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VEGETATION MAPPING AND ANALYSIS OF ERAVIKULAM NATIONAL PARK USING REMOTE SENSING TECHNIQUES

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ABSTRACT

Vegetation mapping of Eravikulam National Park was done using remote sensing techniques. Maps were prepared in 1:25,000 scale using Black and White aerial photographs and in 1: 50,000 scale using IRS 1B Geocoded satellite imagery. A set of supplementary maps viz. physical, digital, drainage, slope maps were also prepared. Vegetation analysis of the area was also done and structural data are presented.

Key words: *Vegetation mapping, Phytosociology, Remote sensing, Photointerpretation, Eravikulam National Park.*

INTRODUCTION

Eravikulam National Park consists of a unique shola-grassland ecosystem which has remained stable and in equilibrium for many decades. According to Clemensian concept, two distinct vegetation types cannot form climax in same regional climate. The successional status of grasslands has been subject of much controversy over the years. Ranganathan (1938) held the view that the grassland of the Nilgiris represent climax vegetation just like shola vegetation, contrary to the view of sub climax as held by many researchers (Champion, 1936; Bor, 1938; Shankaranarayanan, 1958; Gupta and Sankaranarayanan, 1969; Chandrasekharan, 1962a, 1962b, 1962c).

Population growth has a direct effect on forest ecosystem and the latter is passing through a critical stress phase. Therefore, conservation and judicious management of flora and fauna through ecologically viable conservation strategies are essential for sustainable management of National Parks and Wildlife Sanctuaries.

In India, at present, there is tremendous reduction in the forest areas and subsequently that of Wildlife status. Much of the wildlife once widely distributed are now seen in certain pockets. Hence, in situ conservation of wildlife is necessary. In order to conserve the natural flora and fauna it was suggested that a minimum 5% of the geographical area should be conserved as Wildlife Sanctuaries and National Parks.

In Kerala , there are at present 12 Wildlife Sanctuaries and 2 National Parks encompassing about 5.78 % of the geographic area of the State. Information on the spatial distribution of different vegetation cover classes and the pattern of their change is a pre-requisite for planning, and management of Wildlife sanctuaries and National parks. The high altitude shola and grassland vegetation of the Western Ghats is a fragile ecosystem. At present no detailed vegetation map is available regarding the spatial coverage of sholas and grasslands. Similarly information on phytosociological status viz. density, degradation aspects, community wise classification of grassland and the area coverage etc. are also not avilable. In short, the structural status of the permanent vegetation specially quantitative aspects and floristic composition of shola, grassland and other vegetation types is the major lacuna for the better and effective management of Eravikulam National Park.

The present study, undertaken to meet such an inevitable need of management includes broadly two aspects viz., 1. Vegetation mapping, 2. Vegetation Analysis.

Modem tools like remote sensing are applied in lieu of conventional methods so as to reduce the field work and cost. Remote sensing supplemented with ground truths provides a very satisfactory method of obtaining several types of forest management information, which by other methods is either out dated before the data can be fully used or is too expensive to collect. The present work was undertaken to fill up the lacuna with following objectives:

To map the vegetation in suitable scale.

ii To estimate the area of major vegetation types.

iii. To prepare slope and drainage maps of the area.

iv. To study the structural aspects of permanent vegetation.

v. Digital image analysis of the area for land cover classification.

STUDY AREA

LOCATION

Eravikulam National Park falls along the crest of the Western Ghats in the high ranges, Idukky district, Kerala state at 10^{o} 05 to 10^{o} 20' N. Lat. and 77^{o} to 77^{o} 10'E. Long. (Fig. 1). The entire area falls within Devikulam Taluk of Idukky district. The nearest town is Munnar which is accessible by road from Cochin and Kottayam. The nearest air port is Cochin which is 135 km and the nearest railhead is Alway which is 115 km away.

BOUNDARIES

East : The old Kannan Devan Hills produce village boundary along the ridge through Kattumudi and Perumalmalai.

South : Northern bounderies of Chattamunnar, Nyamakad and Vaguvarai estates of Tata tea Ltd.

West : Old Kannan Devan Hills produce village boundary along the ridges through Rajamalai, Sambamalai. and Kollukumalai.

North : The boundary coincides with the inter state boundary between Tamil Nadu and Kerela at 1689 m. msl.

VEGETATION

Shola forests: Shola forest type is the main vegetation type. It is a closed evergreen forest type (temperate rain forest), the trees being mostly short boled and branchy, often attaining a considerable girth. The height of the forest canopy is relatively low, rarely exceeding 25m. The crowns are usually very dense and rounded with entire coriacious leaves. The branches are clothed with mosses, ferns and other epiphytes and woody climbers are common. There is no marked differentiation of canopy layers, but there is a continous series from undershrub to shrub and shrub to shola trees. There is considerable admixture of species. The forest is usually found in patches in the protected pockets in the rolling grassland. They occur as numerous isolated compact, sharply defined and usually small woods interspersed with vast stretchs of grasslands.

FAUNA

There is a wide range of carnivore, herbivore and omnivores found in the National Park. Among the herbivores the first and foremost is the Nilgiri Tahr *(Hemitragus hylocrius)* which occupies the highlands and rocky regions of the National Park. Other herbivores are the Sambar and Barking Deer which are found in sholas, and Gaur in lowlying grasslands. Malabar Gaint Squirrel is another herbivor found in the sholas. Elephants constitute a migratory population and do not occupy a permanent station. Among the carnivores the main species are tiger. panther and wild dogs which occupy both the open grassland and shola forests. Civets and jungle cats are also seen in the sholas. Among the omnivores the main species are the Sloth bear, Nilgiri langur, wild boar, etc. which are found mainly in the sholas and on their fringes. The avifauna includes the Blackbird, Pipit, Black Winged Kite, Bush Lark, Emerald Dove, Wood Pigion. Jungle Crow, etc.

CLIMATE

The monsoons are the dominating feature of the weather cycle. Starting from June rains occur till December. The winter season is from December to February. The lashing rain and high velocity winds and poor visibility during monsoon period make the area totally inaccessible. The average rainfall is 413 mm as per 1994 record (Table 1). The wind blows from east during winter months and gains strength when it blows from west during the monsoon The mean maximum precipitation is in the month of July (1683 mm) and Minimum in March (2.6). Incoming solar radiation is very poor during the monsoon periods due to heavy mist and clouds.

Table 1. Weather Data of Eravikulam National Park for the Year 1994

Months	Rainfall (mm)	Temperature (OC)		Humidity (% RH)
		Min.	Max.	
January	33.4	10	22.0	65
February	25	14	22.0	65
March	2.6	13	27	65
April	142.8	13	25	67
May	245.0	13	25	69
June	1278.6	13	20	82
July	1683.2	13	16	75
August	694	13	18	73
September	365.3	13	20	80
October	394.0	12	24	80
November	94.8	12	22	75
December	11.3	10	26	70

METHODOLOGY

VEGETATION MAPPING

Data used

In the present study the following data products were used

a Aerial photographs

Specifications of Aerial photographs

Type	Vertical, Panchromatic Black & White
Scale	1: 50,000
Camera	RMK 15/23
Focal length	15.3 cm
Date	2 Feb, 1990
Format size	23 x 23 cm
Nature of print	Glossy, Singleweight
Overlap	Forward 60 to 80% Lateral 10 to 40%
Direction of flight	South to North
Film	Kodak xx aerographic, panchromatic
Filter	D 12 x 256

b. IRS data products

The Indian Remote Sensing Satellite IRS 1A and 1B LISS 2 data in the form of false colour composites and computer compatible tapes were used during the study. The data products were procured from NRSA.

False colour composites

An FCC imagery generated by combining IRS bands of 2, 3 and 4 (2 in blue, 3 in green and 4 in red) enables the identification of vegetation types

effectively. In the present study, standard and geocoded data products were used. IRS 1A LISS 2 A2 Path 25, Row 61; scale 1:1,25,000,Year 1990 is used for the preperation of small scale vegetation map.

Computer compatible tapes

The sattelite data in digital form for analysis and interpretation on computer based systems are available as CCCT's. Catridge tapes and Floppy diskettes. CCT's of IRS 1A LISS 2 A2 of Path 25, Row 61, Dated 23 rd December, 1998 were used for the study.

c. Ancillary data

Survey of India Topographic maps of (58 F/3 and 58 F4) 1:50.000 scale and 1: 2,50,000 scale were used for the mapping of vegetation.

ANALYSIS AND INTERPRETATION OF REMOTE SENSED DATA

The Aerial photographs and imageries were interpreted using photo elements viz : tone. texture, pattern. shape, size, location and association. Digital data was analysed on interactive computer systems for extracting stastistical data and thematic information about resources using supervised classification techniques.

Visual interpretation of aerial photographs

The standard interpretation technique based on various photoelements (Tomer and Maslekar. 1972) were adopted for visual interpretation of large scale aerial photographs. Based on the photoelements, a photointerpretation key was prepared (Table 2)Similar to aerial photographs, satellite imageries were interpreted based on its charactarestic photoelements such as colour/tone, texture, pattern, etc.

Field checking

The units delineated on the aerial photographs and satellite imageries were compared with ground details at random to verify the accuracy of interpretation and to check the doubtful areas for correction.

Table 2. Image interpretation key for land cover mapping using pan-chromatic aerial photographs

Sl. No.	Symbol	Cover Type	Tone	Texture	Pattern	Remarks
1.	E	Evergreen forest	Black	Fine	Smooth	--
2.	SH	Sub tropical Hill forest	Deep black	Fine	Smooth	--
3.	S	Shola forest	Deep black	Medium	Smooth	--
4.	G	Grassland	white	Fine	Smooth	--
5.	SC	Scrub	Greyish white	Medium	.Medium	--
6.	PT	Teaplantation	Dark grey	Fine	Medium	Distinct arrangements seen
7.	PW	Wattleplantation	Greyish	Medium	Medium	Distinct crown shape
8.	H	Habitation	Yellowish white	Coarse	--	Distinct appearence
9.	X	Exposed rock	Light grey	Rough	--	
10.	W	Waterbody	Darkblack	Fine	--	--

Fair Map Preparation and printing

Fair mapping was done on a transparent film. The aerial photo/satellite imagery interpreted details were transferred to the base maps. The transparent fair maps were used for making photocopies or prints.

Area estimation

The area estimation of different land cover classes was carried out using Plank-5000 digital planimeter.

Preparation of drainage map

A drainage map was prepared using 1:15,000B &W aerial photographs and Survey of India Topographic sheets. All the major and minor rivers were marked from photographs.

Preparation of slope maps

The slope map of the study area was prepared following Wentworth's method. Area under different slope category and their percentage was calculated using planimeter.

Digital Image Processing

The digital image proccesing was carried out on VAX 11/780 system useing VIPs 32 software available at Regional Remote sensing Service Centre Banglore. Supervised classification of maximum likelihood classifier was used to classify the vegetation types.

