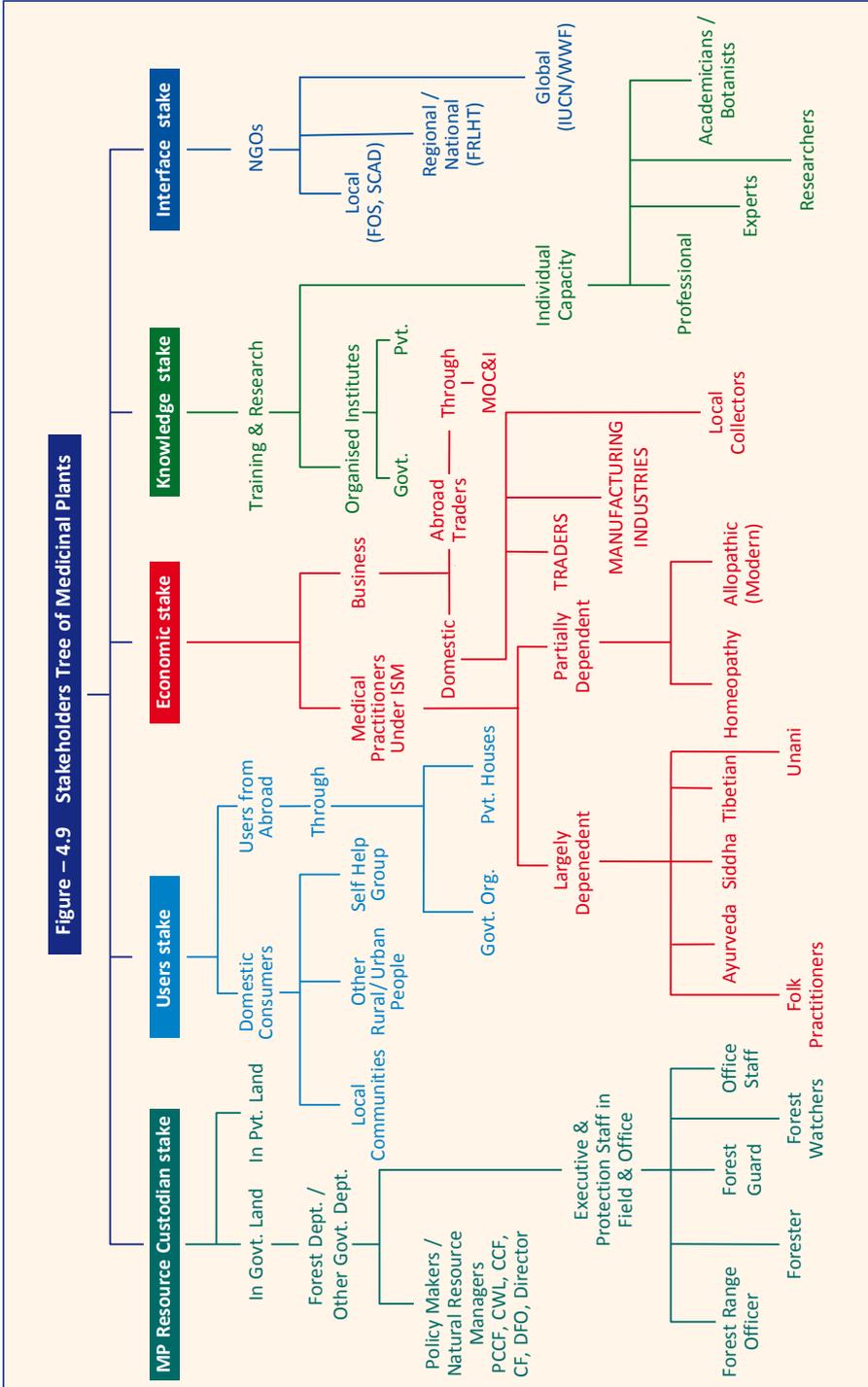
The various groups of stakeholders of medicinal plants and their specific stakes were identified in the study area and grouped into 5 major categories (**Figure - 4.9**) based on their stakes namely.

1. Resource Custodian Stakes (State Forest Department, Tamil Nadu)
2. Users Stakes (Local communities like Kani tribes, Self Help Group under EDP).
3. Economic Stakes [(Medical practitioners under the Department of Indian Systems of medicine) (Business / Commercial users e.g. Traders & Manufacturing traders, & Plant collectors)]
4. Knowledge Stakes (Training & Research Institutes & Professional experts)
5. Interface Stakes (NGOs & Voluntary agencies)

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30 Sarcar, Manoj Kumar. 2009. *Phyto-Chemical Analysis and Activity of Components* identified in *Janakia arayalpathra* [Tuber Dust] 123; *Phyllanthus singampattianus* [Leaf Dust] 124; and [Stem Dust] 125; *Syzygium nesianum* [Fruit Dust] 126 by Gas chromatograph -Mass detector (GC-MS) Method : at Indian Institute of Crop Processing Technology, Thanjavur, Tamil Nadu.

Figure – 4.9 Stakeholders Tree of Medicinal Plants

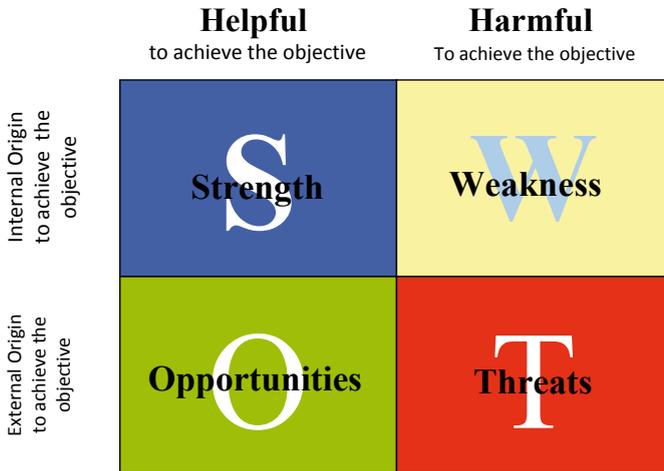


(Note : PCCF - Principal Chief Conservator of Forests, CWL - Chief Wildlife Warden, CCF - Chief Conservator of Forests, CF - Conservator of Forests, DFO - District Forest Officer, MOC&I - Ministry of Commerce and Industries, ISM - Indian Systems of Medicine, Org. - Organization)

#### 4.9. Strength, Weakness, Opportunities and Threats (SWOT) Analysis

A SWOT analysis first starts with defining a desired end state or objective. A SWOT analysis may be incorporated into any strategic planning model. An example of a strategic planning technique that incorporates an objective-driven SWOT analysis is Strategic Creative Analysis (SCAN). More thrust has been given for Strategic Planning, including SWOT and SCAN analysis.

Figure - 4.10 Swot Analysis Diagram



*“It is not how much we do, but how much love we put in the doing”.*

*“It is not how much we give, but how much love we put in the giving”.*

- Mother Teresa

# Chapter – V

## Results, Discussion and Learning

In-depth studies have been carried out on forest types, floristic biodiversity with special attention to the medicinal plants (MPs) and abiotic-biotic factors. Besides, application of geoinformatics, identification of stakeholders of MPs and finally SWOT analysis of all related physio cultural data of MPs and their present protection status have also been studied to evolve management strategies meaningfully.

### 5.1. Results

**The results are presented and discussed in the following order:**

1. Thematic Maps of Abiotic Factors and Forest types and their integration.
2. Floristic Biodiversity analysis and a database of Endemic and Threatened Medicinal Plant species (ETMPs).
3. Mapping of Zones of floristic endemism, Richness, Hotspots, Conservation Values and Threat Assessment of ETMPs.
4. Recovery plans for selected ETMPs and Conservation Models.
5. Stakeholders Analysis and Review results of existing Legal provisions, Policies, Acts, Field Observations, etc.

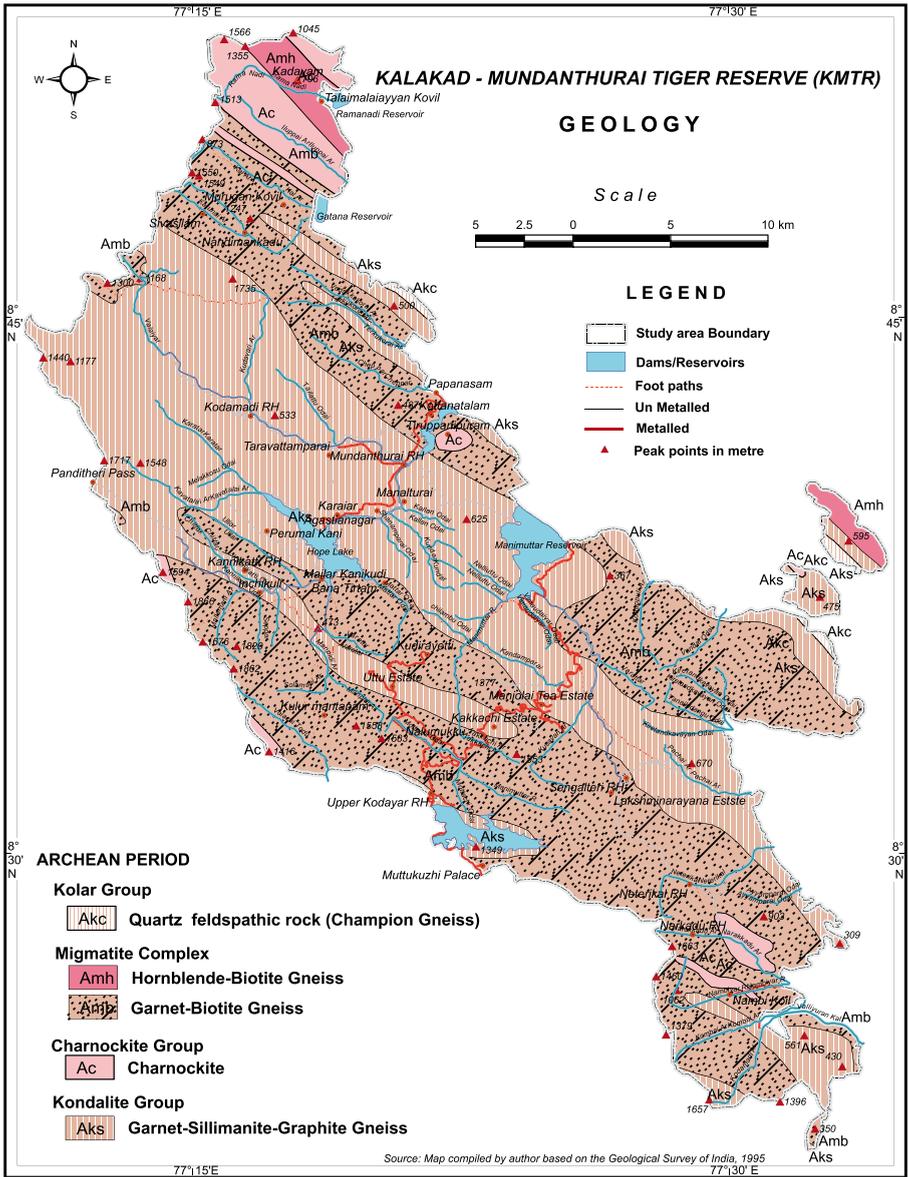
#### 5.1.1. Thematic maps of Abiotic Factors that operate in Forests and their Integration

Geospatial thematic maps such as geology, elevation, slope, rainfall, temperature and drainage density, geomorphology, soils, forest types and location of threatened MPs were prepared on a scale 1 : 50,000 using identical geo-code to use each of them as a component layer of information for integration

##### 5.1.1.1. Geology, Rock vs. Forest types (Map - 5.1)

Geologically, about 48% of the total forest cover of KMTR (all forest types except Hill top evergreen) is supported by *Garnet - biotite gneissic* rock

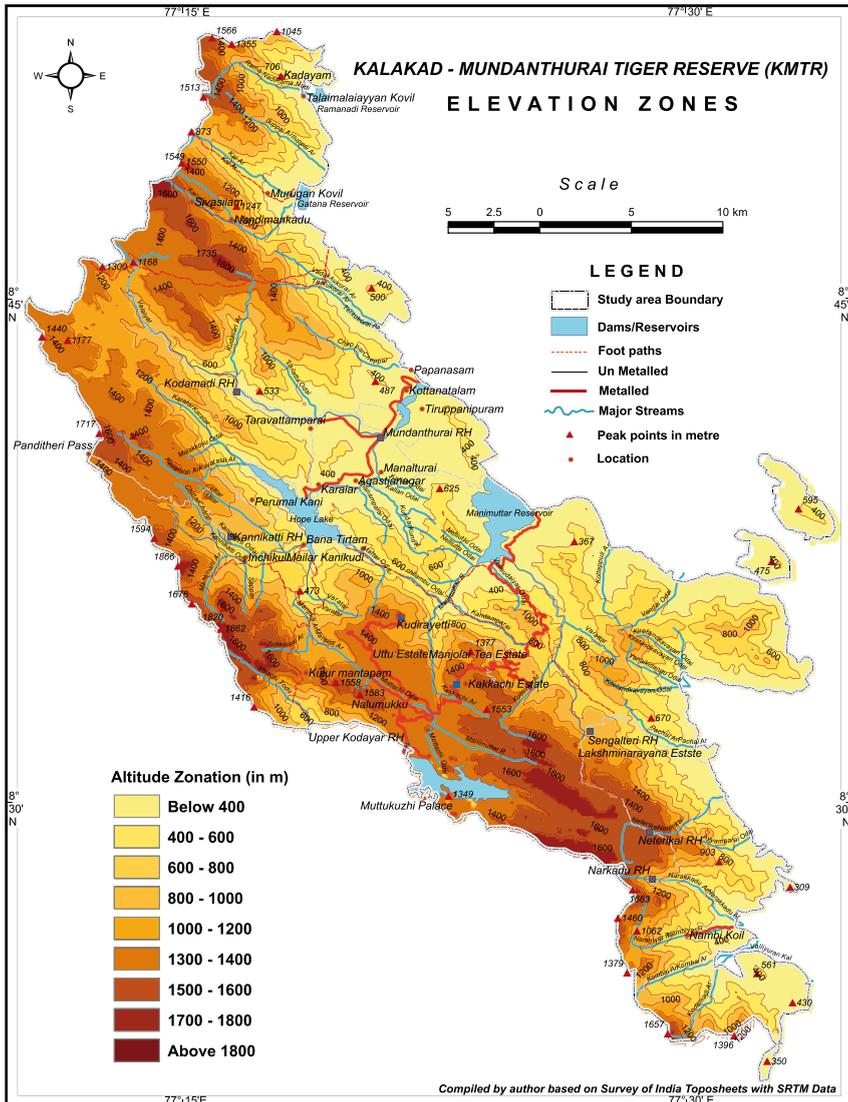
while *Garnet - Sillimanite - Graphite gneissic* rocks carry 43.30% forest cover of all types (except Montane type forest). Totally, 91% of forest covers are located in these two types of Gneissic rocks. Integration of Forest Types verses Geological formation indicates that there is a positive correlation between these two factors. This may be because of the fact that after metamorphism and hydro-geomorphologic process the Gneissic group rocks become easy support for root penetration of plants



Map - 5.1 : Geology map of KMTR

5.1.1.2. Elevation and Relief vs. Forest types (Map – 5.2)

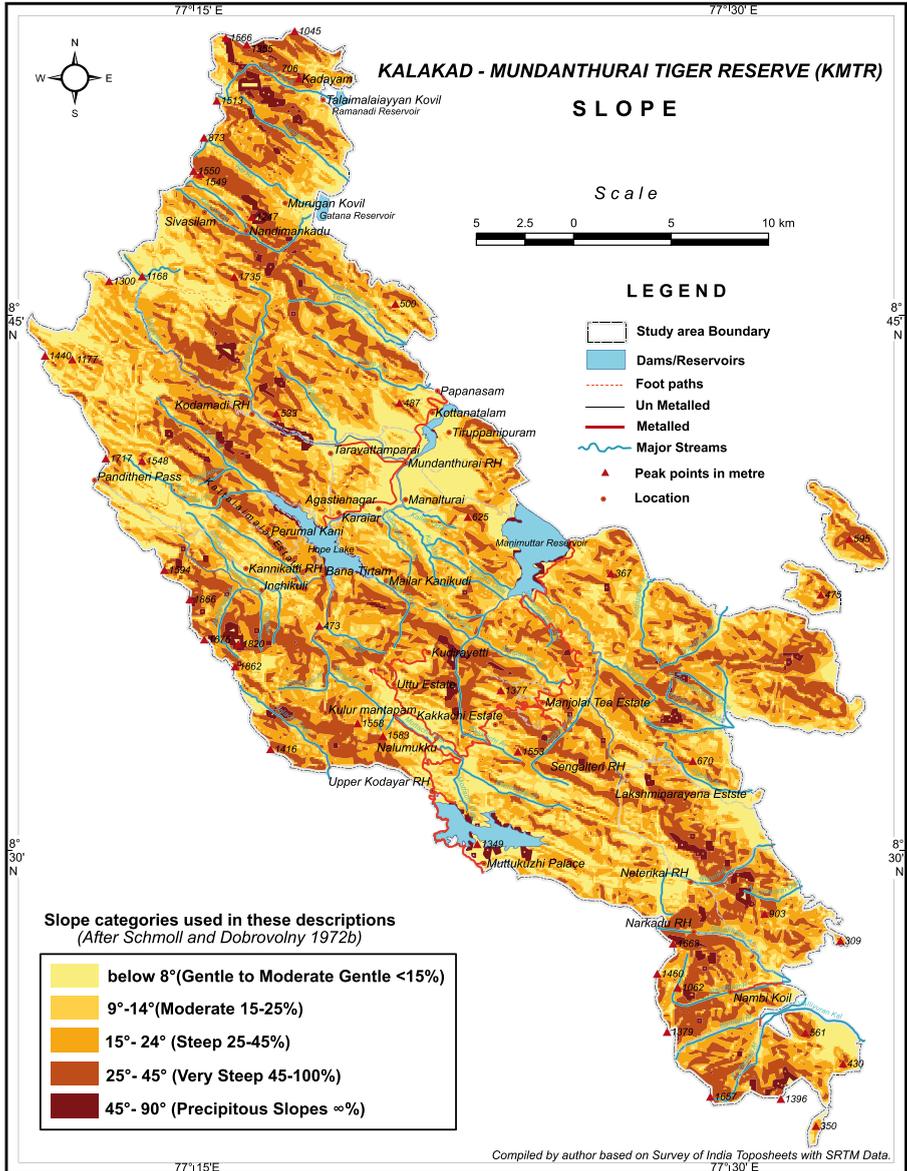
Nine elevation or altitude classes have been categorized using the 20 m contours extracted from the respective SOI Topo sheets. The classes were attributed to the probability of occurrence of the forest types in respect to the altitude or elevation class and it is depicted in **Map – 5.2**. The altitude in KMTR varies from 60 m to 1,867 m. Topographically, it comprises of 3 distinct units namely, a) Steep hilly terrain, b) Low altitude Mundanthurai plateau (300-500 m) and c) High altitude Upper Kodayar plateau (average elevation of 1,400 m)



Map - 5.2 : Elevation zones of KMTR

5.1.1.3. Slope vs. Forest types (Map – 5.3)

About 19.37% of the forest area is conspicuous for *Gentle slope zone*, 11.09% in *Moderate slope*, 47.73% in *Steep slope*, 20.70% in *Very Steep slope zone* and 1.09% falls in Precipitous slope zone. The plain land or nearly level zone is almost absent in the study area. The table indicates that more than 2/3rd area (68.43%) of forest cover is located in the steep to very steep slope zone in KMTR (Map – 5.3).



Map - 5.3 : Slopes in KMTR

#### 5.1.1.4. Rain fall vs. Forest types (Map - 5.4)

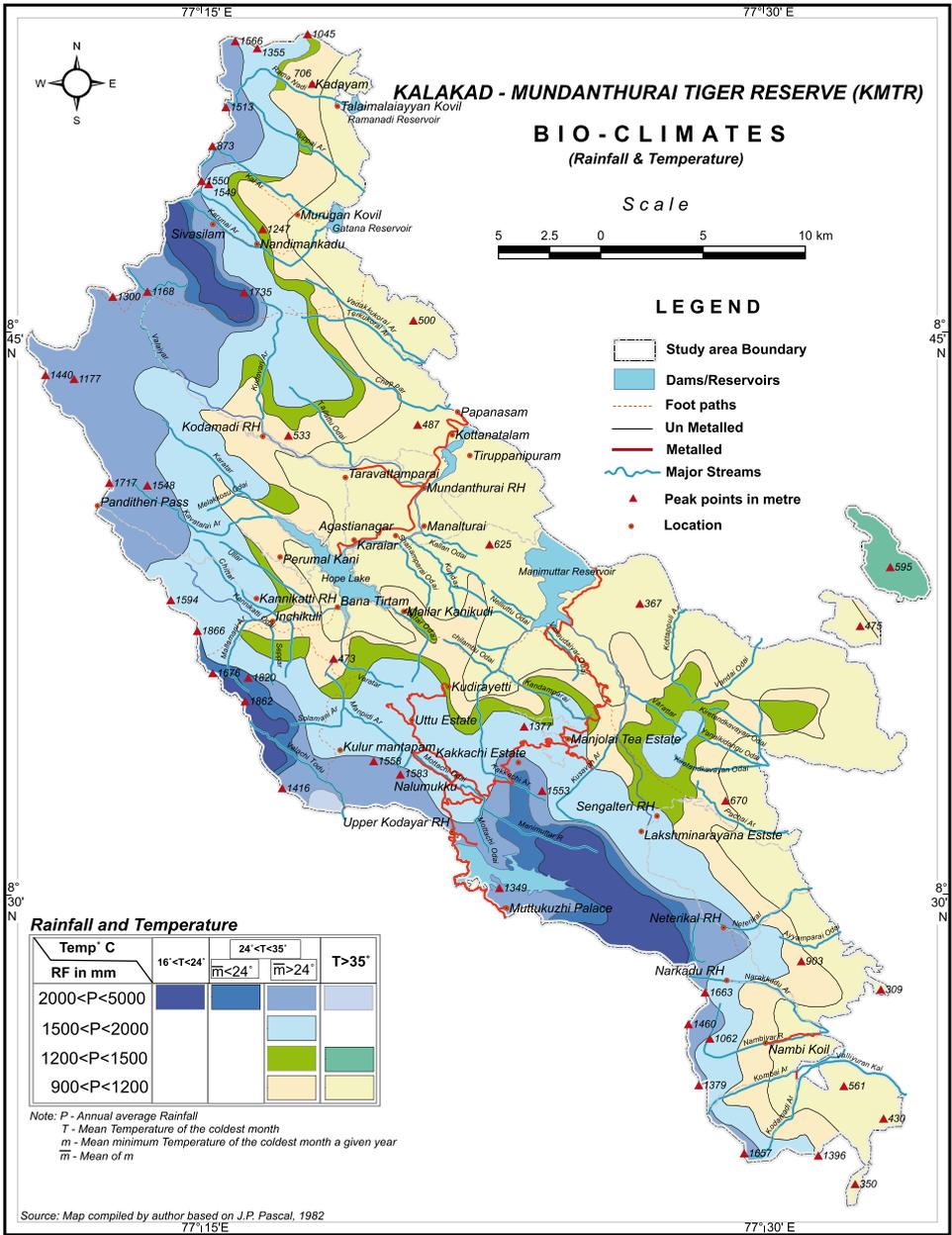
The entire study area has been classified into four major rainfall groups namely *Low*, *Moderate*, *Heavy* and *Very Heavy rainfall* zones having the annual rainfall intensity as 900 - 1,200 mm, 1,200 - 1,500 mm, 1,500 - 2,000 mm and 2,000 - 5,000 mm respectively. The forest types overlaid on rainfall zones revealed the relationships between these two variables. The influence of rainfall on the forest types is shown in **Map - 5.4**. The general distribution pattern of forest cover in various rainfall zones shows that most of the forest area (47.34%) are represented in zone I characterized by *Low rainfall* (900-1200 mm) followed by 23.26% in *Very heavy rain fall zone IV* (2,000-5,000 mm), 21.72% in *Heavy rain fall zone II* and only 7.67% area in *Moderate zone III* (1,200- 1,500 mm).

#### 5.1.1.5. Temperature vs. Forest types (Map – 5.4)

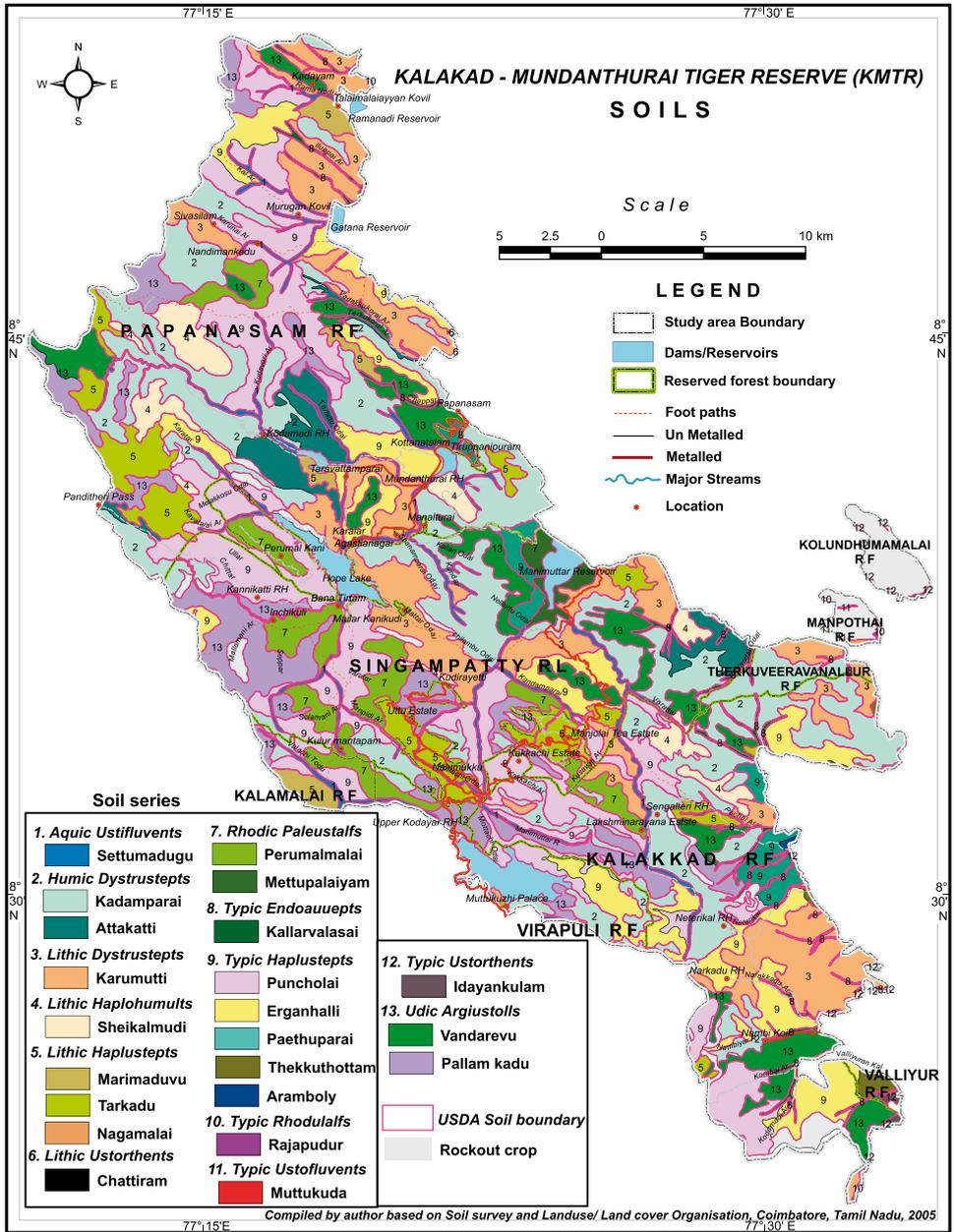
The entire study area has been divided into 3 major temperature zones. They are zone of *Low temperature* (16-24° C) zone of *Moderate or equable temperature* (24-35° C) and zone of *High temperature* (> 35° C). The general distribution pattern of forest cover in various temperature zones show that most of the forest areas are represented in zone II *i.e.*, *equable temperature zones* (24-35° C) covering 63.27% areas and 32.7% areas of forest comes under *high temperature zone*. Only 4% area of forest falls in *low temperature zone*.

#### 5.1.1.6. Soils vs. Forest Types (Map – 5.5)

62 soil samples were collected mainly from places adjacent to the Endemic and Threatened plants identified from the sample quadrats laid in the study area. These soil samples are mainly from the 9 Ecosystems namely in *Evergreen*, *Semi-evergreen*, *Moist mixed deciduous*, *Dry deciduous*, *Montane temperate*, *High altitude grass land*, *Low altitude grassland*, *Thorn scrub* and *Teak Forests*. The soil samples were collected from November 2006 to July 2009. The soil samples were analysed at Soil Testing Laboratory of Tamil Nadu Agricultural Department, Tirunelveli and Tiruchirapalli and the results are discussed.



Map - 5.4 : Bioclimate zones of KMTR



Map. 5.5 : Soil (Series level) map of KMTR

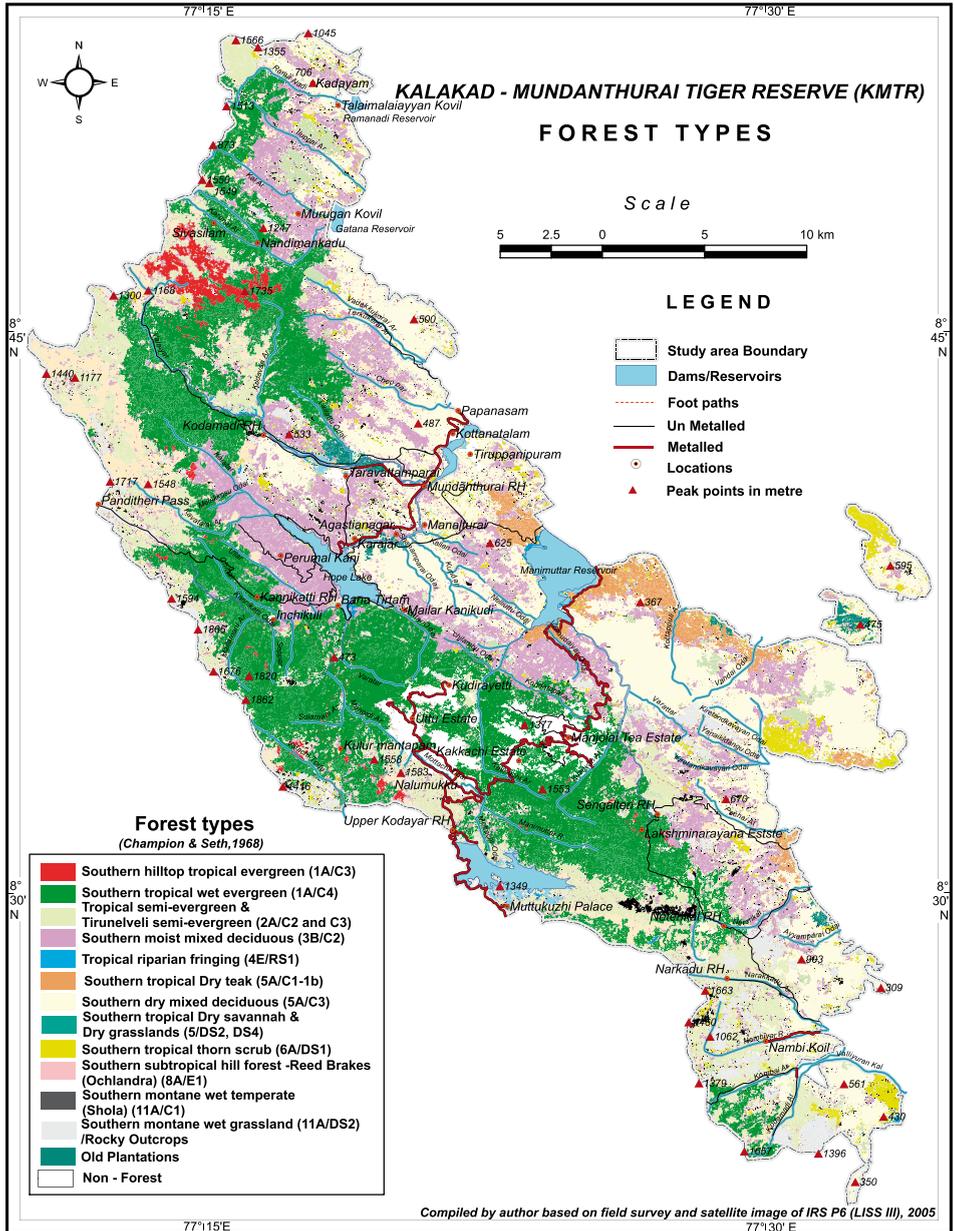
### 5.1.1.7. Thematic Map of Forest Types and their extent

From the False Colour Composite (FCC) of 2005 the entire forest area of KMTR could be classified into 12 Natural Forest Types based on the Monograph “*A revised survey of the Forest Types of India*” by Champion and Seth (1968)<sup>31</sup> with different density classes. The various forest types of KMTR and their extent under each category are given in **Table – 5.1** and in **Map – 5.6**.

**Table 5.1 – Forest Types in KMTR**

Sl. No.	Forest Types	Classification Code	Extent in ha	% of area	No. of Quadrats laid
1	Southern hill top tropical evergreen forest (HE)	(1A/C3)	1,023.78	1.13	3
2	Southern tropical Wet evergreen forest (WE)	(1A/C4)	23,335.62	25.71	29
3	Tropical semi- evergreen forest and Tirunelveli semi-evergreen forest (SE)	(2A/C2 & 2A/C3)	10,140.56	11.17	13
4	Southern Moist mixed deciduous forest (MD)	(3B/C2)	16,300.42	17.95	20
5	Tropical riparian fringing forest (RF)	(4E/RS1)	469.51	0.52	3
6	Southern tropical Dry teak forest (DT)	(5A/C1-1b)	1,968.85	2.17	3
7	Southern Dry mixed deciduous forest (DD)	(5A/C3)	18,475.35	20.35	26
8	Southern tropical Dry savannah & Dry grasslands (DS)	(5/DS2,DS4)	2,710.16	2.55	4
9	Southern tropical Thorn scrub (TS)	(6A/DS1)	2,669.56	2.94	3
10	Southern subtropical hill forest - Reed brakes (Ochlandra) (RB)	(8A/E1)	4,487.75	4.94	5
11	Southern Montane wet temperate forest (Shola) (MT)	(11A/C1)	1,431.66	1.58	4
12	Southern montane wet grassland / Rocky Out crops (MG)	(11/DS4)	3,005.38	3.31	7
<b>Total Natural Forests area</b>			<b>86,018.60</b>	<b>94.77</b>	<b>120</b>

31 ibid



Map - 5.6 : Forest (Types) Map of KMR

### 5.1.2. Floristic Bio diversity analysis and a data base of Endemic and Threatened Medicinal Plant species (ETMPs)

Conservation of forest resources not only requires the canopy density status and aerial extent of various forest types but also the floral species composition and their distribution pattern. Therefore, it becomes essential to estimate the species composition, so that conservation and management planning would be effective. In order to have clear picture about the present status of species composition and their distribution in terms of individuals in different forest types, primary floristic survey were carried out to collect field data on the various biodiversity indices.

In the present study about 120 nested quadrats of 20 m x 20 m size were laid. The locations of sample quadrats could be seen in **Map - 4.2** and the floristic species diversity in **Table - 5.2**.

772 MPs (69.62%) could be shortlisted from the total floral list of 1106 plant species in the study area. It also helped in documenting 164 Endemic and Threatened plant species belonging to 65 families of which 122 are Endemic and Threatened Medicinal Plant species belonging to 57 families of Western Ghat area including the Study Area. It is observed that out of 122 Endemic and Threatened MPs that are housed in Western Ghats, 58 are strict Endemic in nature and found in the KMTR and its surroundings *i.e.*, in Agasthiyamalai Biosphere Reserve and many of these are of high medicinal value. The information with latest taxonomical names, synonyms, family, habits, their utility in Indian systems of medicine, the forest types where they occur, centres of endemisms and also the threat status is given in Appendix - I. The floral biodiversity indices of species is provided in Appendix - II, while in Appendices - III and IV detailed information about 58 endemic MPs, their centre of endemism, intensities of threats along with factors of threats is elaborated. All these appendices and other details are provided in main book. (Sarkar 2012)<sup>32</sup>. (For all Appendices vide in First Edition)

Further, photographs of a few flagship species in each forest types are illustrated under the concerned forest types. The distribution of each Threatened Medicinal Plant species, its realized niche and status, ecological amplitude among forest types and Geographical positions in the landscape were documented and Recovery plan for selected strict Endemic and Threatened MPs of KMTR documented as Pilot study. Finally, based on the computed values of floristic diversity and its status, individual forest type / Ecosystem and indices values are discussed below under each forest types and the salient features of floristic diversity highlighted in **Table – 5.2**.

32 Sarkar, Manoj Kumar, 2012 *Management Strategies for Endemic and Threatened Medicinal Plants in India - A Geoinformatic Approach*, Department of Environment, Government of Tamil Nadu, Chennai.

**Table 5.2 - Floristic species diversity in various Forest types in KMTR**

Habits	HE	WE	SE	MT	RB	MG	DS	MD	DD	DT	TS	RF	KMTR
Tree	32	156	91	43	5	3	9	132	79	11	7	21	375
Liana	-	3	3	-	-	-	-	7	6	-	3	2	16
Shrub	14	77	60	15	2	16	8	57	52	9	16	3	233
S/U. shrub	1	6	12	1	-	4	-	10	8	1	3	-	36
Vine	-	1	1	-	-	-	-	3	2	1	-	-	6
Climber	6	20	9	6	3	-	-	22	20	2	6	-	67
Straggler	1	5	6	1	-	-	-	3	2	1	3	-	17
Herb	27	64	70	30	-	17	-	55	63	20	11	10	270
Orchid	3	13	8	2	-	-	-	3	1	-	-	1	28
Grass	-	4	6	1	1	16	14	2	9	2	3	-	44
Fern	-	4	-	1	-	-	-	-	-	-	-	-	4
Epiphyte	-	1	-	-	-	-	-	-	-	-	-	-	1
Parasites	-	-	-	-	-	-	-	-	2	-	-	-	2
Culm	-	-	-	-	-	1	-	-	-	-	-	-	1
Creepers	-	2	-	-	-	-	-	1	-	-	-	-	2
Twiner	-	-	1	1	-	-	-	1	3	-	-	-	4
<b>Total Species</b>	<b>84</b>	<b>356</b>	<b>266</b>	<b>100</b>	<b>11</b>	<b>57</b>	<b>31</b>	<b>296</b>	<b>247</b>	<b>47</b>	<b>52</b>	<b>37</b>	<b>1106</b>
<b>Total MPs</b>	<b>80</b>	<b>240</b>	<b>183</b>	<b>64</b>	<b>7</b>	<b>30</b>	<b>18</b>	<b>216</b>	<b>221</b>	<b>46</b>	<b>47</b>	<b>32</b>	<b>772</b>
<b>Total ETMPs</b>	<b>10</b>	<b>32</b>	<b>16</b>	<b>7</b>	<b>1</b>	<b>6</b>	<b>1</b>	<b>15</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>8</b>
<b>Total Individuals</b>	<b>179</b>	<b>1938</b>	<b>690</b>	<b>216</b>	<b>186</b>	<b>306</b>	<b>164</b>	<b>848</b>	<b>798</b>	<b>182</b>	<b>154</b>	<b>167</b>	<b>5828</b>
<b>Total genera</b>	<b>71</b>	<b>238</b>	<b>203</b>	<b>84</b>	<b>11</b>	<b>45</b>	<b>28</b>	<b>211</b>	<b>185</b>	<b>43</b>	<b>48</b>	<b>33</b>	<b>588</b>
<b>Total family</b>	<b>50</b>	<b>100</b>	<b>96</b>	<b>44</b>	<b>9</b>	<b>21</b>	<b>12</b>	<b>92</b>	<b>75</b>	<b>25</b>	<b>27</b>	<b>25</b>	<b>158</b>

(HE - Southern Hill Top Evergreen, WE - Southern Wet evergreen, SE - Tropical Semi-evergreen & Tirunelveli Semi-evergreen, MD - Southern Moist Mixed Deciduous, RF - Tropical Riparian Fringe, DT - Dry Teak, DD - Southern Dry Mixed Deciduous, DS - Tropical Dry Savannah & Dry Grasslands, TS - Southern Thorn Scrub, RB - Reed Brakes (Ochlandra), MT - Southern Montane Wet Temperate (Shola), MG - Southern Montane Grassland / Rocky Outcrops. Sps - Species, MPs - Medicinal Plants, ETMPs - Endemic and Threatened Medicinal Plants.)

