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LONG -TERM ENVIRONMENTAL AND ECOLOGICAL STUDIES OF POOYAMKUTTY HYDROELECTRIC PROJECT IN THE WESTERN GHATS OF KERALA - PRECONSTRUCTION STAGE ANALYSIS

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1. INTRODUCTION

It is now well rercgnised that massive multipurpose river valley projects bring about drastic alterations of natural ecosystems. The rost obvious changes include loss of forest cover, increased soil erosicn, disturbance of wildlife, displacement of local populations and alterations of the native flora and fauna. Realising the importance of these, the Department of Environment, Forests and Wildlife, Government of India (GOI) sponsored two research projects in the early nineteen eighties, tc study the impacts cf Beas - Sutlej hydroelectric project in Northwestern India acd Idukki hydroelectric project in Southwestern India. Unfortunately, both these studies were undertaken only after construction of the dams. In the absence of adequate knowledge of the conditions prior to the construction, it was not pcssible to assess the impacts adequately.

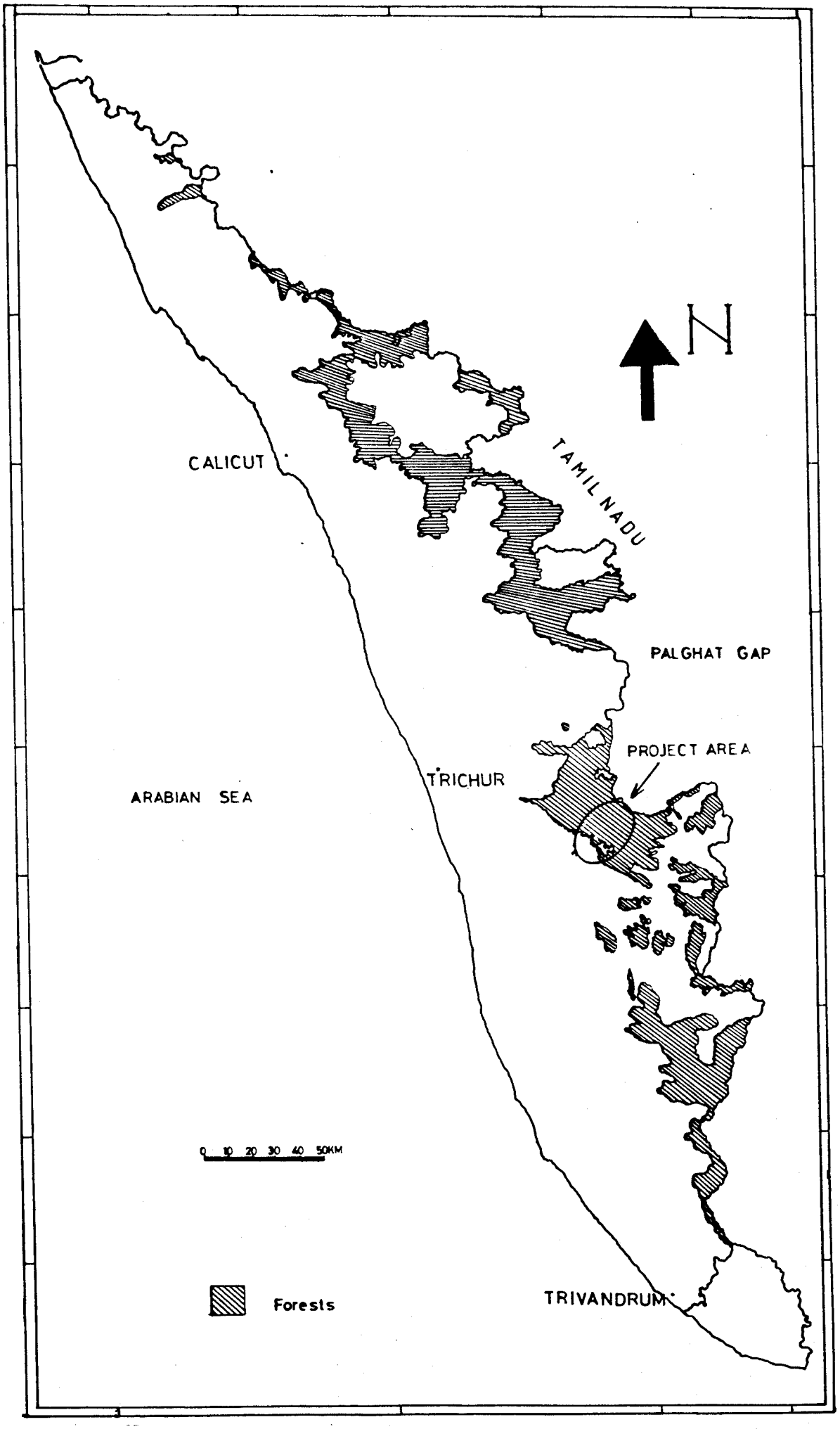
Recognising this, the Department of Environment, Forests and Wildlife financed the Kerala Forest Research Institute tc undertake a multidisciplinary study to generate benchmark data and inventories pertaining to the Pooyamkutty area (Fig. 1) where the Kerala Government had proposed to put up a large hydroelectric project. The results of these studies are reported here.

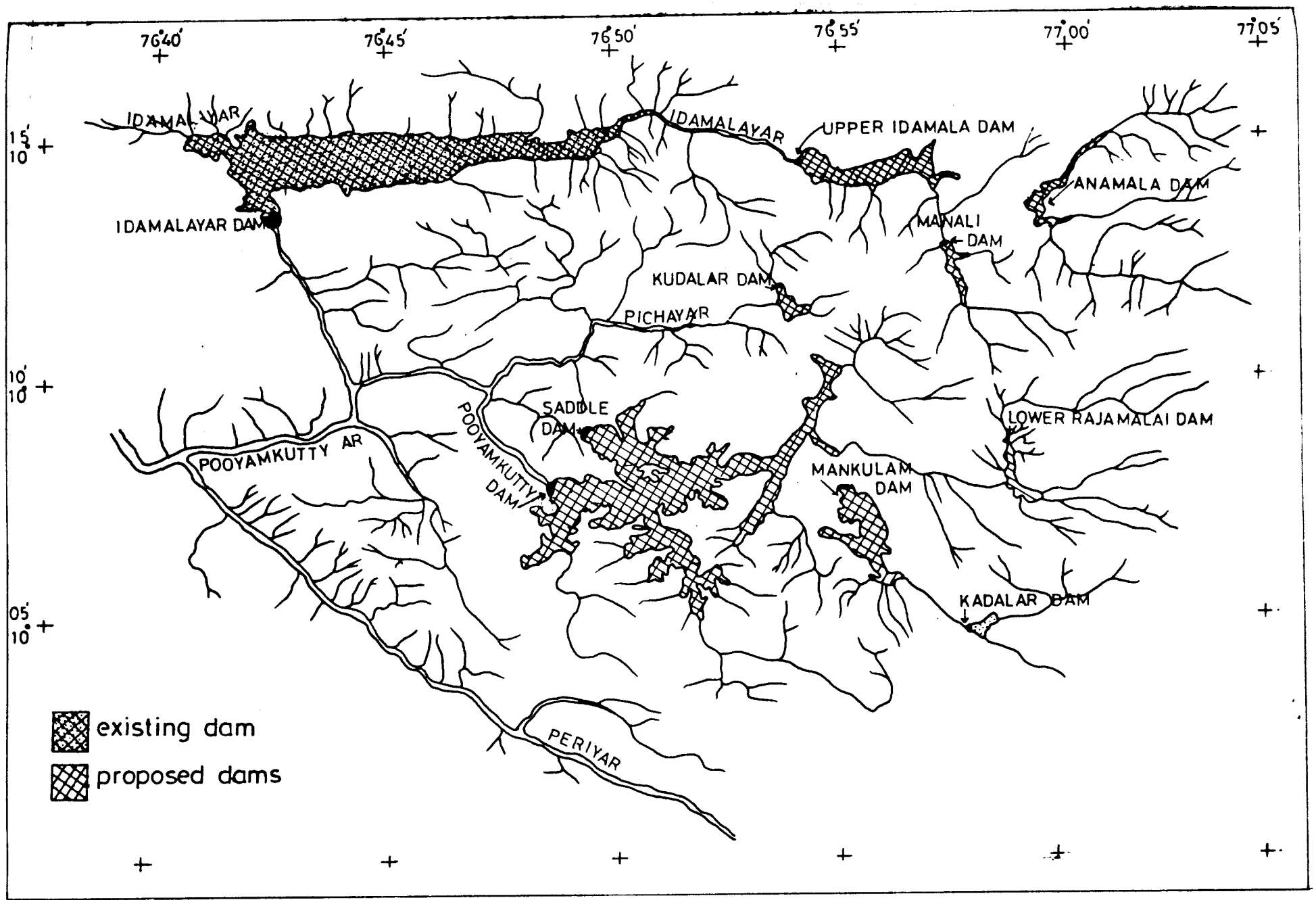
The Pooyamkutty hydroelectric project envisages harnessing the power potential of two major rivers, viz. Pooyamkutty (plate 1) and Idamalayar, both tributaries of river Periyar. A complex of six reservoirs and four separate hydel schemes viz., Anamalayar, Upper Idamalayar, Mankulam and Pooyamkutty with an installed power generating capacity of 750 MW are contemplated (Fig. 2).

The project area is located in the Idukki District, Kerala State and falls within latitude 10° to 10° 15' N and longitude 76° 40' to 77° 10' E with the elevation ranging from about 50 m to 1300 m. The forest area falls within the Malayatoor and Munnar Forest Divisions. An abandoned old Alwaye - Munnar road is the only means of transport within these reserves. The catchment area of the four hydel schemes together cover an area of about 355 km^2. Fig. 3 depicts the physiography of the project area. The project area also has some scenic beauties with cascades. (Plate 2).

Except for some observations made by the Kerala State Electricity Board, nc detailed information is available on the vegetation and wildlife, human settlements and land use pattern in the project area to facilitate impact assessment during and after the implepentation of the project. The following aspects were studied to generate baseline data.

Fig.1.1. Map of Kerala showing location of the Pooyamkutty Dam





Source: KSEB Scale 1:63550

Fig.1.2 Pooyamkutty Project complex

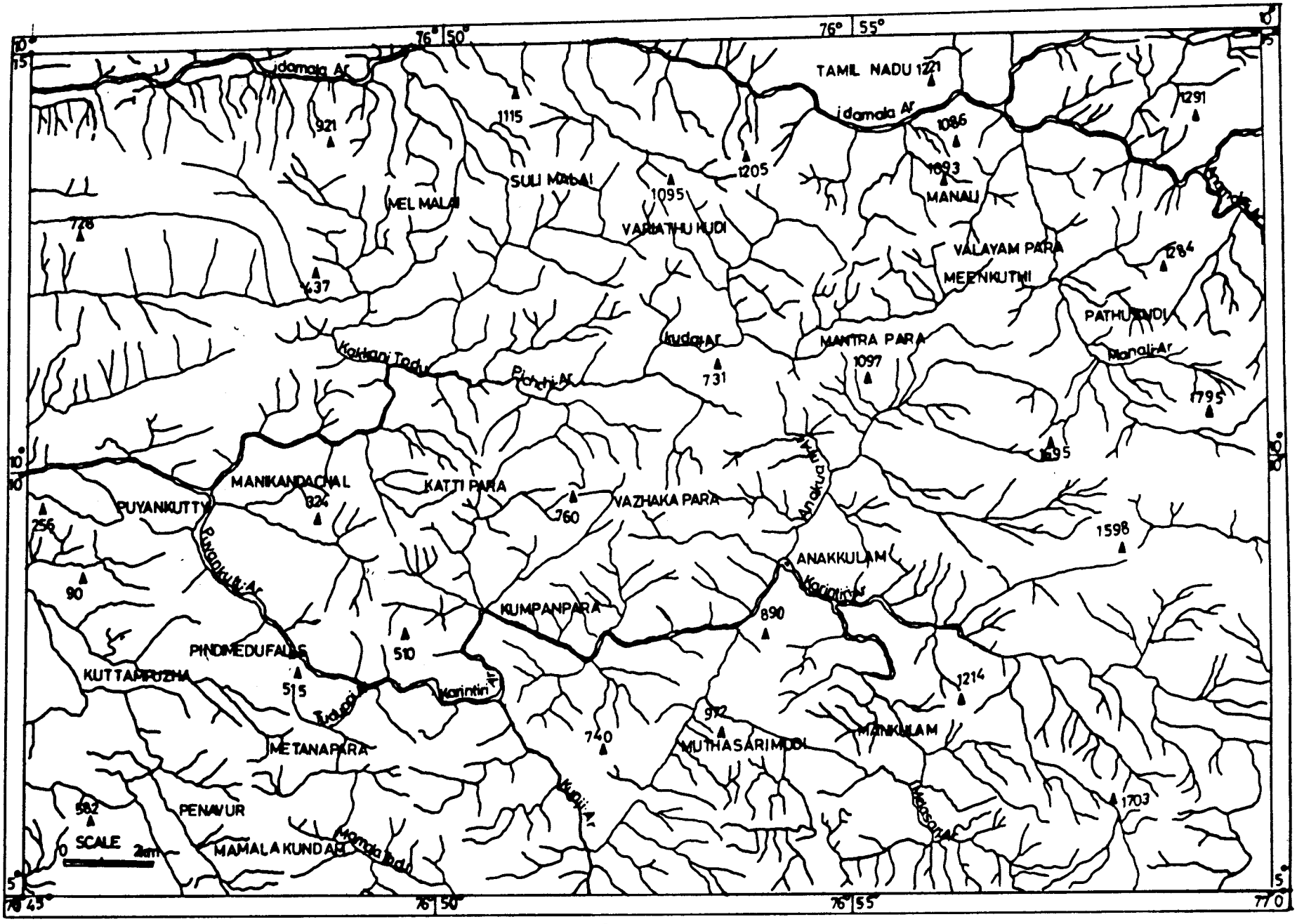


Fig.1.3 Project Area

1. Existing landuse pattern
2. Existing vegetational status
3. Soil conditions and properties
4. Wildlife status
5. Existing human settlements and human impact of the project

The report is organised into six sections covering the aspects identified above. Some degree of overlap between the secticns was unavoidable because each was written by different investigators. However, some integration has been effected through editing. Each section ends with a summary of the findings or conclubions. In addition, in the concluding section an attempt is made to synthesise the findings and resolve the conflicts in approaches among the investigators

3. LAND USE

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The landuse pattern in the proposed project area must he considered in the cortext of the general landuse situation in Kerala. Kerala, a narrow strip of land bcunded by the western Ghats in the east and Arabian sea cn the. west has a geographical area of about 38,000 km^2 of which abcut 56% fall within the Western Ghats. With a population density of 654 persons/km^2 the landuse pattern has been undergoing continuous changes due tc urbanisaticn, agriculture, plantation activities, especially rubber, tea, ccffee and cardamom an4 fcrest plantations. In general, the land under cultivation and under other uses has been steadily increasing at the cost of forest.

The proposed Pooyamkutty hydroelectric project is located at the northwestern corner cf the Idukki District. The landuse pattern of Idukki District where the project is prcposed is given in Table 2.1. About 53% of the total geographical area is under forest, while 33% is under agriculture. Wasteland arcounts fcr 10.7%. In the catchment area cf Idukki reservcir which was built recently less than 20% of the area is under forest while 29.4% is under agriculture.

Table 2.1. Landuse pattern of Idukki District

		in ha.	in %
Agriculture	..	1,64,917	33.1
Forest	..	2,63,438	52.9
Waste land	..	53,220	10.7
Water bodies	..	12,932	2.6
Public use	..	3,475	0.7

Source: Kerala State Landuse Board (1980)

Methods

The existing landuse of the proposed Pooyamkutty Hydroelectric Project area was evaluated in this study. The catchment areas of all the projects were considered viz. Pooyamkutty, Mankulam, Kudal, Anamala, Manali and Upper Idamalayar. Information was collected fror raps prepared by Survey of India and Kerala State Landuse Board. A landuse map for the project area was prepared after extensive field checking and areas under different categories were estimated using a LICOR Area Meter.

Results

The magnitude of the impact of the projects on the environment will vary with the intensity of activities. Based on the projected impact the project area was divided into 3 zones (Fig. 2.1). Zone - 1 represents total destruction of the forest cover in areas of submergence. Zone 2 covers areas like ancillary construction sites,

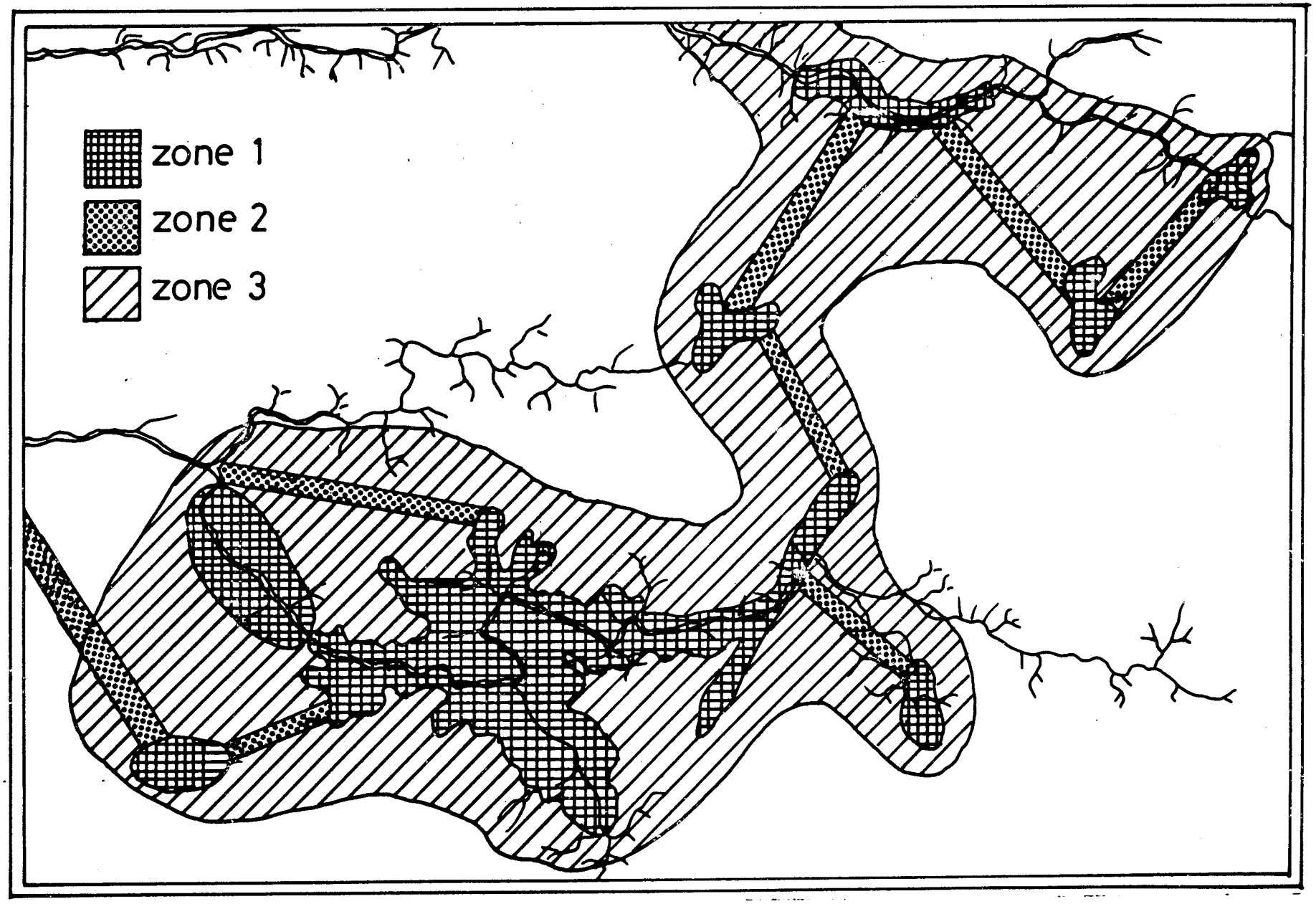

Fig.2.1. Categorisation of the study area based on projected impact

roads, buildings, labour settlements etc. where destruction will take place at a slower pace. With the construction of the project and in the course of time disturbances will tend to spread in a radial manner covering extensive areas. This projected region is shown as zone 3.

The catchcent and submergible areas of Pooyamkutty and allied schemes cover an area of about 355 km^2. The landuse in this region is given in Table 2.2. The submergible area constitute roughly cne tenth.

It is evident from the table that 82% of the area is under reserved forest. Compared to Idukki district as a whole, this region is thickly forested (Fig. 2.2). Idukki district has approximately 53% forest cover as noted earlier. Reed mixed with forest and pure reeds account for nearly half the total forest area.

Table 2.2. Land use pattern of Pooyamkutty and allied river basins

Landuse category	% of total area
Mixed forests	37
Reed mixed with other species	32
Pure reed	5
Teak plantations	4
Forest blanks	4
Mixed crops	10
Other uses (mostly paddy fields)	8

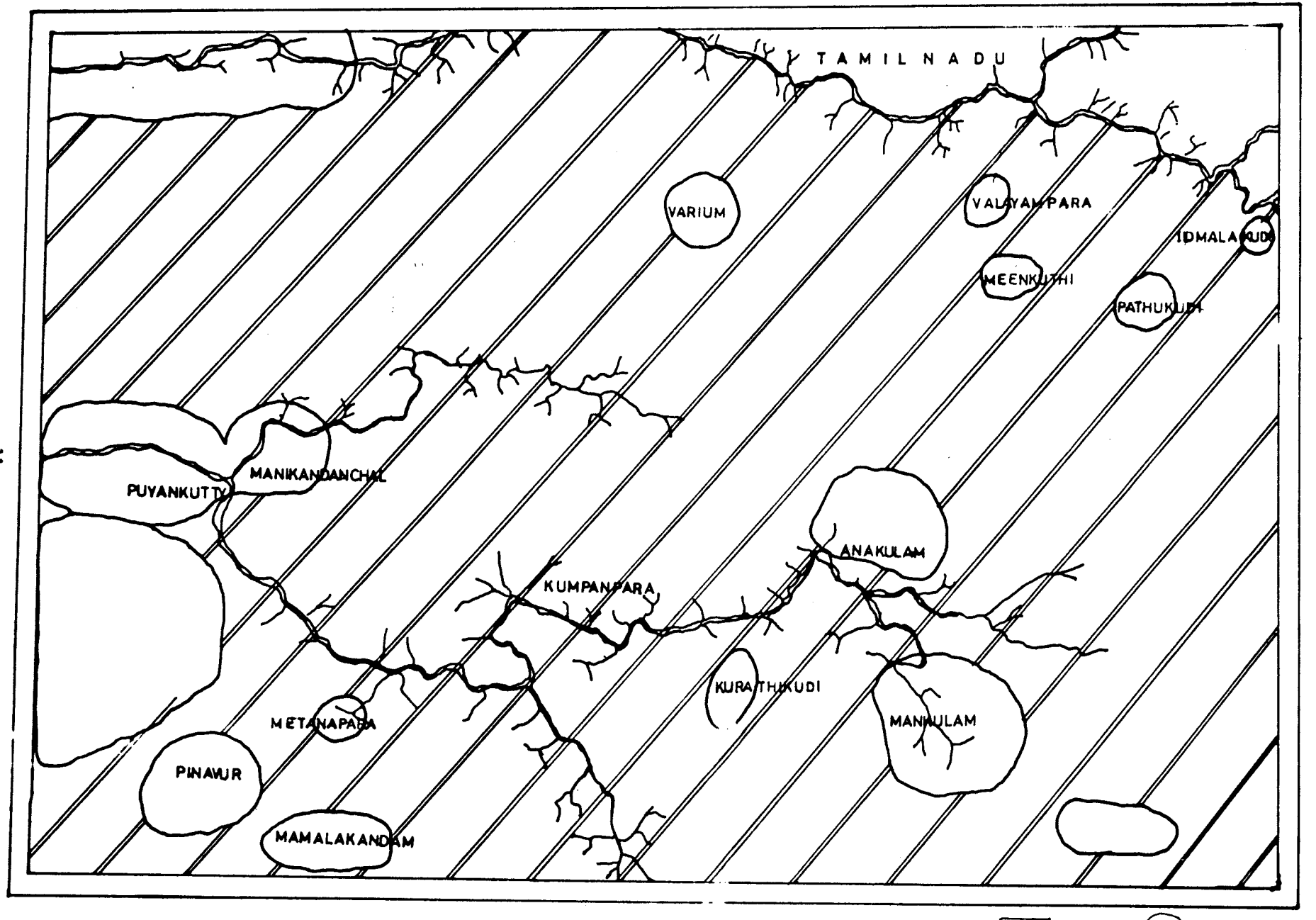

Fig.2.2. Distribution of Forests in Project area

Mixed forests

Mixed forests in the area belong to three categories viz., Evergreen, Semi-evergreen and Moist deciduous.

Moist deciduous and semi-evergreen forests are found at elevations between 50 and 400 m, while evergreen forests are encountered betneen 400 m to 1,000 m.

Reed mixed with other species and pure reeds

The notable feature of the area under consideration is the gregarious growth of reeds (Ochlandra travancorica) as an undergrowth. In addition, reed also occurs in pure patches (Plate 3). Together they cover about 37% of the total area. The reeds are found under moist deciduous, semi-evergreen and evergreen forest types, irrespective of slope, aspect or nearness to water.

Pure reed brakes are noticed along river courses. Each brake ranges from a few hectares to over 300 ha, while patches of reed mixed other species extend over 1,000 ha continuously.

Reed bearing forests extending over thousands of hectares is a striking feature characteristic of only two districts in Kerala, Idukki and Pathanasthitta. Within Idukki district the catchments of all the river systems under consideration viz. Pooyamkutty, Melasari, Idamala and Manali sustain this economically valuable natural resource.

Mixed crops

About 10% of the area under consideration is under mixed crops around human settlements. These settlements belong to either non-tribals or tribals.

In the lower elevations (<500 m) rubber, arecanut, coconut, pepper etc. are grown in homesteads. Above 500 m the crops are coffee, cardamom etc.

The mainstay of tribals around Idamalyar, Manali and Anamala is cardamom cultivation under the evergreen forest canopy. Under the cover of mixed cropping, forests are being cleared especially in Mankulam area and also around Manikantanchal near Pooyaskutty.

Teak Plantations

A stretch of teak plantations are available along the banks cf Periyar and Idamalayar.

Forest Blanks

Degraded forests as blanks cccupy 4% of the area. Compared to Idukki as a whole this is negligible as the district has over 25,000 ha under forest blanks. These blanks have resulted from fires. Reed cutters, who occupy the area during dry months, are responsible for the fires. Tribal cultivation of forest areas has also resulted in forest blanks. As these blanks occupy small areas and are surrounded by forests, given protection from fire and other disturbances, regeneration is possible.

Other uses

Other uses, have been categorised mainly as paddy fields, both low land belonging to non-tribals and high land belonging to tribals.

Discussion

The present landuse pattern of the proposnd project area reveals that 82% are under forests. Among forest types, reed bearing forests (both pure and mixed) account for nearly half. The tract bears the only largest contiguous stretch of forests south of the Palghat gap in the Western Ghats. In other parts of the district, forests are represented as islands vulnerable to degradation and destruction. Across the State in Anamalai of Tamil Nadu, forest contiguity has been destroyed by plantation activities over the years.

Tribals belonging mainly to the ethnic group Muduvas are closely involved in the landuse of Pooyamkutty and allied river basins. Their habitations extend from 1,300 m elevation near the boundary with Tamil Nadu down to 100 m. Most of the hamlets are sprinkled in and around the forests which represent their life support system in the form of cardamom, minor forest prcduce, small games etc. Tribals are also engaged in reed extraction activities.

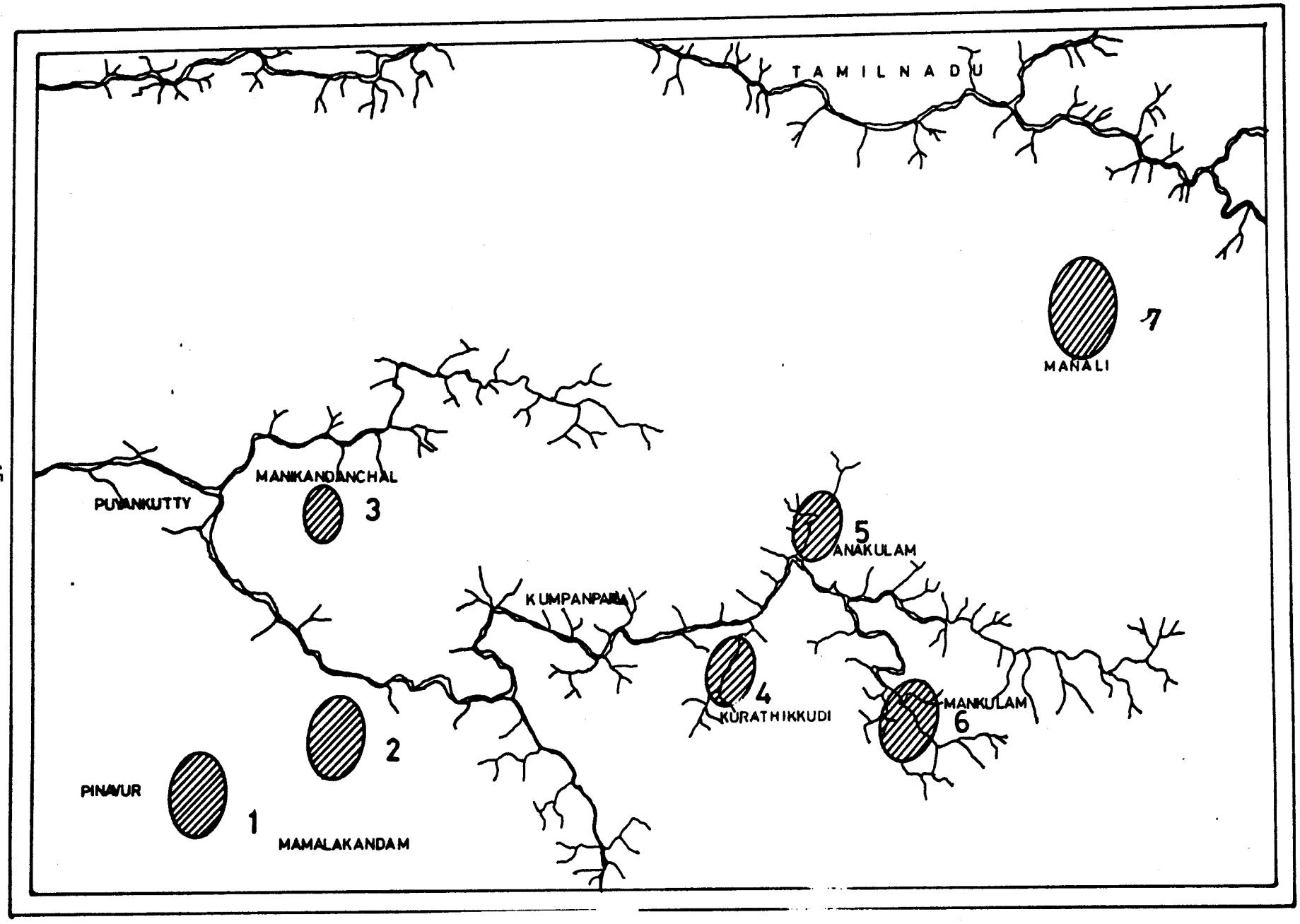

Fig.2.3. Tribal Settlements Displaced by Projects

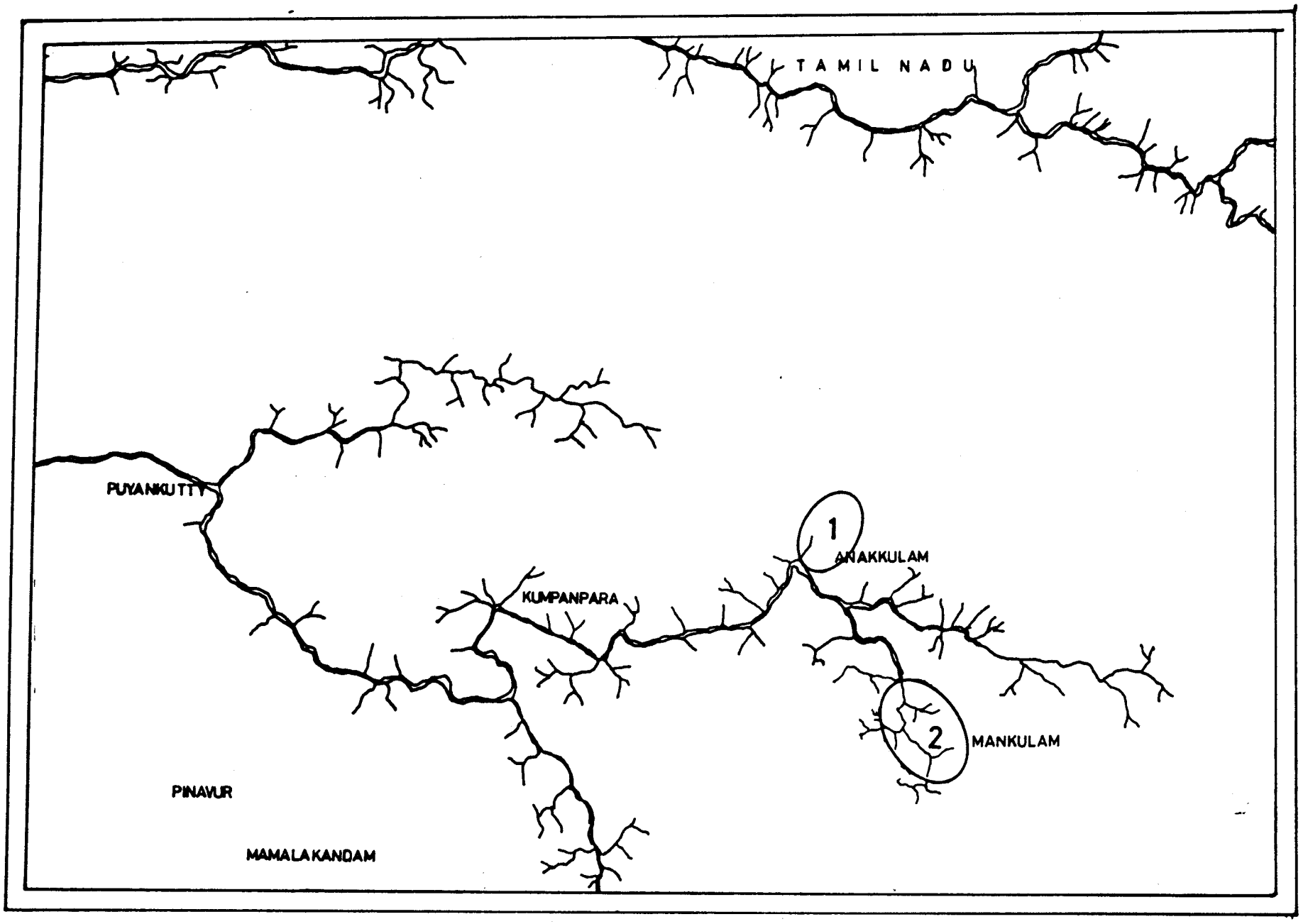

Fig.2.4. Non-tribal Settlements Affected by the Project

Major shifts in landuse with the commissionina of the projects

Possible changes in landuse anticipated with the construction and running of the series of hydroelectric schemes are given project wise.

1. Pooyamkutty Project

This project will submerge prime reed areas. Two tribal hamlets, one at Kurathi and the other at Mettanappara will have to be resettled. A part of the non-tribal settlement at Anakulam will be destroyed (Figs. 2.3 and 2.4). Existing communication between Avarkutty and Kurathi and also between Anakulam and Kurathi will be disrupted.The project will also attract encroachers from Pooyamkutty side viz., Avarkutty. The power house located at Pinavoor threatens to evacuate a viable tribal settlement.

Mankulam Dam

This project will submerge prime agriculture land belonging to settlers in a rehabilitation programme.

Kudal Dam

Prime reed areas will be destroyed by the resrvoir at Kudal.

Manali Dam

The dam at Manali will displace tribal settlements of Muduvas along with the rich and fertile flood plains.

Anamala Dam

The reservoir will submerge an excellent patch of evergreen forests. The contiguity of Idamala forests with those of Anamalais in Tamil Nadu will also be lost. The last two projects can attract an inflow of non-tribal people into a prime tribal life support system.

Upper Idamalavar Dam

This project will submerge prime reed bearing forest. Moreover the communication of tribals at Idamalakudi with Tamil Nadu will be disrupted.

Conclusions

1. The Pooyamkutty and allied river basins represent the only large contiguous stretch of thick forests south of the Palghat gap on the Western Ghats. The six projects will destroy directly only an area of about 6,000 ha but practically break the contiguity of forests. Small chunks of forest land are more vulnerable to degradation. Thus the only largest tract of thick forest in Kerala will be ruined.

2. Prime reed resource base of Pooyamkutty and other river basins will be destroyed irreversibly by the construction of the hydroelectric projects.

3. Tribal settlements will have to be rehabilitated (Fig. 2.5).

4. Increased accessibility due to initiation of the proposed hydroelectric project is likely to add to the encroachment of forest land, given the socio-political situation in Kerala and the history of Idukki district (Fig 2.6).

5. The terrain being rugged, agriculture on steep slopes will not be sustainable in the long run and also accentuation of erosion processes will reduce the life span of reservoirs.

