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ENVIRONMENTAL IMPACT ASSESSMENT OF PILGRIMAGE IN AGASTHYAMALAI REGION

(Final Report of Project KFRI 350/2000)

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ABSTRACT OF PROJECT PROPOSAL

Project No.	:	KFRI 350/2000
Title of the project	:	Environmental impact assessment of pilgrimage in Agasthyamalai region
Objectives	:	1. To conduct the initial environmental examination of the region. 2. To determine the pilgrimage activities 3. To asses the environmental and social impact of pilgrimage. 4. To create an awareness towards an Eco-friendly pilgrimage. 5. To suggest integrative measures to minimize the impact of pilgrimage on the environment.
Expected outcome	:	The output of the impact assessment of the pilgrimage will provide possible integrative measures and guidelines leading to sustainable and ecofriendly pilgrimage. The field implementation of the results of the study will help to create a local institution capable of managing ecofriendly pilgrimage.
Date of commencement	:	April 2000
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Funded by	:	Kerala Forestry Project (World Bank) Kerala Forest Department
Principal Investigator	:	K.V. Mohammed Kunhi
Co-Investigator	:	Dr. S. Sankar

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ABSTRACT

Agasthyamalai, popularly called Agasthyarkoodam, is a landmark on the eastern side of Thiruvananthapuram, known world over for its diverse and rich forests. Almost all types of vegetation found in the forests of the Western Ghats occur in the region. Agasthyarkoodam peak (1870 msl) abodes the shrine of Agasthyamuni. Pilgrims from Kerala and Tamil Nadu visit this place annually between January and April and worship Agasthyamuni, the doyen of Ayurveda. This pilgrimage involving thousands of pilgrims has been regulated from 1999 by the Kerala Forest Department. Being a hotspot of biodiversity, there is a growing concern over the degradation of the region and pilgrimage was attributed as one of the major reasons. This project, to assess the environmental impact of pilgrimage in Agasthyamalai region, was taken up to qualify the region, assess pilgrim activities and impacts so as to create awareness for ecofriendly pilgrimage and recommend measures to minimize the impact on environment.

During the year 2001, 3237 pilgrims visited Agasthyar peak from January to March.

Vegetation plots were taken in each forest type to characterize the forests and regeneration survey was conducted all along the route to assess the impact of trekking on the vegetation. The forest vegetation belongs predominantly to evergreen, semi-evergreen and moist deciduous types. There is a negative impact on regeneration due to visitation by trekkers all along the route. In total the impact due to pilgrimage adds fuel to the fire in the existing and continuing degradation of this unique biodiversity hotspot area. The increasing trends in number of pilgrims over the years raises anxiety, and calls for developing strategies to curtail detrimental factors.

Two Workshops (one with pilgrims and the other with Ecodevelopment Committee Members dealing with pilgrimage) were conducted to determine the aspirations and comments of these two important stakeholders.

Taking into consideration the EIA conducted by us, the deliberations of the Workshop and also the global concepts and tools for conservation and developing ecofriendly resource use, the following recommendations are made. Regulate the pilgrimage taking into account the sensitivity and supportive capacity of the site. Declare closure periods (rest years) so that nature can recuperate the damages. Create Institutions at the eco-development committee level so that they manage the pilgrimage and receive economic benefits. Create awareness among pilgrims and other stakeholders concerned on Agasthyamalai and provide strict guidelines for the conduct of ecofriendly pilgrimage. Measures to minimize the impact of pilgrimage in Agasthyamala have been identified.

INTRODUCTION

Agasthyamalai, popularly called Agasthyarkoodam, is a landmark on the eastern side of Thiruvananthapuram, known world over for its diverse and rich forests. Biogeogrpahically, the southern end of the Western Ghats, i.e. the Agasthyamalai region, is perhaps the richest area remaining fairly intact. Its location at the tip of the Peninsula, peculiar topography, physical isolation, well distributed rainfall, suitable temperature regimes, evolutionary history and absence of human interference till recently enabled it to support and retain extremely rich tropical ecosystems with proportionately a higher number of endemics and rare elements than any other part of the Ghats (Nair, 1991). This area abodes a large number of species of plants and lower animals not reported from elsewhere. There are a number of locations like the Agasthyar peak, Chemmunji, Kannikatty (in Tamil Nadu), etc. that are veritable hot spots of biological diversity. A number of species are found here within an extremely restricted locality.

In the undisturbed tracts of Agasthyamalai an altitudinal zonation of vegetation types can be observed. From an elevation of 30 m to 1700 m the vegetation changes from moist deciduous, to evergreen and to stunted montane evergreen to shola-grasslands in the higher reaches. Nair (1991) observes that these shola grasslands are different from those in the Palni hills and also in the High ranges of the Western Ghats.

Europeans initiated the earliest plantation activity in the southern Western Ghats in Agasthyamalai range. Evergreen forests were cleared in large tracts to give way for coffee, and to an extent, tea plantation. A good part of these plantations was abandoned and the vegetation transformed into reed brakes or grassy patches. Fortunately, the crest line parts of the Ghats were left untouched; however, in due course of time, man-made fires took toll of the remaining vegetation. Major river valley projects were initiated in this region, first in the form of water diversion weirs and later irrigation dams like Neyyar and drinking water project like Peppara.

Construction of motorable roads from the plains to the estates viz. Balamore, Bonacaud, Breymore, Merchinton, Pondumi, etc., contributed to the permanent brakes in the thick forest vegetation of Agasthyamalai. The displaced population of hill men, especially Kanis, due to development contributed to man-forest conflict and unsustainable forest management practices. The Forest Department too contributed to the conversion of the natural forests through clearfelling and rising of eucalypts and teak plantations and also extensive selection felling operations.

The pilgrimage to Agasthyar peak to worship Agasthyamuni, of late, is adding fuel to the fire by attracting thousands of pilgrims annually, who while trekking through the forests set fires and also damage the vegetation. Recently, the Kerala Forest Department has initiated steps to provide a regulatory framework to this pilgrimage so as to prevent further deterioration of this hot spot of biodiversity. This action has attained more importance in the context of declaration of the region as a Biosphere Reserve and Agasthyamalai region forming the core area of the same. This project to understand the impact of pilgrimage on the ecosystem and to evolve integrative measures has the following objectives:

1. To conduct an initial environmental examination of the region;
2. To determine pilgrimage activities;
3. To assess the environmental and social impact of pilgrimage;
4. To create awareness towards an ecofriendly pilgrimage and
5. To suggest integrative measures to minimize the impact of pilgrimage on the environment.

STUDY AREA AND METHODS

Study Area

Although Agasthyamalai region is spread over 2000 km^2 from the Aryenkavu pass in the north to Mahendragiri in the south, for the present study Agasthyamalai region has been defined as the area surrounding the impact zone of the pilgrimage. The area of the present investigation is spread over 200 km^2 around the pilgrim route from Bonacaud to Agasthyar peak (Fig. 1). This zone is situated within the Wildlife Sanctuaries of Peppara and Neyyar.

Details regarding geology, soils, climate and biodiversity are provided in the Initial Environmental Examination.

Methods

The following methods were adopted for the study:

Initial Environmental Examination

Biological

1. Flora and Fauna: Information on flora and fauna was compiled from published sources that are cited in the text.

2. Plots: Vegetation plots of 20 x 20 m were laid along the route, 10 plots in moist deciduous forests and four in semi evergreen and two in evergreen forest types. Phytosociological diversity analysis was carried out using the methodology described in Pascal (1988). Regeneration studies were carried out along the route according to Basha (1997) and Champion and Seth (1968).

3. Change in forest cover: Change in forest cover in the study area was done using the oldest available SOI topo sheets and the latest available satellite imageries. Forest cover pertaining to the year 1969 was taken from SOI toposheets while 1:50,000 scale IRS 1C LISS II geocoded FCC of 1999 was used to arrive at the present coverage. The information and maps were field checked and area identified using a digital planimeter.

Fig. Map of Study area

Socio-economic

1. Participant observation: Data were collected through participant observation during field trips on the human environment in the site and also pilgrim activities.
2. Questionnaire survey: Information on pilgrim characteristics, activities, interaction with people and nature was collected through questionnaire survey.
3. Workshops: Two workshops were conducted with stakeholders to find out their aspirations, needs and opinions about the pilgrimage.

Environmental and social impact assessment (EIA)

The EIA was designed as follows:

Impact Identification Matrix

The Impact Identification Matrix was constructed by placing the pilgrimage activities and associated components on one axis and the environmental and social attributes on the other.

Environmental and Social attributes

Cambridge International Dictionary defines attribute as a quality or feature of something. Here certain features of the physical, biological and social environment that are prone to negative or positive impacts due to the pilgrimage activities are listed out. These attributes are selected from an exhaustive checklist of general attributes that are drawn from writings and case studies on the impacts of tourism development from worldwide. While selecting these features care is taken to select the ones, which are close to the third world situation especially to the Kerala scenario. These attributes are categorised under two major heads, the ecological attributes and the social attributes. Overlapping categories are avoided in this process. This is attained by unwinding the thread of ecological features to the individual basic components and by identifying their key attributes relevant from the view point of the pilgrimage.

Similarly the attributes of social environment are also taken into account. Each of these selected attributes is described below:

Environmental Attributes

The environmental attributes identified under two classes biotic and abiotic are:

Flora, fauna, migration corridor, water, soil, watershed, water table and air.

1. Flora

Flora is considered as an attribute in a broader sense. The term intends to cover all kinds of plant life, in general, including introduced and indigenous cultivated and wild plants in homesteads and wilderness.