### 5.1.2.1. Southern hill top tropical evergreen forest : (1A/C3) (Plate - 5.1.2.1)

Topographically, the Hill top evergreen forest is located on the hill tops between 1,000 and 1,700 m. Unfavourable conditions on top of hills and steep upper slopes, ghastrly winds and shallow soils stunt the plant growth to not more than 10 m though rainfall is high (over 4,500 mm).

#### 5.1.2.1.1. Species composition and diversity

This forest type is characterized by the presence of 84 species belonging to 71 genera of 50 families. Among them 32 are tree species (39%), 15 shrub and under shrub species (17.85%), 30 herb (includes 3 orchids) species (35.71%), 6 climber species (8%) and one of straggler (**Table - 5.2**). Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.1A**. The calculation of diversity indices pertains to these 32 tree species. The Shannon and Simpson diversity indices observed in the forest type are 1.8694 and 0.0151368 respectively (Appendix - II vide in First Edition).



**Plate – 5.1.2.1. Forest Type**

Southern hilltop tropical evergreen forest (1A/C3) at Neterikal (Kalakad RF)

Plate - 5.1.2.1 A

Flagship floral diversity in Southern hill top tropical evergreen forest (1A/C3)



*Adenanthera pavonina* L.

*Antidesma acidum* Retz.

*Artocarpus hirsutus* Lam.



*Daphniphyllum neilgherrense* (Wight)  
K. Rosenthal

*Dimorphocalyx beddomei* (Benth.)  
Airy Shaw

*Dimocarpus longan* Lour.



*Drosera peltata* Thunb.

*Dysoxylum malabaricum* Bedd.

*Huperzia squarrosa*  
(G.Forst) Trevis

*Michelia champaca* L.



*Ochna obtusata* DC.

*Paphiopedilum druryi*  
(Bedd.) Pfitzer

*Smilax aspera* L.

*Syzygium hemisphericum*  
(Wight) Alston

*Vernonia penisularis*  
C.B. Clarke

### 5.1.2.2. Southern tropical wet evergreen forest : (1A/C4) (Plate - 5.1.2.2)

This forest type occurs at Agastiyamalai peak, Muthukuzhivayal, Neterikal to Sengaltheri track, Upper Kodayar, Kannikatti and Inchikuzhi between 762 and 1,524 m elevation in the KMTR. The canopy is dense and has different layers. There is about 23,335.62 ha (25.71%) area under this type of forest in KMTR.

#### 5.1.2.2.1. Species composition and diversity

The Wet evergreen forest type is characterized by the presence of 356 species belonging to 238 genera of 100 families. Among them 156 species (43.82%) belong to trees, 83 species (23.31%) belong to shrub and under shrub, 81 species (22.75%) belong to herbs including 13 orchids and 4 grasses and 20 species (5.62%) belong to climbers. Remaining consists of 5 stragglers and 3 liana. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.2 A, B, C, D**. The calculation of diversity indices pertains only to the tree species. The Shannon and Simpson diversity indices observed in the forest type are 2.2715 and 0.009036561 respectively (Appendix - II vide in First Edition).



**Plate - 5.1.2.2 Forest Type**

Southern tropical wet evergreen forest (1A/C4) at Uthu (Singampatti RL)

Plate - 5.1.2.2 A  
 Flagship floral diversity in Southern Tropical Wet Evergreen Forest (1A/C4)



*Acronychia pedunculata* (L.)  
Miq.



*Actinodaphne madraspatana*  
Bedd.



*Aglaia elaeagnoides*  
(Juss.) Benth.



*Agrostistachys indica* Dalzell



*Antidesma montanum* Blume



*Aphanamixis polystachya*  
(Wall.) R. Parker



*Aristolochia indica* L.



*Asclepias curassavica* L.



*Asystasia gangetica*  
(L.) T. Anderson



*Begonia malabarica* Lam.



*Bulbophyllum sterile*  
(Lam.) Suresh



*Calamus travancoricus*  
Bedd. ex Becc.



*Calophyllum austroindicum*  
Kosterm. ex P.F. Stevens



*Canarium strictum* Roxb.



*Cayratia pedata* (Lam.)  
Juss. ex Gagnep.



*Chassalia curviflora* (Wall.) Thwaites

Plate - 5.1.2.2 B  
 Flagship floral diversity in Southern Tropical Wet Evergreen Forest (1A/C4)



*Cinnamomum filipedicellatum* Kosterm.



*Cinnamomum macrocarpum* Hook. f.



*Cinnamomum verum* J. Presl



*Cullenia exarillata* A. Robyns



*Cyathea nilgirensis* Holttum



*Cyperus iria* L.



*Diospyros montana* Roxb.



*Diospyros ebenum* J. König ex Retz.



*Diospyros malabarica* (Desr.) Kostel.



*Drypetes malabarica* (Bedd.) Airy Shaw



*Drypetes porteri* (Gamble) Pax & Hoffm.



*Elaeocarpus tuberculatus* Roxb.



*Erythralium scandens* Blume



*Terminalia bellirica* (Gaertn.) Roxb.



*Gluta travancorica* Bedd.



*Hydnocarpus alpina* Wight



*Hydnocarpus macrocarpa* (Bedd.) Warb.

Plate - 5.1.2.2 C  
 Flagship floral diversity in Southern Tropical Wet Evergreen Forest (1A/C4)



*Knema attenuata* Warb.



*Lasianthus acuminatus* Wight



*Leea indica* (Burm.f.) Merr.



*Litsea bourdillonii* Gamble



*Litsea wightiana* (Nees) Hook.f.



*Memecylon subcordatum* Cogn.



*Memecylon subramanii*  
 A.N. Henry



*Mesua ferrea* L.



*Miliusa eriocarpa* Dunn



*Symplocos racemosa* Roxb.



*Myristica dactyloides* Gaertn.



*Myristica fatua* Houtt.  
 var. *magnifica*



*Myristica malabarica* Lam.



*Nageia wallichiana* (C.Presl) Kuntze

Plate - 5.1.2.2 D  
 Flagship floral diversity in Southern Tropical Wet Evergreen Forest (1A/C4)



*Neurocalyx calycinus* (R.Br. ex Benn.)  
 Rob.



*Octotropis travancorica* Bedd.



*Ormosia travancorica* Bedd.



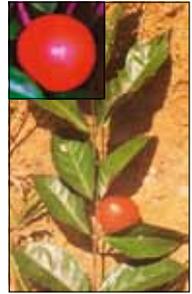
*Palaquium bourdillonii*  
 Brandis



*Piper barberi* Gamble



*Piper nigrum* L.



*Popowia beddomeana*  
 Hook. f. & Thom.



*Pterospermum rubiginosum*  
 B. Heyne



*Selaginella delicatula* (Desv. ex Poir.) Alston



*Spondias pinnata* (L.f.) Kurz.



*Symplocos* sps.



*Syzygium gambleanum*  
 Rathakr. & V. Chithra



*Syzygium mundagam* (Bourd.) Chithra

### 5.1.2.3. West Coast Semi-evergreen & Tirunelveli Semi-evergreen forest (2A/C2, 2A/C3) (Plate - 5.1.2.3)

This forest occurs relatively in a narrow strip between Moist deciduous forests and Southern tropical Wet evergreen forests in the elevation ranges from 250 to 500 m and sometimes up to 1,000 m. The range of the rainfall is from 1,500 mm to 2,000 mm. It is characterized by dense vegetation comprising the top canopy a mix of evergreen and deciduous species. Climbers and canes are abundant.

#### 5.1.2.3.1. Species composition and diversity

The total number of species including trees, shrub, herb and liana was 266 belonging to 203 genera of 96 families. These 266 species comprise 91 tree species (34%) 72 shrub and under shrub species (27.06%), 84 herb species (31.57%) which includes 8 orchids and 6 grasses); 3 species of liana and 9 climber species. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.3 A & B**. Thus the biodiversity calculation pertains to these 91 tree species. The Shannon and Simpson diversity indices observed in the forest type were 2.2189 and 0.01374912 respectively (Appendix - II vide in First Edition).



**Plate – 5.1.2.3. Forest Type**

Tropical semi-evergreen forest (2A/C2) at Tolukkamottai (Papanasam RF)

Plate - 5.1.2.3 A Flagship floral diversity in Tropical Semi Evergreen Forest and Tirunelveli Semi Evergreen Forest (2A/C2 & 2A/C3)



*Acrocarpus fraxinifolius* Wight & Arn.

*Agrostistachys borneensis* Becc.



*Bridelia crenulata* Roxb.

*Bridelia stipularis* (L.) Blume

*Celastrus paniculata* Willd.

*Chukrasia tabularis* A. Juss.



*Connarus monocarpus* L.

*Dianella ensifolia* (L.) DC.

*Elaeagnus conferta* Roxb.

*Elaeocarpus munronii* Mast.



*Garcinia travancorica*  
Bedd.

*Gordonia obtusa*  
Wall. ex Wight & Arn.

*Hedyotis albonervia*  
Bedd.

*Hiptage benghalensis*  
(L.) Kurz.

*Holigarna amottiana* Hook.f

Plate - 5.1.2.3 B Flagship floral diversity in Tropical Semi Evergreen Forest and Tirunelveli Semi Evergreen Forest (2A/C2 & 2A/C3)



*Litsea bourdillonii* Gamble



*Litsea deccanensis* Gamble



*Litsea floribunda*  
(Blume) Gamble



*Litsea laevigata* Gamble



*Mimosa intsia* L.



*Mitragyna parvifolia*  
(Roxb.) Korth.



*Neolitsea zeylanica*  
(Nees & T. Nees) Merr.



*Oberonia santapau*  
Kapadia



*Olea glandulifera*  
Wall. ex D. Don



*Pittosporum naepaulense*  
(DC.) Rehder & E.H. Wilson



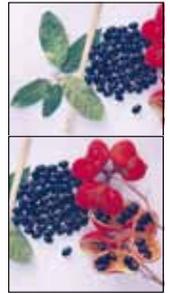
*Schefflera wallichiana*  
(Wight & Arn.) Harms



*Schleicheria oleosa*  
(Lour.) Oken



*Scolopia crenata*  
(Wight & Arn.) Cols.



*Sterculia guttata*  
Roxb.



*Strychnos potatorum* L.f.



*Suregada lanceolata*  
(Willd.) Kuntze



*Thottea barberi* (Gamble)  
Ding Hou



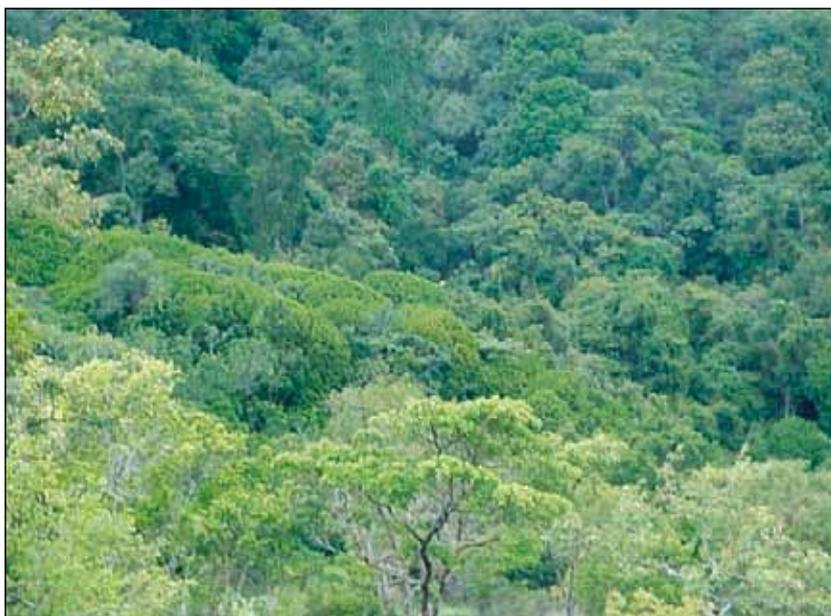
*Vernonia travancorica*  
Hook. f.

#### 5.1.2.4. Southern moist mixed deciduous forest (3B/C2) (Plate - 5.1.2.4)

This type occupies lower Eastern slopes (up to 500 m) of Papanasam RF, Kolundhamalai, Manapothai, Thiruveeravanallur, part of Kalakad and Valliyur RF and also in lower part of Singampatty RL and on high grounds with shallow or porous soils covering an area of 18,475.35 (20.35%).

##### 5.1.2.4.1. Species composition and diversity

The total number of species including trees, shrubs, herbs and lianas was 296 and belonging to 211 genera of 92 families. Among the 296 species 132 species (44.59%) belonged to tree, 67 species (22.63%) to shrub and under shrub, 60 species (20.27%) to herb (including 2 grasses and 3 orchids). Besides, there were 22 species of climbers, 7 Lianas, 3 Vines, 3 Stragglers, 1 Creeper and 1 Twiner. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.4 A, B & C**. Thus the biodiversity calculation pertains to these 132 tree species. The Shannon and Simpson diversity indices observed in the forest type are 2.270680 and 0.0081829 respectively (Appendix - II vide in First Edition).



**Plate – 5.1.2.4 Forest Type**

Southern moist mixed deciduous forests (3B/C2) at Upper Manimuthar (Sinagampatti RL)

Plate - 5.1.2.4 A  
 Flagship floral diversity in Southern Moist Mixed Deciduous Forest (3B/C2)



*Acacia caesia* (L.) Willd.



*Adenia hondala* (Gaertn.) W.J.de Wilde



*Alstonia venenata* R. Br.



*Anamirta cocculus* (L.)  
 Wight & Arn.



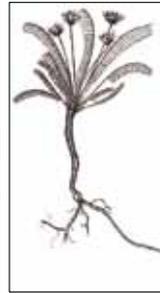
*Antiaris toxicaria* Lesch.



*Arisaema leschenaultii*  
 Blume



*Biophytum insignis*  
 Gamble



*Biophytum longibracteatum*  
 Tadul. & K.C.Jacob



*Bombax ceiba* L.



*Breynia retusa*  
 (Dennst.) Alston



*Caryota urens* L.



*Cinnamomum chemungianum*  
 Mohanan & A.N. Henry



*Cocculus hirsutus* (L.)  
 W. Theob



*Coscinium fenestratum*  
 Colebr.



*Curculigo orchiioides*  
 Gaertn.



*Euphorbia susanholmesiae* Binojk. &  
 Gopalan



*Debregeasia longifolia*  
 (Burm. f.) Wedd.



*Dioscorea pentaphylla* L.

Plate - 5.1.2.4 B

Flagship floral diversity in Southern Moist Mixed Deciduous Forest (3B/C2)



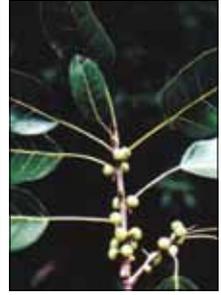
*Entada pursaetha* DC.



*Epiprinus mallotiformis*  
(Muell. - Arg.) Croizat



*Ficus dalhousiae* Miq.



*Ficus virens* Aiton



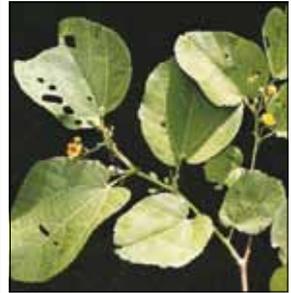
*Gardenia resinifera* Roth



*Glochidion ellipticum* Wight



*Glycosmis cochinchinensis*  
Pierre ex Engl.



*Grewia tiliifolia* Vahl



*Haldina cordifolia* (Roxb.)  
Ridsdale



*Hydnocarpus pentandrus*  
(Buch) Ham. Oken



*Isonandra lanceolata* Wight



*Madhuca longifolia*  
(L.) J.F. Macbr.



*Mallotus philippensis* (Lam.) Muell. - Arg.



*Mallotus tetracoccus*  
(Roxb.) Kurz



*Memecylon umbellatum* Burm.f.

Plate - 5.1.2.4 C  
 Flagship floral diversity in Southern Moist Mixed Deciduous Forest (3B/C2)



*Miliusa eriocarpa* Dunn



*Nothopogia aureo-fulva*  
 Bedd. ex Hook.f.



*Polyalthia cerasoides* (Roxb.)  
 Benth. & Hook. f. ex Bedd.



*Pterospermum diversifolium* Blume



*Rauvolfia serpentina* (L.) Benth. ex Kurz



*Scleria lithosperma* (L.) Sw. var.  
*lithosperma*



*Semecarpus travancorica* Bedd.



*Tiliacora acuminata* Miers.



*Tinospora cordifolia* (Willd.)  
 Hook. f. & Thom.



*Toona ciliata* M. Roem.



*Walsura piscida* Roxb.

### 5.1.2.5. Tropical riparian fringing forest (4E/RS1) (Plate - 5.1.2.5)

This type occurs along the banks of the rivers.

#### 5.1.2.5.1. Species composition and diversity

The total number of 37 species including trees, shrubs, herbs and lianas belong to 33 genera of 25 families. Among the 37 species, 21 tree species (56.76%), 3 shrub species (8%), 11 herb species (29.73%) and 2 species liana were found. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.5A**. The Shannon and Simpson diversity indices observed in the forest type were 1.29 and 0.1129836 respectively (Appendix - II vide in First Edition).



**Plate – 5.1.2.5 Forest Type**

Tropical riparian fringing forest (4E/RS1) at Upper Tamirabarani (Papanasam RF)

Plate - 5.1.2.5 A  
 Flagship floral diversity in Riparian Fringe Forests (4E/RS1)



*Begonia floccifera* Bedd.

*Costus speciosus* (Koenig.) Sm.



*Blachia calycina* Benth.

*Eugenia singampattiana* Bedd.

*Filicium decipiens* (Wight & Arn.) Thwaites



*Ficus hispida* L.f.

*Syzygium calcadense* (Bedd.) Chandrash



*Syzygium zeylanicum* (L.) DC. var. *ellipticum*  
 A.N.Henry, Chandrab. & Nair

*Wendlandia angustifolia* Wight ex Hook. f.

### 5.1.2.6. Dry teak forest (5A/C1-b)

This forest type is represented at Manimuthar catchment areas, Kalakad, Mundanthurai and Papanasam and totally covers an area of 1,968.85 ha (2.17%). On the foothills and in gentle slopes this type occurs at a height of 300 m. The annual rainfall is 750 mm to 1,000 mm. Trees are leafless for about three months. The average height of trees is about 10 m.

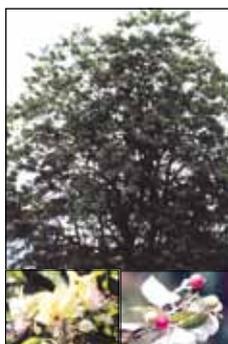
#### 5.1.2.6.1. Species composition and diversity

In total 47 species belonging to 43 genera of 25 families were recorded. Among the 47 species, 11 tree species (23.40%) belong to trees, 10 shrub and under shrubs species (21.27%) and 22 herb species (46.80%) were recorded. Besides, 2 climber, 1 straggler and 1 vine species were found. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.6**. The biodiversity calculation pertains to the 11 tree species. The Shannon and Simpson diversity indices observed in the forest type are 1.29199 and 0.12203 respectively. (Appendix - II vide in First Edition).

#### Plate - 5.1.2.6 Flagship floral diversity in Dry Teak Forests (5A/C1-1B)



*Butea monosperma* (Lam.) Taub



*Crataeva religiosa* G. Forst



*Tectona grandis* L.f.



*Gloriosa superba* L.



*Ziziphus oenoplia* (L.) Mill.



*Catunaregam spinosa*  
(Thumb.) Tirvengadun



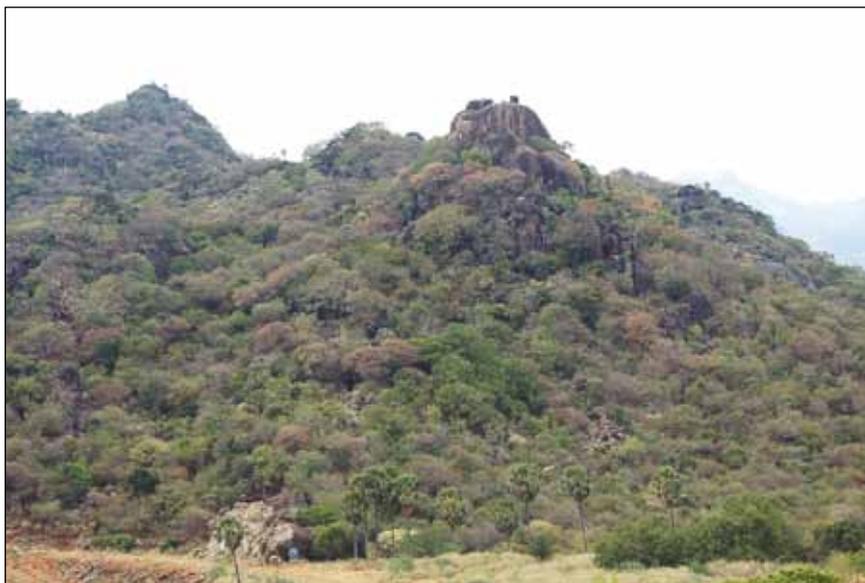
*Cadaba fruticosa* (L.) Druce

### 5.1.2.7. Southern dry mixed deciduous forest : (5A/C3) (Plate - 5.1.2.7)

This forest type occurs in the Eastern half of the KMTR where the rainfall is around 900 mm. It covers an area of 18,475.35 ha. This forest type is seen up to 350 m at Kalakad R.F., Papanasam R.F, Singampatti R.L. and Thulukkamparai.

#### 5.1.2.7.1. Species composition and diversity

The total number of species enumerated in the deciduous was 247, which belong to 185 genera and 75 families. Among them 79 species (31.98%) belong to trees, 60 species (24.29%) belong to shrub and under shrub, 73 species (29.55%) belong to herb includes 1 orchid and 9 grass species. The liana and climbers contributed 6 and 20 species respectively. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.7 A, B, C**. The Shannon and Simpson diversity indices observed in the forest type are 2.164875 and 0.01135043 respectively (Appendix - II vide in First Edition).



**Plate - 5.1.2.7 Forest Type**

Southern dry mixed deciduous forest (DD) (5A/C3) at Thirukurangudi (Kalakad RF)

Plate - 5.1.2.7 A  
 Flagship floral diversity in Dry Mixed Deciduous Forests (5A/C3)



*Abrus precatorius* L.



*Acorus calamus* L.



*Albizia amara* (Roxb.)  
 B. Boivin



*Anogeissus latifolia*  
 (Roxb.ex DC.) Wall. ex. Bedd.



*Asparagus racemosus* Willd.



*Cadaba trifoliata*  
 Wight & Arn.



*Capparis diversifolia*  
 Wight & Arn.



*Capparis sepiaria* L.



*Carissa carandas* L.



*Chloroxylon swietenia* DC.



*Cissus quadrangularis* L.



*Cordia monoica* Roxb.



*Dillenia pentagyna* Roxb.



*Drypetes sepiaria*  
 (Wight & Arn.) Pax &  
 Hoffn.



*Ehretia laevis* Roxb.

Plate - 5.1.2.7 B  
 Flagship floral diversity in Dry Mixed Deciduous Forests (5A/C3)



*Erythrina variegata* L.



*Erythroxylum monogynum*  
 Roxb.



*Ficus mollis* Vahl



*Ficus racemosa* L.



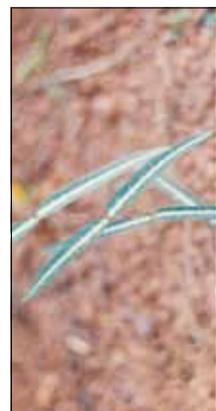
*Gymnema sylvestre*  
 (Retz.) Schult



*Gyrocarpus americanus* Jacq.



*Helicteres isora* L.



*Hemidesmus indicus*  
 (L.) R.Br.



*Hugonia mystax* L.



*Lepisanthes tetraphylla* (Vahl) Radlk.



*Mimusops elengi* L.

Plate - 5.1.2.7 C  
 Flagship floral diversity in Dry Mixed Deciduous Forests (5A/C3)



*Moringa concanensis* Nimmo ex Dalzell & Gibson



*Polyalthia korinti* (Dunal) Thwaites



*Toddalia asiatica* (L.) Lam.



*Santalum album* L.



*Sapindus emarginatus* Vahl



*Semecarpus anacardium* L.f.



*Strychnos nux-vomica* L.



*Typha angustata* Bory & Chaub



*Diospyros melanoxylon*  
Roxb.



*Ventilago maderaspatana* Gaertn.



*Ziziphus xylopyrus* (Retz.) Willd.

### 5.1.2.8. Southern tropical dry savannah & dry grasslands (5/DS2, DS4) (Plate - 5.1.2.8)

The usual but typical formation was lost and the trees stand far apart (single or in small groups) in more or less heavy grass, in which certain fire resistant plants persist, either slowly establishing themselves as trees or sending up annual shoots from a woody rootstock.

#### 5.1.2.8.1. Species composition and diversity

The total number of species including trees, shrub, herb and liana was 31 and belong to 27 genera of 12 families. Among the 31 species, 9 tree species (29%), 8 shrub species (25.8%) and 14 herb (grass) species (45.16%) were recorded. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.8A**. The Shannon and Simpson diversity indices observed in the forest type were 1.40970 and 0.04595 respectively (Appendix - II vide in First Edition).



**Plate – 5.1.2.8 Forest Type**

Southern tropical dry savannah & dry grasslands (5/DS2/DS4) at Sengaltheri (Kalakad RF)

Plate - 5.1.2.8 A  
 Flagship floral diversity in Dry Savannah & Dry Grass Lands (5/DS2, DS4)



*Buchanania lanzan* Spreng.



*Bridelia retusa* (L.) A. Juss.



*Emblica officinalis* Gaertn.



*Osyris quadripartite* Salzm.ex Decne



*Cycas circinalis* L.



*Cynodon dactylon* (L.) Pers.



*Mundulea sericea* (Willd.) A. Chev.



*Osbeckia aspera* (L.) Blume



*Pterocarpus marsupium* Roxb.



*Terminalia chebula* Retz.

### 5.1.2.9. Southern tropical Thorn scrub (6A/DS1)

This forest type is seen at lower elevations up to 200 m. Papanasam, Kalakad and Tirukurungudi beyond Panakudi areas have such forest type. Degradation of Carnatic Umbrella Thorn forest (6A/C2) as a result of the usual maltreatment, results in the formation of thorny thickets of 2-4 m height, without much difference in composition. This Forest type occupies an area of 2,669.56 ha (2.94%) and 3 quadrats were laid.

#### 5.1.2.9.1. Species composition and diversity

In total there were 52 species that belong to 49 genera of 27 families. Among 52 species, 7 tree species (13.46%) 19 shrub species (36.54%) and 14 herb species (26.92%) were recorded. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.9**. The Shannon and Simpson diversity indices in this forest type were 1.5307 and 0.043178 respectively (Appendix - II vide in First Edition).

#### Plate - 5.1.2.9 Flagship floral diversity in Southern Tropical Thorn Scrub (6A/DS1)



*Aloe vera* (L.) Burm. f.

*Capparis divaricata* Lam.

*Cassia senna* L.



*Catunaregam spinosa* (Thunb.) Tirveng.



*Commiphora berryi* Engl.



*Dichrostachys cinerea* (L.) Wight & Arn.



*Flacourtia indica* (Burm.f.) Merr.

### 5.1.2.10. Southern subtropical hill forest-Reed brakes (Ochlandra) (8A/E1)

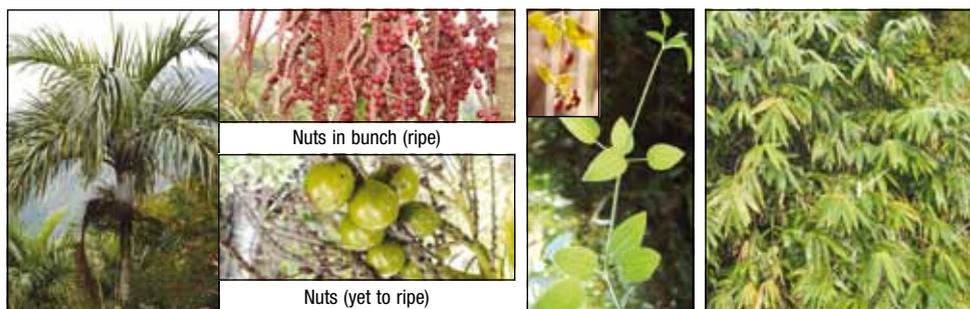
This type was an Edaphic climax (8A/ E1) and covered an area of 4,487.75 ha. Below the summit of hills and above the shola belt and higher slopes of 900 m and above, extensive area was under reeds namely *Ochlandra nighatii*, *Ochlandra travancorica* forming impenetrable thickets of 3 to 5 m height from which stand out scattered trees of *Vernonia monosis* and *Eugenia* species. Impenetrable and gregarious growth of reed, *Ochlandra travancorica*, extensively covered the higher slopes above the belt of sholas in the vicinity of Agastiyar peak and evergreen forests at degraded sites. The other reed species found were *Ochlandra rheedii* and *Ochlandra brandisii*. Often, *Schumannianthus virgatus* grows extensively with this reed.

#### 5.1.2.10.1. Species composition and diversity

The total number of species recorded in 5 quadrats laid in Subtropical hill forest - Reed brakes was only 11. It included trees, shrub, herb and climber and belonged to 11 genera of 9 families. There were, 5 tree species (45.45%), 2 shrub species (18%) and single species of herb (grass) and 3 climber species (27%). Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.10** The Shannon and Simpson diversity indices observed in the forest type are 0.7651 and 0.2774 respectively (Appendix - II vide in First Edition).

#### Plate - 5.1.2.10

#### Flagship floral diversity in Southern Subtropical hill forest-Reed brakes (8A/E1)



*Bentinckia condapanna* Berry

*Rubia cordifolia* L.

*Ochlandra travancorica* Benth.



*Thottea barberi* (Gamble) Ding Hou

*Toddalia asiatica* (L.) Lam.

*Zanthoxylum tetraspermum* Wight & Arn.

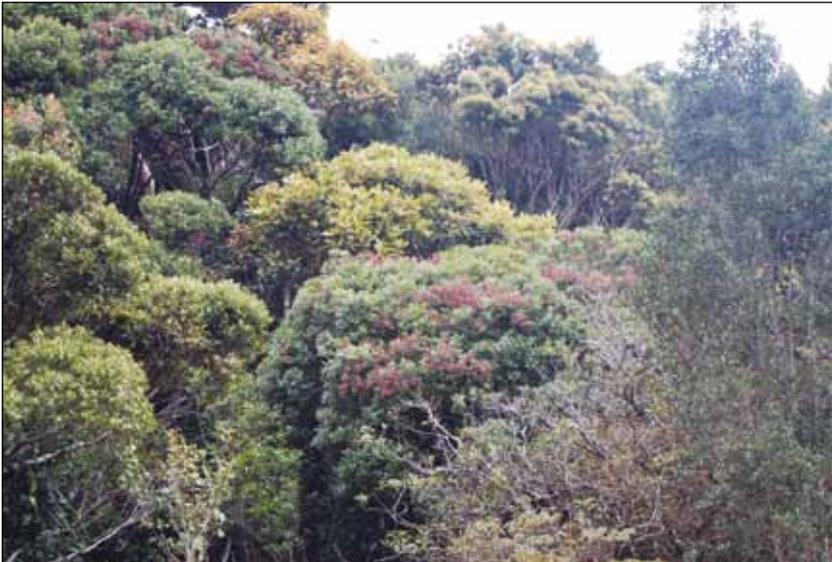
*Macaranga peltata* (Roxb.)

### 5.1.2.11. Southern montane wet temperate forest (11A/C1) (Plate - 5.1.2.11)

This forest type occurs above 1,524 m as continuous expansion of the Evergreen forests at sheltered faces and moist depressions of peaks.

#### 5.1.2.11.1. Species composition and diversity

The total number of species recorded in 4 quadrats laid in Montane wet temperate forest was 100 belonging to 85 genera of 44 families. Among the 100 species, 43 tree species (43%), 16 shrub species (16%), 31 herb species (31%) (Includes 1 grass, 2 orchids), and 6 climber species (6%) were recorded. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.11 A & B**. The Shannon and Simpson diversity indices observed in the forest type were 1.8796 and 0.0196331 respectively (Appendix - II vide in First Edition).



**Plate – 5.1.2.11 Forest Type**

Southern montane wet temperate forest (Shola - 11A/C1) at Muthukuzhivayal (Virapuli RF)

Plate - 5.1.2.11 A

Flagship floral diversity in Southern Montane Wet Temperate Forest (11A/C1)



*Acranthera grandiflora* Bedd.



*Anoectochilus elatus* Lindl.



*Beilschmiedia wightii*  
Benth.



*Callicarpa tomentosa* (L.) L.



*Canthium neilgherrense* Wight



*Cinnamomum sulphuratum* Nees



*Cinnamomum wightii*  
Meissn.



*Desmodium repandum* (Vahl) DC.



*Elaeagnus kologa* Schlecht.



*Embelia ribes* Burm. f.



*Emilia sonchifolia* (L.) DC.



*Ficus retusa* L.

Plate - 5.1.2.11 B

Flagship floral diversity in Southern Montane Wet Temperate Forest (11A/C1)



*Impatiens leschenaultii* (DC.) Wall. ex Wight & Arn.



*Mallotus philippensis* (Lam.) Muell. - Arg.



*Neolitsea scrobiculata*  
(Meissner) Gamble



*Nothapodytes nimmoniana* (J. Grah.) Mabb.



*Olea dioica* Roxb.



*Persea macrantha* (Nees) Kosterm.



*Rapanea wightiana* (Wall. ex A.DC.)



*Schefflera racemosa* (Wight) Harms

### 5.1.2.12. Southern montane wet grassland of high altitudes (11/DS4) (Plate - 5.1.2.12)

The inhospitable, exposed, precipitous rocks and rocky grounds were covered by Grasses and other herbaceous species at high altitudes above 1,524 m. Species of Impatiens, Orchids and Ferns grew luxuriantly amidst grasses and in the rocky crevices. Two insectivorous species, *Utricularia rosea-purpurea* and *Utricularia reticulata* were seen on the dripping rocks. Herbs found among the grassy swards were *Acrotrema arnottianum*, *Exacum travancoricum*, *Hedyotis purpurascens*, *Heracleum candolleianum*, *Leucas vestita*, *Linum mysorense*, *Phyllocephalum rangacharii*, *Senecio ludens* and *Smithia blanda*. *Paphiopedilum druryi*, South India's lone Lady's slipper Orchid was recorded above 1400 m across Tamil Nadu and Kerala. As this was only wild habitat of this rare Orchid in the World it had great conservation potential. The total extent of occurrence of this species has less than 5 km<sup>2</sup>. It is always seen in association with the Grass *Zenkeria sebastiensei*, also endemic to the area.

#### 5.1.2.12.1. Species composition and diversity

The total number of species recorded in 6 quadrats laid in Montane Wet grassland was 57. It included trees, shrub, herb and climber and belong to 45 genera of 21 families. Among the 57 species 3 species (5.17%) belong to tree, 20 species (34.48%) belong to shrub and under shrubs, 33 species (56.89%) belong to the herb (including 16 grasses), 1 creeper and 1 culm. Illustrations of a few flagship species of the Forest Type are given in **Plate 5.1.2.12A**. The Shannon and Simpson diversity indices observed in the forest type was 1.5325 and 0.051392 respectively (Appendix - II vide in First Edition).



**Plate – 5.1.2.12 Forest Type**

Southern montane wet grass lands (11/DS4)

Plate - 5.1.2.12 A  
 Flagship floral diversity in Southern Montane Wet Grassland (11/DS4)



*Hypericum mysorense* B. Heyne ex Wight & Arn.



*Janakia arayalpathra* J. Joseph & V. Chandras.



*Kleinia grandiflora* (Wall. ex DC.) N. Rani



*Knoxia sumatrensis* (Retz.) DC.



*Phoenix loureiroi* Kunth.



*Orthosiphon comosus* Wight ex Benth.



*Vaccinium neilgherrense* Wight



*Strobilanthes consanguinea*  
T. Anderson



*Vernonia gossypina* Gamble



*Vernonia peninsularis*  
C.B. Clarke ex. Hook.f.



*Vernonia ramaswamii* Hutch.

### 5.1.3. Mapping of Floristic endemism, Richness, Hotspots, Conservation Values and Threat Assessment

The major vegetation types occurring in the study area in 2005 are shown in **Table - 5.1** and **Map – 5.6**. Characterization of the forests in terms of biodiversity indices are presented in detail in Appendix – II (vide in First Edition) and this database was used to map the various themes of the forests for the study area as given below.

- i. Zones of floristic endemism*
- ii. Floristic species richness*
- iii. Hotspots of endemic and threatened medicinal plants*
- iv. Threat assessment of endemic and threatened medicinal plants in KMTR*
- v. Conservation Values*

Details of each layer are described below:

#### 5.1.3.1 Zones of floristic endemism (Centres of Endemism)

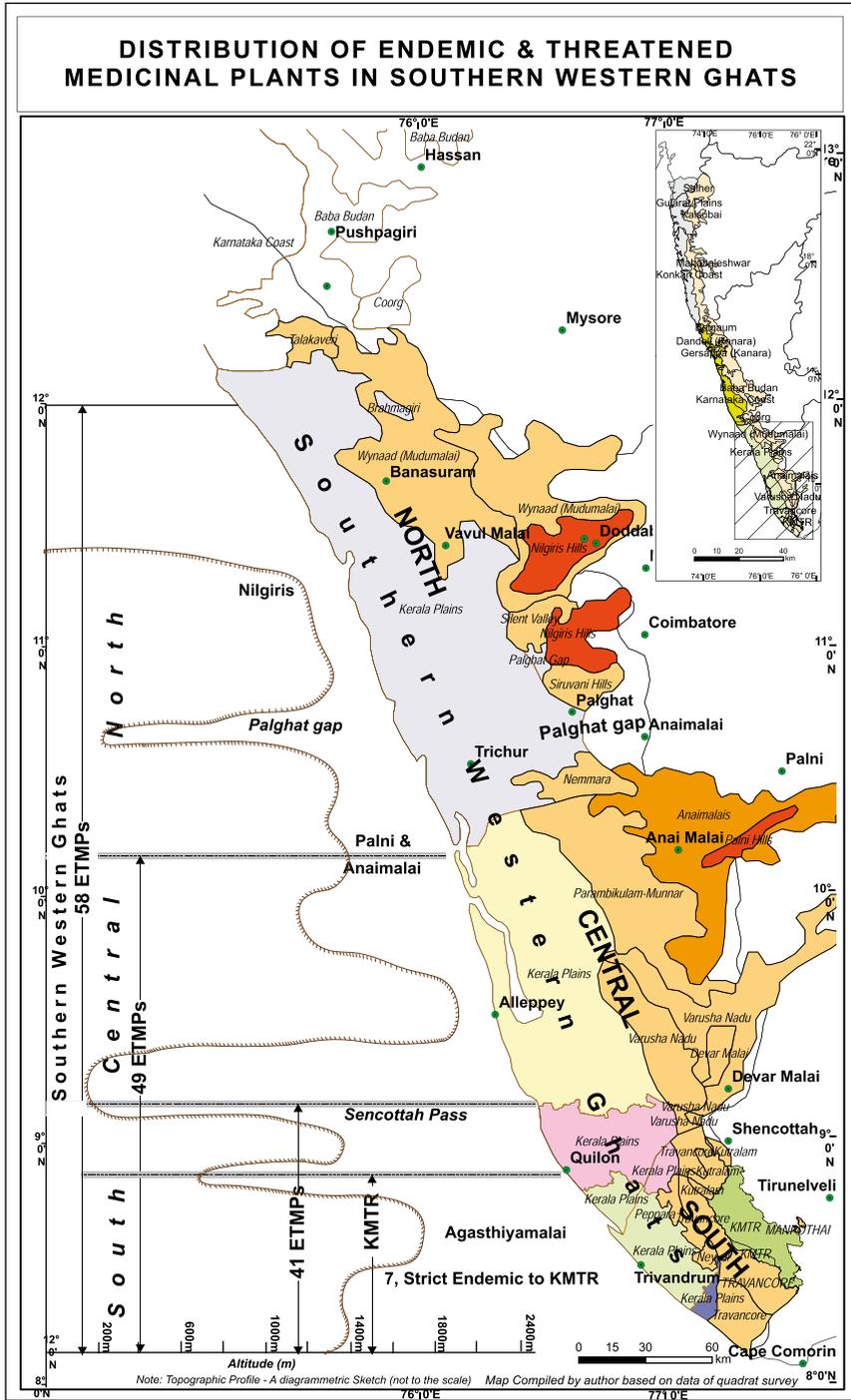
On the basis of the distribution of endemic plants, the entire Western Ghats were divided into three major Centres of endemism in the Peninsular India (Ahmedullah & Nayar 1986)<sup>33</sup>. They are:

1. Northern Western Ghats (River Tapti to Goa)
2. Central Western Ghats (Goa- River Kalinadi to Coorg)
3. Southern Western Ghats (South of Coorg to Tirunelveli hill complex).