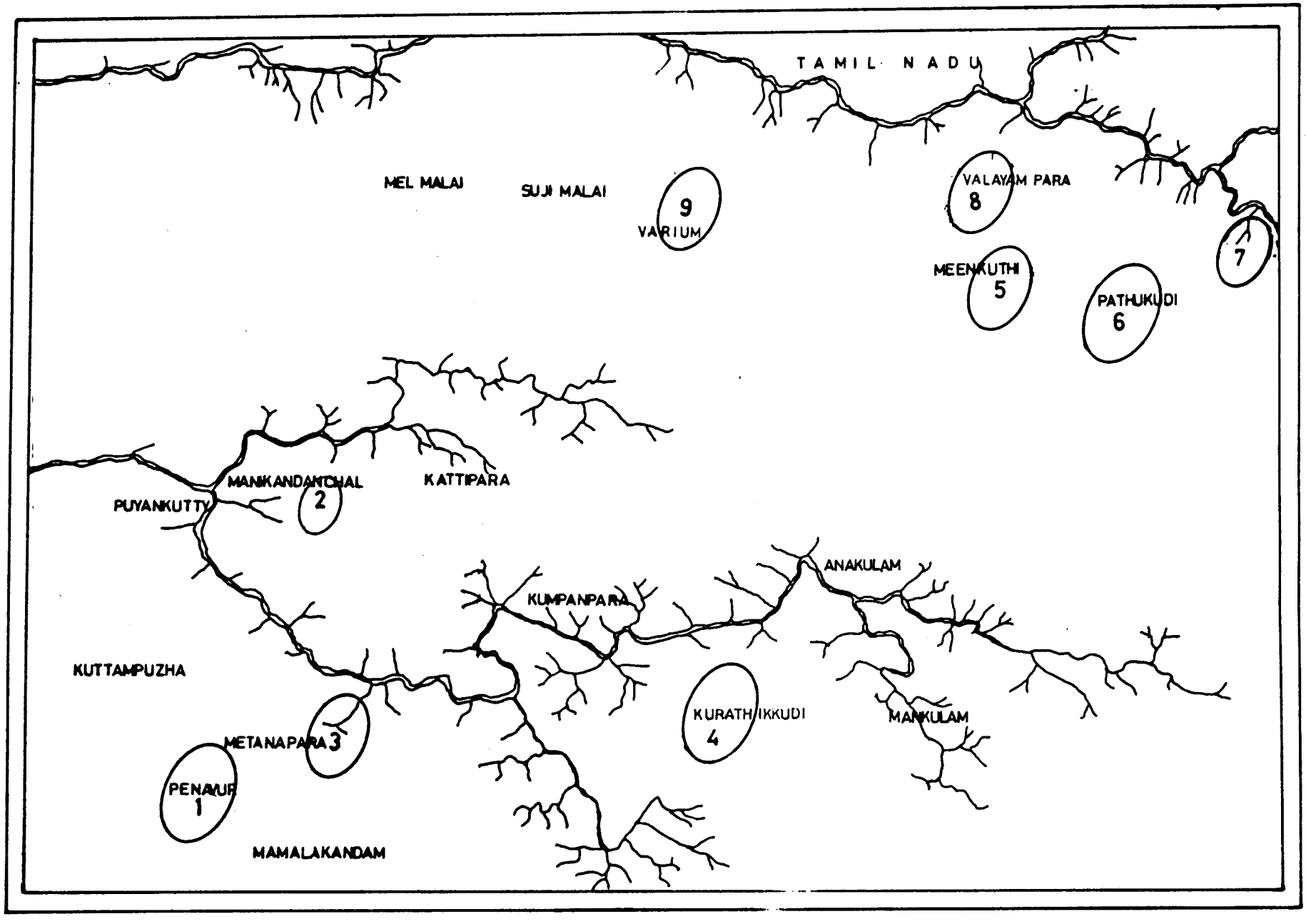

Fig.2.5. Settlements affected by Projects

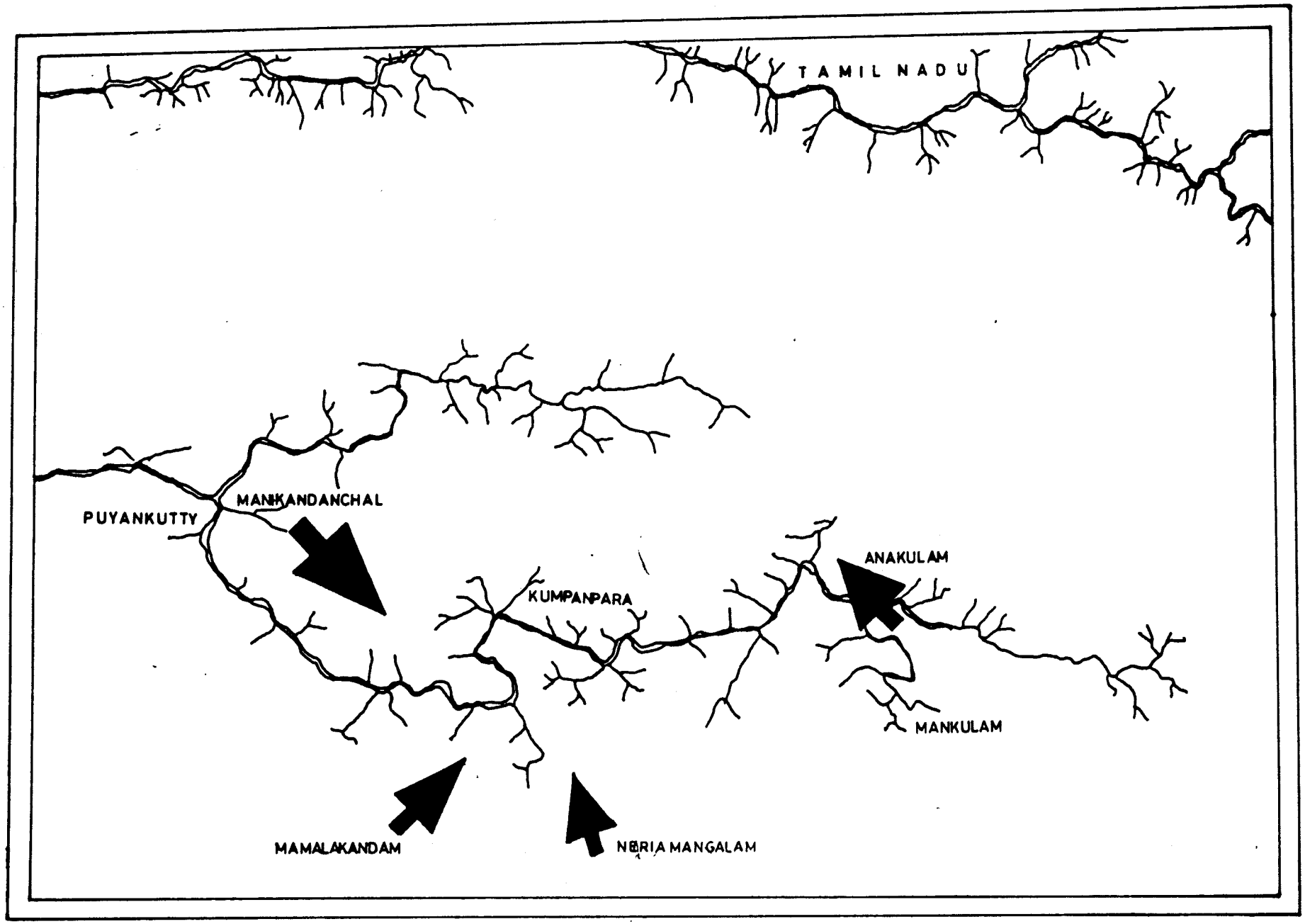

Fig.2.6. Routes of Projected Encroachments

3. VEGETATIONAL STUDIES

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Introduction

In an area essentially dominated by forests analysis of vegetation assumes significance. In this section relevant information on climate and structure of vegetation was gathered to generate baseline data.

Methodoloay

To study the existing vegetation types, the submergible area was thoroughly explored. Based on the exploration, plots of suitable sizes were laid out in different forest types viz; moist deciduous, semievergreen, evergreen and riparian forests. Tho belt transects of 50 x 20 m were laid out in the moist deciduous forests, across the gradient, keeping the river as the basline. Another transect of the same size along the river course was laid out to study the riparian vegetation. Based on earlier studies (Balasubramanyan, 1987 and Chand Basha, 1987) plots of 40 x 40 m were laid out to study the evergreen and semievergreen vegetation. Listing of all trees with a girth of over 10 cm at breast height were carried out to determine the relative density, relative frequency and relative basal area. Based on these the Importance Value Index, an indicator of the vegetation community, was worked out.

To ascertain the regeneration status of important species only qualitative assessment was done.

Results and Discussion

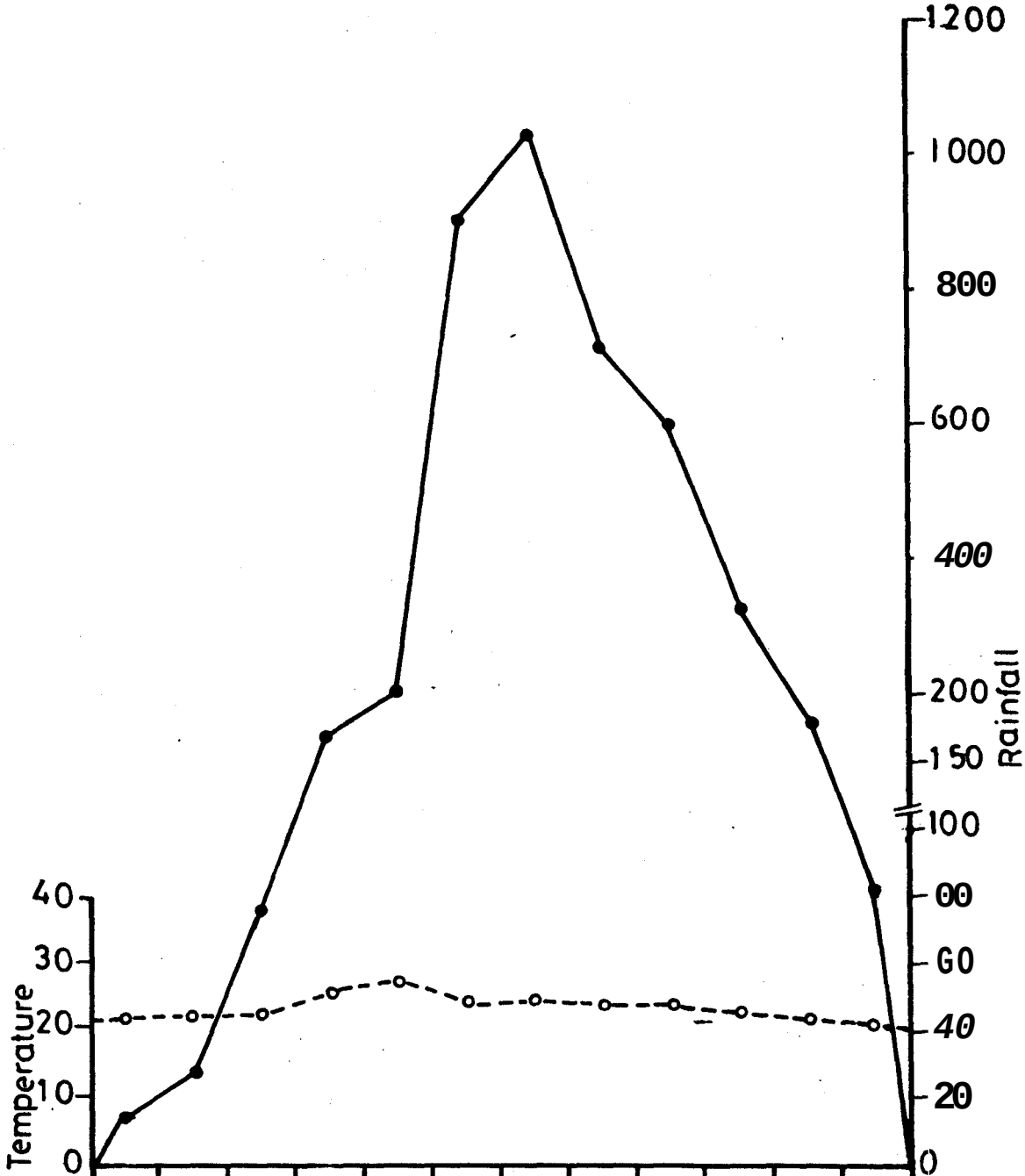
Climate

Data on rainfall, temperature and relative humidity were gathered for the last five years from the Kerala State Electricity Board station at Pindimedu.

The meteorological data are given Fig. 3.1. The data reveal that the area is hot and humid. Rainfall is received both during southvest and northeast monsoon seasons. However, the bulk of the precipitation accounting for neerly 76% occurs during the southwest monsoon season lasting from June tc mid September. January and February are generally dry months. Premonsoon showers are fairly common during April and May.

The mean annual teaperature varies from 20.4 ^{0}C in January to 27.1 ^{0}C in May which is the hottest month of the year. An absolute minimum of 16.1 ^{0}C and an absolute maximum of 37.6 ^{o}C were recorded during January and May respectively.

Relative humidity is quite high in the area always remaining above 80. From June to December it is cften above 90.



	J	F	M	A	M	J	J	A	S	O	N	D
Months												
Rainfall	14	27	76	170	211	898	1031	710	598	261	178	79
Rainy days	6	4	7	10	14	27	29	26	21	18	15	7
Temperature	20·4	20·8	21·9	24·4	27·1	23·4	23·9	23·1	23·1	22·7	21·7	20·9
R·H·	89	86	84	82	80	90	96	94	93	93	90	92

Fig.3.1. Ombrothermic diagram of Pindimedu

a) Moist deciduous forests

Two plots were studied in this vegetation type, one at Sishyamparappu at 300 m and the other at Thuduppiar at 200 m elevation.

Sishyamparappu

The vegetation community at Sishyanparappu is dominated by Dillenia pentagyna - Grewia tiliaefolia - Lannea coromandelica. (Plate 4). While the relative density and relative frequency are high in the case of Grewia tiliaefolia and Dillenia pentagyna, in the case of Lannea coromandelica it was the basal area that was high. Species like Terminalia paniculata, Hydnocarpus laurifolia, Cycas circinalis and Terminalia bellerica also have high Importance Values. Normally in an undisturbed fcrest a clear cut association of a few species can be seen. No clear cut association was seen in the study area indicating that the area is disturbed (Table 3.1).

Girth classwise, trees in the range of 30 to 150 cm are well represented. Isolated trees of Bombax malabarica and Terminalia bellerica with girth ranging from 270 to 330 cm were also encountered. Plants with less than 30 cm girth are very rare. Species in the girth class range 180 to 270 cm are practically absent. Figure 3.2 depicts the situation at Sishyamparappu. The presence of Cycas circinalis and Acacia intsia alongwith low number of species below 30 cm girth suggest that this area has been vulnerable to fire. Practically, no regeneration has taken place in this area which is full of Eupatorium odoratum.

Table 3.1

Structural analysis of the vegetation at Sishyamparappu

Name of the species	D	Ab	%F	R.D	R.F	R.B.A	I.V.I
1. Xylia xylocarpa	0.10	1.00	10	2.70	3.13	8.71	14.54
2. Grewia tiliaefolia	0.50	1.25	40	13.51	12.50	8.71	34.72
3. Terminalla panicu1ata	0.30	1.30	30	8.11	9.38	4.90	22.39
4. Dillenia pentagyna	0.90	1.50	60	24.32	18.75	1.23	44.30
5. Lagerstroemia microcarpa	0.20	1.00	20	5.41	6.25	6.66	18.32
6. Hydnocarpus laurifolia	0.30	1.00	30	8.11	9.38	6.66	24.15
7. Bombax malabarica	0.20	1.00	20	5.41	6.25	2.17	18.83
8. Pterocarpus aarsupium	0.20	2.00	10	5.41	3.13	1.23	9.77
9.Lannea coromandelica	0.40	1.00	40	10.81	12.50	11.04	34.35
10. Scolopia crenata	0.20	1.00	20	5.41	6.25	4.90	16.56
11. Cycas circinalis	0.00	1.00	10	2.70	3.13	22.99	28.82
12.Terminalia bellerica	0.00	1.00	10	2.70	3.13	19.58	25.41
13.Acacia intsia	0.20	1.00	20	5.41	6.25	1.23	12.89

D : Density
Ab : abundance
%F : Percentage frequency
RD : Relative density
RF : Relative frequency
RBA: Relative Basal Area
IVI: Importance Value Index

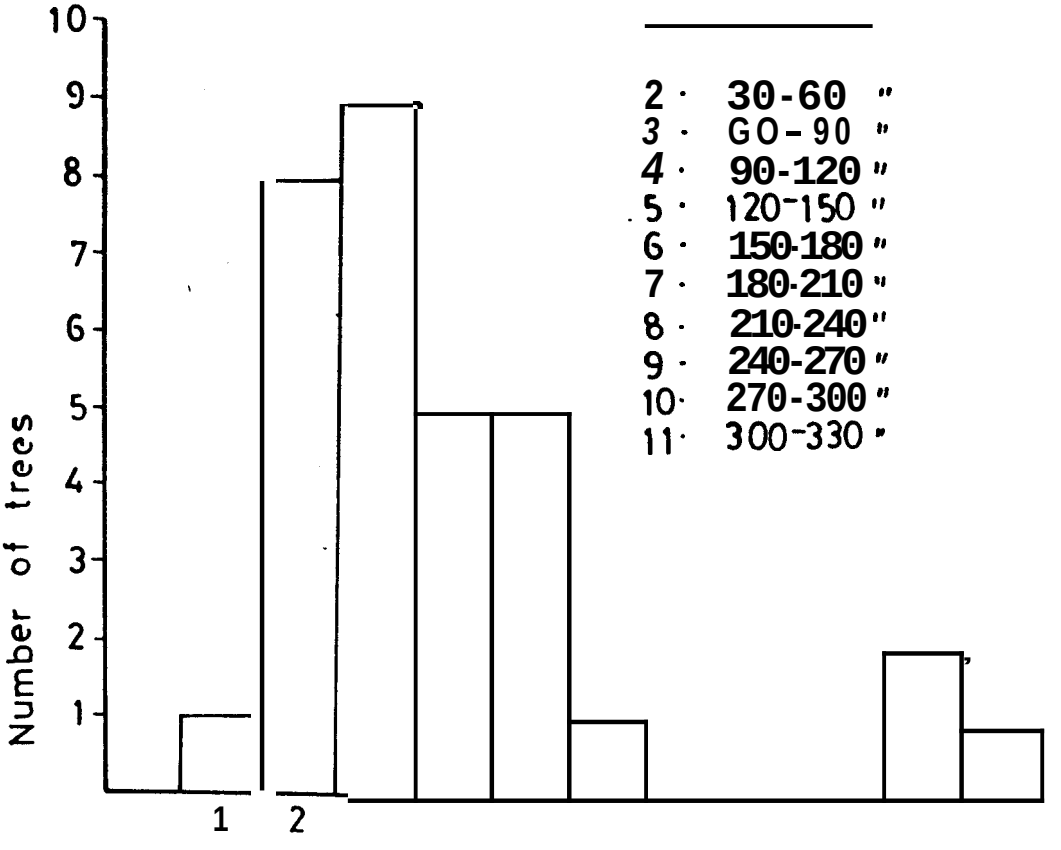


Fig.3.2. Distribution of trees in various girth classes of Sishyamparappu

Thuduppiar

At Thuduppiar, the vegetation is dominated by Wrightia tinctoria - Dillenia pentagyna - Cycas circinalis all of them having an Importance Value exceeding 60 (Table 3.2). The relatively high value of Helecteres isora with Cycas circinalis suggests that this area is also repeatedly razed by fire.

No trees were encountered with girth class exceeding 240 cm. As a rule 30 to 180 cm girth classes are well represented (Fig. 3.3).

Table 3.2

Structural analysis of the vegetation at Thuduppiar

Name of the species	D	Ab	%F	R.D	R.F	R.B.A	I.V.I
1. Dillenia pentagyna	0.80	1.75	80	30.11	23.53	11.00	65.54
2. Xylia xylocarpa	0.10	1.00	10	2.22	2.94	2.16	7.32
3. Wrigtia tinctoria	0.60	1.33	60	17.78	17.65	34.74	70.17
4. Pterocarpus marsupium	0.30	1.00	30	6.67	8.82	22.92	38.41
5. Careya arborea	0.20	1.50	20	6.67	5.88	1.22	13.77
6. Grewia tiliaefolia	0.10	1.00	10	2.22	2.94	6.64	11.80
7. Cycas circinalis	0.80	1.25	80	22.22	23.55	16.42	62.19
8. Helecteres isora	0.50	1.00	50	11.11	14.71	4.89	30.71

Here too, regeneration is almost nil excepting some saplings and poles of Helecteres isora.

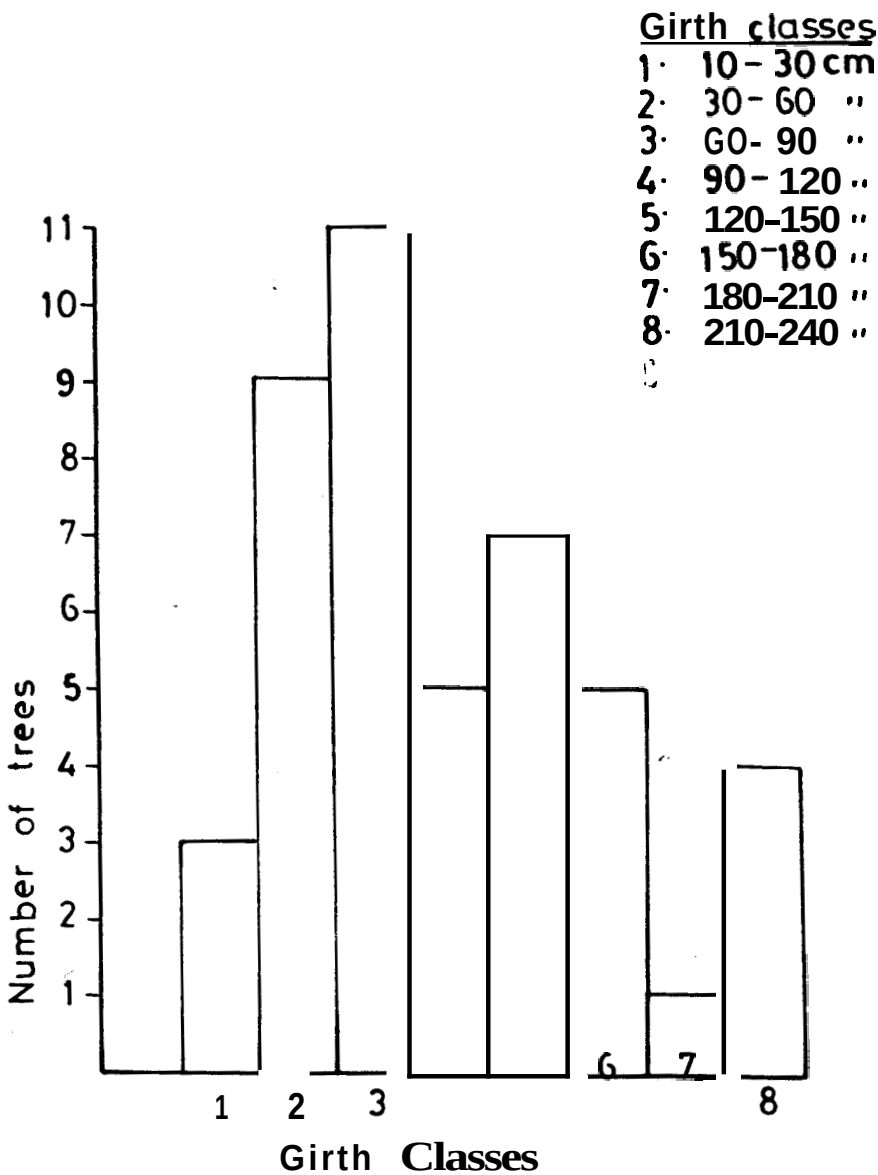


Fig.3.3. Distribution of trees in various girth classes of Thuduppiar

b) Riparian forest

A 50 x 20 m plot at 200m elevation representing the reparian forest (Plate **5)** was studied at Thalakkulam. The following five species, Humboldtia laurifolia, Knema attenuata, Calophyllum trapezifolium, Lophopetalup wightianum and Baccaurea courtallensis were the dominants. Codominants were Canarium strictum and Madhuca species. Humboldtia laurifolia was found to be heavily branched right from the base and its density and frequency were high. The low frequency of Calophyllum trapezifolium and their comparatively high basal area is due to a few individuals with their girth ranging from **150** to **180 cm** (Table **3.3)**. Giant lianas of Entada scandens are quite frequent. Girthwise, the classes 180 to 300 cm were rather negligible. Either one finds medium sized trees or quite huge ones. Species with less than 30 **cm** girth are practically nil (Fig 3.4).

Regeneration is practically nil due to two factors. Since the vegetation is along the river course and subjected to inundation thick mat of Ochlandra travancorica are encountered. Under the thick carpet of reeds regeneration of any species is difficult. Moreover, the ripe seeds are invariably carried away by the strong water current.

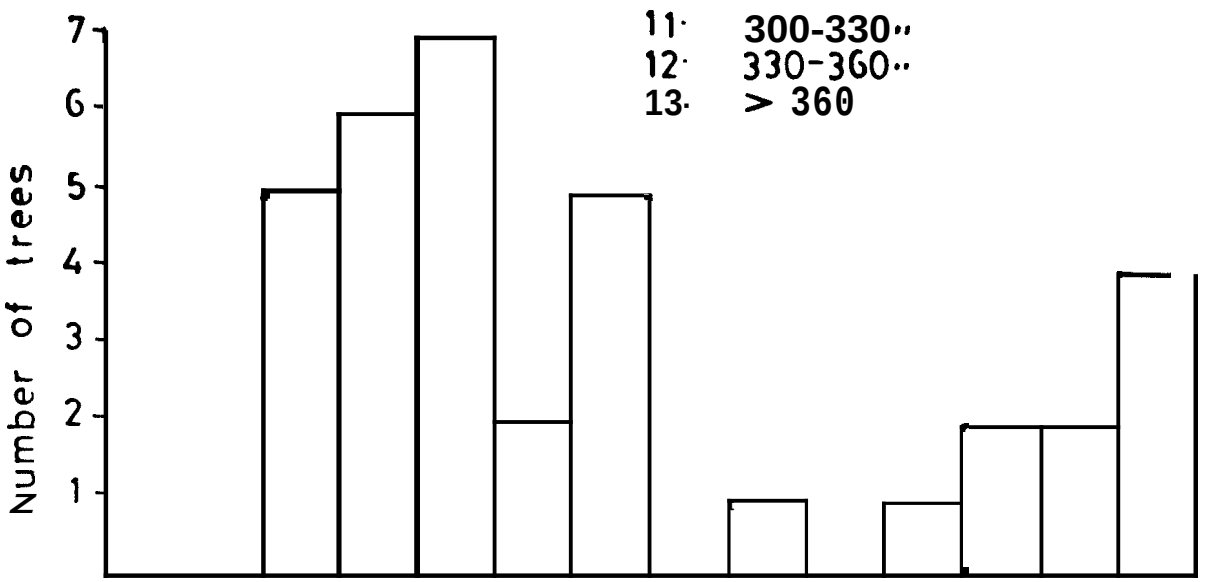


Fig.3.4. Distribution of trees in various girth classes at Thalakulam

Table 3.3

Structural analysis of the vegetation at Thalakkulam

Name of the species	D	Ab	%F	R.D	R.F	R.B.A	I.V.I
Husboldtia laurifolia	0.80	1.10	50	22.86	19.23	10.92	52.51
Knema attenuata	0.80	1.33	60	22.86	23.08	9.30	55.24
Calophyllum trapezifolium	0.30	1.00	30	8.57	11.54	31.30	51.41
Canariua stricturn	0.20	1.00	20	5.71	7.69	7.83	21.23
Lophopetalum wightianum	0.40	1.33	30	11.43	11.54	20.94	43.48
Baccaurea courtallensis	0.50	1.25	40	14.29	15.38	16.55	46.22
Madhuca sp.	0.50	1.67	30	14.29	11.54	3.16	26.99

c) Semievergreen forest

Two plots were laid out representing semievergreen forests (Plate 6), one at Kunjiar -Kathippara (200 m) and the other at Pinavoor (50 m) where the proposed power house is tc be located. In both these areas the evergreen species are seen to be dominating, indicating thereby, that given adequate protection these forests can reach the climax status over a long interval.

The vegetation at Kunjiar-Kathippara is dominated by Myristica dactyloides and Canarium strictum both evergreen species. This is closely followed by **Dysoxylum.** malabaricum, Euphoria longana (both evergreens), Lagerstroemia microcarpa and Tetrameles nudiflora (both deciduous) - (Table 3.4).

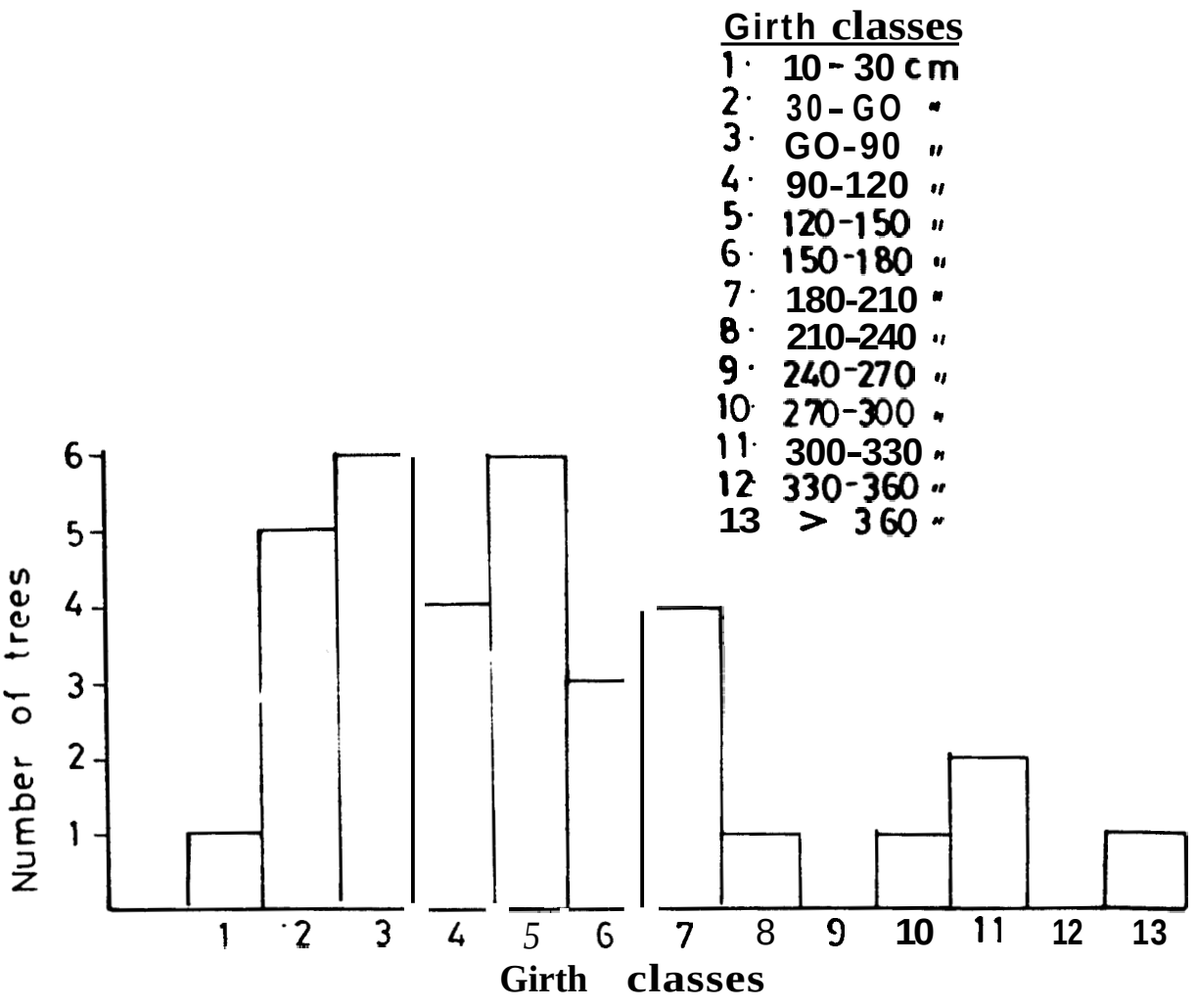
Table 3.4

Structural analysis of the vegetation at Kunjiar - Kathippara

Species	D	Ab	%F	R.D	R.F	R.B.A	I.V.I
Tetrameles nudiflora	0.30	1.00	30	8.82	9.68	9.15	27.65
Lagerstroemia microcarpa	0.10	1.00	10	2.94	3.23	26.91	33.08
Canarium strictum	0.40	1.00	40	11.76	12.90	18.69	43.35
Dysoxylum malabaricum	0.50	1.25	40	14.71	12.90	11.97	39.58
Myristica dactyloides	0.60	1.00	60	17.65	19.35	11.97	48.97
Diospyros microphylla	0.20	1.00	20	5.88	6.45	2.98	15.31
Euphoria longana	0.40	1.33	30	11.76	9.68	9.15	30.59
Polyalthia fragrans	0.30	1.00	30	8.82	9.68	6.74	25.24
Knema attenuata	0.30	1.50	20	8.82	6.45	1.68	16.95
Bischofia zeylanica	0.30	1.00	30	8.82	9.68	0.75	19.25

Girth classwise the species are more or less evenly distributed from. 30 to 210 cm. The two deciduous species attain girth of over 300 cm. Unlike in typical semievergreen forests species with lower girth classes are negligible (Fig 3.5). This is also indicated by very little regeneration.

The community at Pinavoor presents a complicated picture by the presence of both evergreen and deciduous species. Three evergreen species Dipterocarpus bourdillonii, Artocarcus heterophyllus, Persea macrantha together with Vitex altissima, a deciduous species, constitute the vegetation community. Their frequency also is quite high. This area is also floristically rich in the entire project area. Sixteen species are represented within 1600 sq. m. (Table 3.5).



Pig.3.5. Distribution of trees in various girth classes at Kunjiar - Kathippara

Plants with lower girth classes upto 60 cm are quite high and those above 240 cm are also well represented. Girth classes of intermediate range (60 to 240 cm) are moderately represented (Fig. 3.6).

Regeneration of Dipterocarpus bourdillonii, Artocarpus heterophyllus, Elaeocarpus tuberculatus, Myristica dactyloides are heavy. Regeneration of the deciduous species is quite poor, indicating thereby that this forest is progressing towards the climax.

Table 3.5

Structural analysis of the vegetation at Pinavoor

Name of the species	D	Ab	%F	R.D	R.F	R.B.A	I.V.I
Dipterocarpus bourdillonii	1.40	1.75	80	18.18	13.11	4.67	35.96
Artocarpus heterophyllus	0.80	1.33	60	10.39	9.84	2.44	27.67
Persea macrantha	0.30	1.00	30	3.90	4.92	5.17	13.39
Canariua strictum.	1.10	1.57	70	14.29	11.48	5.17	30.94
Elaeocarpus tuberculatus	0.20	1.00	20	2.60	3.28	4.67	10.55
Holigarna arnottiana	0.20	1.00	20	2.60	3.28	5.67	11.05
Myristica dactyloides	0.80	1.14	70	10.39	11.48	4.67	26.57
Vateria indica	0.30	1.00	30	3.90	4.92	3.95	12.74
Holigarna grahamii	0.10	1.00	10	1.30	1.64	2.91	5.85
Mesua nagassarium	0.30	1.50	20	3.90	3.28	15.85	23.03
Calophyllum tomentosum	0.20	1.00	20	2.60	3.28	5.17	11.05
Bombax malabarica	0.60	1.20	50	7.79	8.20	3.95	19.94
Tetrameles nudiflora	0.40	1.00	40	5.17	6.56	5.17	16.92
Vitex altissima	0.60	1.20	50	7.79	8.20	13.66	29.65
Cassia fistula	0.10	1.86	10	1.30	1.64	11.63	14.57
Schleichera oleosa	0.30	1.00	30	3.90	4.92	0.73	8.55

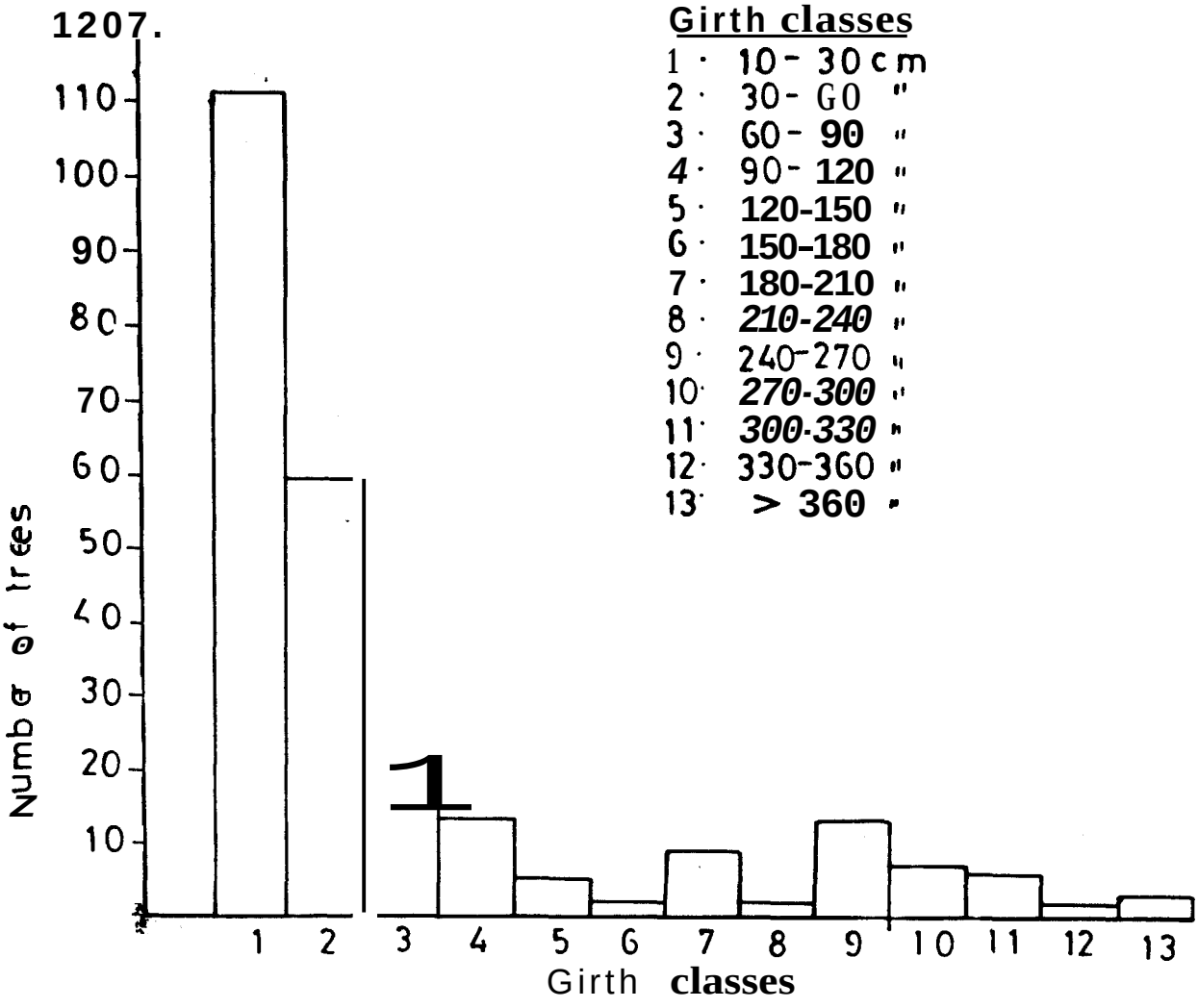


Fig.3.6. Distribution of trees in various girth classes at Pinavoor

d) Evergreen forest

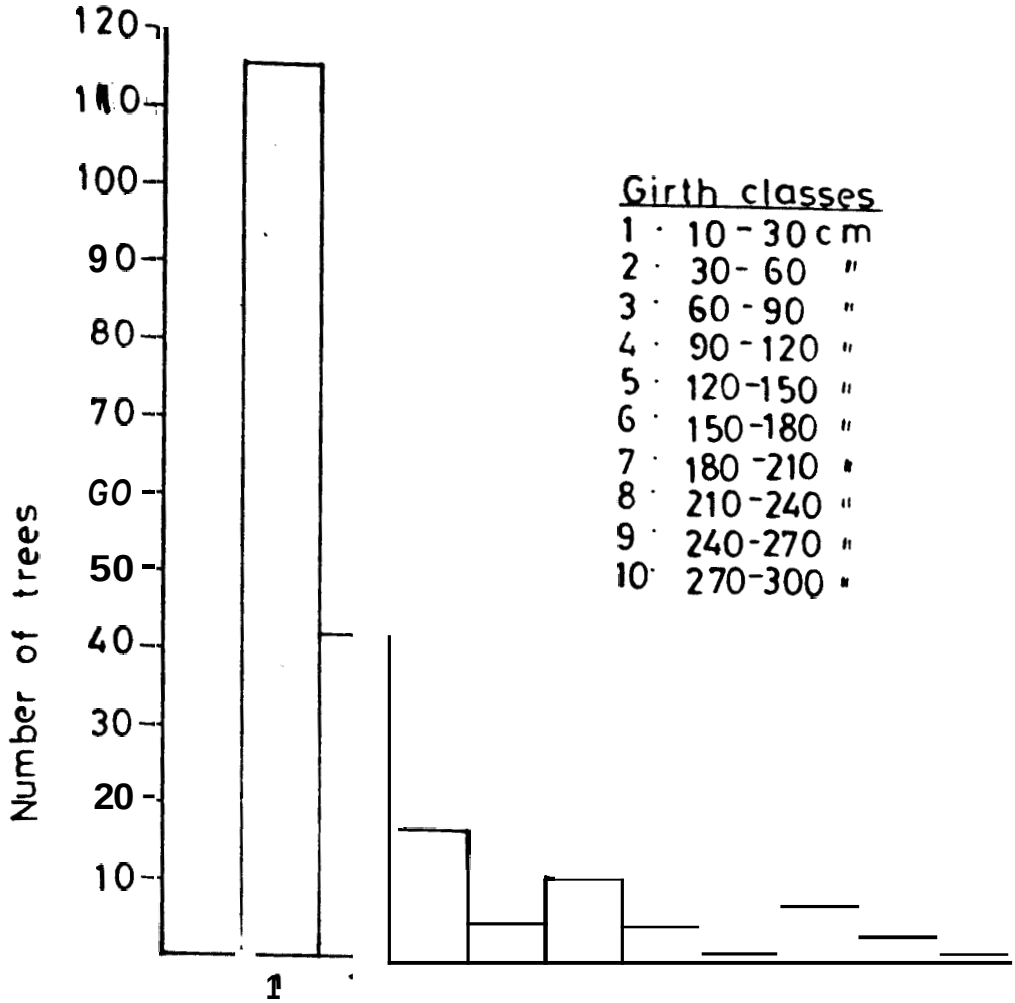
Within the submergible area the only patch of evergreen forest is encountered at Anakulam, situated at 325 m elevation. Due to accessibility and past working, the area is poorly stocked although it still retains the evergreen composition. It exhibits floristic poverty. Only eleven species are encountered in 1600 m^2 as against the normal figure of **30** in most evergreen forests of Kerala.