2. Fauna

Similar to that of flora, the category fauna also serves a general purpose indicating all kinds of faunal groups of the locality. Large-scale alteration of abiotic components such as soil, air and water by any project activity is considered detrimental to the local fauna.

3. Migration corridors, breeding grounds and watersheds

These are certain attributes of biotic components that need additional emphasis. These include migration corridors, breeding ground, water holes that are important for the wild animals. Any activity, which in short or long period, affects the quality or access of any of these, is considered detrimental from the view point of wildlife conservation.

4. Soil

Being one of the primary determinants of the ecological productivity, soil quality is important and is often affected by developmental activities. Soil quality is a general terminology used for indicating a variety of factors including nutrient status, particle size, porosity, moisture retention capacity, etc. Erosion of nutrients, finer particles and organic matter takes place due to excessive run off in disturbed soil. External inputs and waste materials also change the biological environment of the soil considerably. Trekking and trampling of forest soil result in the increased compactness of soil.

5. Watershed

Uplands in high rainfall regions play an important role in deciding the hydrology of down streams. The hydrological services provided by the watersheds such as percolation, regulation of run off, maintenance of water table and checking of soil erosion are crucial as far as the water resources and agro-economy are concerned.

6. Water table

This is another crucial attribute associated with land. Maintenance of a high water table is the most desired outcome as far as local people are concerned.

7. Air

Air quality is affected by a number of activities such as traffic, construction activities, etc. Some of these have local impact whereas some other activities have wider geographical impact. Noise pollution is also considered as a part of the air quality.

Social Attributes

Developmental activities are accompanied by a number of positive and negative impacts on the social environment. A total of six social attributes are selected for representing the impacts of the social environment. They are: Employment, health, services, traditional livelihood, revenue and social security.

Quality of landscape

These attributes are desirable characteristics of the social environment, some of them are already existing and others which are of high priority to the local people. All these attributes are looked at from the view point of local people. The local people's view point is considered by assuming that pilgrimage cannot be globally sustainable unless it is locally equitable in terms of incentives and resource access.

SCORING

The matrix was constructed by placing the project components on the vertical axis and the ecological and social attributes on the horizontal axis (Sankar, 1999). Qualitative aspects of each interacting project component and positive sign (+ve) marks the attribute if the impact is beneficial and negative sign (-ve) if the impact is detrimental. The time factor of the impact is grouped into two the long term and short term. The short term is indicated by a single asterisk (*) and long term by two asterisks (*) marks in the table. Giving weightage to individual impact is also attempted. The information provided in the proposed project, as it is given in the document, is inadequate to consider for a detailed impact analysis and assessment. So an attempt was made to identify potential impacts and to comment on each possible impact. An attempt is made to express the weightage of each impact in relative terms on a 3 point scale- a relatively high negative impact is weighed as –3, medium impact as -2 and low impact as -1. 0 indicates negligible impact. Potential positive impact is indicated using positive sign. In order to reach the final score of each component, tabulating and summing the scores is carried out to derive the grand total. For long-term impacts the score has been multiplied by a value of two. The final score for each project activity varies. This score is used as an easily referable indicator to invite the attention of planners for remodelling the pilgrimage so as to mitigate the impacts and, if possible, to adopt alternative paths.

Solid Waste Assessment: Solid wastes were assessed along the route in two sections of the route after sorting them into paper, plastic and glass by weighing (in kgs).

Awareness Creation: A number of camps were conducted during pilgrimage in the area. A Handbook and a Brochure were produced.

Measures to minimise the impact of pilgrimage: Taking into account the results of the workshops, environmental impact assessment and participant observation, certain measures to minimise the impact of pilgrimage were framed.

RESULTS AND DISCUSSION

Initial Environmental Examination

Ecological features of the Agasthyamalai region

The area under consideration is situated in Thiruvananthapuram district of Kerala State and is located in the eastern side bordering Tamil Nadu within the two Wildlife Sanctuaries of Peppara and Neyyar (Fig.1). In order to understand the sustainability/impact of the pilgrimage, it is essential to take stock of the existing environment, with adequate understanding on the key ecological and social processes in the locality. Here an attempt is made to illustrate the existing ecological and social environment.

Climate

Being located in the western slopes of the Western Ghats the study locality has a wet monsoon climate with annual rainfall varying from 3000 to 4500 mm. A lion's share of the rainfall is received during the south-west monsoon. As the crest line of the Western Ghats is low and due to proximity to the sea, copious rainfall is received during the retreating monsoon period also. The distribution of rainfall is thus bimodal and dry season extends to only two months in a year.

Geology

Geologically the area is composed of kondalites and geomorphologically the terrain is hilly and cut by deep "V" shaped valleys.

Soil

The soil cover of the area belongs to the group of red ferrallitic soil. It is derived from acid crystalline rocks. As this soil is originally formed under forest cover, devoid of forests, they succumb to denudational process and laterisation.

Forests

The forests of the area belong to the biogeographical zone Agasthyamalai and fall administratively under the Thiruvananthapuram Wildlife Division.

Forest types

a. Southern hilltop evergreen forest

These are the stunted evergreen formations found at 700 m to 1300 m above sea level with the maximum height of the canopy around 10 m.

Trees commonly found in this type of forest are: *Cullenia exarillata, Mesua ferrea, Elaeocarpus tuberculatus, Gluta travancorica, Calophyllum apetalum, Syzygium sp.* and *Dimocarpus longan. Piper torioicum, Dioscorea wallichii, Smilax zeylanica, Jasminum sp.* and *Calamus sp*. are the common climbers. *Crotalaria calycina, Leucas vestita, Thottea siliquosa, Rauwolfia densiflora,* varieties of *Impatiens sp. and Curculigo orchioides* are the ground herbs. A large number of mosses, orchids and other epiphytes are also seen.

b. West coast tropical evergreen forest

This is lofty, dense forest seen in the higher slopes. Trees are several storied and the dominant story has a height of 40 m. Lianas and epiphytes are also characteristic to this type.

The dominant trees are, *Artocarpus hirsutus, Bischofia javanica, Vateria indica, Palaquium ellipticum, Garcinia morella, Cullenia exarillata, Calophyllum apetalum, Poeciloneuron indicum, Aporusa lindleyana, Holigarna arnottiana, Baccaurea courtallensis, Xanthophyllum arnottianum, Hydnocarpus alpina, etc. Arenga wightii* and *Pinanga dicksonii* are the common palms found in this evergreen forest. *Piper sp., Calamus sp., Aristolochia indica, Dioscorea oppositifolia, D.pentaphylla, Sarcostigma kleinii, Gnetum scandens, etc*. are the important climbers. Ground flora consists of *Angiopteris evecta, Begonia malabarica, Cyathea gigantea and Ophiorrhiza sp.*

c. West coast semi-evergreen forest

This type of forest can be seen adjacent to evergreen forests and along the sides of rivers and streams.

Important tree species are, *Alstonia scholaris, Artocarpus heterophyllus, Calophyllum apetalum, Knema attenuata, Madhuca neriifolia, Vateria indica, Vitex altissima, Hopea parviflora, Schleichera oleosa, Hydnocarpus alpina, Aporusa lindleyana, Cinnamomum verum, Mallotus philippensis, Elaeocarpus glandulosus, Spondias indica, Olea dioica, etc*. Common climbers are *Butea parviflora, Sarcostigma kleinii, Calamus sp., Calycopteris floribunda, Entada monostachya, etc.* The ground is largely covered *with Costus speciosus, Schumannianthus virgatus, Ophiorrhiza sp*. along with *Desmodium pulchellum, Peperomia pellucida* and *Thottea siliquosa.*

d. Southern secondary moist mixed deciduous forest

This type of forest is commonly seen at the low elevation (below 600 m). Top canopy consists of *Terminalia paniculata, Pterocarpus marsupium, Lagerstroemia microcarpa, Lannea coromandelica, Sterculia sp., Bridelia retusa, Careya arborea, Dillenia pentagyna, Phyllanthus emblica, Cycas circinalis, etc. Helicteres isora and Macaranga peltata* are found commonly in the regenerated patches. Common climbers of this formation are *Butea parviflora, Jasminum rotterianum, Dioscorea sp., Asparagus recemosus, Cyclea peltata, Hemidesmus indicus, etc.* Interesting epiphytes like, *Drynaria sp., Cymbidium sp., Oberonia sp.* are seen in this forest. The ground is commonly covered with a dense growth of grasses such as, *Panicum maximum, Cyrtococcum oxyphyllum, Imperata cylindrica, Pennisetum polystachyon, Themeda cymbaria, T. triandra, etc.* Apart from the grasses, herbs like, *Acrotrema arnottianum, Impatiens latifolia, Crotalaria albida, Desmodium sp., Curcuma aromatica, Shumannianthes virgatus* and *Zingiber zerumbet* are also common.

f. Reed brakes

Large portions on the slopes are covered with reeds. Important species are *Ochlandra ebracteata, O. scriptoria, O. wightii* and *O. travancorica*. of which, *O. scriptoria* and *O. travancorica* are found in the higher reaches. Thick reed brakes are seen in the lower valleys, along the streamsides and fire burnt areas.

Change in forest cover

A percentage change of 13.31 in the forest cover has taken place in the area during the past 30 years. Nearly 45 percent of the forest cover is dense while the rest is degraded (Table 1). This is in comparison to the figure (9.3%) for the whole of Kerala from 1961 to 1988 as arrived by Prasad *et al.,* (1988).