These major Centres of endemism including the study area are shown in **Map – 3.1. Map – 3.1. A**, depicts the 3 different parts of endemism i.e. **Northern Western Ghats**, **Central Western Ghats** and the **Southern Western Ghats**. The **Map – 3.1. B** shows further subdivision of Southern Western Ghats into North, Central and South parts, while **Map – 3.1. C** depicts the **location of KMTR** in South part of Southern Western Ghats. Finally, **Map - 3.1 D** shows the **KMTR** – the study area and its immediate surroundings i.e. parts of Travancore in Thiruvananthapuram and Kollam districts of Kerala and the Kanyakumarai and Tirunelveli districts of Tamil Nadu. The *number of endemic plants* recorded during field survey in the study area and their *Centres of endemism* are depicted in **Table 2.7**.

The **Map – 5.7** shows the distribution pattern of ETMPs in Southern Western Ghats with special reference to KMTR and South, Central and Northern parts of Southern Western Ghats for easy reference. The elevation profile is also included in these maps to bring out the relationship between endemism and altitude.

33 Ahmedullah, M. and M.P. Nayar. 1986. *Endemic plants of the Indian region. Peninsular India*. Vol. 1 : 1-261. Botanical Survey of India, Calcutta.



#### 5.1.3.1.1. Southern Western Ghats (Nilgiri, Anamalai, Palni, Malabar, Travancore, Tirunelveli hills complex). (Map – 5.7)

The Southern section of the Western Ghats in which the study area falls, is by far the richest area in the context of floristic composition and concentration of endemic taxa. This is influenced directly by the high rainfall of this area. The Southern Western Ghats are a conglomerate of hill ranges namely Travancore hills of Kerala and Nilgiri, Anamalais, Palni, Tirunelveli hills of Tamil Nadu. These hills together form the richest Centre of endemism in Peninsular India (Ahmedullah & Nayar 1986)<sup>34</sup>. The List of Endemic and Threatened Medicinal Plants recorded in sample quadrats laid in the study area is given in Appendix - III vide in First Edition.

#### Layer 1 : *Floristic Species Richness Zones* (Map – 5.8)

The total number of species corresponding to each floristic type has been obtained from the field quadrats. To generate the floristic species richness layer, each floristic type was assigned a value corresponding to the number of species in that type. Species richness was classified into five classes namely < 50 species (Very low); 51-150 species (Low), 151-250 species (Moderate); and 251-350 species (High) and > 350 species (Very High).

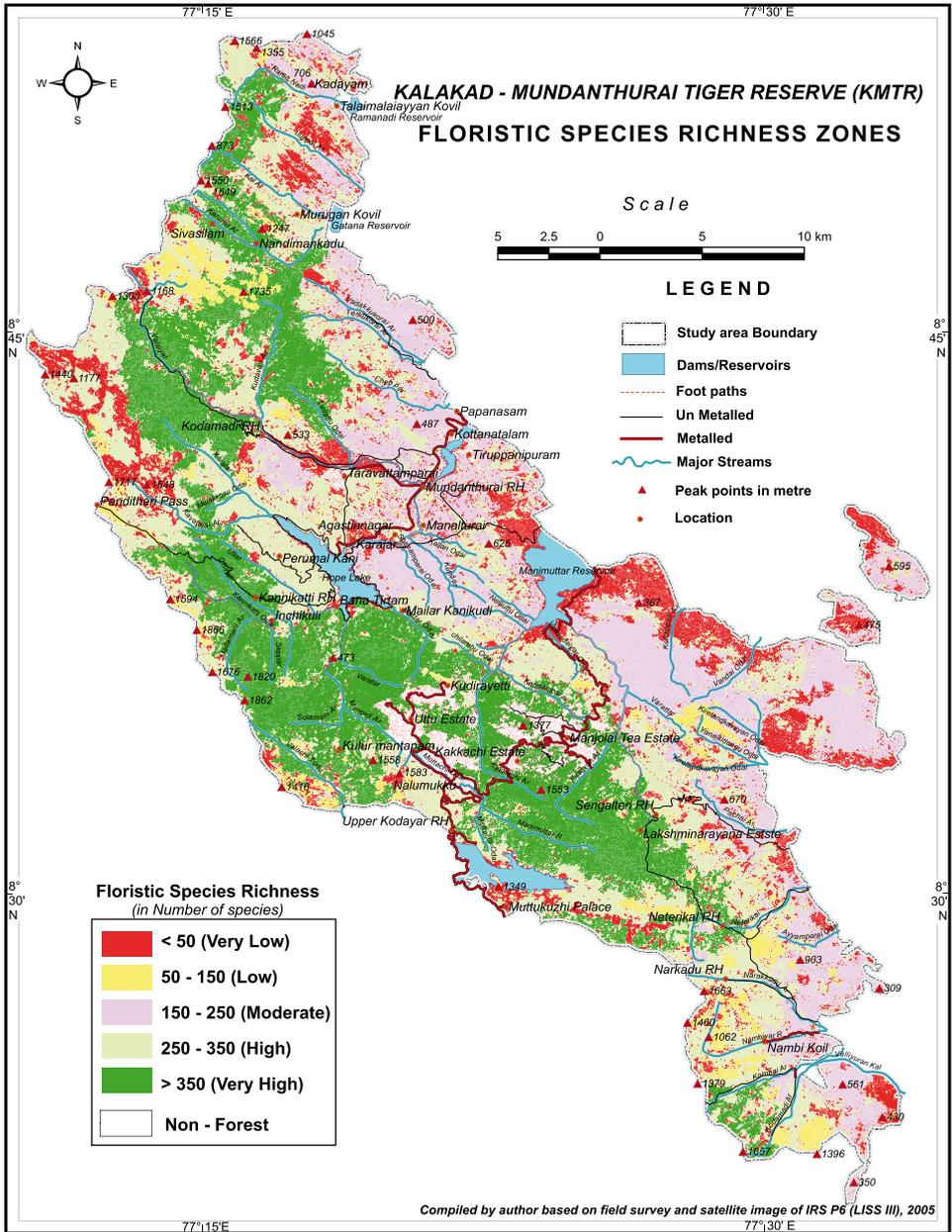
#### Layer 2 : *Floristic Species Richness of Medicinal plants* (Map – 5.9)

The total number of species of medicinal value corresponding to each floristic type has been obtained from the field quadrats. To generate the floristic species richness layer of MPs in particular, each floristic type was assigned a value corresponding to the number of species in that type. Medicinal plant species richness was classified into five classes namely < 25 species (Very low); 25-75 species (Low), 75-125 species (Moderate); and 125-200 species (High) and > 200 species (Very High).

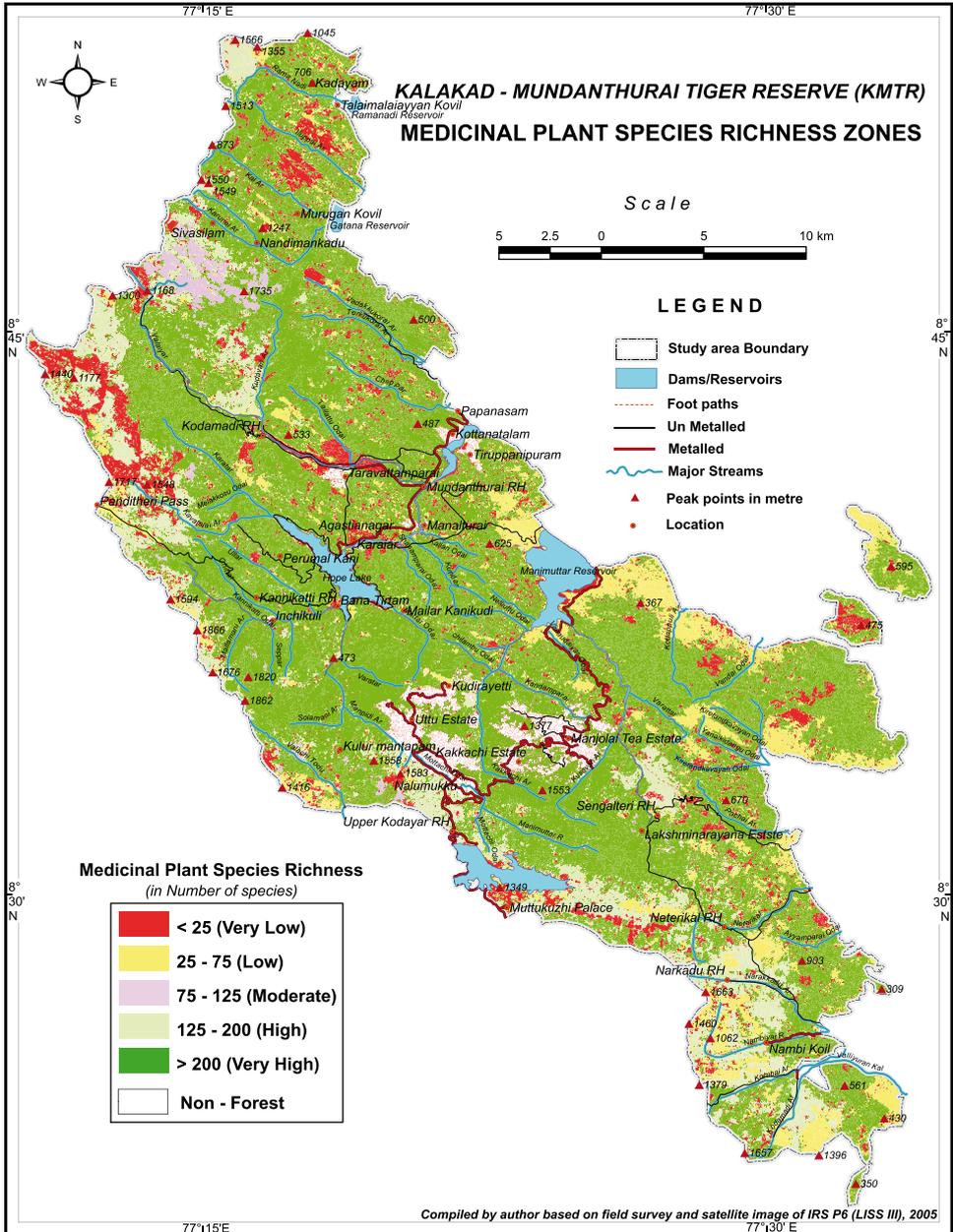
#### Layer 3 : *Hotspots of Endemic and Threatened Medicinal Plants* (Map – 5.10)

A total of 1,106 floral species were recorded in this Reserve spreading over 158 families in 12 Eco-systems (Forest types) based on the result of field study laid in 120 quadrats. Out of this, 164 (14.73%) threatened species were recorded in the study area of which 122 were with medicinal value (74.23%). It is observed that out of 122 endemic and threatened MPs housed in Western Ghats, 58 were strict endemic and found in the KMTR and its surroundings i.e. in Agasthiyamalai Biosphere Reserve and many of these were of high medicinal value Appendix - IV vide in First Edition.

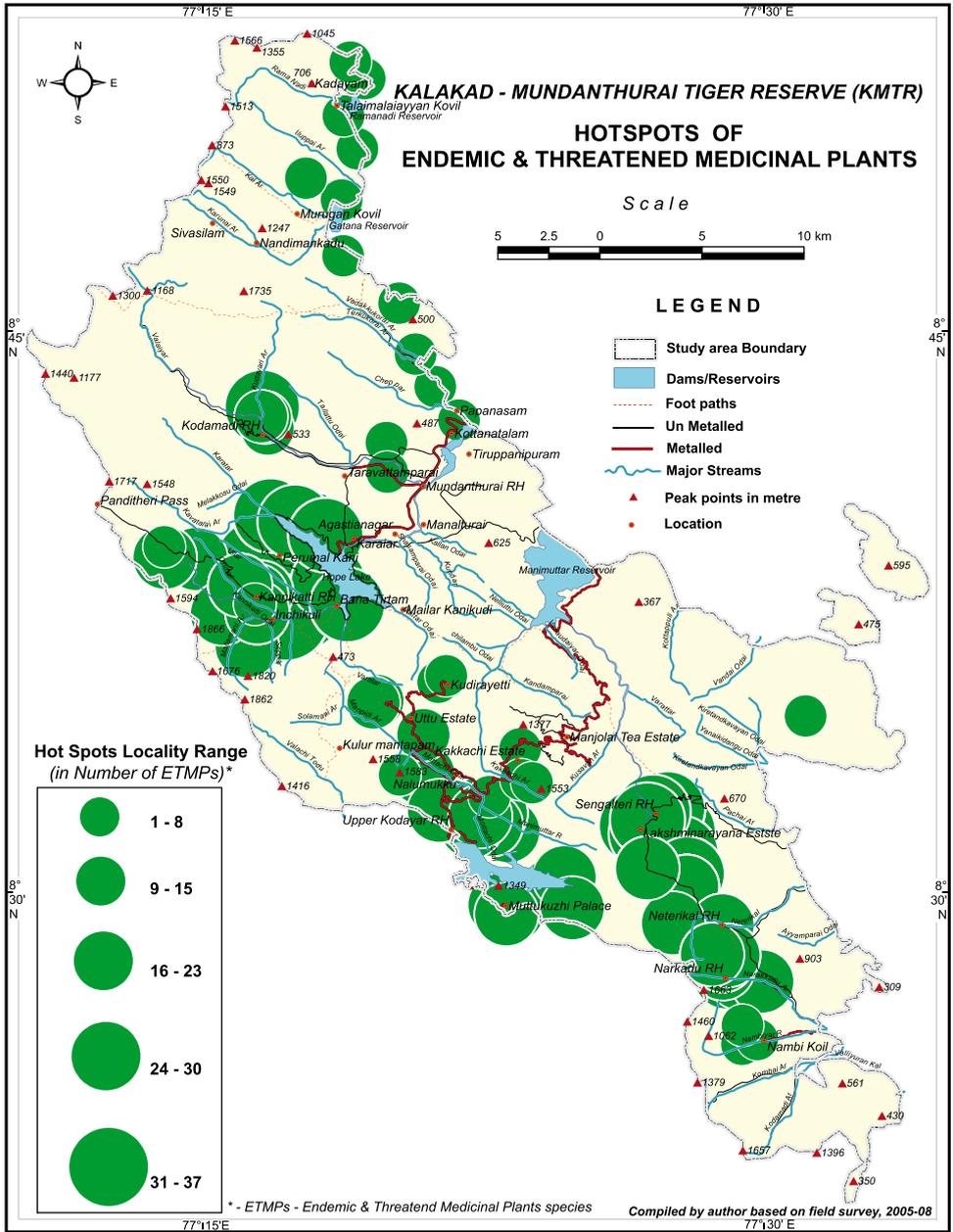
34 ibid



Map - 5.8 : Zonation map of floristic species richness



Map - 5.9 : Zonation map of species richness with reference to Medicinal plants



Map - 5.10 : Delineation of Hotspot zones with reference to Endemic & Threatened Medicinal Plants in KMTR

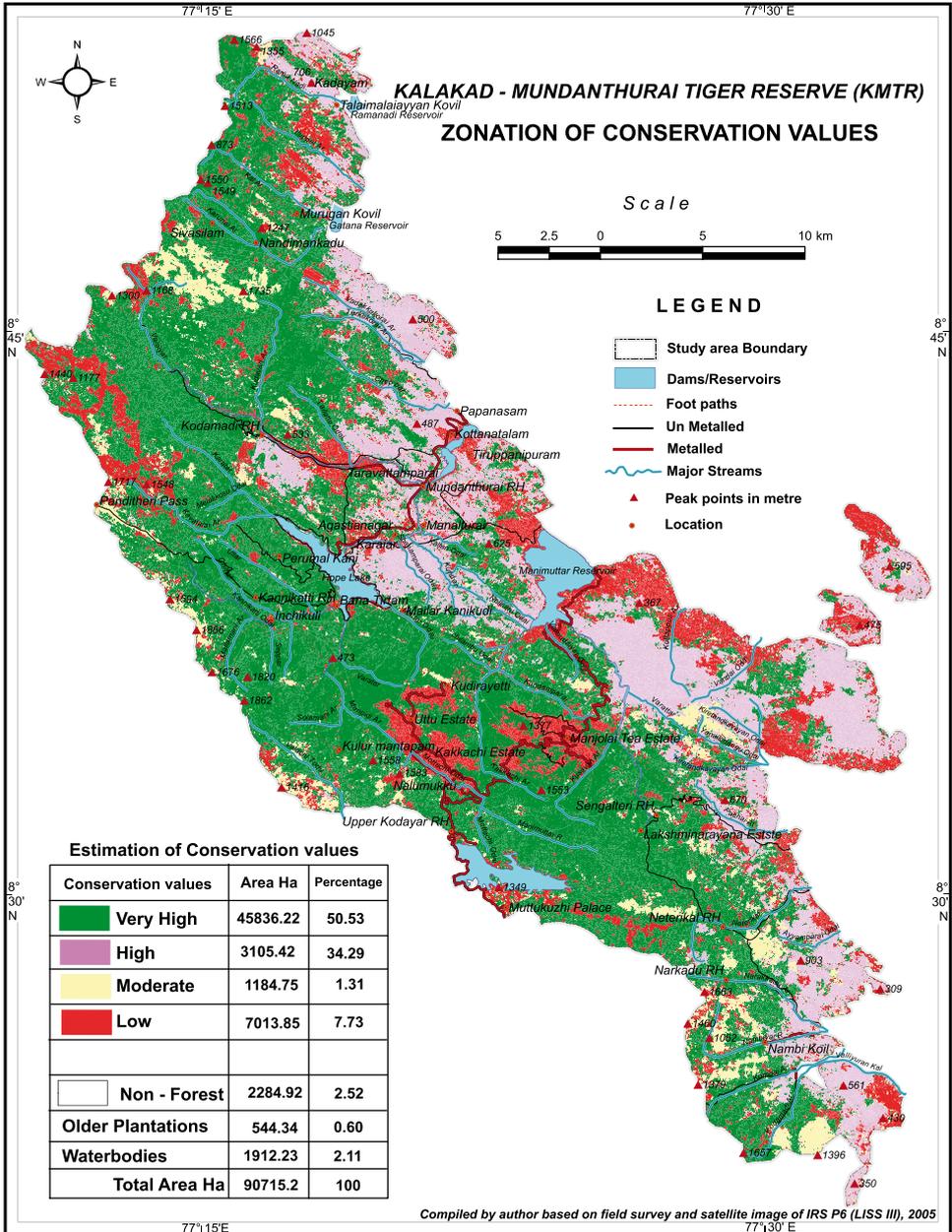
The list of the endemic and threatened MP species is given in Appendix - III (Vide in First Edition). Identification of ETMP species in the field is a difficult task. Hence instead of taking the geo-coordinates of these species, the geo-coordinates of quadrats have been gathered. The geo-coordinates of all 20m x 20m plots (120 plots) were gathered by GPS. Based on the presence and aggregation of ETMP species, a map was created to depict the Hotspots of ETMP species (**Map – 5.10**).

The rare and threatened species recorded in this Reserve are mostly endemic and are confined to the specific locality of the Southern Western Ghats. Southern tropical wet evergreen forest stands first in the occurrence of endemics followed by West Coast semi-evergreen & Tirunelveli Semi-evergreen forest, Southern moist mixed deciduous forest, Southern hill top tropical evergreen forest and Riparian fringing forest. The number of endemics is greater in the climax forests than in the secondary or derived ones, thereby accounting for the low percentage of endemism in the Southern dry mixed deciduous forest, Southern montane wet grassland, Southern subtropical hill forest, Reed brakes (*Ochlandra*), Southern tropical Dry savannah and Dry grasslands and endemic plants are nil in Southern tropical Dry teak forest and Southern tropical thorn scrub.

#### **Layer 4 : Conservation Values (Map – 5.11)**

The information in each of the layers (*Forest Types, Floristic Species Richness Zones, Hotspots of Endemic and Threatened Medicinal Plants recorded in study area*) was combined to yield a composite picture of conservation values. Conservation value map was generated by taking in to account of 3 GIS layers viz., 1. Forest types 2. Floristic Species Richness Zones 3. Hotspots of Endemic and Threatened Medicinal Plants. The layers were prepared on the basis of weighted overlay. For the purpose of this weighted overlay, based on the ranking, layers were given values starting from 1 to 5 in increments by their characters as follows.

On basis of assigned rank values for each weighted factor the final ranking of conservation value obtained were very high (13-15), high (10-12 species), moderate (7-9) and low (<7). These classes with final conservation values were highlighted on a map (**Map - 5.11**) showing areas of various Conservation values. The present analysis indicates that about 45836.22 ha (50.53%) of KMTR falls under Very high conservation value and 31106.24 ha (34.29%) falls under high conservation value, hence warranting immediate and high priority in conservation and management efforts for these areas. This map assumes greater significance for the managers to prioritize the regions for conservation and management. Thus this study is a valuable input to phasing the conservation and management planning and decision making.



Map - 5.11 : Zonation map of conservation values in KMTR

### 5.1.3.2 Threat Assessment of Selected Endemic and Threatened Medicinal Plants in KMTR

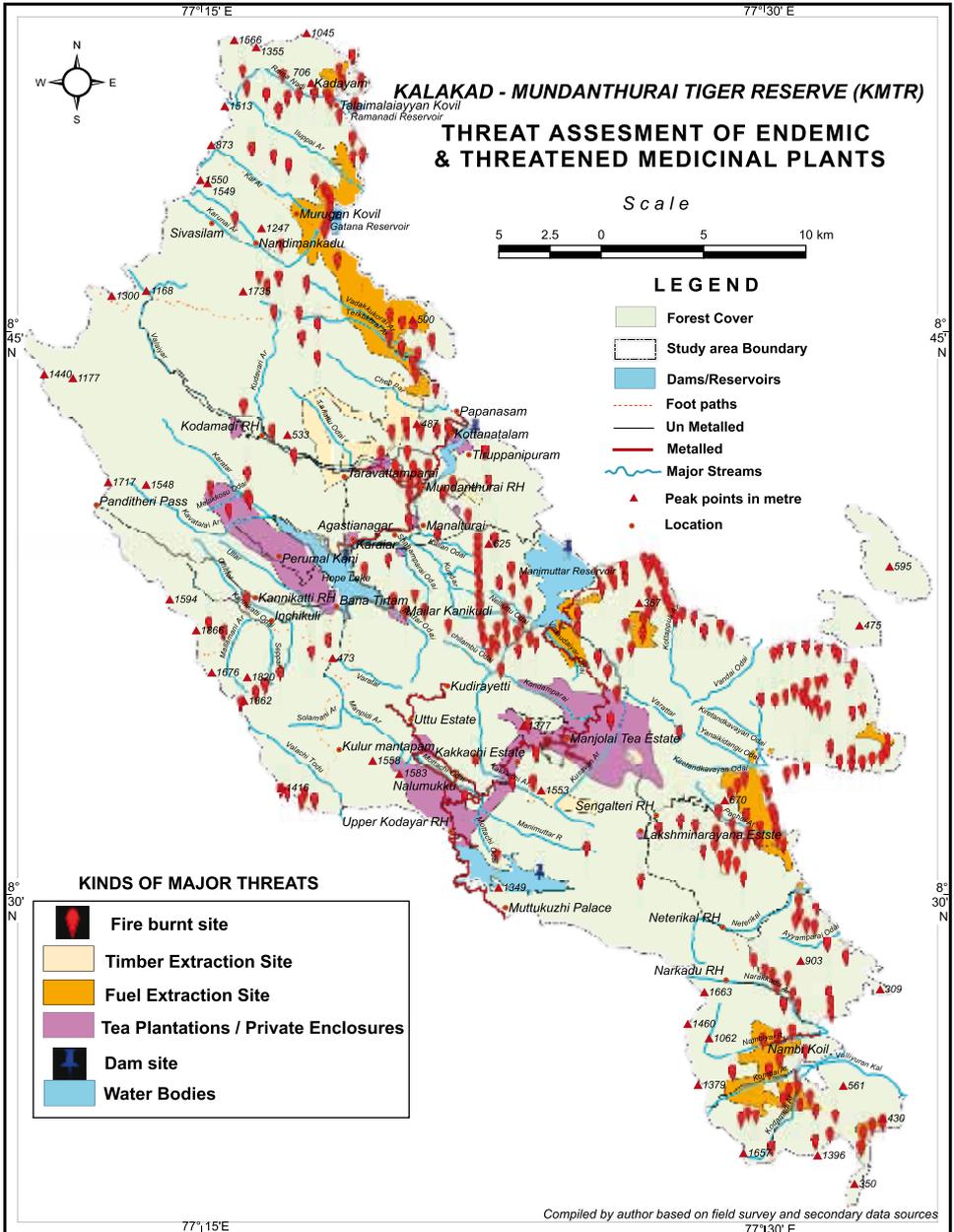
The endemic plants of the study area, their present threat status and the probable causes of threats are shown in Appendix - IV (Vide in First Edition).

#### 5.1.3.2.1 Threats from Anthropogenic Causes (Map - 5.12)

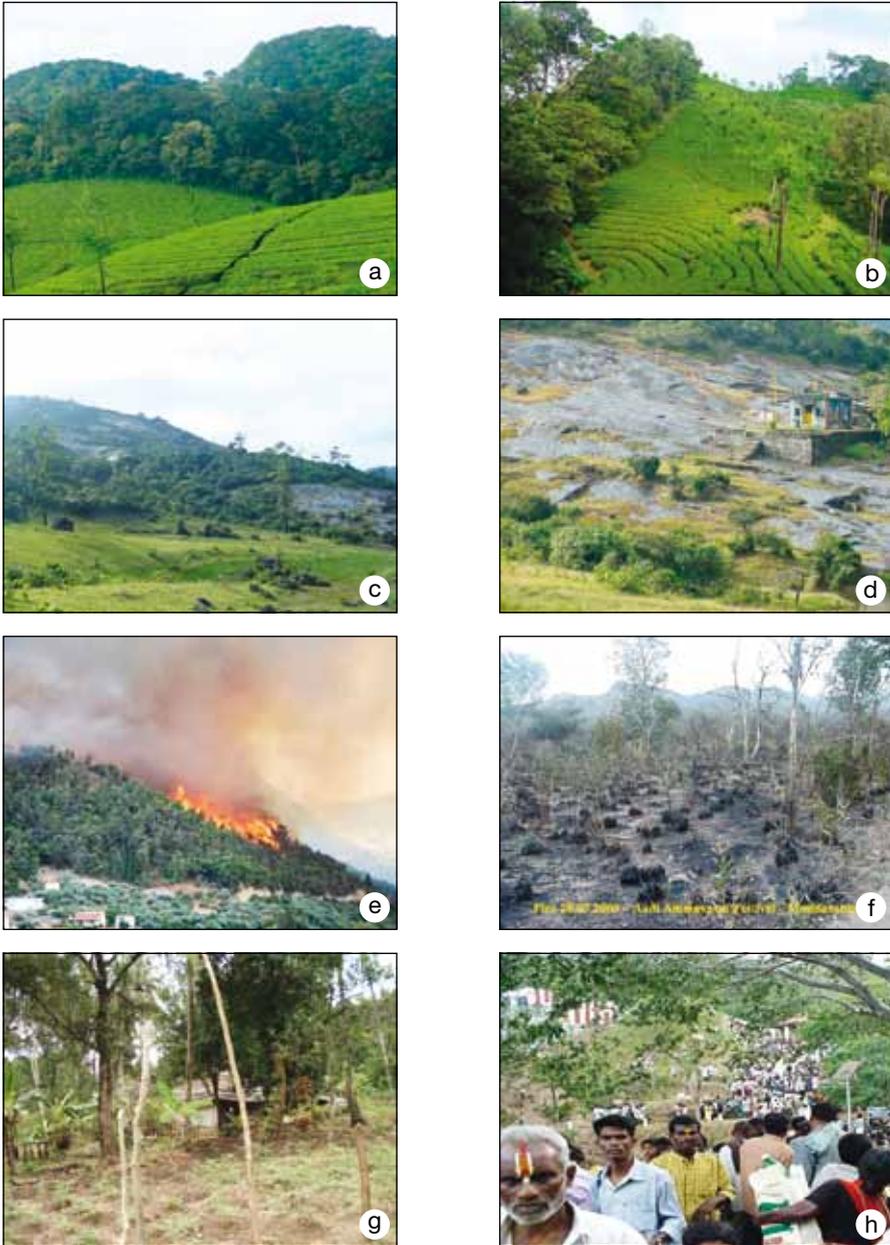
Anthropogenic causes are mainly diversion of forest land for Non Forestry purposes such as raising of tea plantations (3,390.1 ha), formation of dams and reservoirs (>2600 ha), agriculture and farming and construction of roads and buildings. Other anthropogenic causes are private estate enclosures (2292.29 ha), fuel and timber extraction in the past, human habitations inside the Reserve, forest fire, illicit / destructive harvest of floral species, unsustainable collections by scholars, infestation with tourists and pilgrims even in sensitive area and fragmentation of ecosystems. All these anthropogenic causes are basically reflections of absence of rules or working manuals in place to protect and manage the floral species by applying appropriate land use pattern. **(Plate - 5.1.3.1).**

#### 5.1.3.2.2. Threats due to Factors of Natural origin

Besides the anthropogenic causes other factors of natural origin namely climate change (erratic and shortfall in total rainfall, rise in temperature in the locality and thereby increase in the length of dry seasons), landslides, soil erosion, invasions of exotics, *etc.*, also contribute to the threats. The frequency of threats caused due to various kinds of reasons are given in **Table – 5.3** and also depicted in **Figure – 5.1.**



Map - 5.12 : Probable factors that led to threat status of the Endemic & Threatend Medicinal plants in KMTR



**Plate – 5.1.3.1. Kinds of Threats to ETMPs due to Tea Plantations, Soil erosion, fire, farming, etc.**

a.b. Tea Plantations by removing virgin Evergreen Forests; c.d. Heavy soil erosion and exposed parent rock; e.f. Devastation by Forest fire; g. Farming and Human settlement inside forests (Injikuzhi); h. Crowd of Pilgrims inside forest.

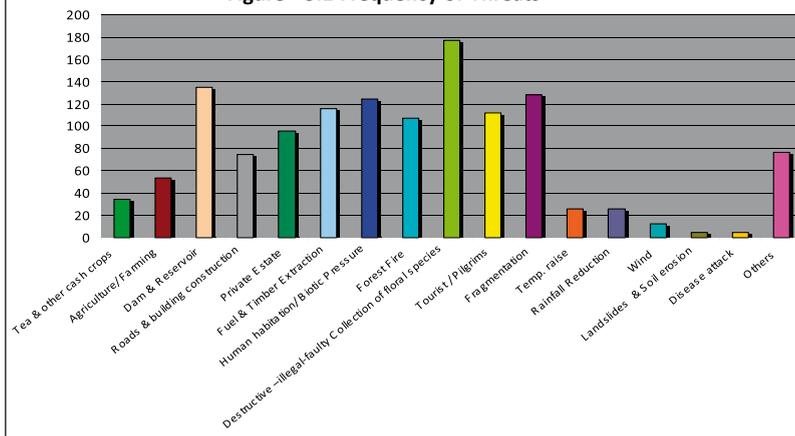
### 5.1.3.2.3 Threats from Change in Forest Cover (Time Series) and loss of habitat of endemic floral species

Changes in forest cover and land-use pattern between the early part of the century (1920), mid-century (1960), and the later part of the century (1990) were estimated by comparing the maps corresponding to the three time periods based on Ramesh (1997)<sup>35</sup>. Data on forest cover and vegetation distribution for 2005 were obtained from studies in the field, satellite imagery and forest department records, forest map of south India (16). Survey of India topographic maps at 1 : 50 000 scale were used to obtain base information such as topography, reserve forest and plantation boundaries and for selecting sites for field stations. Working plan maps of the Forest Department were consulted to update boundaries of the reserve forests and plantations. Satellite (IRS1D) digital data of February 2005, IRS P 6 LISS III data (path : 101 and row : 67 and 68), were used for this purpose.

**Table 5.3 - Frequency of Threats**

	Tea & other cash crops	Agriculture/ Farming	Dam & Reservoir	Roads & building construction	Private Estate	Fuel & Timber Extraction	Human habitation/ Biotic Pressure	Forest Fire	Destructive -Illegal/ faulty Collection of floral species	Tourist / Pilgrims	Fragmentation	Temp. raise	Rainfall Reduction	Wind	Landslides & Soil erosion	Disease attack	Others
Total	34	54	135	75	96	116	124	107	157	112	128	26	26	12	5	5	77
%	2.6	4.13	10.3	5.73	7.33	8.86	9.47	8.17	13.5	8.56	9.78	1.99	1.99	0.92	0.38	0.38	5.88

**Figure - 5.1 Frequency of Threats**



35 Ramesh, B.R., S. Menon and K.S. Bawa. 1997. *A Vegetation based approach to biodiversity gap analysis in the Agastyamalai region, Western Ghats India. Ambio* 26 : 529-536.

The change in extent of forest cover and various land-uses within the study area during 1920, 1960, 1990 and 2005 are shown in **Table 5.4**. The total forest area was 906.82 km<sup>2</sup> (99.92% of the study area) in 1920; 862.07 km<sup>2</sup> (94.99% of the study area) in 1960; 836.99 km<sup>2</sup> (92.22% of the study area) in 1990 and 860.15 km<sup>2</sup> (94.78% of the study area) in 2005. **Table - 5.4** shows the changes in forest cover during these four intervals.

**Table 5.4 - Land use pattern (change) in ha**

Year	Forest		Reservoirs	Non forestry Purpose		Total
	Forest Natural	Plantations		Tea Plantations	Others	
1920	90,681.65	72.40	0	0	0	90,754.05
1960	86,206.98 (-4474.67)	72.40	2,368.59 (+2368.59)	2,106.61 (+21.07)	0	90,753.98
1990	83,698.56 (-2508.43)	874.07 (+801.67)	2,345.41 (-23.18)	2,230.00 (+123.39)	1,606.76	90,754.80
2005	86,018.60 (+2320.04)	544.34 (-329.73)	1,912.10 (-433.31)	2,230.00	55.50 (1,551.26)	90,760.54

Forest loss in the study area between 1920 and 1960 was 47 km<sup>2</sup>. This loss represents 2.9% of the forest cover with an annual deforestation rate of 0.07% during the 40-year period. From 1960 to 1990, 164 km<sup>2</sup> of forest was lost. This represents a loss of 9.9% of the forest cover with an annual deforestation rate of 0.33%. During the 30-year period, 85.6 km<sup>2</sup> were lost to plantations, 42 km<sup>2</sup> came under encroachments, and 36.4 km<sup>2</sup> were lost to reservoirs. This loss of forest cover summarily caused the loss of habitats as well as loss at species level.

#### **5.1.4. Recovery plan for selected Endemic and Threatened Medicinal Plant species (ETMPs) and Conservation Models**

Recovery is the process by which the decline of an Endangered or Threatened species is arrested and threats are removed or reduced, ensuring the long term survival of the species in the wild. Recovery plans provide a road map with detailed site-specific management actions in conserving listed species and their ecosystems. A recovery plan may apply to one species or an ecosystem.

In USA Endangered Species Act (ESA) was commissioned in 1973 and Section 4(d) of the ESA enables them to establish special regulations specifically for threatened species. The “4(d)” or “special rules” allow customizing the protections of the ESA to match the conservation needs of the species and people. In India, the Wildlife (Protection) Act 1972, mainly covers wild fauna with exclusive list of species under Five Schedules while only six plant species are covered under a single Schedule (Schedule - VI). The Biological Diversity Act, 2002 provides for conservation of biological diversity and sustainable use of its components but not for species specific Recovery plan. Detailed floristic biodiversity data recorded from the field survey of 120 quadrats laid in the study area (Appendix - II in First Edition); along with secondary information serve as basis in interpretation and strategy recommendations.

##### **5.1.4.1. Objective of the Recovery Plan**

The overall objective of evolving species specific recovery plan for selected Endemic and Threatened Medicinal Plants (ETMPs) and Conservation Model is to protect existing population of the selected species besides establishing new populations that are stable, viable and self-perpetuating. This Recovery Plan provides a methodology for the protection of existing population, as well as population likely to be impacted by any future development on the site as a pilot study.

##### **5.1.4.2. Taxon data and further efforts on conservation and management of selected Endemic and Threatened Medicinal Plants of KMTR**

Short listing of Endemic and Threatened Medicinal Plant species of the study area was carried out to logically select a workable number of species to first standardize the species specific recovery plan and then to evolve strategic management plan. Habitwise Red listed Endemic Medicinal Plants of KMTR as recorded by quadrat survey (Appendix - I vide First Edition) are given below in **Table – 5.5** which forms the basis for short listing process.

**Table 5.5 - Habitwise Red listed Endemic Medicinal Plants of KMTR**

Habit	Vulnerable (VU)	Endangered (EN)	Critically Endangered (CR)	Near Threatened (NT)	Data deficient (DD)	Total
Tree	7	11	7	2	—	27
Shrub	6	5	6	—	—	17
Herb	1	7	3	—	—	11
Liana	—	—	1*	—	—	1
Climber	2	—	—	—	1**	2+1
Creeper	—	—	1	—	—	—
Total	16	23	17+1	2	1	58+2

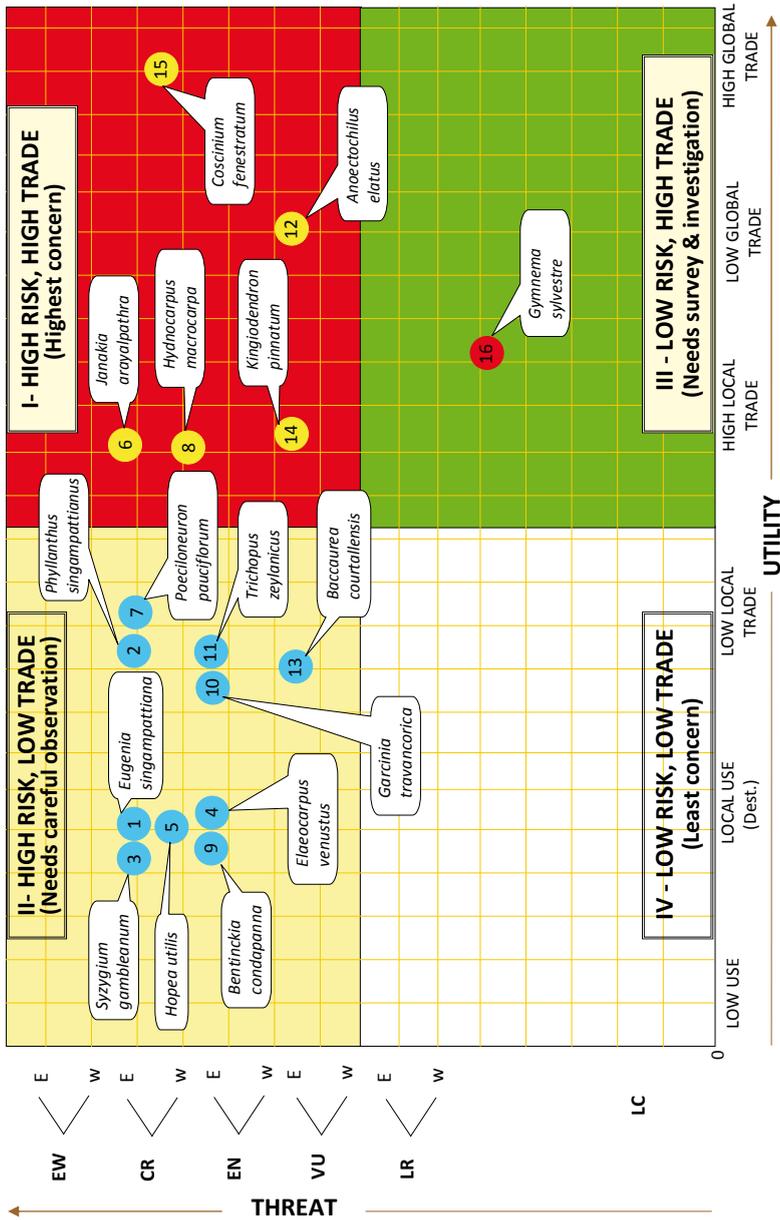
(\* *Coscinium fenestratum*, \*\* *Gymnema sylvestre* —these two MP species are globally distributed and not endemic to KMTR but selected here to represent the case in model formation as given in Figure-5.2)

Based on the floral inventory, relevant literature survey on endemic and threatened plants and CAMP literature published by the FRLHT for the Southern Indian States, it is observed that the threat status of 58 ETMPs of KMTR and its surroundings in Southern Western Ghats are as follows:

Critically Endangered (CR)	–	17
Endangered (EN)	–	23
Vulnerable (VU)	–	16
Near Threatened (NT)	–	2
Data deficient	–	1

The priority analysis indicates that atleast 5 medicinal plants species fall in **I** quadrat of highest concern with High Trade potentiality but with High Risk of losing them forever. The analysis also shows that in **II** quadrat there are 10 medicinal plants which could suffer from high risk of their survival though they are having low Trade value. **III** quadrat, only one plant is located which has High Trade potentiality but with Low Risk which is the desirable quadrat for business management of medicinal plants. For mere biodiversity and total conservation quadrat **IV** will be suitable. An abstract of these 16 species are presented in **Table - 5.6 and Figure 5.2.**

Figure – 5.2 Model showing the Priority Analysis of a few selected Medicinal Plants in KMTR, Tamil Nadu



EW = Extinct in Wild; CR = Critically Endangered; EN = Endangered; Vu = Vulnerable; LR-cd = Low Risk –conservation dependent, LC = Least Concern; E = Endemic, W = Widely distributed, Dest. = Destructive; 0 = Statuesqu.  
 Note - Figures of Trade from 5% sample study of collectors of medicinal plants, undertaken by a coalition of South Indian NGOs and Commissioned by FRLHT (1999).