PHYTOSOCIOLOGY

With a view to study the phytosociological analysis of vegetation in Eravikulam National Park, a thorough reconnaisance survey was carried out initially to assess the overall florestic characterastic of the vegetation so as to design the sampling procedure and intensity.

Sampling

Based on strata identified on aerial photographs, stratified randam sampling was adopted in the area to study the vegetation types, their composition and structural e1ement.A sampling strategy was adopted in order to cover the entire vegetation. The whole area was divided into seven localities.

Census quadrat method

Ten quadrats of 10 m x 10 m were laid down in each locality. Maximum care was given to lay quadrats in different sholas in each locality. but some times due to lack of sufficient number of shola patches or inaccessibility, it was inevitable to lay more than one quadrats in one shola.

Ten randomly selected quadrats of size 10 x10 m in each locality were established to characterise the floristic composition and structure of vegetation, thus covering a sampling area of 1000 sq.m in each locality and 7000 sq.m of total sampling in the study area.

Primary analysis of the vegetation

From quadrat studies, the data on density (D), percentage frequency (%F), abundance (AB),basal area (BA); relative basal area(RBA). relative frequency (RF), relative density (RD), and important value index (IVI)etc. were calculated as per the following formula (Phillips, 1959).

$$\text{Density (D)} = \frac{\text{Total No. of individuals}}{\text{Total No. of quadrats studied}}$$

$$\text{Abundance (AB)} = \frac{\text{TotalNo. of individuals}}{\text{No. of quadrats of occurrence}}$$

$$\text{Frequency (F)} = \frac{\text{No. of quadrats of occurrence}}{\text{Total No. ofquadrats studied}}$$

$$\text{Relative Density (RD)} = \frac{\text{No. of individuals of species}}{\text{No. of individuals of all species}} \times 100$$

$$\text{Relative Frequencey (RF)} = \frac{\text{No. of occurrence of the species}}{\text{NO. of occurrence of all species}} \times 100$$

$$\text{Relative Basal Area (RBA)} = \frac{\text{Basal area of the species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Important value index (IVI)} = \text{Relative density} + \text{Relative frequency} + \text{Relative basal area}$$

The mean density. mean abundance, mean frequency. mean important value index of different species and the percentage IVI value of each species with respect to the total IVI of the locality as a wholewere calculated seperately for each locality to establish the stand relation.

Secondary analysis

Distribution

Distribution of species is one of the important aspect of ecological studies which has attracted attention of a number of ecologists (Cole, 1949; Frackler & Brischle, 1948: Ashby, 1948). Whitford (1948) suggested the abundance/frequency ratio as a measure of contagiousness. As a general rule the high frequency and low abundance indicates regular distribution whereas the converse indicates contagious distribution. The distribution scale states as < 0.025 (regular), 0.025 to 0.05 (random) and >0.05 (contagious distribution). The abundance/frequency value of each locality was worked out and tabulated.

Maturity index

The term maturity index (MI) was first coined by Pichi- Sermolli (1948) to assess the status of the community in relation to successional stages. The maturity index was calculated using the following formula:

$$\text{Maturity Index (M)} = \frac{\text{Total frequency percentage of a locality}}{\text{Total No. of species present}}$$

Community Co-efficient

To assess the overall similarity of different locality with respect to species diversity, the index of similarity is worked out. The study is based on the " community coefficient concept" of Jaccard (1912).

Sorenson (1948) modified the Jaccard's community coeffiecient concept. It is widely accepted.

Sorenson's (1948) formula for similarity index is:

$$IS = \frac{2C}{A + B} \times 100$$

Where,

C = the number of species common to two releves

A = the total number of species in releve A

B = the total number of species in releve B

Continuum concept

Gleason (1926, 1939) pointed out the absence of absolute boundaries between the adjacent plant communities and there fore he proposed the continuum concept in phytosociological researches. Curtis & Mc-Intosh (1950) modified Gleason's individual concept and developed the idea of continnum of vegetation involving gradual variation from stand to stand.

For calculating the continuum index each species was assigned a climax adaptation number, based on the important value index (IVI) ranging from 1-10 for species at both ends. A high adaptation number means better adaptation to all environmental conditions present in terminal stands (Muller-Dombois&Ellenberg, 1974). To assess the position of a single stand the importance value index of different species present in the stand were weighed against their adaptation number. These values are added to give the total value for a stand. This is the continuum index of the locality. The percentage continuum index value for each locality is calculated.

RESULTS AND DISCUSSION

A. VEGETATION MAPPING

Tree different scales of vegetation maps viz, a detailed large scale of 1:25,000. medium scale of 1: 50.000 and a small scale of 1: 1,00,000 were prepared, based on the nature of the data used and the purpose of the vegetation map needed.

Vegetation map prepared from aerial photographs

A detailed large scale vegetation map of 1: 25.000 was prepared from 1:15,000 panchromatic black and white areal photographs (Fig 2).

By using aerial photographs. evergreen forest, sub-tropical hill forest and shola forest could be distingushed and delineated accurately due to it's high resolution and better tonal contrast.

The smallest unit delineated in the aerial photograph of 1:15.000 scale was 5 mm x 5 mm size. Density stratification of Shola forests into three density classes was achieved based on its tonal contrast. The density classes were, 1. low density shola (Crown cover 1-25%). 2. median density shola (26-50%) and a high density shola (crown cover >50 %).

Vegetation map prepared from geocoded FCC

Geocoded FCC of IRS LISS 2 data were used for the preperation of medium scale (1: 50,000) vegetation map (Fig 3). The advantage of using geocoded FCC is that it is prepared after geometric and radiometric correction to the geographic orientation of the real north so that while interpretation the ground control points can be traced easily by using survey of India toposheets.

Features discernible in geocoded FCC is almost comparable with that of aerial photographs (Table 2). Smallest units of sholas are merged with the adjacent features to the greater extend. The accuracy worked out is nearly 75%. The area estimate obtained through geocoded FCC is given in Table 3.

Shola forests were classified based on their density into three classes, viz. low density (1-25% crown cover), medium density (26-50%) and high density (> 50%).

Comparative account of different vegetation classes obtained through the use of various data products are given in Table 3.

Vegetation map prepared from standard FCC

For a small scale (1: 1 ,00,000) vegetation map, standard FCC (1: 1.25,000) of IRS LISS 2 data are used (Fig 4). Land cover classes delineated and area estimates are given in Table 3.

Shola forests were classifled based on their density into three class as in the case of geocoded FCC and Aerial photograph.

Vegetation map prepared from Digital image processing

The false color composite created (plate I) and digitally classifled output of the study area are given. (Plate 2). The major grassland communities of Eravikulam National Park was mapped through digital image processing. The initial reconnaissance survey during the study revelaed the highly heterogenous nature and distribution of grassland communities. Based on the spectral separability, grassland communities of Eravikulam National Park are classified into 3 gropus (Plate 2).

Grassland community type 1 occupies comparatively less area and is mostly seen in the lower elevation of Rajamala side and in some parts of hte centre of the park. Dominant species component of this type are Arundinella *mesophylla, Chrysopogon zeylanicus* and *Andropogon lividis* (Table 3).

Grassland community type 2 occupies more or less equal area as the grassland community type 3. It occupies the north western part of the National Park in Anamudi area. *Dichanthium polyptychum, Eulalia pheothrix* and *Chrysopogon zeylanicus* are the most frequent species.

Grassland community type 3 is seen mostly on the north eastern side of the National Park. The major components of this category are *Arundinella mesophylla, Chrysopogon zeylanicus* and *Eulalia pheaothrix*.

Drainage map, Slope map and Contour map

For better management of wildlife sanctuaries and National parks, ancillary information such as drainage map (Fig 5). contour map (Fig. 6) and slope map (Fig. 7) etc. are highly necessory. Drainage mapes, Contour maps and slopes maps are prepared based on aereal photographs and SIO toposheets.

Land cover classes

Major vegetation types in the study area are grassland and shola forests. In addition to this some transition forests are seen in the lower elevation i.e., southern sub tropical hill forest, in between 1200 m and 1700 m. A small percentage of west coast tropical evergreen forests are also seen. Around 60% of the area is covered with grasslands and about 25% of the area consists of shola forests.

Area estimation of different cover types

Area of each vegetation type estimated through different data products are given in Table 3. Total area of national Park is estimated as 112 sq. km.

Grassland

About 60% of the veegetation occupied as grassland. Grassland comprises 58.429, 59.955, and 59.449 Sq.km in map prepared from Areial photograph, standard FCC and Geocoded FCC respectively. In digital image processing, three different community types of grasslands were identified based on its characterestic spectral radiance value. Total grasslands delineated from the digitaly classifled out put is about 78.248 Sq. km.

Shola

The area of shola forest estimated are 17.81, 29.18, 29.46 and 22.461 Sq. km. in aerial photographs, standard FCC, geocoded FCC and digital image processed out put respectively.

Evergreen

In the study area a small stretch of west coast tropical evergreen forests is located in the lower elevation of the North eastern part of National Park, and is possible to deleniate from shola forests in Aerial photgraphs. At the same time it got merged with shola forests in Satellite data products.

Table 3. Area (sq.km.) estimated for different cover classes obtained from different remote sensing data

Sl. No.	Cover class	Aerial Photo	Standard FCC	Geocoded FCC	Digital Image processing
1.	Shola Total	17.81	29.177	29.46	22.461
	Lowdense	0.3232	1.397	0.648	-
	Medium dense	3.05	2.482	2.860	-
	High dense	14.444	25.298	25.952	-
2.	Grassland Total	58.429	59.955	59.449	78.248
	Type 1	-	-	-	1.177
	Type 2	-	-		18.663
	Type 3	-	-	-	57.321
3.	Evergreen	0.183	-	-	-
4.	Sub tropical Hill forest	8.458	-	-	-
5.	Scrub	7.587	8.018	5.131	2.813
6.	Tea Plantation	0.666	0.891	0.814	-
7.	Waffle Plantation	0.889	0.845	0.775	-
8.	Habitation	0.098	-	-	
9.	Rock	5.868	1.111	3.008	-
	Grand Total	99.98	99.99	98.63	103.52

Southern sub tropical hill forest

In the Eravikulam National Park, about 9.474 Sq. km. of sub tropical tropical hill forests are estimated from areial photographs. These forests are seen in the transition zone between low elevation evergreen forests and high elevation shola forests. This type of forests constitute about 8.458% of the total geographical area of National park.

Scrub

About 7.587% (8.458 Sq. km) of the area covered by scrubs. The estimates of scrubs obtained in different data products are 7.587, 8.018, 5.131,and 2.813% out of total area of 112 Sq. km respectively.

Plantations

Wattle and tea plantation were found in the the south west boundary of National park naer Pettimudy estate plantations. Similarly the Lower Vaguvarai region also had wattle plantations inside of the Park boundary. Total area covered by plantations are 1.742 Sq. km. (1.5%).

Habitation

Some tribal settlements (Muduvakudi)is found inside the National park near Luckum tea estate. The area of settlement is about 0.11Sq. km.

Rock

Rocks and cliffs are one of the important geomorphological feature in the National Park. Based on Aerial photographs the area covered by rocks is 5.868% of the total area.