The community is made up of Holigarna arnottiana - Dysoxylum malabariucm - Persea rnacrantha a situation totally unlike to any of the evergreen forests in Kerala. (Table 3.6)

Table **3.6**

Structural analysis of the vegetation at Anakkulam

Name of the species	D	Ab	%F	R.D	R.F	R.B.A	I.V.I
Canarium stricturn	0.10	**1.00**	**10**	**1.79**	**2.50**	**9.51**	**13.80**
Holigarna armottiana	**1.80**	**2.25**	**80**	**32.14**	**20.00**	**9.51**	**61.65**
Holigarna grahamii	**0.30**	**1.00**	**30**	**5.36**	**7.50**	**5.36**	**18.22**
Vateria indica	**0.10**	**1.00**	**10**	**1.79**	**2.50**	**7.27**	**11.56**
Persea macrantha	**0.90**	**1.29**	**70**	**16.07**	**17.50**	**7.27**	**40.84**
Dysoxylum malabaricum	**0.90**	**1.29**	**70**	**16.07**	**17.50**	**12.05**	**45.62**
Garcinia morella	**0.50**	**1.25**	**40**	**8.93**	**10.00**	**14.85**	**33.78**
Baccaurea courtallensis	**0.10**	**1.00**	**10**	**1.79**	**2.50**	**5.36**	**9.65**
Myristica dactyloides	**0.10**	**1.00**	**10**	**1.79**	**2.50**	**9.51**	**13.80**
Euphoria longana	**1.40**	**1.33**	**30**	**7.14**	**7.50**	**12.05**	**26.69**
Memecylon sp.	**0.40**	**1.00**	**40**	**7.14**	**10.00**	**7.27**	**24.41**



Pig.3.7. Distribution of trees in various girth classes at Anakkulam

Species with lower girth classes (upto 90 cm) are very well represented. Over mature trees (> 300 cm) seem to have been extracted in the past (Fig. 3.7).

Regeneration is profuse for all the species. Holigarna arnottiana and Persea macrantha are well represented in sapling and pole stages.

Conclusions

From the foregoing results the following conclusions could be drawn:

1. The moist deciduous forests in and around Pooyackutty area are in a highly degraded state. This degradation is predominantly due to repeated annual fires. Most of these forests are poorly stocked.

2. The semievergreen forest at Pinavoor is the most diversified vegetation encountered within the project area with a potentiality towards reaching the climax. It is also one of the few low lying forests encountered in Kerala. Construction of a power house will inevitably destroy this unique ecosystem.

3. The only patch of evergreen forest within the submergible area is encountered at Anakulam. Although the stocking level is poor this area still retains its evergreen nature. If the height of the dam is reduced by 50 meters this area can be saved.

4. FLORISTIC STUDIES

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Floristic surveys were undertaken separately in the submergible area around Pindimedu and the upper reaches of the project area viz., Anamala - Manali. Other regions in the project area were not studied in detail as they are under cultivation, settlements etc., and do not possess primary forest.

A. CHECKLIST OF THE FLORA OF THE PROJECT AREA

PINDIMEDU REGION

The submergible and catchaent areas of the proposed Pindimedu dam ccnctitute this region. The vecetation type cf this region is deciduous forest which is degraded to various levels depending upon .locality factors. Reed brakes with regenerating culms of Ochlandra travancorica Benth. ex Gamble is of common occurrence here. A very luxuriant riverine vegetation (Plate 5 and 7) is yet another notable feature of the flora of the region which abode many endemic species of Peninsular India. Rocky out-crops, sheet rock and grasslands are also quite prevalent throughout the region with very poor or no species content. Aquatic vegetation even though not much diverse, include Podostemons, Polygonums, etc. Rotula aquatica Lour. is very commonly seen anchored in rock crevices, which during monsoon get submerged and defoliated, but flourish well in the post-monsoon period when the water flow subsides.

From the Pindimedu region, altogether 340 taxa of angiosperms were recorded during the study belonging to 99 families - 82 dicotyledons and 17 moncotyledons. Dicotyledodous flora of the area comprises 289 taxa and the monocots are represented by 51 taxa, accounting . for 22%. The following list enumerates the flowering . plants recorded from the region, arranged according to the angiosperm classification system of Arthur Cronquist (1981). Notes are also added on the locality of distribution, endemism and conservation status of various species, wherever applicable.

ENUMERATION

D I C O T Y L E D O N S

ANNONACEAE

1. Goniothalamus wihhtii Hoob.f. et Thoms.

   Along the banks of Thuduppi river; endemic to southern Western Ghats, very rare and endangered in the area.

2 Miliusa eriocarpa Dunn.

   Below Kathippara Saddlle dam site, in the moist deciduous forests: endemic of southern India, very rare and endangered in the area.

3. Miliusa tomentosa (Roxb.) Sinclair

   Moist deciduous forests along the hill tops between Thuduppi falls and Avarkutty; endemic to southern Western Ghats, very rare in the area.

4. Polyalthia fragrans (Dalz.) Bedd.

   Fairly common in the moist deciduous forests of 'Tholnada, Avarkutty and Anakulam, and in the degraded semievergreen forest at Pinavur.

5. Uvaria narum (Dunn.) Wt. et Arn.

Fairly common along the sides of rocks at Pindimedu.

MYRISTICACEAE

6. Gymnacranthera canarica (King) Warb.

Along the banks of Thuduppi river; an endemic species of southern Western Ghats, very rare in the area.

7. Knema attenuata (Hook.f. et Thorns.) Warb.

River valleys at Pindimedu, before Avarkutty and at Anakulam; endemic trees of southern India, very rare in the area.

8. Myristica dactyloides Gaertn.

River banks at Tholnada, Pindimedu dam site and at Anakulam; a Peninsular Indo-Sri Lankan species, very rare in the area.

9. Myristica malabarica Lamk.

Moist deciduous forests of the river valleys of Kunjiar, Thuduppi river and Pooyamkutty river; a very rare and endangered Peninsular Indian endemic in the area.

LAURACEAE

10. Actinodaphne bourdillonii Gamble

River valleys at Pindimedu and Tholnada; a highly endemic tree species of southern Western Ghats, very rare in the area.

11. Actinodaphne madaraspatana Bedd. ex Hook.f.

Reed areas in the river valleys at Pindimedu and Anakulam; an endemic species of southern India, very rare in the area.

12. Actinodaphne malabarica Balakr.

Pinavur semievergreen area and river valleys of Pindimedu; an endemic tree species of southern Peninsular India, very rare in the area.

13. Cinnamomum macrocarpum Hook.f.

Below saddle daa site and on the way to Manikantanchal; an endemic tree species of southern Western Ghats, very rare in the area.

14. Cinnamomum malabatrum (Burm.f.) B1.

Up-stream sides of Thuduppi river; an endemic tree of southern Peninsular India, scarce in the area.

15. Cinnamomum riparium Gamble

Curious shrubs forming part of the riparian vegetation, mainly along the banks of Kunjiar, Thudduppi river and at Anakulam; fairly common, endemic of Western Ghats near hill streams.

16. Cinnamomum sulphuratum Nees

Reed areas in the valleys of Pooyamkutty river; a rare tree species in the area, endemic to Peninsular India.

17. Litsea accendentoides K. et V.

Anakulam, along stream sides and in moist deciduous forests; fairly common.

CHLORANTHACEAE

18. Sarcandra grandiflora (Miq.) Subr. et Henry

Hill tops of Hetnappara and between Tholnada and Thuduppi falls; fairly common.

PIPERACEAE

19. Peperomia dindigulensis Miq.

Tholnada area, as Epiphytic on riverside tree trunks; fairly common.

20. Piper niaram L.

Thalakkanny area, as root climbers on trees; rather rare.

21. Pothomorphe subpeltata (Willd.) Miq.

Kunjiar and on the way to Anakulam, in wet, shaded areas near rocks; rather rare.

ARISTOLOCHIACEAE

22. Thottea siliquosa (Lam.k.) Ding Hou

Along forest pathsides, almost throughout the area; a fairly common Peninsular Indo-Sri Lankan species.

RANUNCULACEAE

23. Naravelia zeylanica (L.) A.DC.

Along hedges at Tholnada; rare.

MENISPERMACEAE

24. Cissampelos pareira L.

Along the hedges and streap-sides at Pindimedu and Tholnada; fairly common.

25. Diploclisia glaucacens **(Bl.)** Diels

Climbers on river side trees at Pindimedu; rare.

MELIOSMACEAE

26. Meliosma simplicifolia (Roxb.) Walp.

Anakulam, in moist deciduous forests: rare.

ULMACEAE

27. Trema orientalis **(L.) B1.**

Disturbed forest areas and reed and Mikania growing parts of Pindimedu, Tholnada, Avarkutty, Anakulam and Pinavur; common.

MORACEAE

28. Artocarpus heterophyllus Lamk.

River valleys at Pindirr.edu and Kunjiar and tribal settlement areas near Anakulam; fairly common.

29. Artocarpus hirsuta Lamk.

Between Thclnada and Avarkutty, along the sides cf forest paths; rare.

30. Ficus arnottiana (Miq.) Miq.

Dry deciduous, rocky areas along the right bank of Pooyamkutty river, Avarkutty and Saddle dam area: fairly common.

31. Ficus benghalensis L.

Pindimedu to Kunjiar, elong the sides of rocks near streams; common.

32. Ficus hispida L.f.

Pinavur and Pindimedu, in rocky areas; fairly common.

33. **Ficus** religiosa **L.**

Pindimedu, as epiphytic on rocks bordering the stream; fairly common.

34. Ficus talbotii King

Epiphytic on rocks along stream sides, Tholnada; rare.

35. Ficus tinctoria Forst. f.

In the rocky areas below Kathippara; rare.

36. Ficus travancorica King

Tholnada to Metnappara, along the sides of rocks; an endemic species of South India, very rare in the area.

37. Ficus tsiahela Burm.f.

Kunjiar and Tholnada, in rocky areas; fairly common.

38. Strebles taxoides (Heyne) Kurz

Pinavur and Pindimedu right bank of Pooyamkutty river: fairly common.

URTICACEAE

39. Boehmeria glomerulifera Miq.

In the shady areas below rocks, Kunjiar; fairly common.

40. Boehmeria malabarica Wedd.

Pinavur, in the semievergreen areas: fairly common.

41. Elatostema lineolatum Yt.

Shaded areas, between Avarkutty and Anakulam; fairly common.

42. Laportea interrupta (L.) Chew

Kunjiar river banks, in shade: fairly common.

43. Pellionia heyneana Wedd.

Pinavur and between Avarkutty and Anakulam in shaded localities; common.

44. Pouzolzia zeylanica (L.) Benn.

Kunjiar and Tholnada, in partially shaded areas along forest path sides; common.

NYCTAGINACEAE

45. Boerhavia diffusa L.

Pooyamkutty river sides; fairly common.

AMARANTHACEAE

46. Cyathula prostrata (L.) **Bl.**

Pindimedu, in dry open areas; a fairly common weed.

POLYGONACEAE

47. Polygonum barbatum L.

Marshy areas along the sides of Kunjiar river; common.

48. Polygonum chinense L.

Along river sides and in wet areas at Pindimedu, Kunjiar, Saddle dam area, etc.; common.

DILLENIACEAE

49. Dillenia pentagyna **Roxb.**

In the dry, reed areas at Tholnada and Pindimedu right bank of the river; rather rare.

DIPTEROCARPACEAE

50. Dipterocarpus bourdillonii Brandis

River valleys of Kunjiar, Anakulam and below Saddle dam site; an endemic tree of southern Western Ghats, very rare in the area.

51. Dipterocarpus indicus Bedd.

River banks at Pindimedu and Tholnada and in the degraded semievergreen forest patch at Pinavur; an endangered species in the area, endemic to Peninsular India.

52. Hopea glabra Wt. et Arn.

River banks of Thuduppi; an endemic species of southern Western Ghats, highly endangered in the area.

53. Hopea parviflora Bedd.

Pinavur disturbed, semievergreen forest patch; a rare, endemic of southern India with only **20-30** trees in the locality.

54. Vateria indica L.

Saddle dam area, Kunjiar and Anakulam, confined to valleys and river banks: an endemic tree of southern Western Ghats, very rare in the locality.

55. Vateria macrocarpa Gupta

Anakulam, along river banks and in the valleys; an endemic tree of southern Western Ghats, very scarce in the locality.

GUTTIFERAE

56. Calophyllum apetalum Willd.

Tholnada, along the waterccurses of Thuduppi river: an endemic tree species of Peninsular India, fairly common here.

57. Calophyllum austroindicum Kosterm.

Anakulam and Pindimedu, along the sides of rivers; fairly common.

58. Calophyllum elatum Bedd.

Sides cf the river between Avarkutty and Anakulam; an endemic tree species cf South India, rare in thir locality.

59. Calophyllum inophyllum L.

Fairly common in the Manikantanchal area.

60. Garcinia camboaia (Gaertn.) Desr.

River banks of Kunjiar and at Pindimedu; rare.

61. Garcinia morella (Gaertn.) Desr.

Pindimedu, along the sides of Pooyamkutty river; rare.

62. Garcinia wightii T. And.

Along the sides of Thuduppi river; endemic to Peninsular India, rare in the area.

63. Uesua ferrea L.

Pindimedu, Avarkutty and Anakulam, along the sides of rivers; rare.

ELAEOCARPACEAE

64. Elaeocarpus serratus L.

In the open reed and Mikania growing areas of Pindimedu, Tholnada, Kunjiar and Manikantanchal; comcon.

65. Elaeocarpus tectorius (Lour.) Desr.

Pindimedu, in the open reed areas away from water courses; fairly common.

66. Elaeocarpus tuberculatus Roxb.

Stream banks at Anakulam and in the open areas at Pindimedu and Tholnada-up; fairly common.

TILIACEAE

67. Grewia emarginata Buch.- Ham.

Along the sides of Thuduppi river; rare.

68. Grewia gamblei J.R. Drumm.

Thuduppi river banks; a highly endemic species of southern Western Ghats, very rare in the area.

STERCULIACEAE

69. Helecteris isora L.

Pindimedu, Tholnada, Anakulam, Pinavur, etc. are mainly in open areas; very common.

70. Leptonychia caudata (Wall. ex G. Don) Burrett

Banks of Thuduppi river and above Manikantanchal; rare.

71. Pterospermum suberifolium (L.) Lamk.

Along forest pathsides, Pindimedu; rare.

72. Sterculia guttata Roxb.

Pindimedu, in the river valleys; rare.

BOMBACACEAE

73. Bombax ceiba (L.) DC.

Tholnada, in the moist deciduous river valley forests; rare

74. Cullenia exarillata Robyns

Anakulam semi-evergreen forests: a Peninsular Indo-Sri Lankan species, very rare in the locality.

MALVACEAE

75. Sida cordifolia L.

Pindimedu in the open areas along forest pathsides: fairly common.

76. Sida rhombifolia L.

Tholnada, in the open areas; fairly common.

BARRINGTONIACEAE

77. Careya arborea Roxb.

River banks, mainly around Tholnada; fairly common.

FLACOURTIACEAE

78. Casearia esculenta Roxb.

Pindimedu, in the open areas and along the hedges: fairly common.

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

Hedges at Anakulam; rare.

80. Hydnocarpus alpina Wt.

Pindimedu, along river sides: fairly common.

81. Hydnocarpus pentandrus (Ham.) Oken

Tholnada, Anakulam and Manikantanchal areas, mainly along the sides of water courses: fairly common.

PASSIFLORACEAE

82. Passiflora foetida L.

Hedges around Tholnada; fairly common.

ANCISTROCLADACEAE

83. Ancistrocladus heyneanus Wall. ex Grah.

Pinavur degraded semievergreen forests: an endemic shrub of Peninsular India, fairly common in the forest floor.

BEGONIACEAE

84. Begonia albo-coccinea Hook.

Pindimedu and on the way to Anakulam, in damp, shady areas below rocks; a highly endemic species of southern Western Ghats, very rare and endangered in the area.

85. Begonia malabarica Lamk.

Almost throughout the area, in shaded, wet localities; common.

TETRAMELACEAE

86. Tetrameles nudiflora R.Br. ex Benn.

In the open reed areas of Pindimedu, Tholnada, Anakulam, etc.; fairly common, huge trees of the area.

CLEOMACEAE

87. Cleome viscosa L,

Stream-beds of Pooyamkutty river at Pindimedu; fairly common.

SAPOTACEAE

88. Isonandra perrottiana Kt.

In the degraded semievergreen forest patch at Pinavur; a very rare, Peninsular Indian endemic in the area.

89. Madhuca lonaifolia (Koen.) Mac Bride var. longifolia

Pindirnedu, mainly along the right bank of the river; fairly common.

90. Madhuca longifolia (Koen.) Mac Bride var. latifolia (Roxb.) Cheval.

Along the banks of Kunjiar up-stream; rare.

91. Palaquium ellipticum (Dalz.) Baill.

Anakulam, in the stream beds; a very rare endemic species, fairly common in the upper Ghats namely Manali area.

EBENACEAE

92. Diospyros buxifolia (Bl.) Hiern

Right bank of Pooyamkutty river at Pindimedu and Tholnada; rare.

93. Diospyros candolleana Wt.

In the disturbed semievergreen forest patch at Pinavur; a rare, endemic of southern India, growing almost endangered in the area.

94. Diospyros ovalifolia Wt.

Pindimedu, along the river valleys: an endemic species of Western Ghats, very rare in the area.

SYMPLOCACEAE

95. Symplocos cochinchinensis (Lour.) Moore

Anakulam, moist deciduous forests: rare.

96. Symplocos macrocarpa Wt. ex C.B. C1.

Anakulam and Manikantanchal areas: fairly common, endemic.

97. Symplocos racemosa Roxb.

Anakulam river valleys: endemic to southern India, fairly common in the area.

CRASSULACEAE

98: Kalanchoe pinnata (Lamk.) Pers.

Tholnada, along the sides of rocks; fairly common.

ROSACEAE

99. Rubus indicus Thumb.

Anakulam, along hedges: rare.

CHRYSOBALANACEAE

100. Atuna travancorica (Bedd.) Kosterm.

Thalakkanny area in the river valleys: a highly endemic species of southern Western Ghats, very rare and endangered in the area.

MIMOSACEAE

101. Acacia torta (Roxb.) Craib

Pinavur, Pindimedu and Avarkutty, along hedges: very common.

102. Albizia amara (Roxb.) Boiv. ssp. amara Brenan

Tholnada up and Thalakkanny areas in the dry forests; rare.

103. Albizia lebbeck (L.) Willd.

Saddle dam area in the dry deciduous forests along hill sides; rare.

104. Albizia odoratissima (L.f.) Benth.

Pindimedu, in the open river valleys and reed areas; rare.

105. Mimosa pudica L.

Weed in the open areas; common.

106. Xylia xylocarpa (Roxb.) Taub.

Pindimedu, Avarkutty and Tholnada, in the open rocky areas; fairly common.

CAESALPINIACEAE

107. Bauhinia purpurea L.

Pindimedu left bank, Tholnada, Saddle dam area and Thalakkanny, along river banks: fairly common.

108. Bauhinia racemosa Lamk.

Tholnada, along the river sides; rare.

109. Cassia fistula L.

Tholnada, Kathippara and Pindimedu, in dry open localities; fairly common.

110. Cassia occidentalis L.

Pindimedu in open areas; a common weed.

111. Humboldtia brunonis Wall.

Thuduppi river sides; highly endemic species of southern Western Ghats, very rare and endangered in the area.

112. Humboldtia vahliana Wt.

River banks, Pooyamkutty, Thuduppi river, Anakulam, Kunjiar and at th power house site at Pinavur; endemic to Peninsular India, common.

113. Pterolobium hexapetalum (Roth) Sant.

Hanikantanchaf area: a climber endemic to Peninsular India, very rare in the locality.

PAPILIONACEAE

114. Abrus precatorius L.

Hedges along forest pathsides; fairly common.

115. Butea parviflora Roxb.

Kunjiar up stream sides; rare.

116. Crotalaria juncea L.

Pindimedu forest pathsides; weed, fairly common.

117. Dalbergia benthamii Prain

Stream sides, above Manikantanchal; a very rare and endangered species first reported from India in 1986 from Central Kerala (previously known only from Hongkong).

118. Dalberia horrida (Dennst.) Mabb.

Around Thuduppi falls, above Manikantanchal and before Avarkutty; a very rare woody climber, endemic to Peninsular India.

119. Dalbergia latifolia Roxb.

Tholnada hill tops; rare.

120. Dalbergia sissoides Grah. ex Wt. et Arn.

Tholnada, Saddle dam area, and before Avarkutty in the dry open areas; very rare.

121. Dalbergia volubilis Roxb.

Tholnada to Avarkutty, in the dry open areas near rocks; rare.

122. Desmodium herbaceum Lindl.

Tholnada, in the open areas; rare.

123. Desmodium heterophyllum (Willd.) DC.

Tholnada in the rocky areas; fairly common.

124. Desmodium triangulare (Retz.) Merr.

Pindimedu, along the dry forest pathsides; rare.

125. Erythrina stricta Roxb.

In the dry open forests of Avarkutty and Saddle dam site: very rare.

126. Ormosia travancorica Bedd.

Along the sides of Kunjiar up-stream: a highly endemic species of the Western Ghats of Kerala, represented by an endangered population in the area.

127. Pongamia pinnata (L.) Pierre

Pindimedu, Heenkuthi, Anakulam and Pinavur; rare.

128. Pterocarpus marsupium Roxb.

Pindimedu and Tholnada-up; rare.

129. Tephrosia purpurea (L.) Pers.

Pindimedu, in waste places and along road-sides; common.

PODOSTEMACEAE

130. Polypleurum stylosum (Wt.) J.B. Hill

In the flowing waters of the rivers in the study area, attached to rocks: an Indo-Sri Lankan aquatic species of hill streams, common in the rivers of the project area.

131. Willisia selaainoides (Bedd.) Warm. ex Willis

In the swift flowing waterfall sides, Kunjiar; an endemic aquatic of Western Ghat hill streams, rare in the area.

LYTHRACEAE

132. Ammania baccifera L.

River banks, Pindimedu; rare.

133. Lagerstroemia microcarpa Wt.

River valleys and reed areas at Pindimedu, Tholnada, Avarkutty and Anakulam; fairly common.

134. Lagerstroemia reginae Roxb.

Stream sides and valleys, Pindimedu, Kunjiar, etc.; fairly common.

MYRTACEAE

135. Syzygium caryophyllatum (L.) Alston

Pooyamkutty river banks at Pindimedu; very rare.

136. Syzygium cumini **(L.)** Skeels

Stream sides, Pinavur and Tholnada; rare.

137. Syzygium jambos **(L.)** Alston

Kunjiar up-stream sides: rare.

138. Syzygium laetum (Ham.) Gandhi

Between Avarkutty and Anakulam, along stream sides: an endemic species of southern Western Ghats, very rare and endangered in the area.

139. Syzygium mundagam (Bourd.) Chithra

Between Avarkutty and Anakulam, along river sides: a highly endemic species of the evergreen forests of the Western Ghats of Kerala, represented in the project area by an endangered population of 3-4 trees only.

140. Syzygium occidentale (Bourd.) Gandhi

Pindimedu, along the river banks; a highly endemic tree to southern Western Ghats, represented in the area by an endangered population of 6-7 individuals.

MELASTOMATACEAE

141. Melastoma malabathricum L.

Saddle dam site, in almost open areas: fairly common.

142. Memecylon hevneanum Benth.

Kunjiar valleys, in the moist deciduous forests: fairly common.

143. Memecylon malabaricum (C.B.Cl.) Cogn.

Dry, rocky areas of the right bank of Pooyamkutty river at Pindimedu; a Peninsular Indian endemic species, fairly common in the area.

144. Memecylon umbellatum Burm.f.

Tholnada, Saddle dam site, Pinavur, etc.; common.

145. Osbeckia aspera B1.

Kunjiar and Anakulam areas, in the openings along river banks; fairly common.

146. Osbeckia zeylanica L.f.

Kunjiar up-stream banks, in open areas; fairly common.

147. Sonerila brunonis L.

Anakulam, along the sides of rocks in wet, humid areas; rare.

148. Sonerila elegans Wt.

Shaded rock sides, Avarkutty to Anakulam; a fairly common endemic herb of Peninsular India.

149. Sonerila versicolor Wt. var. axillaris Gamble

Kunjiar river valleys; very rare, endemic to southern India.

150. Sonerila wallichii Benn.

Pindimedu, along the shaded sides of rocks; a rare species in the area, endemic to southern India.

COMBRETACEAE

151. Terminalia gella Dalz.

Pindimedu in the reed areas and river valleys; rare.

152. Terminalia paniculata Roxb. ex Roth

Kunjiar valleys, Tholnada hill top, Pinavur semievergreen forest patch, etc.; an endemic species of Peninsular India, fairly common in this locality.

CORNACEAE

153. Mastixia arborea (Wt.) Bedd.

Kunjiar, Anakulam, Thalakkanny and Manikantanchal moist deciduous forests; rare, endemic to Peninsular India.

154. Mastixia arborea (Wt.) Bedd. var. meziana (Wang.) Matthew

Pindimedu, along the right bank of Pooyamkutty river and Manikantanchal moist deciduous forests: a very rare taxon, endemic to South India.

SANTALACEAE

155. Scleropyrum Dentandrum (Dennst.) Mabb.

Sides of Thuduppi river below Thuduppi falls: endemic to Peninsular India and Sri Lanka, very rare and endangered in the area.

VISCACEAE

156. Viscum orientale Willd.

Along the banks of Thuduppi river, as parasitic on Helicteris isora bushes: rare.

LORANTHACEAE

157. Dendrophthoe falcata (L.f.) Etting

Parasitic on trees boardering Kunjiar river; fairly common.

158. Scurrula cordifolia (Wall.) G. Don

Parasitic on trees in the Tholnada area: rare.

CELASTRACEAE

159. Euonymous dichotomus Heyne ex Roxb.

Anakulam moist deciduous areas: rare.

160. Lophopetalum Wightianum Arn.

Pindimedu, in the river valleys; endemic to Peninsular India, very rare in the area.

ICACINACEAE

161. Gomphandra coriacea Kt.

Above Thuduppi falls, along river sides: a highly endemic species of southern Peninsular India, endangered in the area.

162. Gomphandra tetrandra (Wall. ex Roxb.) Sleum.

Stream sides, above Thuduppi falls: rare.

DICHAPETALACEAE

163. Dichapetalum gelonoides (Roxb.) Engler

Reed areas between Kunjiar and Koompanpara; rare.

EUPHORBIACEAE

164. Agrostistachys indica Dalz.

Pindimedu, Tholnada and Anakulam, as undergrowth in the stream side vegetation; an endemic species of Peninsular India, very rare in the area.

165. Agrostistachys meeboldii Pax et K. Hoffm.

Anakulam, degraded semievergreen forests: fairly common.

166. Antidesma bunius **(L.)** Spreng.

Pindimedu, sides of the river; common.

167. Antidesma menasu Miq. ex Tul.

Tholnada and Kunjiar, river banks; fairly common.

168. Aporosa acuminata Thw.

Pindimedu, right bank of Pooyamkutty river and Anakulam; fairly common.

169. Aporosa lindleyana (Wt.) Baill.

Kunjiar, Anakulam, Pindimedu right bank, etc.; fairly common.

170. Baccaurea courtallensis (Wt.) Muel1.-Arg.

Anakulaa, Pinavur, Kunjiar and around Saddle dam site; an endemic species of Penninsular India, fairly common throughout the are?.

171. Blackia calycina Benth.

Anakulam., semievergreen forests; fairly common.

172. Breynia rhamnoides (Retz.) Muell.-Arg.

Anakulam, along hedges: rare.

173. Bridelia scandens (Roxb.) Willd.

Tholnada and Kunjiar river sides; fairly common.

174. Drypetes oblongifolia (Bedd.) Airy Shaw

Anakulam, moist deciduous forests: an endemic species of Peninsular India, very rare in the area.

175. Emblica officinalis Gaertn.

Pindimedu, right bank of Pooyamkutty river; fairly common.

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

Anakulam, semievergren forests: a species endemic to Peninsular India, very rare in the area.

177. Glochidion ellipticum, Wt.

Anakulam semievergreen forests; a Peninsular Indian endemic, very rare in the project area.

178. Glochidion zeylanicum (Gaertn.) Juss.

Pinavur, degraded semievergreen forest patch; rare.

179. Homonoia riparia Lour.

Throughout, along the river banks; very common.

180. Kirganelia reticulata (Poir.) Baill.

Thclnada, along forest pathsides; fairly common.

181. Macaranga peltata **(Roxb.)** Muell.-Arg.

Throughout, in disturbed, reed areas; common.

182. Mallotus philippensis (Lamk.) Muell.-Arg.

Pindimedu, right bank of Pooyamkutty river and Pinavur degreded semievergreen forests; common.

183. Securinega leucopyrus (Willd.) Muel1.-Arg.

Pindimedu, right bank of the river; fairly common.

184. Tragia involucrata L.

Tholnada, Kunjiar and Pinavur, in open places; common.

RHAMNACEAE

185. Ziziphus oenoplia **(L.)** Mill

Below Kathippara and Pindimedu in dry, rocky areas ; fairly ccommon along hedges.

186. Ziziphus xylopyrus (Retz.) Willd.

Pindimedu, dry, right bank of the river; fairly common.

LEEACEAE

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

Tholnada and Pinavur; fairly comnon.

VITACEAE

188. Cissus auadranaularis L.

Pindimedu, along hedges: fairly common.

189. Cissus repens Lamk.

Streamsides of Saddle dam area: rare.

190. Tetrastigma lanceolarium (Roxb.) Planch.

Pinavur, disturbed seaievergreen forests; fairly common.

STAPHYLEACEAE

191. Turpinia malabarica Gamble

Avarkutty, Kunjiar and Saddle dam area; an endemic tree of Peninsular India, fairly common in the project area.

CONNARACEAE

192. Connarus monocarpus L.

Pindimedu, right bank of Pooyamkutty river; rare.

193. Connarus wightii Hook.f.

Pindiredu, right bank of the river; an endemic specie: cf southern Peninsular India, very rare in the dry places of this region.

SAPINDACEAE

194. Dimocarpus longan Lour.

Pinavur degraded senievergreen forests: rare.

195. Lepisanthes tetraphylla (Vahl) Radlk.

Anakulam, moist deciduous forests: rare.

196. Otonephelium stipulaceum (Bedd.) Radlk.

Tholnada and Anakulam in the moist deciduous forests: an endemic tree of Peninsular India, very rare at Pooyamkutty.

197. Sapindus laurifolius Vahl

Way to Mankulam from Anakulam, along forest path sides: rare.

198. Schleichera oleosa (Lour.) Oken

Pinavur and around Saddle dam site; rare.

BURSERACEAE

399. Canarium strictum Roxb.

Anakulam semievergreen forests; a very rare species, endemic to Peninsular India.

ANACARDIACEAE

200. Holigarna arnottiana **Hook.f.**

Pindimedu and Pinavur in the open reed areas of the river valleys: a species endemic **to** Peninsular India, rare in the area.

201. Holigarna grahamii **(Wt.)** Kurz

Anakulam moist deciduous forests: an endemic tree of southern India, very rare in the area.

202. Lannea coromandelica (Houtt.) Herr.

Pindimedu, river banks; rare.

203. Mangifera indica L.

Findimedu, near the KSEF **Camp** shed; rare.

204. Nothopegia beddomei **Gamble**

River beds at Anakulam; a highly endemic species, **so** far known only from the Tamilnadu part of the Western Ghats, growing in an endangered state in the area.

205. Nothopegia travancorica Bedd. ex Hook.f.

Above Thuduppi falls, along the banks of the river; a highly endemic species of southern Western Ghats, represented by an endangered population in the area.

206. Semecarpus anacardium L.f.

Upper reaches of Tholnada in the degraded moist deciduous forests; rare.

RUTACEAE

207. Acronychia pedunculata **(L.)** Miq.

Anakulam, in the degraded semi-evergreen forests: rare.

208. Glycosmis arborea (Roxb.) DC.

Pindimedu, forest pathsides; rare.

209. Toddalia asiatica (L.) Lamk .

Anakulam, along the hedges: fairly common.

210. Zanthoxylum rhetsa (Roxb.) DC.

Anakulam and Avarkutty, in reed areas: rare.

MELIACEAE

211. Aglaia barberi Gamble

Saddle dam area in the open forests: a highly endemic species of the southern Western Ghats represented by a very endangered population of two trees in the area.

212. Aphanamixis polystachya (Wall.) Parker

Pindimedu and above Manikantanchal, in the deciduous forests; very rare.

213. Dysoxylum malabaricum Bedd. ex Hiern

Anakulam, semievergreens; a species endeaic to southern Western Ghats, very rare in the area.

214. Toona ciliata M. Roem.

Pinavur disturbed semievergreen forests; rare.

215. Trichilia connaroides (Wt. et Arn.) Bent.

Pindimedu, in the river beds: rare.

OXALIDACEAE

216. Biophytum sensitivum (L.) DC.

Pindiaedu, wet sides of rocks; fairly common.

BALSAMINACEAE

217. Impatiens chinensis L.

Kunjiar and Pindimedu, in wet places: fairly common during post monsoon months.

218. Impatiens cordata Wt.

Anakulam, in shady, wet areas: an endemic species of Peninsular India, fairly common in the locality.

219. Impatiens maculata Wt.

Anakulam, in shaded, damp areas; an endemic herb of South India, rare in the area.

220. Impatiens scapiflora Heyne

Pindimedu and Kunjiar in wet, shaded areas; a herb endemic to South India, fairly common in the locality.

XANTHOPHYLLACEAE

221. Xanthophyllum flavescens Roxb.

Pinavur and Anakulan, as undergrowth in moist deciduous forests; fairly common.

ARALIACEAE

222. Schefflera venulosa (Wt. et Arn.) Ham.

Tholnada and Thuduppi river banks: fairly common.

UMBELLIFERAE

223. Centella asiatica (L.) Urb.

Pindirr.edu, along wet sides of rocks; fairly common.

224. Hydrocotyle javanica Thunb.

Way to Anakulam in deeply shaded, wet sides of rocks; fairly common.

LOGANIACEAE

225. Strychnos nux-vomica L.

Pindimedu, banks of the river; rare.

226. Strychnos potatorum L.f.

Anakulam, along hedges: rare.

POTALIACEAE

227. Fagraea ceilanica Thunb.

Pindirnedu, below Metnappara and in the Anakulam area; fairly common.

APOCYNACEAE

228. Alstonia scholaris (L.) R. Br.

Pindimedu, in open reed areas of the river valleys: rare.

229. Chilocarpus malabaricus Bedd.

Anakulan, along riverside hedges; this species first described from Northern Kerala was subsequently located in Karnataka in **1964.** This is possibly the first collection of the species from Kerala after more than 100 years of its type collection.

230. Ervatamia divaricata (L.) Burkill

Pindimedu, Meenkuthi and Anakulam forests; fairly common.

231. Ichnocarpus frutescens (L.) R. Br.

Tholnada and Anakulam, along hedges; fairly common.

SOLANACEAE

232. Rauvolfia serpentina Benth. ex Kurz

Way to Ketnappara, along the sides of the hillock in cultivated land; very rare and endangered Indian endemic.

233. Solanum erianthum **D.** Don

Pindimedu, in dry, open areas: fairly common.

234. Solanum torvum Sw.

Pindimedu, in open areas: fairly common.

BORAGINACEAE

235. Cynoglossum zevlanicum (Hornem.) Thumb. ex Lehm.

Way sides from Avarkutty to Anakulan: rare, endemic of South India and Sri Lanka.

EHRETIACEAE

236. Rotula auuatica Lour.

Pindimedu, Kunjiar and other water courses in the area, in rock crevices; a very common shrub in the area, endemic to Peninsular India and Sri Lanka.

VERBENACEAE

237. Callicarpa tomentosa (L.) Murr.

Below the Koocpanpara Saddle dam mount, in reed areas; fairly common.

238. Clerodendrum viscosum Vent.

Tholnada, in waste places: fairly common.

239. Gmelina arborea Roxb.

Avarkutty, forest path sides; rare.

240. Lantana camara L. var. aculeata Mold.

Pindimedu, along hedges; common.

241. Premna tomentosa Willd.

Tholnada, in reed areas; rare.

242. Tectona grandis L.f.

Growing wild in the Tholnada and Pindimedu areas, in the deciduous forests; rare.

243. Vitex altissima L.f.

Pindimedu, Tholnada and below Metnappara hillock; fairly common.

244. Vitex negundo L.f.

Tholnada, open areas; rare.

LABIATAE

245. Anisomeles malabarica (L.) R. Br. ex Sims.

Pindimedu in rocky areas: fairly common.

246. Hyptis suaveolens (L.) Poit.

Pindimedu, in dry, rocky areas; a common weed.

247. Gomphostemma keralensis Vivek., Gopal. et Ansari

Towards Anakulam side from Avarkutty, as a shade loving species along the wet sides of rocks; a highly endemic species so far known only from Idukki, endangered in the locality.

248. Pogostemon paniculatus (Willd.) Benth.

Pindimedu, in open dry areas; common.

OLEACEAE

249. Chionanthus mala-elengi (Dennst.) P.S. Green

Pindimedu and Kunjiar river valleys: an endemic tree of Peninsular India, fairly common in the locality.

250. Jasminum malabaricum Wt.

Tholnada and along the sides of Thuduppi river above; a wild species of jasmine, endemic to Peninsular India, fairly common in the area.

251. Jasminum rottlerianum Wall. ex DC.

Pinavur sesievergreen forest patch and Manikantanchal fcrest outskirts: endemic to Penninsular India, rare in the area.

252. Olea dioica Roxb.

Pindimedu, right bank of the river and Tholnada- up; fairly common.

SCROPHULARIACEAE

253. Scoparia dulcis L.

Pindimedu, waste places; common.

254. Striga angustifolia (Don) Saldanha

Pindimedu, river deltas: rare.

GESNERIACEAE

255. Aeschynanthus perrottetii A.DC.

Pindimedu, as epiphytic on trees: a very rare and endangered species in the area, endemic to Peninsular India.

256. Rhynchoglossum notonianum (Willd.) Burtt

Pindimedu, river banks; very rare.

257. Rhynchotechum permolle (Nees) Burtt

Anakulam, in shaded, wet areas: rare.

ACANTHACEAE

258. Gymnostachyum febrifunum Benth.

Avarkutty, Kunjiar and Anakulam; very rare along shaded, humid, forest path sides: endemic to Peninsular India.

259. Gymnostachyum latifolium (Dalz.) T. Anders.

Hankulam, along forest pathsides; very rare in the area; an endemic species **of** Peninsular India, very rare and endangered in the area.

260. Justicia betonica L.

Anakulam, shaded forest floor; rare.

261. Justicia wynaadensis (Nees) T. Anders.

Pinavur disturbed semievergreen forests; a highly endemic species of Peninsular India, very rare and endangered in the area.

CAMPANULACEAE

262. Lobelia nicotianaefolia Roem. et Schult. var. trichandra Wt.

Forest outskirts, Anakulam; fairly common.

RUBIACEAE

263. Aarostemma rostratum Wall.

Anakulam semievergreen areas, in shade; a species known from North-East India and recently (1968) reported from. Neriamangalam, very rare in the area.

264. Chassalia curviflora (Wall.) Craib var. ophioxyloides (Wall.) Deb et Krishna

Shaded, wet, forest pathsides at Anakulaa; rare.

265. Ixora arborea Roxb. ex J.E. Sm.

Pindip.edu, along river banks: fairly commcn.

266. Ixora nigricans R. Br.

Pindimedu and Pinavur areas; fairly common.

267. Ixora pavetta Andrews

Kunjiar and Saddle dam area; rare.

268. Mussaenda laxa (Hook.f.) Hutch. ex Gamble

Tholnada, along river side hedges: an endemic species of Peninsular India, rare in the locality.

269. Ophiorrhiza eriantha Wt.

Pinavur, semi-evergreen forests, as part of the ground flora: endemic to Peninsular India, rare in the area.

270. Ophiorrhiza mungos L.

Pindimedu, way to Anakulam and elsewhere in shade; fairly common.

271. Pavetta zeylanica Gamble

Below Metnappara hillock: a species endemic to Peninsular India, very rare in the area.

272. Psychotria congesta (Wt. ex Arn.) Hook.f.

Forests adjoining Thuduppi falls: Peninsular Indian endemic, very rare in the area.

273. Psychotria connata Wall. ex Roxb.

Pindimedu and Thuduppi areas; endemic to Peninsular India, very rare in the locality.

274. Psychotria dalzellii Hook.f.

Anakulam semievergreen forests as undergrowth: endemic to Peninsular India, very rare and endangered in the area.

275. Psvchotria johnsonii Hook.f.

Tholnada, towards the upper side of the ghat: endemic to Peninsular India, very rare in the locality.

276. Psvchotria nigra (Gaertn.) Alston

Saddle dam area in shades: rare.

277. Psvchotria nudiflora Wt. et Arn.

Tholnada and along the banks of Thuduppi river in shade: an endemic of South India, very rare in the locality.

278. Psychotria octosulcata Talbot

Tholnada, along the shaded strem sides: a rare species in the area, endemic to Peninsular India.

279. Randia dumetorum (Thumb.) Poir.

Anakulam, outskirts of the forerts: fairly common.