**Table 5.6 - Lists of Taxon, their Habit, Utility and Threat Status**

Taxon Sl. No	Species Name	Habit	Utility (for X axis)	Threat status (for Y axis)	Zone of Endemism
1	<i>Phyllanthus singampattianus</i>	Shrub	Low Local Trade	Critically Endangered (CR)	KMTR
2	<i>Janakia arayalpathra</i>	Shrub	High Local Trade	Critically Endangered (CR)	SWG(s)
3	<i>Eugenia singampattiana</i>	Tree	Local Use (Dest.*)	Critically Endangered (CR)	KMTR
4	<i>Syzygium gambleanum</i>	Tree	Local Use (Dest.)	Critically Endangered (CR)	KMTR
5	<i>Hopea utilis</i>	Tree	Local Use (Dest.)	Critically Endangered (CR)	KMTR
6	<i>Poeciloneuron pauciflorum</i>	Tree	Low Local Trade	Critically Endangered (CR)	SWG(s)
7	<i>Elaeocarpus venustus</i>	Tree	Local Use (Dest.)	Endangered (EN)	KMTR
8	<i>Bentinckia condapanna</i>	Tree	Local Use (Dest.)	Endangered (EN)	SWG(s)
9	<i>Hydnocarpus macrocarpa</i>	Tree	High Local Trade	Endangered (EN)	SWG(s)
10	<i>Garcinia travancorica</i>	Tree	Low Local Trade	Endangered (EN)	SWG(s)
11	<i>Trichopus zeylanicus</i> ssp. <i>travancoricus</i>	Herb	Low Local Trade	Endangered (EN)	SWG(s)
12	<i>Anoectochilus elatus</i> (orchid)	Herb	Low Global Trade	Vulnerable (VU)	SWG (sc)
13	<i>Baccaurea courtallensis</i>	Tree	Low Local Trade	Vulnerable (VU)	SWG (scn)
14	<i>Kingiodendron pinnatum</i>	Tree	High Local Trade	Vulnerable (VU)	SWG (scn)
15	<i>Coscinium fenestratum</i>	Liana	High Global Trade	Critically Endangered (CR)	Global
16	<i>Gymnema sylvestre</i>	Climber	High Global Trade	Data Deficient (DD)	Global

\* Destructive

The Taxon Data Sheet for recovery plan of individual Priority species are prescribed and narrated below with appropriate recommendations for each plant along with photographs as a Model Study.

### 5.1.4.3 Recovery Plan for Endemic and Threatened Medicinal Plants (ETMPs)

#### TAXON DATA SHEET No. 1

*Phyllanthus singampattianus* (Sebastine & A.N. Henry) Kumari & Chandrab.

#### 1.1 DESCRIPTION

1.1.1 **Synonyms** : *Reidia singampattiana* Sebastine & A.N. Henry

1.1.2 **Family** : EUPHORBIACEAE

1.1.3 **Local name** : *Aathuchadai* (Kani tribe).

1.1.4 **Growth habit** : Shrubs, up to 3.5 m high; it has distinct morphological and silvicultural characters along with specific properties of medicinal value. Flowering Period : November - January; April - June; Seeding Period : December - February; July - September

#### 1.2 HABITAT

1.2.1 **Distribution** : **India** : Southern Western Ghats, 600-900 m, KMTR in Tirunelveli District, Tamil Nadu, Endemic.

1.2.1.1 **Geographical range in KMTR** : Name originated from the place of endemism i.e. Singampatti R.L; Along Tamirabarani River from Banatirtham to Inchikuzhi, scattered up to Paiar, Pambar, Servalar, Valayar and also at Papanasam, Upper Kodayar and Kakachi.

1.2.2 **Ecological situations** : Tropical Riparian fringing forests in the Southern Tropical Wet evergreen forests and in Tropical Moist Deciduous Forests.

1.2.3 **Summary of Abiotic factors for - *Phyllanthus singampattianus***

Geology	Mainly Quartz-feldspathic rock and it is also occurs in Garnet-Biotite gneiss
Elevation & landform	600-900 m, River valley in Lower and Middle plateau
Slope	Moderate (9° to 14°) to Steep (15°-24°)
Rainfall	150-200 cm
Temperature	15°- 24° C
Dry Season Length	2 months
Drainage density	Very High
Geomorphology	River Bed/River Bottom
Soil Type	Puncholai and Erganhalli series under Typic Haplustepts, with very shallow
Soil pH	Mildly acidic to near Neutral

### 1.3 OTHER INFORMATIONS

1.3.1 Trade : Low local trade by a few folk practitioners

#### 1.3.2 Utilization and potential value

The local people use the leaf paste for curing jaundice. So far no detailed Phytochemical and Ethno botanical study was made. The author carried out detailed study of dried leaf and Stem bark and observed that plant is extraordinarily rich in medicinal properties. The **Activity of components identified in *Phyllanthus singampattianus* (dried leaf and stem bark)** is given below in **Table - 5-7 (a) & 5-7 (b)**. The phytochemical analysis by Gas Chromatograph indicates that both the leaf and stem bark of the species have active ingredients of multi activities in human health welfare as they (leaf & stem bark) are antiageing, anti microbial, anti oxidant, anti leukemic, anti tumour, anti cancer or cancer preventive, chemo preventive, anti bacterial, anti algesic, anti coronary, anti arthritic, anti flammatory, nematicide, immuno stimulant, etc.

**Table 5-7 (a) - Activity of components identified in *Phyllanthus singampattianus* [Leaf Dust] 124 [GC MS study]**

S. No	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
1	9.98	3-O-Benzyl-d-glucose	C <sub>13</sub> H <sub>18</sub> O <sub>6</sub>	270	1.97	Sugar compound	Preservative
2	11.17	Dodecanoic acid	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	200	1.14	Lauric acid	Antioxidant, Antibacterial, COX-1 & COX-2 inhibitor, Antiviral, Hypocholesterolemic, Candidicide.
3	12.13	Megastigmatrienone	C <sub>13</sub> H <sub>18</sub> O	190	0.26	Ketone compound	Sweetener
4	12.32	2-Cyclohexen-1-one, 4-(3-hydroxy-1-butenyl)-3,5,5-trimethyl-, [R-[R*,R*-(E)]]-	C <sub>13</sub> H <sub>20</sub> O <sub>2</sub>	208	0.51	Ketone compound	No activity reported
5	13.70	Tetradecanoic acid	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	228	2.11	Myristic acid	Antioxidant, Cancer preventive, Nematicide, Lubricant Hypocholesterolemic
6	14.22	5H-Inden-5-one, octahydro-1-hydroxy-7a-methyl-	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	168	1.21	Ketone compound	No activity reported
7	14.78	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	C <sub>20</sub> H <sub>40</sub> O	296	1.11	Terpene alcohol	Antimicrobial, Antiinflammatory
8	16.62	n-Hexadecanoic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	256	12.07	Palmitic acid	Antioxidant, Hypocholesterolemic, Nematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic 5-Alpha reductase inhibitor

S. No	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
9	16.86	Hexadecanoic acid, ethyl ester	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284	0.93	Fatty acid ester	-do-
10	18.84	Phytol	C <sub>20</sub> H <sub>40</sub> O	296	1.30	Diterpene	Antimicrobial, Antiinflammatory, Anticancer, Diuretic
11	19.36	9,12,15 - Octadecatrienoic acid, (Z,Z,Z)-	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	278	14.21	Linolenic acid	Antiinflammatory, Hypocholesterolemic, Cancer preventive Hepatoprotective Nematicide, Insectifuge Antihistaminic, Antieczemic Antiacne, 5-Alpha reductase inhibitor Antiandrogenic, Antiarthritic, Anticoronary, Insectifuge
12	19.61	Octadecanoic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284	1.57	Stearic acid	No activity reported
13	24.57	Heptadecane, 9-hexyl-	C <sub>23</sub> H <sub>48</sub>	324	0.73	Alkane compound	No activity reported
14	24.72	1-Phenanthrene methanol, 1,2,3,4,4a,9,10,10a - octahydro-6-methoxy-1, 4a-dimethyl-, [1S-(1à,4aà,10aá)]-	C <sub>18</sub> H <sub>26</sub> O <sub>2</sub>	274	0.56	Alcoholic compound	Antimicrobial
15	26.01	Tetracosane	C <sub>24</sub> H <sub>50</sub>	338	0.50	Alkane	No activity reported
16	29.64	Squalene	C <sub>30</sub> H <sub>50</sub>	410	53.79	Triterpene	Antibacterial, Antioxidant, Antitumour, Cancer preventive, Immunostimulant, Chemo preventive, Lipoxygenase-inhibitor, Pesticide
17	35.12	à-Amyrin	C <sub>30</sub> H <sub>50</sub> O	426	6.02	Triterpenoid	Antimicrobial Cancer preventive

\*\*Source : Dr. Duke's Phytochemical and Ethnobotanical Databases

**Table 5-7 (b) - Activity of components identified in *Phyllanthus singampattianus* [Stem Dust] 125[GC MS study]**

S. No	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
1	3.94	Benzene, 1-ethyl-4-methyl-	C <sub>9</sub> H <sub>12</sub>	120	0.15	Aromatic compound	No activity reported
2	11.17	Dodecanoic acid	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	200	0.41	Lauric acid	Antioxidant, Antibacterial, COX - 1 & COX-2 inhibitor, Antiviral, Hypocholesterolemic, Candidicide.

S. No	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
3	13.68	Tetradecanoic acid	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	228	0.26	Myristic acid	Antioxidant, Cancerpreventive, Nematicide, Lubricant Hypocholesterolemic
4	16.55	n-Hexadecanoic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	256	1.55	Palmitic acid	Antioxidant, Hypocholesterolemic Nematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic 5-Alpha reductase inhibitor
5	16.85	Hexadecanoic acid, ethyl ester	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284	0.11	Fatty acid ester	-do-
6	18.65	Vitamin E	C <sub>29</sub> H <sub>50</sub> O <sub>2</sub>	430	5.31	Vitamin	Antiageing, Analgesic, Antidiabetic Antiinflammatory, Antioxidant, Antidermatitic, Antileukemic, Antitumor, Anticancer, Hepatoprotective, Hypocholesterolemic, Antiulcerogenic, Vasodilator, Antispasmodic, Antibronchitic, Anticoronary
7	19.23	Oleic Acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	282	1.59	Un saturated Fatty acid	Antiinflammatory, Antiandrogenic, Cancerpreventive, Dermatitigenic, Hypocholesterolemic, 5-Alpha reductase inhibitor, Anemiagenic, Insectifuge, Flavor
8	19.56	Octadecanoic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284	0.43	Stearic acid	No activity reported
9	22.79	12-Oleanen-3-yl acetate, (3à)-	C <sub>32</sub> H <sub>52</sub> O <sub>2</sub>	468	12.10	Acetate compound	No activity reported
10	24.55	Heptacosane	C <sub>27</sub> H <sub>56</sub>	380	0.73	Alkane	No activity reported
11	25.98	Tetracosane	C <sub>24</sub> H <sub>50</sub>	338	0.91	Alkane	No activity reported
12	28.05	Lup-20(29)-en-3-ol, acetate, (3à)-	C <sub>32</sub> H <sub>52</sub> O <sub>2</sub>	468	68.75	Lupeol acetate	Antiarthritic
13	29.46	2,6,10,14,18,22 - Tetracosahexaene, 2,6,10,15,19,23 - hexamethyl-, (all-E)- (Synonyms : All-trans-Squalene)	C <sub>30</sub> H <sub>50</sub>	410	1.00	Triterpene	Antibacterial, Antioxidant, Antitumor, Cancer preventive, Immunostimulant, Chemo preventive, Lipoxigenase-inhibitor, Pesticide
14	35.03	Lanosterol	C <sub>30</sub> H <sub>50</sub> O	426	6.71	Sterol compound	Antimicrobial Antiinflammatory

\*\*Source : Dr. Duke's Phytochemical and Ethnobotanical Databases

## 1.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

Extent of occurrence (km<sup>2</sup>) : < 75; Area of occupancy (km<sup>2</sup>) : < 10; Number of sub populations / locations : < 15 locations; Habitat status : Decrease in area due to construction of Karayar Dam < 20%; Threat status : Damming, Flash floods wash them away. Floods play a role controlling factor in limiting the number of individuals of their population. Habitat Loss, Habitat Fragmentation; Numbers / Generations studied : > 3 generations / 10 years; Data quality: Literature, herbarium and field study; IUCN Status: Critically Endangered (CR)-A1C, B2a, bi, ii, iii E.

## 1.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

**1.5.1 CITES** : Not included in CITES list.

**1.5.2 WPA (1972, 2006)** : Not included in Schedule.

**1.5.3 National legislation** : No National or State legislation is formed.

## 1.6 RECOVERY AND MANAGEMENT OPTIONS

### 1.6.1 Management Issues

The main threats to *Phyllanthus singampattianus* are habitat disturbance mainly because of Karayar Dam, Hope Lake formation, forest enclosure like Katalamalai Estate, Tribal hamlet at Inchikuzhi, tourist pressure in Hope Lake and its neighbouring places, clearing. Besides, flash floods in rivers with huge boulders often suppress the plants and also cause injuries to the stems and entire plants (**Plate - 5.1.4.3.1d**).

### 1.6.2 Plant propagation practices

There is no recorded information on natural regeneration of the species. Artificial reproduction methods were attempted from seed origin.

#### 1.6.2.1 Seed collection and propagation

The flowering and seed maturation periods of the species have been provided above. Mature globose capsules of brown colour were collected from Inchikuzhi in the month of February 2008, from the branchlets by stripping the capsules along with leaves and dried under shade in aerated place for two / three days. Brown colour triangular shaped seeds (1 x 0.5 mm) were then separated from the leaflets and leaf stems. 4600 – 5000 seeds make a kilogram. The seeds are viable for 2-3 months. Before putting in mother bed, seeds were soaked in water for 3-4 hours. Seed can be directly dibbled in the mother bed already prepared with forest soil and sand in and around the place of endemism like Inchikuzhi. The germinative capacity is 85% and the plant per cent 80. The seeds take 36-60 days for germination. Germination is quicker and

more in the open than under shade. A kilogram of seeds will yield 3600 to 4000 plantable seedlings. Temporary nurseries in / near the zones of endemism with source of water is preferable than the permanent nursery outside. There are several proven methods for vegetative propagation including division, cuttings and tissue culture but it was not attempted for this species.

### 1.7 RECOMMENDATIONS FOR *Phyllanthus singampattianus*

The plant is included in the proposed **Plant Schedule (Figure – 6.7)**. The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

#### Selected Species No. 1 - *Phyllanthus Singampattianus* (Sebastine & A.N. Henry) Kumari & Chandras



**Plate – 5.1.4.3.1. Selected Species No. 1 - *Phyllanthus singampattianus***

a. Gregarious growth of species in river bed; b. A twig in natural habitat with fruits, c. Natural habitat of the species; d. Injured roots and stems; e. Twig with Flowers; f. Mature Seeds; g. Twig with Seeds

## TAXON DATA SHEET No. 2

*Janakia arayalpathra* J. Joseph & V. Chandras.

### 2.1 DESCRIPTION

2.1.1 Local name : *Amritpala, Palarasu.*

2.1.2 Family : PERIPILOLACEAE

2.1.3 Growth habit : Profusely branched, perennial shrub grows up to 1m height. Each plants has 6 to 24 slender branches arising from a common root stock. Flowering Period : February - September; Fruiting Period : March - October

### 2.2 HABITAT

#### 2.2.1 Distribution

India : Southern Western Ghats, 800-1000 m, KMTR in Tirunelveli and Kanyakumari Districts in Tamil Nadu and Kurisimalai near Bonnaccord Estate in Kerala (750-950 m) Thiruvananthapuram District in Kerala. Endemic.

##### 2.2.1.1 Geographical range in KMTR

In Kalakad RF, Grass lands located North of Donavur fellowship Rest house, Taragankadu Theri (S W. Aspect) both in eastern and western side of Mancholai Cardamom abandoned Estate the species occurs (**Plate - 5.1.4.3.2**). During the field study the author could identify **a new location of occurrence of this critically endangered species** at **Thai Padai** in Nambi koil saragam, Thirukurungudi Range; Mahendragiri (950m). It is also noticed on steep slopes above the Poonkulam (1230 m). It is reported on the way to Muthukuzhivayal from Balamore Estate, (1000m).

##### 2.2.2 Ecological situations :

Plant grows in Montane grasslands in the form of bushes through tuberous root system in exposed gneissic rock (Garnet-Biotite) crevices and small cracks. Locations observed mainly in steep and inaccessible slope of Montane grasslands.

### 2.2.3 Summary of Abiotic factors for *Janakia arayalpathra*

Geology	Quartz-feldspathic rock and Charnockite
Elevation & landform	800-1400 m; Steep Hilly terrain
Slope	Steep (15°-24°) to Very Steep slope (25°-45°)
Rainfall	150-200 cm
Temperature	16°- 30° C
Dry Season Length	6 months
Drainage density	Low to medium
Geomorphology	Part of Upper & Middle Plateau, Structural Hill, Mountain cliff
Soil Type	Puncholai and Erganhalli series under Typic Haplustepts, with very shallow soil depth
Soil pH	Mildly acidic to neutral to mildly alkaline (pH varies from 5.6 to 8.0)

## 2.3 OTHER INFORMATION

**2.3.1 Trade information :** High local trade There is a very high demand of the tuberous fruits of this species in local area of Tamilnadu and Kerala.

### 2.3.2 Utilization and potential value

Medicinal value : The tuberous root is used as a rejuvenating tonic by Kani tribes. It is also used as remedial measure for peptic ulcers and liver affections. The tuberous root are also reported to be useful in digestive and gastric problems and also used as pickles. So far no detailed phytochemical and ethnobotanical study has been made. The author carried out detailed study of the tuber and observed that plant is extraordinarily rich in medicinal properties. The activity of components identified in *Janakia arayalpathra* [Tuber] are given in **Table - 5.8**. The phytochemical analysis by Gas Chromatograph indicates that the tuberous roots of the species has active ingredients of multi activities in human health welfare as it is antioxidant, antimicrobial, antitumour, cancer preventive, chemo preventive, immuno stimulant, anti asthma, anti arthritic, anti inflammatory, anticorrosion, anti androgenic, nematicide, etc.

**Table - 5.8 Activity of Components identified in *Janakia arayalpathra* [Tuber Dust] 123 [GC MS study]**

S. No	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
1	5.08	4-Nonene	C <sub>9</sub> H <sub>18</sub>	126	0.73	Alkene	No activity reported
2	5.89	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	144	0.49	Flavonoid fraction	Antimicrobial Antiinflammatory
3	6.93	2-Furancarboxaldehyde, 5-(hydroxymethyl)-	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	126	2.50	Aldehyde	Antimicrobial Preservative
4	7.43	Nonanoic acid	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	158	0.13	Fatty acid	No activity reported

S. No	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
5	8.28	Benzaldehyde, 2-hydroxy- 4-methoxy-	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	152	49.27	Aldehyde	Antimicrobial Antiinflammatory
6	9.96	Vanillin	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	152	6.31	Fragrance compound	Antimicrobial Antioxidant Antiinflammatory
7	11.18	Dodecanoic acid	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	200	0.43	Lauric acid	Antioxidant, Antibacterial, COX-1 & COX-2 inhibitor, Antiviral, Hypocholesterolemic, Candidicide.
8	12.97	Phenol, 2,6-dimethoxy-4-(2-propenyl)-	C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	194	0.53	Phenolic compound	Analgesic, Anesthetic, Antioxidant, Antiseptic, Antibacterial, Antiviral Cancer preventive, Fungicide, Rodenticide Emetic, Vasodilator.
9	13.72	Tetradecanoic acid	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	228	0.33	Myristic acid	Antioxidant, Cancer preventive, Nematicide, Lubricant Hypocholesterolemic
10	16.69	n-Hexadecanoic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	256	5.75	Palmitic acid	Antioxidant, Hypocholesterolemic Nematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic 5-Alpha reductase inhibitor
11	16.96	Hexadecanoic acid, ethyl ester	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284	0.20	Fatty acid ester	-do-
12	17.08	Oleic Acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	282	0.16	Unsaturated fatty acid	Antiinflammatory, Antiandrogenic, Cancer preventive, Dermatitigenic, Hypocholesterolemic, 5-Alpha reductaseinhibitor, Anemiagenic, Insectifuge, Flavor
13	19.49	9,12-Octadecadienoic acid (Z,Z)-	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	280	5.79	Linoleic acid	Antiinflammatory, Hypocholesterolemic, Cancer preventive Hepatoprotective Nematicide, Insectifuge Antihistaminic, Antieczemic Antiacne, 5-Alpha reductase inhibitor Antiandrogenic, Antiarthritic, Anticoronary, Insectifuge

S. No	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
14	19.77	Octadecanoic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284	1.46	Stearic acid	No activity reported
15	21.88	Eicosane	C <sub>20</sub> H <sub>42</sub>	282	0.17	Alkane	No activity reported
16	23.36	Androstan-17-one, 3-ethyl-3-hydroxy-, (5à)-	C <sub>21</sub> H <sub>34</sub> O <sub>2</sub>	318	4.62	Steroid	Antimicrobial, Anticancer, Antiinflammatory, Antiasthma, Antiarthritic
17	24.51	Codeine	C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	299	1.95	Alkaloid	Antimicrobial Antiinflammatory
18	25.04	Pentacosane	C <sub>25</sub> H <sub>52</sub>	352	1.70	Alkane	No activity reported
19	30.40	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)- (Synonyms : trans-Squalene)	C <sub>30</sub> H <sub>50</sub>	410	17.46	Triterpene	Antibacterial, Antioxidant, Antitumour, Cancer preventive, Immunostimulant, Chemo preventive, Lipoxigenase-inhibitor, Pesticide

\*\*Source : Dr. Duke's Phytochemical and Ethnobotanical Databases

## 2.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

Extent of occurrence (km<sup>2</sup>) : < 100; Area of occupancy (km<sup>2</sup>) : < 10; Number of sub populations/locations : < 6 locations; Habitat status : Decrease in area due to construction of Upper Kodayar Dam < 20%; Threats status : Present in the core zone; Numbers / Generations studied : > 3 generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : **Critically Endangered** (CR)-A1c, B2a, bii, iv, v, cii, iv, D.

## 2.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

2.5. CITES : Not included in CITES list.

2.5.2 IWPA (1972, 2002) : Not included in Schedule.

2.5.3 National legislation : No National or State legislation is formed.

## 2.6 RECOVERY AND MANAGEMENT OPTIONS

### 2.6.1 Management Issues

The main threats to *Janakia aryalpathra* are habitat disturbance mainly because of plantation crops like tea raised in Chinna - Manjolai Estate and also at Neterikal during British period and afterwards, collection of tubers illegally by local people and people from neighbouring state like Kerala for medicinal purpose and also for making pickle and sarbat. Due to the fragmented nature of the populations, their small size in narrow endemic zone of distribution and anthropogenic activities the species is susceptible to catastrophic events of

further erosion unless time bound special care is taken for this plant in its place of occurrence.

### 2.6.2 Plant propagation practices

There is no recorded information on natural regeneration of the species. During field study it was observed that natural regeneration was very restricted only in their specific places of origin in very steep slope (24°-45°) to precipitous slope, below the mother shrub in rock crevices where some soil with shallow depth is available. Artificial reproduction is yet to be attempted from seed origin. Attempt was made to propagate the species by collecting small stem along with tuberous root (5 to 10 cm). Tuberous root is placed in the loamy soil of plastic container of 30 x 45 cm bags. The stem 5 to 8 cm should remain above the soil (Vide Image below). In the first 15 days, polybags along with the plants should not be kept under direct sunlight. Watering can be done sparingly once in alternate days. Within a period of 15 - 20 days, sprouting will start and in 5 - 6 months *Janakia arayalpathra* will be of plantable size and these can be planted bag to its places of endemism to increase the plant stock.



**Stem along with tuberous root for vegetative propagation**

*Ex-situ* planting can be done in similar abiotic factors and bio climatic zone as given in para No. 2.2.3.

#### 2.6.2.1 Seed collection and propagation

The flowering and seed maturation periods of the species have been provided above. Regular inspections of populations across the site are needed to determine the appropriate time for seed collection.

## 2.7 RECOMMENDATIONS FOR *Janakia arayalpathra*

The plant is included in the proposed Plant Schedule (**Figure – 6.7**). The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

**Selected Species No. 2 - *Janakia arayalpathra* J. Joseph & V. Chandras.**



**Plate – 5.1.4.3.2A. Selected Species No. 2 - *Janakia arayalpathra***

a. A stout bush of species at steep slope above Poonkulam (1230m); b. Nursery raised from tuberous root; c - i. Twigs with flower and Pods



**Plate – 5.1.4.3.2B. Selected Species No. 2 - *Janakia aryalpathra*  
J. Joseph & V. Chandras.**

a. Species identification at precarious location; b. Close look of the bush bottom; c,d. Tuberous roots which is used for medicine; e. Measuring the weight of a tuberous root.

**TAXON DATA SHEET No. 3*****Eugenia singampattiana* Bedd.****3.1 DESCRIPTION****3.1.1 Family :** MYRTACEAE

**3.1.2 Local name : Tamil (Kanis) :** Korandi palam, Kaatukorandipatchilai, Kattuperumpulipatchilai

**English :** *Eugene Myrtle of the Singampatty Hills of Tinnevely* (Lushington - 1915)<sup>36</sup>.

**3.1.3 Growth habit :** A small, dense, evergreen tree, under favourable situation, it attains a height of about 6-9 m with 40 cm girth. Flowering Period : February - June; Fruiting Period : July - October.

**3.2 HABITAT**

**3.2.1 Distribution : India :** Southern Western Ghats, Tamil Nadu (Tirunelveli Dist.), Endemic.

**3.2.1.1 Geographical range in KMTR :** Name originated from the place of endemism i.e. Singampatti R.L. Also occurs in neighbouring Papanasam R.F., Karaiar to Tholukkamottai to Inchikuzhi to Kannikatty; Periyamalar, Pambar, Banathirtham, Kodamadi to Kuduvaraiar Ar (vide map in Sarcar *et.al*, 2005).

**3.2.3 Ecological situations**

Tirunelveli semi-evergreen forest (2A/C3) and Moist deciduous forests. Semi-evergreen forest type is the major group which is distributed all around Hope Lake, particularly 300-700 m.

**3.2.4 Summary of Abiotic factors - *Eugenia singampattiana***

Geology	Quartz-feldspathic rock
Elevation & landform	250-800m; Part of Lower Mundanthurai plateau and its adjacent surroundings
Slope	Moderate (9° to 14°)
Rainfall	100-200 cm
Temperature	16°- 30° C
Dry Season Length	4 months
Drainage density	High
Geomorphology	Structural Hill, Debris slope and Valley fill
Soil Type	<i>Karumutti</i> series under Lithic Dystrustepts and <i>Puncholai</i> under Typic Haplustepts, shallow to medium soil depth, well drained.
Soil pH	Acidic (pH 4.9 - 6.6)

36 Lushington, A.W. 1915. *Vernacular list of Trees, Shrubs and Woody Climbers in the Madras Presidency*; Superintendent, Government Press, Madras.

### 3.3 OTHER INFORMATION

**3.3.1 Trade :** Fruits and leaves are locally used by the Kani tribes. It has the potential medicinal value like other sister species of the *Syzygium* genus like *Syzygium cumini*.

**3.3.2 Utilization and potential value :** Medicinal value - Local people of Kani Tribes uses ripe fruit carpel and stem bark for medicinal purpose for the diabetic patient.

Bark, leaf and roots of the plant were collected during the field survey and the sample was sent to Foundation for Revitalization of Local Health Tradition (FRLHT), Bangalore in April 2003 to obtain its phytochemical parameters.

**Table - 5.9 *Eugenia singampattiana* – phytochemical parameters**

	Visible	Long UV	Short UV	Anisaldehyde
TLC Profile				
<i>Syzygium cumini</i>	Nil	0.41, 0.506, 0.58	Nil	0.072, 0.228, 0.337, 0.578, 0.686, 0.891
<i>Eugenia singampattiana</i>	Nil	0.41, 0.506, 0.58	Nil	0.072, 0.18, 0.265, 0.337, 0.42, 0.578
		<b><i>S. cumini</i></b>		<b><i>E. singampattiana</i></b>
Foreign organic matter		Nil		Nil
Moisture content		8.8		10.2
Total ash (%)		4.97		8.19
Acid insol. ash (%)		0.2650		0.3563
Alcohol sol. ext (%)		14.77		4.08
Water sol. ext (%)		11.89		3.66
Reducing sugars (%)		+		+
Hydrolizable sugars		+		+
Phenolics		+		+

Bark from *E. singampattiana* are scrapings from a young and immature plant, whereas bark from *S. cumini* is from a mature tree. These are the preliminary observations from a single sample. TLC profile shows some common bands both in the UV light and on spraying with anisaldehyde. +, Present.

### 3.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

The species is categorized as **Endangered or Possibly Extinct** by the Botanical Survey of India, Calcutta (1987). The present conservation assessment management plan of the species is as follows: Extent of occurrence (km<sup>2</sup>) : < 100; Area of occupancy (km<sup>2</sup>) : < 10; Number of sub populations / locations : < 10 locations; Habitat status : Decrease in area due to construction of Karayar and Servalar Dam < 20%; Threat status : Damming, Habitat Loss, Habitat

Fragmentation; Numbers / Generations studied : > 3 generations / 10 years;  
Data quality : Field study, Literature and herbarium; IUCN Status : **Critically Endangered** (CR)-A1C, B2a, bi, ii, iii E.

### **3.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION**

**3.5.1 CITES** : Not included in CITES list

**3.5.2 WPA (1972, 2006)** : Not included in Schedule.

**3.5.3 National legislation** : No National or State legislation is formed.

### **3.6 RECOVERY AND MANAGEMENT OPTIONS**

#### **3.6.1 Management Issues**

The main threats to *Eugenia singampattiana* are habitat disturbance mainly because of Karayar Dam-Hope Lake formation and Servalar Dam, forest enclosure like Katalamalai Estate, tribal hamlet at Inchikuzhi, tourist pressure in Hope Lake and its neighbouring places (including road, trail and power line maintenance, and recreational vehicle use), clearing.

#### **3.6.2 Methods of plant propagation practices**

There is no recorded information on natural regeneration of the species, but during field study it was noticed that natural regenerations was available below the tree shade near the streams, where the soil has sufficient humus and moisture content. Artificial reproduction methods were attempted both from seed origin and by stem cuttings.

##### **3.6.2.1 Seed collection and propagation**

###### **Plant propagation practices**

Propagation from seed origin: The ripened light yellowish to orange colour fruits was collected during September and October. These were kept in a heap under shade for 2–3 days. This helps the pericarp to rot and then pulp is removed by rubbing and washing in water. The seeds were dried in shade. The number of fruits and seeds per kg was found to be ca 440 and 360–870 respectively. The seeds have a germination capacity of 87% and plant survival of 61%. Seeds appear to have a dormancy period of a few months. Seeds were collected from fresh, ripened fruits in the Banathirtham area at the end of September and dibbled soon after the removal of pulp at Palayamkottai forest campus. Germination could be noticed only in January, indicating that the dormancy period could run for a few months. About 514 plants were obtained from 1 kg of seeds. Seed viability could be retained maximum for a period of 7–8 months, after which the endosperm of the seeds gets dried-up and the seeds lose their germination capacity.

Seedlings of *E. singampattiana* have been raised for experimental purposes by sowing seeds in the nursery. No specific problems were faced during raising of the plant in the nursery. However, the growth pattern was slow in the early stages. Raised bed nursery of forest soil with sufficient leaf litter and humus content helps in better and early germination, while in ordinary soils the result is not encouraging. Covering the mother bed with about 1.0 – 1.5 cm thick straw gives better results as it provides required warmth to the seeds. Water is supplied in the morning and evening. When seedlings become 3–4 cm, they are dibbled in 16 x 30 cm or 15 x 25 cm polythene bags.

**Vegetative propagation:** The species is an excellent coppicer. Keeping this character in mind, ten stump cuttings of a small root portion of pencil thickness were kept in mud pots. All ten stumps started giving shoots within 25 to 30 days. Small stump with root portion were collected from its habitat and at the time of collection itself, a handful of local moist soil was kept with the collected stump to avoid dehydration of the root portion. The stumps and soil were kept in small bags before they were transplanted into the mud pots. The root portion of the stump was carefully kept in the mud pot. Mixed soil, sand and green leaf manure (2 : 1 : 1) was tightly packed around the stump. Then a cylindrical mud pot having a small hole on the top was kept on the mother mud pot. Water was sparingly sprinkled once in two days through this hole without opening the cylindrical mud jar. The jar should not be opened frequently. Keeping an empty mud jar on the mother pot creates a natural greenhouse effect, stimulating early and ensured shoot formation. Within 25–30 days new shoots appeared with red-coloured young leaves. The plant was allowed to continue in such confinement for two months. Then the jar was opened in the evening and again closed in morning without allowing direct sunlight. Slowly, the exposure period was extended. This led to the formation of chlorophyll in the plant, which will change its colour from red to light green. After the third month, plants were kept in shade and normal care was taken. To produce large number of plants from stump cuttings, mist chamber methods by Silpaulin sheets can be used economically.

Artificial reproduction methods were attempted both from seed origin and also by stem cuttings by the authors at Tirunelveli. About 46 seedlings of seed origin and 9 plants from stem cuttings were raised as a preliminary experiment.

### 3.7 RECOMMENDATIONS FOR *Eugenia singampattiana*

The plant has to be included in the proposed **Plant Schedule (Figure – 6.7)**. The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

**Selected Species No. 3 - *Eugenia singampattiana* Bedd.**



**Plate – 5.1.4.3.3. Selected Species No. 3 - *Eugenia singampattiana***

a & d. Striking orange colour fruits; b. Twig with flower; c. Mature seeds; b. Twigs with fruits, e. Seedlings. A. Stages of Germination; B. Vegetative Propagation

**TAXON DATA SHEET No. 4*****Syzygium gambleanum* Rathakr. & Chithra****4.1 DESCRIPTION**

**4.1.1 Synonyms :** *S. microphyllum* (Beddome), *Eugenia microphylla* Beddome

**4.1.2 Family :** MYRTACEAE.

**4.1.3 Local name : English name :** Small leaved Black Plum of Travancore (Lushington - 1915)<sup>37</sup>.

**4.1.4 Growth habit :** A small, dense, evergreen tree grows a height of about 6-9 m with 85 cm girth. Flowering Period : January - April; Fruiting Period : May - June - July.

**4.2 HABITAT**

**4.2.1 Distribution : India :** Southern Western Ghats, Tamil Nadu (Kanyakumari and Tirunelveli Districts in Tamil Nadu). Endemic.

**4.2.1.1 Geographical range in KMTR :** Uthu Estate Lake view point, Upper Kodayar, Muthukuzhivayal; Yanai Ellumbu Odai on the way to Neterikal from Sengaltheri.

**4.2.2 Ecological situations**

**The species occurs in Southern Tropical Wet evergreen forest.**

**4.2.3 Summary of Abiotic factors for *Syzygium gambleanum***

Geology	Quartz-feldspathic rock and Garnet-Biotite gneiss
Elevation & landform	800-1400 m; Part of Upper Plateau & Hilly terrain
Slope	(9° to 14°) to Steep (15°-24°)
Rainfall	200-300 cm
Temperature	15°- 24° C
Dry Season Length	4 months
Drainage density	Low to medium
Geomorphology	Part of Upper Plateau, Structural Hill, Debris slope
Soil Type	<i>Pallam kadu</i> series under Udic Argiustolls and <i>Tarkadu series</i> under Lithic Haplustepts, with shallow to moderately deep soil.
Soil pH	Acidic (pH 4.8-5.5)

37 ibid

### 4.3 OTHER INFORMATION

4.3.1 Trade : Local use

4.3.2 Utilization and potential value : Kani Tribes use the leafy twigs to bake tubers of *Manihot esculenta* Crantz. that add flavour. Fruits are edible.

### 4.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

The species is categorised as Endangered by the Botanical Survey of India, Calcutta (1987)<sup>38</sup>. The present conservation assessment management plan of the species is as follows :

**Extent of occurrence** : (km<sup>2</sup>) : < 10; Area of occupancy (km<sup>2</sup>) : < 1; Number of sub populations / locations : < 1 location; Habitat status : Decrease in area due to tea plantations; Threat status : Present in the core zone; Numbers / Generations studied : > 3 Generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : Critically Endangered (CR)-A1C, B2a, bii, iv, v, cii, iv, D.

### 4.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

4.5.1 CITES : Not included in CITES list

4.5.2 WPA (1972, 2006) : Not included in Schedule.

4.5.3 National legislation : No National or State legislation is formed.

### 4.6 RECOVERY AND MANAGEMENT OPTIONS

#### 4.6.1 Management Issues

The main threats to *Syzygium gambleanum* are habitat disturbance mainly because of decrease in area due to tea plantations, Upper Kodayar Dam - Reservoir formation. Due to the fragmented nature of the populations, their small size, and anthropogenic activities the species is susceptible to catastrophic events of further erosion unless time bound special care is taken for this plant across the site.

#### 4.6.2 Methods of plant propagation practices

There is no recorded information on natural regeneration of the species. However, natural regeneration was available below the tree shade near the streams, where the soil has sufficient humus and moisture content. Artificial reproduction methods were attempted both from seed and stem cuttings.

38 Nayar, M.P. and A.R.K. Sastry. (Eds.) 1987. *Red Data Book of Indian Plants. Vol. 1*. Botanical Survey of India, Calcutta.

### 4.6.3 Seed collection and propagation

The flowering and seed maturation periods of the species have been provided above. The ripened berries of whitish pink colour were collected during July and August. The small brown colour seeds were extracted after removing the over ripened pulp by washing in water. The seeds were dried in shade. The number of fruits and seeds per kg was found to be 510-540 and 425-910 respectively. The seeds have a poor to medium germination capacity (35-50%) and plant survival of 41%. Getting ripened fruits from mature trees is a difficult task. Seeds were collected from fresh, ripened fruits in the Yanai Elumbu Odai (Way to Neterikal) area at the beginning of August and dibbled during third week at Palayamkottai forest campus. Germination could be noticed only in December indicating that the dormancy period could run for a few months. Seed viability could be retained maximum for a period of 1 month, after which the endosperm of the seeds gets dried-up and the seeds lose their germination capacity. Seedlings of *Syzygium gambleanum* have been raised for experimental purposes by sowing seeds in the nursery. The growth pattern was found to be very slow. Bed of forest soil with sufficient leaf litter and humus content helps in better and early germination. Covering the mother bed with about 1.0-1.5 cm thick straw gives better results as it provides required warmth to the seeds. Water is supplied in the morning and evening. When seedlings become 3-4 cm, they are dibbled in 16 x 30 cm or 15 x 25 cm polythene bags.

### 4.6.4 Vegetative propagation

The species is a coppicer. Twenty stump cuttings with small root portion of pencil thickness were planted in individual small mud pots in mist tent. Only eight stumps started giving shoots within 26 to 32 days with red-coloured young leaves. The plants were continued in such confinement for two months. Then the mud pots were kept under filtered light in hardening chamber. Slowly, the light exposure period was extended. After the third month, plants were kept in shade and normal care was given. Artificial reproduction methods were attempted both from seed origin and also by stem cuttings by the author at Tirunelveli. About 22 seedlings of seed origin and 5 plants from stem cuttings were raised as a preliminary experiment.