Table 1. Change in forest cover

	1969	**1999**		**Difference**
		Dense	**Degraded**	
Forest cover (km^2)	200	78.1	95.7	26.62

Biodiversity of Agasthyamalai Region

The Western Ghats are one of the 25 hotspots of biodiversity in the world and Agasthyamalai region is a part of the Western Ghats. An account of the flora and fauna in the area is provided below.

The details on the flora are from Mohanan *et al.,* (1997).

Flora

During the present work, a study of the diversity of Angiosperm flora only has been taken into account. The comparatively small area of 200 sq. km studied yielded 1084 species of flowering plants coming under 569 genera, spread over 132 families. The number of families, genera and species with respect to dicots and monocots are as follows.

	Families	**Genera**	**Species**
Dicots	108	414	795
Monocots	24	155	289
Total	132	569	1084

Forty three percent of the flora is composed of herbs (467 species) and fifty seven percent of woody plants(617 species). Among 617 species of woody plants, 284 species are tree and 333 species are shrubs including shrubby climbers and lianas.

The flora has a good representation of specialized groups of plants such as epiphytes, parasites, insectivorous plants and saprophytes. Following table details the representation of special groups of plants.

Groups	No. of species	Families with no. of species in each	
		Asclepiadaceae	3
		Balasaminaceae	1
		Commelinaceae	2
Epiphytes	55	Gesneriaceae	1
		Melastomataceae	2
		Orchidaceae	42
		Piperace	4
		Balanophoraceae	1
		Loranthaceae	9
Parasites	17	Orobanachaceae	3
		Scrophulariaceae	1
		Viscaceae	3
		Droseracceae	3
Insectivorous plants	7	Lentibulariaceae	4
Saprophytes	2	Orchidaceae	

Following six families rank first with respect to the number of species, among the 132 families represented in the flora.

Family	No. of genera	No. of species
Rubaceae	32	85
Poaceae	48	78
Orchidaceae	41	74
Fabaceae	33	68
Asteraceae	23	45
Cyperaceae	13	42

Occupance of Rubiaceae at the first position is noteworthy. This is contradictory to the general trend seen elsewhere in the Western Ghats, where

Fabaceae and Poaceae occupy first two positions. Wet evergreen forest forming the major component of the vegetation of Agasthyamalai housing many endemic Rubaceae species accounts for this.

Endemism

In addition to peninsular effect, the Palghat Gap has provided almost an island nature to southern region of the Western Ghats. These factors made the area the richest with respect to floristic composition and concentration of endemic taxa, within peninsular India. Out of the 1084 species reported, 301 species (28%) were found to be endemic to peninsular India. Among these, 45 species are local endemics of Agasthyamala region, some of them having distribution restricted to the 'Type locality' alone.

Twelve families showed more than 40 percent endemism. Dipterocarpaceae is with 100 percent endemism whereas Myristicaceae comes next with 75 percent. Rubiaceae, the top family with respect to number of species (85), also is the family with maximum number of endemic species (35). Details are shown in a following table.

Sl.No	Family	Total No. of species	No. of endemic species	% of endemism
1	Dipterocarpaceae	3	3	100.00
2	Myristicaceae	4	3	75.0
3	Lauraceae	22	15	68.1
4	Anacardiaceae	13	8	66.6
5	Balsaminaceae	12	8	66.6
6	Arecaceae	9	6	64.4
7	Araceae	17	11	64.1
8	Annonaceae	13	8	61.5
9	Melastomataceae	25	13	52.0
10	Clusiaceae	10	5	50.0
11	Acanthaceae	25	11	44.0
12	Rubiaceae	85	35	41.4

Rarity/Vulnerability of species

Critical analysis of the flora was done with respect to the species rarity/vulnerability, on the basis of their range of distribution, strength of population and threats caused. The analysis showed that 147 species are extremely rare with very few individuals. The percentage of total variety is 14, which demands immediate conservation measures to be undertaken to save these species.

It is interesting to note that 26 species listed in the Red Data Book of Indian Plants under category "rare/possibly extinct" were reported from the study area. These include the following five very rare species, recollected after about 100 years from their only previous record (Mohanan *et al.*, 1997).

Sl.No	Name of species	Family
1	*Cynometra beddomei* Prtain	Fabaceae
2	*Garcinia imberti* Bourd	Clusiaceae
3	*Nothopegia aureo-fulv* Bedd. Ex Hook.f	Anacardiaceae
4	*Peociloneuron pauciflorum* Bedd.	Clusiaceae
5	*Syzygium bourdillonii* (Gamble) Rathakar. & Nair	Myrtaceae

Wild relatives of crop plants

The plants located at Agasthyamala include 88 species, which are close relatives of the cultivated crops. Among these are relatives of cereals and millets like *Eleusine* and *Oryza* and pulses like *Atylosia* and *Vigna.* A rich diversity is found with respect to fruit crops and species. There are 25 species of furit crop relatives coming under genera such as *Artocarpus, Cissus, Garcinia, Mangifera, Musa, Prunus, Spondias* and *Syzygium*. Species relatives are represented by 18 species belonging to *Alpina,Cinnamomum, Curcuma, Ablmoschus, Ammaranthus, Solamum,* etc. and tuber crops such as *Amorphophallus* and *Dioscorea* are also represented. It is highly significant to note that among these species, *Amorphophallus bonaccordensis, A. Smithsonianus, Cinnamomum chemungianum, Garcinia imberati, G. travancorica, Piper barberi, Syzygium bourdillonii* and *S. parameswaranii* have their only home in

Agasthyamala and depletion of the vegetation here may cause the extinction of these very important crop relatives.

Medicinal plants

Agasthyamalai harbours enormous number of medicinal plants used in ayurveda, siddha and modern medicine. Most of these plants are becoming more and more rare due to commercial over exploitation. One hundreds and twenty four medicinal species, which demand active conservation measures, were identified.

Alien species

Occurrence of exotic species in the area is comparatively less when compared to other forest areas of the Western Ghats. About 25 exotic species were recorded, most of which belong to tropical America.

Floristic novelties

Mohanan *et al.*, (1997) have reported five species new to science, which are given below:

Sl. No.	Name of species	Habit	Family
1	*Amorphophallus bonaccordensis*	Herb	Araceae
2	*Laxora agasthyamalyana*	Tree	Rubiaceae
3	*Pavetta bourdillonii*	Tree	Rubiaceae
4	*Pothos crassipedunculaus*	Scrub climbing	Araceae
5	*Symplocos namboodirianus*	Tree	Symplocaceae

New distributional records

Finding of *Litsea myristicaefolia* (Wall.) Hoof. f. (Lauraceae), a Malesia species and *Memecylon discolor* Cogn. (Melastomataceae), a Sri Lankan element, formed new distributional records for the country.

Fauna

The region is very rich in faunal diversity too. Forty-three species of mammals, 142 birds, 33 reptiles, 27 amphibians, 27 fishes and 84 butterflies have been recorded from the area (Sreekumar, 2000). On the 14 species of mammals endemic to the Western Ghats, eight are observed in the study area.

Number of endemic vertebrates in the Western Ghats

Sl. No	Class	Western Ghats	Project site
1.	Mammalia	14	8
2.	Aves	34	18
3.	Reptilia	93	--
4.	Amphibia	88	-
5.	Pisces	114	-

There are 430 mammals in India of which 76 are categorised in the Red Data book. The Western Ghat region abodes 75 mammals of which 14 are endemic. The project site has 43 mammals of which eight are endemic and 14 are in the Red Data book.

There are 1200 species of birds in India of which 475 are available in Kerala. The study area has over 142 species of birds. There are 34 species of birds endemic to the Western Ghats of which 18 are available here.

Human settlements

Agasthyamala region, which comprises of two wildlife sanctuaries, Neyyar and Peppara has a resident population of Kani tribes in 35 settlements. There are 392 families.

The Kanis are basically shifting cultivators who also practice foraging. Most of the settlements are along the basins of streams of Neyyar and Karamanayar.

At Neyyar Wildlife Sanctuary there are 1473 tribals. Gender wise 50 percent are male and 50v percent female. Majority of the people are illiterate (73%). They are engaged in different kinds of jobs. Unskilled labour (23%) dominates. They cultivate 11 varieties of crops including banana, pepper, rubber and arecanut. One hundred and eighty one families rear cattle. Most of them receive an annual income between Rs. 1000 and 5000. Most of the houses are either made of bamboo or tiled. The houses

are not electrified. Fuel wood is the main source for cooking (nearly 15 kgs of wood is collected daily by each family). Most of the families have agricultural land more than 0.4 ha. Collection of NTFP is a major activity.

At Peppara Wildlife Sanctuary there are 17 settlements of Kanikkar with a population of about 729 individuals living inside the sanctuary area. They enjoy the privileges of hunting, fishing, gathering of NTFP and settled cultivation within their occupancy. Besides the settlements inside the sanctuary, another 20 Kani settlements with a population of 939 people are located along the periphery. The workers and their family residing inside the Bonacaud estate constituted a population of around 2500 people. They reside in 400 houses within the estate premises; most of them are settlers from Tamil Nadu. The tribal settlements are surrounded by thick forest area and are facing frequent wildlife attack. Most of the people are engaged in agricultural occupations and facing severe seasonal unemployment.

Dependency on forests

There is a very close and suitable relationship between the Kani and the forests. In early time the Kani was aware of the rhythm of the forest and lived as ecosystem people. With the arrival of civilization, the tribals are heavily dependent on forest for survival, for their home, food, medicine, entertainment,etc. They use forests to cultivate food, collect fuel wood, building materials, medicines, fish and small game. The world famous Arogyapacha (*Trychopes zeylanica*) was the discovery of the Kani tribe and a product of community wisdom.