PHYTOSOCIOLOGY

Primary analysis

Following vegetation types are recognised and structural aspectes of two major types, Viz. Shola Forest and Grass land.

Shola forest (Southern montane wet temperate forest)

b. Grassland (Southern montane wet temperate grassland)

c. Transition forest (Southern sub tropical hill forest)

d. Evergreen forest (Southern west coast evergreen forest)

e. Scrub

a. Shola Forest

894 trees above 15 cm. GBH coming under 49 species were enumerated in the 7,000 m2 sampling area. Highest percentage of density (6.86) recorded by Measa indica followed by *Microtropis ramiflora* (6.62), *Syzigiurn arnottianum* (6.38). *Ixora notoniana* (5.51), *Cinnamornum wightii* (4.25) *and Mahonia leschnaultii* (4.09).

Density (D)

With respect to the density data, the species which recorded mean density greater than 0.5 are *Measa indica* (0.87), *Micritropis ramiflora* (0.81), *Cinnamomum wightii* (0.54), *Garcinia cambogia* (0.521, *Mahonia leschnaultii* (0.52). and *Ternstroemia japonica* (0.5). While individual localities shows different density values for different species (Appendix 1).

Abundance (AB)

Out of 49 species enumerated in the study area 19 species recorded mean abundance value greater than 1. These are *Measa indica* (2.02). *Mahonia leschnaultii* (1.6), *Lasianthus venulosus* (1.57), *Schefflera racemosa* (1.52), *Ixora notoniana* (1.48), *Euonymus angulatus* (1.42), *Eutya nitida* (1.39), *Rhododendron arborium* (1.33), *Syzigium arnottianum* (1.28), *Microtropis ramiflora* (1.24). *Cinnamornum wightii* (1.23), *Litsea wightiana* (1.21), *Garcinia combogia* (1.2), *Syrnplocos spicata* (1.19), *Daphniphyllum glaucescence* (1.19), *Actinodaphne bourdillonii* (1.14), *Turpinia nepalensis* (1.09), *Ligustrum perrotettii* (1.08) and *Litsea ligustrina* (1.02).

Species which recorded mean abundance value less than 0.2 are *Flaucourtia montana* (0.14), *Persia macrantha* (0.14), *Glochiodion neilgherrence* (0.14), *Ilex wightiana* (0.14), *Cryptocarya neigherensis* (0.14), *Alseodaphne semicarpifolia* (0.14), *Neolitsea foliosa* (0.17) and *Rhodomyrtus tomentosa* (0.19). Abundance values of different localities are given in appendix 1.

Frequency percentage (PF)

With respect to the mean percentage frequency, only one species *viz. Syzigium arnottianum* recorded percentage frequency greater than 50 (54.28)followed by *Mesua indica* (47.14) *Mahonia leschnaultii* (42.85), *Microtropis ramiflora* (35.71), *Cinnamomum wightii* (35.71)and *Actinodaphne bourdillonii* (30).The lowest percentage frequency value (1.42)are recorded by four species such as *Glochidion neilgherense, Ilex wightiana, Cryptocarya neilgherence* and *Alseodaphne semicarpifolia.* Frequency values of different loacalities are given in Appendix 2-9.

Basal area (BA)

Syzigium arnottianum represented by maximum basal area (677.89)followed by *Rhododendron arborium* (254.6l), *Cinamomum wightii* (249.17), *Elaeocarpus recurvatus* (193.11). *Mahonia feschnaultii* (159.35). *Turpinia nepalensis* (156.58), *Garcinia combogia* (153.13), *Ilex dendiculata* (152.82), *Microtropis ramiflora* (149.97), *Euonyrnus angulatus* (141.97), *Litsea ligustrina* (141.9). *Symplocos pendula* (123.93), *Ternstroemia japonica* (117.92), *Ligustum perrottetti* (l05.68), *Eurya nitida* (101.76).Total 15 speciess records basal area more than 100, and 25 species records basal area more than 50. The lowest basal area (2.55)represented by *Gaultheria fragrantissima* and *Gomphandra coriarea,* followed by *Persia macrantha* (2.9 l), *Rhodomyrtus tornentosa* (3.68), *Allophyllus rhomboidea* (4.1), *Cryptocarya neilgherense* (4.54). *Ilex wightiana* (7. l), *Glochiodion neilgherense* (7.11) and *Dodoneae viscosa* (9.66). Basal area of different localities are given in Appendix 2-9.

Importance value index (IVI)

It is observed that wide range of variation is seen among species when we consider the mean IVI of species. The mean IVI ranges from 0.37 to 30.24. Only 8 species recorded mean IVI more than 10. These are *Syzigium arnottianum* (30.24), *Ixora notoniana* (17.42). *Mahonia feschnaultii* (16.02), *Measa indica* (15.03), *Cinnamomum wightii* (14.9), *Microtropis ramiflora* (14.05), *Garcinia cambogia* (1 1.35) and *Litsea wightiana* (10.3). Based on the IVI value it is impossible to say the dominant associations of Shola forest, though based on the mean IVI value it can be understood that the most dominant spesies of shola forests of Eravikulam National Park is *Syzigiun arnottianum Cryptocarya neilgherrense* records the lowest mean IVI value (0.37) followed by *Glochidion neilgherrense* (0.45), *Gornphandra coriarea* (0.63), *Flacourtia montana* (0.79), *Alseodaphne semicarpifolia* (0.8). *Debregesia longifolia* (0.88).

Derris brevipes (0.93),*Gaultheria fragrantissima* (0.95) and *Allophyllus romboidea* (0.99). while analysing the IVI value of each locality, dominant species varies with locality. IVI of different localities are given in appendix 2-9.

Secondary analysis

Law of homogeneity of vegetation

Based on the text of homogencity (Rauntiar, 1934)result it was clear that all localities expect Rajamala are heterogenous.

Distribution (ABF)

Based on the AB/F ratio (Whitford, 1948),out of 49 species encountered, 8 (16.32%) species show contagious distribution (AB/F value >0.05), 22 (44.9%) species have random distribution and 19 (38.8%) species distributed regularly.

Important species distributed contagiously are *Measa indica, Litsea wightiana,Euonymous angulatus* and *Rododentron arboreum*

Species which have random distribution are *Actinadaphne bourdillonii, Mahonia leschnaultii. Cinnamomum wightii, Syzigium arnottianum, Symplocos spicata* and *Elaeocarpus recurvatus.* Species which have regular distribution are *Microtropis ramiflora, Ternstroemia japonica, Symplocos pendula, Litsea glabrata, Cinnamomum perrottettii* and *Rhodomyrtus tornentosa.*

Maturity *index (MI)*

Maturity index value of 7 localities are given in appendix 1-9. Only a negligible amount of variation are observed in the maturity index value among all localities. Maturity value ranges from 37.92 (Rajamala)to 26.40 (Tumursvalley).

Similarity index (IS)

Highest percentage similarity (84.44)was obtained in the locality Eravikulam with Puvar. Rajamala shows highest (70.84%) dissimilarity with Anamudi. More than 60% similarity observed among localities Naikollymala with Anamudi and Umayamala; Anamudi with Umayamala, Eravikulam with Puvar and Eravikulam with Puvar. More than 60% dissimilarity observed among localities Rajamala with Anamudi and Puvar (Appendix

Continuum index (CI)

Continuum index value ranges from 1428.33 to 1640.48. Anamudi records the highest value where as Turnurs valley has the lowest value (Appendix 12).Considering the whole area there is not much variation in the percentage continuum index value of different localities (13.36-15.34). This indicates more or less uniform environmental impact over vegetation.

b. Grasslands

Based on quadrat data three different composition of grasslands were identified. With respect to the percentage frequency of species, dominant grass species were identified as community types. Thus three major grassland communities obtained are:

1. *Dichanthium polyptychurn - Eulalia pheothrix - Chrysopogon zeylanicus.*
2. *Arundinella rnesophylh - Andropogon lividis - Ischamum indicum - Chrysopogon zeylanicus.*
3. *Arundinella purpuria - Chrysopogon zeylanicus - Eulalia pheothrix.*

A total of 23 grass species were recorded, of these highest mean percent frequency showed by *Chrysopogon zeylanicus* (63.3), followed by *Dychanthium polyptychum* (40), *Eulalia pheothrix* (40), *Andropogon lividis* (40), *Arundinella purpuria* (36.6) *and Ischaemum indicum* (33.3) indicating the dominant position.

Lowest mean percentage frequency (3.3) represented by species like *Eulalia trispicata, Digitaria wallichiana,* and *Panicum gardeneri.*

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Appendix -1

Mean values of Abundunce, Density, Basal area, and Frequency of different localities of National Park

Species	MAB	MD	MBA	MPF
Actinodaphne bourdillonii	1.14	0.470	97.830	30.000
Allophillus rhomboidea	0.23	0.070	4.100	4.280
Alseodaphne semicarpifolia	0.14	0.010	18.180	1.420
Ardisia rhomboidea	0.70	0.280	37.850	21.420
Cinnamomum wightii	1.23	0.540	249.170	35.710
Cinnomomum perrottetii	0.40	0.100	29.100	7.140
Cryptocarya neilgherrensis	0.14	0.010	4.540	1.420
Daphniphyllum glaucescens	1.19	0.370	76.460	17.140
Debregeasia longifolia	0.42	0.040	49.720	2.850
Derris brevipes	0.28	0.020	18.570	2.850
Dodonaea viscosa	0.61	0.150	9.060	5.710
Elaeocarpus recurvatus	0.90	0.250	193.110	20.000
Eugenia spp.	0.57	0.100	96.840	7.140
Euonymus angulatus	1.42	0.350	141.970	18.570
Eurya nitida	1.39	0.320	101.760	17.840
Flaucourtia montana	0.14	0.020	10.220	2.850
Garcinia cambogia	1.20	0.520	153.130	25.710
Gaultheria fragrantissima	0.28	0.050	2.550	2.850
Glochidion neilgherrense	0.14	0.010	7.110	1.420
Gomphandra coriacea	0.21	0.040	2.550	2.850
Ilex denticulata	0.95	0.240	152.820	17.140
Ilex wightiana	0.14	0.010	7.100	1.420
Ixora notoniana	1.48	0.700	69.040	25.710

Appendix 1 contd.