## 4.7 RECOMMENDATIONS FOR *Syzygium gambleanum*

The plant is included in the proposed **Plant Schedule (Figure – 6.7)**. The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

**Selected Species No. 4 - *Syzygium gambleanum* Rathakr. & Chithra**



**Plate – 5.1.4.3.4. Selected Species No. 4 - *Syzygium gambleanum***

a. Twig with fruits; b. a Juvenile tree at Yanai Elumbu Odai, Neterikal; c. Delicate fruits; d. Precious seedlings e. Herbarium

**TAXON DATA SHEET No. 5*****Hopea utilis* (Bedd.) Bole****5.1 DESCRIPTION**

**5.1.1 Synonyms :** *Balanocarpus utilis* Bedd. *Hopea longifolia* Dyer in Hook.  
*Dioticarpus barryi*

**5.1.2 Family :** DIPTEROCARPACEAE.

**5.1.3 Local name :** **Tamil :** Karungongu.

**5.1.4 Growth habit :** Trees, up to 33 m high; trunk 4.6 m in diam. Flowering period April - June, Fruiting Period; July - September.

**5.2 HABITAT****5.2.1 Distribution**

India : Southern Western Ghats, 250-800 m, KMTR in Tirunelveli District, Tamil Nadu. Endemic.

**5.2.1.1 Geographical range in KMTR :** Singampatti R.L, Papanasam R.F. Inchikuzhi, Karayar to Kannikatty, Kodamadi, Mundanthurai, Ullar, Papanasam.

**5.2.2 Ecological situations :** It occurs in Southern Tropical Wet Evergreen Forest and in Tirunelveli Semi-Evergreen forests.

**5.2.3 Summary of Abiotic factors for *Hopea utilis* (Bedd.)**

Geology	Quartz-feldspathic rock and Garnet-Biotite gneiss
Elevation & landform	300-800 m; Part of Lower Mundanthurai plateau and its adjacent surroundings
Slope	Moderate (9° to 14°) to Steep (15°-24°)
Rainfall	150-200 cm
Temperature	15°- 24° C
Dry Season Length	2 months
Drainage density	Medium to High
Geomorphology	Structural Hill, Debris slope and Valley fill
Soil Type	<i>Puncholai and Erganhalli</i> series under Typic Haplustepts, with very shallow soil depth; Perumalmalai series of Rhodic Paleustalfs, Pallam kadu of Udic Argiustolls
Soil pH	Mildly acidic to neutral to mildly alkaline (pH varies from 5.6 to 8.0)

**5.3 OTHER INFORMATION**

**5.3.1 Trade :** Not known

**5.3.2 Utilization and potential value :** Timber is valuable, Kani tribal people use its parts as medicine for treating different ailments.

## 5.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

Extent of occurrence (km<sup>2</sup>) : < 50; Area of occupancy (km<sup>2</sup>) : < 10; Number of sub populations / locations : < 10; Habitat status : Decrease in area due to construction of Karayar Dam < 20%; Threats status : construction of dams, habitat loss, habitat fragmentation; Numbers / Generations studied > 3 generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : **Critically Endangered (CR)**- A1C, B2a, bi, ii, iii, E.

## 5.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

5.5.1 CITES : Not included in CITES list.

5.5.2 WPA (1972, 2006) : Not included in Schedule.

5.5.3 National legislation : No National or State legislation is formed.

## 5.6 RECOVERY AND MANAGEMENT OPTIONS

### 5.6.1 Management Issues

The main threats to *Hopea utilis* are habitat disturbance mainly because of Karayar Dam - Hope Lake formation and Servalar Dam, forest enclosure like Katalamalai Estate, Tribal hamlet at Inchikuzhi, Tourist pressure in Hope Lake and its neighbouring places (including road, trail and power line maintenance, and recreational vehicle use), clearing. Due to the fragmented nature of the population, their small size, and anthropogenic activities the species is susceptible to catastrophic of further erosion unless time bound special care is taken for this plant across the site.

### 5.6.2 Plant propagation practices

There is no recorded information on natural regeneration of the species, but during field study it was noticed that natural regeneration was available below the tree shade near the streams. Artificial reproduction methods were attempted both from seed origin.

### 5.6.3 Seed collection and propagation

Fruits were collected from Inchikuzhi in the month of October 2007. About 100-150 ripened drupes make a kilogram. In each drupe a solitary seed is available. Mature globose fruits i.e., wingless nuts with solitary seed can be directly dibbled in the mother bed already prepared with forest soil and sand in around the place of endemism like Inchikuzhi. The seeds are having poor viability. As soon as the seeds are germinated they can be transferred to plastic container of 16 cm x 30 cm size already filled with loamy soil and sufficient humus content. Special care should be taken to ensure that the dycotyledon is not separated from the germinated plant. The germinative capacity is more

than 80% and the plant per cent 80. The seeds take 36 to 60 days for germination. Germination is quicker and more in the open than under shade. A kilogram of seeds will yield 80 to 120 usable seedlings. Temporary nurseries are near the place of endemism with source of water is preferable than the permanent ones. The method for vegetative propagation including division, cuttings and tissue culture was not attempted for this species. **(Plate - 5.1.4.3.5.)**

## 5.7 RECOMMENDATIONS FOR *Hopea utilis*

The plant is included in the proposed Plant Schedule **(Figure – 6.7)**. The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12.**

### Selected Species No. 5 - *Hopea utilis* (Bedd.) Bole.



**Plate – 5.1.4.3.5. Selected Species No. 5 - *Hopea utilis***

a. *Hopea utilis* grove at Injikuzhi; b. Tree trunk with special identifying bark; c & d. Seedlings at Nursery

**TAXON DATA SHEET No. 6*****Poeciloneuron pauciflorum* Bedd.****6.1 DESCRIPTION****6.1.1 Family :** BONNETIACEAE.**6.1.2 Local name****Tamil :** *Boothankali, Puthangkolli, Puthangali;***Malayalam :** *Puli vayila,***Common / Trade Names :** *Ballagi;***English :** *Few flowered Milled Leaf Tree* (Lushington - 1915)<sup>39</sup>.**6.1.3 Growth habit :** Evergreen trees, up to 18 m high; Flowering Period : February - April; Fruiting Period : April - July**6.2 HABITAT****6.2.1 Distribution**

India : Endemic to the Evergreen forests of Travancore and Tirunelveli hills of Southern Western Ghats in peninsular 600-1200 m, i.e., KMTR in Kanyakumari and Tirunelveli Districts in Tamil Nadu.

**6.2.1.1 Geographical range in KMTR**

Inchikuzhi to Naga Pothigai, Kalyankadu, Kannikatty, Papanasam, Mahendragiri, Valayar river bank, Ethaa aru bank, Sigapparu bank way to Naga Pothigai, Mallamianar, mostly on banks of Streams.

**6.2.2 Summary of Abiotic factors for *Poeciloneuron pauciflorum***

Geology	Garnet-Biotite gneiss and Quartz-feldspathic rock
Elevation & landform	600-1200 m; Part of Middle plateau & Hilly terrain
Slope	Moderate (9° to 14°) to Steep (15°-24°)
Rainfall	120-200 cm
Temperature	16°- 24° C
Dry Season Length	2 months
Drainage density	High
Geomorphology	Part of Upper & Middle Plateau, Structural Hill, Debris slope
Soil Type	Perumalmalai series of Rhodic Paleustalfs, Pallam kadu of Udic Argiustolls; Puncholai series under Typic Haplustepts, with very shallow soil depth
Soil pH	Mildly acidic to neutral to mildly alkaline (pH varies from 5.6 to 8.0)

39 *ibid*

### 6.3 OTHER INFORMATION

6.3.1 Trade : Local use

6.3.2 Utilization and potential value : Medicinal value.

### 6.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

The species is categorised as **Indeterminate** by the Botanical Survey of India, Calcutta (1990)<sup>40</sup>. The present conservation assessment management plan of the species is as follows : Extent of occurrence (km<sup>2</sup>) : < 75; Area of occupancy (km<sup>2</sup>) : < 10; Number of sub populations/locations : < 10 locations; Habitat status : Decrease in area due to construction of Karayar Dam < 20%; Threat status : Present in the core zone; Numbers / Generations studied : > 3 generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : **Critically Endangered** (CR)-A1c, B2a, bii, iv, v, cii, iv, D.

### 6.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

6.5.1 CITES : Not included in CITES list.

6.5.2 WPA (1972, 2006) : Not included in Schedule.

6.5.3 National legislation : No National or State legislation is formed.

### 6.6 RECOVERY AND MANAGEMENT OPTIONS

#### 6.6.1 Management Issues

The main threats to *Poeciloneuron pauciflorum* are habitat disturbance mainly because of Tribal hamlet at Inchikuzhi, Tourist pressure in Hope lake, Agasthiyamalai and its neighbouring places Karayar Dam-Hope lake formation, forest enclosure like Katalamalai Estate and clearing.

#### 6.6.2 Plant propagation practices

There is no recorded information on natural regeneration of the species, but during field study at Kalyankadu and Inchikuzhi it was noticed that natural regeneration was available below the tree shade near the streams. Artificial reproduction methods were attempted from seed origin.

##### 6.6.2.1 Seed collection and propagation

The flowering and seed maturation periods of the species have been provided above. Fruits of sub-globoid shape, (c. 1.7 x 2 cm) smooth were collected from Kaliyankadu and Inchikuzhi in the month of May 2007. Mature brown colour subspherical, hard, coriaceous seeds (c. 10 x 7 mm) were then separated

40 Nayar, M.P. and A.R.K. Sastry. (Eds.) 1990. *Red Data Book of Indian Plants. Vol. 3*. Botanical Survey of India, Calcutta.

from the persistent sepals of globose capsules. 540-660 seeds make a kilogram. The seeds are viable maximum up to 2 months. Before putting in mother bed seeds were soaked in water for 3-4 hours. Seed can be directly dibbled in the mother bed already prepared with forest soil and sand in around the place of endemism like Inchikuzhi. The germinative capacity is 77% and the plant per cent 70. The seeds take 30-60 days for germination. Germination is quicker and more in the open than under shade. A kilogram of seeds will yield 370 to 450 plantable seedlings. Temporary nurseries near the place of endemism with source of water is preferable than the permanent ones. The vegetative propagation method including division, cuttings and tissue culture was not attempted for this species. (Plate - 5.1.4.3.6).

### 6.7 RECOMMENDATIONS FOR *Poeciloneuron pauciflorum*

The plant is included in the proposed Plant Schedule (Figure – 6.7). The report recommendations have been prioritised and provided in Table - 5.10, 5.11 and 5.12.

#### Selected Species No. 6 - *Poeciloneuron pauciflorum* (Bedd.)



Plate – 5.1.4.3.6. Selected Species No. 6 - *Poeciloneuron pauciflorum* Bedd.

a. General shape of Tree (*Boothbankali* - reversed branches look like ghost fingers); b. Scarce fruits at different tree branches; c. Mature tree trunk with regenerations of species; d. Subspherical coriaceous brown colour seeds; e. Seed pericarp, f. Twig with fruits; g. Twig with flower.

**TAXON DATA SHEET No. 7*****Elaeocarpus venustus* Bedd.****7.1 DESCRIPTION**

**7.1.1 Synonyms :** *Elaeocarpus monocera* sensu Mast.

**7.1.2 Family :** ELAEOCARPACEAE.

**7.1.3 Local name**

**Tamil :** *Tamarai*.

**English :** *Gland-axilled Elliptic leaved Olive Linden* (Lushington - 1915)<sup>41</sup>.

**7.1.4 Growth habit :** A moderate, evergreen glabrous tree up to 10-15 m tall with large snow white flowers grows in evergreen forests.

**7.2 HABITAT**

**7.2.1 Distribution**

India : Endemic to a narrow zone of distribution in Evergreen forests of Travancore, Kerala and Kanyakumari District, Tamilnadu of Southern Western Ghats between 800-1500 m.

**7.2.1.1 Geographical range in KMTR :** Chemunji, Kakachi, Muthukuzhivayal, Uthu to Upper Kodayar Left bank saddle no 1, Uthu Estate, Yanai elumbu odai, Neterikal, Ullar, and Ooth - Kodayar.

**7.2.2 Ecological situations :** Southern Tropical Wet Evergreen Forest (1A/C4) & Tirunelveli Semi - Evergreen Forests (2A/C3) and Moist Deciduous forests.

**7.2.3 Summary of Abiotic factors for - *Elaeocarpus venustus* Bedd.**

Geology	Garnet-Biotite gneiss and Quartz-feldspathic rock
Elevation & landform	800-1500 m; Middle & Upper Plateau
Slope	Moderate (9° to 14°) to Steep (15°-24°)
Rainfall	200-500 cm
Temperature	15°- 24° C
Dry Season Length	2 months
Drainage density	Medium to High
Geomorphology	Part of Upper & Middle Plateau, Structural Hill,
Soil Type	Puncholai series under Typic Haplustepts, with very shallow soil depth
Soil pH	Mildly acidic to near neutral (pH varies from 5.6 to 7.5)

41 ibid

## 7.3 OTHER INFORMATION

7.3.1 Trade : Not Known

7.3.2 Utilization and potential value : Medicinal value - Kanis use the seeds and the kernel for medicinal purpose. Further utility of the species is not studied in detail. This tree with its profuse beautiful snow white flowers can be cultivated for its horticultural potential.

## 7.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

The species is categorised as **Vulnerable** by the Botanical Survey of India, Calcutta (1988)<sup>42</sup>. The present conservation assessment management plan of the species is as follows : Extent of occurrence (km<sup>2</sup>) : < 100; Area of occupancy (km<sup>2</sup>) : < 10; Number of sub populations / locations : < 25 locations; Habitat status : Decrease in area due to construction of Upper Kodayar Dam < 20%; Threats status : Damming, Habitat Loss, Habitat Fragmentation; Numbers / Generations studied : > 3 generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : **Endangered** (EN)-A1c, B1a, bi, ii, iii, E.

## 7.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

7.5.1 CITES : Not included in CITES list.

7.5.2 WPA (1972, 2006) : Not included in Schedule.

7.5.3 National legislation : No National or State legislation is formed.

## 7.6 RECOVERY AND MANAGEMENT OPTION

### 7.6.1 Management Issues

The main threats to *Elaeocarpus venustus* Bedd. are habitat disturbance mainly because of Upper Kodayar Dam and the Upper Kodayar Reservoir, tea plantations in Kakachi, Uthu Estates, tea Estate labour colony, PWD, EB staff quarters, tourist pressure in reservoir and its neighbouring places and clearing.

### 7.6.2 Methods of Plant propagation practices

There is no recorded information on natural regeneration of the species, however many natural regenerants were noticed below the tree shade near the streams. Artificial reproduction methods were attempted both from seed origin and by stem cuttings

42 Nayar, M.P. and A.R.K. Sastry. (Eds.) 1988. *Red Data Book of Indian Plants. Vol.2*. Botanical Survey of India, Calcutta.

### 7.6.2.1 Seed collection and propagation (Plate - 5.1.4.3.7)

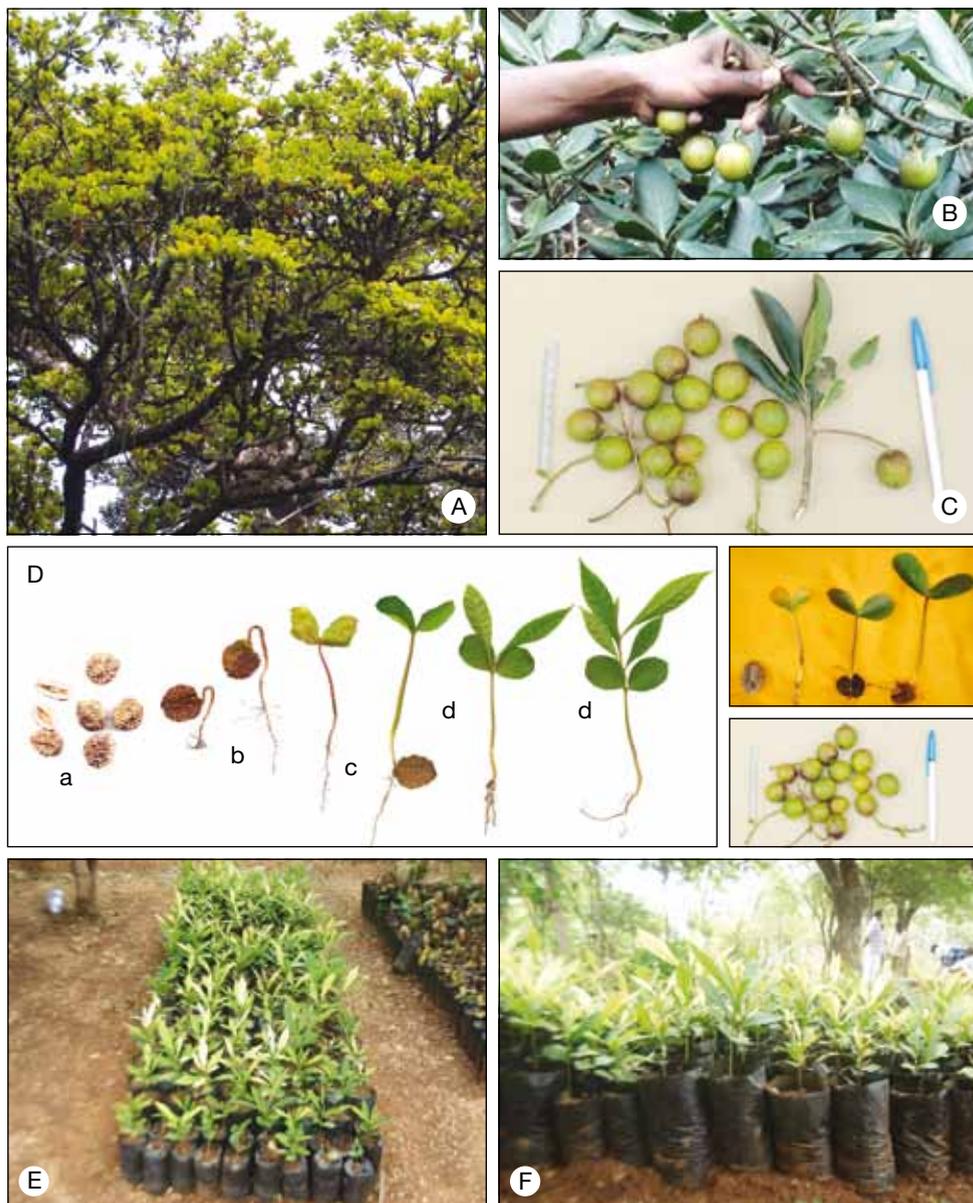
The flowering and seed maturation periods of the species have been provided above. Fruits were collected from Muthukuzhivayal, and also from Yanai Elumbu Odai, in the month of October 2009. About 100-150 ripened drupes make a kilogram. In each drupe a solitary seed was available. Seeds were extracted from the drupes by removing the pulp and dried under shade for 3-4 days before putting in mother bed specially prepared by forest soil mixed with fine sand. 240-300 seeds make a kilogram. The seed was viable for 6 to 8 months. Before putting in mother bed seeds were soaked in cow dung water for 24 hours. The germinative capacity was 90% and the plant per cent 85. The seeds take 36 to 60 days for germination. Germination is quicker and more in the open than under shade. A kilogram of seeds will yield 200 to 255 usable seedlings.

205 seedlings of the species were raised during 2009-2010 in Tamil Nadu Forest Training College, Vaigai Dam by the author and handed over to the Deputy Director, Ambasamudram for planting them back to their place of origin. Temporary nurseries in places of endemism are preferable to permanent ones outside. There are several proven methods for vegetative propagation including division, cuttings and tissue culture but it was not attempted for this species.

## 7.7 RECOMMENDATIONS FOR *Elaeocarpus venustus*

The plant is included in the proposed **Plant Schedule (Figure – 6.7)**. The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

**Selected Species No. 7 - *Elaeocarpus venustus* Bedd.**



**Plate – 5.1.4.3.7. Selected Species No. 7 - *Elaeocarpus venustus***

A. Branches of a full grown Tree; B. Twig with fruits; C. Fruits D. Seeds, Germination stages and Seedlings. a - seeds, b - germination, c - d seedlings; E & F Seedlings in nursery

**TAXON DATA SHEET No. 8*****Bentinckia condapanna* Berry****8.1 DESCRIPTION**

**8.1.1 Family :** ARECACEAE (PALMACEAE).

**8.1.2 Local names / English / common / trade names**

**Malayalam :** *Coddappanna, Kanthal, Kanthakamugu, Varu Kamavu;*  
**Tamil :** *Varei - Kamugu;* **Telegu :** *Codda- Panna;* **English :** *Lord Bentinck's palm; The Hill Arecanut; Rock Areca.*

**8.1.3 Growth habit :** It is an erect palm with 10-12 m height and 15-20 cm diameter, with 1.0-1.5 m long leaves, scarlet male flowers, lilac or violet female flowers.

**8.2 HABITAT**

**8.2.1 Natural distribution zone**

India : The species is Endemic to the hills of South Travancore and Tirunelveli Hills, i.e. to tail end of the Southern Western Ghats, Agasthiyamalai area, Tirunelveli District, Srivilliputhur and Palani Hills, Tamil Nadu and Thiruvanthapuram, Idukki and Periyar areas of Kerala of the Peninsular India (760-1830 m). It has very restricted distribution in steep precipitous slope. Endemic.

**8.2.1.1 Geographical range in KMTR**

Nine natural distribution zones of *Bentinckia condapanna* Berry could be delineated using the satellite image of KMTR and detailed floristic study by sample quadrats.

1) Nambi Koil Zone (Nambiyar upper reaches), 2) Naraikadu - Neterikal Zone (Naraikadu Ar, Manimuthu Ar upper reaches), 3) Muthukuzhi vayal Zone, 4) Upper Kodayar Zone, 5) Valachi Todu upper reaches, 6) Mallamani upper reaches, 7) Pei Ar upper reaches, 8) Sinikala patnas (Valayar upper reaches), 9) Sivasailam and surroundings (Karunaier upper reaches). These 9 zones occupy 1087.35 ha covering 4 Reserved Forests (RFs) and one Reserved Land (RL) namely Virapuli RF (362.62 ha), Papanasam RF (315.56 ha), Kalakad RF (303.09 ha), Kalamalai RF (16.44 ha) and Singampatty RL (89.63ha). The species could also be located in adjacent Peppara Wildlife Sanctuary in Kerala and on Sulakoil mettu in Kadayanallur range of Tirunelveli Forest Division.

### 8.2.2. Ecological Situations

The species occurs in a very restricted zone of Southern tropical wet evergreen forest (IA/C4) and Tirunelveli semi-evergreen forest (2A/C3).

### 8.2.3. Summary of Abiotic factors for - *Bentinckia condapanna*

Geology	Garnet-Biotite gneiss and Quartz-feldspathic rock (Champion gneiss)
Elevation & landform	760-1800 m; Part of Upper Plateau & Steep Hilly terrai
Slope	Precipitous slope (45° to 90°)
Rainfall	200-500 cm
Temperature	15°- 24° C
Dry Season Length	2 months
Drainage density	High
Geomorphology	Mountain Cliff ,Part of Upper Plateau, Structural Hill
Soil Type	Puncholai series under Typic Haplustepts, with very shallow soil depth
Soil p <sup>H</sup>	Mildly acidic to neutral to mildly alkaline (pH varies from 5.6 to 8.0)

## 8.3 OTHER INFORMATION

**8.3.1 Trade :** Not known.

### 8.3.2 Utilization and potential value

It has medicinal value. The wood is not used, the terminal buds and juvenile leaves are edible, and may be eaten either raw or cooked. Local Kani people used to eat the same. It has a nutty flavour. It is a palm of great botanical interest. Its slender stem and feather like leaves are very graceful can be suitably cultivated as Ornamental Palm in Botanic Gardens and Parks.

## 8.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

The Botanical Survey of India, Calcutta (1988) has enlisted this plant as **RARE** category in their Red Data Book on Indian Plants in Vol-II. However, the recent field survey finds as follows : Extent of occurrence (km<sup>2</sup>) : < 150; Area of occupancy (km<sup>2</sup>) : < 15; Number of sub populations/locations : < 5 locations; Habitat status : Not stable in area as its habitats is being encroached gradually by *Ocblandra travancorica* and *Ocblandra scriptoria*. The natural regeneration is affected by the *Ocblandra* invasion. Threats status: It appears that because of gradual rise in temperature along with scarcity of rainfall in the habitat, the period of dry months has extended from 2 to 4 months; Numbers / Generations studied : > 3 generations / 10 years; Data quality :

Literature, herbarium and field study; IUCN Status : **Endangered** (EN)-A1c, B2a, bi, ii, iii, Cl, E.

## 8.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

8.5.1 CITES : Not included in CITES list.

8.5.2 WPA (1972, 2006) : Not included in Schedule.

8.5.3 National legislation : No national or state legislation is formed.

## 8.6 RECOVERY AND MANAGEMENT OPTIONS FOR *Bentinckia condapanna*

### 8.6.1 Management Issues

The main threats to *Bentinckia condapanna* are habitat disturbance. *Bentinckia condapanna* is also seen as pure patches in subtropical regions, especially in steep rocky slopes, besides occurring in subtropical hill forest. A total of 2000 ha area is occupied by these patches in this sanctuary. It is observed that the *Bentinckia condapanna* brake in this sanctuary is being replaced by *Ochlandra* reed brake. The establishment of reeds has been suppressing the regeneration of *Bentinckia condapanna* species. These threats are relevant to the threatened species occurring across the site.

### 8.6.2 CONSERVATION EFFORTS

#### a. Measures taken :

The species is already enlisted as a threatened palm (Jain & Sastry, Basu). No significant efforts have been made so far except a few plants were planted in the Indian Botanic Garden, Howrah, West Bengal and Experimental Garden, Botanical survey of India, Yercaud, Salem District; Tamilnadu.

#### b. Measures proposed :

Protection of its habitat to ensure natural regeneration should be done. *Ex-situ* conservation is recommended. The plant **flowers** in April - May and **fruits** in Nov - Dec. Efforts needs to be taken to raise its seedlings in its natural habitat. Artificial reproduction must be made for restocking the area in addition to cultivate it as Ornametal Palm in Botanic Gardens & Parks etc. as *ex-situ* measures.

### 8.6.3 Habitat protection

The locations of *Bentinckia condapanna* across the site have previously been recorded. *Bentinckia condapanna*, *Ochlandra travancorica* and *Ochlandra scriptoria* occur side by side along with other species associated as mentioned earlier. With the change in climatic condition over the period (> 3 generations/10 years) *Ochlandra* species which comparatively thrive better in drier condition than *Bentinckia condapanna* are colonizing vigorously in the habitat by suppressing

the younger regeneration of the species. To protect the natural regeneration of this beautiful palm species from the invasion of *Ocblandra* species boundary clearing in the habitat will be of immense use.

#### **8.6.4. Plant propagation practices**

There is no recorded information on natural regeneration of the species, but during field study it was noticed that natural regenerations was available below the tree shade near the streams, where the soil is sandy and devoid of reeds. Artificial reproduction methods were attempted from seed origin.

#### **8.6.5. Seed collection and propagation**

The flowering and seed maturation periods of the species have been provided above. Regular inspections of populations across the site are needed to determine the appropriate time for seed collection. Dark scarlet shining ovoid fruits with fleshy pericarp were collected from Naraikadu (sample quadrat no K8 and K11) the month of November, 2006. 916 mature nuts made a kilogram. Again mature fruits were collected by end of May from Vellachipadu (below Agaasthiyamalai) when 940 mature nuts made a kilogram. In each nut solitary seed was available; they were covered with fleshy and fibrous pericarp. 2600 seeds made a kilogram. Before putting in mother bed nuts (with fleshy and fibrous pericarp) were soaked in water for 2 hours. The germinative capacity could be noticed as high as 77%. Nuts were germinated after a wide gap of more than 6 months and the plant per cent recorded as 70. The nuts take 170-190 days for germination. Growth rate of seedlings also found to be slow at the initial stages. **(Plate - 5.1.4.3.8A & 5.1.4.3.8B)**

### **8.7. RECOMMENDATIONS FOR *Bentinckia Condapanna***

The plant is included in the proposed **Plant Schedule (Figure – 6.7)**. The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

Selected Species No. 8 - *Bentinckia condapanna* Berry



Plate – 5.1.4.3.8A. Selected Species No. 8 - *Bentinckia condapanna*

a. A Mature Palm Tree; b. Flowers and nuts c. Nuts in bunch (yet to ripe) d. Nuts in bunch (ripe)



Plate – 5.1.4.3.8B. Selected Species No. 8 - *Bentinckia condapanna* Berry

Nursery at TN Forestry College, Vaigai Dam; a. Seedlings in mother bed; b. Stages of Seedlings; c. Seedlings in poly bags

**TAXON DATA SHEET No. 9*****Hydnocarpus macrocarpa* (Bedd.) Warb.****9.1 DESCRIPTION**

**9.1.1 Synonyms :** *Asteriastigma macrocarpa* Bedd; *Taraktozenos macrocarpa* Bedd.

**9.1.2 Family :** FLACOURTIACEAE (Bixaceae).

**9.1.3 Local name**

**Tamil :** *Malai maravattai, Malai neervetti, Kurangu thalai maram, Vellai nangu.*

**Malayalam :** *Mala kummatti.*

**English :** *Cannon-ball Tree of Southern Hills.*

**9.1.4 Growth habit :** A moderate, evergreen tree up to 10-20 m tall. Flowering Period : January - April; Fruiting Period : March - June.

**9.2 HABITAT****9.2.1 Distribution**

India : Endemic to Southern Western Ghats between 900-1500 m in a narrow Zone of distribution in Evergreen forests of Travancore, Kerala and Kanyakumari and Tirunelvely Districts, Tamilnadu.

**9.2.1.1 Geographical range in KMTR :** Kakachi, Muthukuzhivayal, Uthu to Upper Kodayar, Yanai Elumbu Odai, Sengeltheri to Neterikal, Ullar.

**9.2.2 Ecological Situation**

The species occurs in Southern tropical wet evergreen forest (IA/C4) and Tirunelveli Semi-evergreen forest (2A/C3) especially along stream banks and in moist valleys.

**9.2.3 Summary of Abiotic factors for - *Hydnocarpus macrocarpa***

Geology	Garnet-Biotite gneiss and Quartz-feldspathic rock
Elevation & landform	900-1500 m; Part of Upper Plateau & Hilly terrain
Slope	Moderate (9° to 14°) to Steep (15°-24°)
Rainfall	200-500 cm
Temperature	15°- 24° C
Dry Season Length	2 months
Drainage density	High
Geomorphology	Part of Upper Plateau, Structural Hill, Debris slope
Soil Type	Mainly in Kadamparai series under Humic Dystrustepts and Puncholai series under Typic Haplustepts
Soil pH	Mildly acidic to near neutral (pH varies from 5.6 to 7.5)

### 9.3 OTHER INFORMATION

9.3.1 **Trade** : Local, regional and National Seeds and mixed with that of *Hydnocarpus pentandra*

#### 9.3.2 Utilization and potential value : Chemical Constituents

Chaulmoogric, hydnocarpic, gorlic, lower homologues of hydnocarpic, palmitic and oleic. The seed oil is used in the treatment of leprosy and to cure skin diseases; (locally known as *Chal mugra* oil). The fruits and seeds are used as a substitute for *Hydnocarpus pentandra*.

### 9.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

The species is categorised as **Endangered** by the Botanical Survey of India, Calcutta (1990). The present conservation assessment management plan of the species is as follows :

Extent of occurrence (km<sup>2</sup>) : < 400; Area of occupancy (km<sup>2</sup>) : < 100; Number of sub populations/locations : < 50 locations; Habitat status : Decrease in area due to construction of Upper Kodayar Dam < 20%; Threats status : Damming, Habitat Loss, Habitat Fragmentation; Numbers / Generations studied : > 3 generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : **Endangered** (EN)- A1c,- Globally

### 9.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

9.5.1 **CITES** : Not included in CITES list.

9.5.2 **WPA (1972, 2006)** : Not included in Schedule.

9.5.3 **National legislation** : No National or State legislation is formed.

### 9.6 RECOVERY AND MANAGEMENT OPTIONS FOR *Hydnocarpus macrocarpa*

#### 9.6.1 Management Issues

The main threats to *Hydnocarpus macrocarpa* are habitat disturbance mainly because of Upper Kodayar Dam and the Upper Kodayar Reservoir, tea plantations in Kakachi, Uthu estates, tea estate labour colony, PWD, EB staff quarters, tourist pressure in Reservoir and its neighbouring places and clearing. Due to the fragmented nature of the population, their small size and anthropogenic activities the species is susceptible to catastrophic events of further erosion unless time bound special care is taken for this plant.

## 9.6.2 Methods of Plant propagation practices

There is no recorded information on natural regeneration of the species, but during field study it was noticed that natural regeneration was available below the tree shade near the streams. Artificial reproduction methods were attempted from seed origin.

### 9.6.2.1 Seed collection and propagation

The flowering and seed maturation periods of the species have been provided above. Fruits were collected from Muthukuzhivayal and also from Yanai Elumbu Odai in the month of October 2009. About 6-10 ripened drupes make a kilogram. In each drupe about 40-50; egg-shaped dark brown seeds are available. Seeds were extracted from the drupes by removing the pulp and dried under shade for 3-4 days before putting in mother bed specially prepared by forest soils mixed with fine sands 240-300 seeds make a kilogram. The seeds are viable for 3-4 months. Before putting in mother bed seeds were soaked in cow dung water for 24 hours. The germinative capacity is 65% and the plant per cent 70. The seeds take 38 to 60 days for germination. Germination is quicker and more in the open than under shade. A kilogram of seeds will yield 150 to 200 usable seedlings. Temporary nurseries near the places of endemism are preferable than permanent ones.

## 9.7 RECOMMENDATIONS FOR *Hydnocarpus macrocarpa*

The plant is included in the proposed **Plant Schedule (Figure – 6.7)**. The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

**Selected Species No. 9 - *Hydnocarpus macrocarpa* (Bedd.) Warb.**



**Plate – 5.1.4.3.9. Selected Species No. 9 - *Hydnocarpus macrocarpa***

a. Twig with a fruit; b. Seeds; c. Unprocessed seeds; d. Twig with fruits; e. Artificially raised seedling; f. Seedlings in Natural regeneration

**TAXON DATA SHEET No. 10*****Anoectochilus elatus* Lindl. (Jewel orchid)****10.1 DESCRIPTION**

**10.1.1 Synonyms :** *Anoectochilus elatus* Lindl., A “*elator*”; (Plate - 5.1.4.3.10.)

**10.1.2 Family :** ORCHIDACEAE.

**10.1.3 Local name :** Not known

**10.1.4 Growth habit :** *Anoectochilus elatus* a slow growing perennial small terrestrial herb grows in semi evergreen to evergreen forests in the Singampatti hills of Southern Western Ghats. Flowering Period : Only once a year in the winter between November - January; Fruiting Period : December - February.

**10.2 HABITAT****10.2.1 Distribution**

India : Southern Western Ghats, 900-1600 m, Kanyakumari, Tirunelveli, Nilgiri in Tamil Nadu. Endemic.

**10.2.1.1 Geographical range in KMTR**

Kannikatty, Muthukuzhivayal, Upper Kodayar-in dense forest floor, Sengaltheri to Neterikal

**10.2.3 Ecological Situations**

Southern tropical wet evergreen forest (IA/C4) and Tirunelveli Semi-evergreen forest (2A/C3).

**10.2.3 Summary of Abiotic factors for *Anoectochilus elatus***

Geology	Mainly located in Quartz-feldspathic rock (Champion Gneiss). It also occurs in Garnet-Biotite gneiss
Elevation & landform	900-1600; Part of Upper & Middle Plateau
Slope	Moderate (9° to 14°) to Steep (15°-24°)
Rainfall	300-500 cm
Temperature	16°- 24° C
Dry Season Length	2 months
Drainage density	Medium - High
Geomorphology	Part of Upper & Middle Plateau, Structural hill, Plain, Debris slope
Soil Type	Kadamparai series under Humic Dystrustepts; Puncholai and Erganhali series under Typic Haplustepts and Pallam kadu series of Udic Argiustolls
Soil pH	Mildly acidic to neutral to mildly alkaline (pH varies from 5.6 to 8.0)

### 10.3 OTHER INFORMATION

#### 10.3.1 Trade

The species has International market. In Malaysia, Indonesia and Singapore this species and the species of its sister genus are being sold at very high rate.

#### 10.3.2 Utilization and potential value

There is very high potential demand for this species both for medicinal value and also for its ornamental value.

### 10.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

Extent of occurrence (km<sup>2</sup>) : < 500; Area of occupancy (km<sup>2</sup>) : < 50; Number of sub populations / locations : < 15 locations; Habitat status : Decrease in area due to construction of Upper Kodayar Dam < 20%; Threat status : construction of dam, habitat loss, habitat fragmentation; Numbers / Generations studied : > 3 generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : Vulnerable (VU)-A1c, B1a, bi, ii, iii; E.

*Anoectochilus formosanus* is an important ethno medicinal plant of Taiwan. The current market price of the fresh and dry herb collected from its natural habitat is around US\$320 and \$3,200 per kilogram respectively (Lin and Namba, 1981a; 1981b)<sup>43</sup>. Often before they have a chance to bloom, has reduced the species towards rarity. Due to high cost of *Anoectochilus formosanus* and increasing demand, *Anoectochilus elatus* Lindl. may also face similar problem being the sister species of same genus and has the bright chance to possess similar medicinal properties.

### 10.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

10.5.1 CITES : Not included in CITES list.

10.5.2 WPA (1972, 2006) : Not included in Schedule.

10.5.3 National legislation : No National or State legislation is formed

### 10.6. RECOVERY AND MANAGEMENT OPTIONS

#### 10.6.1 Management Issues

The main threats to *Anoectochilus elatus* are habitat disturbance mainly because of indiscriminate clear felling of evergreen forest and converting the area in to tea plantations in addition to formation of many Dams and Reservoirs like Karayar Dam -Hope Lake formation, Servalar Dam, Upper Kodayar Dam and Reservoirs. Besides, forest enclosure like Katalamalai estate, tribal hamlet at Inchikuzhi, tourist pressure in Hope Lake and its neighbouring places has disturbed the habitat.

43 Lin, C.C. and T. Namba. 1981a. *Pharmacognostical studies on the crude drugs of Orchidaceae from Taiwan* (VI) on “Kimsòanlián” (1). *Shoyakugaku Zasshi* 35 : 262-271.

### 10.6.2 Plant propagation practices

There is no recorded information on natural regeneration of the species, but during field study it was noticed that natural regenerations was available below the tree shade where the soil has sufficient humus and moisture content. Artificial reproduction methods were yet to be attempted both from seed origin and by stem cuttings. Seeds may be collected by very careful observation in the floor of the evergreen forests. Seedlings mature and reproduce through seeds after 2-3 years of their growth.

#### 10.6.2.1 Propagation

Yih-Juh Shiau, *et al.*, (2001)<sup>44</sup> *Department of Agronomy, Taiwan Agricultural Research Institute, Taiwan* has optimized a method for mass propagation of *Anoetochilus formosanus* by artificial cross-pollination and asymbiotic germination of seeds. Similar method can be followed for mass propagation of *Anoetochilus elatus* also.

### 10.7. RECOMMENDATIONS FOR *Anoetochilus elatus*

The plant is included in the proposed Plant Schedule (**Figure – 6.7**). The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

#### Selected Species No. 10 - *Anoetochilus elatus* Lindl.



**Plate – 5.1.4.3.10. Selected Species No. 10 - *Anoetochilus elatus***

Species at different location in KMTR

44 Yih-Juh Shiau, Abhay P. Sagare, Uei-Chin Chen, Shu-Ru Yang, and Hsin-Sheng Tsay. 2001. *Conservation of Anoetochilus formosanus Hayata by artificial cross-pollination and in vitro culture of seeds*, Department of Agronomy, Taiwan Agricultural Research Institute, Wufeng, Taichung 41301, Taiwan

**TAXON DATA SHEET No. 11*****Baccaurea courtallensis* Muell. - Arg.****11.1 DESCRIPTION**

**11.1.1 Synonyms :** *Baccaurea courtallensis* Muell. - Arg. *Baccaurea courtallensis* (Wight) Muell. - Arg.

*Pierardia courtallensis* Wight.

**11.1.2 Family :** EUPHORBIACEAE.

**11.1.3 Local names**

**Tamil :** *Puvai*

**Malayalam :** *Muttakaipu, Muttaturi, Nannil, Tipu*

**Canarese :** *Kolikukke*

**English / common / trade name :** *Crimson draped Kin Ramboutan (Lushington-1915)*

**11.1.4 Growth habit :** Trees, up to 10 m high; branches horizontal to ground.  
Flowering Period : February - April; Fruiting Period : April - June

**11.2 HABITAT**

**11.2.1 Distribution :** **India :** South Western Ghats; South of Kanara, Anamalais, Travancore; Nilgiri and Tirunelveli Districts in Tamil Nadu. Endemic.