In the area of conservation of forest and ecosystem, the Kani is ready to contribute to the welfare of the forest while deriving survival benefits through the newly formed Eco-Development Committees (EDCs). Even the Agasthyamalai pilgrimage is beginning to be managed by EDC s of the Kani residing in the region.

Pilgrims

Pilgrim flow and characteristics

Agasthyamalai attracts annually thousands of pilgrims, who trek the peak to worship Agasthyamuni, considered to be the doyen of Ayurveda. The season of pilgrimage is between the months of January and April. The peak visitation occurs during February and March, rather coinciding with Sivarathri festival. The pilgrimage was recognized for the past 50 years but was made official by the Kerala Forest Department in the year 1999 only. Since then we have records of visit as each pilgrim acquires permission and groups are allowed with guides provided by the Kerala Forest Department. Quite a few visit the area from the Tamil Nadu side too.

Perusal of the records of the last three years reveals that there has been an increase in the number of pilgrims over the years (Table 2).

Table 2. Year wise arrivals of pilgrims

Year	Number	% Change
1999	1658	---
2000	3173	48
2001	3237	2

In the year 2001, 175 pilgrims from Tamil Nadu visited Agasthyamalai. As per official records with the Wildlife Warden of Thiruvananthapuram Wildlife Division, 224 groups visited Agasthyamalai during the pilgrim season of 2001. Of these 195 groups were represented by individuals, 3 nature clubs, 5 saints/ poojaris, 3 Government officials, 10 political party groups, 3 Ayurveda/Sidha physicians, one tribal and 3 Muslim groups. During the pilgrim season in 2001, through participant observation and questionnaire survey, information on the pilgrims was collected. The information was collected from 104 pilgrims distributed in 24 groups.

Fifty seven per cent of the pilgrims arrived at Bonacaud by public transport and the rest (43%) by taxi. Nearly 82 percent of them were from places located beyond 50 km from the area. There was nobody from location less than 10 kms. New visitors were few (11%), while most (46%) were visiting for the second time or more

(43%). As per the purpose of visit, 64 percent stated the reason as nature interaction, 35 percent worship and for adventure. Only 1percent of the pilgrims were keen to collect necessary medicinal plants.

All pilgrims were literate, 46 percent being graduates and postgraduates. Most of them were self- employed (60%), while others belonged to labourers, farmers, teachers, employees, doctors, etc. As per age, very rarely pilgrims were below 10 years. Most (68%) were in the age group 10-40 years. There were a few (9.6%) above 60 years indicating the hazardous nature of the pilgrimage.

Visitors belonged to all religions and castes indicating the secular nature of the pilgrimage. Hindus (Ezhava, Nadar, Viswakarma, Nair etc. 79%), Christians (4%), Muslims (5%), tribals and Scheduled Castes (12%) were recorded in the year 2001.

Most of the pilgrims (71%) had a moderate level of nature awareness; only a few (17.3%) were ignorant while 10 percent of the pilgrims were hardcore nature lovers. This indicates that Agasthyamalai attracts nature-loving people and hence there is a potential to develop ecofriendly practices.

Majority (75%) of the pilgrims take three days to complete the pilgrimage including time taken to reach Bonacaud and travel back. Nearly 20 percent need two days and percent took three days. Thus, the pilgrimage can be regulated to two days.

Regarding the facilities available, 15 percent did not require any facility while 63 percent were pleased with the present arrangement. Few people (13%) demanded better facilities while 9 percent required better arrangement for pooja and worship.

Regarding food and beverages 86 percent of the pilgrims carried a certain amount of food and used canteen facilities also. Quite a few totally depend on the EDC canteen (41%). Rarely (6%), pilgrims cook their own food. Water is drawn from nature only.

The Forest Department regulates the pilgrims by providing guides. The guides are drawn from nearby EDCs. Most pilgrims (42%) did not get any service from the guides (guides are transformed into porters). Some pilgrims (13%) did not wish to

have guides, while 20 percent were unhappy with their performance. Only 25 percent were pleased with the guides. This information reveals the necessity for improving the quality of the guides through proper training programmes.

Pilgrim activities

The pilgrimage season is notified by the Forest Department, which invites applications for receiving permits for the visit. Prospective pilgrims are provided dates for arrival at Bonacaud forest check post. The actual pilgrimage starts there. Activities of the pilgrimage are as follows.

1. Group formation at Bonacaud and attachment of guides and provision of food
2. Walk to Karamanayar and worship Maladevan
3. Walk to Attayar - halt for lunch
4. Walk to Athirumala - over night halt
5. Climb Pongalappara - Pongala rituals
6. Climb Agasthyar peak - rituals
7. Return (The return is neither monitored nor registered).

Pilgrimage and solid waste disposal

One of the negative sides of pilgrimage is the disposal of solid wastes at various sites in the region.

Solid waste assessment

Solid wastes were assessed during the pilgrimage. Paper, plastic and glass bottle were the major wastes in this region. Identification and classification of solid wastes generated during pre-pilgrimage, during pilgrimage and post pilgrimage. The entire pilgrimage route was divided in to two units. One section is from Bonacaud to

Athirumala and the next from Athirumala to Agasthyarkoodam. In Athirumala, where pilgrims stay overnight, and in Pongalappara and Agasthyarkoodam, where they offer pongala with worshipping materials. Wastes were assessed by hand picking with the help of Eco-Development Committee members, guides, conscious pilgrims and local NGO groups (Table 3).

Table 3. Solid waste in the Agasthyamala region

Station	Type of waste	Pre pilgrimage season (kg)	Pilgrimage season (kg)	Post pilgrimage season (kg)
Bonacaud	Paper	1.45	14.5	0
	Plastic	1.30	17	6.5
	Glass bottles	0	1.0	1.0
Athirumala	Paper	2.10	5	0
	Plastic	6.70	47	0
	Glass bottles	0	100	0

Impact of development

Agasthyamalai region has been bearing the brunt of development for the past 150 years. Plantations of tea and coffee, Punalur Paper Mill, submersion of vast areas under reservoir, conversion to plantation, both forests and rubber, have marginalized the forest cover, which exists only along the crest line. Communication development in the midland has affected migrants and most of the foothills have been converted to suburban agglomerations. Tribal settlements have been rehabilitated due to developmental project and as forests have been degraded, traditional livelihood and life support system are at stake. Uncontrolled tourism and pilgrimage are taking their toll too.

Vegetational studies along the pilgrim route

Vegetation analysis

A total of 16 study plots (each 400 m^2) were taken in the region and data compiled. Out of the 16 plots, 10 belong to moist deciduous habitat type, four semi- evergreen and the rest evergreen.

Floristic richness and importance

Thirty-six tree species were recorded from 10 moist deciduous plots (Table 4). The Importance Value Index is maximum for *Careya arborea*(*43.54*) followed by *Terminalia panicualta* (41.8) and *Pterocarpus marsupium* (23.17). The least IVI value was found for *Phyllanthus polyphyllus* (1.55) and F*icus.* sp. (1.61) (Table 4).

Table 4. Vegetation analysis in the moist deciduous forest Agasthyamalai

Sl.No	Species	RD*	RELDO	RF	IVI
1	*Careya arborea*	20.49	12.58	10.47	43.54
2	*Terminalia paniculata*	13.54	20.20	8.14	41.88
3	*Pterocarpus marsupium*	6.96	10.40	5.81	23.17
4	*Grewia tiliifolia*	6.96	8.62	6.98	22.56
5	*Dillenia pentagyna*	9.29	5.60	5.81	20.70
6	*Dalbergia latifolia*	4.63	8.38	5.81	18.82
7	*Macaranga peltata*	4.63	2.56	5.81	13.00
8	*Hopea parviflora*	3.10	4.44	2.33	9.87
9	*Alstonia scholaris*	2.33	2.33	4.65	9.31
10	*Vateria indica*	1.95	2.37	3.49	7.81
11	*Bombax ceiba*	2.71	2.12	2.33	7.16
12	*Oroxylum indicum*	1.95	2.15	2.33	6.43
13	*Spondias pinnata*	1.53	1.08	3.49	6.10
14	*Terminalia chebula*	1.15	1.77	2.33	5.25
15	*Hydnocarpus wightiana*	1.53	1.13	2.33	4.99
16	*Terminalia tomentosa*	1.15	1.37	2.33	4.85
17	*Cinnamomum malabatrum*	1.53	0.72	2.33	4.58
18	*Lagerstroemia microcarpa*	1.15	2.02	1.16	4.33
19	*Cinnamomum* sp.	2.33	0.56	1.16	4.05

20	*Emblica officinalis*	0.77	0.74	2.33	3.84
21	*Lagerstroemia reginae*	0.77	1.53	1.16	3.46
22	*Persea macrantha*	0.77	0.93	1.16	2.86
23	*Elaeocarpus serratus*	0.77	0.84	1.16	2.77
24	*Artocarpus heterophyllus*	0.38	1.12	1.16	2.66
25	*Buchanania latifolia*	1.15	0.34	1.16	2.65
26	*Pagiantha dichotoma*	0.77	0.71	1.16	2.64
27	*Acacia catechu*	0.77	0.62	1.16	2.55
28	*Miliusa tomentosa*	0.77	0.49	1.16	2.42
29	*Diospyros* sp.	0.77	0.44	1.16	2.37
30	*Aporusa lindleyana*	0.77	0.35	1.16	2.28
31	*Anogeissus latifolia*	0.77	0.28	1.16	2.21
32	*Tectona grandis*	0.38	0.43	1.16	1.97
33	*Wrightia tinctoria*	0.38	0.38	1.16	1.92
34	*Semecarpus anacardium*	0.38	0.29	1.16	1.83
35	*Ficus* sp.	0.38	0.07	1.16	1.61
36	*Phyllanthus polyphyllus*	0.38	0.01	1.16	1.55
	Total	100.04	99.97	99.98	299.99

RD- Relative Density, RELDO- Relative Dominance, RF- Relative frequency
IVI- Importance Value Index.