280. Wendlandia bicuspidata Wt. et Arn.

Anakulam, in open areas; very rare in this area, but very common in the upper ghat like Manali.

COMPOSITAE

281. Blainvillea acmella (L.) Philipson

Weed, in Pindimedu waste places; fairly common.

282. Blumea lacera (Burm.f.) DC.

Waste places, Pindimedu; rare, weed.

283. Chromolaena odorata (L.) King et Robinson

Tholnada, along hedges; a common exotic weed.

284. Elephantopus scaber L.

Pindimedu, open waste places; fairly common.

285. Emilia sonchifolia (L.) DC.

Pindimedu, forest path sides; common.

286. Xikania micrantha H.B.K.

Throughout, especially in open, reed areas; Post common.

287. Tridax Drocumbens L.

Pindimedu, waste places; common.

288. Vernonia arborea Ham.

Throughout, in open, reed growing areas; the endemic tree composit of South India, very common here.

289. Vicoa indica (L.) DC.

Thuduppi, open, weed areas; common.

COMMELINACEAE

290. Aclisia secundiflora **(Bl.)** Bakh.f.

Above Thuduppi falls; rare.

291. Aneilema ovalifolium (Wt.) **Hook.f. ex** C.B. **C1.**

Pindirr.edu in wet places; fairly ccmmon.

292. Commelina benshalensis L.

Pindimedu, river sides and wet areas; common.

293. Commelina diffusa Burm.f.

Wet localities, Pindimedu; fairly common.

294. Commelina paludosa B1.

Tholnada, in shaded, wet areas; common.

ERIOCAULACEAE

295. Eriocaulon quinquangulare L.

Thuduppi, river deltas; common.

CYPERACEAE

296. Bulbostylis barbata (Rottb.) **C.B. C1.**

Pindimedu, waste places; fairly common.

297. Cyperus exaltatus Retz.

Pindimedu, dry forest path sides; fairly common.

298. Cyperus tenuisvica Steud.

Metnappara hill sides, in disturbed areas; cocmon.

299. Fimbristylis dichotoma **(L.)** Vahl

Pindimedu, open waste areas; fairly common.

GRAMINEAE

300. Centothecca latifolia (Osbeck.) Trim.

Anakulam, in the semievergreen forests: rare.

301. Chloris barbata Sw.

Pindimedu, dry path sides: fairly common.

302. Coix lacryma-jobi L.

Temporary deltas of Thuduppi river above Tholnada: very rare.

303. Cymbopogon caesius (Hook.f. et Arn.) Stapf

Tholnada, in open areas; common.

304. Cynodon dactylon **(L.)** Pers.

Pindimedu, dry, open areas; fairly common.

305. Digitaria ciliaris (Retz.) Koen.

Pindimedu, dry, rocky open areas; common.

306. Eragrostis uniloides (Retz.) Nees ex Steud.

Pindimedu, forest path sides: fairly common.

307. Panicum repens L.

Kunjiar river deltas; common.

BAMBUSACEAE

308. Bambusa arundinacea (Retz.) Rcxb.

Saddle dam site, in open areas; fairly common.

309. Ochlandra travancorica Benth. ex Gamble

Throughout the project area: most common.

MUSACEAE

310. Ensete superbum **(Roxb.)** Cheesm.

Between Avarkutty and Anakulam in semievergreen forests, along river banks and in watersheds: an endemic species of Peninsular India, rare in the area.

ZINGIBERACEAE

311. Alpinia malaccensis (Burrn.f.) Roxb.

Forest pathsides, Pindimedu to Kunjiar and Avarkutty to Anakulam; common.

312. Amomum cannicarpum (Wt.) Benth.

Forest pathsides and river valleys on the way to Anakulam; fairly common.

313. Elettaria cardamomum (L.) Manton

Along the sides of rivers in deeply shaded areas on the way to Anakulam; rare.

COSTACEAE

314. Costus speciosus (Koenig) Smith

Throughout, along forest path sides; common.

MARANTACEAE

315. Schumannianthus virgatus (Roxb.) Rolfe

Throughout in open areas: very common.

PALMAE

316. Calamus thwaitesii Becc.

Pinavur, Kunjiar stream sides and on the way to Anakulam; an endemic species of Peninsular India, fairly common in the area.

PONTEDERIACEAE

317. Monochoria vaginalis (Burm.f.) Persl.

Thuduppi river banks: rare.

ARACEAE

318. Pothos scandens L.

Tholnada, Pindiaedu, etc.; comnon climbers on riverside trees.

319. Rhaphidophora lacinata (Burm.f.) Merr.

Tholnada, as climbers on riverside trees: very rare.

320. Remusatia vivipara (Lodd.) Schott

Pindimedu, in the debris deposited along the sides of rocks; very rare.

HYPOXIDACEAE

321. Curculigo orchioides Gaertn.

Tholnada, in open areas: rare.

322. Molineria trichocarpa (Wt.) Balakr.

Tholnada, in open areas, along with grasses; rare.

AGAVACEAE

323. Dracaena terniflora Roxb.

Pinavur, Tholnada and Anakulam, in the dense forests bordering rivers: fairly common.

SMILACACEAE

324. Smilax zeylanica **L.**

Below the Saddle dam site and along the right bank of the river at Pindimedu; fairly common.

DIOSCOREACEAE

325. Dioscorea oppositifolia L.

Along the hedges at Pindimedu, on the way to Anakulam, etc.; fairly common.

326. Dioscorea pentaphylla L.

Pinavur and on the way to Anakulam, along the hedges: fairly common.

ORCHIDACEAE

327. Bulbophyllum fimbriatum (Lindl.) Reichb. f.

Epiphytic on trees around Tholnada; an endemic orchid of Peninsular India, fairly common in the area.

328. Bulbophyllum fischeri Seidenfaden

Tholnada, as epiphytic on riverside trees: rare.

329. Bulbophyllum neilaherrense Wt.

Pindimedu and Tholnada, as epiphytic of river bank trees; rare, endemic to Peninsular India.

330. Cleisostoma tenerum Hook.f.

Between Pindir.edu and Tholnada, as epiphytic on river side trees; a highly endemic. orchid, confined to southern Western Ghats, very rare and endangered in the area.

331. Dendrobium barbatulum Lindl.

Between Tholnada and Avarkutty in dry areas; and endemic species of Peninsular India, rare in the locality.

332. Dendrobium herbaceum Lindl.

Tholnada, as epiphytic on river side trees; rare.

333. Dendrobium macrostachyum Lindl.

Saddle dam area and Anakular, as epipytic on river side trees; fairly common.

334. Dendrobium ovatum (Willd.) Kranz.

Tholnada, as epiphytic on trees; very rare, endemic to Peninsular India.

335. Luisia zeylanica Lindl.

Pindimedu and below Metnappara, along Thuduppi river sides; rare.

336. Pholidota pallida Lindl.

Tholnada, as epiphytic on riverine trees; rare.

337. Podochilus malabaricus Vt.

Tholnada, as epiphytic on river bank trees; rare.

338. Sirhookeria latifolia (Wt.) Θ. Ktze.

Between Tholnada and Avarkutty and along Thuduppi river banks, as epiphytic on trees; an endemic orchid of Peninsular India, fairly common in the area.

339. Terniola zeylanica Tub.

Koompanpara Saddle dam area, as epiphytic on trees; an endemic orchid of Peninsular India, very rare and endangered in the area.

340. Vanda tessellata (Roxb.) Hook. ex G. Don

Tholnada, Kunjiar and Avarkutty, as epiphytic on trees: rare.

ANAMALA - MANALI REGION

Vegetation in the Anamala - Manali region is mostly of the evergreen and semi-evergreen types whereas that of the lower portion down the Meenkuthi tribal settlerrent is almost of the moist deciduous type. Riverine vegetation in the area is very rich as in Pindimedu and eventhough patches of grasslands and rocky outcrops are common, vegetation cover is almost coaplete and mostly undisturbed. Feed breaks commonly occur in this area. Further, cardamom cultivation by the tribals in the area had resulted in the removal of the ground flora of some of the semi-evergreen areas, especially above the Manali tribal settlement. Mikania micrantha, an exotic weed is commonly encountered in the disturbed areas (Plate 8).

Common to this area are 171 taxa of flowering plants. They belong to 73 families - 60 dicots and 13 monocots. The dicotyledonous flora comprises 154 taxa **(90%)** and the monocotyledons 17 taxa (10%). The recorded species of angiosperms fror the Anamala - Manali region are enumerated below:

ENUMERATION

D I C O T Y L E D O N S

MYRISTICACEAE

1. Myristica dactyloides Gaertn.

   Between Meenkuthi tribal settlements and Anakulam, along the river sides: a tree species endemic to Peninsular India and Sri Lanka, rare in the area.

LAURACEAE

2. Actinodaphne lawsonii Gamble

Between Anamalai dam site and Manali tribal settlements, in the semievergreen forests; a Peninsular Indian endemic tree, very rare in the locality.

3. Actinodaphne malabarica Balakr.

Semievergreen forests between Manali tribal settlements and Anakulam; an endemic tree of southern Vectern Ghats, very rare in the area.

4. Cinnamomum sulphuratum Nees

Around Anamalai dam site, in the semievergreen forests; an endemic tree of Peninsular India, very scarce in the locality.

5. Cinnamomum verum J.S. Persl.

Anamalai, forests adjoining the dam site; very rare.

6. Gymnacranthera canarica (King) Warb.

Streamsides between Meenkuthi tribal settlement and Anakular; an enderic tree of southern Western Ghats, very rare in the area.

7. Litsea accendentoides K. et V.

Forest streach between Manali and Meenkuthi tribal settlements; very rare.

8. Litsea bourdillonii Gamble

Between Manali and Meenkuthi tribal settlements; a highly endemic species confined to southern Peninsular India, very rare and endangered in the locality.

9. Neolitsea cassia (L,.) Kosterm.

Between Meenkuthi and Anakulam, in the moist deciduous forests; rare.

10. Persea macrantha (Nees) Kosterm.

Meenkuthi tribal settlement area, along the fringes of grassy slopes; a tree species confined to Peninsular India and Sri Lanka, very rare and endagered in the area.

CHLORANTHACEAE

11. Sarcandra grandifolia (Miq.) Subr. et Henry

Meenkuthi area, in the forests adjoining grasslands; a Peninsular Indo-Sri Lankan species, very rare in the area.

PIPERACEAE

12. Peperomia dindiuulensis Miq.

As epiphytic on tree trunks, between Anamalai and Manali; fairly common.

13. Piper nigrum L.

In the moist deciduous forests along the slopes between Meenkuthi and Anakulam; very rare, with unusually long spikes measuring 20-30 cm in length.

14. Pothomorphe subpeltata (Willd.) Miq.

In the moist deciduous forests between Meenkuthi and Anakulam, along the side. of rocks in shade; very rare.

ARISTOLOCHIACEAE

15. Thottea siliquosa (Lamk.) Ding Hou

Manali, forest bordering tribal settlements; a Peninsular. Indo-Sri Lankan species, rare in the area.

RANUNCULACEAE

16 Naravelia zeylanica (L.) A. DC.

Outskirts of the forests near Kanali tribal settlements; fairly comon.

MELIOSMACEAE

17. Meliosma simplicifolia (Roxb.) Valp.

Deciduous forests between Meenkuthi and Anakulam; fairly common.

ULMACEAE

18. Trema orientalis (L.) Bl.

Betveen Meenkuthi and Anakulam, in the deciduous forests; fairly common, especially in the openings.

MORACEAE

19. Artocarpus heterophyllus Lamk.

Between Anamalsi and Manali, along forest path sides; a species native to South- West India, introduced else where in the tropics; rare.

20. Streblus taxoides (Heyne) Kurz

Between Meenkuthi and Anakulam, in the bushy areas; common.

URTICACEAE

21. Boehmeria malabarica Lamk.

Anamalai to Manali, along forest path sides; common.

22. Elatostema lineolatum Wt.

Evergreen forest floor between Anamalai and Manali; fairly common.

23. Laportea crenulata (L.) Chew

Semievergreen forest floor in the Anamalai - Manali region; abundant.

24. Oreccnide integrifolia (Gaud.) Miq.

In the evergreen forests between Anamalai and Manali; fairly common as an undergrowth.

25. Pellionia heyneana Wedd.

Deciduous forests between Keenkuthi and Anakulam, in shade; fairly common.

POLYGONACEAE

26. Polygonum chinense L.

Streamsides near Anakulam; fairly common.

DIPTEROCARPACEAE

27. Dipterocarpus indicus Eedd.

Forests between Meenkuthi tribal settlements and Anakulam; rare, isolated trees representing only an endangered population; an endemic tree species of Peninsular India.

28. Vateria indica L.

Meenkuthi tribal settlement area to Anakulam, as isolated trees in the valleys; an endemic tree specie? of southern Kestern Ghats, very rare and endangered in the area.

THEACEAE

29. Gordonia obtusa Wall. ex Wt. et Arn.

Evergreen forests between Anamalai and Manali as undergrowth; an endemic species of Peninsular India, very rare in the area.

GUTTTFERAE

30. Calophyllum austro-indicum Kosterm.

Anamalai to Anakulam, along stream sides; a Peninsular Tnds-Sri Lankan species, very rare in the area.

31. Calophvllum elatum Bedd.

Anamalai to Manali in the evergreen forests bordering streams: an endemic tree of Peninsular India, very rare in the area.

32. Garcinia morella (Gaertn.) Desr.

Stream sides between Meenkuthi and Anakulam; an Indo-Sri Lankan species of very limited occurrence in the area.

33. Hesua ferrea L.

Huge trees in the forests between Meenkuthi and Anakulam; an endemic tree of South India, very rare in the locality.

ELAEOCARPACEAE

34. Elaeocarpus tuberculatus Roxb.

In the open valleys between Meenkuthi and Anakulam; an Inda-Malayan species, rare in the area.

TILIACEAE

35. Grewia tiliifolia Vahl

Deciduous forests between Meenkuthi and Anakulam; fairly common.

STERCULIACEAE

36. Helicteris isora L.

Meenkuthi to Anakulam, in the open areas: common.

BOMBACACEAE.

37. Cullenia exarillata Robyns

Evergreen forests between Anamalai and Manali; Peninsular Indo-Sri lankan species, very rare in the area.

FLACOURTIACEAE

38. Flacourtia indica (Burm.f.) Herr.

In the dry, open areas between Meenkuthi and Anakulam; rare.

PASSIFLORACEAE

39. Passiflora foetida L.

Along the hedges at Meenkuthi, Kanali and Anakulam; fairly common.

ANCISTROCLADACEAE

40. Ancistrocladus heyneanus Wall. ex Grah.

In the moist deciduous forests, as undergrowth: fairly common.

BEGONIACEAE

41. Begonia malabarica Lamk.

Forests between Anamalai and Anakulam; an endemic species cf South India, very common in shaded localities.

TETRAKELACEAE

42. Trameles nudiflora R. Br.

Huge trees in the forests between Meenkuthi and Anakulam; an endemic tree species of South India, fairly common in the area.

SAPOTACEAE

43. Isonandra perrottiana Kt.

In the semievergreen forests of the ghat between Anamalai and Manali; a highly endemic species of southern Peninsular India, very rare in the area.

44. Madhuca longifolia (Koen.) Wacbride var. longifolia

River banks near Anakulas; common.

45. Palaquium ellipticum (Dalz.) Baill.

Manali to Anakulam, ghat forests: an endemic tree of South India, very rare in the area.

SYMPLOCACEAE

46. Symplocos cochinchinensis (Lour.) Moore

In the valley forests from Weenkuthi to Anakulam; a Peninsular Indo-Sri Lankan species, rare in the locality.

47. Symplocos macrocarpa Wt. ex C.B. C1.

Weenkuthi to Anakulam in the valleys; a Peninsular Indian endemic, rare in the area.

48. Symplocos racemosa Roxb.

Towards Anakulam side in the valleys of the ghat: an endemic tree species of the Western Ghats of Peninsular India, very rare in the locality.

CRASSULACEAE

49. Kalanchoe pinnata (Lamk.) Pers.

Along the sides of rocks between Meenkuthi and Anakulam. in shade; fairly common.

MYRSINACEAE

50. Ardisia pauciflora Heyne

Anamalai to Manali, as undergrowth in the evergreen forests: a highly endemic species of the Western Ghats south of Karnataka, very rare and endangered in this locality.

51. Ardisia polanacea Roxh.

Dry forest patches between Manali and Meenkuthi; an endemic species of Peninsular India, very rare and endangered in the area.

52. Maesa indica (Roxb.) DC.

Along hedges bordering the rivulets at Heenkuthi, near the tribal settlements; fairly common.

ROSACEAE

53. Photinia integrifolia Lindl. var. publanceolata Miq.

Meenkuthi, open vallies of the Ghat:, an Indo-Malayan species, very rare in the area.

54. Rubus indicus Thumb.

Meenkuthi, open areas along the hedges: a Peninsular Indo-Sri Lankan species, very rare and endangered in the area.

MIMOSACEAE

55. Mimosa invasia Mart. var. inermis Adelb.

River banks at Meenkuthi, mostly in the soil deposits along river banks: an American weed so far known only from Changanacherry in central Kerala; very rare.

CAESALPINIACEAE

56. Humboldtia vahliana Wt.

River banks between Meenkuthi and Anakulam; a tree species endemic to Western Ghats of South India, fairly common in the area.

PAPILIONACEAE

57. Dalbergia benthamii Prain

Along the rocky sides of the river below the KSEB ware across Idliyar at Anamalai: a species earlier known only from Hongkong and recorded from Central Kerala in 1986, very rare and endangered in the area.

58. Flemingia macrophylla (Willd.) Prain ex Merr.

Between Meenkuthi and Anakulam in the moist deciduous forests; fairly common.

59. Pongamia pinnata (L.) Pierre

Lower portions of the ghat towards Anakulam; fairly common.

PODOSTEMACEAE

60. Willisia selaainoides (Bedd.) Warm. ex Willis

In the flowing waters of the rivers at Anamalai and Manali; a highly endemic species of the Western Ghat rivers, fairly common in the area.

MYRTACEAE

61. Syzygium cumini (L.) Skeels

In the river side forests between Meenkuthi and Anakulam; rare.

62. Syzygium laetum (Ham.) Gandhi

Meenkuthi to Anakulam, in the valleys of the ghat; a highly endemic species of Western Ghats represented by an endangered population in the area.

63. Syzygium mundagam (Bourd.) Chithra

Anamalai dam site in the evergreen forests: a highly endemic tree of the Western Ghats of Kerala and Tamilnadu, very rare and endangered in the area.

64. Syzygium munronii (Wt.) Chandr.

Along the river sides and in the densely forested valleys between Meenkuthi and Anakulam; an endemic tree of Peninsular India, very rare in the locality.

MELASTOMATACEAE

65. Hemecvlon umbellatum Burm.f.

Meenkuthi to Anakulam in the drier parts of the forests; a fairly common Indo-Sri Lankan species in the area.

66. Osbeckia aspera Bl.

Forests between Neenkuthi and Anakulam in the opens: fairly common.

67. Sonerila brunonis Wt. et Arn.

Anamalai to Manali in the evergreen forests along river banks; a rare, Peninsular Indo-Sri Lankan species in area.

68. Sonerila eleaans Kt.

Forests between Manali and Anakulam, along the sides of rocks in shaded areas; a southern Peninsular Indian endemic herb, very rare in the area.

69. Sonerila speciosa Zenk.

Meenkuthi to Anakulam in the moist deciduous forests; herbs, endemic to Western Ghats of Peninsular India, very rare and endangered in this locality.

COWBRETACEAE

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

Drier parts of the forests between Manali and Anakulam; rare.

CORNACEAE

71. Mastixia arborea (Wt.) Bedd.

Anamalai and Manali forests; a species endemic to Western Peninsular India, very rare in the locality.

CELASTRACEAE

72. Bhesa indica (Bedd.) Ding Hou

Semievergreen forest pockets between Meenkuthi and Anakulam; a highly endemic huge tree species, endangered in the locality and represented by 4-6 individuals only.

73. Celastrus paniculata Willd.

Manali to Anakulam in the deciduous forests; rare.

74. Euonymous dichotomus Heyne ex Roxb.

Manali to Anakulam in the drier areas: rare.

75. Microtropis latifolia Wt.

Hanali to Meenkuthi, in the moist deciduous forests: a highly endemic species of the southern Western Ghats from Karnataka southwards, very rare and endangered in the area.

ICACINACEAE

76. Gomphandra coriacea Wt..

Anamalai to Manali in the evergreen forests as an undergrowth: a species confined to southern Western Ghats and Sri Lanka, very rare and endangered in the area.

BUXACEAE

77. Sarcococca pruniformis Lindl.

Heenkuthi, along the fringes of moist deciduous forests: very rare.

78. Agrostistachys indica Dalz.

Valleys between Meenkuthi and Anakulam in moist deciduous forests: a shrub confined to Central and Peninsular India, very rare in the locality.

79. Agrostistachys meeboldii Pax et K. Hoffm.

Manali to Heenkuthi, in the semievergreen forests: a Peninsular Indo-Sri Lankan species, very rare in this locality.,

80. Aporosa acuminata Sw.

Meenkuthi to Anakulam, in the dry deciduous forests; rare.

81. Aporosa lindleyana Wt.

Dry deciduous forests below the Heenkuthi tribal settlements; fairly common.

82. Baccaurea courtallensis (Wt.) Muell.- Arg.

Smievergreen forests between Meenkuthi and Anakulam; a highly endemic species of southern Western Ghats, fairly common in the area.

83. Blachia calycina Benth.

Meenkuthi to Anakulam, in the valleys: rare.

84. Breynia rhamnoides (Retz.) Muell.- Arg.

Anakulam, along the hedges: fairly common.

85. Croton bonplandianum Baill.

Manali tribal settlement area, near cultivated lands: rare.

86. Drypetes oblonnifolia (Bedd.) Airy Shaw

Manali to Meenkuthi in the moist deciduous forests; an endemic species of Peninsular India, very rare and endangered in the area.

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

Evergreen forests between Anamalai and Manali; an endemic species of Peninsular India, very rare and endangered in the locality.

88. Glochidion ellipticum Wt.

Anamalai dam site in the evergreen forests and between Weenkuthi and Anakulam in shaded areas; an endemic species of South India, rare in the area.

89. Homonoia riparia Lour.

Along the sides of fdliyar and in the crevices of rocks in the middle of the river; fairly common.

90. Macaranga peltata (Roxb.) Muell.-Arg.

Valleys between Manali and Meenkuthi and Weenkuthi and Anakulam; rare, in the disturbed forests.

91. Mallotus philippensis (Lamk.) Muel1.-Arg.

In the deciduous forests between Meenkuthi and Anakulam, especially in the valleys near Anakulam; fairly common.

92. Phyllanthus debilis Klein ex Willd.

In the open areas between Wanali and Meenkuthi; rare.

STAPHYLEACEAE

93. Turpinia malabarica Gamble

Along the slopes between Meenkuthi and Anakulam, more towards Anakulam side; an endemic tree species of South India, fairly common in the area.

SAPINDACEAE

94. Dimocarpus lonaan Lour.

Heenkuthi to Anakulam, along the slopes; rare.

95. Lepisanthes tetraphylla (Vahl) Radlk.

Deciduous forests between Meenkuthi and Anakulam; rare.

96. Otonephelium stipulaceum (Bedd.) Radlk.

Slopes of the ghat between Weenkuthi and Anakularn and in the forests around Anakulam; a highly endemic species of South - Vest India, fairly common in the area.

BURSERACEAG

97. Canarium strictum Roxb.

Isolated trees in the moist deciduous forests between Heenkuthi and Anakulam; a very rare South - West Indian endemic in the locality.

ANACARDIACEAE

98. Holigarna arnottiana Hook.f.

Lower Manali area in the degraded semievergreen forests; a tree species endemic to southern Western Ghats, rare in the locality.

99. Holigarna grahamii (Wt.) Kurz

Scattered in the forests between Anamalai and Manali and also along the slopes of the ghat towards Anakulam; a South - West Indian endemic tree species, rather rare in the area.

RUTACEAE

100. Acronychia pedunculata (L.1 Miq.

Semievergreen forests between Meenkuthi and Anakulam; fairly common.

101. Clausena dentata (Willd.) Roem. et Schult.

Forests between Meenkuthi and Anakulam; rare.

102. Toddalia asiatica (L.) Lamk.

Drier areas of the forests between Meenkuthi and Anakulam; fairly common.

MELIACEAE

103. Aglaia elaesnoidea (Juss.) Benth.

Deciduous forests along the slopes between Meenkuthi and Anakulam; rare.

104. Cipadessa baccifera (Roth) Miq.

In the deciduous forests between Meenkuthi and Anakulam; rare.

105. Dysoxylum malabaricum Bedd. ex Hiern

Near Anakulam settlement area: a highly endemic species cf southern Western Ghats, very rare and endangered in the area.

106. Toona ciliata M. Roem.

Semievergreen forests between Anamalai and Manali; very rare.

BALSANINACEAE -

107. Impatiens chinensis L.

Along the sides of rocks in wet, shaded, openings of the evergreen forest; rare.

108. Impatiens cordata Wt.

Anamalai to Hanali in the evergreen forest floor: a highly endemic species of southern Western Ghats, very rare in the area.

109. Impatiens grandis Heyne ex Wall.

In the evergreen forest floor, near path sides between Anamalai and Hanali; a Peninsular Indian endemic balsam, rare in the locality.

110. Impatiens maculata Wt.

Forests between Anamalai and Manali, in small openings; an endemic balsam of South India, very rare in the area.

XANTHOPHYLLACEAE

111. Xanthophvllum flavescens Roxb.

Way to Anakulam from Manali, espescially in the valleys; rare.

UMBELLIFERAE

112. Centella asiatica (L.) Urb.

Along the sides of the rivulet at Meenkuthi; common.

113. Hydrocotyle javanica Thunb.

In shaded, wet areas between Anamalai and Hanali; very common.

POTALIACEAE

114. Fagraea ceilanica Thunb.

Between Heenkuthi and Anakulam, as epiphytic on trees; rare.

115. Strvchnos potatorum L.f.

Meenkuthi to Anakulam in dry, open areas; rare.

APOCYNACEAE

116. Chilocarpus aalabaricus Bedd.

In the valleys between Heenkuthi and Anakulam; a species first described from Kerala in the last century and recorded recently from Karnataka; a highly endemic climber, endangered in the area.

117. Ervatamia divaricata (L.) Burkill

In the valleys between Heenkuthi and Anakulam; rare.

118. Ichnocarpus frutescens (L.) R Br.

Deciduous forest openings between Meenkuthi and Anakulam; fairly common.

BORAGINACEAE

119. Cynoglossum zeylanicum (Vahl ex Hornem.) Thumb. ex Lehm.

Near the proposed dam site at Manali; a Peninsular Indo-Sri Lankan species, very rare in the locality.

EHRETIACEAE

120. Rotula aauatica Lour.

In the flowing water and exposed areas in the rivers, rooted in the rock crevices; fairly common at Anakulam.

121. Aarostemma rostratum Wall.

Forest floor between Anamalai and Manali; a species earlier known from North- East India and recorded from Neriamangalam, Idukki District, Kerala in 1968, very rare and endangered in the area.

122. Anisomeles malabarica (L.) R. Br. ex Sims.

Meenkuthi, open areas near tribal settlements; common.

123. Gomphostemma. keralensis Vivek., Gopal. et Ansari

Forest floor between Anamalai and Manali;. a species recently described from Idukki, very rare and endangered in the area.

124. Leucas aspera (Willd.) Link

Open areas near the tribal settlements at Manali and Meenkuthi; common.

125. Pogostemon paniculatus (Willd.) Benth.

In the open dry areas of Manali and Meenkuthi tribal settlements; fairly common.

OLEACEAE

126. Cbionanthus mala-elengi (Dennst.) P.S. Green

Meenkuthi to Anakulam, in the dry deciduous forests: an endemic tree species of South India, rare in the locality.

127. Jasminum rottlerianum Wall. ex DC.

In the forest streach between Anamalai and Hanali, mostly along hedges and in the openings; an endemic wild jasmine of Peninsular India, rare in the area.

GESNERIACEAE

128. Rhynchotechum permolle (Nees) Burtt

Evergreen forest floor between Anamalai and Hanali; a Peninsular Indo-Sri Lankan species, very rare in the locality.

ACANTHACEAE

129. Andrographis paniculata (Burm.f.) Vahl ex Nees

In the open areas at Manali; rare.

130. Gvmnostachvum latifolium (Dalz.) T. Anders.

Open areas and fringes of forests at Manali and Meenkuthi; an endemic herb of South India, very rare in the locality.

131. Justicia betonica L.

As an undergrowth in the evergreen forests between Anarnalai and Manali: rare.

132. Nilairianthus hevneanus (Nees) Bremek.

Manali, along the fringes of the semievergreen forests ; a South - West Indian endemic herb, very rare in the area.

CAMPANULACEAE

133. Lobelia nicotianaefolia Roth ex Roem. et Schult. var. trichandra (Wt.) C.B.C1.

Outskirts of the 'forests and open areas at Manali; fairly common.

RUBIACEAE

134. Chassalia curviflora (Wall.) Craib var. ophioxyloides (Wall.) Deb et Krishna

Weenkuthi to Anakulam in the deciduous forests, mostly in shade; fairly common.

135. Hedyotis umbellata (L.) Lamk.

Open areas at Wanali and Weenkuthi, mostly in wet localities: fairly common.

136. Ixora arborea Roxb. ex J. E. Smith

Valleys with semievergreen forests in the Anarnalai - Manali region: rare.

137. Ixora nigricans R. Br. ex Wt. et Arn.

In the valleys between Meenkuthi and Anakulam; fairly common.

138. Ophiorrhiza eriantha B1.

Anamalai - Manali region, as undergrowth in evergreen forests; fairly common.

139. Ophiorrhiza mungos L.

In shaded areas between Meenkuthi and Anakulam; fairly common.

140. Pavetta calophylla Bremek.

Undergrowth in the evergreen forests of Anamalai; a rare, endemic shrub of Peninsular India, endangered in this locality.

141. Psvchotria anamallavana Bedd.

Evergreen forests and tribal cardamom cultivation areas near Manali; a highly endemic species of southern Vestern Ghats, very rare and endangered in the area.

142. Psvchotria barberi Gamble

Evergreen forests at Anamalai in shaded, humid areas; a highly endemic shrub of southern Vestern Ghats represented by an endangered population of 5-10 plants in the area.

143. Psvchotria dalzellii Hook.f.

Valley forests near Anakulam, as undergrowth in shaded localities; a highly endemic species of southern Western Ghats, endangered in the area.

144. Randia dumetorum (Retz.) Poir.

In the deciduous forests between Meenkuthi and Anakulam; rare.

145. Wendlandia bicuspidata Wt. et Arn.

Open areas at Weenkuthi, along the hedges and near bushy patches in open areas: fairly common.

COMPOSITAE

146. Blainvillea acmella (L.) Philipson

In shaded and wet areas near Manali; fairly common.

147. Blumea lacera (Burm.f.) DC.

Along the sides of the forest path between Anamalai and Manali; common.

148. Blumea mollis (D. Don) Merr.

Forests near Manali, in shade: rare.

149. Crassocephalum crepidioides (Benth.) S. Moore

Shaded, wet localities between Anamalai and Manali, in semievergreen forests: a weed, rare in the area.

150. Erigeron karvinskianus DC.

In shaded areas of the forest between Heenkuthi and Anakulam; rare.

151. Gynura lycoperscifolia DC.

In the forest floor near Meenkuthi; rare.

152. Mikania micrantha H.B.K.

In the open areas along hedges and in the outskirts of forests adjacent to Meenkuthi and Manali tribal settlements: common.

153. Tridax procumbens.L.

Open areas at Meenkuthi and Manali; common.

154. Vernonia arborea Buch.- Ham-.

Along the fringes of the forests at Meenkuthi and in the open areas towards Anakulam: the endemic tree composit of South India, fairly common in the area.

M O N O C O T Y L E D O N S

COMMELINACEAE

155. Amischophacelus axillaris (L.) Rolla Rao et Kamrnathy

Forests around Manali tribal settlements; fairly common.

POACEAE

156. Centothecca latifolia (Osb.) Trim.

Anamalai to Manali, in the evergreen forests as undergrowth; rare.

BAHBUSACEAE

157. Ochlandra travancorica Benth. ex Gamble

Heenkuthi to Anakulam, as extensive patches: very common.

MUSACEAE

158. Fnsete Superbum (Roxb.) Cheesm.

Evergreen forests along the sides of deeply shaded ravines; a highly endemic species of South India, very rare and endangered in the area.

MARANTACEAE

159. Schumannianthus virgatus (Roxb.) Rolfe

Outskirts of the forests at Hanali; a Peninsular Indo-Sri Lankan species, fairly common here.

ZINGIBERACEAE

160. Alpinia malaccensis (Burm.f.) Rosc.

Forests of Anamalai - Manali region, in shade; fairly common.

161. Amomum cannnicarpum (Wt.) Benth. ex Baker

Anamalai and Hanali forests as an undergrowth; a South - West Indian endemic, fairly common in the area.

162. Elettaria cardamomum (L.) Manton

Common in cultivation by tribals and occasionally running wild in the evergreen forests near Manali; common.

PALHAE

163. Calamus thwaitesii Becc.

In the watersheds of Anamalai and Manali region: a South - West Indian endemic species of cane, rare in the area.

HYPOXIDACEAE

164. Curculimo orchioides Gaertn.

Forest floor between Weenkuthi and Anakulam, in open, dry areas; fairly common.

AGAVACEAE

165. bracaena terniflora Roxb.

Meenkuthi forests, in shaded areas: fairly common.

DIOSCOREACEAE

166. Dioscorea oppositifolia L.

Forests near Anakulam from Meenkuthi side, mostly in the openings: rare.

PANDANACEAE

167. Pandanus fascicularis Lamk.

In the watersheds between Anamalai and Manali; fairly common along the deeply shaded sides of the ravines.

LILIACEAE

168. Chlorophytum laxum R. Br.

In the open areas at Manali; fairly common.

ORCHIDACEAE

169. Cleisostoma ternerum Hook.f.

Forests towards Anakulam side from Meenkuthi: a highly endemic orchid of Southern India, rare in the locality.

170. Dendrobium macrostachvum Lindl.

Epiphytic on trees between Meenkuthi and Anakulam; rare.

171. Sirhookera latifolia (Wt.) O. Ktze.

Epiphytic on the stream-side trees between Heenkuthi and Anakulam; a highly endemic orchid, very rare in this locality but fairly common in the submergible and catchment areas of the proposed Pindimedu dam.

B. ENDEMISM AND AFFINITIES OF THE FLORA

Phytogeographical analysis of the flora of Pindimedu and Anamala - Manali regions of the project area was done during this study to assess the percentage of endemism and to get details on the affinities of the flora. During this analysis, species recorded from the project area were classified into the following categories depending on their world distribution pattern (Table 4.1).

1. Species endemic to Peninsular India.
2. Species of Peninsular Indian and Sri Lankan range.
3. Indian elelments (excluding Peninsular Indian endemics).
4. Indo - Malayan elements.
5. Pluri-regional species.

The following paragraphs deal with the above mentioned phytogeographical groups of plants in the Pindimedu and Anamalai-Manali regions separately, with notes on the significance of each of the group from the point of view of endemism and affinities of the floras of the two regions.

PINDIMEDU REGION

As mentioned earlier, the submergible and catchment areas of the proposed Pindimedu dam and the Pinavur power house area come under this region. Phytogeographically, out of the 340 taxa of flowering plants recorded from this region, 33.89 of the floristic elements are those endemic to Peninsular India and the remaining 66.2% taxa are of more wider ranges belonging to categories like Peninsular-Indo Sri

Lankan, Indian, Indo - Malayan and species of transcontinental or more wider ranges. Details of each of the phytogeographical group of plants in this part of the project area are as follows.

Species endemic to Peninsular India

In the flora of Pindimedu region, 115 taxa of flowering plants belonging tc 47 families confined to Peninsular India. This comes to more than 33.85. of the total number of floristic elements in this area. Most of the Peninsular Indian endemics in the flora here are species confined to the Western Ghats, which abode about 60% of the Peninsular Indian endeeics (Chatterjee, **1939**). Such a high degree of endemism noted for the region suggests that evolution must be very active here also as is the case with many other areas in the Western Ghats (Rao, **1978**).

As mentioned earlier, endemics in the flora of Pindimedu region belong to 47 families, the dominant ones among them being Rubiaceae **(9** sp.), Lauraceae **(7 sp.)**, Fabaceae s.1. **(8 sp.)** and Orchidaceae (7 sp.). Following are the families that contain South Indian endemics in the region with their species content given in parenthesis. Lauraceae (7), Gesneriaceae **(1)** Meliaceae (2), Ancistrocladaceae **(1)**, Commelinaceae (1), Moraceae **(1)**, Chrysobalanaceae **(1)**, Euphorbiaceae (6), Begoniaceae (2), Orchidaceae (7), Palmae **(1)**, Verbenaceae (2), Guttiferae (3), Burseraceae **(1)**, Apocynaceae **(1)**, Oleaceae (3), Zingiberacese (1), Connaraceae **(1)**, Bombacaceae **(1)**, Fabaceae **s.1.** (8), Ebenaceae (1), Dipterocarpaceae **(6)**, Musaceae **(1)**, Labiatae **(1)**, Icacinaceae (1), Annonaceae (4), Acanthaceae (3), Tiliaceae (2), Anacardiaceae **(4)**, Flacourtiaceae **(2)**, Balsaminaceae (3), Sapotaceae

(2), Celastraceae (1), Cornaceae (2), Myristicaceae (3), Melastomataceae (6), Rubiaceae (9), Bambusaceae (1), Sapindaceae (1), Symplocaceae (2), Myrtaceae (3), Combretaceae (1), Tetramelaceae (1), Rutaceae (1), Staphyleaceae (1), Compositae (1) and Podostemaceae (1). Some of the Peninsular Indian endemic tree species in the area are Actinodaphne bourdillonii Garble, Aglaia barberi Gamble, Atuna travancorica (Bedd.) Kosterr., Baccaurea courtallensis (Wt.) Muell.-Arg., Calophyllum apetalum Willd., Canarium strictum Roxb., Cinnamomum riparium Gamble, Cullenia exarillata Rcbyns, Dalbergia sissoides Grah. ex Wt. et Arn., Diospyros candolleana Ut., Dipterocarpus indicus Bedd., Dysoxylum malabaricum Bedd. ex Hiern, Garcinia wightii T. Anders., Gymnacranthera canarica (King) Warb., Hopea glabra Wt. et Arn., Humboldtia brunonis Wall., Knema attenuata (Hook.f. et Thoms.) Varb., Palaquium ellipticum (Dalz.) Baill., Syzygium mundagam (Bourd.) Chithra, Turpinia malabarica Gamble, Vateria indica L. and so on. Genus Psychotria (Rubiaceae) with six Peninsular Indian endemics in the region is one that is maximum represented here with regard to Peninsular Indian endemics, followed by Cinnamomum (4 sp.), Actinodaphne (3 sp.), Memecylon (3 sp.), Sonerila (3 sp.) and Syzygium (3 sp.).

Within the group of Peninsular Indian endemics which comes to 115 taxa in the area, 65 are confined to the southern parts of the Western Ghats, namely Karnataka southwards and the remaining 50 taxa are distributed almost throughout the Western Ghats. This further elucidates that flora of the region with more of those highly endemic species of southern Western Ghats than Peninsular Indian endemics is much important from a conservation point of view. Species like Aglaia

barberi Gamble, Gymnacranthera canarica (King) Warb., Cinnamomum macrocarpum Hook.f., Bulbophyllum neilgherrense Wt., Vateria indica L., Begonia albo-coccinea Hook., Actinodaphne bourdillonii Gamble, Humboldtia brunonis Wall., Atuna travancorica (Bedd.) Kosterm., Ormosia travancorica Bedd., Svzygium laetum (Ham.) Gandhi, S. mundagam (Bourd.) Chithra, Nothopegia beddomei Gamble, N. travancorica (Bedd.) Hook.f., Grewia gamblei J.R. Drumm., Dysoxylum malabaricum Bedd. ex Hiern., Miliusa tomentosa (Roxb.) Sinclair, Chilocarpus malabaricus Bedd., Gomphostemma keralensis Vivek., Gopal. et Ansari, Goniothalamus wightii Hook.f. et Thomas., Hopea glabra Wt. et Arn., Cleisostoma teneruv Hook.f., etc. are some of the rare or endangered, highly endemic taxa in the area.