**11.2.1.1 Geographical range in KMTR :** Tulukkamottai, Kannikatty, Valayaar, Inchikuzhi.

**11.2.2 Ecological situations**

It occurs in Southern tropical wet evergreen forest and also in Moist mixed deciduous

**11.2.3 Summary of Abiotic factors for - *Baccaurea courtallensis***

Geology	Garnet-Biotite gneiss and Quartz-feldspathic rock (Champion gneiss)
Elevation & landform	300-900 m; Part of Lower, Middle plateau & Hilly terrain
Slope	Gentle (below 8°) to Moderate (9° to 14°)
Rainfall	150-200 cm
Temperature	16°- 30° C
Dry Season Length	4 months
Drainage density	Medium to High
Geomorphology	Part of Lower & Middle plateau, Structural Hill, Plain, Debris slope
Soil Type	Puncholai series under Typic Haplustepts and Perumal malai series of Rhodic Paleustalfs
Soil pH	Mildly Acidic (pH 5.6 - 6.5)

### 11.3 OTHER INFORMATION

**11.3.1 Trade :** Not Known

**11.3.2 Utilisation and potential value**

Fruits are edible-sour taste; the local people-the kanis use the fruits as alternative of tamarind and also used as pickle.

**Uses :** Medicinal value

### 11.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

**Extent of occurrence (km<sup>2</sup>) :** < 1000; Area of occupancy (km<sup>2</sup>) : > 100; Number of sub populations / locations : < 20 locations; Habitat status : Decrease in area due to human habitations, farming, private estates, formation of dams and reservoirs and other non forestry activities; Threat status : Harvest for food (fruits used to prepare pickle; habitat loss, habitat fragmentation; Numbers / Generations studied : > 3 generations / 10 years; Data quality : Literature, herbarium and field study; IUCN Status : **Vulnerable** (VU)-A1c, B1a, bi, ii, iii, C1, E.

### 11.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION

**11.5.1 CITES :** Not included in CITES list.

**11.5.2 WPA (1972, 2006) :** Not included in Schedule.

**11.5.3 National legislation :** No National or State legislation is formed.

### 11.6 RECOVERY AND MANAGEMENT OPTIONS

**11.6.1 Management Issues**

The main threats to *Baccaurea courtallensis* are habitat disturbance mainly because of Karayar Dam - Hope lake formation and Servalar Dam, forest enclosure like Katala malai estate, tribal hamlet at Inchikuzhi, tourist pressure in Hope Lake and its neighbouring places clearing.

**11.6.2 Conservation Efforts**

A few decades back, the species was a common tree in Southern Western Ghats. The greatest source of danger to this species is the destruction of its habitats mainly because of Karayar Dam - Hope lake formation and Servalar Dam, forest enclosure like Katala malai estate, tribal hamlet at Inchikuzhi, tourist pressure in Hope Lake and its neighbouring places.

#### 11.6.3.METHODS OF PROPAGATION

**a. Natural Regeneration :**

Information of the natural reproduction of the species is somewhat meagre. Natural regeneration found to be meagre, probably because of advance

collection of fruits (edible) by the local people of Kani Tribes of Inchikuzhi and other places.

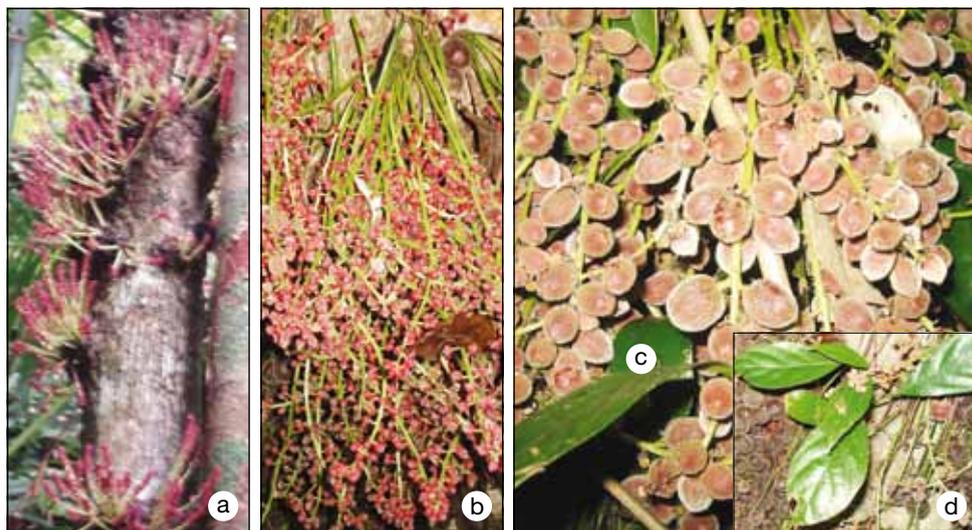
### b. Artificial Reproduction :

Fruits were collected from Inchikuzhi and also from Courtallam in the month of May, 2001. About 100-150 ripened fruits make a kilogram. In each fruit 3 - 4 seeds were available; they were covered with fleshy aril (**Plate - 5.1.4.3.11A and 5.1.4.3.11B**). Seeds were extracted from the berries by removing the pulp and dried under shade for 2-3 days before putting in mother bed specially prepared by forest soils mixed with fine sand. About 3400- 4200 seeds make a kilogram. The seeds are not viable for long. Ripen fruits are to be used to extract seeds within 2 weeks, failing which seeds get rotten and germination may not be possible. Before putting in mother bed, seeds were soaked in water for 2 hours. The germinative capacity is 75% and the plant per cent 70. The seeds take 14 to 30 days for germination. Germination is quicker and more in the open than under shade. A kilogram of seeds will yield 2380 to 2940 usable seedlings. Temporary nurseries are preferable near the zones of endemism to permanent ones.

### 11.7. RECOMMENDATIONS FOR *Baccaurea courtallensis*

The plant is included in the proposed Plant Schedule (**Figure – 6.7**). The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12**.

#### Selected Species No. 11 - *Baccaurea courtallensis* Muell. - Arg.



**Plate – 5.1.4.3.11A. Selected Species No. 11 - *Baccaurea courtallensis***

a. Tree trunk with flowering; b. c. Budding fruits on tree trunk; d. Twig

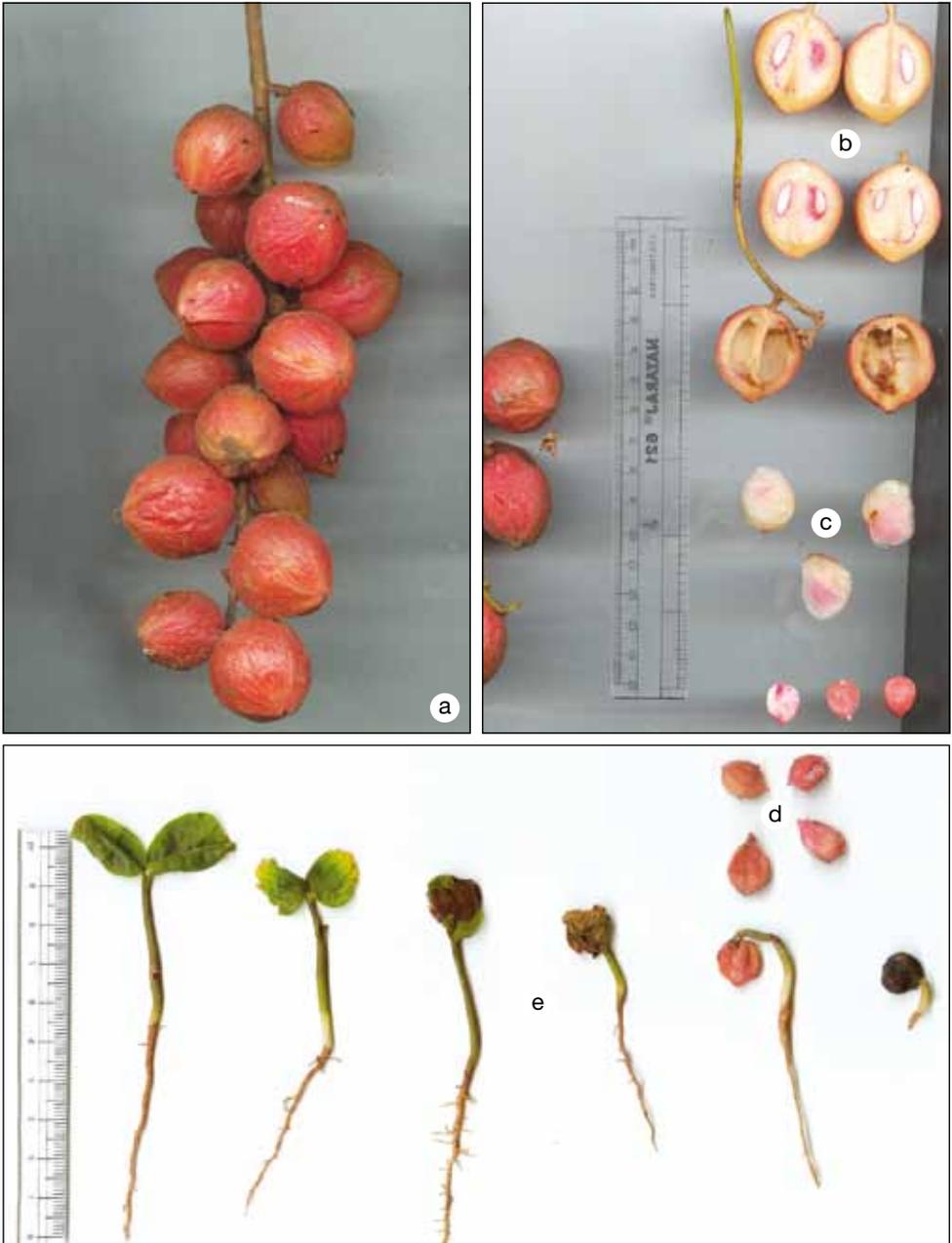


Plate – 5.1.4.3.11B. Selected Species No. 11 - *Baccaurea courtallensis* Muell. - Arg.

a. Beautiful juicy fruits; b. Vertical section of fruits; c. Extracted seeds with pulp; d. Seeds; e. Stages of germination and seedlings.

**TAXON DATA SHEET No. 12*****Kingiodendron pinnatum* (Roxb. ex Dc.) Harms****12.1 DESCRIPTION**

**12.1.1 Synonyms :** *Hardwickia pinnata* **Roxb.ex DC.**

**12.1.2 FAMILY :** CAESALPINIACEAE.

**12.1.3 Local names / English / Common / Trade name**

**Malayalam :** *Chukkannpayini, Kiyavu, Kodapalai, Shurali*; **Tamil :** *Kolavu, Kodapalai, Madayen samprani*; **English:** *Piney; Malabar mahogany* (Lushington - 1915).

**12.1.4 Growth habit**

It is a large, handsome, evergreen tree, attaining a height of 40 m and a girth of 4.3 m. (**Plate - 5.1.4.3.12**). Flowering Period : January - March and again in July - August. Fruiting Period : May - July and again in October.

**12.2 HABITAT**

**12.2.1 Distribution**

India, Southern Western Ghats, Tamil Nadu and Kerala. Southern part of Karnataka in Central Western Ghats Endemic. The tree is confined to the Semi evergreen to Evergreen forests of the Western Ghats from South Canara Southwards via Malabar and Travancore to Tirunelveli in slopes of hills between 200-800 m altitudes. The species is scattered in a few localities up to Central Western Ghats but its main distribution is limited to the evergreen forests on the slopes of Southern Western Ghats.

**12.2.1.1 Geographical ranges in KMTR**

Kodamadi, Banathirtham, Karayar, Sengaltheri, Naraikadu, Kalakad, Tirukankudi in low altitude (300-800 m) near river banks where water availability is more. Further, in Kadayam and Courtallam range of Courtallam hills the authors have identified totally 213 full grown trees along streamlets of 3 specific areas namely i) Kadayam range of KMTR and near Old Courtallam falls ii) In Kudiruppu Beat iii) Between Shenbhagadevi Fall and Then Aruvi Falls.

**12.2.2 Ecological situations :**

*Kingiodendron pinnatum* grows in the Southern tropical wet evergreen and semi - evergreen forests and is found in West Coast Tropical Evergreen Forests (IA/C4), in the Tirunelveli Semi-Evergreen Forests (2A/3C), West Coast Secondary Evergreen Dipterocarpus Forests (2A/2SI).

### 12.2.3 Summary of Abiotic factors for *Kingiodendron pinnatum*

Geology	Mainly in Garnet-Biotite gneiss and also in Quartz-feldspathic rock
Elevation & landform	200-800 m; Part of Lower & Middle Plateau
Slope	Gentle (below 8°) to Moderate (9° to 14°)
Rainfall	200-400 cm
Temperature	15°- 35° C
Dry Season Length	3 months, Frost is unknown to its habitat
Drainage density	Medium to high
Geomorphology	Part of Lower & Middle plateau, Structural Hill, Plain, Debris slope
Soil Type	Mainly in Attakatti and Kadamparai series under Humic Dystrustepts and Puncholai series under Typic Haplustepts
Soil pH	Acidic (pH 5.5-6.5)

## 12.3 OTHER INFORMATION

**12.3.1 Trade :** Parts Used : Resin.

### Chemical Constituents :

Solubility in 95% alcohol, 1 in 5 vol., or more. The main constituent of the oil is  $\beta$  - caryophyllene;  $\alpha$  - caryophyllene and a cadinene sesquiterpene are also present. The oil may be used as a substitute for imported clove oil. There are incidences when people illegally collected the bark and oil from the tree trunk. It appears secret trade continues in adjacent areas of its place of endemism.

**12.3.2 Utilization and potential value :** Medicinal value. The oleoresin is reportedly used for treating gonorrhoea, rheumatism and as a dressing of sores of elephants.

## 12.4 CONSERVATION ASSESSMENT MANAGEMENT PLAN (CAMP)

The Botanical Survey of India, Calcutta has categorised this tree species as **“RARE”** plant in their “Red Data Book on Indian Plants” in Vol-III (142); 1990. The species is scattered in a few localities up to Central Western Ghats but its main distribution is limited to the evergreen forests on the slopes of Southern Western Ghats. The present conservation assessment management plan of the species is as follows : Extent of occurrence (km<sup>2</sup>) : < 1000; Area of occupancy (km<sup>2</sup>) : < 200; Number of sub populations/ location : < 50 locations; Habitat status : Decrease in area, >20%; Threats status : Damming, tea cultivation, Diversion of area for non forestry purpose; habitat loss, habitat fragmentation; Numbers/ Generations studied : >3 generations/10 years; Data quality : Literature, herbarium and field study; IUCN Status : **Vulnerable** (VU)-A2c, B1a, bi, ii, iii, E.

## **12.5 ACTS, LEGISLATION, POLICIES TO SUPPORT PLANT PROTECTION**

**12.5.1 CITES :** Not included in CITES list.

**12.5.2 WPA (1972, 2006) :** Not included in Schedule.

**12.5.3 National legislation :** No National or State legislation is formed.

## **12.6 RECOVERY AND MANAGEMENT OPTION**

### **12.6.1 Management Issues**

The main threats to *Kingiodendron pinnatum* are habitat disturbance mainly because of indiscriminate clearing of the evergreen forests for cultivation of plantation crops like tea, coffee, rubber etc and diversion of forest land for non forestry purposes which have drastically reduced and disturbed the area of its natural habitat. This seems to be the main causal factor for bringing the species to its present position. Due to the fragmented nature of the populations, their small size and various anthropogenic activities the species is susceptible to catastrophic events and localised threats to the species.

### **12.6.2 Conservation Efforts**

A few decades back, the species was a common tree in Southern Western Ghats. The greatest source of danger to this species is the destruction of its habitat for cultivation of plantation crops.

#### **a. Measures taken :**

No substantive action has been taken so far. However, the species is called ‘Malabar Mahagony’ as it was once collected from Malabar region (Wynaad) which is a part of the Nilgiri Biosphere Reserve, in which, if the species grows, is accorded protection.

#### **b. Measures proposed :**

Seeds are to be collected from the trees of all the known localities for multiplication in forest nurseries in the suitable habitats of the species itself, for in-situ propagation and conservation. To restrict expansion of plantation crops in and around suspected habitats of the species, necessary steps should be taken. No diversion of forestland for non forestry purpose should be allowed.

### **12.6.3 Methods of Propagation**

#### **12.6.3.1 Natural Regeneration**

Information on the natural reproduction of the species is somewhat meagre. In Coorg regeneration fellings were carried out in evergreen forest, felling and removing everything including trees in the middle and lower storey except for the retention of 175 to 250 trees per hectare in the upper storey. Observations

about two years subsequent to the laying of the experimental plot showed that the seedlings which were 0.5 m at the conclusion of fellings increased to a height of 0.77 m. The feasibility of increasing natural reproduction by suitable generation fellings is therefore evident. Abundant natural regeneration, advance growth and poles are also recorded to be frequent in Wynad forests of Kerala (Nair; 1960).

### 12.6.3.2. Artificial Reproduction

The seed seems to keep well up to a year under storage (Dent : 1948). It weighs upto 210 seeds per kilogram. The germinative capacity is 76% and the plant per cent 67. The seeds take 36 to 67 days for germination. Germination is quicker and more in the open than under shade. A kilogram of seeds will yield 112 to 168 usable seedlings. The nursery beds are preferable to be formed in their habitats so that local humus rich soils could be utilized to get better results.

A good nurse was raised at Palayamkottai Forest campus by the author during his tenure as District Forest Officer, Tirunelveli (Prabhakaran et al., 2001)<sup>45</sup>

#### 12.6.3.2.1. Formation of Stands

Entire planting of nursery raised seedlings 3-6 months old was the old method of artificial reproduction in gaps. Direct sowing of about 6 seeds per patch has also been tried. Later, planting out of 1 year old nursery stock in June was recommended. In localities with the West Coast type of climate, the best time for planting out seedlings is mid-June to mid-July. In an experiment in Palghat, stump plants from 1.5 m high seedlings also gave satisfactory results.

In Nilambur, where it was introduced under the fairly heavy shade of mixed natural forest, chiefly containing *Terminalia alata* var. *alata*, with the object of converting deciduous forest to evergreen, 65% of the plants survived at the end of the first year. Plants put in under the shade of an old teak plantation, with adequate under wood, gave 73% survival at the end of one year.

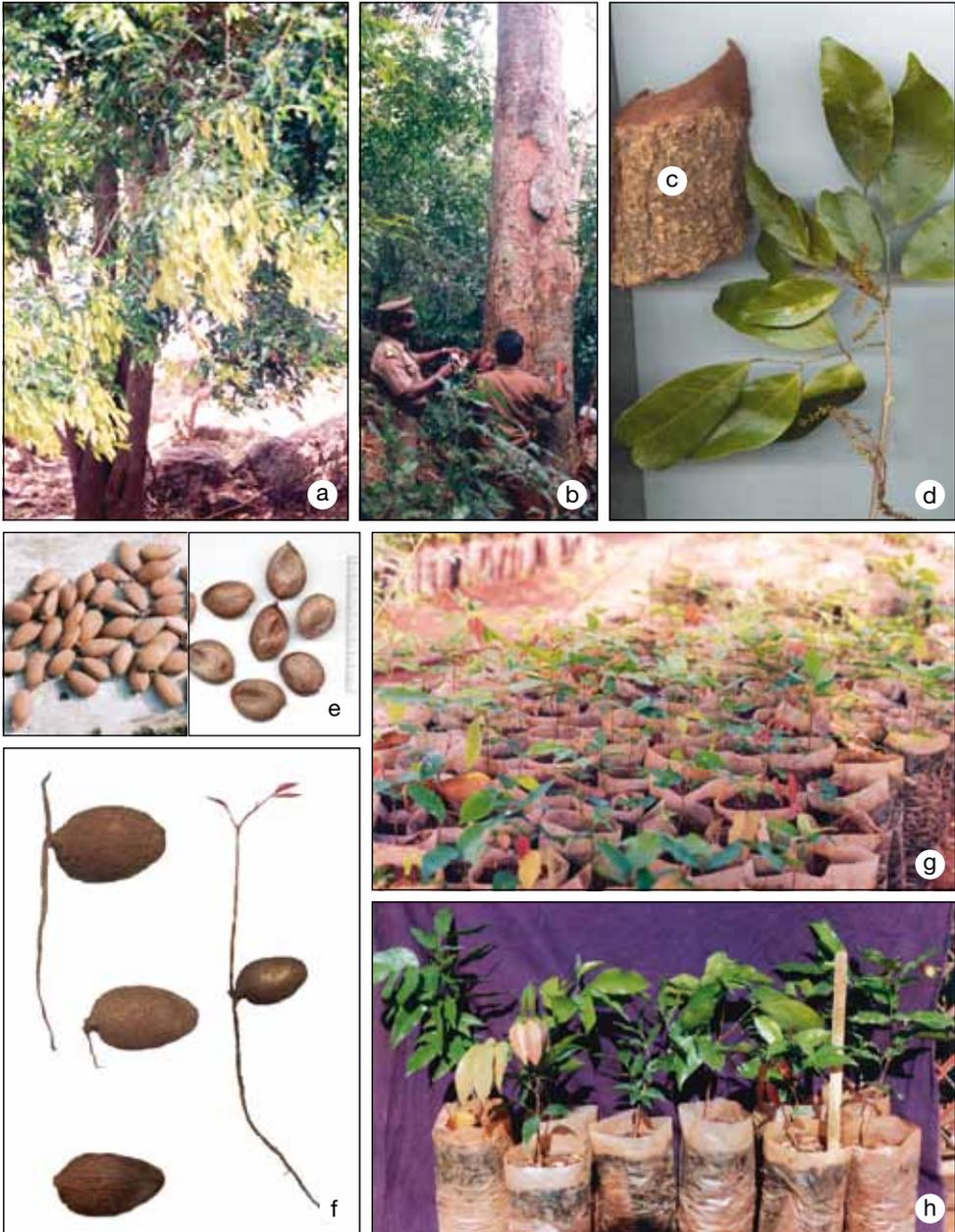
**12.6.3.2.2. Injuries and Protection Fungi** - the fungus *Schizophyllum commune* Fr, is known to cause 'Mottled Sap Rot' in the plant. Insect pests - Beetle and larva of *Thammurgides cardamoni* Schauffuss bore in fallen fruits and seeds.

## 12.7 RECOMMENDATIONS FOR *Kingiodendron pinnatum*

The plant is included in the proposed Plant Schedule (**Figure – 6.7**). The report recommendations have been prioritised and provided in **Table - 5.10, 5.11 and 5.12.**

45 Prabhakaran, V., K. Ravikumar, R. Vijay Sankar. 2001. *Unveil the wild Janakia aryalpatbra* - The Quest Vol-5, issue 5, 23-27.

**Selected Species No. 12 - *Kingiodendron pinnatum* (Roxb. ex DC.) Harms**



**Plate – 5.1.4.3.12. Selected Species No. 12 - *Kingiodendron pinnatum***

a & b. Trees; c. Bark; d - Twig with flower; e - Seeds; f. Germination stages; g. Seedlings (3 months old); h. Seedlings (9 months old)

#### 5.1.4.4 Management Recommendations for effective species recovery of selected ETMPs of the Study Area

Sanjib Phansalkar (2001)<sup>46</sup> in his second Management framework uses the species as rows in a matrix and the specific recommendation as columns. Here for Model study operational plans for a few species are illustrated in **Table 5.10 and 5.11**. The Managers of KMTR may study further regarding these species and carry out operational work based as the field condition and the findings from this analysis.

**Table 5.10 : Operational Plans prescription for a few Select MPs Species**

OPERATIONS →	Operational Plans											
	Survey & Demarcation / Population study	Potection	Careful and regular monitoring for in-stiu conservation	in-vitro multiplication (Tissue culture) and preparation of planting materials	Study of Reproductive biology	Collection of propagules from wild and standardized propagation techniques	Afforestation	Research and demonstration of Sustainable harvesting Techniques	Deliberation introduction of seedlings in different sites	Making commercially oriented nursery	Developing manuals on Cultivation Practices and Demo plots	Skill training for field staff for identification and propagation.
<i>Poeciloneuron Pauciflorum</i>						✓						
<i>Kingiodendron pinnatum</i>						✓	✓					
<i>Janakia arayalpathra</i>			✓	✓	✓							
<i>Trichopus zeylanicus</i>									✓	✓	✓	
<i>Phyllanthus sigampattanus</i>			✓	✓	✓							
<i>Coscinium fenestratum</i>			✓	✓	✓							
<i>Bentinckia Condapanna</i>						✓	✓		✓			
<i>Gymnema sylvestre</i>	✓							✓		✓	✓	
<i>Eugenia singampattiana</i>						✓	✓		✓			
<i>Syzygium gambleanum</i>						✓	✓					
<i>Elaeocarpus vensutus</i>						✓	✓					
<i>Poeciloneuron pauciflorum</i>						✓	✓					
<i>Anoectochilus elatus</i>			✓	✓	✓							

This Management framework is modified and the choice of operational plans for these selected 16 ETMP species are grouped into actions of Immediate attention, Short term and Long term actions as given in **Table - 5.11**.

46 ibid

**Table 5.11 : Management Strategy for a few Select Medicinal Plant Species**

Strategy	Species
Survey & Demarcation / Population study	<i>Gymnema sylvestre</i>
Careful and regular monitoring for <i>in-situ</i> conservation	<i>Janakia arayalpathra, Coscinium fenestratum, Phyllanthus sigampattanus</i>
<i>In-vitro</i> multiplication (Tissue culture) and preparation of planting materials	<i>Janakia arayalpathra, Coscinium fenestratum, Anoectochilus elatus</i>
Study of Reproductive biology	<i>Janakia arayalpathra, Coscinium fenestratum</i>
Collection of propagules from wild and standardized propagation techniques	<i>Kingiodendron pinnatum, Bentinckia condapanna, Eugenia singampattiana, Syzygium gambleanum</i>
Afforestation	<i>Kingiodendron pinnatum, Bentinckia condapanna, Elaeocarpus ventusutus, Eugenia singampattiana, Poeciloneuron pauciflorum</i>
Research and demonstration of sustainable harvesting techniques	<i>Gymnema sylvestre</i>
Deliberation introduction of seedlings in different sites	<i>Bentinckia condapanna, Eugenia singampattiana</i>
Making commercially oriented nursery	<i>Trichopus zeylanicus, Gymnema sylvestre</i>
Developing manuals on cultivation Practices and Demo plots	<i>Trichopus zeylanicus, Gymnema sylvestre</i>
Skill training for field staff for identification and propagation	<i>Trichopus zeylanicus</i>

**Table 5.12 - Species Recovery and Management Recommendations**

(Species wise Operational Plan for Selected Endemic &amp; Threatened Medicinal Plants)

Plans of Immediate Action	Plans of Short term Action	Plans of Long term Action
<ol style="list-style-type: none"> <li>Species Identification and location marking by GPS</li> <li>Survey and Demarcation of place of Endemism</li> <li>Monitoring of Phenology and Calendar Preparation</li> <li>Standardization of Propagation techniques from Seeds</li> <li>Propagation by Stem cuttings / Rhizome</li> <li>Preparation of Species specific Zonation Maps</li> <li>Integration of Growing parameters of ETMPs</li> <li>Threat assessment of ETMPs and Alternatives</li> <li>Bio-chemical Analysis of all the ETMPs</li> <li>Inclusion of ETMPs in Plant Schedule</li> </ol>	<ol style="list-style-type: none"> <li>Meeting stakeholders of MPs and Data collection</li> <li>Study of Reproductive Biology of ETMPs</li> <li><i>In-vitro</i> multiplication (Tissue culture) and preparation of Planting Materials</li> <li>Ongoing Propagation efforts and monitoring programme</li> <li>Careful and regular Monitoring for <i>in-situ</i> conservation</li> <li>Identifying of similar Niches and other sites by Geoinformatics</li> <li>Afforestation in Similar Phytogeographic and Ecological conditions (<i>ex-situ</i> conservation)</li> <li>Skill training for Field staff and stakeholders for identification &amp; propagation of ETMPs</li> </ol>	<ol style="list-style-type: none"> <li>Deliberate Transplantation of seedlings of ETMPs in similar phyto climatic sites</li> <li>Research into seed availability and viability</li> <li>Research &amp; demonstration of sustainable harvesting techniques</li> <li>Making commercially oriented nursery</li> <li>Practices, raising Demo plots and Developing Manuals on cultivation</li> <li>Stakeholders participation in protection &amp; conservation</li> <li>Protection of Existing ETMPs and their Habitat</li> <li>ETMPs Population study and Formation of Plant Sanctuary</li> </ol>

These recommendation strategies hold good for all the 16 species with slight modifications if needed during the implementation phase in the field. The Managers of KMTR may study further regarding these 16 species and carryout operational work based on the field condition. A comprehensive calendar on Phenology and propagation for these 16 ETMP species of KMTR is depicted in **TABLE - 5.13** as ready reference. This will help the field executives in planning for collecting seeds and other planting materials in time for further propagation activities of these ETMPs.

Table - 5.13 Phenology &amp; Propagation Calendar of Endemic &amp; Threatened Medicinal Plants in KMTR

Sl. No	Botanical names	IUCN Status	Flowering / Fruiting Period	Phenology Calendar												Propagation Method			
				Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.				
1	<i>Anoetochilus elatus</i> Lindl. (Jewel orchid)	VU	Fl : Nov - Jan																SO/TC
			Fr : Dec - Feb																
2	<i>Baccaurea courtallensis</i> (Wight) Muell - Arg	VU	Fl : Feb - Apr.																SO
			Fr : Apr - Jun.																
3	<i>Bentinckia condapanna</i> Berry ex Roxb.	VU	Fl : Apr - Jun																SO
			Fr : Jun - Sep																
4	<i>Coscinium fenestratum</i>	CR	Fl : Aug - Nov.																SO/SC/TC
			Fr : Dec - Mar.																
5	<i>Elaeocarpus venustus</i> Bedd.	EN	Fl : Jul - Sep.																SO
			Fr : Oct - Dec.																
6	<i>Eugenia singampattiana</i> Bedd.	CR	Fl : Feb - Jun.																SO
			Fr : July - Oct.																
7	<i>Gymnema sylvestre</i> R. BR.	DD	Fl : Nov-Jan.																SC/SO
			Fr : Dec-Mar.																
8	<i>Garcinia travancorica</i> Bedd.	EN	Fl : May - Aug.																SO
			Fr : Aug - Nov.																

Fl : Flowering      Fr : Fruiting

Jan - January; Feb - February; Mar - March; Apr - April; Jun - June; Jul - July; Aug - August; Sep - September; Oct - October; Nov - November; Dec - December.

IUCN Threat Status : DD - Data Deficient; NT - Near Threat; VU - Vulnerable; EN - Endangered; CR - Critically Endangered Propagation Method: SO - Seed Origin; ST - Stem cuttings; TC - Tissue culture; RZ - Rhizome cuttings.



### 5.1.5. Stakeholders Analysis and Review results of existing Legal provisions, Policies, Acts, Field Observations, etc.

#### 5.1.5.1. Testing Research Proposition

Consolidation of the information from Primary and Secondary sources have led us to come out with four critical and definite research propositions as follows :

#### **Research Proposition - I : *The medicinal plant species and their wild habitats are getting depleted at alarming rates.***

Many plants mentioned by members of three stakeholder groups are common. A comprehensive list was prepared by recording the repeated frequency and sequencing them. It shows that commonly used medicinal plant species are on the decline as reported by Field staff of KMTR, Kani Tribes and Nattu Vaidyas. The declining trend of medicinal plant species is also validated from the screening of literature survey as well as from the Quadrat survey.

Further, the extent of forest cover and various land-use pattern within the study area during 1920, 1960, 1990 and 2005 are shown in Table No. 5.4. The total forest area was 906.82 km<sup>2</sup> (99.92% of the study area) in 1920; 862.07 km<sup>2</sup> (94.99% of the study area) in 1960; 836.99 km<sup>2</sup> (92.22% of the study area) in 1990 and 860.15 km<sup>2</sup> (94.78% of the study area) in 2005 (**Table - 5.12**). Forest loss in the study area between 1920 and 1960 was 47 km<sup>2</sup> and from 1960 to 1990, 164 km<sup>2</sup>. This loss of forest cover summarily caused the loss of habitat as well as loss at species level. Thus habitat loss (Chronological) adds support to this proposition.

#### **Research Proposition – II : *The medicinal plants do not get the attention they deserve due to lack of appreciation of their value, utility and survival status by the custodian.***

The following points are valid testimonial for this second research propositions.

- No Operational Manual / Guide / Procedures exist to empower the protection staff under resource custodian to check illegal harvesting of MPs from forest areas.
- Steady decline in population of MP species in forest areas.
- No inventory of MP species / ETMPs undertaken by the custodian.
- No checklist of Endemic and Threatened Medicinal Plant species available based on field survey in KMTR except a manual compilation from different sources.

- No budgetary provisions for conservation or propagation of MP species in KMTR was made till an interim report submitted by the author on 27.05.2008 to the Chief Wildlife Warden, Chennai and accordingly a Government order (D) No. 296 dated 8.10.2009 issued by Environment and Forests(FR.V) Department, Chennai.
- India is the world's second largest exporter of medicinal plant material, most of which is harvested mainly from the wild/forest. The trade in MPs has increased 100% from 1991-97, i.e. since globalisation. This trade is completely controlled by the informal sector with large traders operating from port towns. The custodian has no material stake in the trade, either in terms of revenue, or even in terms of surveillance of what is exported from the forest areas.
- There is no species-specific rehabilitation / recovery plan undertaken by the Custodian for such MPs.

**Research Proposition – III : *Protection and conservation of wild fauna and timber species usually receives high priority, on the contrary little emphasis is placed on herbaceous wild flora.***

- Analysis of the working plan operations over the period since 1900 clearly reveals that the tree species of commercial value and fuel wood received overdue importance than their counter parts like shrubs, herbs, climbers, grasses which accounts for 66% of forest flora consisting of highly utilised medicinal plants.
- In KMTR, census of wild fauna has been done many times. But the inventory of floral species, the checklist of MPs and number of threatened plants are yet to be prepared.
- Since inception of Tiger project in KMTR all expenditure is done for wild fauna related issue but neither allocated nor spent any amount for the rehabilitation of the imperilled MPs.
- This lack of sensitivity to the floral resources by the custodian appears to be a global phenomenon, with the US flora sharing a similar plight. Only 2% of the total expenditure on endangered species has been spent on plants, 97% goes for vertebrates (Jason & John, 2001)<sup>47</sup>

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<sup>47</sup> Jason F. Shogren and John Tschirhart. 2001. *Protecting Endangered Species in United States* : Biological needs, political realities, economic choices. Washington, DC.

## 5.1.5.2. Analysis of existing Legal provisions, Policies, Acts and etc.

**Research Proposition – IV : *Legal support and policy vision for conservation and management of floral species particularly plants of medicinal value is inadequate.***

- Under Wildlife (Protection) Act 1972 and even now in its amended version i.e. in Wildlife Protection Amendment Act 2006, only six plants received special protection under Schedule - VI, while for the wild fauna many species including insects and beetles find place in the schedules of 1 to V in the same Act. In Biological Diversity Act 2002 only one section 38 talks about empowerment of the Central Government to notify any species as Threatened and make regulation on the same. **Table No. 5.14** shows the role of different existing legal provisions and policies to protect the TMPs.

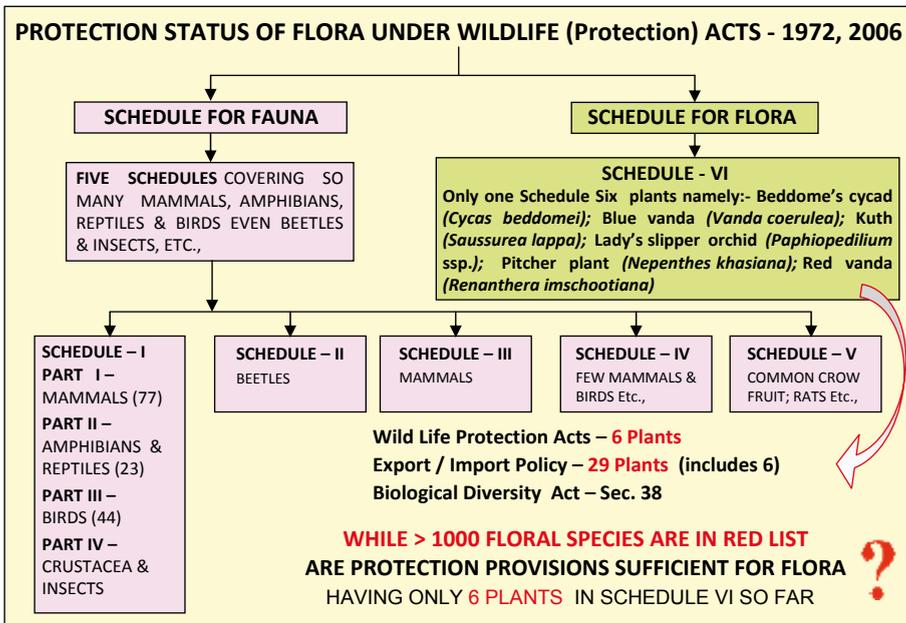
**Table 5.14 - Role of Existing Legal provisions and policies in protecting Medicinal Plant**

Sl. No.	LEGAL PROVISIONS	ROLE
1	Madras Forest Act (1882),	Passive Role
2	Indian Forest Act (1927),	
3	National Forest Policy (1952),	
4	Tamil Nadu Hill Areas (Preservation of Trees) Act (1955)	
5	Tamil Nadu Timber Transit Rules (1968)	
6	The Indian Wildlife (Protection) Act (1972), - 6 MPs	Able to play active role in Species protection but it covers only 6 plants.
7	Forest (Conservation) Act (1980)	Active role in Habitat protection
8	National Forest Policy (1988),	Passive Role
9	Export & Import Policy (1997-2002) – 28 MPs	Active role / Without having proper implementing mechanism.
10	Export & Import Policy (2002-2007) –Mainly Sandal and Red Sanders.	With gaps in enforcement.
11	Wildlife (Protection) Amendment Act (2006)	No addition than WLA 1972.
12	Biological Diversity Act (2002) Sec.38	Only Section 38 empowers the Central Govt. to notify threatened species.

- The notification by Ministry of Commerce during 1998 and 2002 bans (28) MPs from export but it lacks a fool-proof mechanism for implementation of this regulation. Further the notification is not in complete shape as it lacks in providing complete name of many floral species namely *Paphiopedilum spp*, *Ceropegia species*, *Cyatheaceae species*, *Cycadaceae species*, *Euphorbia species*, *Orchidaceae species*, *Aconitum species*, *Gnetum species*, which gives room for ambiguity and continue the trade on them. No direct legal rule is in place to check illegal harvesting of MPs from any of the forest areas. Even in case of a big haul of MPs found outside the reserved forest, no booking of case

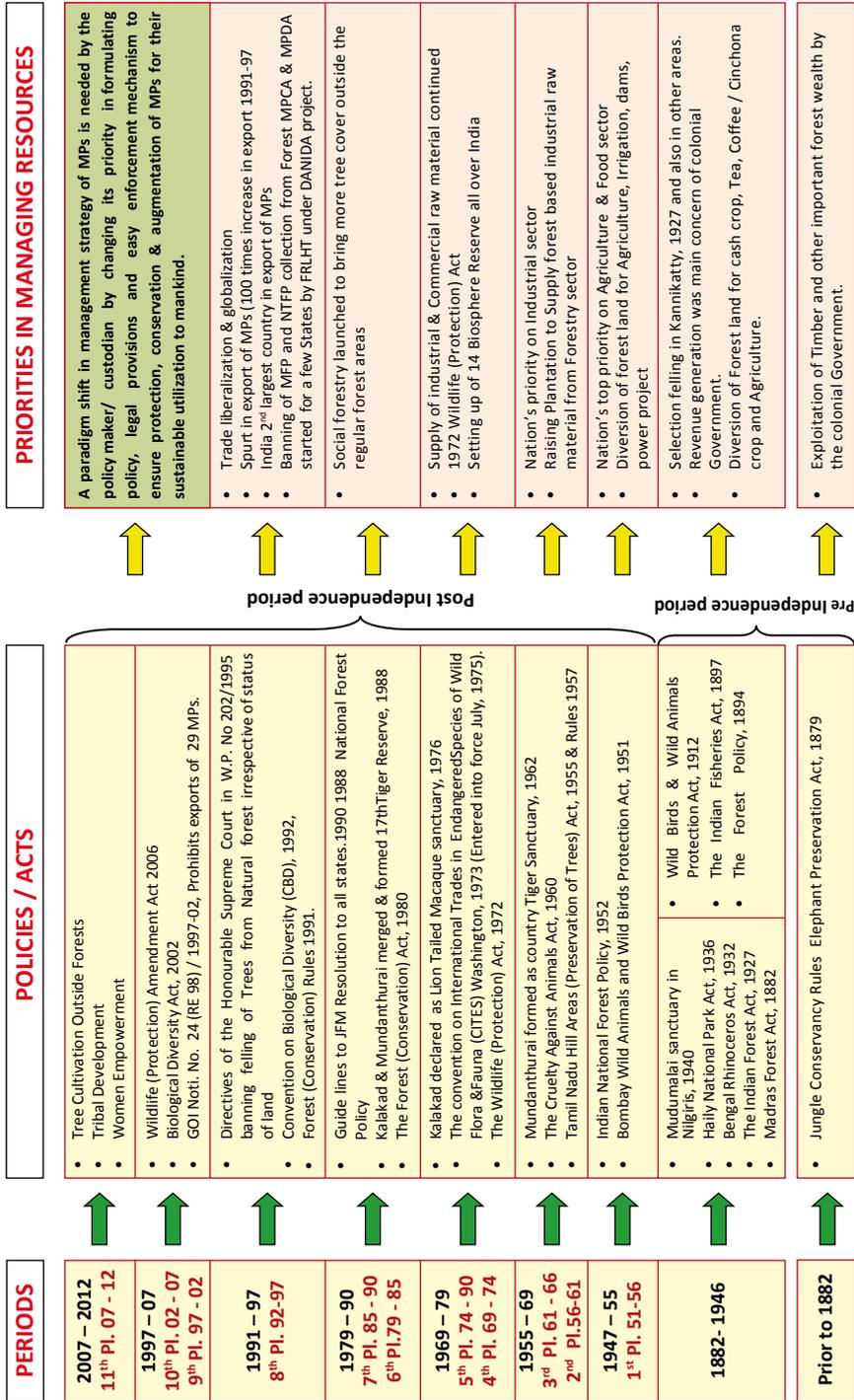
is possible even when the scale of such collections is very large. This is due to lack of direct legal provisions available in existing Forests Acts except six plant species in Schedule VI of Wildlife Protection Amendment Act, 2006 and a list of 28 plants (including these six plants) as enlisted by the Ministry of Commerce prohibiting trade on them. A protection status of plants under Wildlife Protection Acts, Biological Diversity Acts, and Export Import policy are shown below in **Figure – 5.3**.