In semi-evergreen habitat type, highest IVI value was found for *Artocarpus hirsutus* (23.32), followed by *Cullenia exarillata* (22.34) and *Eleocarpus tuberculatus* (20.42). *Lagerstroemia microcarpa*, *L. reginae*, *Canarium strictum*, etc. have also good IVI values. The least IVI value was obtained for *Kingiodendron pinnatum* (4.2) and *Diospyros ebenum* (4.41) (Table 5).

Table 5. Vegetation analysis in the semi-evergreen forest of Agasthyamalai

Sl.No	Species	RD	RELDO	RF	IVI
1	*Artocarpus hirstus*	6.82	12.09	5.41	24.32
2	*Cullenia exarillata*	6.82	10.11	5.41	22.34
3	*Elaeocarpus tuberculatus*	5.68	9.33	5.41	20.42
4	*Canarium strictum*	6.82	8.13	5.41	20.36
5	*Lagerstroemia reginae*	4.55	6.04	5.41	16.00
6	*Dipterocarpus bourdillonii*	3.41	7.03	2.70	13.14
7	*Vateria indica*	3.41	3.91	5.41	12.73
8	*Calophyllum apetalum*	4.55	2.76	5.41	12.72
9	*Lagerstroemia microcarpa*	5.68	4.12	2.70	12.50
10	*Hopea parviflora*	4.55	2.61	2.70	9.86
11	*Myristica malabarica*	2.27	4.64	2.70	9.61
12	*Diospyros sp.*	4.55	2.14	2.70	9.39
13	*Palaiqium ellipticum*	3.41	2.87	2.70	8.96
14	*Mallotus distance*	4.55	1.67	2.70	8.92
15	*Mangifera indica*	1.14	3.75	2.70	7.59
16	*Olea dicoca*	3.41	1.30	2.70	7.41
17	*Callicarpa lanata*	2.27	2.24	2.70	7.21
18	*Hopea utilis*	2.27	2.03	2.70	7.00
19	*Eugenia mundagum*	3.41	0.78	2.70	6.89
20	*Tabernaemontana dichotoma*	2.27	1.46	2.70	6.43
21	*Persea macrantha*	2.27	1.35	2.70	6.32
22	*Myristica sp*	1.14	2.40	2.70	6.24
23	*Agrostistachys indica*	2.27	1.20	2.70	6.17
24	*Eurya nitida*	2.27	1.15	2.70	6.12
25	*Cinnamomum iners*	2.27	0.99	2.70	5.96
26	*Toona ciliata*	2.27	0.83	2.70	5.80
27	*Elaeocarpus munronii*	1.14	1.82	2.70	5.66
28	*Garcinia echinocarpa*	2.27	0.31	2.70	5.28
29	*Diospyros ebenum*	1.14	0.57	2.70	4.41
30	*Kingiodendron pinnatum*	1.14	0.36	2.70	4.20
	Total	100.02	99.99	99.97	299.98

In the evergreen habitat type, highest IVI was found for *Elaeocarpus munronii* (35.31), followed by *Artocarpus hirsutus* (33.34) and C*ullenia exarillata* (31.31). The least IVI value was obtained for *Kingiodendron pinnatum* (10.04) and *Eugenia mundagum* (10.54) (Table 6).

Of the total 15 tree species recorded, eight fall in the IVI class between 10 and 20 (53.33%), four between 20 and 30 (26.66%)and three above 30 (20%) (Table 1.9).

Table 6. Vegetation analysis in the evergreen forest of Agastyamalai

SI No	Species	RD	RELDO	RF	IVI
1	*Elaeocarpus munronii*	12.12	16.39	6.67	35.18
2	*Artocarpus hirsutus*	6.06	20.61	6.67	33.34
3	*Callicarpa exarillata*	6.06	18.58	6.67	31.31
4	*Callicarpa lanata*	9.09	6.08	6.67	21.84
5	*Mallotus distance*	9.09	5.24	6.67	21.00
6	*Hopea glabra*	6.06	7.77	6.67	20.50
7	*Palaquium ellipticum*	9.09	4.73	6.67	20.49
8	*Agrostistachys indica*	9.09	4.05	6.67	19.81
9	*Garcinia echinocarpa*	6.06	6.08	6.67	18.81
10	*Cinnamomum iners*	6.06	2.87	6.67	15.60
11	*Eurya japonica*	6.06	2.70	6.67	15.43
12	*Antidesma menasu*	6.06	2.70	6.67	15.43
13	*Holarrhena antidysenterica*	3.03	1.01	6.67	10.71
14	*Eugenia mundagum*	3.03	0.84	6.67	10.54
15	*Kingeodendron pinnatum*	3.03	0.34	6.67	10.04
	Total	99.99	99.99	100.05	300.03

Regeneration studies

Regeneration studies were carried out along the route covering a distance of 20 km. Plots of 5x1m were laid in each location. There were three plots near the route Category- 3), at a distance of 50 m (Category- 2) and finally 200 m (Category-1) from the route. Altogether, 20 plots of each category were laid at one km interval. Data from plots of the same category were pooled and the results are provided in Table 7.

Table 7 Regeneration per ha. in plots along the route (n=20)

Category of plot	Un-established	Established	Advance growth	Sapling	Total
1	4000	10000	9500	3000	26500
2	1800	2300	550	425	5045
3	1525	1325	675	300	3825

The study reveals that the trekking along the route hampers regeneration up to 50 m along both sides of the path. The regeneration is more than five times less in Category 2 and seven times in Category 3 than in Category 1.

Environmental Impact Assessment

Group formation at Bonacaud

The Agasthyamalai pilgrimage commences at Bonacaud forest check post. Pilgrims, who have registered earlier at the office of the Wildlife Warden, Thiruvananthapuram and provided specific date for arrival at Bonacaud check post form into groups.

Bonacaud entry point is at the fringe of the forests of Peppara Wildlife Sanctuary bordering the Bonacaud Tea Estate (Plate 1), which is closed at present. Most pilgrims arrive by bus (KSRTC) from Thiruvananthapuram (Plate 2) and walk nearly 2 km to the check post.

Plate 1. Bonacaud tea estate

Plate 2. Transport to Bonacaud

Bonacaud is situated at the foot hill of Agasthyamalai peak at an elevation of 800 m above sea level. The area comprises evergreen, semi-evergreen and moist deciduous forests, rubber and tea plantations with human habitations.

During the season, approximately 100 pilgrims arrive daily at Bonacaud, who are grouped into nearly 10 groups. During peak days, for e.g., Sivarathri, pilgrim arrivals were much more, running into over 200 persons.

The check post is very poorly equipped to meet the demands of the pilgrims. There is no shelter but for a temporary shed. Drinking water, toilets, first aid, etc. are not available. Further, there is no arrangement to provide necessary information and direction to the pilgrims. The do's and don'ts of ecofriendly pilgrimage, permissible activities, items etc. are not told to the pilgrims. Further, vehicles of pilgrims are not parked properly, but are left in a haphazard manner. The availability of guides is not

guaranteed and at times pilgrim groups are forced to wait till some one is available. There is an information gap between the Head office and the check post regarding the quantum of daily arrivals and necessary arrangements to be made.

The luggage of the pilgrims is supposed to be checked by forest officials at Bonacaud (Plate 3). Intoxicants and narcotics are not allowed, and further, even vessels to cook food are confiscated. There is a provision to provide food from Bonacaud, which is prepared and packed by the Eco-Development Committee at Bonacaud (Bonacaud EDC). This EDC comprises non-tribals and is the one and only non-tribal EDC in the region. Food and beverages up to Athirumala are provided by this EDC. Most items are packed in disposable plastic ware (Plate 4) and form the source of waste on the way, and up to Attayar.

Plate 3. Luggage checking

Plate 4. Food provided by EDC

A cluster of 50 people (Plate 5) is provided with two guides. The pilgrims have no rapport with the guides, and the guides are not able to provide necessary information to the pilgrims. Finally, the guides turn into porters to carry the luggage of pilgrims. The environmental and social impacts of the group formation activity at Bonacaud are provided in Table 8.

The soil around is trampled and compacted affecting the watershed services of the site. The water table in the area is affected. With reference to social impacts there is a low and seasonal positive impact on employment. As non-tribals are managing the EDC, there is no gain/loss for traditional livelihood. As part of fee and food charges some revenue is generated through services rendered. Thus, the group formation at Bonacaud receives an overall score of -15 indicating the magnitude of negative impacts on both ecology and social sectors (Table 8).

Plate 5. Group preparing to leave

There is a low, but permanent impact on flora, fauna and migration corridors. The effect on water is medium and long term as water is being drawn from a temporary hole. During peak visitation time the quality of water is poor.

2. Walk to Karamanayar

The second leg of the pilgrimage to Agasthyamalai is the walk from Bonacaud to Karamanayar. This involves 4 km and the path undulates through moist deciduous (Plate 6) and semi evergreen forests (Plate 7).