Peninsular Indc-Sri Lankan species

This group of plants with limited distribution in Peninsular India and Sri Lanka is yet another notable group. It comes to 47 taxa (13.8%) belonging to the following 29 families: Euphorbiaceae (7 sp.), Oxalidaceae (1 sp.), Orchidaceae (3 sp.), Guttiferae (3 sp.) Rubiaceae (4 sp.), Connaraceae (1 sp.), Borauinaceae (1 sp.), Dioscoreaceae (1 sp.), Ebenaceae (1 sp.), Zinaiberaceae (1 sp.), Celastraceae (1 sp.), Moraceae (2 sp.), Icacinaceae (1 sp.), Myrtaceae (1 sp.), Myristicaceae (1 sp.), Melastomataceae (3 sp.), Fabaceae s.1. (1 sp.), Urticaceae (1 sp.), Podostemaceae (1 sp.), Verbenaceae (1 sp.), Gesneriaceae (2 sp.), Rosaceae (1 sp.), Sterculiaceae (2 sp.), Chloranthaceae (1 sp.), Marantaceae (1 sp.), Santalaceae (1 sp.), Symlocaceae (1 sp.), Aristolochiaceae (1 sp.) and Annonaceae (lsp.). As may be noted, the maximum represented families of

Peninsular Indo - Sri Lankan species in the area are Euphorbiaceae (7 sp.), Rubiaceae (4 sp.), Orchidaceae (3 sp.) and Guttiferae (3 sp.), with the genera Aporosa (2 sp.), Ficus (2 sp.) Garcinia (2 sp.) and Osbeckia (2 sp.) represented by 2 to 3 species in this range. Further, genera like Agrostistachys, Antidesma, Biophytum, Calophvllum, Chassalia, Connarus, Cynoalossum, Dendrobium, Dioscorea, Diospyros, Eletteria. Euonymous, Gomphandra, Ixora, Macaranaa, Myristica, Pellionia, Pterocarpus, Podochilus, Polypleurum, Premna, Psychotria, Pterospermum, Rhynchoalossum, Rhynchotechum, Rubus, Sarcandra, Schumannianthus, Scleropyrum, Sonerila, Sterculia , Symplocos, Syzygium, Terminalia, Thottea, Uvaria and Wendlandia in this region contain only one species each confined to the Peninsular Indo-Sri Lankan range. As in the case of any other part of Peninsular India (Razi, 1954) and especially the Western Ghats (Arora, 1954; Subramanyam and Nayar, 1974), Peninsular Indo-Sri Lankan species is a remarkable group of plants in the Pindimedu region also, showing affinity of the two floras.

Plants of Indian region

A total of about 39 species in the flora in Pindimedu area are plants of Indian region which accounts for about 11.58 cf the total number of species in the flora. This group of plants in the region are represented by species like Acacia torta (Roxb.) Craib, Aclisia secundiflora (81.) Bakh.f., Agrostemma rostratum Wall., Butea parviflora Roxb., Careva arborea Roxb., Dendrobium herbaceum Lindl., Glochidion zeylanicum (Gaertn.) Juss., Ixora arborea Roxb. ex J.E. Sm., Lepisanthes tetraphylla (Vahl) Radlk., Leptonychia caudata (Wall. ex G. Don) Burett, Luisia zeylanica Lindl., Melastoma malabathricum

(C.B.Cl.) Cogn. Naravelia zeylanica (L.) A. DC., Scurrula cordifolia (Wall.) G. Don, Vanda tessellata (Roxb.) Hook. ex G. Don, Xylia xylocarpa (Roxb.) Taub., etc. As noted from the distribution pattern of the Indian elements in the Pindimedu flora, they are mostly species common to Western Ghats of Peninsular India and hills of North-East India or the foot of Himalayas confirming what Blasco (1971) had remarked on the distribution of the South Indian orophytes.

Indo-Malayan elements

Satpura hypothesis (Hora, 1962) had already illustrated the affinity of Peninsular Indian flora and fauna with that of Malaya, and Western Ghats is identified as the western limit of this phytogeographical range. Distribution pattern of the floristic elements of Pindimedu region also supports this theory and apart from the Peninsular Indian endemics and 'wides' that are less characteristic to any flora, Indc-Malayan plants represent the maximum in this region. In total, 54 taxa in the flora belong to this group which is about 15.9% of the total number of floristic elements known from there. Representative families of this group of plants in the flora are Rutaceae (2 sp.) , Fabaceae s.l. (4 sp.), Zingiberaceae (1 sp.), Apocynaceae (1 sp.), Labiatae (1 sp.), Euphorbiaceae (1 sp.), Urticaceae (2 sp.), Bombacaceae (1 sp.), Poaceae (2 sp.), Vitaceae (2 sp.), Commelinaceae (1 sp.), Costaceae (1 sp.), Hypoxidaceae (1 sp.), Dichapetalaceae (1 sp.), Dioscoreaceae (1 sp.), Ebenaceae (1 sp.), Xanthophyllaceae (1 sp.) , Loranthaceae (1 sp.) , Sapotaceae (1 sp.) , Agavaceae (1 sp.), Verbenaceae (4 sp.), Scrophulariaceae (1 sp.), Myrtaceae (1 sp.), Meliaceae (2 sp.), Elaeocarpaceae (3 sp.),

potaliaceae (1 sp.), Moraceae (2 sp.), Flacourtiaceae (1 sp.), Rubiaceae (3 sp.), Lythraceae (1 sp.), Campanulaceae (1 sp.), Guttiferae (1 sp.), Orchidaceae (1 sp.), Sapindaceae (1 sp.), Smilacaceae (1 sp.), Araceae (1 sp.), Malvaceae (1 sp.) and Menispermaceae (1 sp.). Elaeocarpus with three Indo-Malayan species is the maximum represented genus of this group of plants in the region with Boehmeria and Ficus containing twc Indc-Malayan elements each. Eventhough in certain pockets of the Western Ghats like Courtallum (Thirunelveli, Tamil Nadu), Peninsular Indo-Sri Lankan species are more than the Indo-Malayan elesents (Mair, 1982), flora cf Pindimedu region is the abode for more Malayan elements thsn Peninsular Indo-Sri Lankan plants, as shown by this study.

P1uri-regiona1 speciee

85 species representing almost 25% of the flora of the region are plants of more wider distibution like Indo-African, pantropical or cosmopolitan. Such species often designated as 'wides' are noted to belong to the families like Fabaceae s.l. (12 sp.), Cornpositae (8 sp.), Pcaceae (6 sp.), Cyperaceae (4 sp.), Euphorbiaceae (5 sp.), Urticaceae (2 sp.), Moraceae (3 sp.), Umbelliferae (2 sp.), Guttiferae (1 sp.), Amaranthaceae (1 sp.), Dilleniaceae (1 sp.), Sacindaceae (1 sp.), Sterculiaceae (1 sp.), Labiatae (1 sp.), Balsaminaceae (1 sp.), Commelinaceae (2 sp.), Loranthaceae (2 sp.), Apocynaceae (2 sp.), Anacardiaceae (3 sp.), Piperaceae (2 sp.), Araceae (2sp.), Solanaceae (2 sp.), Lythraceae (2 sp.), Nyctaginaceae (1 sp.), Ulmaceae (1 sp.), Acanthaceae (1 sp.), Crassulaceae (1 sp.),

Verbenaceae (1 sp.), Leeaceae (1 sp.), Pontederiaceae (1 sp.), Menispermaceae (I sp.), Vitaceae (1 sp.) Meliosmaceae (1 sp.), Passifloraceae (1 sp.), Polygonaceae (1 sp.), Rubiaceae (1 sp.), Araliaceae (lsp.) , Scrophulariaceae (1 sp;), Malvaceae (1 sp.), Loganiaceae (lsp.), and Mvrtaceae (1 sp.) As is common with any other part of Peninsular India, a maximum number of pluri-regional species of Pindimedu region also belong to the families Compositae, Fabaceae. Poaceae and Cyperaceae. Notably, the Compositae plant Mikania micrantha H.B.K. has become a highly noxious weed in the whole of the area, which had suppressed reed regeneration and checked the growth of ground flora to the maximum. extent. There are also several instances where even arborescent species got covered up by this weed posing threat to their survival' and growth.

Table No. 4.1. Alphabetical list of species In the Pindimedu region giving their world distribution pattern.

Species	Distribution				
	I	II*	III*	IV*	V*
Abrus precatorius L.	-	-	-	-	+
Acacia torta (Roxb.) Craib	-	-	+	-	-
Aclisia secundiflora (B1.) Bakh.f.	-	-	+	-	-
Acronychia pedunculata (L.) Miq.	-	-	-	+	-
Actinodaphnae bourdillonii Gamble	+	-	-	-	-
Actinodaphne madaraspatana Bedd.ex Hook.f.	+	-	-	-	-
Actinodaphne malabarica Balakr.	+	-	-	-	-
Aeschynanthus perrottetii A. DC.	+	-	-	-	-
Aglaia barberi Gamble	+	-	-	-	-
Agrostemma rostratum Wall.	-	-	+	-	-
Agrostistachys indica Dalz.	+	-	-	-	-
Agrostistachys meeboldii Pax et Hoffm.	-	+	-	-	-
Albizia amara (Roxb.)Boiv.ssp. amara Brenan	-	-	-	-	+
Albizia lebbeck (L.) Willd.	-	-	-	-	+
Albizia odoratissima (L.f.) Benth.	-	-	-	+	-
Alpinia malaccensis (Burm.f.) Roxb.	-	-	-	+	-
Alstonia scholaris (L.) R.Br.	-	-	-	+	-
Ammania baccifera L.	-	-	-	-	+
Amomum cannicarpum (Wt.) Benth.	+	-	-	-	-
Ancistrocladus heyneanus Wall. ex Grah.	+	-	-	-	-

* I. Peninsular Indian, II. Peninsular Indo-Sri Lankan, III. Indian, IV. Indo-Malayan, V. Transcontinental or cosmopolitan.

Aneilema ovalifollum(Wt.) Hook.f. ex C.B.Cl.	+	–	-	-	-
Anlsomeles malabarica **(L.)** R.Br. ex **Sims.**	-	-	-	+	-
Antldesma bunius **(L.)** Spreng.	-	-	-	+	-
Antldesma menasu **Miq.** ex Tul.	-	+	-	-	-
Aphanamixis polystachya (Wall.) Parker	-	-	-	+	-
Aporosa acuminata Thw.	-	+	-	-	-
Aporosa lindleyana (Wt.) Baill.	-	+	-	-	-
Artocarpus hirsutus Lamk.	+	-	-	-	-
Artocarpus heterophyllus Lamk.	-	-	-	-	+
Atuna travancorica (Bedd.) **Kosterm.**	+	-	-	-	-
Baccaurea courtallensis (Wt.) Muel 1.– Arg.	+	-	-	-	-
Bambusa arundinacea (Retz.) Roxb.	-	-	+	-	-
Bauhinia purpurea L.	-	-	-	-	+
Bauhinia racemosa Lamk.	-	-	-	-	+
Begonia albo– coccinea **Hook.**	+	-	-	-	-
Begonia malabarica Lamk.	+	-	-	-	-
Biophytum sensitivum (L.) DC.	-	+	-	-	-
Blachia calycina Benth.	-	+	-	-	-
Blainvillea acmella **(L.)** Philipson	-	-	-	-	+
Blumea lacera (Burm.f.) DC.	-	-	-	-	+
Boehmeria glomerulifera Miq.	-	-	-	+	-
Boehmeria malabarica Wedd.	-	-	-	+	-
Boerhavia diffusa L.	-	-	-	-	+
Bombax ceiba L.	-	-	-	+	-
Breynia rhamnoides (Retz.) Muel 1.– Arg.	-	-	-	-	+
Bridelia scandens (Roxb.) Willd.	+	-	-	-	-
Bulbophyllum fimbriatum (Lindl.) Reich.f.	+	-	-	-	-

Bulbophyllum fischeri Seidenfaden	-	+	-	-	-
Bulbophyllum neilgherrense Wt.	+	-	-	-	-
Bulbostylis barbata (Rottb.) C.B.Cl.	-	-	-	-	+
Butea parviflora Roxb.	-	-	+	-	-
Calamus thwaitesii Becc.	+	-	-	-	-
Callicarpa tomentosa (L.) Murr.	+	-	-	-	-
Calophyllum apetalum Willd.	+	-	-	-	-
Calophyllum austroindicum Kosterm.	-	+	-	-	-
Calophyllum elatum Bedd.	+	-	-	-	-
Calophyllum inophyllum L.	-	-	-	-	+
Canarium strictum Roxb.	+	-	-	-	-
Careya arborea Roxb.	-	-	+	-	-
Casearia esculenta Roxb.	+	-	-	-	-
Cassia fistula L.	-	-	-	-	+
Cassia occidentalis L.	-	-	-	-	+
Centella asiatica (L.) Urb.	-	-	-	-	+
Centotheca latifolia (Osbeck.) Trim.	-	-	-	-	+
Chassaliacurviflora (Wall.) Craib ophioxyloides(Wall.)Deb et Krishna	-	+	-	-	-
Chilocarpus malabaricus Bedd.	+	-	-	-	-
Chionanthus mala-elengi(Dennst.) P.S.Green	+	-	-	-	-
Chloris barbata Sw.	-	-	-	+	-
Chromolaena odorata (L.) King et Robinson	-	-	-	-	+
Cinnamomum macrocarpum Hook.f.	+	-	-	-	-
Cinnamomum malabatrum (Burm.f.) Bl.	+	-	-	-	-
Cinnamomum riparium Gamble	+	-	-	-	-
Cinnamomum sulphuratum Nees	+	-	-	-	-
Cissampelos parieria L.	-	-	-	-	+

Cissus quadrangularis L.	-	-	-	-	+
Cissus repens Lamk.	-	-	-	+	-
Cleisostoma tenerum Hook.f.	+	-	-	-	-
Cleome viscosa L.	-	-	+	-	-
Clerodendrum viscosum Vent.	-	-	-	+	-
Coix lacryrna-jobi L.	-	-	-	-	+
Commelina benghalensis L.	-	-	-	-	+
Commelina diffusa Burm.f.	-	-	-	-	+
Commelina paludosa Bl.	-	-	-	+	-
Connarus monocarpus L.	-	+	-	-	-
Connarus wightii Hook.f.	+	-	-	-	-
Costus speciosus (Koenig) Smith	-	-	-	+	-
Crotalaria juncea L.	-	-	-	+	-
Cullenia exarillata Robyns	+	-	-	-	-
Curcu 1igo orchioides Caertn.	-	-	-	+	-
Cyathula prostrata (L) Bl.	-	-	-	-	+
Cymbopogon caesius (Hook.et Arn.) Stapf	-	-	-	-	+
Cynodon dactylon (L.) Pers.	-	-	-	-	+
Cynoglossum zeylanicum (Hammem.) Lehlm.	-	+	-	-	-
Cyperus exaltatus Retz.	-	-	-	-	+
Cyperus tenuispica Steud.	-	-	-	-	+
Dalbergia benthamii Prain	+	-	-	-	-
Dalbergia horrida (Dennst.) Mabb.	+	-	-	-	-
Dalbergia latifolia Roxb.	-	-	-	+	-
Dalbergia sissoides Grah. ex Wt.et Arn.	+	-	-	-	-
Dalbergia volubil is Roxb.	-	-	-	+	-
Dendrobium barbatulum Lindl.	+	-	-	-	-

Dcndrobium hcrbaceum Llndl.	-	-	+	-	-
Dendrobium macrostachyum Llndl.	-	+	-	-	-
Dendrobium ovatum (Wi 1Id.) Kranz.	+	-	-	-	-
Dendrophthoe falcata (L.f.) Etting	-	-	-	-	+
Desmodium herbaceurn Lindl.	-	-	-	+	-
Desmodium heterophyllum (Wil ld.) DC.	-	-	-	-	+
Desmodium triangulare (Retz.) Merr.	-	-	-	-	+
Dichapetalum gelonoides (Roxb.) Engler	-	-	-	+	-
Digitaria ciliaris (Retz.) Koen.	-	-	-	-	+
Dil lenia pentagyna Roxb.	-	-	-	-	+
Dimocarpus longan Lour.	-	-	-	-	+
Dioscorea oppositifolia L.	-	+	-	-	-
Dioscorea pentaphyll a L.	-	-	-	+	-
Diospyros buxifolia (Bl.) Hiern	-	-	-	+	-
Diospyroscandolleana Yt.	+	-	-	-	-
Diospyros ovalifolia Wt.	-	+	-	-	-
Diploclisia glaucacens (B1.) Diels	-	-	-	+	-
Dipterocarpus bourdillonii Brandis	+	-	-	-	-
Dipterocarpus indicus Bedd.	+	-	-	-	-
Dracaena terniflora Roxb.	-	-	-	+	-
Drypetes oblongifolia (Bedd.) Airy Shaw	+	-	-	-	-
Dysoxylum malabaricum Bedd. ex Hiern	+	-	-	-	-
Elaeocarpus serratus L.	-	-	-	+	-
E1aeocarpus tectorius (Lour.) Perr.	-	-	-	+	-
Elaeocarpus tuberculatus Roxb.	-	-	-	+	-
Elatostema lineolatum Wt.	-	-	+	-	-
Elephantopus scaber L.	-	-	-	-	+
Elettaria cardamomum (L.) Hanton	-	+	-	-	-

Emblica officinalis Caertn.	-	-	-	-	+
Emilia sonchifolia (L.) DC.	-	-	-	-	+
Ensete superbum (Roxb.) Cheesm.	+	-	-	-	-
Epiprinus mallotiformis (Muell.-Arg.)Croiz.	+	-	-	-	-
Eragrostis uniloides (Retz.) Nees ex Steud.	-	-	-	+	-
Eriocaulon quinquangulare L.	-	-	+	-	-
Ervatamia divaricata (L.) Burkill	-	-	-	-	+
Erythrina stricta Roxb.	+	-	-	-	-
Euonymous dichotomus Heyne ex Roxb.	-	+	-	-	-
Fagraea ceilanica Thumb.	-	-	-	+	-
Ficus arnottiana (Miq.) Miq.	-	+	-	-	-
Ficus benghalensis L.	-	-	+	-	-
Ficus hispida L.f.	-	-	-	+	-
Ficus religiosa L.	-	-	-	-	+
Ficus talbotii King	-	-	-	+	-
Ficus tinctoria Forst.f.	-	-	-	-	+
Ficus travancorica King	+	-	-	-	-
Ficus tsjahela Burm.f.	-	+	-	-	-
Fimbristylis dichotoma (L.) Vahl	-	-	-	-	+
Flacourtia indica (Burm.f.) Merr.	-	-	-	+	-
Garcinia gummi-guttata (L.) Robs.	-	+	-	-	-
Garcinia morella (Gaertn.) Desr.	-	+	-	-	-
Garcinia wightii T. And.	+	-	-	-	-
Clochidion ellipticum Wt.	+	-	-	-	-
Clochidion zeylanicum (Gaertn.) Juss.	-	-	+	-	-
Clycosmis arborea (Roxb.) DC.	-	-	+	-	-
Gmelina arborea Roxb.	-	-	-	+	-

Gomphandra coriacea Wt.	+	-	-	-	-
Gomphandra tetrandra (Wall. ex Roxb.)Sleum.	-	+	-	-	-
Gomphostemma keralensis Vivek., Gopal. et Ansari	+	-	-	-	-
Goniothalamus wightii Hook.f. et Thoms.	+	-	-	-	-
Grewia emarginata Buch.- Ham.	+	-	-	-	-
Crewia gamblei J.R. Drum.	+	-	-	-	-
Cymnacranthera canarica (King) Warb.	+	-	-	-	-
Gymnostachyum febrifugum Benth.	+	-	-	-	-
Cymnostachyum latifolium (Dalz.) T.And.	+	-	-	-	-
Helicteris isora L.	-	-	-	-	+
Holigarna arnottiana Hook.f.	+	-	-	-	-
Holigarna grahamii (Wt.) Kurz	+	-	-	-	-
Homonoia riparia Lour.	-	-	-	-	+
Hopea glabra Ut. et Arn.	+	-	-	-	-
'Hopea parviflora Bedd.	+	-	-	-	-
Humboldtia brunonis Wall.	+	-	-	-	-
Humboldtia vahliana Wt.	+	-	-	-	-
Hydnocarpus alpina Ut.	+	-	-	-	-
Hydnocarpus pentandrus (Ham.) Oken	+	-	-	-	-
Hydrocotyle javanica Thumb.	-	-	-	-	+
Hyptis suaveoleus (L.) Poit.	-	-	-	-	+
Ichnocarpus frutescens (L.) R. Br.	-	-	-	-	+
Impatiens chinensis L.	-	-	-	-	+
Impatiens cordata Wt.	+	-	-	-	-
Impatiens maculata Wt.	+	-	-	-	-
Impatiens scapiflora Heyne ex Roab.	+	-	-	-	-
Isonandra perrottiana Wt.	+	-	-	-	-

Ixora arborea Roxb. ex J.E. Sm.	-	-	+	-	-
Ixora nigricans R.Br.	-	-	-	+	-
Ixora pavetta Andrews	-	+	-	-	-
Jasminum malabaricum Wt.	+	-	-	-	-
Jasminum rottlerianum Wall. ex DC.	+	-	-	-	-
Justicia betonica L.	-	-	-	-	+
Justicia wynaadensis (Nees) T. And.	+	-	-	-	-
Kalanchoe pinnata (Lamk.) Pers.	-	-	-	-	+
Kirganelia reticulata (Poir.) Baill.	-	-	-	-	+
Knema attenuata (Hook.f. et Thoms.) Warb.	+	-	-	-	-
Lagerstroemia microcarpa Wt.	-	-	-	+	-
Lagerstroemia reginae Roxb.	-	-	-	-	+
Lannea coromandelica (Houtt.) Merr.	-	-	-	-	+
Lantana camara L. var. aculeata Mold.	-	-	-	-	+
Laportea interrupta (L.) Chew.	-	-	-	-	+
Leea indica (Burm.f.) Merr.	-	-	-	-	+
Lepisanthes tetraphylla (Vahl) Radlk.	-	-	+	-	-
Leptonychia caudata (Wall. ex C. Don) Burrett	-	-	+	-	-
Litsea accendentoides K. et V.	-	-	+	-	-
Lobelia nicotianefolia Roem. & Schult. var.trichandra (Wt.) C.B.Cl.	-	-	-	+	-
Lophopetalum wightianum Arn.	+	-	-	-	-
Luisia zeylanica Lindl.	-	-	+	-	-
Macaranga peltata (Roxb.) Muell.-Arg.	-	+	-	-	-
Madhuca longifolia (Koen.) Macbride	-	-	+	-	-
Madhuca longifolia var.latifolia (Roxb.) Cheval.	-	-	+	-	-
Mallotus philippensis (Lamk.) Muell.-Arg.	-	-	-	-	+

Mangifera indica L.	-	-	-	-	+
Mastixia arborea (Wt.) Bedd.	+	-	-	-	-
Mastixia arborea (Wt.) Bedd.var. meziana (Wang.) Matthew	+	-	-	-	-
Melastoma malabathricum L.	-	-	+	-	-
Meliosma simplicifolia (Roxb.) Walp.	-	-	-	-	+
Memecylon heyneanum Benth.	+	-	-	-	-
Memecylon malabaricum (C.B.Cl.) Cogn.	+	-	-	-	-
Memecylon umbellatum Burm.f.	+	-	-	-	-
Mesua ferrea L.	-	-	-	+	-
Mikania micrantha H.B.K.	-	-	-	-	+
Hiliusa eriocarpa Dunn.	+	-	-	-	-
Miliusa tomentosa (Roxb.) Sinclair	+	-	-	-	-
Mimosa pudica L.	-	-	-	-	+
Molineria trichocarpa (Wt.) Balakr.	-	-	+	-	-
Monochoria vaginalis (Burm.f.) Persl.	-	-	-	-	+
Mussaenda laxa (Hook.f.) Hutch. et Gamble	+	-	-	-	-
Myristica dactyloides Gaertn.	-	+	-	-	-
Myristica malabarica Lamk.	+	-	-	-	-
Naravelia zeylanica (L.) A.DC.	-	-	+	-	-
Nothopegia beddomei Gamble	+	-	-	-	-
Nothopegia travancorica Bedd. ex Hook.f.	+	-	-	-	-
Ochlandra travancorica Benth. ex Gamble	+	-	-	-	-
Olea dioica Roxb.	-	-	+	-	-
Ophiorrhiza eriantha Wt.	+	-	-	-	-
Ophiorrhiza mungos L.	-	-	-	+	-
Ormosia travancorica Bedd.	+	-	-	-	-
Osbeckia aspera Bl.	-	+	-	-	-

Osbeckia zeylanica L.f.	-	+	-	-	-
Otonephelium stipulaceum (Bedd.) Radlk.	+	-	-	-	-
Palaquium ellipticum (Dalz.) Baill.	+	-	-	-	-
Panicum repens L.	-	-	-	-	+
Passiflora foetida L.	-	-	-	-	+
Pavetta zeylanica Gamble	+	-	-	-	-
Pellionia heyneana Wedd.	-	+	-	-	-
Peperomia dindigulensis Miq.	-	-	+	-	-
Pholidota pallida Lindl.	-	-	-	+	-
Piper nigrum L.	-	-	-	-	+
Podochilus malabaricus Wt.	-	+	-	-	-
Pogostemon paniculatus (Willd.) Benth.	-	-	+	-	-
Polyalthia fragrans (Dalz.) Bedd.	+	-	-	-	-
Polygonum barbatum L.	-	-	-	-	+
Polygonum chinense L.	-	-	+	-	-
Polypleurum stylosum (Wt.) J.B. Hill	-	+	-	-	-
Pongamia pinnata (L.) Pierre	-	-	-	-	+
Pothomorphe subpeltata (Willd.) Miq.	-	-	-	-	+
Pothos scandens L.	-	-	-	-	+
Pouzolzia zeylanica (L.) Benn.	-	-	-	-	+
Premna tomentosa Willd.	-	+	-	-	-
Psychotria congesta (Wt. et Arn.) Hook.f.	+	-	-	-	-
Psychotria connata Wall. ex Roxb.	+	-	-	-	-
Psychotria dalzellii Hook.f.	+	-	-	-	-
Psychotria johnsonii Hook.f.	+	-	-	-	-
Psychotria nigra (Gaertn.) Alston	-	+	-	-	-
Psychotria nudiflora Wt.et Arn.	+	-	-	-	-

Psychotria octosulcata Talbot	•	-	-	-	-
Pterocarpus marsupium Roxb.	-	+	-	-	-
Pterolobium hexapetalum (Roth) Sant.	+	-	-	-	-
Pterospermum tuberifolium Lamk.	-	+	-	-	-
Randia dumetorum (Thumb.) Poir.	-	-	-	-	+
Rauvolfia serpentina Benth. ex Kurz	-	-	-	+	-
Remusatia vivipara (Lodd.) Schott.	-	-	-	-	+
Rhaphidophora lacinata (Burm.f.) Merr.	-	-	-	+	-
Rhynchoglossum notonianum (Willd.) Burtt	-	+	-	-	-
Rhynchotechum permolle (Nees.) Burtt	-	+	-	-	-
Rotula aquatica Lour.	-	-	-	-	+
Rubus indicus Thunb.	-	+	-	-	-
Sapindus laurifolius Vahl	-	+	-	-	-
Sarcandra grandiflora (Miq.) Sub. et Henry	-	+	-	-	-
Schefflera venulosa (Wt. et Arn.) Hams.	-	-	-	-	+
Schleichera oleosa (Lour.) Oken	-	-	-	+	-
Schumannianthus virgatus (Roxb.) Rolfe	-	+	-	-	-
Scleropyrum pentandrum (Dennst.) Mabb.	-	+	-	-	-
Scoparia dulcis L.	-	-	-	-	+
Scurulla cordifolia (Wall.) G. Don	-	-	+	-	-
Securinega leucopyrus (Willd.) Muell.-Arg.	-	-	+	-	-
Semicarpus anacardiurn L.f.	-	-	-	-	+
Sida cordifolia L.	-	-	-	-	+
Sida rhombifolia L.	-	-	-	+	-
Sirhookeria latifolia (Wt.) O. Ktze.	+	-	-	-	-
Smilax zeylanica L.	-	-	-	+	-
Solanum erianthum D.Don	-	-	-	-	+
Solanum torvum Sw.	-	-	-	-	+

Sonerlla brunonls L.	-	+	-	-	-
Sonerila elegans Wt.	+	-	-	-	-
Sonerila versicolor Wt. var. axillaris Gamble'	+	-	-	-	-
Sonerila wa11ichii Benn.	+	-	-	-	-
Sterculia guttata Roxb.	-	-	-	+	-
Streblus taxoides (Heyne) Kurz	-	-	-	+	-
Striga angustifolia (Don) Saldanha	-	-	-	+	-
Strychnos nux-vomica L.	-	-	-	-	+
Strychnos potatorum L.f.	-	-	+	-	-
Symplocos cochnichinensis (Lour.) Moore	-	+	-	-	-
Symplocos macrocarpa Wt. ex C.B.Cl.	+	-	-	-	-
Symplocos racemosa Roxb.	+	-	-	-	-
Syzygium caryophyllatum (L.) Alston	-	+	-	-	-
Syzygium cumini (L.) Skeels	-	-	-	-	+
Syzygium jambos (L.) Alston	-	-	-	+	-
Syzygium laetum (Ham.) Gandhi	+	-	-	-	-
Syzygium mundagam (Bourd.) Chithra	+	-	-	-	-
Syzygium occidentale (Bourd.) Gandhi	+	-	-	-	-
Tectona grandis L.f.	-	-	-	+	-
Tephrosia purpurea (L.) Pers.	-	-	-	-	+
Terminalia gella Dalz.	-	+	-	-	-
Terminalia paniculata Roxb. ex Roth	+	-	-	-	-
Terniola zeylanica Tul.	+	-	-	-	-
Tetrameles nudiflora R.Br. ex Benn.	+	-	-	-	-
Tetrastigma lanceolarium (Roxb.) Planch.	-	-	-	+	-
Thottea siliquosa (Lamk.) Ding Hou	-	+	-	-	-
Toddalia asiatica (L.) Lamk.	+	-	-	-	-

Toona ciliata M. Rocm.	-	-	-	+	-
Tragia involucrata L.	-	-	-	-	+
Trema orientalis (L.) Bl.	-	-	-	-	+
Trichilia connaroides (Wt. et Arn.) Bent.	+	-	-	-	-
Tridax procumbens L.	-	-	-	-	+
Turpinia malabarica Gamble	+	-	-	-	-
Uvaria narum (Dunna 1) Wt.et Arn.	-	+	-	-	-
Vanda tessellata (Roxb.) Hook. ex G.Don	-	-	+	-	-
Vateria indica L.	+	-	-	-	-
Vateria macrocarpa Cupta	+	-	-	-	-
Vernonia arborea Ham.	+	-	-	-	-
Vicoa indica (L.) DC.	-	-	-	-	+
Viscum orientale Willd.	-	-	-	-	+
Vitex altissima L.f.	+	-	-	-	-
Vitex negundo L.f.	-	-	-	+	-
Uendlandia bicuspidata Wt. et Arn.	-	+	-	-	-
Willisia selaginoides (Bedd) Warm. ex Willis	+	-	-	-	-
Xanthophyllum flavescens Roxb.	-	-	-	+	-
Xanthoxylurn rhesta (Roxb.) DC.	-	-	-	+	-
Xylia xylocarpa (Roxb.)Taub.	-	-	+	-	-
Ziziphus oenoplia (L.) Mill.	-	-	-	-	+
Ziziphus xylopyrus (Retz.) Willd.	-	-	+	-	-

ANAMALA - MANAL1 REGION

This region has 171 taxa of flowering plants of which about 35% are endemic to Peninsular India. Others have been classified as in Pindimedu.

Species endemic to Peninsular India

Anamala - Manali region abodes 60 species of angiosperms that are confined to Peninsular India, especially to the Western Ghats region, and this, as already mentioned, comes to 35.6%. Families like Euphorbiaceae (5 sp.), Rubiaceae (5 sp.), Lauraceae (4 sp.), Fabaceae s.1. (3 sp.), Myrtaceae (3 sp.), Balsaminaceae (3 sp.), Myrsinaceae (2 sp.), Dipterocarpacaeae (2 sp.), Acanthaceae (2 sp.), Anacardiaceae (2 sp.), Sapotaceae(2 sp.), Celastraceae (2 sp.), Melastomataceae (2 sp.), Orchidaceae (2 sp.), Svmplocaceae (2 sp.), Zinsiberaceae (1 sp.), Begoniaceae (1 sp.), Guttiferae (1 sp.), Burseraceae (1 sp.), Oleaceae (2 sp.), Palmae (1 sp.), Meliaceae (1 sp.), Apocynaceae (1 sp.), Musaceae (1 sp.), Theaceae (1 sp.), Labiatae (1 sp.), Myristicaceae (1 sp.), Cannaceae (1 sp.), Sapindaceae (1 sp.), Staphyleaceae (1 sp.), Podostemaceae (1 sp.), Compositae (1 sp.), Piperaceae (1 sp.) and Tetramelaceae (1 sp.) are the ones that represent the Peninsular Indian endemics in the flora, with number of species belonging to each of them given in parenthesis. Genera like Impatiens (3 sp.), Psychotria (3 sp.), Syzygium (3 sp.), Ardisia (2 sp.), Actinodaphne (2 sp.), Holigarna (2 sp.) and Symplocos (2 sp.) are better represented by way of endemics in the area and species like Baccaurea courtallensis (Wt.) Muell.-Arg., Calophyllum elatum Bedd., Chionanthus mala-elengi (Dennst.) P.S. Green, Dipterocarpus indicus

Bedd., Dysoxylum malbaricum Bedd. ex Hiern, Bhesa indica (Bedd.) Ding Hou, Chilocarpus malabaricus Bedd., Ensete superbum, (Roxb.) Chruman, Epiprinus mallotiformis (Muell.-Arg.) Croizat, Gomphostemma keralensis Vivek., Gopal. et Ansari, Isonandra perrottiana Wt,, Litsea bourdillonii Gamble, Microtropis latifolia Wt., Otonephilium stipulaceum (Bedd.) Radlk., Palaquium ellipticum (Dalz.) Baill., Turpinia malabarica Gamble and Willisia selaginoides (Bedd.) Karr. ex Willis are some such endemics known from the region. Further, more than *50%* of the Peninsular Indian endemics of the area, as in the case of Pindimedu region, are those confined to the southern end of Western Ghats, like Actinodaphne malabarica Balakr., Gymnacranthera canarica (King), Warb., Litsea bourdillonii Gaable, Vateria indica L., Isonandra perrottiana Wt., Ardisia pauciflora Heyne, Syzygium mundagam (Bourd.) Chithra, Microtropis latifolia Wt., Gomphandra coriacea Kt., Otonepheliur stipulaceum (Bedd.) Radlk., Holigarna grahamii (Wt.) Kurz, Dysoxylum malabaricum Bedd. ex Hiern, Impatiens cordata Wt., Chilocarpus malabaricus Bedd., Gomphostemma keralensis Vivek., Gopal. et Ansari, Psychotria barberi Gamble, P. anamallavana Bedd., etc. and this further signifies the importance of the flora of the region from a conservation point of view.

Peninsular Indo-Sri Lankan species

There are about 25 species in the flora of the region which are Peninsular Indo-Sri Lankan. Such species in the flora are represented in the families like Guttiferae (2 sp.), Boraginaceae (1 sp.), Zingiberaceae (1 sp.), Celastraceae (1 sp.), Dioscoreaceae (1 sp.), Bombacaceae (1 sp.), Icacinaceae (1 sp.), Compositae (1 sp.),

Myristicaceae (1 sp.), Melastomataceae (2sp.), Lauraceae (1 sp.), Rosaceae (1 sp.), Gesneriaceae (1 sp.), Symplocaceae (1 sp.), Chloranthaceae (1 sp.), Marantaceae (1 sp.), Rubiaceae (2 sp.), and Urticaceae (1 sp.). This group of plants represent 15.8% of the total number of species in the area. It is only the genus Aporosa (Euphorbiaceae) which is represented by 2 species common to the two regions and the remaining genera in this group are all with only single species each in this phytogeographical range.

Plants of Indian region

Excluding Peninsular Indian endemics, plants confined to the Indian region is only 14 species which represent 8.8%. They are Anogeissus latifolia (Roxb. ex DC.) Wall. ex Bedd., Alpinia malaccensis (Burm.f.) Rosc., Celastrus paniculata Willd., Aurostemma rostratum Wall., Dendrobium macrostachyum Lindl., Elatostemsa lineolatum Wt., Ixora arborea Roxb. ex J.E. Smith, Lepisanthes tetraphylla (Vahl) Radlk., Madhuca longifolia (Koen.) Lamk., Maesa indica (Roxb.) DC., Memecylon umbellatum Burrn.f., Naravelia zeylanica (L.) A. DC., Pogostemon panicultus (Willd.) Benth. and Sarcococca pruniformis Lindl. Some of the species of the Indian region in the flora are those confined to Peninsular India and North-eastern parts of the country, sometimes extending in their distribution to the foot of the Himalayas.

Indo - Malayan elements

Indo-Malayan elements are represented by 27 taxa belonging to the families Lauraceae (3.sp.), Rutaceae (3 sp.), Urticaceae (2 sp.) Rubiaceae (2 sp.), Meliaceae (2 sp.), Labiatae (1 sp.),

Zingiberaceae (1 sp.), Hypoxidaceae (1 sp.), Auavaceae (1 sp.), Elaeocarpaceae (1 sp.), Flacourtiaceae (1 sp.), Fabaceae s.l. (1 sp.), Potaliaceae (1 sp.), Campanulaceae (1 sp.); Guttiferae (1 sp.), Pandanaceae (1 sp.), Polygonaceae (1 sp.), Rosaceae (1 sp.), Moraceae (1 sp.) and Ulmaceae (1 sp.), which comes to 14% of the total number of species noted from the area. When compared to the Pindimedu region with about 16% of species in this range, flora of Anamalai - Manali region shows a lesser affinity with that of the Malayan Islands. Further, flora of this region is more related to that of Sri Lanka than to Malesian flora and it is also noteworthy that there is not even a single genus in the flora of the region represented by more than 1 species in the Indo - Malayan range.

Pluri-resional species

45 species represent this group. Such species, often designated as wides belong to the following families: Compositae (6 sp.), Euphorbiaceae (5 sp.), Acanthaceae (1 sp.), Poaceae (1 sp.), Umbelliferae (2 sp.), Apocynaceae (2 sp.), Rubiaceae (2 sp.), Fabaceae s.l. (3 sp.), Piperaceae (2 sp.), Ancistrocladaceae (1 sp.), Commelinaceae (1 sp.), Moraceae (2 sp.), Agavaceae (1 sp.), Meliaceae (1 sp.), Sapindaceae (1 sp.), Tiliaceae (1 sp.), Sterculiaceae (1 sp.), Labiatae (1 sp.), Urticaceae (1 sp.), Balsaminaceae (1 sp.), Passifloraceae (1 sp.), Rutaceae (1 sp.), Borasinaceae (1 sp.), Crassulaceae (1 sp.), Meliosmaceae (1 sp.), Polygonaceae (1 sp.), Ehretiaceae (1 sp.), Myrtaceae (1 sp.), and Loganiaceae (1 sp.). As in the case of any other tropical flora, Compositae weeds rank first in the list of families that contain 'wides' in the flora,

followed by Euphorbiaceae. In total, this group of plants constitute 25.86 of the total number of species. As in the case of Pindimedu region, the Compositae-weed Mikania micrantha H.B.X. is gregarious in certain pockets in the Anamalai-Manali region also acquiring a weed status.

Table No. 4.2. Alphabetical list of species in the Anamalai-Manali region giving their world distribution pattern.

Species	Distribution				
	I*	II*	III*	IV*	V*
Acronychia pedunculata (L.) Miq.	-	-	-	+	-
Actinodaphne lawsonii Gamble	+	-	-	-	-
Actinodaphne malabarica Balakr.	+	-	-	-	-
Aglaia elaegnoidea (Juss.) Benth.	-	-	-	+	-
Agrostemma rostratum Wall.	-	-	+	-	-
Agrostistachys indica Dalz.	+	-	-	-	-

* I. Peninsular Indian, II. Peninsular Indo-Sri Lankan, 111. Indian, IV. Indo-Malayan, V. Transcontinental or cosmopolitan.