Lasianthus venulosus	1.57	0.250	95.300	12.850
Lasiosiphon eriocephalus	0.44	0.150	35.740	10.000
Ligustrum perrottetii	1.08	0.380	105.680	21.420
Linociera macrophylla	0.60	0.140	32.180	11.420
Litsea glabrata	0.46	0.150	24.950	10.000
Litsea ligustrina	1.02	0.310	141.900	22.850
Litsea wightiana	1.21	0.470	95.160	28.570
Mahonia leschnaultii	1.60	0.520	159.350	42.850
Measa indica	2.02	0.870	84.640	47.140
Meliosma wightii	0.42	0.050	61.120	5.710
Microtropis microcarpa	0.57	0.040	19.930	17.140
Microtropis ramiflora	1.24	0.840	147.970	35.710
Neolitsea foliosa	0.17	0.080	24.040	7.140
Persia macrantha	0.14	0.040	2.910	4.280
Pittosporum nilgherense	0.85	0.080	36.360	2.850
Psychotria anamallayana	0.77	0.280	27.840	24.280
Rhododendron arboreum	1.33	0.150	254.610	10.000
Rhodomyrtus tomentosa	0.19	0.050	3.680	4.280
Symplocos pendula	0.75	0.240	123.930	12.800
Symplocos spicata	1.19	0.370	99.160	20.000
Schefflera recemosa	1.52	0.340	82.390	17.140
Syzigium arnottianum	1.28	0.810	677.890	54.280
Tarenna monosperma	0.50	0.080	11.640	4.280
Ternstroemia japonica	0.65	0.500	117.920	21.420
Turpinia nepalensis	1.09	0.200	156.580	14.280
Vaccinium leschenaultii	0.57	0.140	16.760	11.420
Wlacourtia montana	0.14	0.020	10.220	2.850

Appendix -2

Vegetation analysis - Puvar

Record #	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	Litsea ligustrina	0.70	1.75	40.00	215.12	5.60	5.26	4.39	15.25	0.04
2	Mahonia leschnaultii	0.90	2.25	40.00	49.72	7.20	5.26	1.01	13.47	0.06
3	Measa indica	1.30	1.44	90.00	38.50	10.40	11.84	0.79	23.03	0.02
4	Microtropis ramiflora	0.40	2.00	20.00	127.29	3.20	2.63	2.60	8.43	0.10
5	Ligustrum perrottetii	0.80	1.33	60.00	471.68	6.40	7.89	9.63	23.92	0.02
6	Actinodaphne bourdillonii	1.10	1.57	70.00	58.00	8.80	9.21	1.18	19.19	0.02
7	Syzigium arnottianum	1.10	1.57	70.00	389.82	8.80	9.21	7.95	25.96	0.02
8	Cinnamomum wightii	0.30	3.00	10.00	161.10	2.40	1.32	3.29	7.01	0.30
9	Symplocos spicata	0.70	2.33	30.00	97.45	5.60	3.95	1.99	11.54	0.08
10	Elaeocarpus recurvatus	0.40	1.33	30.00	198.89	3.20	3.95	4.06	11.21	0.04
11	Turpinia nepalensis	0.20	1.00	20.00	378.76	1.60	2.63	7.73	11.96	0.05
12	Ilex denticulata	0.60	1.50	40.00	258.47	4.80	5.26	5.27	15.33	0.04
13	Shefflera racemosa	0.50	2.50	20.00	389.82	4.00	2.63	7.95	14.58	0.13

14	Eurya nitida	0.30	3.00	10.00	97.45	2.40	1.32	1.99	5.71	0.30
15	Ardisia rhomboidea	0.40	1.33	30.00	97.45	3.20	3.95	1.99	9.14	0.04
16	Daphniphyllum glaucescens	0.40	1.33	30.00	315.75	3.20	3.95	6.44	13.59	0.04
17	Cinnomomum perrottetii	0.40	1.33	30.00	161.10	3.20	3.95	3.29	10.44	0.04
18	Rhododendron arboreum	0.20	2.00	10.00	286.40	1.60	1.32	5.84	8.76	0.20
19	Litsea wightiana	0.60	1.50	40.00	161.10	4.80	5.26	3.29	13.35	0.04
20	Euonymus angulatus	0.50	1.67	30.00	161.10	4.00	3.95	3.29	11.24	0.06
21	Vaccinium leschenaultii	0.40	2.00	20.00	717.98	3.20	2.63	14.65	20.48	0.10
22	Dodonaea viscosa	0.10	1.00	10.00	17.90	0.80	1.32	0.37	2.49	0.10
23	Ilex wightiana	0.20	2.00	10.00	49.72	1.60	1.32	1.01	3.93	0.20

TOTAL NO. OF SPECIES = 125
TOTAL NO. OF QTD.OCC. = 76
TOTAL BASAL AREA = 4900.57
TOTAL RELATIVE DENSITY = 100.00
TOTAL RELATIVE FREQUENCY = 100.01
TOTAL RELATIVE BASAL AREA = 100.00
TOTAL IVI = 300.01
MI = 33.04

Appendix-3

Vegetation anlysis - Eravikullam

Record#	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	**Ixora notoniana**	1.30	2.60	50.00	97.45	8.07	6.10	1.97	16.14	0.05
2	**Shefflera racemosa**	0.50	1.67	30.00	127.29	3.11	3.66	2.57	9.34	0.06
3	**Syzigium arnottianum**	1.80	3.60	50.00	717.98	11.18	6.10	14.52	31.80	0.07
4	**Garcinia cambogia**	1.20	1.71	70.00	258.47	7.45	8.54	5.23	21.22	0.02
5	**Microtropis ramiflora**	1.20	2.00	60.00	103.10	7.45	7.32	2.09	16.86	0.03
6	**Litsea wightiana**	0.60	2.00	30.00	183.29	3.73	3.66	3.71	11.10	0.07
7	**Litsea ligustrina**	0.20	2.00	10.00	31.82	1.24	1.22	0.64	3.10	0.20
8	**Linociera macrophylla**	0.60	1.20	50.00	81.46	3.73	6.10	1.65	11.48	0.02
9	**Ardisia rhomboidea**	0.60	1.50	40.00	31.82	3.73	4.88	0.64	9.25	0.04
10	**Rhodomyrtus tomentosa**	0.40	1.33	30.00	45.82	2.48	3.66	0.93	7.07	0.04
11	**Mahonia leschnaultii**	0.70	1.40	50.00	127.29	4.35	6.10	2.57	13.02	0.03
12	**Measa indica**	1.30	2.17	60.00	286.40	8.07	7.32	5.79	21.18	0.04
13	**Ilex denticulata**	0.20	1.00	20.00	389.82	1.24	2.44	7.88	11.56	0.05

14	**Symplocos spicata**	0.80	2.00	40.00	198.89	4.97	4.88	4.02	13.87	0.05
15	**Cinnamomum wightii**	1.10	1.57	70.00	447.49	6.83	8.54	9.05	24.42	0.02
16	**Euonymus angulatus**	0.70	7.00	10.00	336.12	4.35	1.22	6.80	12.37	0.70
17	**Actinodaphne bourdillonii**	0.20	1.00	20.00	286.40	1.24	2.44	5.79	9.47	0.05
18	**Turpinia nepalensis**	0.40	4.00	10.00	108.91	2.48	1.22	2.20	5.90	0.40
19	**Daphniphyllum glaucescens**	1.00	2.50	40.00	127.29	6.21	4.88	2.57	13.66	0.06
20	**Vaccinium leschenaultii**	0.50	1.25	40.00	574.78	3.11	4.88	11.63	19.62	0.03
21	**Ligustrum perrottetii**	0.40	4.00	10.00	183.29	2.48	1.22	3.71	7.41	0.40
22	**Eurya nitida**	0.40	1.33	30.00	198.89	2.48	3.66	4.02	10.16	0.04

Appendix -4

Vegetation anlysis- Rajmala

Record#	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	Allophillus rhomboidea	0.50	1.67	30.00	66.91	2.59	3.30	1.64	7.53	0.06
2	Litsea glabrata	0.50	1.25	40.00	249.48	2.59	4.40	6.10	13.09	0.03
3	Gomphandra coriacea	0.30	1.50	20.00	49.72	1.55	2.20	1.22	4.97	0.07
4	Microtropis microcarpa	2.20	2.20	100.00	249.48	11.40	10.99	6.10	28.49	0.02
5	Daphniphyllum glaucescens	1.00	2.50	40.00	140.33	5.18	4.40	3.43	13.01	0.06
6	Ternstroemia japonica	2.30	2.56	90.00	231.98	11.92	9.89	5.67	27.48	0.03
7	Syzigium arnottianum	1.50	1.67	90.00	644.39	7.77	9.89	15.76	33.42	0.02
8	Shefflera racemosa	1.20	3.00	40.00	127.29	6.22	4.40	3.11	13.73	0.07
9	Vaccinium leschenaultii	0.80	4.00	20.00	447.49	4.15	2.20	10.94	17.29	0.20
10	Actinodaphne bourdillonii	1.30	2.17	60.00	58.00	6.74	6.59	1.42	14.75	0.04
11	Measa indica	1.20	1.71	70.00	108.91	6.22	7.69	2.66	16.57	0.02
12	Eurya nitida	0.40	4.00	10.00	97.45	2.07	1.10	2.38	5.55	0.40
13	Flacourtia montana	0.30	1.50	20.00	71.60	1.55	2.20	1.75	5.50	0.07
14	Debregeasia longifolia	0.20	2.00	10.00	31.82	1.04	1.10	0.78	2.92	0.20

15	Psychotriaanamallayana	0.60	1.00	60.00	38.50	3.11	6.59	0.94	10.64	0.02
16	Ixora notoniana	1.90	3.17	60.00	161.10	9.84	6.59	3.94	20.37	0.05
17	Pittosporum nilgherense	0.50	5.00	10.00	240.65	2.59	1.10	5.88	9.57	0.50
18	Garcinia cambogia	0.90	2.25	40.00	240.65	4.66	4.40	5.88	14.94	0.06
19	Linociera macrophylla	0.20	2.00	10.00	62.37	1.04	1.10	1.53	3.67	0.20
20	Mahonia leschnaultii	0.60	3.00	20.00	286.40	3.11	2.20	7.00	12.31	0.15
21	Symplocos spicata	0.20	1.00	20.00	198.89	1.04	2.20	4.86	8.10	0.05
22	Cryptocarya neilgherrensis	0.10	1.00	10.00	31.82	0.52	1.10	0.78	2.40	0.10
23	Lasianthus venulosus	0.30	1.00	30.00	127.29	1.55	3.30	3.11	7.96	0.03
24	Alseodaphne semicarpifolia	0.30	3.00	10.00	127.29	1.55	1.10	3.11	5.76	0.30

TOTAL NO. OF SPECIES = 193
TOTAL NO. OF QTD. OCC. = 91
TOTAL BASAL AREA = 4089.81
TOTAL RELATIVE DENSITY = 100.00
TOTAL RELATIVE FREQUENCY = 100.03
TOTAL RELATIVE BASAL AREA = 99.99
TOTAL IVI = 300.02
MI = 37.92