Plate 6. Route to Karamanayar

Plate7. Semi-evergreen forest

There is grazing in this area by cattle owned by labourers of the Bonacaud Tea Estate (Plate 8). Littering of forests due to visitation begins here (Plate 9).

Plate 8. Cattle grazing

Plate 9. Littering enroute

The phase ends at a small shrine (Plate 10), where pilgrims worship the forest god Maladevan. The route through forests is compacted due to trampling and there is sparse regeneration on both sides.

Plate 10. Shrine at Karamanayar

The environmental and social impact scoring provided in Table 8 shows that there are medium negative impacts on the ecology of the area around the path, while the social impact is negligible. The overall score is -27 (Table 9) revealing the magnitude of the impact.

3. Walk up to Attayar and halt

The next leg of the pilgrimage is from Karamanayar to Attayar, which passes through a network of streams. The terrain is more or less flat to undulating and passes through semi evergreen forests. As the pilgrims commence their trip in the morning hours from Bonacaud, they reach Attayar by noon.

Plate 11. Fire line

Pilgrims have lunch and take rest here. In the past, there existed a mini café run by Podiyam EDC. As the same was not economically viable, there is no café today. To prevent fire, fire lines have been taken (Plate11).

Plate 12. Bonafalls

There is a picturesque Bonafalls, as one deviates from Karamanayar (Plate12). As most visitors are unaware of its existence, they miss it. Attayar camp is within a stream running through a rocky bed. Pilgrims cook, eat, bathe and take rest (Plate 13). Hence, considerable amount of waste is generated and left on the site.

Plate 13. Rest at Attayar

The scoring of environmental and social impacts (Table 8) reveals that there is a medium long-term impact on the ecological status of the forests, especially on water and soil quality. No employment or services are generated. Polluting of the landscape is rampant. The overall score is -36 (Table 9), as the process affects the quality of landscape very much.

4. Walk up to Athirumala and halt

After food and rest at Attayar, the pilgrims commence the steep climb to Athirumala (Plate 14). They cover a distance of 3.5 km through moist deciduous forests, highly burnt grassland savannas (Plate 15) and evergreen forests. An environmental awareness programme for pilgrims was conducted in this route (Plate 16). The steep topography and elevation change the vegetation from lofty evergreen to dwarf subtropical evergreen and to patches of pure reed brakes (plate 17). The elevation at Athirumala is 1250 m, the pilgrims reach this place by dusk and is the official overnight halting place.

Plate 14. Climb to Athirumala

Plate 15. Burnt forest

Plate 16. Awareness camp

Plate 17. Reed brake

The Forest Department has provided a permanent concrete shed at Athirumala as a dormitory for nature education. This building comprises four rooms, a hall and a verandah (Plate 18). Pilgrims use this shed as a resting place. Today the same is in a dilapidated condition and bears a danger sign too. Podiyam EDC runs a canteen at Athirumala for catering to the needs of pilgrims. The canteen provides coffee, tea, chappathi, rice, and kanji at the request of pilgrims. There is a stream nearby to cater

to the water needs of the pilgrims. There are no toilets in the area. Even the water drawn for cooking and drinking purposes is polluted. The pilgrims tired of the walk take bath, sleep for a while and after food engage in card game. A few forest guards serve as watch and ward. Lot of firewood is collected from the vicinity for cooking purposes. The area is littered with plenty of solid wastes, which were assessed (Plate 19). Athirumala has a wireless station for communication. In general, a feeling of pilgrimage and the sanctity attached to it are absent as pilgrims engage in card game and resort even to consumption of alcohol.

Plate 18. Shed at Athirumala

Plate 19. Assessment of solid wastes

The Environmental and Social Impact assessment (Table 8) of this phase revealed medium and long term negative impacts on flora, fauna, migration corridors, watershed services, soil quality, health and landscape quality. At the same time some positive impacts are noticed through generation of services, employment and revenue. The overall score is -31(Table 9) as negative impacts over ride the positive ones.

5. Pongalappara - Agasthyamalai climb and rituals

Early in the morning on the second day pilgrims leave Athirumala after tea and carry breakfast with them. A few pilgrims do not halt at Athirumala but proceed straight to Pongalappara on the first day itself and camp there. There are also some pilgrims who leave Athirumala after breakfast.

The climb is neck breaking till the shrine and a part of the route traverses through Tamil Nadu. Dense evergreen forests, very rich in species, cover the terrain up to Pongalappara. As one climbs from Athirumala, the Peppara reservoir is visible (Plate 20). The forest is diverse and beautiful (Plate 21) and all life forms are available

(Plate 22). As one reaches Pongalappara, the landscape is rocky, misty and windy (Plate 23).

Plate 20. View of Peppara

Plate 21. Forest beyond Athirumala

One of the major activities of the Agasthyamalai pilgrimage is offering of Pongala at Pongalappara (the area deriving its name from Pongala). Pongala is an offering made of cooked rice. The pilgrims carry a vessel to cook this rice, while water and firewood are collected from the vicinity. The cooked food (offering) is left on the rocky surface along with semi- burnt wood pieces from the fire.

Plate 22. Animal life

Plate 23. Landscape at Pongalappara

Plate 24. Returning pilgrims

A part of the pilgrims returns to the base camp from Pongalappara (Plate 24) while the hardcore ones climb further up to the Agasthyar peak.

The trek from Pongalappara to Agasthyar peak is steeper, hazardous and adventurous (Plate 25). The route is through a steep scarp and dwarf trees are interspersed only where some soil is left. *Arenga wighti* is a dominant species in the plant community (Plate 26). The area forms the origin of many a small rivulets. The Department has provided iron railings to assist the pilgrims in the hazardous belt.

The peak of Agasthyamala is a flat rocky surface and the area is windy and mostly covered with mist. There is an idol of Agasthyamuni, which is made of stone and painted. The idol is four feet tall and placed on a raised platform. It was a small idol in the past, which has been recently replaced by the present one.

Plate 25. Climb to Agasthyar peak

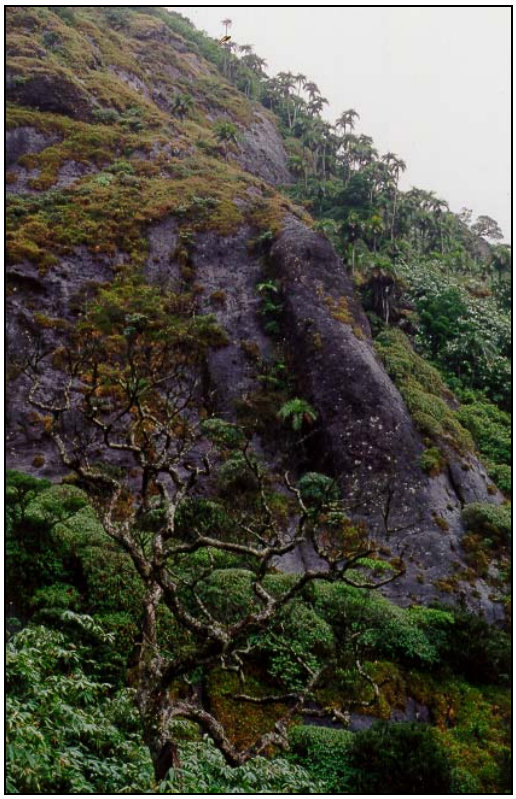

Plate 26. *Arenga wighti* and the scarp

The idol is worshipped by the pilgrims using ghee, turmeric powder, flowers, sacred ash (Bhasmam), etc., which are brought from the plains. They make offerings with banana. The area is covered with empty bottles, agar bathis, flowers, and garlands, left by the pilgrims. They halt here only for nearly an hour as further stay is hindered by mist and strong winds.

The environmental and social impact scoring (Table 8) of this phase of the Agasthyamalai pilgrimage, Pongalappara Agasthyamudi climb and rituals, revealed medium but long-term impacts on all ecological attributes, and provided zero impact on social aspects (Table 8). The quantum of waste generated is high and waste is left behind. Even the footgear of pilgrims is left at the peak, as many of them do not use it, while returning due to steep sloping terrain.

The summary of graded environmental and social impact is provided in Table 9. The score for the first component is group formation at Bonacaud is -15. As the route proceeds towards interior Agasthyamalai the value of total impacts rises from -27 to -36. Maximum impacts are felt at the halting place at Attayar (-36), Athirumala (-31) at Pongalappara and Agasthyar peak (-36) and Karamanayar (-27). The impact at Attayar is high because social benefits are virtually absent. In general, although the impacts are of medium scale, they create permanent irreversible scars on the structure and functioning of this biologically rich area. The ecological impacts are much higher compared to social.

Table 9. Summary of graded impacts

Component	Ecology	Social	Total
Group formation at Bonacaud	-14	-1	-15
Walk to Karamanayar	-23	-4	-27
Halt at Attayar	-28	-8	-36
Halt at Athirumala	-28	-3	-31
Pongalappara Agasthyakoodam	-32	-4	-36

Table 8 . Scoring of impact

Components	Ecology								Social						
	Biotic			Abiotic											
	Flora	Fauna	Mig. corridor	Water	Soil	Water shed	Water table	Air	Employment	Health	Service	Traditi-onal livelihood	Revenue	Social security	Landscape quality
Group formation at Bonacoud	- **	- *	- *	-- **	- **	- *	- **	0	+ *	-- **	+ *	Var.	+ *	+ *	- *
Walk to Karamanayar	-- **	-- **	-- **	-- **	-- **	-- **	-- **	0	0	0	0	Var.	0	0	-- **
Halt at Attayar	-- **	-- **	-- **	-- **	-- **	-- **	-- **	0	0	-- **	0	Var.	0	0	-- **
Halt at Athirumala	-- **	-- **	-- **	-- **	-- **	-- **	-- *	-- *	+ *	-- **	+ *	+ *	+ *	0	-- **
Pongalappara Agasthyamala	-- **	-- **	-- **	-- **	-- **	-- **	-- **	-- **	0	0	0	0	0	0	-- **

* Short term, ** Long term, - Negative and + Positive,Var- Variable

Stakeholder workshops

After completing the initial environmental examination and environmental and social impact assessment, we conducted two workshops with stakeholders concerned.