Agrostistachys meeboldii Pax et K. Hoffm.	-	+	-	-	-
Alpinia malaccensis (Burm.f.) Rosc.	-	-	-	+	-
Amischophacelus axi1laris (L.) Roll a Rao et Kammathy	-	-	-	-	+
Amomum cannicarpum (Wt.) Benth. ex Baker	+	-	-	-	-
Ancistrocladus heyneanus Wall. ex Grah.	+	-	-	-	-
Andrographis panicu1ata (Burm. f.) Vahl ex Nees	-	-	-	-	+
Anisomeles malabarica (L.)R. Br. ex Sims	-	-	-	+	-
Anogeissus latifolia (Roxb. ex DC.) Wall. ex Bedd.	-	-	+	-	-
Aporosa acuminata Thw.	-	+	-	-	-
Aporosa 1ind1eyana Wt.	-	+	-	-	-
Ardisia pauciflora Heyne	+	-	-	-	-
Ardisia solanacea Roxb.	+	-	-	-	-
Artocarpus heterophyllus Lamk.	-	-	-	-	+
Baccaurea courtallensis(Wt.) Muel1.–Arg.	+	-	-	-	-
Begonia malabarica Lamk.	+	-	-	-	-
Bhesa indica (Bedd.) Ding Hou	+	-	-	-	-
Blachia calycina Benth.	-	+	-	-	-
Blainvillea acme1la (L.) Philipson	-	-	-	-	+
Blumea lacera (Burm.f.) DC.	-	-	-	-	+
Blumea mollis (D. Don) Merr.	-	-	-	-	+
Boehmeria malabarica Wedd.	-	-	-	+	-
Breynia rhamnoides (Retz.) Muel1.– Arg.	-	-	-	-	+
Calamus thwaitesii Becc.	+	-	-	-	-
Calophyllum austroindicum Kosterm.	-	+	-	-	-
Ca1ophy1lum elatum Bedd.	+	-	-	-	-

Canarium strlctum **Roxb.**	+	-	-	-	-
Celastrus paniculata Wil Id.	-	-	+	-	-
Centella asicatica (L.) **Urb.**	-	-	-	-	+
Centothecca latifolia (Osb.) Trim.	-	-	-	-	+
Chassalia curviflora (Wall.) Craib var. ophioxyloides (Wall.) Deb et Krishna	-	+	-	-	-
Chilocarpus malabaricus Bedd.	+	-	-	-	-
Chionanthus mala-e lengi (Dennst.) P.S. Green	+	-	-	-	-
Chlorophytum laxum R.Br.	-	-	-	-	+
Cinnamornum sulphuratum Nees	+	-	-	-	-
Cinnamornum verum J.S. Presl.	-	-	-	+	-
Cipadessa baccifera (Roth) Miq.	-	-	-	-	+
Clausena dentata (Wil Id.) Roem. et Schult.	-	-	-	+	-
Cleisostoma ternerum HOok.f.	+	-	-	-	-
Crassocephalum crepidioides (Benth.) S. Moore	-	-	-	-	+
Croton bonplandianum Bail 1.	-	-	-	-	+
Cu 1lenia exari 1lata Robyns	-	+	-	-	-
Curculigo orchioides Caertn.	-	-	-	+	-
Cynoglossum zeylanicum (Vahl ex Hornem.) Thumb. ex Lehm.	-	+	-	-	-
Da 1bergia benthamii Prain	+	-	-	-	-
Dendrobiurn macrostachyum Lindl.	-	-	+	-	-
Dimocarpus longan Lour.	-	-	-	-	+
Dioscorea oppositifolia ia L.	-	+	-	-	-
Dipterocarpus indicus Bedd.	+	-	-	-	-
Dracaena terniflora Roxb.	-	-	-	+	-
Drypetes oblongifolia (Bedd.) Airy Shaw	+	-	-	-	-

Dysoxylum malabaricum Bedd. ex Hiern	+	-	-	-	-
Elaeocarpus tuberculatus Roxb.	-	-	-	+	-
Elatostema lineolatum Wt.	-	-	+	-	-
Elettaria cardamomum (L.) Manton	-	+	-	-	-
Ensete superbum (Roxb.) Cheruman	+	-	-	-	-
Epiprinus mallotiformis (Muell.-Arg.) Croizat	+	-	-	-	-
Erigeron karvinskianus DC.	-	-	-	-	+
Ervatamia divaricata (L.) Burkill	-	-	-	-	+
Euonymous dichotomus Heyne ex Roxb.	-	+	-	-	-
Fagraea ceilanica Thunb.	-	-	-	+	-
Flacourtia indica (Burm.f.) Merr.	-	-	-	+	-
Flemingia macrophylla (Willd.) Prain ex Merr.	-	-	-	+	-
Garcinia morella (Gaertn.) Desr.	-	+	-	-	-
Glochidion ellipticum Wt.	+	-	-	-	-
Comphandra coriacea Wt.	-	+	-	-	-
Comphostemma keralensis Vivek., Gopal. et Ansari	+	-	-	-	-
Gordonia obtusa Wall. ex Wt. et Arn.	+	-	-	-	-
Crewia tiliifolia Vahl	-	-	-	-	+
Cymnacranthera canarica (King) Warb.	+	-	-	-	-
Gymnostachyum latifolium (Dalz.) T.And.	+	-	-	-	-
Gynura lycopersicifolia DC.	-	+	-	-	-
Hedyotis umbellata (L.) Lamk.	-	-	-	-	+
Helicteris isora L.	-	-	-	-	+
Holigarna arnottiana Hook.f.	+	-	-	-	-
Holigarna grahamii (Wt.) Kurz	+	-	-	-	-
Homonoia riparia Lour.	-	-	-	-	+

Humboldtie vahliana Wt.	+	-	-	-	-
Hydrocotyle javanica Thunb.	-	-	-	-	+
Ichnocarpus frutescens (L.) R. Br.	-	-	-	-	+
Impatiens chinensis L.	-	-	-	-	+
Impatiens cordata Wt.	+	-	-	-	-
Impatiens grandis Heyne ex Wall.	+	-	-	-	-
Impatiens maculata Wt.	+	-	-	-	-
Isonandra perrottiana Wt.	+	-	-	-	-
Ixora arborea Roxb. ex J.E. Smith	-	-	+	-	-
Ixora nigricans R.Br. ex Wt. et Arn.	-	-	-	+	-
Jasminum rottlerianum Wall. ex DC.	+	-	-	-	-
Justicia betonica L.	-	-	-	-	+
Kalanchoe pinnata (Lamk.) Pers.	-	-	-	-	+
Laportea crenulata (L.) Chew	-	-	-	-	+
Lepisanthes tetraphylla (Vahl) Radlk.	-	-	+	-	-
Leucas aspera (Willd.) Link	-	-	-	-	+
Litsea accendentoides K. & V.	-	-	-	+	-
Litsea bourdillonii Gamble	+	-	-	-	-
Lobelia nicotianaefolia Roth ex Roem. et Schult.	-	-	-	+	-
Macaranga peltata (Roxb.) Muell.- Arg.	-	+	-	-	-
Madhuca longifolia (Koen.) Lamk. var. longifolia	-	-	+	-	-
Maesa indica (Roxb.) DC.	-	-	+	-	-
Mallotus philippensis (Lamk.)Muell.-Arg.	-	-	-	-	+
Mastixia arborea (Wt.) Bedd.	+	-	-	-	-
Meliosma simplicifolia (Roxb.) Walp.	-	-	-	-	+
Memecylon umbellatum Burm.f.	-	-	+	-	-
Mesua ferrea L.	-	-	-	+	-

Microtropis latifolia Wt.	+	-	-	-	-
Mikania micrantha H.B.K.	-	-	-	-	+
Mimosa invasia Mart. var. inermis Adelb.	-	-	-	-	+
Myristica dactyloides Gaertn.	-	+	-	-	-
Naravelia zeylanica (L.) A. DC.	-	-	+	-	-
Neolitsea cassia (L.) Kosterm.	-	-	-	+	-
Nilgirianthus heyneanus (Nees) Bremek.	+	-	-	-	-
Ochlandra travancorica Benth. ex Gamble	+	-	-	-	-
Ophiorrhiza eriantha Bl.	+	-	-	-	-
Ophiorrhiza mungos L.	-	-	-	+	-
Oreocnide integrifolia (Gaud.) Miq.	-	-	-	+	-
Osbeckia aspera El.	-	+	-	-	-
Otonephelium stipulaceum (Bedd.) Radlk.	+	-	-	-	-
Palaquium ellipticum (Dalz.) Baill.	+	-	-	-	-
Pandanus fascicularis Lamk.	-	-	-	+	-
Passiflora foetida L.	-	-	-	-	+
Pavetta calophylla Bremek.	+	-	-	-	-
Pellionia heyneana Wedd.	-	+	-	-	-
Peperomia dindigulensis Miq.	-	-	-	-	+
Persea macrantha (Nees) Kosterm.	-	+	-	-	-
Photinia integrifolia Lindl.	-	-	-	+	-
Phyllanthus debilis Klein ex Willd.	-	-	-	-	+
Piper nigrum L.	+	-	-	-	-
Pogostemon paniculatus (Willd.) Benth.	-	-	+	-	-
Polygonum chinense L.	-	-	-	+	-
Pongamia pinnata (L.) Pierre	-	-	-	-	+
Pothomorphe subpeltata (Willd.) Miq.	-	-	-	-	+

Psychotria anamalayana Bcdd.	+	-	-	-	-
Psychotria barberi Gamble	+	-	-	-	-
Psychotria dalzellii Hook.f.	+	-	-	-	-
Randia dumetorum (Retz.) Poir.	-	-	-	-	+
Rhynchotechum permolle (Nees) Burtt	-	+	-	-	-
Rotula aquatica Lour.	-	-	-	-	+
Rubus indicus Thumb.	-	+	-	-	-
Sarcandra grandifolia (Miq.) Subr. et Henry	-	+	-	-	-
Sarcococca pruniformis Lindl.	-	-	+	-	-
Schumannianthus virgatus (Roxb.) Rolfe	-	+	-	-	-
Sirhookera latifolia (Wt.) O.Ktze.	+	-	-	-	-
Sonerila brunonis Wt. et Arn.	-	+	-	-	-
Sonerila elegans Wt.	+	-	-	-	-
Sonerila speciosa Zenk.	+	-	-	-	-
Streblus taxoides (Heyne) Kurz	-	-	-	+	-
Strychnos potatorum L.f.	-	-	-	-	+
Symplocos macrocarpa Wt. ex C.B. Cl.	+	-	-	-	-
Symplocos racemosa Roxb.	+	-	-	-	-
Symplos cochinchinensis (Lour.) Moore	-	+	-	-	-
Syzygium mundagam (Bourd.) Chithra	+	-	-	-	-
Syzygium cumminii (L.) Skeels	-	-	-	-	+
Syzygium laetum (Ham.) Candhi	+	-	-	-	-
Syzygium munronii (Wt.) Chandr.	+	-	-	-	-
Tetrameles nudiflora R.Br.	+	-	-	-	-
Thottea siliquosa (Lamk.) Ding Hou	-	+	-	-	-
Toddalia asiatica (L.) Lamk.	-	-	-	-	+
Toona ciliata M. Roem.	-	-	-	+	-

Trema orientalis (L.) Bl.	-	-	-	+	-
Tridax procumbens L.	-	-	-	-	+
Turpinia malabarica Gamble	+	-	-	-	-
Vateria macrocarpa Cupta	+	-	-	-	-
Vernonia arborea Ham.	+	-	-	-	-
Wendlandia bicuspidata Wt. et Arn.	-	+	-	-	-
Willisia selaginoides (Bedd.) Warm. ex Willis	+	-	-	-	-
Xanthophyllum flavescens Roxb.	-	-	-	+	-

SIGNIFICANCE OF THE FLORA FROM THE POINT OF VIEW OF ENDEMISM AND AFFTNITIES.

Based on the distribution pattern of various floristic elements recorded from Pindimedu and Anamala - Manali regions indications were given earlier on the phytogeographical significance of the flora, mainly from the points of view of endemism and affinities. The following table (Table 4.3) summarises and compares the percentage of plants in different phytogeographical groups as represented in the two regions.

Table4.3. Percentage cf different phytogeographical groups of plants in the project area.

Plant group	Pindimedu	Anamala - Manali
Peninsular Indian endemics	33.3	35.6
Peninsular Indo-Sri Lankan species	13.8	15.8
Indian elements	11.5	8.8
Indo-Malayan species	15.9	14.0
Others (Wides)	25.0	25.8

Endemism

As evident from Table 4.3. with regard to endemism, flora of the two regions are almost equal in their importance and Anamala-Manali region is slightly better than Pindimedu region in the representation of the endemics, as it contains about 1.5% more of such elements. Further, within the group of Western Ghat endemics in the Indian

flora which comes, to a total of about **1500** species, Peninsular Indian endemics **(175** species) noted from the **two regions** of Pooyamkutty flora comes to about **11.7%,** and for such a limited area like Pooyamkutty this is fairly **a** high percentage. This observation depicts in general the significance of the flora of the region from a conservation point of view. Further, **50%** or more of the Peninsular Indian endemics in the area are those confined to southern Western Ghats alone and this also has to be considered while assessing the importance of the flora of the region and projecting the need to protect it.

Affinities

Distribution data of the floristic elements of Pindimedu and Anamala - Manali regions separately had shown that Pindimedu flora is more related to that of Malesia (16%) than to Sri Lanka (13.8%) and Anamala - Manalai region is with a better representation of Peninsular Indo-Sri Lankan species **(15.8%)** when compared to the number of plants that include Malesia **(14%)** in their distribution range. Probably, altitudinal factor of the region might have contributed to the higher percentage of Indo - Malayan elements in the Anamalai - Manali region which forms a continuous streath of the Western Ghats connected farther in the North to the Vindhya-Satpura-Assam range, through which Malayan flora and the fauna had migrated to the mountainous tracts of Peninsular India (Hora, **1948).** However, the affinity of the flora of the project area to that of Sri Lanka and Walesia is equally profound and about **72** species are Peninsular Indo - Sri Lankan and 81 species Indo - Malayan in their distribution.

Species common to other parts of India and especialy North-eastern part of the country comes to 43 species and within the group of transcontinental or cosmopolitan species, there are a total of 130 taxa of which about 85 are those recorded from the Pindimedu region. This comparatively higher representation of 'wides' in the Pindimedu region can reasonably be attributed to the disturbances to the flora of the region, promoting colonisation of 'wides' and exetrmination of indigenous and other characteristic elements of the flora. This is more evident from the fact that in the less disturbed Anamala - Wanali region, 'wides' are comparatively less and those present are mostly confined to certain pockets like Wanali, Weenkuthi and adjoining areas only, where there is some amount of interferences to the natural forested habitat. To conclude, the two regions that comes under the submergible and catchment areas of the proposed Pooyarnkutty hydro-electric project, from a conservation point of view, is worth preserving to save a large percentage of endemics and species depicting the affinity of Peninsular Indian flora with that of Sri Lanka and Walesia.

C . ECONOMICALLY IMPORTANT PLANTS

As already noted, there are 340 species of 'flowering plants in the flora of Pindimedu region and 171 species in the Anamala - Wanali region. Based on literature like Uatt (1889-96), Wealth of India (1948-'76), Daniel Sunderaraj and Girija Balasubramanyan (1959), etc. species in both regions are classified and tabulated (Table No.4.4) accordng to their economic potential like timber species (I), medicinal plants (II), food and fodder yielding species (III), oil yielding plants (IV), gum and resin yielding plants (V), tan and dye species (VI), fibre and floss yielding plants (VII), spice and condiment yielding plants (VIII) and others (IX) that are used as sources of products like insecticides, paper and mat, fat for soap making, etc.

Table No.4.4. Alphabatical list of economically important plants in Pindimedu and Anamala - Manali regions.

Species	I	II	III	IV	V	VI	VII	VIII	IX
Abrus precatorius	-	+	+	-	-	-	-	-	+
Acacia torta	-	+	-	-	-	+	-	-	+
Aclisia secundiflora	-	-	-	-	-	-	-	+	-
Acronychia pedunculata	-	+	-	+	-	-	-	+	-
Actinodaphne bourdillonii	-	-	-	-	-	-	-	-	-
Actinodaphne lawsonii	-	-	-	-	-	-	-	-	-
Actinodaphne aadaraspatana	-	-	-	-	-	-	-	-	-
Actinodaphne malabarica	-	-	-	-	-	-	-	-	-
Aeschynanthus perrottettii	-	-	-	-	-	-	-	-	-
Aglaia barberi	-	-	-	-	-	-	-	-	-
Aglaia elaegnoidea	+	+	+	-	-	-	-	+	-
Agrostemma rostratum	-	-	-	-	-	-	-	-	-
Agrostistachys indica	+	+	-	-	-	-	-	-	-
Agrostistachys meeboldii	+	+	-	-	-	-	-	-	-
Albizia amara	+	+	+	-	+	-	-	-	+
Albizia lebbeck	+	+	+	+	+	+	-	-	-
Albizia odoratissima	+	+	+	-	t	+	-	-	-

Alpinia malaccensis	-	+	-	+	-	+	-	-	-
Alstonia scholaris	+	+	-	-	-	-	-	-	-
Amischophacelus axillaris	-	-	-	-	-	-	-	-	-
Ammania baccifera	-	+	-	-	-	-	-	-	-
Amomum cannicarpum	-	-	-	-	-	-	-	-	-
Ancistrocladus heyneanus	-	+	-	-	-	-	-	-	-
Andrographis paniculata	-	+	-	-	-	-	-	-	-
Aneilema ovalifolium	-	-	-	-	-	-	-	-	-
Anisomeles malabarica	-	+	-	+	-	-	-	-	-
Anogeissus latifolia	+	+	+	-	+	+	-	-	-
Antidesma bunius	-	+	+	-	-	+	-	-	-
Antidesma menasu	+	-	-	-	-	-	-	-	-
Aphanamixis polystachya	+	+	-	+	-	-	-	-	-
Aporosa acuminata	-	-	-	-	-	-	-	-	-
Aporosa lindleyana	+	+	+	-	-	-	-	-	-
Ardisia pauciflora	-	-	-	-	-	-	-	-	-
Ardisia solanacea	-	+	+	-	-	+	-	-	-
Artocarpus heterophyllus	+	+	+	-	-	+	-	-	-
Artocarpus hirsutus	+	+	-	-	+	-	-	-	-
Atuna travancorica	-	-	-	-	-	-	-	-	-
Baccaurea courtallensis	+	-	t	-	-	-	-	-	-
Bambusa arundinacea	-	+	+	-	-	-	-	-	-
Bauhinia purpurea	+	+	+	-	+	+	+	-	-
Bauhinia racemosa	+	+	+	-	+	+	+	-	+
Begonia albo-coccinea	-	-	-	-	-	-	-	-	-
Begonia malabarica	-	-	-	-	-	-	-	-	-
Bhesa indica	+	-	-	-	-	-	-	-	-
Biophytum sensitivum	-	+	-	-	-	-	-	-	-
Blachia calycina	-	-	-	-	-	-	-	-	-
Blainvillea acmella	-	-	-	-	-	-	-	-	-
Blumea lacera	-	+	-	+	-	-	-	-	-
Blumea nollis	-	-	-	-	-	-	-	-	-
Boehmeria glomerulifera	-	-	-	-	-	-	-	-	-
Boehmeria malabarica	-	-	-	-	-	-	+	-	-
Boerhavia diffusa	-	+	-	-	-	+	-	-	-
Bombax ceiba	+	+	+	-	+	-	+	-	-
Breynia rhamnoides	+	+	-	-	-	-	-	-	-
Bridelia scandens	+	+	-	-	-	-	-	-	-
Bulbophyllum fimbriatum	-	-	-	-	-	-	-	-	-
Bulbophyllum fischeri	-	-	-	-	-	-	-	-	-
Bulbophyllum neilgherrense	-	-	-	-	-	-	-	-	-
Bulbostylis barbata	-	-	-	-	-	-	-	-	-
Butea parviflora	+	+	-	-	-	-	-	-	-
Calamus thwaitesii	-	-	-	-	-	-	-	-	+
Callicarpa tomentosa	+	+	-	-	-	-	-	-	-
Calophyllum apetalum	-	+	-	+	-	-	-	-	-
Calophyllum austroindicum	-	-	-	-	-	-	-	-	-
Calophyllum elatum	+	+	-	+	-	-	-	-	-
Calophyllum inophyllum	+	+	-	+	+	-	-	-	-
Canarium strictum	+	-	-	-	+	-	-	-	-
Careya arborea	+	+	+	-	+	+	+	-	+
Casearia esculenta	-	+	+	-	-	-	-	-	-
Cassia fistula	+	+	+	-	+	-	-	-	-
Cassia occidcntalis	-	+	-	-	-	-	-	-	-
Celastrus paniculata	-	+	-	-	-	-	-	-	-

Centella asiatica	-	+	-	-	-	-	-	-	-
Centotheca latifolia	-	-	-	-	-	-	-	-	-
Chassalia curviflora var. ophioxyloides	-	-	-	-	-	-	-	-	-
Chilocarpus malabaricus	-	+	-	-	-	-	-	-	-
Chionanthus mala-elengi	-	-	-	-	-	-	-	-	-
Chloris barbata	-	-	+	-	-	-	-	-	-
Chlorophytum laxum	-	-	-	-	-	-	-	-	-
Chromolaena odorata	-	-	-	-	-	-	-	-	-
Cinnamomum macrocarpum	-	+	-	-	-	-	-	-	-
Cinnamomum malabatrum	-	-	-	-	-	-	-	-	-
Cinnarnomum riparium	-	-	-	-	-	-	-	-	-
Cinnamonum sulphuratum	-	-	-	-	-	-	-	-	-
Cinnamomum verum	+	+	-	-	-	-	-	-	-
Cipadessa baccifera	-	-	-	-	-	-	-	-	-
Cissampelos pariera	-	+	-	-	-	-	+	-	-
Cissus quadrangularis	-	+	-	-	-	-	+	-	-
Cissus repens	-	-	-	-	-	-	+	-	-
Clausena dentata	-	-	+	+	-	-	-	-	-
Cleisostoma tenerum	-	-	-	-	-	-	-	-	-
Cleome viscosa	-	-	+	+	-	-	-	-	-
Clerodendrum viscosum	-	-	-	-	-	-	-	-	-
Coix lacryma-jobi	-	+	+	-	-	-	-	-	-
Commelina benghalansis	-	+	+	-	-	-	-	-	-
Commelina diffusa	-	-	-	-	-	-	-	-	-
Commelina paludosa	-	-	-	-	-	-	-	-	-
Connarus monocarpus	+	+	-	+	-	-	-	-	-
Connarus wightii	-	-	-	-	-	-	-	-	-
Costus speciosus	-	+	+	-	-	-	-	-	+
Crassocephalum crepidioides	-	-	-	-	-	-	-	-	-
Crotalaria juncea	-	+	+	-	-	-	+		-
Croton bonplandianum	-	-	-	-	-	-	-	-	-
Cullenia exarillata	+	-	-	-	-	-	-	-	-
Curculigo orchioides	-	+	-	-	-	-	-	-	-
Cyathula prostrata	-	+	-	-	-	-	-	-	-
Cymbopogan caesius	-	-	-	+	-	-	-	-	-
Cynadon dactylon	-	+	+	-	-	-	-	-	+
Cynoglossum zeylanicum	-	-	-	-	-	-	-	-	-
Cyperus exaltatus	-	-	-	-	-	-	+	-	-
Cyperus tenuispica	-	-	-	-	-	-	-	-	-
Dalbergia benthamii	-	-	-	-	-	-	-	-	-
Dalbergia horrida	-	+	-	-	-	-	-	-	-
Dalbergia latifolia	+	+	+	+	+	-	-	-	-
Dalbergia sissoides	+	-	-	-	-	-	-	-	-
Dalbergia volubilis	-	+	+	-	-	-	-	-	-
Dendrobium barbatulum	-	+	-	-	-	-	-	-	-
Dendrobius herbaceum	-	-	+	-	-	-	-	-	-
Dendrobium herterophyllum	-	-	-	-	-	-	-	-	-
Dendrobium ovatum	-	+	-	-	-	-	-	-	-
Dendrophthoe flacata	-	+	-	-	-	-	-	-	-
Desmodium herbaceum	-	-	-	-	-	-	-	-	-
Desmodium herophyllua	-	+	-	-	-	-	-	-	-
Desmodium triangulare	-	-	-	-	-	-	-	-	-
Dichapetalum gelonoides	-	-	-	-	-	-	-	-	-
Digitaria ciliaris	-	-	+	-	-	-	-	-	-

Dillenia pentagyna	+	-	+		-	-	+	-	-
Dimocarpus longan	+	+	+	-	-	-	-	-	-
Dioscorea oppositifolia	-	+	+	-	-	-	-	-	-
Dioscorea pentaphylla	-	+	+		-	-	-	-	-
Diospyros buxifolia	+	-	-	-	-	-	-	-	-
Diospyros candolleana	-	+	-	-	-	-	-	-	-
Disopyros ovalifolia	+	-	-	-	-	-	-	-	-
Diploclisia glaucacens	-	-	-		-	-	-	-	-
Dipterocarpus bourdillonii	+	-	-		+	-	-	-	-
Dipterocarpus indicus	+	+	-	-	+	+	-	-	-
Dracaena terniflora	-	-	-	-	-	-	-	-	-
Drypetes oblongifolia	-	-	-	-	-	-	-	-	-
Dysoxylum malabaricum	+	+	-	-	-	-	-	-	-
Elaeocarpus serratus	+	+	+		-	-	-	-	
Elaeocarpus tectorious	-	+	-	-	-	-	-	-	-
Elaeocarpus tuberculatus	+	+	-	-	-	-	-	-	+
Elatostema lineolatum	-	-	-	-	-	-	-	-	-
Elephantopus scaber	-	+	-	-	-	-	-	-	-
Elettaria cardamomum.	-	+	+	+	-	-	-	+	-
Emblica officinalis	+	+	+	+	-	-	-	-	+
Emilia sonchifolia	-	+	-	-	-	-	-	-	-
Ensete superbum	-	+	-	-	-	-	-	-	+
Epiprinus mallotiformis	-	-	-	-	-	-	-	-	-
Eragrostis uniloides	-	-	+	-	-	-	-	-	-
Erigeron karvinskianus	-	-	-	-	-	-	-	-	-
Eriocaulon quinquangulare	-	-	-	-	-	-	-	-	-
Ervatamia divaricata	+	+	-	-	-	+	-	-	-
Erythrina stricta	+	+	-	-	-	-	-	-	-
Euonymus dichotomus	-	-	-	-	-	-	-	-	-
Fagraea ceilanica	-	-	-	-	-	-	-	-	-
Ficus arnottiana	-	+	-	-	-	-	-	-	-
Ficus benghalensis	+	+	+	-	+	-	+	-	-
Ficus hispida	-	+	+	-	+	-	-	-	-
Ficus religiosa	+	+	+		+	+	+	-	-
Ficus talbotii	-	+	-	-	-	-	-	-	-
Ficus tinctoria	-	+	-	-	-	-	-	-	-
Ficus travancorica	-	-	-	-	-	-	-	-	-
Ficus tsjahela	+	+	+	-	-	-	-	-	-
Fimbristylis dichotoma	-	+	-	-	-	-	-	-	-
Flacourtia indica	+	+	+	-	-	-	-	-	-
Flemingia macrophylla	-	-	-	-	+	-	-	-	-
Garcinia gummi-guttata	+	+	+	+	+	-	-	-	-
Garcinia morella	-	+	+	+	+	+	-	-	-
Garcinia wightii	-	-	-	-	-	-	-	-	-
Glochidion ellipticum	-	-	-	-	-	-	-	-	-
Glochidion zeylanicum	-	+	-	-	-	-	-	-	-
Glycosmis arborea	-	+	+		-	-	-	-	-
Gmelina arborea	+	+	+	-	+	+	-	-	-
Gornphandra coriacea	-	-	-	-	-	-	-	-	-
Gomphandra tetrandra	-	-	-	-	-	-	-	-	-
Gomphostemma keralensis	-	-	-	-	-	-	-	-	-
Goniothalamus wightii	-	-	-	-	-	-	+	-	-
Gordonia obtusa	+	-	-	-	-	-	-	-	-
Grewia emarginata	-	-	-	-	-	-	-	-	-
Greuia gambleii	-	-	-		-	-	-	-	-

Grewia tiliifolia	+	+	+	-	-	-	+	-	-
Gymnacranthera canarica	+	-	-	+	-	-	-	-	+
Gymnostachyum febrifugum	-	+	-	-	-	-	-	-	-
Gymnostachyum latifolium	-	-	-	-	-	-	-	-	-
Gynura lycopersicifolia	-	-	-	-	-	-	-	-	-
Hedyotis umbellata	-	+	-	-	-	+	-	-	-
Helicteris isora.	-	+	+	-	-	+	+	-	-
Holigarna arnottiana	+	+	-	-	+	+	-	-	-
Holigarna grahamii	+	-	-	-	+	+	-	-	-
Homonoia riparia	-	+	+	-	-	-	-	-	-
iiopea glabra	+	-	-	-	-	-	-	-	-
Hopea parviflora	+	-	-	-	-	+	-	-	-
Humboldtia brunonis	-	+	-	-	-	-	-	-	-
Humboldtia vahliana	+	+	-	-	-	-	-	-	-
Hydnocarpus alpina	+	+	-	+	-	-	-	-	-
Hydrocotyle javanica	-	+	-	-	-	-	-	-	-
Hyptis suaveolens	-	+	+	+	-	-	-	-	-
Ichnocarpus frutescens	-	+	-	-	-	-	+	-	+
Impatiens chinensis	-	+	-	-	-	-	-	-	-
Impatiens cordata	-	-	-	-	-	-	-	-	-
Impatiens grandis	-	-	-	-	-	-	-	-	-
Impatiens maculata	-	-	-	-	-	-	-	-	-
Impatiens scapiflora	-	-	-	-	-	-	-	-	-
Isonandra perrotiana	+	-	-	-	-	-	-	-	-
Ixora arborea	+	+	+	-	-	-	-	-	-
Ixora nigricans	-	+	-	-	-	-	-	-	-
Ixora pavetta	+	+	+	-	-	-	-	-	-
Jasminum malabaricum	-	+	-	-	-	-	-	-	-
Jasminum rottlerianum	-	+	-	-	-	-	-	-	-
Justicia betonica	-	+	-	-	-	-	-	-	-
Justicia wynaadensis	-	-	-	-	-	-	-	-	-
Kalanchoe pinnata	-	+	-	-	-	-	-	-	-
Kirganelia reticulata	-	+	-	-	-	+	-	-	-
Kneaa attenuata	+	-	-	+	-	-	-	-	-
Lagerstroemia microcarpa	+	-	+	-	-	-	-	-	-
Lagerstroemia reginae	+	+	+	-	+	-	-	-	-
Lannea coromandelica	+	+	-	-	+	+	+	-	-
Lantana camera	-	+	-	-	-	-	-	-	-
Laportia crenulata	-	+	-	-	-	-	-	-	-
Laportia interrupta	-	+	-	-	-	-	+	-	-
Leea indica	-	+	+	-	-	-	-	-	-
Lepisanthes tetraphylla	+	-	+	-	-	-	-	-	-
Leptonychia caudata	-	+	-	-	-	-	-	-	-
Leucas aspera	-	+	-	-	-	-	-	-	-
Litsea accedentoides	-	-	-	-	-	-	-	-	-
Litsea bourdillonii	-	-	-	-	-	-	-	-	-
Lobelia nicotianafolia var. trichandra	-	+	-	-	-	-	-	-	+
Lophopetalum wightianum	+	-	-	-	-	-	-	-	-
Luisia zeylanica	-	-	-	-	-	-	-	-	-
Macaranga indica	+	-	-	-	+	-	-	-	-
Macaranga peltata	+	+	-	+	+	-	-	-	-
Madhuca longifolia	+	+	+	-	-	-	-	-	+
Nadhuca longifolia var. latifolia	+	+	-	-	-	-	-	-	-

Maesa indica	-	-	+	-	-	-	-	-	+
Mallotus philippensis	+	+	+	+	-	+	-	-	-
Mangifera indica	+	+	+	-	+	+	-	-	-
Mastixia arborea	+	-	-	-	-	-	-	-	-
Mastixia arborea var. mezina	+	-	-	-	+	-	-	-	-
Melastoma malabathricum	-	+	-	-	-	+	-	-	-
Meliosma simplicifolia	+	-	-	-	-	-	-	-	-
Mamecylon heyneanum	-	-	-	-	-	-	-	-	-
Memecylon rnalabaricum	-	+	-	-	-	-	-	-	-
Memecylon umbellatum	+	+	+	-	-	+	-	-	-
Mesua ferrea	+	+	+	+	+	+	-	-	+
Microtropics latifolia	-	-	-	-	-	-	-	-	-
Mikania micrantha	-	-	+	-	-	-	-	-	-
Miliusa eriocarpa	-	-	-	-	-	-	-	-	-
Miliusa tomentosa	-	-	-	-	-	-	-	-	-
Mimosa invasia var. inermis	-	-	-	-	-	-	-	-	-
Mimosa pudica	-	+	-	-	-	-	-	-	-
Molineria trichocarpa	-	-	-	-	-	-	-	-	-
Monochoria vaginalis	-	+	+	-	-	-	-	-	-
Mussaenda laxa	-	+	+	-	-	-	-	-	-
Myristica dactyloides	+	+	-	-	-	-	-	-	-
Myristica malabarica	+	+	-	+	-	-	-	+	-
Naravelia zeylanica	-	+	+	-	-	-	+	-	-
Neolitsea cassia	+	+	-	+	-	-	-	-	+
Nilgirianthus heyneanus	-	-	-	-	-	-	-	-	-
Nothopegia beddomei	-	-	-	-	-	-	-	-	-
Nothopegia travancorica	-	-	-	-	-	-	-	-	-
Ochlandra travancorica	-	-	-	-	-	-	-	-	-
Olea dioica	+	+	+	-	-	-	-	-	-
Ophiorrhiza eriantha	-	-	-	-	-	-	-	-	-
Ophiorrhiza mungos	-	+	-	-	-	-	-	-	-
Oreocinde integrifolia	-	+	-	-	-	-	+	-	-
Ormosia travancorica	+	-	-	-	-	-	-	-	-
Osbeckia aspera	-	-	-	-	-	-	-	-	-
Osbeckia zylanica	-	-	-	-	-	-	-	-	-
Otonephelium stipulaceum	+	-	+	-	-	-	-	-	-
Palaquium ellipticum	+	-	-	-	+	-	-	-	+
Pandanus fascicularis	-	+	+	+	-	-	+	-	+
Panicum repens	-	-	+	-	-	-	-	-	-
Passiflora foetida	-	+	+	-	-	-	-	-	-
Pavetta calophylla	-	-	-	-	-	-	-	-	-
Pavetta zeylanica	-	-	-	-	-	-	-	-	-
Pellionia heyneana	-	-	-	-	-	-	-	-	-
Peperomia dindigulensis	-	-	-	-	-	-	-	-	-
Persea macrantha	-	+	-	-	-	-	-	-	-
Pholidota pallida	-	+	-	-	-	-	-	-	-
Photinia integrifolia	-	-	-	-	-	-	-	-	-
Phyllanthus debilis	-	+	-	-	-	-	-	-	-
Piper nigrum	-	+	+	+	-	-	-	+	-
Podochilus malabaricus	-	-	-	-	-	-	-	-	-
Pogostemon paniculatus	-	-	-	-	-	-	-	-	-
Polyalthia fragrans	+	-	-	-	-	-	-	-	-
Polygonum barbatum	-	+	+	-	-	+	-	-	-
Polygonum chinense	-	+	+	-	-	-	-	-	-
Polypleurum stylosum	-	-	-	-	-	-	-	-	-

Pongamia pinnata	+	+	+	+	-	-	-	-	-
Pothomorphe subpeltata	-	-	-	-	-	-	-	-	-
Pothos scandens	-	+	-	-	-	-	-	-	-
Pouzolzia zeylanica	+	+	-	-	-	-	-	-	-
Premna tomentosa	+	+	-	-	-	-	-	-	-
Psychotria anamalayana	-	-	-	-	-	-	-	-	-
Psychotria barberi	-	-	-	-	-	-	-	-	-
Psychotria connata	-	-	-	-	-	-	-	-	-
Psychotria dalzellii	-	-	-	-	-	-	-	-	-
Psychotria johnsonii	-	-	-	-	-	-	-	-	-
Psychotria nigra	-	-	-	-	-	-	-	-	-
Psychotria nudiflora	-	-	-	-	-	-	-	-	-
Psychotria octosulcata	-	-	-	-	-	-	-	-	-
Pterocarpus marsupium	+	+	+	-	+	+	-	-	-
Pterolobium hexapetalum	-	-	-	-	-	-	-	-	-
Pterospermum suberifolium	+	+	+	-	-	-	-	-	-
Randia dumetorum	-	+	-	-	-	+	-	-	-
Rauvolfia serpentina	-	+	-	-	-	-	-	-	-
Remusatia vivipara	-	+	-	-	-	-	-	-	-
Rhaphidophora lacinata	-	-	-	-	-	-	-	-	-
Rhynchoglossum notonianum	-	-	-	-	-	-	-	-	-
Rhynchoglossum permolle	-	-	-	-	-	-	-	-	-
Rotula aquatica	-	+	-	-	-	-	-	-	-
Rubus indicus	-	-	+	-	-	-	-	-	-
Sapindus laurifolius	+	+	-	+	+	-	-	-	+
Sarcandra grandiflora	-	+	-	-	-	-	-	-	-
Sarcococca pruniformis	+	+	-	-	-	-	-	-	-
Schefflera venulosa	+	+	-	-	-	-	-	-	-
Schleichera oleosa	+	+	+	+	-	-	-	-	-
Schunannianthus virgatus	-	-	-	-	-	-	-	-	-
Scleropyrum pentandrum	-	-	-	-	-	-	-	-	-
Scoparia dulcis	-	+	+	-	-	-	-	-	-
Scurulla cordifolia	-	-	-	-	-	-	-	-	-
Securinega leucopyrus	+	+	+	-	-	-	-	-	-
Semicrapus anacardium	+	+	+	+	+	+	-	-	-
Sida cordifolia	-	+	-	-	-	-	+	-	-
Sida rhombifolia	-	-	-	-	-	-	+	-	-
Sirhookeria latifolia	-	-	-	-	-	-	-	-	-
Smilax zeylanica	-	+	+	-	-	-	-	-	-
Solamum erianthum	-	+	+	-	-	-	-	-	-
Solamum torvum	+	+	-	-	-	-	-	-	-
Sonerila brunonis	-	-	-	-	-	-	-	-	-
Sonerila elegans	-	-	-	-	-	-	-	-	-
Sonerila versicolor var. axillaris	-	-	-	-	-	-	-	-	-
Sonerila wallichii	-	-	-	-	-	-	-	-	-
Streculia guttata	-	-	+	-	+	-	+	-	-
Streblus taxoides	+	+	+	-	-	-	+	-	-
Striga angustifolia	-	-	-	-	-	-	-	-	-
Strychnos nux-vomica	+	+	-	-	-	+	-	-	+
Strychnos potatorum	+	+	-	-	-	-	-	-	-
Symplocos cochinchinensis	+	+	-	-	-	+	-	-	-
Symplocos macrocarpa	-	-	-	-	-	-	-	-	-
Symplocos racemosa	+	+	-	-	-	+	-	-	-
Syzygium caryophyllatum	-	+	+	-	-	-	-	+	-

Syxygium cumini	+	+	+	-	-	+	-	-	-
Syzygium jambos	-	-	+	+	-	-	-	-	-
Syzygium laetum	-	-	-	-	-	-	-	-	-
Syzygium mundagam	-	-	-	-	-	-	-	-	-
Syzygium munronii	-	-	-	-	-	-	-	-	-
Syzygium occidentale	-	-	-	-	-	-	-	-	-
Tectona grandis	+	+	-	+	+	+	-	-	-
Tephrosia purpurea	-	+	-	-	-	+	-	-	+
Terminalia gella	+	+	+	+	+	+	-	-	+
Terminalia paniculata	+	+	-	-	-	+	-	-	-
Terniola zeylancia	-	-	-	-	-	-	-	-	-
Tertrameles mudiflora	+	+	-	-	-	-	-	-	-
Tetrastigma lanceolarium	-	+	+	-	-	-	-	-	-
Thottea silquosa	-	+	-	-	-	+	-	-	-
Toddalia asiatica	-	+	+	+	-	+	-	-	-
Toona ciliata	+	+	+	-	+	+	-	-	-
Tragia involucrata	-	+	-	-	-	-	-	-	-
Trema orientalis	-	+	+	-	-	-	+	-	+
Trichilia connaroides	-	-	-	-	-	-	-	-	-
Tridax procumbens	-	+	+	-	-	-	-	-	-
Turpinia malabarica	-	-	-	-	-	-	-	-	-
Uvaria narum	-	+	-	+	-	-	-	-	-
Vanda tessellata	-	+	+	-	-	-	-	-	-
Vateria indica	+	+	-	+	+	-	-	-	-
Vateria macrocarpa	-	-	-	-	-	-	-	-	-
Vernonia arborea	-	+	-	-	-	-	-	-	-
Vicoa indica	-	+	+	-	-	-	-	-	-
Viscum orientale	-	+	-	-	-	-	-	-	+
Vitex altissima	+	-	-	-	-	-	-	-	-
Vitex negundo	+	+	-	+	-	+	-	-	-
Wendlandia bicuspidata	-	-	-	-	-	-	-	-	-
Willisia selaginoides	-	-	-	-	-	-	-	-	-
Xanthophyllum flavescens	+	-	-	-	-	-	-	-	-
Xylia xylocarpa	+	+	+	-	-	-	-	-	-
Zanthoxylum rhesta	+	+	+	+	-	-	-	-	-
Ziziphus oenoplia	-	+	+	-	-	-	-	-	-
Ziziphus xylopyrus	+	-	+	-	-	+	-	-	-

Summing up, in the flora of Pindimedu region, following categories of economically important plants are seen and the number of species that belong to each category and their percentage in the total number of species in the flora are as follows:

1. Timber species - **100** taxa **(27.02%)**
2. Medicinal plants - **174** taxa **(51.17%)**
3. Food and fodder yielding plants - 90 taxa **(26.47%)**
4. Oil yieldings plants - 35 taxa **(10.58%)**
5. Gum and resin yielding plants - 39 taxa **(11.47%)**
6. Tan and dye yielding plants - **40** taxa **(11.76%)**
7. Fibre and floss yielding plants - 22 taxa **(6.47%)**
8. Spices, contiments, etc. yielding species - **5** taxa **(1.47%)**
9. Others - 21 taxa **(6.17%)**

In the case of the flora of Anamala - Manali region the percentages of the different categories of economic plants in the total flora are as given below.