Appendix -5

Vegetation anlysis - Turnur's valley

Record#	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	Litsea glabrata	0.60	2.00	30.00	127.29	3.97	4.55	3.21	11.73	0.07
2	Tarenna monosperma	0.30	1.50	20.00	31.82	1.99	3.03	0.80	5.82	0.07
3	Mahonia leschnaultii	0.60	2.00	30.00	127.29	3.97	4.55	3.21	11.73	0.07
4	Lasiosiphon eriocephalus	0.70	1.75	40.00	76.45	4.64	6.06	1.93	12.63	0.04
5	Garcinia cambogia	1.00	2.50	40.00	286.40	6.62	6.06	7.22	19.90	0.06
6	Ternstroemia japonica	1.20	2.00	60.00	198.89	7.95	9.09	5.01	22.05	0.03
7	Syzigium arnottianum	1.50	2.14	70.00	748.53	9.93	10.61	18.86	39.40	0.03
8	Dodonaea viscosa	1.00	3.33	30.00	49.72	6.62	4.55	1.25	12.42	0.11
9	Psychotria anamallayana	0.70	1.40	50.00	286.40	4.64	7.58	7.22	19.44	0.03
10	Actinodaphne bourdillonii	0.60	1.50	40.00	71.60	3.97	6.06	1.80	11.83	0.04
11	Cinnomomum perrottetii	0.30	1.50	20.00	154.02	1.99	3.03	3.88	8.90	0.07
12	Debregeasia longifolia	0.20	2.00	10.00	49.72	1.32	1.52	1.25	4.09	0.20
13	Eugenia spp.	0.40	2.00	20.00	127.29	2.65	3.03	3.21	8.89	0.10
14	Microtropis microcarpa	0.80	4.00	20.00	240.65	5.30	3.03	6.06	14.39	0.20

15	Shefflera racemosa	0.40	4.00	10.00	161.10	2.65	1.52	4.06	8.23	0.40
16	Lasianthusvenulosus	0.20	2.00	10.00	127.29	1.32	1.52	3.21	6.05	0.20
17	Rhododendron arboreum	0.40	4.00	10.00	49.72	2.65	1.52	1.25	5.42	0.40
18	Euonymusangulatus	1.40	4.67	30.00	336.12	9.27	4.55	8.47	22.29	0.16
19	Ixora notoniana	1.30	2.60	50.00	127.29	8.61	7.58	3.21	19.40	0.05
20	Microtropis ramiflora	0.30	1.50	20.00	183.29	1.99	3.03	4.62	9.64	0.07
21	Elaeocarpus recurvatus	0.10	1.00	10.00	49.72	0.66	1.52	1.25	3.43	0.10
22	Measa indica	0.40	4.00	10.00	31.82,	2.65	1.52	0.80	4.97	0.40
23	Daphniphyllumglaucescens	0.20	2.00	10.00	258.47	1.32	1.52	6.51	9.35	0.20
24	Ardisia rhomboidea	0.40	4.00	10.00	17.90	2.65	1.52	0.45	4.62	0.40
25	Meliosma wightii	0.10	1.00	10.00	49.72	0.66	1.52	1.25	3.43	0.10

TOTAL NO. OF SPECIES = 151
TOTAL NO. OF QTD. OCC. = 66
TOTAL BASAL AREA = 3968.51
TOTAL RELATIVE DENSITY = 99.99
TOTAL RELATIVE FREQUENCY = 100.07
TOTAL RELATIVE BASALAREA = 99.99
TOTAL IVI = 300.05
MI = 26.40

Appendix-6

Vegetation analysis- Umayamala

Record#	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	Microtropis ramiflora	2.00	2.22	90.00	389.82	15.87	12.33	5.91	34.11	0.02
2	Litsea wightiana	0.90	1.80	50.00	231.98	7.14	6.85	3.52	17.51	0.04
3	Syzigium arnottianum	0.40	2.00	20.00	1243.0	3.17	2.74	18.84	24.75	0.10
4	Ilex denticulata	0.60	1.20	50.00	357.12	4.76	6.85	5.41	17.02	0.02
5	Persia macrantha	0.30	1.00	30.00	49.72	2.38	4.11	0.75	7.24	0.03
6	Turpinia nepalensis	0.50	1.67	30.00	198.89	3.97	4.11	3.02	11.10	0.06
7	Rhododendron arboreum	0.10	1.00	10.00	447.49	0.79	1.37	6.78	8.94	0.10
8	Symplocos pendula	0.30	1.00	30.00	240.65	2.38	4.11	3.65	10.14	0.03
9	Psychotria anamallayana	0.50	1.00	50.00	389.82	3.97	6.85	5.91	16.73	0.02
10	Mahonia leschnaultii	0.60	1.20	50.00	42.08	4.76	6.85	0.64	12.25	0.02
11	Litsea ligustrina	0.40	2.00	20.00	548.05	3.17	2.74	8.31	14.22	0.10
12	Ligustrum perrottetii	0.50	1.25	40.00	240.65	3.97	5.48	3.65	13.10	0.03
13	Cinnamomum wightii	1.10	1.57	70.00	471.68	8.73	9.59	7.15	25.47	0.02
14	Meliosma wightii	0.40	2.00	20.00	315.75	3.17	2.74	4.79	10.70	0.10

15	**Euonymus angulatus**	0.60	6.00	10.00	97.45	4.76	1.37	1.48	7.61	0.60
16	**Measa indica**	0.70	7.00	10.00	161.10	5.56	1.37	2.44	9.37	0.70
17	**Ardisia rhomboidea**	0.30	1.50	20.00	62.37	2.38	2.74	0.95	6.07	0.07
18	**Symplocos spicata**	0.30	3.00	10.00	161.10	2.38	1.37	2.44	6.19	0.30
19	**Eugenia spp.**	0.20	1.00	20.00	103.10	1.59	2.74	1.56	5.89	0.05
20	**Linociera macrophylla**	0.20	1.00	20.00	81.46	1.59	2.74	1.23	5.56	0.05
21	**Elaeocarpus recurvatus**	0.40	1.33	30.00	121.00	3.17	4.11	1.83	9.11	0.04
22	**Euryanitida**	0.30	1.50	20.00	240.65	2.38	2.74	3.65	8.77	0.07
23	**Shefflera racemosa**	0.50	5.00	10.00	240.65	3.97	1.37	3.65	8.99	0.50
24	**Lasianthus venulosus**	0.50	2.50	20.00	161.10	3.97	2.74	2.44	9.15	0.13

TOTAL NO. OF SPECIES = 126
TOTAL NO. OF QTD. OCC. = 73
TOTAL BASAL AREA = 6596.68
TOTAL RELATIVE DENSITY = 99.98
TOTAL RELATIVE FREQUENCY = 100.01
TOTAL RELATIVE BASAL AREA = 100.00
TOTAL IVI = 299.99
MI = 30.42

Appendix -7

Vegetation analysis - Anamudi

Record#	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	Meauaindica	1.30	2.60	50.00	161.10	9.09	7.25	2.88	19.22	0.05
2	Gaultheria fragrantissima	0.40	2.00	20.00	17.90	2.80	2.90	0.32	6.02	0.10
3	Symplocos spicata	1.00	2.50	40.00	71.60	6.99	5.80	1.28	14.07	0.06
4	Elaeocarpus recurvatus	0.50	2.50	20.00	198.89	3.50	2.90	3.55	9.95	0.13
5	Mahonia leschnaultii	0.60	1.50	40.00	62.37	4.20	5.80	1.11	11.11	0.04
6	Litsea ligustrina	0.60	1.20	50.00	175.74	4.20	7.25	3.14	14.59	0.02
7	Turpinia nepalensis	0.40	1.33	30.00	548.05	2.80	4.35	9.79	16.94	0.04
8	Meliosma wightii	0.20	2.00	10.00	62.37	1.40	1.45	1.11	3.96	0.20
9	Microtropis ramiflora	1.20	2.00	60.00	389.82	8.39	8.70	6.97	24.06	0.03
10	Euonymus angulatus	0.60	3.00	20.00	154.02	4.20	2.90	2.75	9.85	0.15
11	Cinnamomum wightii	0.60	1.50	40.00	630.15	4.20	5.80	11.26	21.26	0.04
12	Syzigium arnottianum	1.20	6.00	20.00	357.12	8.39	2.90	6.38	17.67	0.30
13	Derris brevipes	0.30	3.00	10.00	17.90	2.10	1.45	0.32	3.87	0.30
14	Ardisia rhomboidea	0.90	1.80	50.00	28.72	6.29	7.25	0.51	14.05	0.04

15	Ligustrum perrottetii	1.20	3.00	40.00	401.03	8.39	5.80	7.17	21.36	0.07
16	Lasianthus venulosus	0.50	2.50	20.00	154.02	3.50	2.90	2.75	9.15	0.13
17	Neolitsea foliosa	0.60	1.20	50.00	168.34	4.20	7.25	3.01	14.46	0.02
18	Eugenia spp.	0.30	3.00	10.00	447.49	2.10	1.45	8.00	11.55	0.30
19	Litsea wightiana	0.60	1.20	50.00	86.63	4.20	7.25	1.55	13.00	0.02
20	Ilex denticulata	0.30	3.00	10.00	147.10	2.10	1.45	2.63	6.18	0.30
21	Actinodaphne bourdillonii	0.20	2.00	10.00	49.72	1.40	1.45	0.89	3.74	0.20
22	Glochidion neilgherrense	0.10	1.00	10.00	49.72	‘0.70	1.45	0.89	3.04	0.10
23	Rhododendron arboreum	0.30	3.00	10.00	1089.0	2.10	1.45	19.46	23.01	0.30
24	Symplocos pendula	0.40	2.00	20.00	127.29	2.80	2.90	2.27	7.97	0.10

TOTALNO. OF SPECIES = 143
TOTALNO. OF QTD. OCC. = 69
TOTAL BASAL AREA = 5596.09
TOTAL RELATIVE DENSITY = 100.04
TOTAL RELATIVE FREQUENCY = 100.05
TOTAL RELATIVE BASAL AREA = 99.99
TOTAL IVI = 300.08
MI = 28.75

Appendix -8

Vegetation anlysis - Naikollymala

Record#	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	Psychotria anamallayana	0.20	2.00	10.00	35.08	1.77	1.52	0.87	4.16	0.20
2	Lasiosiphon eriocephalus	0.40	1.33	30.00	215.12	3.54	4.55	5.32	13.41	0.04
3	Elaeocarpus recurvatus	0.60	1.20	50.00	296.02	5.31	7.58	7.32	20.21	0.02
4	Lasianthus venulosus	0.30	3.00	10.00	161.10	2.65	1.52	3.99	8.16	0.30
5	Mahonia leschnaultii	1.10	1.57	70.00	38.50	9.73	10.61	0.95	21.29	0.02
6	Derris brevipes	0.10	1.00	10.00	62.37	0.88	1.52	1.54	3.94	0.10
7	Cinnamomum wightii	0.90	1.50	60.00	240.65	7.96	9.09	5.95	23.00	0.03
8	Euryanitida	1.20	2.40	50.00	161.10	10.62	7.58	3.99	22.19	0.05
9	Turpinia nepalensis	0.30	3.00	10.00	198.89	2.65	1.52	4.92	9.09	0.30
10	Litsea ligustrina	0.50	1.25	40.00	140.33	4.42	6.06	3.47	13.95	0.03
11	Rhododendron arboreum	0.40	1.33	30.00	133.73	3.54	4.55	3.31	11.40	0.04
12	Syzigium arnottianum	0.80	1.33	60.00	644.39	7.08	9.09	15.94	32.11	0.02
13	Actinodaphne bourdillonii	0.10	1.00	10.00	161.10	0.88	1.52	3.99	6.39	0.10
14	Symplocos pendula	1.10	2.75	40.00	81.46	9.73	6.06	2.02	17.81	0.07