1. Workshop with pilgrims - A pilgrim- oriented workshop was conducted on 6th January 2002 at Thiruvananthapuram (Plate 27). Over 100 participants, mostly pilgrims, prospective pilgrims, religious heads, swamis, NGO groups, etc. attended the workshop. Scientists, officials of the Forest Department, naturalists and others joined the discussion.

Plate 27. Workshop with pilgrims

Plate 28. Workshop with EDC members

The participants were briefed about the objectives, findings and expected output from this project. Dr. S. Sathish Chandran Nair gave a historical overview of the region, its importance as biodiversity hotspot and concerns about the degradation of the area.

Poojaris and Swamis of Agasthyar Madom were very much keen to develop pilgrimage activities at Agasthyamalai. Their demands hovered around developing the path, provision of better infrastructural facilities like lodging, boarding, health care, etc. They expressed strong wish to enhance the rituals, which are being carried out at Agasthyamala. Finally, they disclosed their desire to transform the area into a pilgrim centre of national importance at par with Benares, Badhrinath and Sabarimala.

The audience reacted with concern over the prospect of escalating pilgrim activities. Most were concerned about the biodiversity of the area and opined in one voice that it is conservation that has to be given first preference. If any pilgrim

activity poses threat to the biodiversity of Agasthyamalai, then it is wiser to relegate pilgrimage to the background.

Majority voiced strongly to regulate the pilgrimage, ban any permanent structure, prohibit plastic and other wastes, discontinue advertisement on pilgrimage by the Forest Department etc. They insisted on off-season years between pilgrimages to permit the ecosystem to recover from the damages. To convert the present form of the pilgrimage into more ecofriendly visits, conducting nature awareness programmes, exhibitions etc was suggested.

2. Workshop with EDC members at Chathancode (Plate 28). Yet another workshop, with members of Chathancode, Podiyam and Bonacaud. EDCs was conducted on 23rd May 2002. The Wildlife Warden of Thiruvananthapuram, researchers from Periyar Tiger Reserve Ecodevelopment project, Scientists, tribals and non-tribals, the President of Vithura Panchayath and members participated.

Plate 29. Group discussion

After briefing the group on the required output from the workshop a general consensus was arrived at (Plate 29).

The EDC members were in a position to take over the complete management of the pilgrimage in an ecofriendly manner. They demanded sufficient training in concepts, skills, financial management, etc. Finally all were of the opinion that the EDCs may be empowered to carry out the sensitive task.

Creation of awareness for ecofriendly pilgrimage

One of the important outputs envisaged in this project is to provide materials for awareness creation on Agasthyamalai so as to transform the pilgrimage into an ecologically friendly one. To achieve this objective, we participated in the pilgrimage for few days to understand the need for awareness creation, quality and quantum of pilgrims, nature of the area, the need of pilgrims and the supportive and assimilative capacity of the environment. Our efforts to deliver the output were as follows.

1. Creation of awareness among pilgrims during the pilgrimage - We conducted camps for groups (Plate 16) at various locations to illustrate to the pilgrims regarding the biodiversity importance of Agasthyamalai and the do’s and don'ts of pilgrimage.
2. Preparation of a draft handbook - A draft handbook -"Know Agasthyamalai” has been prepared for use by various stakeholders and also for pilgrims.
3. A draft brochure has been prepared on the "Pilgrimage to Agasthyamalai" which can be given to prospective pilgrims while registering their names with the Wildlife Warden, Thiruvananthapuram. An application form (detachable) is a part of the brochure. The remaining pages are devoted to the conduct of ecofriendly pilgrimage.

Measures to minimize the impact of pilgrimage in Agasthyamalai region

It is needless to state that the Agasthyamalai region is an important hotspot of biological diversity, and of late, has been designated the status of a biosphere reserve (Agasthyamala Biosphere Reserve). Our investigation reveals that the pilgrimage route passes through the core area of the Biosphere Reserve and mostly through the crest line, which is an extremely sensitive element of the landscape. Indeed, there is an impact on the flora, landscape quality, regeneration status, etc due to the pilgrimage. Although the impact is low at present due to small number of visitors and adventurous or spiritual character of the visit, the same status need not be maintained in future. Anticipating a quantum increase in the number of visitors over the coming years, the Kerala Forest Department needs to adopt certain measures within the broad frame work of conservation of biodiversity, creation of environmental/conservation awareness and local participation in visitor/pilgrimage management.

1. Conservation of biodiversity

Conservation of biodiversity of the region, especially in the pilgrimage-impacted site, is important. The activities of pilgrimage cause damage to the flora along the trek path and also to birds, insect nests and small animals. There is hampering of regeneration along the path and also incidents of fire damage. Hence, steps need to be taken to prevent damage.

a. Group formation at Bonacaud: - A regular arrangement has to be set up at Bonacaud check post. The status of the same may be elevated to that of a forest station (office + quarters + open auditorium + toilets). The site can be beautified, constructions made ecofriendly in nature and with proper amenities to assist the pilgrims, guides and protection staff.
b. Trek path: All along the trek path sign boards illustrating do's and don'ts for conservation may be displayed at vantage points. The practice of taking fire line may be avoided while introducing no fire zone management. Guides who can control all damaging activities need watch all pilgrim groups constantly. The route is to be declared as no smoking area and free from alcohol. Visitors

must be forbidden from cooking food, littering and polluting streams/water holes. They should be permitted to rest only in designated area at Karamanayar and Attayar. No one should be allowed to stray away from the group, indulging in plant/animal collection, damaging trees, plants, etc. No one should be permitted to inscribe anything on rock faces.

c. Rest at Karamanayar: Pilgrims/visitors take rest at Karamanayar. The guides/nature interpretation fellows can use this place for interaction with them to highlight the importance of the location. Littering and trampling should be prohibited.
d. Rest and food at Attayar: Makeshift facilities may be made at Attayar for people to rest and bathe. Care should be taken not to pollute the water; consumption of intoxicants, cooking food, lighting fires and also littering should not be allowed.
e. Halt at Athirumala: Athirumala is a location where pilgrims spend the night. Ecofriendly facilities are to be created for pilgrims to rest, take food and attend to their daily chores. The halt time can be utilized for awareness programmes also. Wholesome food may be provided before venturing to climb the peak. The present concrete structure is in a bad shape. Temporary rest places and potable water are to be provided.
f. Climb and Pongala at Pongalappara: Here the visitors pass through high altitude, which is very much vulnerable to even small impacts. Hence proper attention needs be paid not to trample the plants, set fire or even collect specimens and materials. At Pongalappara a fire is made for preparing the Pongala. The guide should prevent cutting of live branches of trees or bushes and permit only collection of dead and fallen wood. Fires should be set only under strict supervision of guides and need be put off after use. Pilgrims may be instructed to carry all left over things back with them and not to litter the area.

g. Agasthyar peak and rituals: At Agasthyar peak care should be taken not to litter /set fires and also destroy the vegetation. The shrine and its surroundings need be kept clean and this message has to be transferred to the visitors.

h. All visitors need be accompanied in the return trip also. The present practice of letting them off at Agasthyar peak itself needs be dispensed with for reasons of forest protection.

2. Conservation awareness and nature interpretation

A guided tour to Agasthyar peak offers immense scope for conservation awareness and nature interpretation.

Firstly, brochures, displays, study materials, films, etc. are to be prepared on the following themes:

*Importance of conservation.

*Relevance of Agasthyamalai as a hotspot of biodiversity

*Know Agasthyamalai- the do's and don'ts of ecofriendly pilgrimage

Display boards all along the trek path may be placed informing the visitors the importance of location, fire proneness, watershed services, fragility of the ecosystem, its conservation value, etc. Facilities may be provided for slide shows, film screenings and talks at the beginning of the pilgrimage, i.e. at Bonacaud.

The next part is nature interpretation, which is different from education and awareness. For nature interpretation the visitor has to feel, experience and form his opinion on an operation/site. The interpreter plays a key role in the creation of the experience (change in vegetation with altitude, decrease in temperature with altitude, etc.). The interpreter can then create a story and select stops that demonstrate each key part of the story. Another experience is vegetarian food- where visitors experience eating lower down the food chain. Solar power can be widely used in the pilgrimage area to demonstrate the importance of energy conservation. Pilgrims can be enthused to clear all garbage and take them away to the urban areas. The delivery of interpretive messages is much stronger when visitors are asked to change their behaviour first and are then offered the rationale of conservation. While ecological sustainability to

pilgrimage to Agasthyamalai can be offered through smart technology, rules and regulations, interpretation requires an operator to instill in the visitor a cultural commitment for continuous support to conservation in future life.