1. Timber species - **39** taxa (22.80%)
2. Medicinal plants - **65** taxa **(38.01%)**
3. Food and fodder yielding plants - **25** taxa **(14.61%)**
4. Oil yielding plants - **14** taxa **(8.18%)**
5. Gum & resin yielding plants - 10 taxa **(5.84%)**
6. Tan and dye yielding plants - **12** taxa **(7.01%)**
7. Fibre and floss yielding plants - 10 taxa **(5.84%)**
8. Spices, continents, etc. yielding plants - **4** taxa (2.33%)
9. Others - 12 taxa **(7.01%)**

Thus, it may be seen that, medicinal plants come first in the of economically important species in both Pindimedu and Anamala - Hanali regions, followed by timber species and food and fodder yielding plants. It may also be noted that at present indigenous timber

species and medicinal plants are the two categories of plants that are getting fast depleted from our natural forests. Hence, the flora of the two regions with a good representation of these two groups of plants is quite siginificant as the habitat of indigenous, economically important plants.

5. SOIL PROPERTIES, EROSION RATES AND SUSPENDED LOAD

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A. SOIL PROPERTIES

INTRODUCTION

Characterisation of soils in an area provides an inventory of this resource which can be used as a basis for future management. This section deals with certain physical and chemical properties of soils in the area.

Methodology

Pocyarkutty project area (River basin) was taken as the unit (Fig. 5.1). Soils were studied through profiles (150 cm) or pits (60 cm) in forest areas. The samples were collected from genetic horizons (for profiles) and 00-20, 20-40 and 40-60 cm layers (for pits).

The samples were air dried and passed through a 2 mm sieve. Analysis for gravel, texture (Sand and silt + clay separates), organic carbon, exchange acidity, exchangeable bases and pH (2C=40 water) were carried out (Jackson, 1973)

Results

The properties of soils from 4 pits and 4 profiles are given in Tables 5.1 to 5.8.

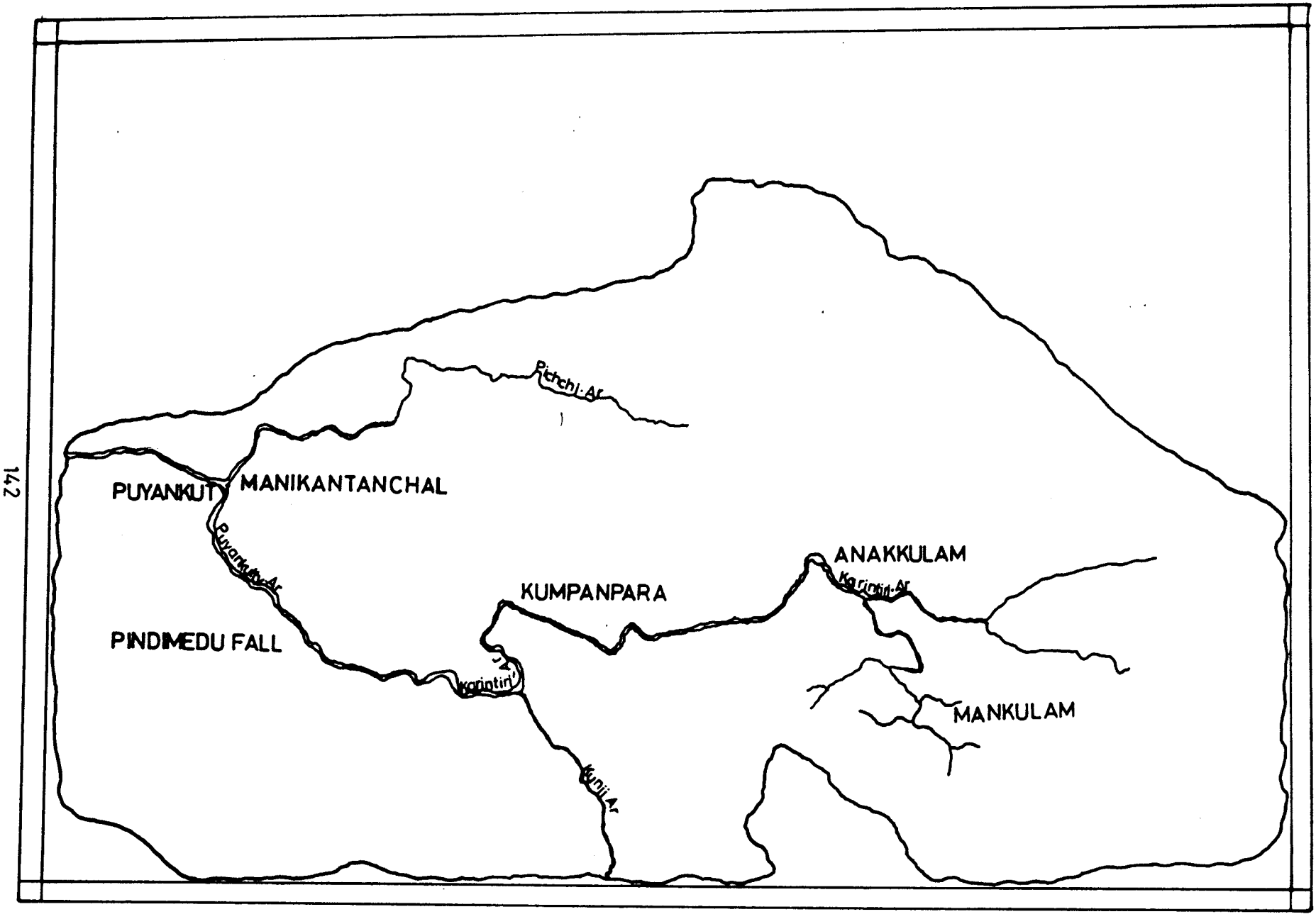

Fig.5.1. Poovamkutty River Basin

Table 5.1 Description and properties of soil pit in pure reed brake (undisturbed)

Locality : Shishyanparappu

Depth (cm.)

00-20 Dark yellowish brown, granular, abundant roots, few gravel pieces, strongly acid.

20-40 Greyish brown, granular, plentiful rcots, fen pieces of gravel, very strongly acid.

40-60 Dark greyish red, massive, plentiful mottles, few roots, stony, very strongly arid

Properties	Depth cm 00-20	20-40	40-60
Gravel %	8	12	28
Sand % . .	81	75	74
Silt + clay%	19	25	26
pH	5.2	5.0	5.0
OC%	1.6	0.9	0.8
EA me/100g	6	7	3
EB me/100g	12	7	5

Table 5.2 Description and properties of soil pit in Reed brake (flowered and regenerating)

Locality : Kattippara

Depth (cm,.)	
00-20	Dark reddish brown, granular, friable, plentiful roots, few pieces of gravel, very strongly acid.
20-40	Reddish brown, massive, firm, few roots, few pieces. of gravel, very strongly acid.
40-60	Yellowish red, massive, firm, very few roots, fen mottles, very strongly acid

Properties	Depth cm 00-20	20-40	40-60
Gravel %	13	11	14
Sand %	83	78	69
Silt + clay%	17	22	31
pH	4.9	4.9	4.9
OC%	1.5	1.2	0.8
EA me/100g	4	3	5
EB me/100g	9	7	5

Table 5.3 Description and properties of soil pit in Semievergreen forest

Locality : Thalakulam

Depth (cm.)

00-20 Dark brownish red, granular, friable, plentiful roots, few pieces of gravel, very strongly acid.

20-40 Reddish brown, massive, firm, few roots, plentiful pottles, extremely acid

40-60 Reddish yellow, massive, hard, plentiful mottles, strongly acid

Properties	Depth cm 00-20	20-40	40-60
Gravel %	18	13	15
Sand %	85	80	73
Silt + clay%,	15	20	27
pH	5.0	4.4	5.2
OC%	1.3	0.8	0.3
EA me/100g	5	5	4
EB me/100g	12	9	6

Table 5.4 Description and properties of soil pit in Evergreen fore: t

Locality : Ttliar

Depth (CF.)	
00-20	Dark grey, granular, friable, plentiful roots, very strongly acid.
20-40	Yellowish brown, massive, hard, few roots, very strongly acid
40-60	Yellowish brown, massive, hard, few pieces of gravel, very few rcots, very strongly acid

Properties	Depth cm 00-20	20-40	40-60
Gravel %	11	9	lo
Sand %	71	58	70
Silt + clay%	29	32	30
pH	4.9	4.9	4.9
OC%	2.1	0.6	0.3
EA me/100g	5	4	4
EB me/100g	9	6	5

Table 5.5 Description and propertier of soil profile in Moist deciduous forest with reed (undisturbed)

Locality : Mcokan

Description

Dept. (cm)	
0-20	Dark gray, granular, firm abundant rcots, very strongly acid
20-40	Brown, granular, very firm, few roots, few pieces cf litho marge, very strongly acid
40-60	Reddish brown, massive, very firm, few mottles, few roots, strongly acid
60-83	Brownish red, massive, hard, plentiful concretions, strongly acid
83-150	Brownish red, massive, hard, few cottles, plentiful iron! concretions, strongly acid

Properties

Depth cm	Gravel	Sand	Silt + clay	pH	OC%	EA	EB
	----------%		----------			--me/100g	
00-20	12	75	25	5.0	1.97	7	**13**
20-40	**15**	74	26	**4.9**	1.18.	**5**	10
40-60	**11**	75	25	5.2	**0.58**	**4**	6
60-83	7	80	20	**5.3**	0.34	**5**	**6**
83-150	**24**	67	33	**5.3**	**0.59**	**4**	7

Table 5.6 Description and properties of soil profile in Moist deciduous forest with reed (distributed)

Locality : Kunjiar

Depth. (cm)	
0-8	Dark brown, granular, friable, plentiful roots, very strongly acid
8-38	Brown red, massive, firm, plentiful pieces of lithomarge, few rocts, very strongly acid
38-54	Reddish brown, massive, firm, few concretions, few roots, very strongly acid
54-79	Reddish brown, massive, hard, plentiful pieces of lithomarge, few roots, very strongly acid
79-107	Red, massive, hard, plentiful concretions, very strongly acid
107-150	Yellowish red, massive, hard, plentiful concretions, very strongly acid

Properties

Depth Cm	Gravel	Sand	Silt+clay	pH	OC %	EA	EB
	----------%		----------			--me/100g-	
0-8	22	81	19	4.6	1.47	4	8
8-38	25	78	22	4.5	1.13	4	6
38-54	18	79	21	4.5	0.71	5	5
54-79	28	76	24	4.7	0.71	3	4
79-107	13	73	27	4.7	0.54	4	4
107-150	7	68	32	4.7	0.67	4	5

Table 5.7 - Description and properties of soil profile in Semievergreen with reed (undisturbed)

Locality : Avarkutty

Depth (cm)	
0-13	Dark greyish brown, granular, friable, plentiful roots, very strongly acid
13-42	Reddish brown, massive, friable, few roots, very strongly acid
42-80	Yellowish red, massive, hard, few aottles, few concreticns, very strongly acid
80-126	Reddish yellow, massive, hard, plentiful mottles, very strongly acid
126-150	Yellowish red, passive, hard, few concretions, plentiful mottles, very strongly acid

Properties

Depth	Gravel	Sand	Silt+Clay	pH	OC	EA	EB
	----------%----------					me/100g	
0-13	12	78	22	4.8	1.60	6	9
13-42	8	74	26	4.8	0.90	4	6
42-80	9	79	21	4.7	0.55	5	6
80-126	7	71	29	d.8	0.50	5	6
126-150	28	73	27	5.0	0.46	4	5

Table 5.E Description of properties of soil profile in semievergreen forest with reed (disturbed)

Locality : Kattippara

Depth (cm)	
0-12	Dark reddish brow, granular, friable, abundant roots, plentiful pieces of gravel, strongly acid
12-39	Reddish brown, massive, firn, plentiful roots, plentiful pieces of gravel, very strongly acid
39-80	Reddish brown, massive, firm, few roots, very strongly acid
80-122	Yellowish red, massive, firm, few roots, very strongly acid
122-150	Reddish yellow, massive, firm, plentiful mottles, few iron concretions, extremely acid

Properties

Depth Cm	Gravel	Sand	Silt+Clay	pH	OC	EA	EB
	----------%	----------			%	--me/100g	
0-12	32	86	14	5.1	1.30	5	9
12-39	53	84	16	4.7	0.80	6	7
3F-80	55	81	19	5.0	0.74	4	6
80-122	17	73	27	4.9	0.74	4	7
122-150	8	74	26	4.4	0.70	5	7

Discussion

The soils in the Pooyamkutty river basin are light textured, being either sandy or 1oamy. Clay loam texture is met with in the deeper horizons of the 'profile:. This may be attributed to heavy rainfall and warm temperature.

The content of gravel (particles › 2mm) show variation with disturbance. Soils in disturbed areas have higher gravel content indicating more intense rates of erosicn.

The soil reaction is very strongly to strongly acid, which is characteristic of soils in humid tropics. Even soils in moist deciduous forests of the river basin exhibit **low pH** contrary to observation from. elsewhere (Sankar ***et al.*** **1987;** Alexander and Balagopalan, **1981)** This may be due to the reed coaponent in the understorey.

The organic carbon status of the soils is moderate. Higher level of organic carbon is met with in soils of evergreen forests (Table **5.4)** and in less disturbed locations. There is a sudden drop of organic carbon content with depth. The base status of the soils is **low** varying from 5 to **13** me/100g. In certain cases the exchange acidity is high enough to be the same as bases.

Conclusion

The soils the Pooyamkutty river basin are light in texture, strongly acidic in reaction, and contain medium level of organic carbon in surface horizons which is resulting in locking up of bases.

B.SOIL EROSION

Introduction

Soil erosion has many important consequences for human ecolcgy and economics becuase it can remcve productive top soil, damage roads and fields by gullying and landsliding, cause eutrcphicaticn and silting cf river channels and reservoirs. The most important contrcls cf erosion are climate, vegetation, soil and topography. Thus fcr the assessment of the impoundments upon rivers the sediment flow intc the reservoir has to be taken into account.

Siltation occurs vhen soil is washed dovn from the land by rain and flood waters. The rate of silt build up in a reservoir depend. on the amount of silt carried by rivers flowing into the reservoir and the extent cf soil erosion upstream. Vegetation end relief influence the pattern of erosion and removal of vegetation by man can produce extreme rates of scil ercsion.

The rater of soil erosion and its impact on the economic life of dams is rarely taken intc account in cost-benefit analysis. It is assumed that the reservoir will not silt up for ever one hundred years. Indian hydroprojects show great differences between predicted and actual silt loads (Table 5.9). The reason for this is the absence of rigid control over the watersheds.

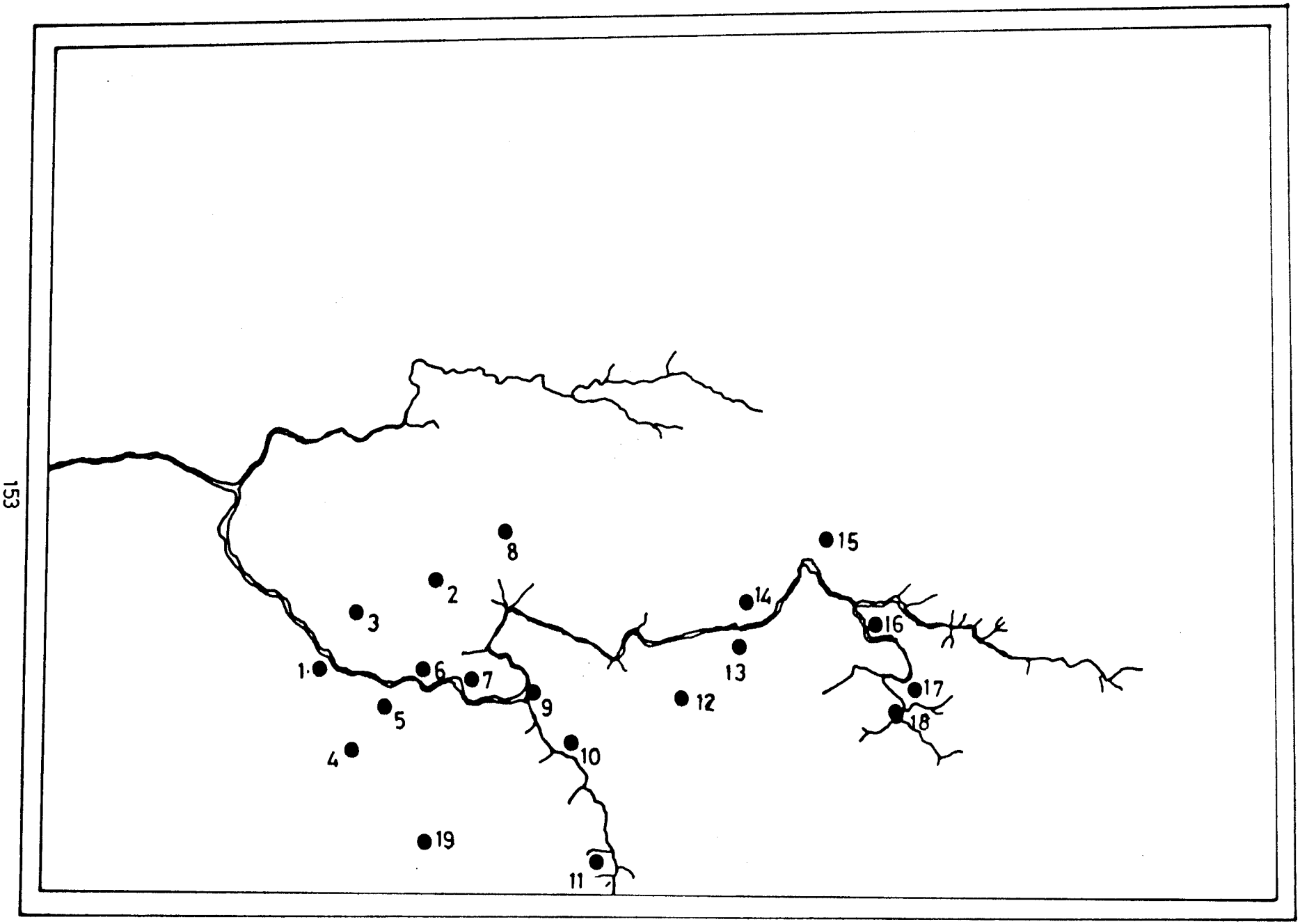

Fig.5.2. Locations for Soil Erosion Monitoring

Table 5.9. Annual rate of silting per 100 Km^2 catchment area

Project	Year of impounding	Hectometres of silt assumed	Observed	Survey year
Maython	1956	3.62	13.10	1963, 65, 71
Mayurakshi	1955	3.61	16.43	1965, 70
Ramganga	1974	4.29	18.19	
Ghod	1966	3.61	15.24	

* National Commission on Agriculture (1976)

Taking these points into account, an attempt was made to estimate soil erosion rate: in Pooyamkutty river basin.

Methodology

Nineteen watersheds were located in the basin representing a variety of geomorphological and landuse units (Fig. 5.2). Pins were installed and soil denudation was recorded during the period 1986-88. Denudation rates were converted to soil erosion classes as given in Table 5.10.

Table 5.10. Erosion class rating Based on denudation paraneterr

Denudation mm/ha/yr	Erosion
1-5	Low
6-10	Moderate
>10	High

Table 5.11 Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Pindimedu
2.	Altitude (m)	- 300 - 350
3.	Slope	- 35°
5.	Type	- Degraded moist deciduous
6.	Vegetation cover	- 30%
7.	Undergrowth	- Sparse
8.	Incidense of fire	- Common
9.	Soil erosion mm/ha/yr	- 8
10.	Erosion class	- Moderate

Table 5.12 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Valpanijakavala
2.	Altitv.de (m)	- 400 - 450
3.	Slope	- 30°
4.	Landuse	- Forest
5.	Type	- Semievergreen + reed undergrowth
5.	Vegetation cover	- 80%
7.	Undergrowth	- Thick
8.	Incidence of fire	- N
9.	Soil erosion mm/ha/yr	- 2
10.	Erosion class	- Low

Table 5.13 - Soil erosion in selected watersheds of Pooyamkutty river basin

1. Watershed	-	Kalluppara
2. Altitude (m)	-	300 - 500
3. Slope	-	25°
4. Landuse	-	Forest
5. Type	-	Degraded
6. Vegetation cover	-	25%
7. Undergrowth	-	Sparse
8. Incidence of fire	-	Common
9. Soil erosion mm/ha/yr	-	8
10. Erosion class	-	Moderate

Table 5.14 - Soil erosion in selected watersheds of Pooyamkutty river basin

1. Watershed	-	Mettanappara
2. Altitude (m)	-	300-500
3. Slope	-	25°
4. Landuse	-	Agriculture
5. Crops	-	Annual
6. Land management	-	Exposed
7. Vegetation cover	-	25%
8. Soil erosion mm/ha/yr	-	13
9. Erosion class	-	High

Table 5.15 - Soil erosion in selected watersheds of Pooyamkutty river basin

1. Watershed	-	Sishyanparappu
2. Altitude (m)	-	325 -380
3. Slope	-	10°
4. Landuse	-	Forest
5. Type	-	Reed
6. Vegetation cover	-	75%
7. Undergrowth	-	Thick
8. Incidence of fire	-	Sparse
9. Soil erosion rnm/ha/yr	-	3 mm
10. Erosion class	-	Low

Table 5.16 - Soil erosion in selected watersheds of Pooyamkutty river basin

1. Watershed	-	Mookkan
2. Altitude (m)	-	280 - 300
3. Slcpe	-	15°
4. Landuse	-	Forest
5. Type	-	Semievergreen t reed as undergrowth
6. Vegetation cover	-	45%
7. Undergrowth	-	Thick
8. Incidence of fire	-	Nil
9. Soil erosion mm/ha/yr	-	3 mm
10. Erosion class	-	Low

Table 5.17 - Soil erosion in selected watersheds of Pooyamkutty river basin

1. Watershed	-	Thudupi
2. Altitude (m)	-	300 - 400
3. Slope	-	30°
4. Landuse	-	Forest
5. Type	-	Reed
6. Vegetation cover	-	100%
7. Undergrowth	-	Thick
8. Incidence of fire	-	Nil
9. Soil erosion mm/ ha/yr	-	3
10. Erosion class	-	Low

Table 5.18 - Soil erosion in selected watersheds of Pooyamkutty river basin

1. Watershed	-	Kattippara
2. Altitude (c)	-	300 - 500
3. Slope	-	30°
4. Landuse	-	Forest
5. Type	-	Semievergreen + reed as undergrowth
6. Vegetation cover	-	60%
7. Undergrowth	-	Thick
8. Incidence of fire	-	Nil
9. Soil erosion mm/ha/yr	-	4
10. Erosion class	-	Low

Table 5.19 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Kunjiar
2.	Altitude (m)	- 200 - 280
3.	Slope	- 10°
4.	Landuse	- Forest
5.	Type	- Degraded moist deciduous
6.	Vegetation cover	- 25%
7.	Undergrowth	- Sparse
8.	Incidence of fire	- High
9.	Soil erosion mm/ha/yr	- 8
10.	Erosion class	- Moderate

Table 5.20 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Thalakulam
2.	Altitude (m)	- 350 - 400
3.	Slope	- 25°
4.	Landuse	- Forest
5.	Type	- Semievergreen + reed as undergrowth
6.	Vegetation cover	- 60%
7.	Undergrowth	- Thick
8.	Incidence of fire	- Nil
9.	Soil erosion mm/ha/yr	- 2
10.	Erosion class	- Low

Table 5.21 - Soil erosion in selected watershed. of Pooyamkutty river basin

1.	Watershed	- Avarkutty
2.	Altitude (m)	- 350 - 400
3.	Slope	- 10°
4.	Landuse	- Forest
5.	Type	- Degraded moist deciduous + reed as undergroeth
6.	Vegetation cover	- 30%
7.	Undergrowth	- Sparse
8.	Incidence of fire	- Common
9.	Soil erosion mm/ha/yr	- 11
10.	Erosion class	- High

Table 5.22 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Nellimala
2.	Altitude (m)	- 400 - 500
3.	Slope	- 25o
4.	Landuse	- Forest land under tribal cultivation
5.	Type	- Grassland
6.	Vegetation cover	- 5%
7.	Undergrowth	- Dense grass
8.	Incidence of fire'	- Common
9.	Soil erosion mm/ha/yr	- 9
10.	Erosion class	- Moderate

Table 5.23 - Soil erosion in selected watershed. of Pooyamkutty river basin

1.	Watershed	- Kurathi
2.	Altitude (m)	- 400 - *500*
3.	Slope	- 250
4.	Landuse	- Agriculture (Tribal)
S.	Crops	- Perennial + annual
6.	Land management	- Partially covered
7.	Vegetation cover	- 25%
8.	Soil erosion mn/ha/yr	- 10
9.	Erosion class-	- Moderate

Table 5.24 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Anakulam 1
2.	Altitude (m)	- 400 - 500
3.	Slope	- 25o
4.	Landuse	- Forest
5.	Type	- Semievergreen + reed as undergrowth
6.	Vegetation cover	- *758*
7.	Undergrowth	- Thick
8.	Incidence of fire	- Nil
9.	Scil erosion m/ha/yr	- 4
10.	Erosion class	- Low

Table 5.25 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Anakulam 2
2.	Altitude (m)	- 450 - 600
3.	Slope	- 30 C
4.	Landuse	- Agriculture
5.	Crops	- Rubber + tapioca
6.	Vegetation cover	- 50%
7.	Land management	- Partially covered
8.	Soil erosion mm/ha/yr	- 9
9.	Erosion class	- Moderate

Table 5.26 - Soil erosion in selected watersheds of Pcoyamkutty river basin

1.	Watershed	- Perumbankuttu
2.	Altitude (m)	- 500 - 600
3.	Slope	- 40 C
4.	Landuse	- Agriculture
5.	Crcps	- Tapioca
6.	Vegetation cover	- Nil
7.	Land management	- Exposed
8.	Soil erosion mm/ha/yr	- 15
9.	Erosion class	- High

Table 5.27 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Mankulam 1
2.	Altitude (m)	- 600 - 650
3.	Slope	- 35°
4.	Landuse	- Agriculture
5.	Crops	- Tapioca + rubber
6.	Vegetation cover	- 25%
7.	Land management	- Partially exposed
8.	Soil erosion mm/ha/yr	- 16
9.	Erosion class	- High

Table 5.28 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	- Mankulam 2
2.	Altitude (m)	- 600 - 700
3.	Slope	- 40°
4.	Landuse	- Agriculture
5.	Crops	- Cardamom. under shade trees
6.	Land management	- Covered
7.	Vegetation cover	- 50%
8.	Soil erosion mm/ha/yr	- 6
9.	Erosion class	- Moderate

Table 5.29 - Soil erosion in selected watersheds of Pooyamkutty river basin

1.	Watershed	-	Mamalakandam
2.	Altitude (m)	-	400 - 450
3.	Slope	-	20°
4.	Landuse	-	Agriculture
5.	Crops	-	Annual crops + rubber
6.	Land management	-	Partially covered
7.	Vegetation cover	-	25%
8.	Soil erosion mm/ha/yr	-	15
9.	Erosion class	-	High

Results

The description of watersheds and the soil denudation recorded are given in Tables **5.11** to **5.29.** Of the 19 watersheds observed seven had low rates of soil erosion and five high. Seven are moderately erosion prone.

Discussion

An analysis of the denudation rates and the characteristics of the watersheds reveal the following.

(1) Soil erosion is **low** or negligible in forested watersheds irrespective of slope features. Reed areas are the least erosion prone.

(2) Rates of erosion increase consequent to depletion of forests.

(3) Conversion of forests to agriculture triggers denudational rates. They are low under perennial crops (tree crops) and high under annual crops.

The 19 watersheds monitored represent the soil erosicn status of the Pooyamkutty river basin as a whole. It can be estimated that 37% of the basin is subject to low rates of soil erosion; 37% to moderate and 26% to high. These trends are validated by the sediment flow data presented subsequently.

Projection

With the commissioning of the project (Pooyamkutty Project Per Se) over 3,000 ha of land will be deforested. To add to the devastation, new settlements are bound to come up in the catchment area. A drastic change in landuse can be expected and also an increase in the rates of erosion. At present all the silt is carried downstrear!. With the commissioning of the dam, silt loads of greater magnitudes will settle in the reservoir.

The river continuum concept (Vannote et al. 1980) proposes that the gradient of physical factors formed by the drainage network exert a direct control upon the dynamics cf the river system. The river can be divided into 3 zones the headraters, middle order streams and large rivers. Pooyamkutty river, being only a tributory of a major river Periar, has only the first and second zones.

Zone 1 is the primary sediment producer, and strong links with terrestrial systems are reflected by marked influence of riparian vegetation. The head water zone of Pooyamkutty is almost 35% of its total watershed. Maxinum human pressure is already being exerted in this zone compared to other parts of the river basin. Thus, further deforestation can produce higher rates of sedimentation and premature siltation of the reservoir.

C. SUSPENDED LOAD

Changes in sediment transport have often been identified as the most important impart consequent to impounding river?. These impacts arise becuase more than 90% of the sediment load and practically all the coarser materials will be trapped behind the dam during the early years of operation.

Methodology

According to the river continuum concept the Pooyankutty river was divided into headwater streams and middle order streams. Observation: were taken at the following locations - Karinthiriar, Melasariar, Kunjiar, Thudupiar and Pooyamkuttiar. (Fig 5.3) and (Plates 9 and 10).

Depth intergrated samples were collected during premonsoon 1986 - monsoon 1986 and post monsoon 1986. Suspended load was estimated in these samp1es.

Resu1ts

The results are given in Table 5.30

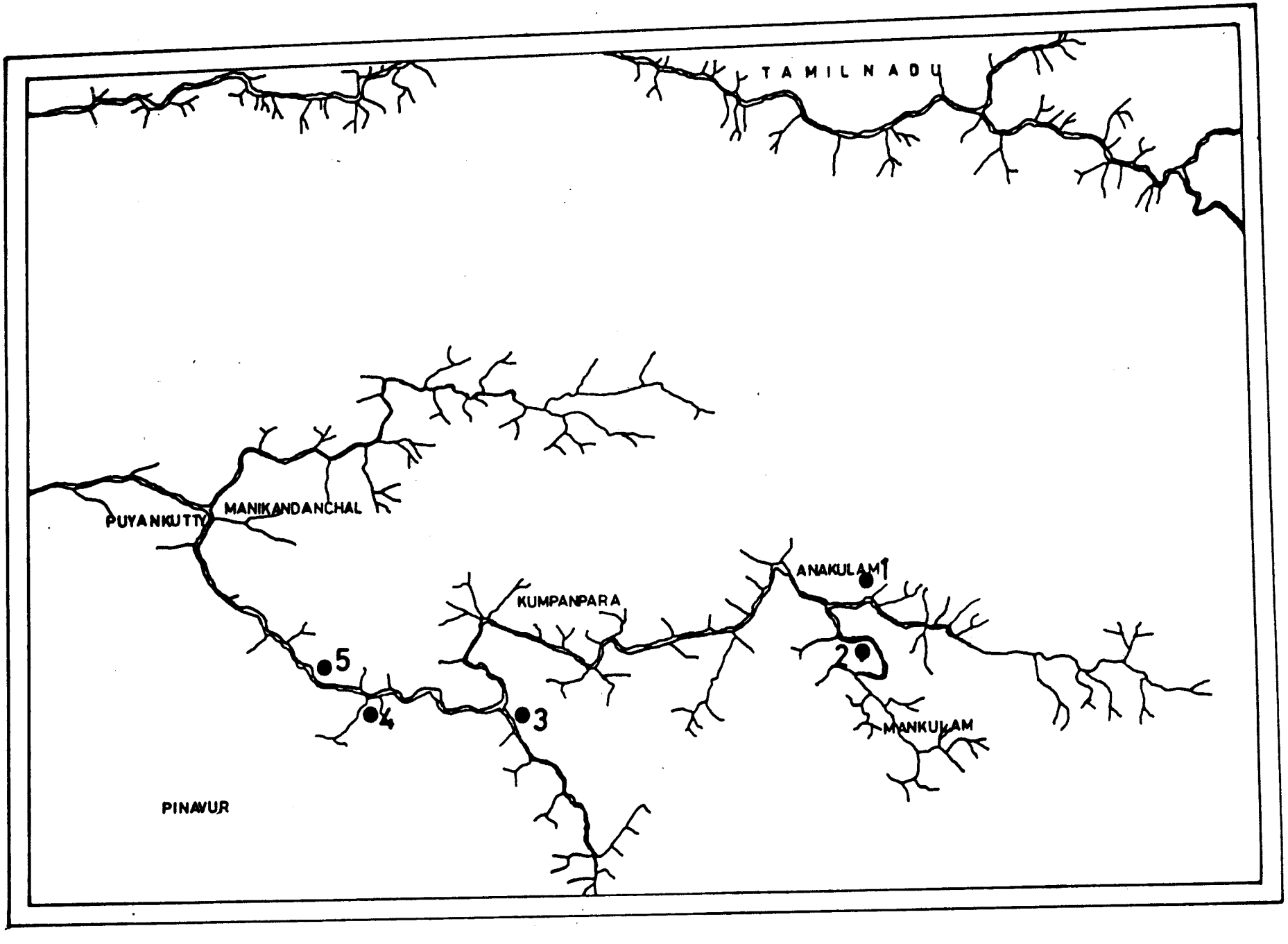

Fig.5.3. Locations where suspended load was monitered in Poovamkutty River Basin

Table **5.30** Suspended sediment load **(g/1) of** selected rivers in the Pooyamkutty river basin

No.	station	Pre monsoon	Monsoon	Post monsoon
1.	Melasariar	**0.138**	**0.520**	0.201
2.	Karinthiriar	**0.089**	**0.180**	0.146
3.	Kunjiar	**0.104**	0.346	**0.118**
4.	Thudupiar	**0.088**	0.418	**0.201**
5.	Pooyamkuttiar	**0.078**	0.224	**0.085**

The results clearly indicate that the distrubed watershed of Melasari and Thudupi yield higher rates of sediment during the monsoon period.

Projection

If the projects is implemented the resultant destruction of the protective cover of watersheds will drastically increase the sediment flow in the river. Thus sooner or later, the reservoir of the will be filled up with silt.

6. WILDLIFE STUDIES

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Division of Wildlife Biology

INTRODUCTION

Status of larger mammals and birds in the Pooyamkutty hydroelectric project area was investigated. An area of about 160 km^2 situated in and around the submersion area of the main reservoir and lying between 10° 05' to 10° 15'N and 76° 45' to 77° 55'E was chosen for studying status of wildlife and availability of water (Fig. 6.1). The status of wildlife in the 160 km^2 area is compared with that of the submersion area to highlight the peculiarities of the submersion area.

METHODS

The area selected for intensive study was marked on a topo map of 1:50,000 scale. Each square falling within five minute latitude and longitude was divided into 100 grids. Thus the area was divided into 200 grids of 0.81 km^2 each. The grids were located in the field and various parameters recorded on the These included sightings of larger mammals or their droppings or other indirect evidences and water availability.

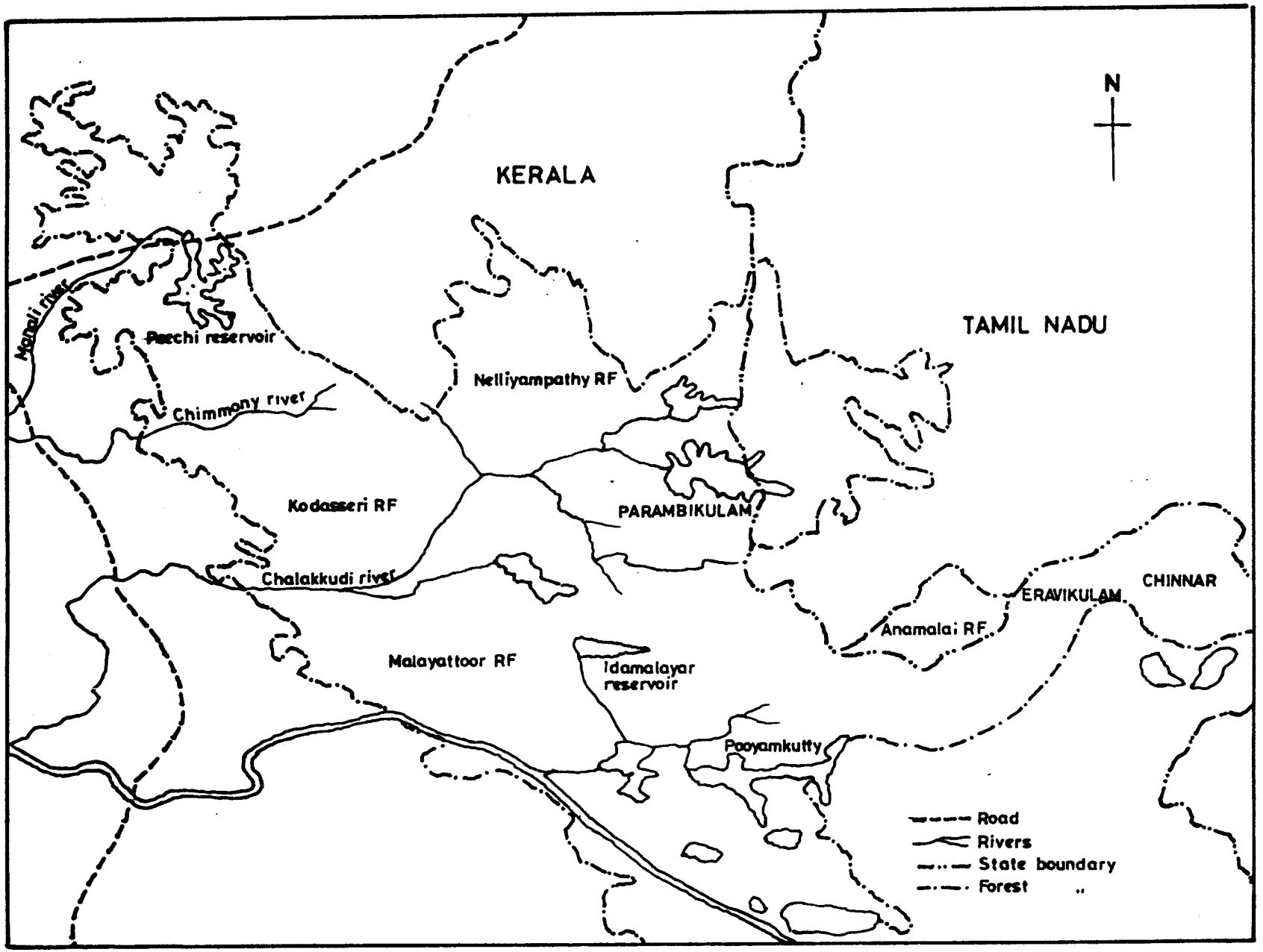

Fig.6.1. Pooyamkutty hydroelectric Project Area and the gird study regions

The status of animal: and availability of water to the animals were recorded from each grid. A comparison was made betwen the submersion area and the area covered by the grids.

Larger mammals

Small herds of elephants were sighted in many parts of the study area. It was not possible to estivate their number. **Rut** they probably do not exceed 50. Elephants were common in 6% of the grids. They **were** occasicnal visitors tc 65.8% of the grids. There had been no report of elephants in 16.8% of the grids. Elephants were reported only in the past in about 12% of the grid? (Ten years ago in 1.3% and two years ago in 10.4 % of the grids). When the submersion area alone is considered, most cf the area is frequented **by** elephants (Figs 6.2 and 6.3). Two herds observed near the main dam site had the following composition (Table 6.1) :*

Herd1		Herd2	
Adult females	2	Adult females	5
Subadult female	1	Subadult female	1
Adult male	1	Calves	2
		Adult male	1
Total	4	Total	9

Table 6.1 Elephant herds observed in the study area.