15	Litsea wightiana	0.60	2.00	30.00	286.40	5.31	4.55	7.09	16.95	0.07
16	Measa indica	0.50	1.25	40.00	97.45	4.42	6.06	2.41	12.89	0.03
17	Garcinia cambogia	0.60	2.00	30.00	286.40	5.31	4.55	7.09	16.95	0.07
18	Tarenna monosperma	0.30	3.00	10.00	49.72	2.65	1.52	1.23	5.40	0.30
19	Shefflera racemosa	0.20	2.00	10.00	127.29	1.77	1.52	3.15	6.44	0.20
20	Ixora notoniana	0.40	2.00	20.00	161.10	3.54	3.03	3.99	10.56	0.10
21	Euonymus angulatus	0.40	1.33	30.00	336.12	3.54	4.55	8.32	16.41	0.04
22	Pittosporum nilgherense	0.30	3.00	10.00	127.29	2.65	1.52	3.15	7.32	0.30

TOTAL NO. OF SPECIES = 113
TOTAL NO. OF QTD. OCC. = 66
TOTAL BASAL AREA = 4041.61
TOTAL RELATIVE DENSITY = 99.95
TOTALRELATIVE FREQUENCY = 100.07
TOTAL RELATIVE BASAL AREA = 100.01
TOTAL IVI = 300.03
MI = 30.00

Appendix -9

Average value for Eravikulam National Park

Record#	SPE	D	AB	PF	BA	RD	RF	RBA	IVI	ABF
1	Actinodapne bourdillonii	0.47	1.57	30.00	91.96	3.69	4.02	1.38	9.09	0.05
2	Allophyllus rhomboidea	0.07	1.67	4.29	28.72	0.56	0.57	0.43	1.56	0.39
3	Alseodaphne semicapifolia	0.01	1.00	1.43	127.29	0.11	0.19	1.92	2.22	0.70
4	Ardisia rhomboidea	0.29	1.33	21.43	45.82	2.24	2.87	0.69	5.80	0.06
5	Cinnamomum wightii	0.57	1.60	35.71	325.86	4.47	4.78	4.91	14.16	0.04
6	Cinnamomum perrottettii	0.10	1.40	7.14	97.45	0.78	0.96	1.47	3.21	0.20
7	Cryptocarya neilgherensis	0.01	1.00	1.43	31.82	0.11	0.19	0.48	0.78	0.70
8	Daphniphyllum glaucescens	0.37	2.17	17.14	133.73	2.91	2.29	2.01	7.21	0.13
9	Debregeasis longifolia	0.04	1.50	2.86	25.78	0.34	0.38	0.39	1.11	0.53
10	Derris brevipes	0.03	1.00	2.86	38.50	0.22	0.38	0.58	1.18	0.35
11	Dodonaea viscosa	0.14	2.50	5.71	31.82	1.12	0.76	0.48	2.36	0.44
12	Elaeocarpus recurvatus	0.26	1.29	20.00	215.12	2.01	2.68	3.24	7.93	0.06
13	Eugenia spp.	0.10	1.40	7.14	198.89	0.78	0.96	2.99	4.73	0.20
14	Euonumus angulatus	0.36	1.92	18.57	147.10	2.80	2.49	2.21	7.50	0.10
15	Eurya nitida	0.33	1.92	17.14	133.73	2.57	2.29	2.01	6.87	0.11
16	Flacourtia montana	0.03	1.00	2.86	71.60	0.22	0.38	1.08	1.68	0.35

17	**Garcinia combpgia**	0.53	2.06	25.71	267.62	4.14	3.44	4.03	11.61	0.08
18	**Gaultheria fragrantissima**	0.06	2.00	2.86	17.90	0.45	0.38	0.27	1.10	0.70
19	**Glochidion neilgherrense**	0.01	1.00	1.43	49.72	0.11	0.19	0.75	1.05	0.70
20	**Gomphandra coriceae**	0.04	1.50	2.86	17.90	0.34	0.38	0.27	0.99	0.53
21	**Ilex denticulata**	0.24	1.42	17.14	258.47	1.90	2.29	3.89	8.08	0.08
22	**Ilexwightiana**	0.01	1.00	1.43	49.72	0.11	0.19	0.75	1.05	0.70
23	**Ixora notoniana**	0.70	2.72	25.71	121.00	5.48	3.44	1.82	10.74	0.11
24	**Lasianthus venulosus**	0.24	1.89	12.86	127.29	1.90	1.72	1.92	5.54	0.15
25	**Lasiosiphon eriocephalus**	0.16	1.57	10.00	108.91	123	1.34	1.64	4.21	0.16
26	**Ligustrum perrottettii**	0.39	1.80	21.43	183.29	3.02	2.87	2.76	8.65	0.08
27	**Linociera macrophylla**	0.14	1.25	11.43	76.45	1.12	1.53	1.15	3.80	0.11
28	**Litsea glabrata**	0.16	1.57	10.00	86.63	1.23	1.34	1.30	3.87	0.16
29	**Litsea ligustrina**	0.31	1.38	22.86	161.10	2.46	3.06	2.43	7.95	0.06
30	**Litsea wightiana**	0.47	1.65	28.57	114.88	3.69	3.82	1.73	9.24	0.06
31	**Mahonia leschnaultii**	0.67	1.57	42.86	127.29	5.26	5.74	1.92	12.92	0.04
32	**Measaindica**	0.87	1.85	47.14	66.91	6.82	6.31	1.01	14.14	0.04
33	**Meliosma wightii**	0.06	1.00	5.71	121.00	0.45	0.76	1.82	3.03	0.17
34	**Microtropis microcarpa**	**0.40**	2.33	17.14	66.91	3.13	2.29	1.01	6.43	0.14
35	**Microtropis ramiflora**	**0.70**	**1.96**	**35.71**	**175.74**	**5.48**	**4.78**	**2.65**	**12.91**	**0.05**
36	**Neolitsea foliosa**	**0.09**	**1.20**	**7.14**	**168.34**	**0.67**	**0.96**	**2.53**	**4.16**	**0.17**

37	**Persia macrantha**	0.04	1.00	4.29	20.37	0.34	0.57	0.31	**1.22**	**0.23**
38	**Pittosporum neilgherense**	0.09	3.00	2.86	127.29	0.67	0.38	1.92	2.97	**1.05**
39	**Psychotria anamalayana**	0.29	1.18	24.29	49.72	2.24	3.25	0.75	**6.24**	**0.05**
40	**Rhododendron arboreum**	0.16	1.57	10.00	258.47	1.23	1.34	3.89	**6.46**	**0.16**
41	**Rhodomyrtus tomentosa**	0.06	1.33	4.29	25.78	0.45	0.57	0.39	**1.41**	**0.31**
42	**Shefflera racemosa**	0.34	2.00	17.14	86.63	2.68	2.29	1.30	**6.27**	**0.12**
43	**Symplocos pendula**	0.24	1.89	12.86	231.98	1.90	1.72	3.49	**7.11**	**0.15**
44	**Symplocos spicata**	0.37	1.86	20.00	97.45	2.91	2.68	1.47	**7.06**	**0.09**
45	**Syzigium arnottianum**	0.81	1.50	54.29	658.79	6.38	7.27	9.92	**23.57**	**0.03**
46	**Tarenna monosperma**	0.09	2.00	4.29	42.08	0.67	0.57	0.63	**1.87**	**0.47**
47	**Ternstroemiajaponica**	0.50	2.33	21.43	412.41	3.91	2.87	6.21	**12.99**	**0.11**
48	**Turpinia nepalensis**	0.20	1.40	14.29	183.29	1.57	1.91	2.76	6.24	0.10.
49	**Vaccinium leschnaultii**	0.14	1.25	11.43	336.12	1.12	1.53	5.06	7.71	0.11

TOTAL NO. OF SPECIES = 894
TOTAL NO. OF QTD. OCC. = 523
TOTAL BASAL AREA = 6642.64
TOTAL RELATIVE DENSITY = 99.99
TOTAL RELATIVE FREQUENCY = 99.97
TOTAL RELATIVE BASAL AREA = 100.02
TOTAL IVI = 299.98
MI = 15.25

Appendix -10

Mean IVI and percentage IVI of the vegetation of different localities

Species	Mean IVI	%IVI
Cryptocarya neilgherrensis	0.370	0.110
Glochidion neilgherrense	0.450	0.140
Gomphandra coriacea	0.630	0.190
Flacourtia montana	0.790	0.240
Alseodaphne semicarpifolia	0.800	0.250
Debregeasia longifolia	0.880	0.270
Derris brevipes	0.930	0.290
Gaultheria fragrantissima	0.950	0.290
Allophillus rhomboidea	0.990	0.310
Rhodomyrtus tomentosa	1.020	0.320
Persia macrantha	1.050	0.330
Tarenna monosperma	1.660	0.520
Pittosporum nilgherense	2.000	0.630
Neolitsea foliosa	2.200	0.690
Dodonaea viscosa	2.350	0.740
Meliosma wightii	2.460	0.770
Cinnomomum perrottetii	2.740	0.860
Vaccinium leschenaultii	2.860	0.900
Litsea glabrata	3.070	0.960
Linociera macrophylla	3.240	1.020
Lasiosiphon eriocephalus	3.680	1.160
Eugenia spp.	3.760	1.180
Microtropis microcarpa	4.880	1.530

Psychotria anamallayana	6.110	1.920
Lasianthus venulosus	6.150	1.930
Symplocos pendula	6.260	1.970
Ardisia rhomboidea	6.390	2.010
Shefflera racemosa	6.890	2.170
Daphniphyllum glaucescens	7.010	2.200
Turpinia nepalensis	7.310	2.300
Rhododendron arboreum	7.630	2.400
Eurya nitida	7.650	2.410
Symplocos spicata	8.230	2.590
Ilex denticulata	8.650	2.720
Ligustrum perrottetii	8.690	2.730
Litsea ligustrina	9.220	2.900
Euonymus angulatus	9.280	2.920
Ternstroemia japonica	9.370	2.950
Elaeocarpus recurvatus	9.450	2.970
Actinodaphne bourdillonii	9.930	3.130
Ixora notoniana	9.950	3.130
Litsea wightiana	10.300	3.240
Garcinia cambogia	11.350	3.570
Microtropis ramiflora	14.050	4.420
Cinnamomum wightii	14.900	4.460
Measa indica	15.030	4.730
Mahonia leschnaultii	16.020	5.040
Ixora notoniana	17.420	5.490
Syzigium arnottianum	30.240	9.530

Appendix -11

Matrices of Similarity and Dissimilarity

similarity (%)