3. Local participation in pilgrim/visitor management at Agasthyamalai

Local communities living around the pilgrimage zone can use pilgrim management as an accessible development alternative, which can enable them to improve their standard of living, quality of life, without having to sell off or degrade their natural resources or compromise with their culture. In the absence of other sustainable options their participation in pilgrim and pilgrimage management is perceived as the best option for achieving their aspirations for sustainable development.

The ecodevelopment committees (EDC) at Bonacaud, Podiayam and Chathancode are the ones identified by us to manage the pilgrimage to achieve the goals of conservation and local development. The Workshop on pilgrimage, which we conducted with the members of these EDCs revealed their willingness to organize, conduct and manage the pilgrimage on behalf of the Forest Department. Hence, it is required to:

1. Set up a pilgrimage management institution at the local level involving the members of these EDCs.
2. Divide the area and work among the EDCs.
3. Provide financial and technical support.
4. Train the members in all facets of handling pilgrims from providing food to creation of conservation awareness.

Abstract of measures for ecofriendly pilgrimage

Aim	Tasks
1. Conservation of biodiversity	• Bring the pilgrimage under strict framework. • Effect trekking under strict surveillances. • Prevent littering, trampling, setting fires, cooking food, polluting water bodies, and collecting plant/animal specimens. • Carry back everything – do not leave anything (non-degradable) in the forests. • Report before and after the pilgrimage.
2. Conservation awareness/interpretation	• Prepare pamphlets, brochures, and handbook, display board. • Provide nature interpretation through experiences during the pilgrimage.
3. Local institution to the pilgrimage.	• Set up an institution with members of EDC s. • Delegate powers; provide financial support, training and capacity building. • This institution provides guides, food and beverages, nature interpretation and awareness, and controls all activities of pilgrims.

CONCLUSIONS

An Initial Environmental Examination revealed that:

1. The Agasthyamalai region occupying a land area of 200 km^2 and situated in the southern Western Ghats of Kerala abodes all vegetation types met within the forests of Kerala from montane grasslands and evergreen forests to moist deciduous forests and plantations.

2. The region forms critical upland watersheds of Neyyar and Karamana rivers, which are extremely important to the water supply of agricultural economy of Thiruvananthapuram district.

3. The area is rich in flora represented by 1084 angiosperms belonging to dicots (795) and monocots (289). Endemism is high as revealed by 301 species endemic to India, 254 to the Western Ghats and 45 to the region. Of the angiosperms 88 are wild relatives of cultivated crops, 100 are rare medicinal plants and 25 species are new to science. Of the 1084 species, 147 are extremely rare and 26 are placed in the Red Data Book.

4. The faunistic wealth of the area is diverse represented by 43 species of mammals, 142 birds, 33 reptiles, 27 amphibians, 27 fishes and 84 butterflies. Of the mammal species, 14 are placed in the Red Data book.

5. There are nearly 35 settlements (392 families and 1473 members) of tribals belonging to the ethnic group Kanikar in the region. They impact the region through their settlements, shifting agriculture, fishing, hunting, collection of NWFP, thatch, poles, sand and use of water for drinking and irrigation.

6. The fringes of the forest area abode over 1000 families of locals and settlers who in turn use the region for various purposes and cause harm to the integrity and biodiversity of the forests.

7. Forest fires caused by residents within and outside forests are a major threat to the structure and functioning of biodiversity rich forest ecosystems of the Agasthyamalai region.

8. Forest cover during the past 30 years has declined by 13.3 percent in the region.

9. Approximately 50 percent of the forest cover in the region belongs to the degraded category (<40% canopy cover) indicating the magnitude of impact the area is experiencing already.

10. Regeneration of tree species is hampered along the pilgrim route up to 200m width. This can cause deterioration of forest cover subsequently in the long run.

Investigations into the activities of pilgrims to the Agasthyamalai revealed that:

1. Over and above the damage caused by inhabitants within and outside forests, the region is experiencing the pressure from pilgrimage to Agasthyamalai from Kerala and Tamil Nadu for 4 months in a year from January to April.

2. Although, the pilgrimage to Agasthyamalai has been taking place for the past five decades a regulatory framework with involvement of the Forest Department was initiated only in the year 1999. The pilgrimage season is notified through media and applications are invited from prospective pilgrims. Permission is accorded and a date is fixed to report at Bonacaud forest station, which serves as a facilitation centre for pilgrimage. A group (max. 50 pilgrims) is provided with two guides (from EDC) under payment. Food and beverages are provided by the EDC and pilgrims on return need to report at Bonacud check post. There has been a doubling in the number of pilgrims, from 1658 (in 1999) to 3237 (in 2001) indicating the possibility of escalation in the future.

3. During the period under consideration (January-April 2001), 3237 pilgrims visited Agasthyamalai from Kerala side, the maximum number coming in February (2147). By March the number lowered to 65 and in April there were none.

4. The pilgrims visited the area in 2001 in groups, which amounted to 224. Twelve groups totaling 175 persons visited the site from Tamil Nadu during the pilgrimage season of 2001.

5. Of the 3237 pilgrims, majority belonged to the Hindu religion and others including Muslims also visited the area. Most of them were self-employed and were financially and educationally backward. A good majority of them arrive from a radial distance of 50 km from the region and are in the age group of les than 40 years.

6. There are four main reasons for the visitation viz. Nature interaction, Worship, Medicinal plant collection and Adventure.

The Environmental Impact Assessment of pilgrimage during 2001 revealed the following:

1. The pilgrimage route extending over 25 km traverses through moist deciduous forests, evergreen forests, grasslands and montane subtropical evergreen forests located at the peak. The actual pilgrimage (walking) has temporary negative impacts on flora, fauna and migration corridors during the season. Fire is a major threat posed by the pilgrims.

2. Water quality and soil quality are adversely affected due to solid waste disposal. Paper (5 kg), plastics (47 kg) and bottles (>100 kg) were collected during the study.

3. Overnight halt at Athirumala has long lasting impact on the ecology (vegetation removal, trampling, soil and water quality) of the surrounding area.

4. The Pongalappara area and Agasthyamalai have been disturbed to the maximum possible due to firewood collection, lighting fires for religious rites and over crowding during the season.

5. Positive impacts were noticed as regards to employment generation, services, and revenue generation. The pilgrimage has a variable impact on traditional livelihood, as the visitation activities are seasonal and not economically enterprising.

6. Overall the pilgrimage adds to the impacts created by other activities in the region and serves as an excuse for plundering the biodiversity rich unique region in the southern Western Ghats, especially in the background of an increasing trend in the number of pilgrims year over.

RECOMMENDATIONS

The Kerala Forest Department, taking into account the sensitivity of the biodiversity hotspot area has to regulate the pilgrimage more effectively and efficiently. This study, based on Environmental Impact Assessment of Pilgrimage in Agasthyamalai Region and consequent stakeholder workshops with pilgrims and Eco-development Committee members, makes the following recommendations.

1. An institution at the local level (Eco-development Committee) may be authorised to handle all facets of pilgrimage and make it environment friendly and economically enterprising. This can be done by raising the awareness of the pilgrims and also by fixing appropriate levies and fees. Relevant training in environment and hospitality management may be provided to EDC members.

2. As the trend reveals an increase in the number of pilgrims over the years, there is an urgent need to curtail the inflow in accordance with the supportive and assimilative capacity of the site.

3. Pilgrims are instructed to take away what they bring (especially plastics, bottles, food remnants, etc) with them for the pilgrimage.

4. Although seasonal, the pilgrim activities cause temporary damages to the ecosystem, which in turn can become permanent and therefore affect the serenity of the site. Alternate years may be declared as non-pilgrimage years to provide enough time for the ecosystems to recuperate.

5. At present the pilgrimage season is notified in the media and in future this practice may be avoided in order not to attract more enthusiasts.

6. The present facilities at the pilgrimage route although sufficient are not properly maintained. Provision of sufficient toilets and safe places for resting may be arranged.

7. Awareness programmes may be conducted before, during and after each pilgrim season.

8. Appropriate brochures, pamphlets and handouts may be prepared highlighting the importance of Agasthyamalai and also guidelines for eco-friendly conduct of the pilgrimage.

9. Periodic monitoring of the pilgrimage routes and activities may be carried out and the results of such investigations may be used to make timely corrections.

10. In the context of the overall importance to conservation efforts of Agasthyamalai, pilgrimage activities may be relegated to the background.

LITERATURE CITED

Basha S C 1987 Studies on the ecology of evergreen forests of Kerala with special reference to Silent Valley and Attappady. PhD Thesis, University of Kerala, 232p

Champion H G and Seth S K 1968. General Silviculture for India. Manager Publications, New Delhi.

Mohanan N, Rajkumar G and Shaju T 1997 Floristic diversity of Agasthyamala, Western Ghats. Proceedings of the 9th Kerala Science Congress, pp. 444-448.

Nair S C 1991 The Southern Western Ghats: A biodiversity conservation plan. INTACH, 92 p.

Pascal J P 1988 Wet evergreen forests of the Western Ghats of India. Ecology, Structure and Floristic composition. French Institute of Pondicherry, Pondicherry, 305 p.

Prasad SN, Vijayan L, Balachandran S, Ramachandran VS and Verghese CPA 1998. Conservation planning for the Western Ghats of Kerala:I A GIS approach for location of biodiversity hotspots. Current Science, 75 (3), 211-219.

Sankar S 1999 Environmental Impact Assessment of Thenmala Ecotourism development Project. KFRI Consultancy Report. 144 p.

Sreekumar PG 2000 Animal Diversity in a tropical rainforest with emphasis at the community level. PhD Thesis Kerala University, 172 p.