**Figure 5.3. - Protection Status of Flora (includes MPs) in Comparison to Fauna**



The historical perspective of Policies and Acts formulated over last 120 years in Forestry sector is shown in **Figure 5.4**. It depicts that more than 16 Acts and Policies were made for protection and conservation of fauna during this period, whereas for floral species specific Acts or Policies are yet to be formulated. During the colonial and pre-independence period, exploitation of the valuable timber species, raising commercial cash plantations and extraction of other forest products from the natural forests were the main concern. Subsequently, in post-independence and early plan periods (Five year), agriculture and industry received attention as top priority sectors by the policy makers. Hence, diversion of forestland for non-forestry purposes and also use forest and forestry sector as the sources for livelihood was practised.

Figure 5.4 – Policies & Priorities in Managing Natural Resources – A Historical Perspective



Pl. = Five Year Plan

During 1970s and 80s forestry got special emphasis on Wildlife and Forest protection by commissioning Wildlife (Protection) Act, 1972 and the Forest (Conservation) Act, 1980. Social forestry becomes the mainstay of all activities. In later part of 1980, Government of India circulated the Guidelines for passing JFM resolution to all State Governments.

During 1980s and 90s, the concept of biodiversity and the management of natural resource of forest was considered as a global phenomena. The trade in MPs has increased 100% from 1991-97, i.e. since globalization. But this trade is completely controlled by the informal sector. The custodian has no material stake in the trade, either in terms of revenue, or even in terms of surveillance. During last 13 years, i.e. 1997-2010, Wildlife (Protection) Act 1972 was amended as Wildlife protection Amendment Act 2006 and Biological Diversity Act,2002 but failed to extend the list of threatened plants in the schedule. It is a matter of concern that when more than 1200 floral species suffer from various degrees of threats in the country and when the plants of medicinal value received spurt in global trade since 1991, there is no policy formulation /reformation to this sector of the forestry operations which needs immediate attention. Therefore, a paradigm shift in management strategy of MP species is needed with immediate effect by the custodian by changing its priority in formulating policy, legal provisions and easy enforcement mechanism.

#### **5.1.5.3. SWOT Analysis**

To find an appropriate solution to any problem first the various aspects of the problems should be properly understood. In this sense a **SWOT (Strength, Weakness, Opportunity and Threats)** analysis for existing management system of MPs was carried out (**Table 5.15**).

Table 5.15 - Swot Analysis

STRENGTH	WEAKNESS
<ul style="list-style-type: none"> <li>• More than 4.5% geographical area of the country gets umbrella protection under Wildlife (Protection) Act, 1972, 2006;</li> <li>• 8,000 plant species of 17,500 known flowering plant species of India covering 45% have been recorded in medicinal use under Indian systems of Medicine.</li> <li>• Single Agency - FD works as custodian of these resources</li> <li>• Strong institutional framework of FD available for conservation and protection.</li> <li>• Various legislative Acts and Rules provided for habitat Conservation Action e.g. FCA, 1980; Wildlife (Protection) Amendment Act. 2006; BDA, 2002.</li> <li>• About 70- 80% populations relying on Traditional Medicine System.</li> <li>• Heritage of rich knowledge on local MPs among the various ethnic communities.</li> <li>• Setting up of National Medicinal Plant Board by Govt. of India encouraging <i>in-situ</i> Conservation of MPs.</li> <li>• Global acceptance for Ayurveda system of Medicine.</li> <li>• Traditional Knowledge Digital Library (TKDL) at the Central Institute for Medicinal and Aromatic plants, (CSIR) Lucknow.</li> <li>• Scientific institutions across the Nation undertaking research on MPs and availability of Human resources.</li> <li>• Enormous biodiversity, all types of soil and climate, a rich heritage of Indian System of Medicine (ISM), a strong base of Research and Development laboratories, skilled manpower, lower production and manpower costs and a well-developed pharmaceutical industry.</li> </ul>	<ul style="list-style-type: none"> <li>• Till date <ul style="list-style-type: none"> <li>➤ No inventory of floral resource,</li> <li>➤ No comprehensive list of MPs,</li> <li>➤ No check list of ETMPs,</li> <li>➤ No species specific recovery plan for ETMPs</li> </ul> </li> <li>• Policy framework (e.g. Wildlife Protection Act,) is biased towards fauna, does not provide for specific floral conservation except six plants</li> <li>• Although 85% of MPs used by Indian industry comes from wild/forest, conservation and management of MPs is not seen as the mandate of FD.</li> <li>• No specific legal support to the custodian to deal with offences related to MPs.</li> <li>• Awareness about the Indian medicinal heritage is weak</li> <li>• No technological knowhow to identify species other than gross plant</li> <li>• Lack of coordination and concerted action among stakeholders.</li> <li>• Lack of provision for financial support for conservation and protection of MPs.</li> <li>• Weak in research and training</li> <li>• Despite large global demand for MPs, India's contribution to the Global market is &lt; 1%</li> <li>• Trade is unorganised, secretive, non transparent and opportunistic.</li> <li>• Excessive regulatory regimes &amp; lack of transparency in collection and trade.</li> <li>• Lacks of linkage in buyback arrangement, thus MPs cultivators do not come forward to cultivate MPs. Hence the safest option for them is extracting from the natural populations.</li> <li>• Demonstrated benefits local communities from conservation effort insignificant.</li> </ul>

OPPORTUNITY	THREATS
<ul style="list-style-type: none"> <li>• FD can be a nodal agency to coordinate stake holders Tremendous opportunities in field of Research in               <ol style="list-style-type: none"> <li>1) Conservation biology of Threatened species</li> <li>2) Sustainable utilisation of MP resources (NWFP studies)</li> <li>3) Rehabilitation &amp; recovery plan for TMAPs.</li> </ol> </li> <li>• Training of various kinds of stakeholders;</li> <li>• Conservation with community participation.</li> <li>• Service of millions of households, Native Healers, ISM practitioners, R&amp;D Institutions, Herbal manufacturing industries.</li> <li>• International market for MPs is over US \$62 billion per year and growing at the rate of 7% per annum.</li> <li>• Annual demand is about 2.5 lakh tonnes and growing at the rate of 20% per year.</li> <li>• Interest amongst financial institutions &amp; donors to support Medicinal Plant related entrepreneurship.</li> <li>• Government developmental programme recognizing MPs as a potential sector.</li> <li>• Employment / income generating sector.</li> <li>• Zeal for diversified medicinal products is increasing.</li> <li>• All win game (Producer – price, Consumer – quality).</li> <li>• Demand herbal products in USA/Europe, Japan and other developed nations.</li> </ul>	<ul style="list-style-type: none"> <li>• Threats of extinction of several species in wild as presently about 1000 MPs. Still the policy makers have not taken any specific measures for rehabilitation &amp; recovery of those ETMPs.</li> <li>• Destruction of habitat by diversion of forestland for non-forestry purpose. Excessive harvest of Timber, Fuel &amp; MFP in past</li> <li>• Forest enclaves inside RF/PAs causing biotic pressure to adjoining areas.</li> <li>• Non availability of cultivation package of several MPs.</li> <li>• Lack of extension activities.</li> <li>• Conservation Biology – No state of art with the result that conservation action may be too little and too late.</li> <li>• Unorganized sector</li> <li>• Wrong enforcement of regulations</li> <li>• Loss of traditional knowledge &amp; Bio-piracy of long inherited native medicinal knowledge.</li> <li>• Price fluctuation, exporters' non-compliance with rules &amp; regulations of importing countries &amp; consequent refusal, quality constraints, asymmetric information with suppliers about the total world-trade in MPs, limited number of botanical suppliers &amp; traders who have a strong bargaining power vis-à-vis the growers, irregular supply, inappropriate methods of collection &amp; storage leading to sub-optimal levels of active constituents &amp; consequent increase in price of their derivatives are some of the major constraints faced by this sector.(Alma Ata Declaration, (1978).</li> </ul>

Based on all these findings, as well as the lessons learnt from the case study of Species Preservation in United States particularly the strength of Endangered Species Act (ESA) 1973, concerted attempts have to be made to enlist these as policy recommendations. Further, a specific action plan has to be formulated to the sixteen select ETMPs taking necessary action by the managers of KMTR, Tamil Nadu Forest Department.

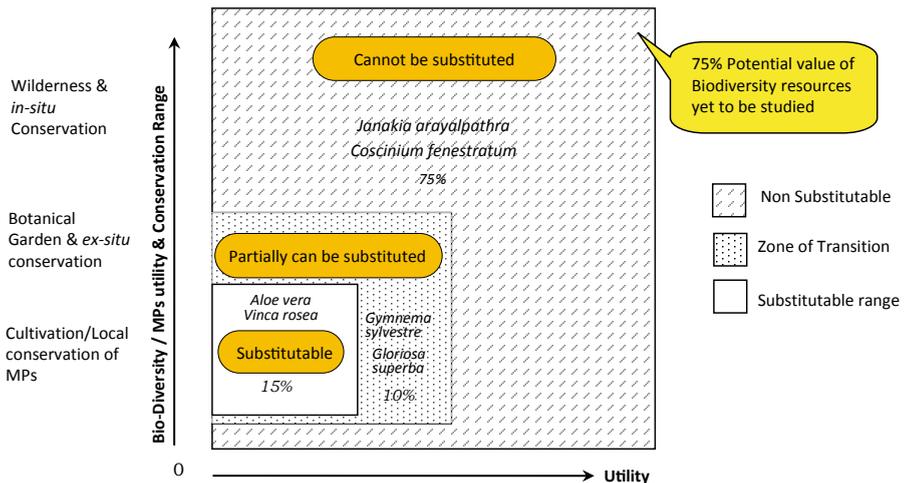
# Chapter – VI

## Recommendations and Action Plan

### 6.1. Introduction

The details of MP resources and their depletion trends are already explained under the ‘Background and Context’. However, the present utility and conservation status of MPs within the country is illustrated in **Figure - 6.1**. It indicates that only a tiny portion about 25% (cultivation practices of a small number of MPs, only about 15%) is within the purview of human knowledge in *ethno botanic* use and *substitutable* while more than 75% potential value of biodiversity resources are yet to be studied and *not substitutable* and in between these two remains the *transition zone* which can be *partially substituted*. Meanwhile, more than 1000 plants are recorded in the threatened list of medicinal plants (Kerry *et al.*, 1998)<sup>48</sup>.

**Figure 6.1 – Frame work for Biodiversity / MPs Utility & Conservation**



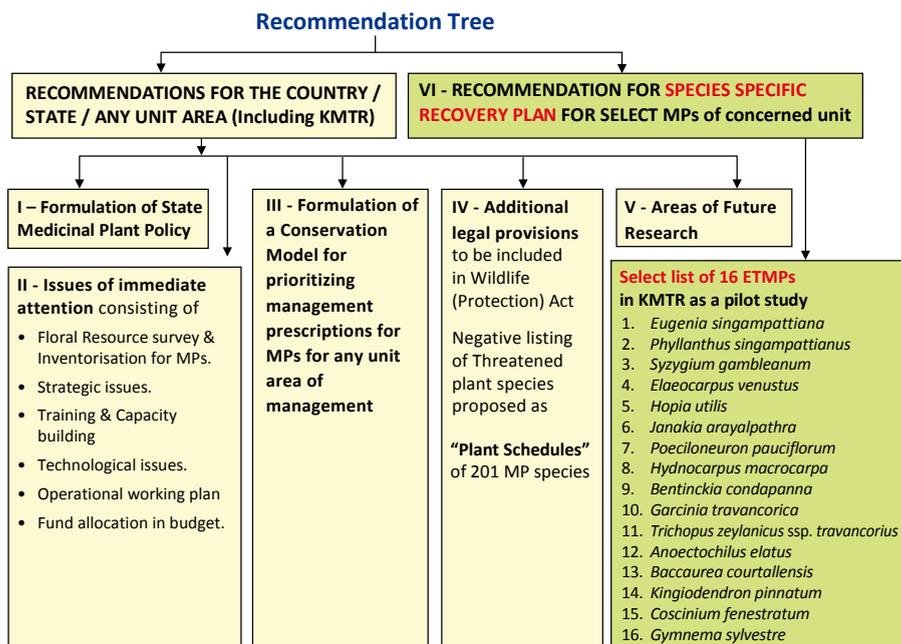
(Source : Modified from Damodaran. A, 1992)<sup>49</sup>

48 ibid

49 Damodaran. A. 1992. *The Economics of Forest Conservation and sustainable Development*.

In order to have check on threats and depletion of plant resources particularly, plant species of medicinal value, the strategy for resource augmentation with multi pronged management action have to be adopted. Therefore based on the results and discussion, specific policy recommendations and action plans are developed for strategic management, conservation and sustainable utilisation of MPs.

**Figure 6.2 - Depicts a Recommendation Tree for conservation and sustainable use of MPs.**



## 6.2. Recommendation Tree for Conservation and Sustainable use of MPs

The main trunk of this **Recommendation Tree** sustains on six important issues (*root systems*). They are:

### I. Formulation of State Medicinal Plant Policy (SMPP)

### II. Issues of immediate attention consisting of

- a. Floral Resource survey and Inventorisation for MPs.
- b. Strategic issues
- c. Technological issues
- d. Training and capacity building

- e. Operational working plan
- f. Fund allocation in budget.

### III. Formulation of a Conservation Development Model for prioritizing management prescriptions for MPs for any unit area of management.

#### IV. Additional legal provisions to be included in

- a. Wildlife (Protection) Act / Biological Diversity Act
- b. Negative listing of threatened plant species proposed as “**Plant Schedule**” of 201 MP species

#### V. Areas of future research.

#### VI. Recommendation for species specific recovery plan for select MPs of concerned unit

The first five issues can be applicable for the entire country / state or any unit area of management including the KMTR while the last one is species-specific recovery plan recommended mainly for selected species of KMTR area.

#### 6.2.1. State Medicinal Plant Policy – A Proposal

As forests are on the concurrent list in the Indian Constitution, the Government of India needs to issue some policy guidelines, under which each state can formulate its own medicinal plant policy based on the local conditions. A draft policy guideline is suggested in **Figure - 6.3**.

**Figure 6.3 - Proposed Medicinal Plants State Policy**

Proposed State Policy for Strategic Management of Medicinal Plants	
Introduction	Transparency in all problems
Preamble	<ul style="list-style-type: none"> <li>• Inventory of MPs Resource: preparation of checklist and recovery plan, potential scope of MPs in India</li> <li>• Legislation; enforcement mechanism</li> </ul>
Approach	<ul style="list-style-type: none"> <li>• Fringe Areas – Local Community Management (1988 Policy Joint Forest Management concept)</li> <li>• High Forests – Forest Development with other sister departments, stakeholders (1882 ACT, 1927 Policy, 1972 &amp; 2006 WLPA, Export/Import with Additional Legal Provisions).</li> <li>• Outside Forest Areas – all stakeholders in coordination</li> </ul>
Strategy	<ul style="list-style-type: none"> <li>• Conservation</li> <li>• Cultivation</li> <li>• Marketing</li> <li>• Trade</li> <li>• Training and capacity building</li> <li>• Future research</li> </ul>

## 6.2.2. Issues of Immediate Attention

### 6.2.2.1. Floral Resource Survey and Inventorisation

Resource survey and inventorisation of MP species should be given top priority, for which training and skill development of staff, including field managers, is a vital step. A systematic study should be conducted in each unit (division level of the forest department) to list all species growing naturally in the area. A comprehensive plant resources inventory encompassing herbs, shrubs, climbers, lianas and trees will be useful to build a database, out of which species distribution and frequency, association, regeneration status, species interaction, availability of medicinal plants etc. can be studied. Cost effective but reliable methods need to be evolved to carry out comprehensive plant resources inventory over extensive forests. Two methods that have been found to be suitable for ground enumeration after field-testing are the ordinate method and the line plot method (Harrison, 1950).<sup>50</sup>

In the absence of such inventory and species specific biochemical exploration, prioritization of species based on their therapeutic and economic importance can not be done. Hence domestication of important wild floral species also remains out of reach to the scientific world.

### 6.2.2.2. Strategic Issues

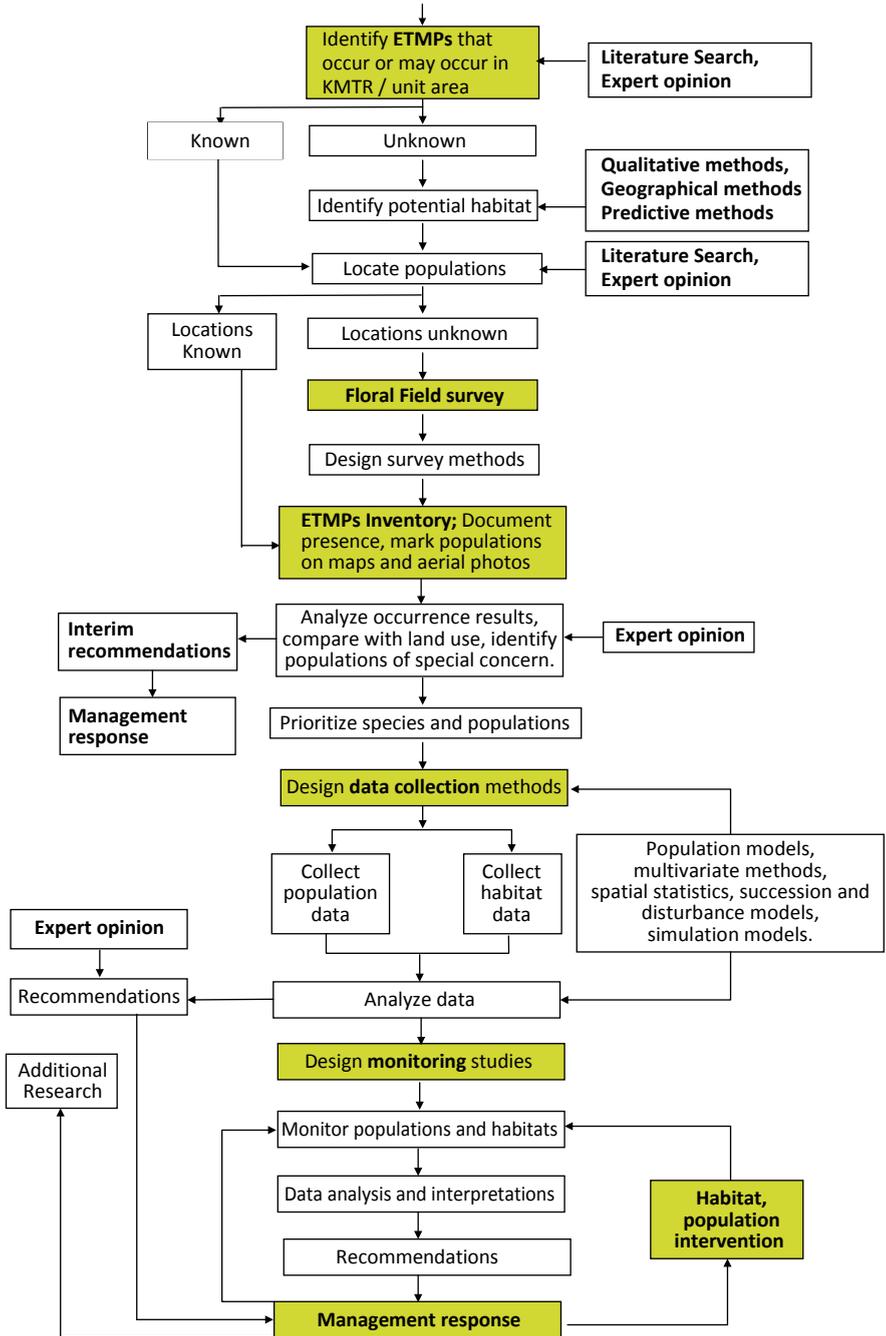
Habitat protection ensures species protection in general. But specific species with narrow spatial distribution zones i.e., endemic in nature for a particular area, whose population has gone down to a critical level, need special attention to be preserved in their natural habitat. Management intervention should include developing a systematic protocol consisting of field survey, inventory, monitoring and additional research and population/habitat manipulation (Charles D. Bonham *et al.*, 2001)<sup>51</sup>. **(Vide Figure 6.4)** Identification of plants that are in stress, preparation of negative *lists of 201 plants*, threat assessment and development of a recovery plan including regulated harvesting and cultivation are also part of this process. Conservation could focus on valuable species, for instance those that provide life saving drugs.

An effective *modus operandi* would be for the Ministry of Environment and Forests to conduct a centrally coordinated threat assessment exercise, comprising experts from government organizations like the National Biodiversity Authority and the Botanical Survey of India, state level Research institutes and biodiversity

50 Harrison, J.D.B. 1950. *Planning a National Forest Inventory Division of Forestry and Forest products*. Food and Agriculture Organisation, Rome.

51 Charles D. Bonham., Stephen G. Bousquin and David Tazik. 2001. *Protocol for Inventory and monitoring of Threatened and Endangered plant species*, Colorado State University Department of Rangeland Ecosystem Science, Fort Collins and Army Corps of Engineers, Vicksburg.

**Figure 6.4 - Flow Chart for Endemic and Threatened MPs Protocol in KMTR / unit area**



(Charles D. Bonham *et al.*, 2001)

boards, universities and colleges and NGOs. The programme could be an annual time-bound nationwide programme with the State as the unit. This would yield a comprehensive checklist of TMPs, which can be used to prepare schedules of threatened plants to be included under The Indian Wildlife (Protection) Act 1972 and the Biological Diversity Act 2002.

### 6.2.2.3. Training and Capacity Building (HRD)

The major short comings in the sector is that only about 25% of the species could be identified and their major uses are known, while the remaining 75% of the species are still undetected and unutilized and unknown of their taxonomical characters and bio chemical properties. Hence training should be imparted to the foresters at field level as well as senior level to identify the species, their taxonomical characters, phyto chemical properties they have and their proper utilization.

Further mutual understanding, respect, trust and benefit flow sharing are vital for the conservation and sustainable use of such resources. Therefore training and capacity building of the stakeholders, including foresters at all levels and the local people, is essential. Training packages need to be developed in the vernacular language for training local healers and traders. MPs authority at the state level must ensure networking of all the stakeholders and continuous interaction and integration of their activities for strengthening the MPs management strategy; awards could be instituted for the best performers in cultivation, market linkage, management effort etc. A flow chart showing the training field of various stakeholders is shown in **Figure – 6.5**.

### 6.2.2.4. Technological Issues

More than 75% of potentially valuable biodiversity resources of the country are yet to be studied (Damodaran, 1992)<sup>52</sup>. Sophisticated biochemical technology is required for the study of these resources. Forensic biochemical laboratories also need to be established for identification of seized plant material. Tissue culture and other technologies should be developed and facilitated for *in-situ* and *ex-situ* propagation of medicinal plants and their conservation. *Distinctness, Uniqueness and Stability (DUS) Testing*; application of high resolution satellite image along with common Geo reference of species with their growth parameters and ecological zonation can make a quantum jump in Bio prospecting of MPs through the present day technological advancement. **Figure - 6.6** represents a flow chart of technology issues related to identification, propagation and conservation of MPs.

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52 ibid

Figure 6.5 – Flow Chart for Training of Stakeholders of MPs at Various Levels

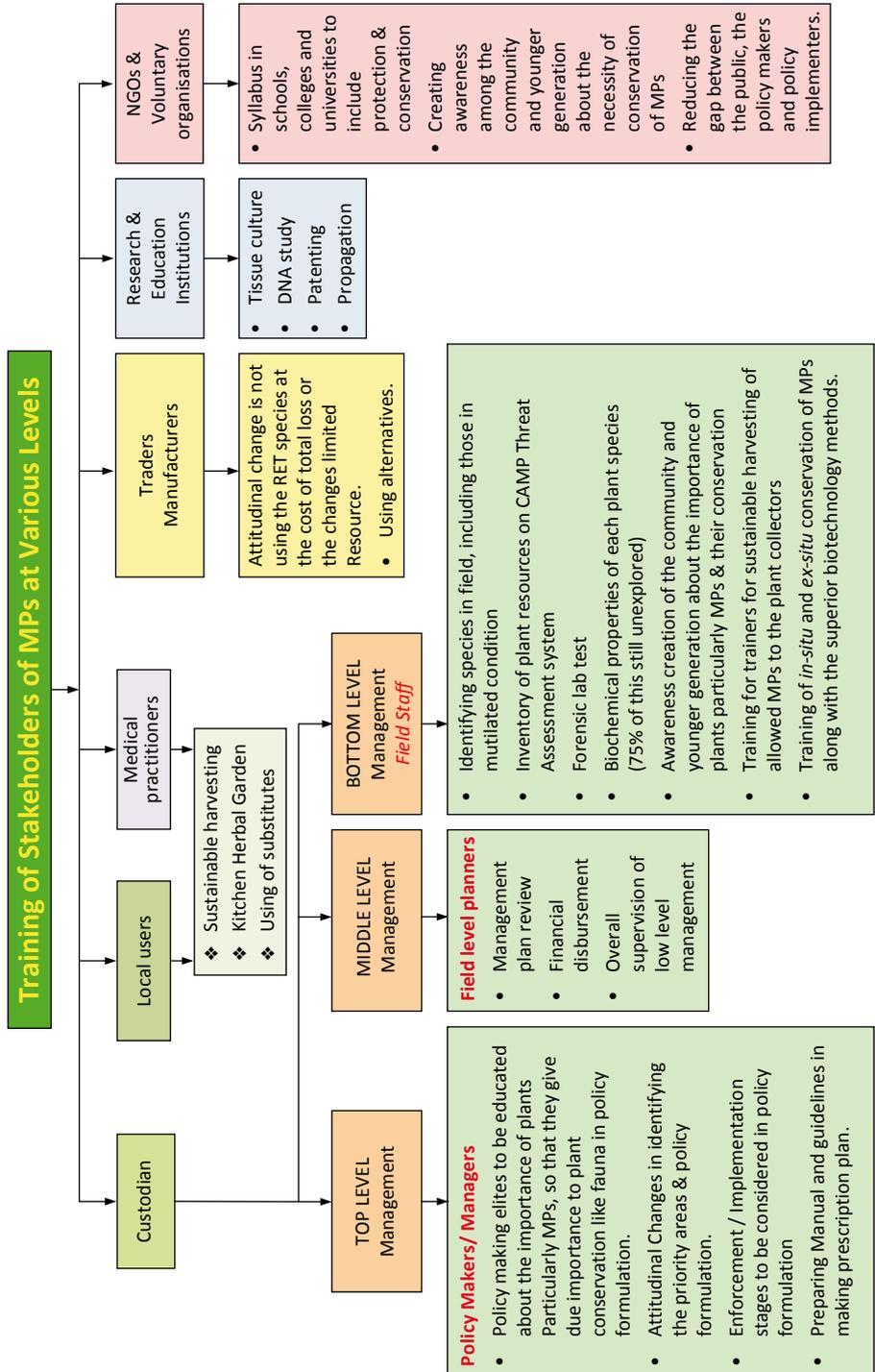
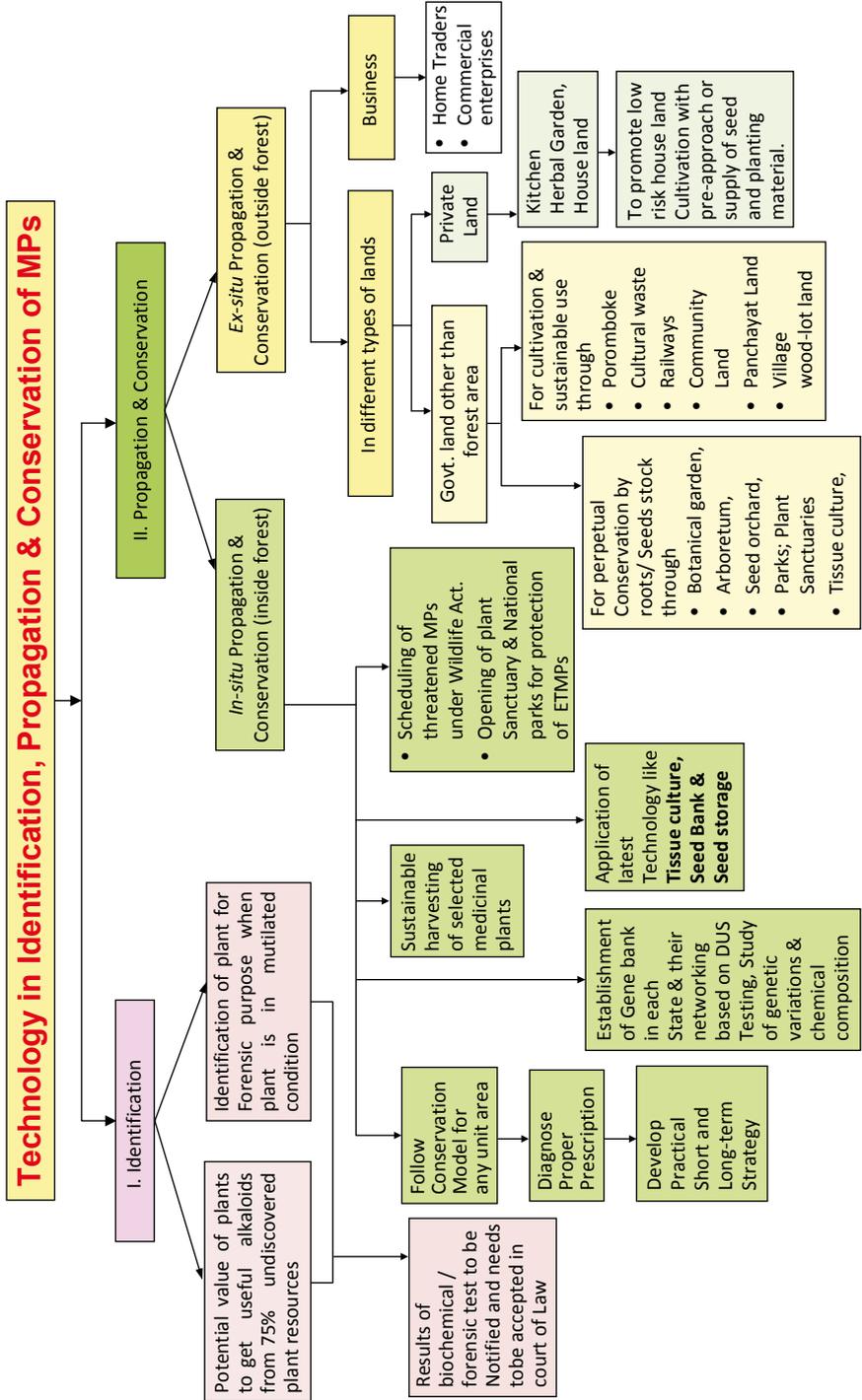


Figure 6.6 – Flow Chart for Application of Technology



### 6.2.2.5. Operational Working Plan

Plant resource assessments for forestry practices are usually done on *ad hoc* basis and confined mainly to tree species whether it is for formulating working plan prescriptions, harvesting or assessing regeneration status. Only predominant trees, shrubs, climbers, lianas are recorded in existing working plans but the grasses met within the undergrowth and ground flora and herbs are often not given adequate attention. This type of assessment is not holistic. Even working plans and resource surveys carried out in Tamil Nadu have not made any inventory of the shrubs and herbs and other ground flora. Analysis of the working plan operations since 1900 shows that Tree species of commercial value and fuel wood received far more importance than other habits like shrubs, herbs, climbers and grasses, which account for 66% of forest flora and include many species of great medicinal and commercial value.

Of late, there is a spurt in demand for MPs and estimated 880 plant species are used for large-scale production of medicines by the industry. Therefore the working plan of a unit area needs to follow a specific format, including the following steps (Kinhla and Srinivasamurthy 2002)<sup>53</sup>: preparing a checklist of MPs for each agro climatic region, to be provided to the forest manager and the executive and field staff; putting in place the institutional mechanism at District Forest Officer level for threat assessment and negative listing; preparing species-specific working plans; making arrangements for both *in-situ* and *ex-situ* propagation and conservation efforts; creating awareness among the local community; and making specific conservation and recovery plans for threatened plants.

### 6.2.2.6. Fund allocation and Budget

Resource allocation in the budget for taking up both development and conservation work needs the special attention of the policy makers. Budget allocation to the forestry sector is inadequate, never more than 1% of the total allocation in the plan periods. This needs to be enhanced, while simultaneously making a specific budget plan allocation for protection of MPs under the Ministry of Environment and Forests and National Medicinal Plant Board.

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53 Kinhal Girridher, A. and T.S. Srinivasamurthy 2002. *Guidelines for Working Plan Officer on Medicinal Plants Conservation* 1-23, Foundation for Revitalisation of local Health Tradition, Bangalore.

### 6.3. Development of Methodology to select plant species in evolving Conservation / Management Strategy

Sanjib Phansalkar (2001)<sup>54</sup> prepared two Management frameworks for developing Business Development Plans for Conservation of Medicinal Plants. These Management frameworks were applied to develop species specific recommendations for selected ETMPs in KMTR as follows:

Based on the details collected from the field survey, literature, a check list of ETMPs of the study area was prepared. To find out the stress level of each MP, **Trade / Utility** and **Threat Status** were plotted in a quadrat to diagnose the actual problem of individual plant to make appropriate prescription accordingly.

A quadrat is developed with the X-axis showing the status of a specific Medicinal plants in *Trade/ utility* and the Y axis indicated the present *threat status* of the same Medicinal Plants. Now from the check list of ETMPs both the **utility level** and its **threat status** are plotted for a particular threat species in the quadrat based on the degree of its utility and threat status. Likewise all the medicinal plants of the area can be plotted in the quadrat. Based on this plotting we can find out the group of plants as found in four categories namely

I	Top right	High risk	High Utility
II	Top left	High risk	Low Utility value
III	Bottom right	Low risk	High Utility
IV	Bottom left	Low risk	Low Utility

Now based on the location of a particular species where it got plotted, accordingly prescription or Recovery Planning / Strategy Plan is done for all the selected ETMP species. (Figure – 5.2)

*The quadrat of high trade and high threat merit the **highest attention, to have check on trade** on them followed by high risk and low trade status. The quadrat of high threat and low trade requires **close surveillance to find out the causes for threat status**. The III quadrat which shows low risk and high trade which is **highly recommended class for continuing trade on a large scale**. The last quadrat of low threat and low trade is of least concern. The medicinal plant species are marked on this graph using available data on threat and trade status. After prioritization, the specific strategy for each species needs to be worked out.*

54 ibid

## 6.4. Additional legal provisions to be included in

### 6.4.1 Wildlife (Protection) Act, 1972 / Biological Diversity Act, 2002

It was expected that a number of threatened categories of plants would be added to the schedule in the Wildlife (Protection) Act, 1972. However, we have failed to extend the list of threatened plants in the schedule. Separate schedules need to be created for the imperilled plants in either the Wildlife (Protection) Act or the Biological Diversity Act, based on the list of plants already available in Schedule VI of the WPA, the Ministry of Commerce list of notified plants, 1997 IUCN Red list of Threatened Plants and the Conservation Assessment and Management Plan (CAMP) lists of TMPs in southern and northern India. This then needs to be legislated as in the case of fauna species. Presently it is suggested that 201 TMPs be covered under three separate Plant Schedules (Sarkar, 2010) as shown in **Figure - 6.7**.

### 6.4.2 Negative listing of Threatened plant species proposed as “Plant Schedule” of 201 MP species

The order of Plant Scheduling may be in following way. Mere name of Schedule for flora under Wildlife Protection Acts may mix up the issue with the existing schedule of fauna. Therefore it is suggested that scheduling for plants may be specifically called as **Plant Schedule I, Plant Schedule II, Plant Schedule III**.

From the various sources as mentioned above at present totally 201 Threatened MPs may be covered under 3 Plant schedules in the following ways; under Plant Schedule I, it can be given importance as Part I, Part II & Part III for following group of threatened Plants (**Vide Figure - 6.7**).

**Plant Schedule - I**: 125 plants (It covers 31 plants under Part I, 50 Plants under Part II and 44 plants under Part III).

**Part – I** : 31 Plant Species already existing under Schedule - I of the Wildlife (Protection) Act 1972 and Partly under government of India, Ministry of Commerce Notification. No. (RE - 98)/ (1997 - 2002). (**Plate - 6.1 A & B**)

**Part – II** : 50 Plant Species, declared as *Extinct in wild, Globally Critically Endangered, (Endemic to India)*. (**Plate - 6.2 A, B & C**).

**Part – III** : 44 Plant Species declared as *Globally Endangered (Endemic to India and Nationally Critically Endangered)*. (**Plate - 6.3 A, B & C**).

**Plant Schedule - II** : Covers 51 plants (Plant Species declared as *Globally Vulnerable (Endemic to India and Nationally Endangered)*. (**Plate - 6.4 A, B, C & D**).

***Plant Schedule - III*** : Covers 25 plants Plant Species declared *Globally near Threatened* (Endemic to India) and Nationally Endangered). (**Plate - 6.5 A, B & C**).

## 6.5. Areas of Future Research

India is the most suitable country for conducting fundamental and application oriented research in this field because of its vast wealth of knowledge on MPs and herbs. In fact, after information technology and biotechnology, research in MPs, should emerge as the most sustainable growth sector in the years to come.

Research in MPs at various stages is being done by research and development organizations in Government of India, under Ministry of Agriculture (through ICAR), Department of Science and technology (CSIR), Ministry of Health and Family Welfare (CCRAS), Ministry of Environment and Forests (through ICFRE), Defense Research and Development Organization (DRDO). But according to Scientific Advisory Committee to the Cabinet, research and development (R&D) in MPs is beset with the following problems (Singh, 2006)<sup>55</sup>:

- Too many plants are taken up for research, hence focus is lost
- Poor intra-institutional linkages lead to non availability of data on past and current research
- Priorities assigned in mandate of these organizations are different and hence the focus is diffuse
- No interaction between these research institutions and growers on one hand and industry on the other hand. Therefore, research conducted by institutions does not reach farmers and research institutions do not come to know about needs of industry.

Further, the medicinal plant trade shows a lot of price variation within a 200 km radius, indicating the extent to which the sector is unorganized and opaque. The market networks, pricing trends and mechanisms of this sector need to be thoroughly studied to understand the stakes and movements of the valuable commodity. The surveillance mechanism of trade in MPs has to be researched in order to develop and put in place a system for monitoring the real volume of trade and the species traded and exported. Other areas of potential research include: propagation techniques, seed storage and propagation materials; *in-vitro* multiplication of rare plants; species specific research and recovery plan for ETMPs; sustainable harvesting of MPs; local community management– health

55 *ibid*

and food security; and research information management systems. Therefore, the need of the hour is an integrated approach which addresses various issues in the field of future research in MP sector in the supply chain right from farm to firm and consumers.

## 6.6. Summary

The study resulted in documenting 1106 plant species belonging to 157 families with 58 strict Endemics and Threatened Medicinal Plant species of the study area. The distribution of each endemic and threatened species of medicinal value, their realized niches and status, ecological amplitude among forest types and their geographical positions in the landscape were documented and mapped.