Localities 1		2	3	4	5	6	7
1	--	60.86	65.21	59.57	59.09	47.82	57.77
2	39.14	--	79.16	48.97	60.86	29.16	*68.08*
3	34.79	20.84	--	53.06	69.56	37.5	72.34
4	40.43	51.03	46.94	--	46.80	57.14	54.16
5	40.91	39.14	30.44	53.20	--	52.17	84.44
6	52.18	70.84	62.5	42.86	47.83	--	35.29
7	42.23	31.92	27.66	45.84	15.56	64.71	--

Dissimilarity (%)

1. Naikollmala 2. Anamudy 3. Umayamala 4. Turner'svalley 5. Eravikulam
6. Rajamala 7. Puvar

Appendix -12

Continuam indices and percentage values

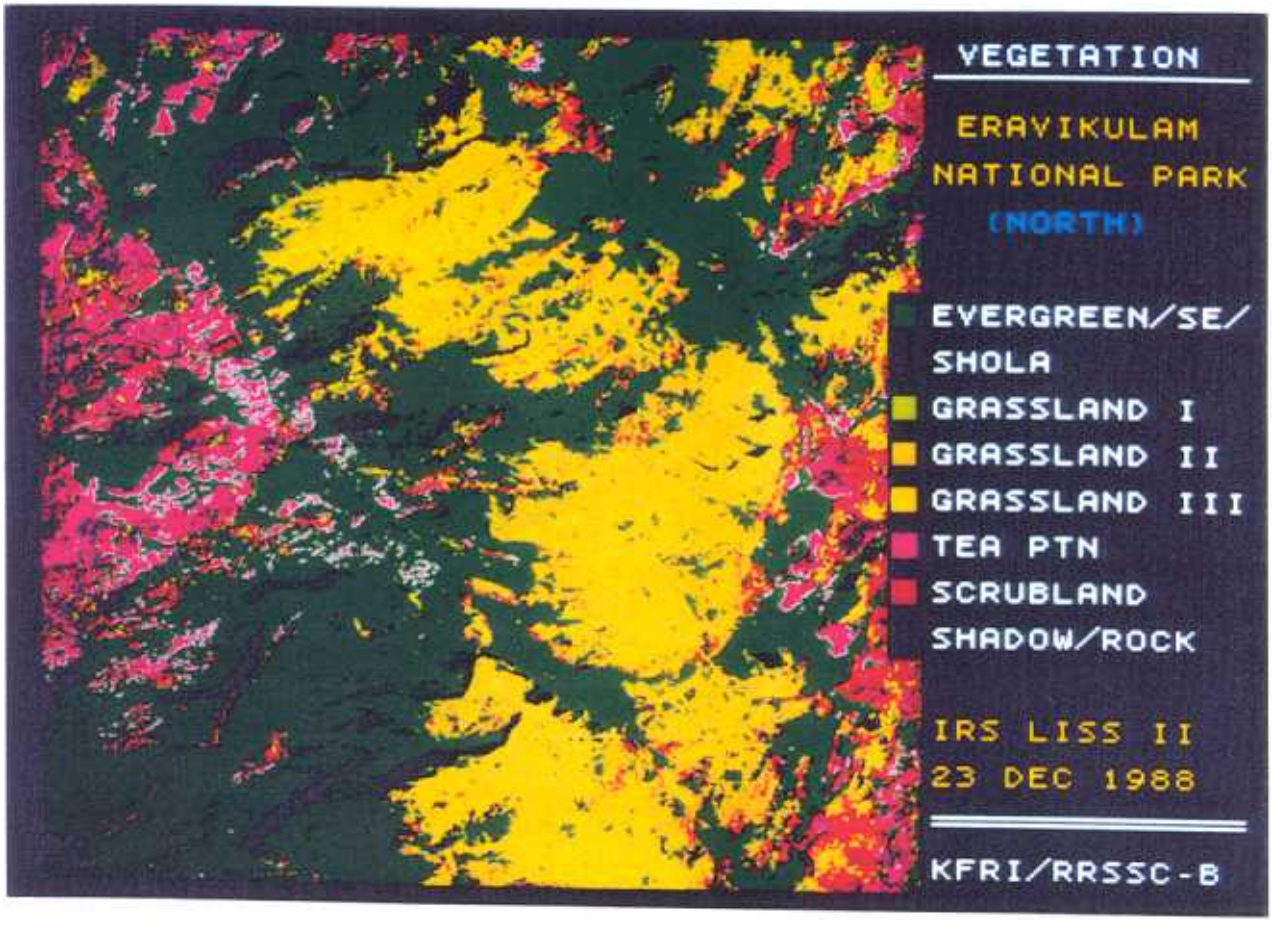
Locality		CI value	%value
1.	Naikolly mala	1550.67	14.5
2.	Anamudi	1640.45	15.34
3.	Umayamala	1492.41	13.96
4.	Turnursvalley	1428.33	13.36
5.	Eravikulam	1514.15	14.16
6.	Rajamala	1550.23	14.5
7.	Puvar	1512.96	14.15

Plate.1


ERAVIKULAM
NATIONAL PARK
(NORTH)
FALSE COLOUR
COMPOSITE
IRS LISS-II
23 DEC 1988
KFRI/RRSSC-B


ERAVIKULAM
NATIONAL PARK
(SOUTH)
FALSE COLOUR
COMPOSITE
IRS LISS-II
23 DEC 1988
KFRI/RRSSC-B

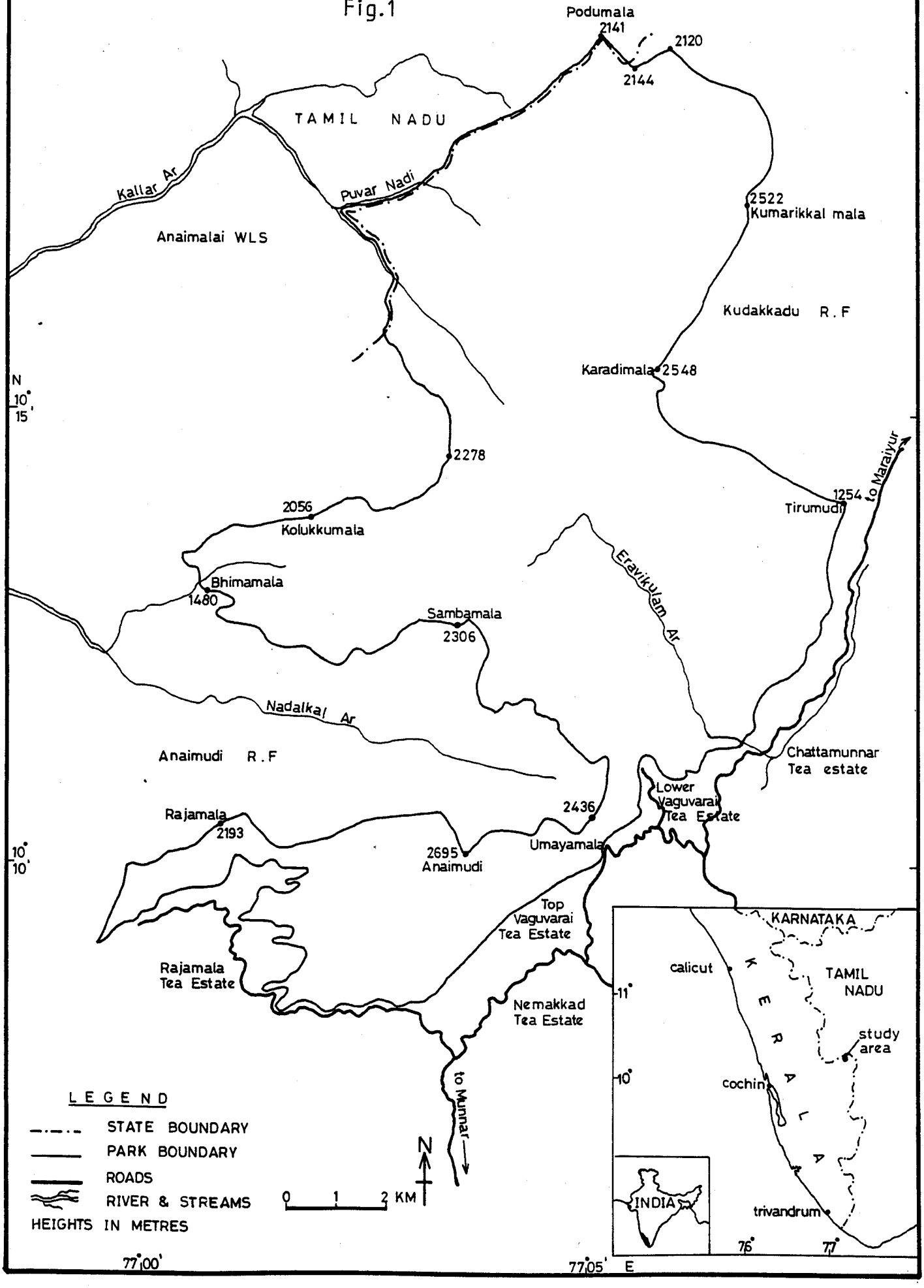
Plate 2


VEGETATION
ERAVIKULAM
NATIONAL PARK
(NORTH)
EVERGREEN/SE/
SHOLA
GRASSLAND I
GRASSLAND II
GRASSLAND III
TEA PTN
SCRUBLAND
SHADOW/ROCK
IRS LISS II
23 DEC 1988
KFRI/RRSSC-B


VEGETATION
ERAVIKULAM
NATIONAL PARK
(SOUTH)
EVERGREEN/SE/
SHOLA
GRASSLAND I
GRASSLAND II
GRASSLAND III
TEA PTN
SCRUBLAND
SHADOW/ROCK
IRS LISS II
23 DEC 1988
KFRI/RRSSC-B

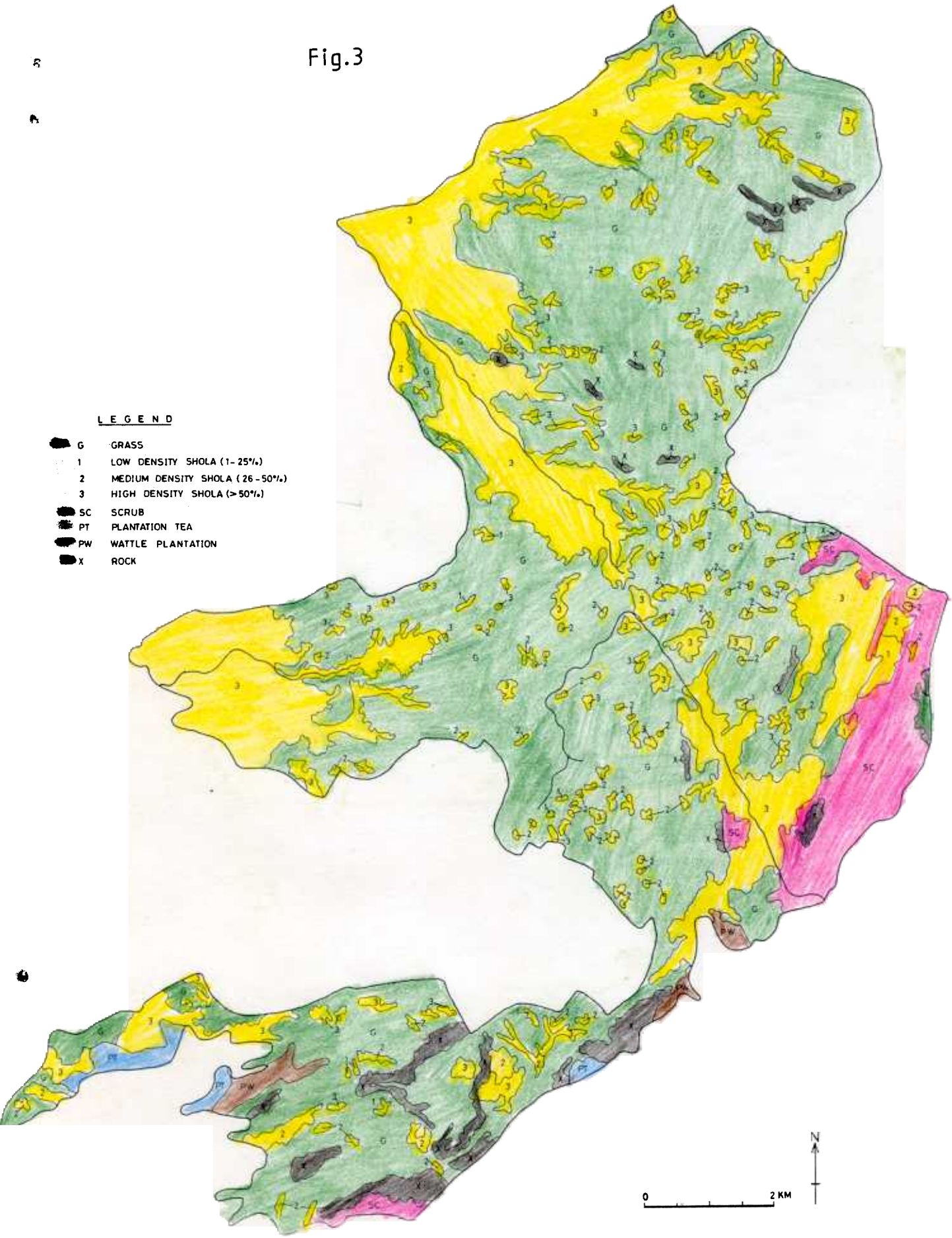
ERAVIKULAM NATIONAL PARK-LOCATION

Fig.1



ERAVIKULAM NATIONAL PARK - LANDCOVER
(prepared from 1:50,000 IRS 1B LISS 2 geocoded imagery of 1993)

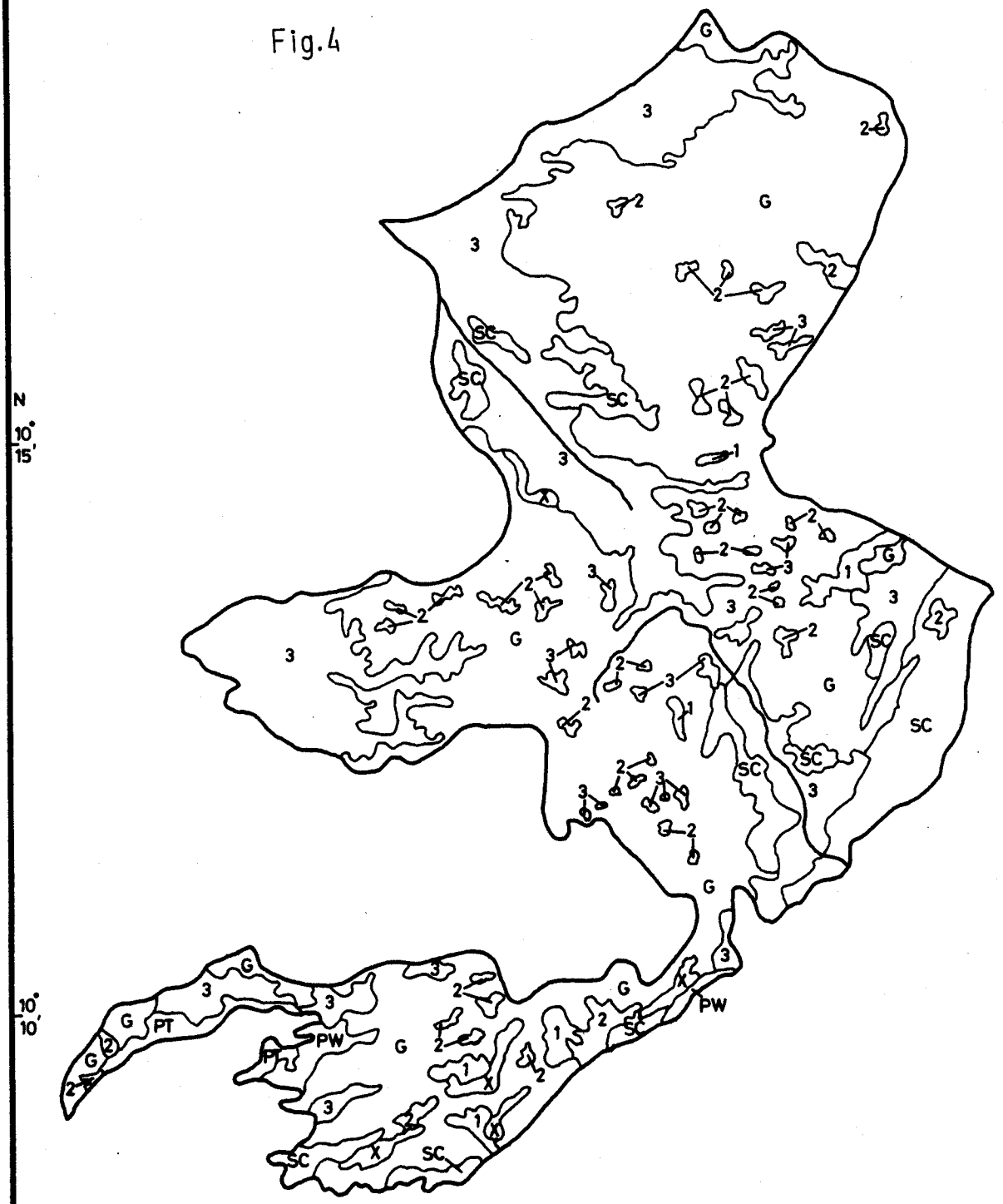
Fig.3



ERAVIKULAM NATIONAL PARK - LANDCOVER

(prepared from 1:1,25,000 IRS 1A LISS 2 imagery of 1990)

Fig.4



LEGEND

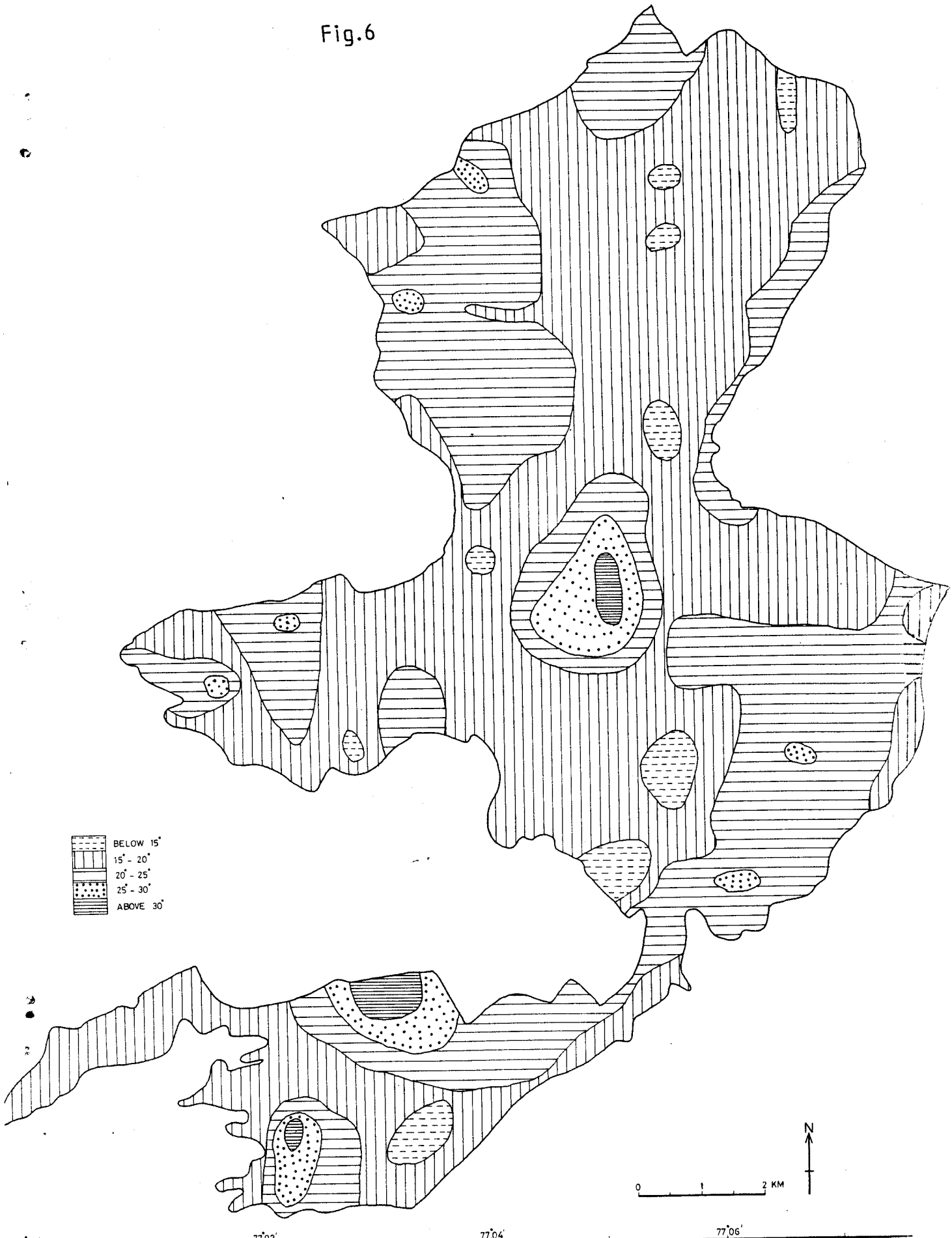
G	GRASS
1	LOW DENSITY SHOLA (1 - 25%)
2	MEDIUM DENSITY SHOLA (26 - 50%)
3	HIGH DENSITY SHOLA (> 50%)
SC	SCRUB
PT	TEA PLANTATION
PW	WATTLE PLANTATION
X	ROCK

ERAVIKULAM NATIONAL PARK - DRAINAGE

Fig.5

ERAVIKULAM NATIONAL PARK - SLOPE

Fig.6



ERAVIKULAM NATIONAL PARK - CONTOURS

Fig.7