Detailed study of various phytogeographic parameters for plant growth of the study area were taken up and completed. Accordingly thirty two thematic maps of the study area have been prepared and finally the causes for the decline the medicinal plants to reach their threshold point of threatened conditions are found out especially for the sixteen select ETMPs. Latest taxonomical names of all 1106 floral species, their synonym, along with illustration of more than 300 species are provided in this book.

Species specific recovery plans of twelve selected Endemic and threatened medicinal plants of the area have been discussed at length and prescribed for future course of action by the custodian. Identifying these species in the field along with their specific geo-coded location and then prescribing specific recovery plan for each species with the *Phenological Calendar* is altogether a new venture in the scientific literature related with wild plants.

Specific recommendations for Policy Formulations, extensions of legal provisions for conservation and sustainable utilization of medicinal plants were developed based on the findings of this study. Finally, lists of 201 Threatened Medicinal plants have been proposed for inclusion as **Plant Schedules** in Wildlife (Protection) Act / Biological Diversity Act.

## 6.7. Significance

1. Generation of thematic maps on many themes, (e.g. geology, elevation and relief, slope, geomorphology, drainage, slope, bio-climate, soil etc), all in common geo reference can be used in GIS domain for modeling. To prepare maps on MPs with its environmental entity (with all abiotic and biotic parameters) using geospatial techniques is a model study.

2. Methodology used to study various aspects of natural resources is depicted in self explanatory flow charts which could be of much use to users. Digital database is an ideal format for data analysis and planning. Methodology evolved could be used for places of biodiversity importance in similar places / in any unit area.
3. Creation of a Conservation Development Model and Action Plan, a real need of the hour has been suggested for selected species. Modeling for strategic management and conservation by prioritization of threatened MPs of any unit area as generated in this study will have much application value to develop protocol for similar purposes for any other area.
4. The findings provide necessary input for the policy makers to evolve conservation strategies, formulate negative list of MPs from the threatened groups of plants so that this can be well protected by using appropriate Plant Schedule.
5. Inventory of MPs and the development of plant specific recovery plan are the most valuable inputs for field executives to conserve and argue the TMPs.
6. The study has identified the problems and prospects of medicinal plant sector in the country and accordingly prescribed necessary management strategies to overcome the same in a comprehensive way based on detailed field survey as a pilot study. The methodology and approach dealt here can be applied for any unit area for better management of this resource.

Figure 6.7 – List of Threatened Medicinal Plants proposed as *Plant Schedules* under Wildlife (Protection) Act / Biological Diversity Act

**PROPOSED PLANT SCHEDULES**  
(Covers Totally 201 Threatened Medicinal Plants)

**PLANT SCHEDULE - I**  
Part - I (31) Part - II (50) & Part - III (44)  
Covers 125 plants

**PLANT SCHEDULE - II**  
Covers 51 plants  
(Plant Species declared as Globally Vulnerable  
(Endemic to India and Nationally Endangered))

**PLANT SCHEDULE - III**  
Covers 25 plants  
Plant Species declared Globally near  
Threatened (Endemic to India) and  
Nationally Endangered)

**Part - I - (27+4) = 31 Plants**  
Species already existing under Schedule - VI of the Wild life (Protection) Act 1972 & Partly under Govt. of India, Ministry of Commerce Notification. No (RE-98) / (1997-2002)

- Aconitum falconeri* Stapf var. *falconeri*
- Aconitum ferox* Wall. ex Ser.
- Aconitum kashmiricum* Stapf ex Coventry Syn. *Aconitum heterophyllum* var. *bracteatum* Stapf
- Aquilaria malaccensis* Lam. (Agarwood)
- Ceropegia beddomei* Hook. f.
- Ceropegia omissa* H. Huber
- Coptis teeta* Wall.
- Coscinium fenestratum* Colebr. (Calumba wood)
- Cyathea nilgirensis* Holttum (Tree Ferns)<sup>1</sup>
- Cycas beddomei* Dyer (Beddome's cycad)
- Cycas circinalis* L.
- Dactylorhiza hatagirea* (D. Don) Soo
- Dioscorea deltoidea* Wall. ex Griseb (Elephant's foot)
- Euphorbia katrajensis* Gage
- Euphorbia panchganiensis* Blatt. & McCann
- Frerea indica* Dalzell. (Shindal Mankundi)
- Gentiana kurroo* Koylu (Kuru, Kutki)
- Gnetum ula* Brong.
- Kaempferia galanga* L.
- Nepenthes khasiana* Hook. f. (Pitcher plant)
- Panax pseudoginseng* Wall.
- Paphiopedilum druryi* (Bedd.) Pfitzer (Lady's Slipper Orchid) Syn. *Cypripedium druryi* Bedd.<sup>3</sup>
- Picrorhiza kurrooa* Royle ex Benth.
- Podophyllum hexandrum* Royle (Indian Podophyllum) Syn. *Sinopodophyllum hexandrum* (Royle) T.S. Ying
- Pterocarpus santalinus* L.f. (Red Sanders)
- Rauvolfia serpentina* Benth. ex Kurz (Sarpagandha)
- Renanthera imschootiana* Rolfe (Red vanda)
- Saussurea costus* (Falc.) Lipsch. Syn. *Aucklandia costus* Falc.
- Swertia macrosperma* C.B. Clarke (Charayatah)
- Taxus wallichiana* Zucc. (Common Yew or Birmi leaves)
- Vanda coerulea* Griff. ex Lindl. (Blue vanda)

(28 Illustrations provided)

**Part - II - 50 Plants**  
Plant Species, declared as Extinct in wild, Globally Critically Endangered, (Endemic to India)

**A. CAMP in South India<sup>1</sup>**

- Adhatoda beddomei* C.B. Clarke (CR./G)
- Aerva wightii* Hook. f. (Ex)
- Asparagus rottleri* Baker (Ex)
- Biophytum insignis* Gamble<sup>2</sup>
- Cayratia pedata* (Lam.) Juss. ex Gagnep. var. *glabra* Gamble (CR./G)<sup>3</sup>
- Dioscorea wightii* Hook. f.<sup>3</sup>
- Eugenia discifera* Gamble<sup>3</sup>
- Eugenia singampattiana* Bedd.<sup>3</sup>
- Eulophia cullenii* (Wight) Blume (CR./G)
- Eulophia dabia* (D. Don) Hochr. (CR./G)
- Euodia lunu-ankenda* (Gaertn.) Merr. var. *tirunelvelica* A.N. Henry & Chandr.<sup>3</sup>
- Garcinia travancorica* Bedd. (CR./G)<sup>3</sup>
- Janakia arayalpathra* J. Joseph & V. Chandras (CR./G)
- Decalepis arayalpathra* (J. Joseph & V. Chandras.) Venter<sup>3</sup>
- Knoxia sumatrensis* (Retz.) DC. var. *linearis* Bhattacharjee & Deb<sup>3</sup>
- Madhuca insignis* H.J. Lam. (Ex)
- Phyllanthus singampattianus* (Seb. & A.N. Henry) Kum. & Chandrab.<sup>3</sup>
- Piper barberi* Gamble (CR./G)<sup>3</sup>
- Pogostemon travancoricus* Bedd. var. *travancoricus*<sup>3</sup>
- Shorea tumbuggaia* Roxb. (CR./G)
- Syzygium gambleanum* Rathakar. & Chithra<sup>3</sup>
- Syzygium parameswaranii* M. Mohanan & A.N. Henry<sup>3</sup>
- Syzygium rama-varmae* (Bourd.) Chithra<sup>3</sup>
- Syzygium travancoricum* Gamble (CR./G)<sup>3</sup>
- Teucrium plectranthoides* Gamble<sup>3</sup>
- Trichopus zeylanicus* Gaertn. var. *travancoricus* (Bedd.) Burkill. K. Narayanan (CR./G)<sup>3</sup>
- Trichosanthes anaimalaiensis* Bedd. (CR./G)
- Uleria salicifolia* Bedd. (CR./G)
- Valeriana leschenaultii* DC. (CR./G)
- Vateria macrocarpa* B.L. Gupta (CR./G)
- Vernonia gossypina* Gamble<sup>3</sup>

**B. CAMP in North India<sup>2</sup>**

- Aconitum balfourii* Stapf var. *balfourii*
- Aconitum deinorrhizum* Stapf – CR-NW Syn. *Aconitum heterophyllum* (Brühl) Stapf
- Aconitum heterophyllum* Wall. ex Royle – CR-NW
- Aconitum violaceum* Jacquem. ex Stapf – CR-NW
- Acorus calamus* L. – CR-NE
- Angelica glauca* Edgew. – CR-NW
- Arnebia benthamii* (Wall. ex G. Don) I.M. Johnston. – CR-NW
- Atrapa acuminata* Royle ex Lindl. – CR-NW
- Berberis kashmirana* Ahrendt – CR-NW
- Craterostigma plantagineum* Hochst. – CR-CEN
- Curcuma caesia* Roxb. – CR-CEN
- Delphinium denudatum* Wall. ex Hook. f. & Thoms. – CR-NW
- Fritillaria roylei* Hook. – CR-NW Syn. *Fritillaria cirrhosa* D. Don.
- Ilex khasiana* Purakay. – CR-NW
- Inula racemosa* Hook. f. – CR-NW
- Luwunga scandens* (Roxb.) Buch. - Ham. ex Wight & Arn. – CR-NE
- Miconia aculeata* Royle – CR-NE
- Nardostachys jatamansi* DC. – CR-NE
- Prezowskia tangutica* – CR-NE
- Valeriana jatamansi* Jones. – CR-NE

(47 Illustrations provided)

**Part - III - 44 Plants**  
Plant Species declared as Globally Endangered (Endemic to India and Nationally Critically Endangered)

**A. CAMP in South India<sup>1</sup>**

- Acranthera grandiflora* Bedd.<sup>3</sup>
- Anoectochilus elatus* Lindl.<sup>3</sup>
- Biophytum longibracteatum* Tadul. & K.C. Jacob<sup>3</sup>
- Cyclea fissicalyx* Dunn
- Decalepis hamiltonii* Wight & Arn.
- Diotacanthus albiflorus* (Bedd.) Benth.<sup>3</sup>
- Dipterocarpus indicus* Bedd.
- Dysoxylum malabaricum* Bedd. ex C. DC.
- Elaeocarpus venustus* Bedd.<sup>3</sup>
- Elatostema lineolatum* Wight var. *setosum* A.N. Henry<sup>3</sup>
- Gymnema khandalense* Santapau
- Gymnema montanum* (Roxb.) Hook. f.
- Heliotropium keralense* Sivarajan & Manilal
- Hopea utilis* (Bedd.) Bole<sup>3</sup>
- Hydnocarpus macrocarpa* (Bedd.) Warb.<sup>3</sup>
- Lamprachaenium microcephalum* Benth.
- Madhuca diplostemon* (C.B. Clarke) P. Royen
- Nilgirianthus ciliatus* (Nees) Bremek.
- Palaquium bourdillonii* Brandis<sup>2</sup>
- Poeciloneuron pauciflorum* Bedd.<sup>3</sup>
- Popowia beddomeana* Hook. f. & Thoms.<sup>3</sup>
- Semecarpus travancorica* Bedd.<sup>3</sup>
- Stenosiphonium parviflorum* T. And.<sup>3</sup>
- Strychnos aenea* A.W. Hill
- Swertia lawii* (C.B. Clarke) Burkill
- Syzygium zeylanicum* (L.) DC. var. *ellipticum* A.N. Henry, Chandrab. & Nair Syn. *Syzygium zeylanicum* (L.) DC.<sup>3</sup>
- Thottea barberi* (Gamble) Ding Hou<sup>3</sup>
- Vernonia penisularis* (C.B. Clarke) ex Hook. f. var. *kodayarensis* A.N. Henry & Gopalan<sup>3</sup>
- Vernonia ramosvaransii* Hutch<sup>3</sup>
- Vernonia travancorica* Hook. f.<sup>3</sup>

**B. CAMP in North India<sup>2</sup>**

- Berberis aristata* DC. – EN-NW
- Berberis lycium* Royle – EN-NW
- Bunium persicum* (Boiss.) B. Fedtsch. – EN-NW
- Gastrochilus longiflorus* Wall. – EN-NE Syn. *Boesenbergia longiflora* (Wall.) Kuntze
- Gloriosa superba* L. – EN-CEN
- Heracleum candicans* Wall. Ex DC. – EN-NW
- Hydnocarpus kurzii* (King) Warb. – EN-NE
- Lavatera cashmeriana* Cambess. – EN-NW
- Polygonatum verticillatum* (L.) All. – EN-NW
- Rheum nobile* Hook. f. & Thoms. – EN-NE
- Saussurea gossypiphora* D. Don. – EN-NW
- Saussurea obvelata* (DC.) Edgew. – EN-NW
- Saussurea simpsoniana* (Fielding & Gardner) Lipsch. – EN-NW
- Swertia angustifolia* Buch. – Ham. ex D. Don

(42 Illustrations provided)

**A. CAMP in South India<sup>1</sup>**

- Aglaia elaeagnoidea* (Juss.) Benth. var. *bourdillonii* (Gamble) K.K.N. Nair<sup>3</sup>
- Amorphophallus commutatus* (Schott) Engl. (VU/G)
- Ampelocissus araneosa* (Dalzell.) Gamble (VU/G)
- Artocarpus hirsutus* Lam. (VU/G)
- Baccaurea courtallensis* Muell. - Arg.<sup>3</sup>
- Bentinckia condapanna* Berry<sup>3</sup>
- Calophyllum apetalum* Willd. (VU/G)
- Capparis diversifolia* Wight & Arn.<sup>3</sup>
- Cayratia tenuifolia* Gagnep.<sup>3</sup>
- Cinnamomum macrocarpum* Hook. f. (VU/G)
- Cinnamomum sulphuratum* Nees (VU/G)
- Curcuma pseudomontana* J. Graham (VU/G)
- Diospyros candolleana* Wight. (VU/G)
- Diospyros paniculata* Dalzell. (VU/G)
- Elaeocarpus munronii* Mast. (VU/G)<sup>3</sup>
- Garcinia gummi-gutta* (L.) Roxb. (VU/G)
- Garcinia indica* (Thouars) Choisy (VU/G)
- Hedyotis eualata* (Gamble) A.N. Henry & Subr. var. *agastyamalayana* A.N. Henry & Subr.<sup>3</sup>
- Hedyotis travancorica* Bedd.<sup>3</sup>
- Heracleum candolleianum* (Wight & Arn.) Gamble (VU/G)
- Holostemma annulare* (Roxb.) K. Schum (VU/G) Syn. *Holostemma ada-kodien* Schult.
- Humboltia vahliana* Wight (VU/G)
- Hydnocarpus alpina* Wight (VU/G)<sup>3</sup>
- Hydnocarpus pentandra* (Buch.-Ham.) Oken (VU/G)<sup>3</sup>
- Kingiodendron pinnatum* (Roxb. ex DC.) Harms.<sup>3</sup>
- Meteoromyrtus wynadenis* (Bedd.) Gamble<sup>3</sup>
- Myristica malabarica* Lam. (VU/G)
- Ochreinauclea missionis* (Wall. ex G. Don) Ridsdale (VU/G)
- Piper nigrum* L. (VU/G)
- Plectranthus nilgherriensis* Benth. (VU/G) Syn. *Isodon nilgherriensis* (Benth.) H. Hara
- Saprosma corymbosum* (Bedd.) Bedd.<sup>3</sup>
- Strophanthus wightianus* Wall. ex Wight<sup>3</sup>
- Swertia corymbosa* Wight ex Griseb. (VU/G)
- Syzygium calcadense* (Bedd.) Chandras. Syn. *Eugenia calcadensis* Bedd. (CR)<sup>3</sup>
- Tragia bicolor* Miq. (VU/G)

**B. CAMP in North India<sup>2</sup>**

- Berberis chitria* Buch. - Ham ex Lindl. – VU-NW
- Bergenia ligulata* (Wall.) ex Engl. – VU-NW Syn. *Bergenia pacumbis* (Buch. - Ham. ex D. Don) C.Y. Wu & J.T. Pan
- Clerodendrum colebrookianum* Walp. – VU-NE
- Clerodendrum serratum* (L.) Moon – VU-CEN
- Curculigo orchoides* Gaertn. – VU-CEN
- Curcuma angustifolia* Roxb. – VU-CEN
- Gymnema sylvestre* (Retz.) Schult. – VU-CEN
- Hedychium spicatum* Sm. – VU-NW
- Ipomoea turpethum* (L.) R. Br. – VU-CEN
- Paeonia emodi* Wall. ex Royle – VU-NW
- Rheum australe* D. Don. – VU-NW
- Rhododendron anthopogon* D. Don. – VU-NE
- Rhus semialata* Murray – VU-NE
- Thalictrum foliolosum* DC. – VU-NW
- Tylophora indica* (Burm. f.) Merr. – VU-CEN
- Urginea indica* (Roxb.) Kunth – VU-CEN

(51 Illustrations furnished)

**A. CAMP in South India<sup>1</sup>**

- Aglaia barberi* Gamble<sup>3</sup>
- Capparis fusifera* Dunn<sup>3</sup>
- Drosera indica* L. (LR-NT-R)
- Embelia ribes* Burm. f. (LR-NT-G)
- Gardenia gummifera* L. f. (LR-NT-G)
- Glycosmis macrocarpa* Wight (LR-NT-G)
- Hedychium coronarium* J. Koenig (LR-NT-R)
- Hedyotis albionerva* Bedd.<sup>3</sup>
- Hedyotis viscida* Bedd.<sup>3</sup>
- Knema attenuata* (Hook. f. & Thomson) Warb. (LR-NT-G)
- Nothopegia heyneana* (Hook. f.) Gamble<sup>3</sup>
- Octotropis travancorica* Bedd.<sup>3</sup>
- Operculina turpethum* (L.) Silva Manso (LR-NT-R)
- Orophea uniflora* Hook. f. & Thomson Wazuz<sup>3</sup>
- Piper longum* L. (LR-NT-R)
- Pseudarthria viscidula* (L.) Wight & Arn. (LR-NT-R)<sup>3</sup>
- Pueraria tuberosa* (Roxb. ex Willd.) DC. (LR-NT-R)
- Symplocos cochinchinensis* (Lour.) Moore (LR-NT-R)
- Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. (LR-NT-R)
- Vateria indica* L. (LR-NT-G)

**B. CAMP in North India<sup>2</sup>**

- Baliospermum montanum* (Willd.) Muell. - Arg. – LR-NT-CEN
- Celastrus paniculatus* Willd. – LR-NT-CEN
- Cinnamomum tamala* T. Nees & Eberm. - LT/NT-NW
- Cordia rothii* Roem. & Schult. – LR/NT-CEN Syn. *Cordia sinensis* Lam.
- Jurinea dolomiaea* Boiss. – LR/NT-NW

(25 Illustrations furnished)

**IUCN RED LIST CATEGORIES**

Ex – Extinct  
EW – Extinct in Wild  
CR – Critically Endangered  
En – Endangered  
Vu – Vulnerable  
LR – Low Risk  
LR-cd – Low Risk conservation dependent  
LR-nt – Low Risk Near Threatened  
LR-lc – Low Risk least concern  
DD – Data Deficient  
NE – Not Evaluated  
G – Globally  
R – Regionally

1. Based on the Conservation Assessment and Management Plan (CAMP) Workshop conducted by FRLHT, Bangalore during 1994-1998;  
2. Based on the Conservation Assessment and Management Plan (CAMP) workshop process WWF, India; Zoo/CBSG, India; UP Forest Department, Lucknow. 1997;  
3. Conservation Assessment and Management Plan (CAMP) by the Author based on Results of the Field Study in KMTR during 2004-2009.



Plate 6.1 A - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - I (Photographs : 28/31)



*Aconitum falconeri*  
Stapf var. *falconeri*



*Aconitum ferox* Wall. ex Ser.



*Aconitum kashmiricum*  
Stapf ex Coventry



*Aquilaria malaccensis* Lam.



*Coptis teeta* Wall.



*Coscinium fenestratum*  
Colebr.



*Cyathea nilgirensis*  
Holttum



*Cycas beddomei*  
Dyer Bedd.



*Cycas circinalis* L.



*Dactylorhiza hatagirea*  
(D. Don) Soo



*Dioscorea deltoidea* Wall. ex Griseb



*Euphorbia panchganiensis*  
Blatt & McCann



*Frerea indica* Dalzell.  
(Shindal Mankundi)



*Gentiana kurroo* Royle  
(Kuru, Kutki)

Plate 6.1 B - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - I (Photographs : 28/31)



*Gnetum ula* Brong.



*Kaempferia galanga* L.



*Nepenthes khasiana* Hook. f.



*Panax pseudoginseng* Wall.



*Paphiopedilum druryi* (Bedd.) Pfitzer



*Picrorhiza kurroa*  
Royle ex Benth.



*Podophyllum hexandrum* Royale



*Pterocarpus santalinus* L. f.



*Rauvolfia serpentina* Benth. ex Kurz



*Renanthera imschootiana*  
Rolfe (Red vanda)



*Saussurea costus* Falc.



*Swertia macrosperma* C.B. Clarke



*Taxus wallichiana* Zucc.



*Vanda coerulea* Griff.  
ex Lindl. (Blue vanda)

Plate 6.2 A - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - II - CAMP in South India (Photographs : 28/30)



*Adhatoda beddomei* C.B. Clarke



*Aerva wightii* Hook. f.



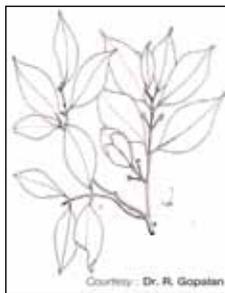
*Biophytum insignis* Gamble



*Cayratia pedata* (Lam.) Juss. ex Gagnep. var. *glabra* Gamble



*Dioscorea wightii* Hook. f.



*Eugenia discifera* Gamble



*Eugenia singampattiana* Bedd.



*Eulophia dabia*  
(D. Don) Hochr.



*Euodia lunu-ankenda* (Gaertn.) Merr. var. *tirunelvelica* A.N. Henry & Chandr.



*Garcinia travancorica* Bedd.



*Janakia arayalpathra*  
Joseph & V. Chandras.



*Knoxia sumatrensis* (Retz.) DC. var. *linearis* Bhattacharjee & Deb.



*Madhuca insignis* H.J. Lam.



*Phyllanthus singampattianus*  
(Seb. & A.N. Henry) Kum. & Chandr

Plate 6.2 B - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - II - CAMP in South India (Photographs : 28/30)



*Piper barberi* Gamble.



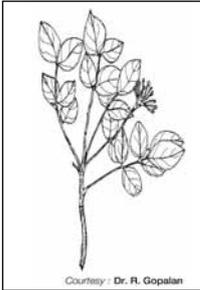
*Pogostemon travancoricus* Bedd.



*Shorea tumbergaia* Roxb.

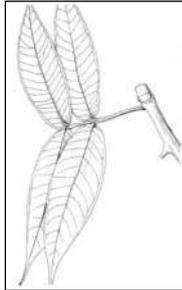


*Syzygium gambleanum* Rathakr. & Chithra



Courtesy: Dr. R. Gopalan

*Syzygium parameswaranii* M. Mohanan & A.N. Henry



*Syzygium rama-varmae* Bourd. Chithra



*Syzygium travancoricum* Gamble



*Teucrium plectranthoides* Gamble



*Trichopus zeylanicus* Gaertn. var. *travancoricus* (Bedd.) Burkill. K. Narayanan



*Trichosanthes animalaiensis* Bedd.



*Utteria salicifolia* Bedd.



*Valeriana leschenaultii* DC.



*Vateria macrocarpa* B.L. Gupta



*Vernonia gossypina* Gamble



Plate 6.2 C - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - II - CAMP in North India (Photographs : 19/20)



*Aconitum balfourii*  
Stapf var. *balfourii*

*Aconitum deinorrhizum*  
Stapf

*Aconitum heterophyllum* Wall. ex Royle

*Aconitum violaceum*  
Jacquem. ex Stapf



*Acorus calamus* L.

*Angelica glauca* Edgew.

*Arnebia benthamii*  
(Wall. ex G. Don) I.M. Johnst.

*Atropa acuminata*  
Royle ex Lindl.

*Craterostigma  
plantagineum* Hochst.



*Curcuma caesia* Roxb.

*Delphinium denudatum*  
Wall. ex Hook. f. & Thoms.

*Fritillaria roylei* Hook.

*Ilex khasiana* Purakay.

*Inula racemosa* Hook. f.



*Luvunga scandens* (Roxb.)  
Buch. - Ham. ex Wight & Arn.

*Meconopsis aculeata* Royle

*Nardostachys jatamansi* DC.

*Prezwalskia tangutica*

*Valeriana jatamansi* Jones.

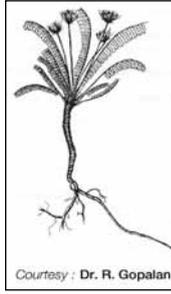
Plate 6.3 A - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - III - CAMP in South India (Photographs : 28/30)



*Acranthera grandiflora* Bedd.

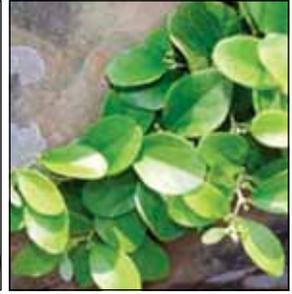


*Anoectochillus elatus* Lindl.



Courtesy : Dr. R. Gopalan

*Biophytum longibracteatum*  
Tadul. & K.C. Jacob



*Cyclea fissicalyx* Dunn



*Decalepis hamiltonii*  
Wight & Arn.



*Diotacanthus albiflorus*  
(Bedd.) Benth.



*Diptercarpus indicus*  
Bedd.



*Dysoxylum malabaricum* Bedd. ex C.DC.



*Elaeocarpus venustus* Bedd.



*Elatostema lineolatum* Wight  
var. *setosum* A.N.Henry



*Gymnema khandalense*  
Santapau



*Gymnema montanum*  
(Roxb.) Hook. f.



*Hopea utilis* (Bedd.) Bole



*Hydnocarpus macrocarpa* (Bedd.) Warb.

Plate 6.3 B - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - III - CAMP in South India (Photographs : 28/30)



*Lamprachaenium microcephalum*  
Benth.



*Madhuca diplostemon*  
(C.B. Clarke) P. Royen



*Nilgirianthus ciliatus* Nees Bremek.



*Palaquium bourdillonii*  
Brandis



*Poeciloneuron pauciflorum*  
Bedd.



*Popowia beddomeana*  
Hook. f. & Thoms



*Semecarpus travancorica* Bedd.



*Swertia lawii* C.B. Clarke Burkill



*Stenosiphonium parviflorum* T. And.



*Syzygium zeylanicum* (L.) DC. var. *ellipticum*  
A.N. Henry, Chandrab. & Nair



*Thottea barberi* (Gamble) Ding Hou



*Vernonia penisularis* (C.B. Clarke) ex Hook. f. var.  
*kodayarensis* A.N. Henry & Gopalan



*Vernonia ramaswamii* Hutch.



*Vernonia travancorica* Hook. f.

Plate 6.3 C - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - I  
Part - III - CAMP in North India (Photographs : 14/14)



*Berberis aristata* DC.



*Berberis lycium*  
Royle



*Bunium persicum* Boiss.  
B. Fedtsch.



*Gastrochilus longiflorus* Wall.



*Gloriosa superba* L.



*Heracleum candicans* Wall. ex DC.



*Hydnocarpus kurzii* (King) Warb.



*Lavatera cashmeriana*  
Cambess.



*Polygonatum verticillatum* L.



*Rheum nobile*  
Hook. f. & Thoms.



*Saussurea gossypiphora*  
D. Don



*Saussurea obvelata* (DC.) Edgew.



*Saussurea simpsoniana*  
(Fielding & Gardner) Lipsch.



*Swertia angustifolia*  
Buch. - Ham. ex D. Don

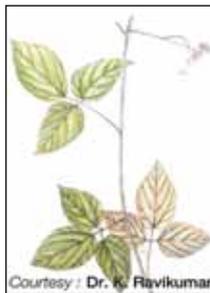
Plate 6.4 A - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - II  
CAMP in South India (Photographs : 35/35)



*Aglaia elaeagnoidea* Juss. Benth.  
var. *bourdillonii* Gamble K.K.N. Nair



*Amorphophallus commutatus* (Schott) Engl.



*Ampelocissus araneosa*  
Dalzell. Gamble



*Artocarpus hirsutus* Lam.



*Baccaurea courtallensis*  
Muell. - Arg.



*Bentinckia condapanna* Berry



*Calophyllum apetalum*  
Willd.



*Capparis diversifolia*  
Wight & Arn.



*Cayratia tenuifolia* Gagnep.



*Cinnamomum macrocarpum* Hook. f.



*Cinnamomum sulphuratum* Nees



*Curcuma pseudomontana* J. Graham



*Diospyros candolleana* Wight



*Diospyros paniculata* Dalzell.

Plate 6.4 B - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - II  
CAMP in South India (Photographs : 35/35)



*Elaeocarpus munronii* Mast.



*Garcinia gummi-gutta* (L.) Roxb.



*Garcinia indica*  
(Thouars) Choisy



*Hedyotis eualata* (Gamble) A.N. Henry &  
Subr. var. *agastyamalayana*



*Hedyotis travancorica*  
Bedd.



*Heracleum candolleianum*  
(Wight & Arn.) Gamble



*Holostemma annulare* (Roxb.) K. Schum



*Humboldtia vahliana* Wight



*Hydnocarpus alpina*  
Wight



*Hydnocarpus pentandra*  
(Buch. - Ham.) Oken



*Kingiodendron pinnatum*  
(Roxb.) ex DC Harms



*Meteoromyrtus wynaadensis*  
(Bedd.) Gamble



*Myristica malabarica* Lam.



*Ochreinauclea missionis*  
Wall. ex G. Don Ridsdale

Plate 6.4 C - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - II  
CAMP in South India (Photographs : 35/35)



*Piper nigrum* L.



*Plectranthus nilgherricus* Benth.



*Saprosma corymbosum*  
(Bedd.) Bedd.



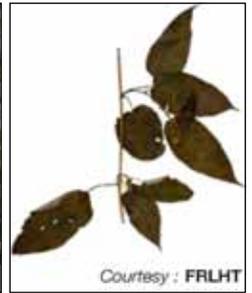
*Strophanthus wightianus*  
Wall. ex Wight



*Swertia corymbosa* Wight ex Griseb.



*Syzygium calcadense* (Bedd.) Chandras.



*Tragia bicolor* Miq.

Plate 6.4 D - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - II  
CAMP in North India (Photographs : 16/16)



*Berberis chitria* Buch. -  
Ham ex Lindl.



*Bergenia ligulata* Wall. ex Engl.



*Clerodendrum colebrookianum*  
Walp.



*Clerodendrum serratum*  
(L.) Moon



*Curculigo orchiooides* Gaertn.



*Curcuma angustifolia* Roxb.



*Gymnema sylvestre*  
(Retz.) Schult.



*Hedychium spicatum* Sm



*Ipomoea turpethum* (L.) R. Br



*Paeonia emodi* Wall. ex Royle



*Rheum australe* D. Don



*Rhododendron anthopogon*  
D. Don



*Rhus semialata* Murray



*Thalictrum foliolosum* DC.

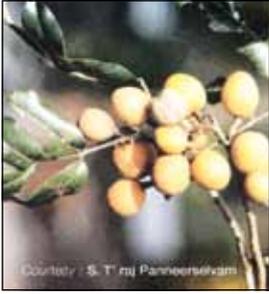


*Tylophora indica* (Burm. f.) Merr.



*Urginea indica* (Roxb.) Kunth

Plate 6.5 A - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - III  
CAMP in South India (Photographs : 20/20)



*Aglaia barberi* Gamble



*Capparis fusifera* Dunn



*Drosera indica* L.



*Embelia ribes* Burm f.



*Gardenia gummiifera* L. f.



*Glycosmis macrocarpa* Wight



*Hedychium coronarium* J. Koenig



*Hedyotis albonerva*  
Bedd.



*Hedyotis viscida* Bedd.



*Knema attenuata* Hook. f. &  
Thomson Warb



*Nothopegia heyneana* Hook. f. Gamble



*Octotropis travancorica*  
Bedd.



*Operculina turpethum*  
(L.) Silva Manso



*Orophea uniflora* Hook. f. &  
Thomson Wazzu



*Piper longum* L.



*Pseudarthria viscida*  
(L.) Wight & Arn.

Plate 6.5 B - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - III  
CAMP in South India (Photographs : 20/20)



*Pueraria tuberosa* (Roxb. ex Willd.) DC.

*Symplocos cochinchinensis*  
(Lour.) Moore

*Terminalia arjuna* (Roxb. ex DC.)  
Wight & Arn.



Courtesy : V. Chelladurai

Courtesy : Dr. K. Ravikumar

*Vateria indica* L.

Plate 6.5 C - ILLUSTRATIONS OF SPECIES PROPOSED IN PLANT SCHEDULE - III  
CAMP in North India (Photographs : 5/5)



*Baliospermum montanum* (Willd.)  
Muell. - Arg.

*Celastrus paniculatus* Willd.

*Cinnamomum tamala* T. Nees & Eberm



*Cordia rothii* Roem. & Schult.

*Jurinea dolomiaea* Boiss

## Chapter – VII

# Conclusions

The importance of the MPs sector can be understood from the fact that herbal medicines serve the health care needs of about 70 to 80 per cent of the world's population (WHO). The demand for herbal medicines is growing in developing as well as in developed countries. This has renewed interest by the multinational pharmaceutical industry in bio- prospecting. But the lack of national legislation or effective international agreements on conservation of biodiversity has resulted in 'destructive harvesting' of MPs and massive depletion of biodiversity leading to more than 1000 MP species in threat category.

Analysis of the overall issues related to management of MPs indicates that major policy gaps exist in three areas of the management in the country. These are:

- i) Policy gaps leading to MP resource depletion and handicapping resource augmentation.
- ii) Loopholes in existing policy framework in organizing trade of MPs and its by-products transparently.
- iii) Lack of organizational network in promoting Indian System of Medicine (ISM).

Issues about the Policy gaps in all the 3 major segments have been discussed in detail earlier.

The first two of these gaps have been discussed in detail above. For promotion of ISM, the active involvement of the Government of India is required in policy decisions, promotional strategy and investment in the ISM colleges and research institutes. Today more than 880 MP species are used in over 50,000 herbal formulations; the codified medical tradition has nearly 7 lakh registered medical practitioners, and 9000 registered and licensed manufacturing units, but the growth of the ISM sector has stagnated over the years. Teaching and research institutes, including the Central Council for Research in Ayurveda

and Siddha, need to be strengthened with quality inputs. Public awareness of ISM needs to be created, and public and private partnership for building the domestic herbal industry encouraged. In addition the existing curriculum of the Medical Colleges in India should incorporate the uniqueness of the Herbal based medicines.

Finally, the export, import and other policies of the government have to be re-examined, and many legal, technical and regulatory gaps need to be plugged so that trade in MPs can be effectively monitored.

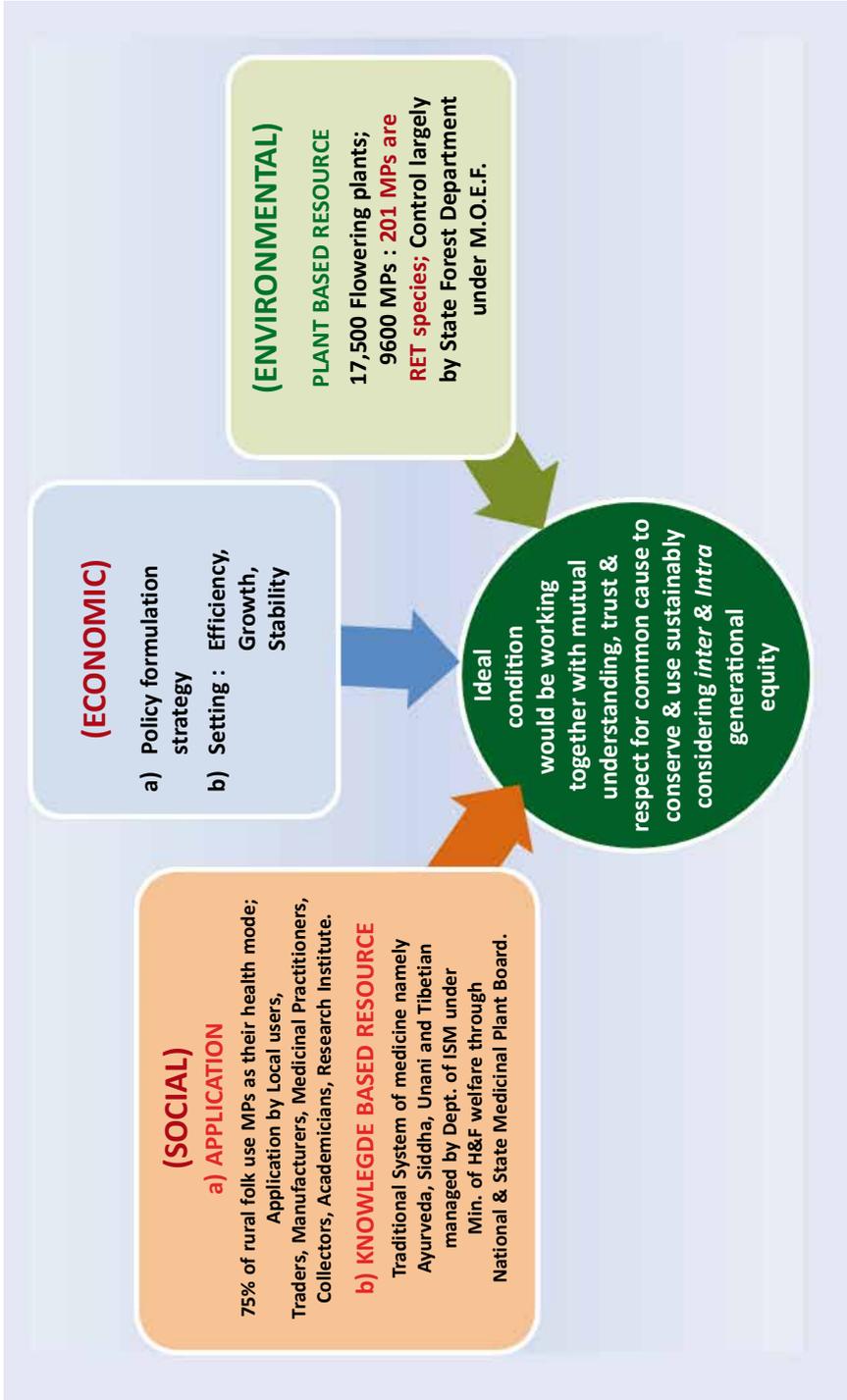
According to Raven (1990)<sup>56</sup>, *“It is likely that a quarter of all species of Indian plants may be either extinct or on way to extinction within 25 years, and the great majority of the species present now are likely to be extinct within a century if proper conservation efforts are not in place and in time”*

Given the extent of biodiversity in India, a major task of all the concerned including the policy planners has to be the identification and guided development of new products with large export potential. However, the fact that all MPs are not amenable for cultivation should not be ignored. Hence, conservation and cultivation must go together with prioritization for development of the MPs sector as a whole. Effective policy making for this sector calls for awareness raising, coordination and engagement of all the stakeholders.

The available flexibility under TRIPS provisions should be utilised fully for protecting the pool of our plant genetic resources and traditional knowledge in an effective way. It is equally important that the interests of the growers are well protected by supply of modern technologies, services and credit supplies and above all a good marketing system. The national policy should have effective provisions for ensuring equitable benefit sharing for all stakeholders. This would go a long way in fulfilling traditional health care needs and ensuring conservation and sustained utilisation of medicinal plant resources of the country. A system of modelling of sustainable development of MPs can be thought of based on perspective of problem and identification of stakeholders of MPs as shown in **Figure – 7.1**.

56 Raven, P.H. 1990. ‘The Politics of Protecting Biodiversity’, Bio Science, Vol. 40, pp. 769.774.

Figure 7.1 – Perspective of problem and identification of stakeholders



The protection and management of natural resources need support of various kinds – effective regulations, institutional mechanism and strong legislative support. Systematic short term and long term planning are equally necessary. It is high time for the custodians of these valuable resources, as well as the authorities of ISM and the policy makers for trade and environment, to revamp the existing policy framework and management strategies. Systematic, coordinated and concerted efforts by all the stakeholders to manage both the resources and the technology will ensure that the rich potential of the sector is realised in a sustainable manner.

As a member of the custodian family from Indian Forest Service it becomes mandatory on my part that the findings, research propositions and recommendations of the study are brought to the notice of the policy makers so as to evolve correct plan of actions and appropriate schedules for the conservation of seriously affected flora and thereby the sustainable benefits flow to my countrymen.