* These two herds were observed **by** Mr. K.K.Ramachandran on 10th and 11th September **1987.**

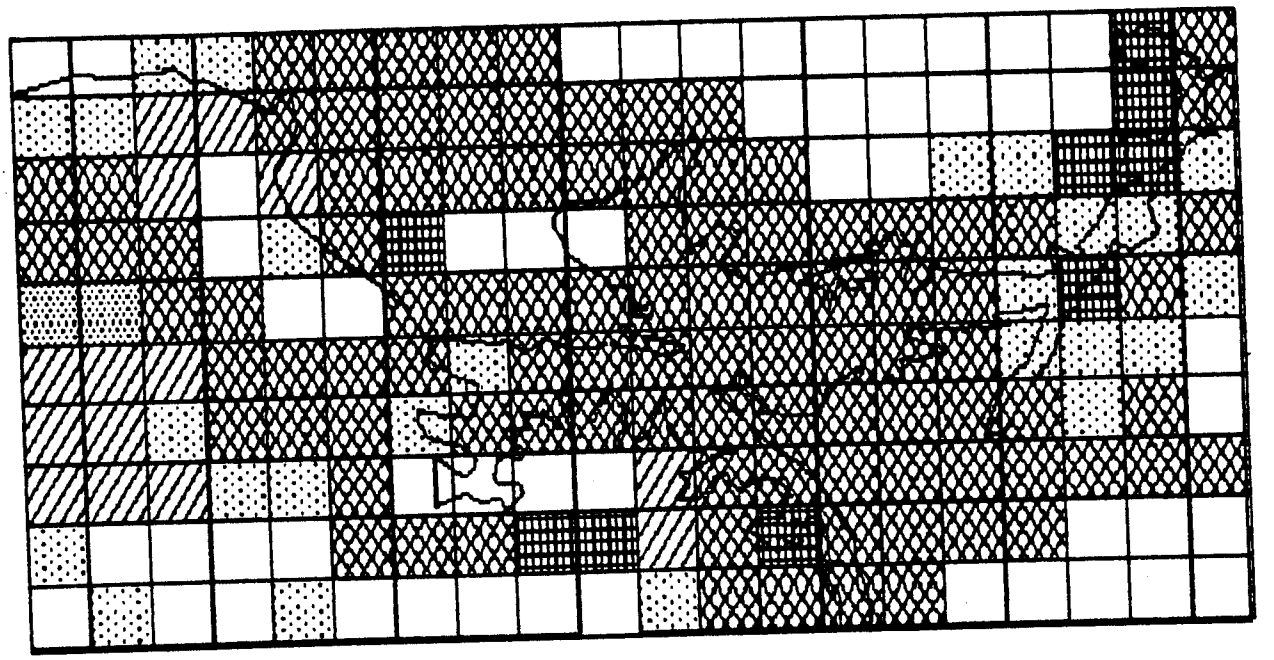

Fig. 6.2 Distribution of elephants in the study area

Legend: blank = no data, spaced dots = no report,
dots = 10 years ago, slashes = 2 years ago
cross hatches = rare, checks = common

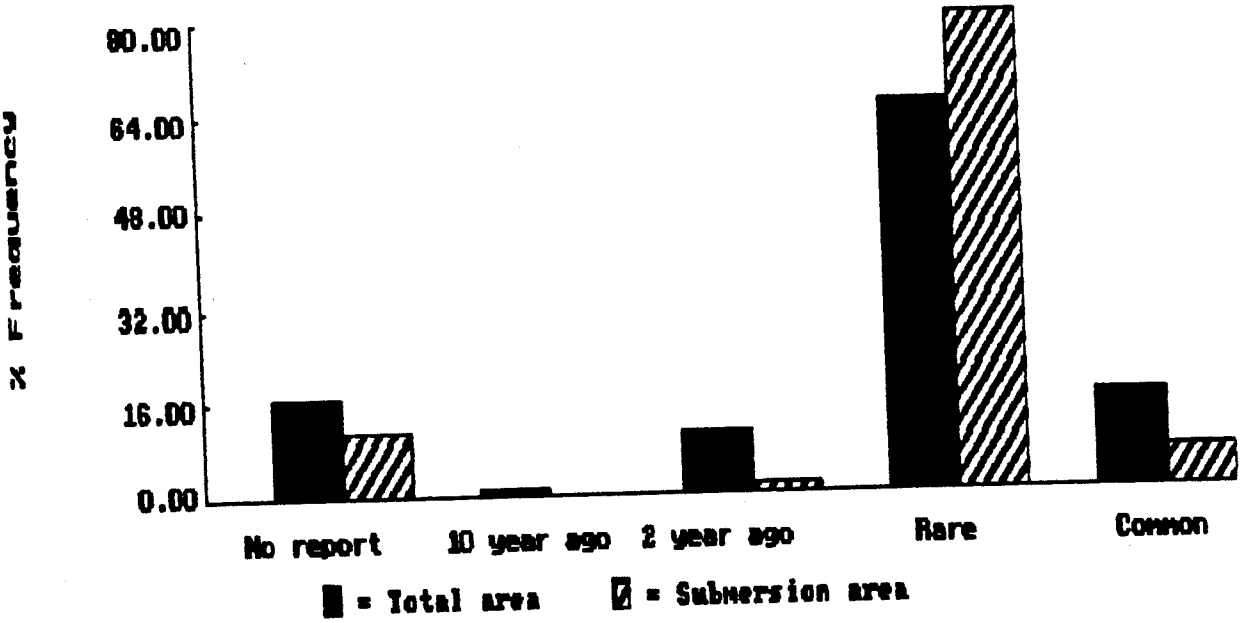

Fig. 6.3 Distrubution of elephants in the study area.

The study area contains many animals common to the forests of this region. Wild pigs and sambar were present almost throughout the habitat, except in highly disturbed areas like Anakulam, but not in such density as in protected areas. Wild pigs were more prevalent in areas adjoinig cultivation. Gaur was observed or reported in the submergible area and in Varium and in the Vellarankuttu area Regarding other animals bonnet macaque seers to be present in many localities. They were observed near the dam site and at Kattipara on inaccessible rocky ledges. Bear has ben reported near Vellarankuthu and Pinavoor and in a few other scattered grids. There was report of panther near Mettanappara. Wild **dogs** were reported from most of the areas but rarely from the submersion area. In general, both the study area and the submergible area had animals in low density. The submergible area had slightly higher density (Table 6.2 and 6.3).

No	Animal	Common	Rare	Only in past
1.	Elephant	+	+++	+
2.	Sambar	+	+++	+
3.	Gaur	+	+	+
4.	Wild pig	+	++	++
5.	Bonnet macaque		++	
6.	Panther		+	
7.	Wilddog		++	
9.	Sloth bear	+	+	

Table 6.2 Status of animals in the grid **area.**
(+=Less than 25%,++=25-50%,+++=50-75%,++++ More than **75%** grids)

No	Animal	Common	Rare	Only in past
1.	Elephant	+	+++	t
2.	Sambar	+	++++	
3.	Gaur		++	+
4.	Wild pig	+	++++	
5.	Bonnet macaque		+++	
6.	Panther		+	
7.	Wilddog		++	
9.	Sloth bear	+	+	

Table 6.3 Status of animals in the submergible area.

(+=Less than '25%,++=25-50%,+++=50-75%,++++ More than 75% grids)

Birds

The following birds were observed in the study area, mainly from Pindimedu and Anakulam regions.

Common myna	Acridotheres tristis
Southern jungle myna	Acridotheres fuscus
Common kingfisher	Alcedo atthis
White breasted water hen	Amaurornis phoenicurus
Pond heron	Ardeola gravii
Cattle egret	Bubulcus ibis
Brown fish owl	Bubo zevlanicus
Crow pheasant	Centropus sinensis
Chloropsis	Chloropsis cochinchinensis
Magpie robin	Copychus saularis
Southern Indian roller	Coracias benahalensis
Common crow	Corvus splendens
Jungle crow	Corvus macrorhvnchos
Southern tree pie	Dendrocitta leucogastra
Tree pie	Dendrocitta vaaabunda
Black drongo	Dicrurus adsimilis
Racket tailed drongo	Dicrurus paradiseus
Malabar golden backed wood pecker	Dinopium benghalense
Heart spotted wood pecker	Hemicircus canente
Grey jungle fowl	Gallus sonnerati
Bill myna	Gracula religiosa

White breasted kingfisher	Halcyon smyrnensis
Fairy blue bird	Irena puella
Grey backed shrikde	Lanius schach
Small green barbet	Megalaima viridis
Crimson breasted barbet	Megalaima rubricapilla
Chestnut headed bee eater	Merops leschenaulti
Yellow browed bulbul	Hypsipetes indicus
Rufous woodpecker	Micropternus brachvurus
Paria kite	Milvus migrans
Yellow wagtail	Motacilla flava
Forest wagtail	Motacilla indica
Large pied wagtail	Motacilla maderaspetensis
Malabar whistling thrush	Myiophonus horsfeldii
Purple sunbird	Nectarina asiatica
South Indian Blackheaded oriole	Oriolus xanthornus
Tailor bird	Orthotomus sutorius
Grey tit	Parus major
Brown headed stork billed king fisher	Pelargopsis capensis
White breasted king fisher	Halcyon smirnensis
Orange (scalrlet) minivet	Pericrocotus flammeus
Small minivet	Pericroctus cinnamomeus
Ruby throated bulbul	Pycnotus aularis
Red whiskered bulbul	Pycnotus jocosus
Black bulbul	Hypsipetes madaaascariensis
Indian pitta	Pitta brachyura
Blue winged parakeet	Psittacula colomboides
Scimitar babbler	Pomatorhinus horsfieldii
Spotted dove	Streptopelia chinensis
Grey headed myna	Sturnus malabaricus
Common green pigeon	Treron phoenicoptera
Malabar grey hornbill	Tocus griseus
Rufous babbler	Turdoides striatus
Ceylon Hoopoe	**Upupa epops**
Yellow wattled lapwing	Vanellus malabaricus
White rumped spine tailed swift	Chaetura sylvatica
Crested serpent eagle	Spilornis cheela
Red wattled lapwing	Vanellus indicus

Water availability

Water availability to the larger mammals was uneven among the grids. **14%** of the grids did not have a permanent source, **28.4%** had seasonal availability and the rest had perennial rivers or streams. The submersion area, as one would expect is a perennial source of water to animals (Fig **6.4** and ***6.5).***

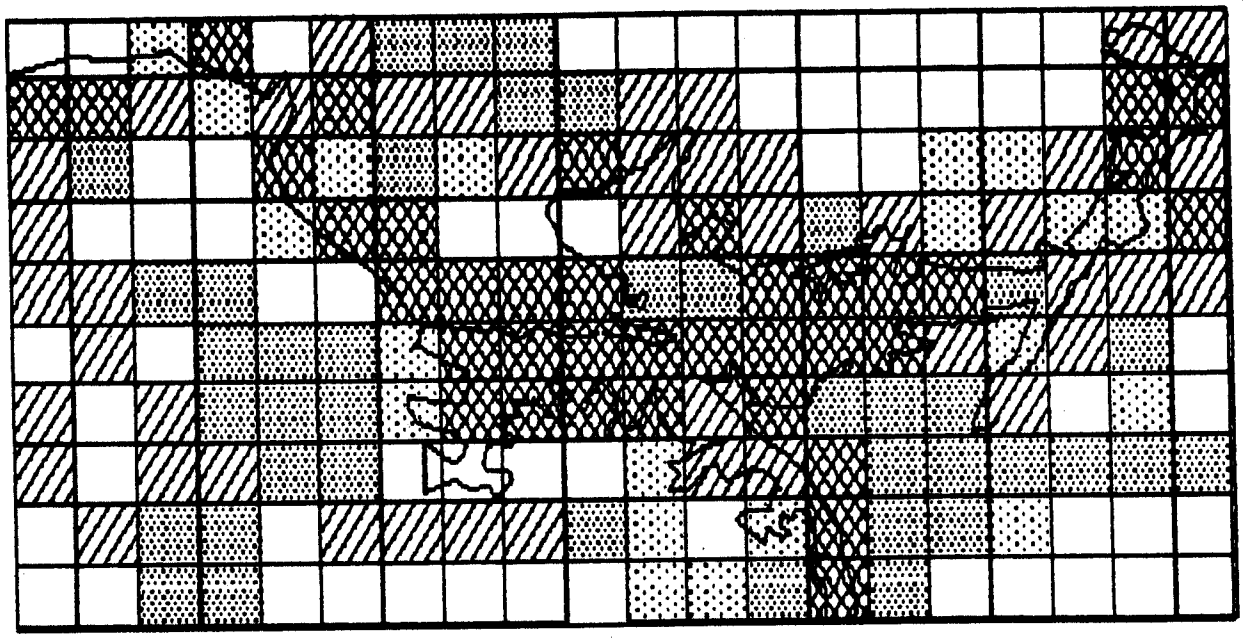

Fig. 6.4 Distribution of water availability to the animals in the study area.

Legend: blank = no data, spaced dots = nil,
dots = seasonal, slashes = perennial streams,
cross hatches = perennial rivers

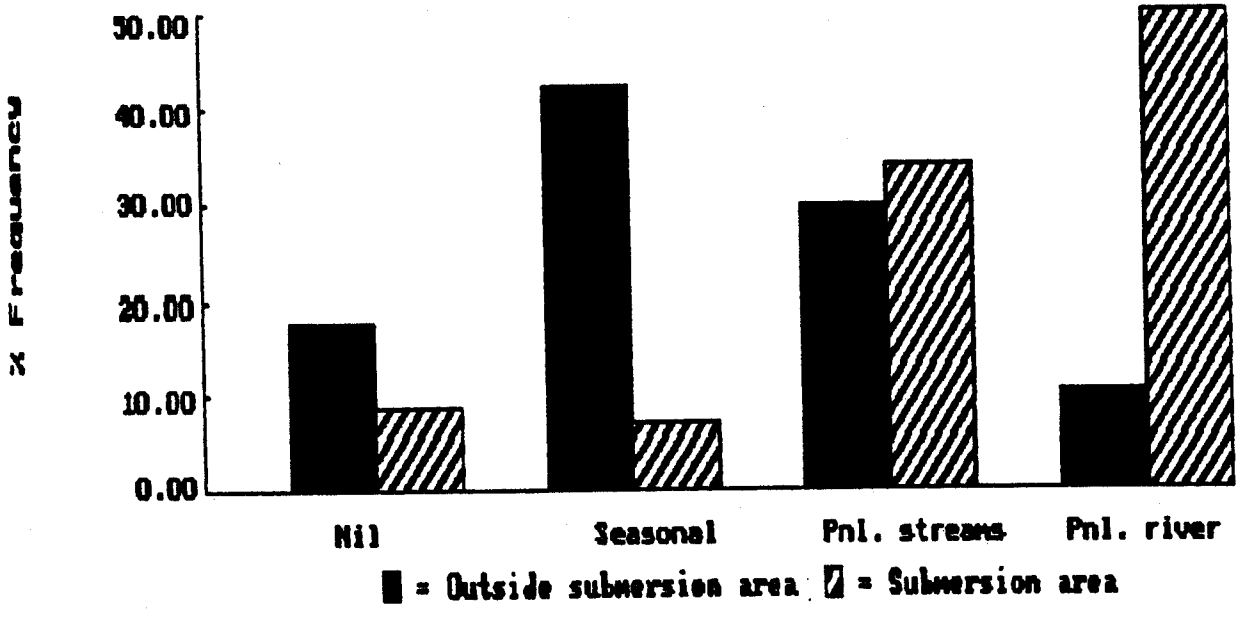

Fig. 6.5 A comparison of water availability between the submersion area and its sarroundings.

DISCUSSION

The upper reaches of Pooyamkutty are important from the point of view forest continuity. It connects a stretch of forests extending from the Parambikulam Wildlife Sanctuary to the Eravikulam National Park (Fig. 6.6). The area contains some of the representative animals of the region, while a few have disappeared due to disturbance. A few herds of elephants totalling not more than about 50 are present. Calves, juve- niles, adult females and adult males have been observed in the herd reflecting a healthy status. Sambar deer and wild boar are present in low density almost throughout the area as is the case with most of the forests in Kerala. Gaur is seen occasionally in the undisturbed areas. There are rare reports of wild dog, panther and sloth bear. There has not been any recent report of tiger or liontailed macaque. Bonnet macaques are present on steep inaccessible ledges of rocks. About 65 species of birds have been sighted, mostly from Pindimedu and Anakulam areas. This probably is an under estimate due to the limited area studied.

The site of the main dam and its submersion area is not particularly rich in larger mammals. Nor does the area contain any viable population of endangered animals except the elephant. The forest continuity between the nearby wildlife sanctuaries is impo- rtant, but the area where the main dam is proposed is not an imporatant corridor. Therefore construction of the main dam at Pindimedu on the Pooyamkutty river is not likely to affect the wild animals very adversely. As against this, the case with the feeder dams are entirely different. They would submerge rich evergreen forests of

upper Pooyamkutty region which is an important corridor that links the Parambikulam Wildlife Sanctuary with Eravikulam National Park and Chinnar Wildlife Sanctuary. In addition, ,construction of these dams would lead to establishment of a network of roads linking Pinavur, Idamalayar, Pooyamkuttyy, Upper Idamalayar, Anamala and Mankulam and thus opening up almost all the presently inaccessible forests in the Pooyamkutty region to encroachment and destruction. Thus, the construction of the feeder dams would very adversely affect the forests and animals of the region.

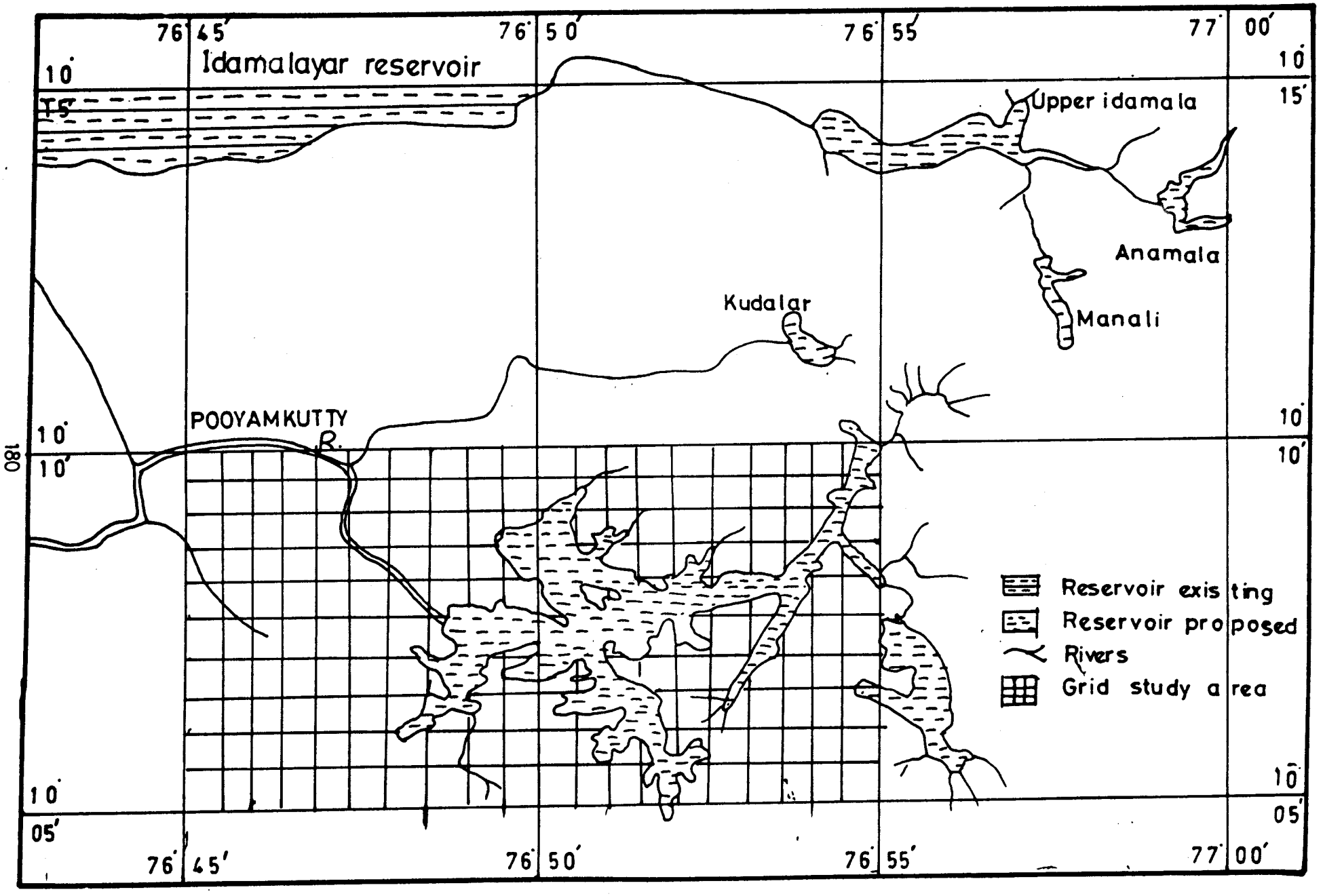

Fig.6.6. Pooyamkutty and adjacent forest areas

7. HUMAN IMPACT STUDIES

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Introduction

For the purpose of this study, only the first dam at Pindimedu with a submergible area of 2,800 ha is considered. The catchment area of this dam consists of natural forests with human settlements in several valleys. When the remaining dams come up, several settlements in the catchment of the first dam will be submerged.

This section consists of five sub sections. 1. Analysis of reed -based economy, 2. human settlements in the submergible area of Pindimedu dam 3. settlements in the catchment. 4. Discussion, emphasising conflicts of interest between power production and forest resource utilisation 5. Conclusions.

The reed economy of Pooyamkutty

The Pooyamkutty project area is rich in reed resources which is an important raw material for mat and basket weaving in the traditional sector and for paper making in the modern sector. The traditional sector consists of the Kerala State Bamboo Corporation (KSBC) formed by the Government of Kerala in 1971 to organise the extraction and supply to the weavers households all over Kerala and to

market their products. Although the KSBC has been given monopoly rights to extract and supply reeds to the traditional sector they have been unable to meet the full requirement of the sector. The corporation has concentrated on supplying reeds to the weaver groups living away from the forests. Hundreds of weaves families live on the forest fringes around Pooyamkutty who collect their requirements directly from the forests.

The modern sector consists of two units: the century old Punalur Paper Hill (PPH) and the Hindustan Newsprint Limited (HNL), a subsidiary of the giant public sector Hindustan Paper Corporation which started production in 1982-83. As the PPH is lying closed for the last five years for various reasons, including the shortage of reeds, only the HNL is working the forests at present. The quantity of reeds collected by different agencies is given in Table 7.1. It can be seen that the collection of reeds by all agencies from Pooyamkutty ranges from 21 to 26 thousand tonnes during the last three years. HNL accounted for the largest share with around 16 thousand tonnes during 1985-86 to 1987-88. The traditional sector comprising the KSBC and the weavers who collect their requirements directly from the forests together collect about 7 thousand tonnes of reeds from Pooyamkutty on the average. While the reed collection from Pooyamkutty region represented about 23 to 30 percent of the total reed collection of HNL during the period for the KSBC collection from Pooyamkutty represented about 33 to 49 percent.

Table 7.1. Collection of reeds by different agencies

(Quantity in tonnes)

Year	HNL	KSBC	Direct collection by weavers**	Total collection from Pooyamkutty
1985-86	54677 (25.33)*	14415 (49.05)	958 (100.0)	21876
1986-87	69201 (22.79)	13867 (47.44)	579 (100.0)	22926
1987-88	66385 (29.53)	17500 (33.39)	505 (100.0)	25953
Average				
Rexala	63421	15261	-	-
Pooyam-kutty	16407 (25.87)	6498 (42.58)	680 (100.0)	23585

* The figures in paranthesis refer to the percentage of quantity collected from Pooyaakutty area to the total quantity collected by each agency

** Estimated by converting the quantity of mats collected from Pooyaakutty area by KSBC using a conversion factor of 1 bundle of reeds of 50 kg equals 336 sq. feet of mats and assuming that private traders collect about the same quantity of mats as the KSBC from Pooyamkutty area. 720 numbers of reeds equals 1 tonne.

Source: Annual Report8 and files of the HNL and KSBC

The modern sector units have signed long term agyrements with the Government of Kerala in which the government has assured a specified annual supply of reeds from the forests. The PPH is to obtain an

allotment of 85,000 tonnes and the HNL 1,89,000 tonnes of reeds. The KSBC also gets an allotment of 30,000 tonnes of reeds. It can be seen from the table that the actual supply is far short of the commitments indicating the scarcity of tbe raw material.

Considering the average quantity of reeds extracted from Pooyankutty during the period 1985-86 to 1987-88 the employment generated has been estimated and is shown in Table 7.2. In the traditional sector, as only mature reeds can be used, the outturn of a reed cutter is less than that in the paper industry. It has been estimated by the KSBC that the average outturn per day for a cutter is 40 numbers. This is equivalent to 18 man days for extracting a tonne of reeds. From the registers maintained by the contractor of the paper industry it was estimated that the average daily outturn of reeds per worker was 123 kg. This is equivalent to 8.13 man days for extracting a tonne of reeds for the paper industry.

Estimating the employment generated for reed processing is more complex. The HNL employed on the average 1717 persons. Since reed is used for making chemical pulp, employment in reed processing in the paper industry is apportioned on the basis of the ratio of chemical pulp to chemi-mechanical pulp which is 24:76. For the traditional sector it is assumed, based on the interviews with weavers and the officials of the KSBC, that on the average 3 reeds per worker per day is used for mat weaving and 2 reeds per worker per day for basket weaving.

Table 7.2. Distribution of Employment per year from reeds of Pooyamkutty origin *

Products	Employment in thousand		Total
	Reed extraction	Reed processing	
Paper	133	124	257 (11.05)
Hat & basket	129	1939	2068 (88.95
Total	262 (11.27)	2063 (88.73)	2325 (100.0)

* Considering the average extraction of reeds from Pooyamkutty for the years 1985-86 to 1987-88 by different agencies.

It can be seen that while the paper industry consumes about 70 percent of the reed production from Pooyamkutty it provides only 11 percent of the total employment. Employment in reed extraction for both the sectors together is 2.6 lakhs man days per year and the total employment in reed extraction and processing together from the reeds from Pooyamkutty comes to 23.25 lakh man days per year. This does not include the employment in transport of reeds from the forest to the processing centres or for supervision in the extraction areas.

The modern sector units organise extraction of reeds through the agency of contractors. The runtractor is paid on the basis of quantity of reeds supplied at the factory gate after making

adjustments for the moisture content. The contractor in turn fixes the cutting charge paid to the cutters in the coupe per quintal of reed6 brought to the loading site. Both male and female cutters work in the reed coupes in almort equal numbers. Women are as adept as men in this activity that there is no marked difference in the earning capacity. The number of workers in a coupe vary from 200 to 600 between low and peak seasons. A closure period of three nonths from July to September, during the rains, is enforced since 1986. The KSBC has around 800 cutters on its rolls in Pooyamkutty area.

As the coupe boundary and the submergible area do not coincide, this include6 some areas above the PRL and even some area down stream of the dam. However, as further disaggregation is not possible and as the quantity from outside the Pooyamkutty catchment is quite small the difference is ignored.

The difference between the extraction activity by the modern and traditional sector is that while the paper industry can use both the mature as well as the immature reeds, the traditional sector can accept only the mature ones. As the paper industry collects their requirement through the agency of contractors, selected after competitive bidding on the extraction and transportation charges, a concentrated type of felling is adopted which minimises the cost per unit volume as well as the cost per unit area. The workers are also paid on the basis of the quanitity cut. So there is a natural tendency to include the immature stock also. Silvicultural rules regarding reed extraction is never imposed on the paper industry mainly because of institutional coustraints of the Forest Department

and the shortage of field staff. Even the closure period of three months during the rains, has been implemented only since 1986-87 in Malayattur Division. The normal practice is that the paper industry requests suspension of the closure period due to inadequate stock to run the factory and the same is routinely granted. It must be pointed out that the closure during 1986 and 1987 were possible because of the comfortable reed stock position of HNL, the only user. PPM is closed and Gwalior Rayons, another bamboo using unit, was also closed which enabled HNL to collect bamboo from their coupe also. The traditional sector adopts a dispersed type of felling, which due to necessity, conforms to the slection felling advocated by the Forest Department.

The KSBC does not supply reeds to the weavers in Pooyamkutty area. The whole quantity collected by the Corporation is transported to 19 main depots and 83 sub depots throughout Kerala and a few co operative weaving societies. The KSBC has 4 mat collection depots in Pooyamkutty area. There are 647 registered weaver families attached to these depots. Weavers living away from the depots find it more convenient to sell their mats to private traders who have several collection centres around Pooyaakutty. They also arrange door to door collection with cash down payment. Further, only 5' X 3' size mats are collected by KSBC from Pooyamkutty. Seme areas specialise in larger sized mats which only private traders accept. The officials of the KSBC estimate that private traders together collect about the same quantitiy of mats as the Corporation from the Pooyamkutty area.

A comparison of the characteristics of the modern and traditional reed processing sectors (Table 7.3) shows that the employment provided by the modern sector is very low compared to the traditional sector. The earning per worker in the modern sector is substantially higher, but the wages per tonne of reed processed is quite low in comparison to the traditional sector. Investment in fixed capital as well as power consumption is enormously higher in the modern sector. As the employment potential of the modern industry is very limited, given a situation of reed scarcity and depletion, an allocation policy favouring the modern sector has significant negative redistributional effects (Nair 1986). Further, the concentrated type of extraction adopted by the modern sector which do not make fine distinction between mature and immature stock accentuates the depletion of the resources and delays the regeneration process.

Table 7.3.

Characteristics of Reed-based industry

Important ratios	Traditional Sector	Modern Sector	
	Hat weaving	Punalur Paper Hill	Bindustan Newsprint
Consumption of reed (per worker/yr in MT)	1.2	38	40
Wages and salaries per MT of reeds (in rupees)	750	284	189
Wages and salaries (per worker/yr in rupees)	900	10,775	28,356
Fixed capital investment (per worker in rupees)	50	71,000	9,15,510
Power and fuel consumption (per worker/yr in rupees)	0.2	18,850	95,272

* . Based on the accounts of the Kerala State Bamboo Corporation. Fixed capital mostly relates to warehouses for storage of finished products, office buildings, vehicles, etc.

** Based on the accounts of Punalur Paper Hills for the years 1980-81 during which the capacity utilization was only 20 percent.

Source Col. 2 & 3 Nair (1986)
Col. 4 HNL Annual Report 1986-1987

The PPH which started with the reed forests around the mill, steadily exhausted the reeds in their earlier coupes and moved on to fresh areas. The reed forests of Kulathupuzha, Neyyatinkara and

Anchal areas have disappeared[1] after the extraction activities of the mill. The PPM started working the forests in the Neriamangalm area since 1957-58 and since 1965 worked the Bhoothathankettu area. After exhausting the reeds on the Neriamanagalam - Adimali route they built the road from Aran Mile to Averkutty on the old Alwaye-Munnar road and reveral pocket roads into the interior during late 60s and early 70s. The paper industry is mainly responsible for the development of accessibility in the Pooyamkutty forests. After the entry of the HNL in to Pooyaakutty in early 80s, the road building activity was intensified. Nor the road network extends to all the reed growing areas. The Kunjyar-Kathippara road and the roads from Manjappara to Parantha and Pattanamppara and their feeder roads were built by the ENL contractors since 1983-84. The bamboo extraction for Gwalior Rayons in 1973 helped improve the PPM coupe road from Thuduppi to Kalladi pocket.

It must be noted that the high level of reed extraction was maintained by the paper industry due to its ability to move on to new coupes when the old ones are depleted. Now the situation has changed. The reed coupes hare expanded to all the reed growing areas making it necessary to return to the old regenerated coupes. Sustainability of production has become relevant as never before. The paper industry's extraction practices do not give priority for sustained yield, since the contractors do not have any long term interest in this activity. Even the reed cutters are forced to undermine their future employment becuase their current earnings are quite low and the contractor does not provide any incentive for collecting mature reeds.

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1 S. Gopalakriahnan Nair (1985) 'Traditional Reed Mat Industry - Problems and Prorpects' cited in Kumar (1985)

Criticism of the paper industry by outsiders can perhaps be ignored as motivated but surely the opinion of the Forest Department has to be examined. Circular No. 12-82 dated 2.5.'82 issued by the Chief Conservator of Forests says,

> "..... It has come to the notice of the undersigned that the felling rules are honoured more by its violation than by adherance in that extraction of reeds by contractors engaged by the various firms for reed collection. It appears that they are doing a clearfelling of reeds in many places and not selection felling as stipulated in the felling rules. This is a sad reflection of the supervision by the departmental staff and it is needless to point out that such violation of felling rules will jeopardise regular sustained yield and deplete the reed stock thereby aggravating the alredy delicate raw material position in the State. This will in due course adversely affect the industries concerned as also hundreds of labourers involved in it. It is therefore once again emphasised to see and enforce strictly the felling rules so as to attain the maximum sustained yield ....."

There is no evidence to show that either the paper industry has changed its method of working or that the supervision of the Forest Department has been vigilant since, except for adopting a closure period during two years when the stock position of the industry was comfortable.

The forests in Pooyamkutty has been degraded in patches due to human activity in the distant past. But unlike in other forest areas, the degradation process has had a benificial effect, in that reeds, an eecononic resource, has colonised the open areas and the vegetation cover has been maintained. The emergence of large patches of reeds

are attributed to biotic interference in the past. Bourdillon (1893) considers shifting cultivation (hill cultivation as he calls it) in the past to have promoted reeds in the place of tall trees. The Working Plan of Malayattur Division states that " most of the reed areas that we find in the midst of otherwise continuous evergreen forests are the result of clearing the evergreen forests for shifting cultivation" (Viswanathan, 1956)

The degradation process has been arrested due to three factors:

a) Heavy human casualties in the tribal hamlets engaged in shifting cultivation due to small pox, malaria etc.
b) Persistant crop damage due to wildlife depredation and
c) Restrictions on shifting cultivation imposed by the Forest Department

Intensive extraction of reeds, particularly by the paper industry, is currently threatening the regeneration of forests and activating the degradation process. It is relevant now to reconsider the forest management strategy and decide whether accelerating the degradation process is acceptable or a conservation oriented policy can be adopted and the forests be allowed to recover.

Forest management options in this situation are - (1) Attempt to bring the forests back to the climax stage by appropriate cultural practices, (2) To maintain the reed areas in a sustained yield management and (3) Permit further degradation of the forests by unsustainable extraction processs. No doubt the present policies with

regard to reed management is leading to further degradation of the forest by unsustainable extraction practices. This policy, if it continues, will adversely affect the reed using sectors within a fen years.

In the interests of forest conservation, the first option is preferable. But when we consider the short term social cost of adopting this path, the second is more feasible. KSBC has more than 14,000 registered mat weaver families on their rolls. There exist hundreds of other weaver families who collect their requirement directly from the forests. Although the modern sector industries can diversify their raw material base in the long run, in the interim period, their requirement of reeds has also to be met. Therefore a time bound programme to reduce reed extraction which includes a comprehensive plan to find alternative employment to the traditional sector reed workers and finding alternative ran material sources for the modern sector is the best option.

In order to ensure working the reed forests on sustained yield, non-declining, even flow basis, it is necessary to reduce the level of current extraction. How the reduction should be shared by the two sectors is important. The traditional sector has a better claim to the reeds of Pooyamkutty in that it has been their traditional source and it is closest to their main weaving centres. Further, weavers have a preference for reeds from Pooyamkutty as they report that they get 8 to 10 slivers from each reed of Pooyamkutty origin whereas they get only 5 slivers from Ranni reeds. Therefore the claim of the traditional sector has to be given priority and the reed areas of Pooyamkutty should be reserved for the traditional sector.

The Pindimedu dam and the related works, if sanctioned, will gravely affect not only the reed resources of Pooyamkutty but also the whole reed economy of Kerala. It will irreversibly destroy the sustenance of a large section of the population. Therefore, in the interests of forest conservation and the reed using sectors, it is very important that the hydro electric project is shelved.

Settlements in the submergible area and powerhouse area of the Pindimedu dam

There are human settlements both in the submergible area of the Pindimedu dam and in the power house site at Pinavur, The settlements in the submergible area are Arakulam (non-tribals) Xettanappara (tribal and non tribals) and Kurathikudi (tribals). The settlement at Pinavoor is again of tribals. In this section each of these settlements are described. Also presented are the number of households below the submersion line marked on the ground by the FRL Survey of the Kerala State Electricity Board (KSEB). The resettlement proposal and its inadequacies are also pointed out.

Anakulam

According to the FRL line marked on the ground, 65 households consisting of 291 persons (183 adults and 108 children) live below the water line. If the edge of the reservoir is also to be cleared of habitations and agricultural activity, then the number of households will be much more. In this tiny township, 5 rows of shops, the forest gaurd station, a temple and a church fall under the water line.

Anakulam was the western boundary of the Kannam Devan Concession granted to the consortium of European planters about a century back. Much of the concession land were retained as forests by the planting company. During early 70s the unplanted areas were taken over by the Government. Anakulam area was developed as a rubber plantation. The access to Anakulam was from Wunnar, the headquarters of the planting company. This estate, which was 387 ha as a long strip from Anakulam upto Hankulam, changed hands several times. One of the later owners built the old Alway-Munnar road which passes through Pindimedu. A portion of this road got washed away in floods during 1924. A new road via. Adimali was opened in 1931 eclipsing the importance of the old road.

The working plan for the Woovattupuzha part of the Walayattur Division 1951–52 to 1966-67 by TP Visnanathan records that 35 acres of forest in Anakulam estate has been de-reserved in 1920. In late 60's the rubber trees were slaughter tapped the estate was divided into small bits and sold it to settlers from Palai. The new owners started cultivation in 1969. The liquidator of the Palai Central Bank contested the right of the settlers on this land claming that the estate was mortaged with the bank. The High Court of Kerala upheld the right of the settlers in 1980.

At present there are three groups of settlers living adjacent to one another at Anakulam. The first group of people are those who have purchased land which was part of the old rubber estate. Their holding range from 3 acres to 25 acres. The density of cultivation and the investments in land development is quite high. The second group

consists mostly of agricultural labourers who have come to work in the above mentioned land. They occupy a of pocket of 98 acres of forest within the estate. They have no title to this land. This group consists of about 300 households. As they occupy relatively elevated areas, none of this group will be affected by the formation of the reservoir.

The third group consists of households which have been resettled by the Government in 1980 in cleared forest lands which has been resumed form the Kannan Devan Concession land. Each family was granted one hactare each. Host of the beneficiaries are encorachers who had occupied forest land in Wankulam. Some retired workers of the Kannan Devan Company have also obtained plots. Ten percent of the beneficiaries are ex-service personnel.

In spite of the isolated nature of the settlement and the high cost of transport, the land is intensively cultivated. During the rainy months Anakulam is completely cut off. Rubber is the most important crop followed by pepper, arecuanut , coconut, tapioca, coffee, plantain ttc.

Mile the lands of the first two groups described earlier have started yielding, the third group is just about to realise the benefits of their labour. Due to the undulating topography, only the households settled on the river side will be affected by the formation of the reservoir. The absence of educational and health care facilities, added to the high cost of all purchased items, have

divided the community into two groups. Those who expect to escape eviction welcome the proposal of the dam, as they see it as their only hope of development of accessibility, while those who live under the water line marked, express desperation, as their life's efforts will be wasted. The lands that will be submerged is mostely the best valley bottom land which has been developed and started yielding. They feel that even if alternate lands are available, it will never be of the same quality and it will take more than a decade of hard labour to make it productive.

The people of Anakulam are very anxious to know two things - 1. Will the eviction be confined to the FRL marking or will it also affect those on the margins? If so, upto what distance? and (2) What is the nature of compensation they can expect? The answer to these questions will determine the response of the Anakulam community to the dam. To prempt any opposition of their work, the surveyors of the Electricity Board have mentioned fantastic amounts as the compensation envisaged for specific trees and crops. These promises are not seen backed by any provision in the project report. Even the proposal for rehabilitation of the project evacuees do not include those from Anakulam as "no tribal families are affected".

Hettanappara

Hettanappara is the common name of the locality which includes the Banippara, Huthuvan kudi and the adjoining settlements of Karyad, Charnappara and Kollappara. The Eanippara kudi is less than 20 years old and consists mostly of migrants from Pinavoor and Nellimala. Some 8 years back several households have migrated to Vallaramkuthu kudi. Now 30 households are settled in the Eanippara Muthuvankudi.

The Eanippara Uuthuvan kudi is encircled by encroacher settlers who have come during the last 15 years. The settlement comprising Karyad, Chamappara and Kollappara is actually the western fringe of the Hamalakandam settlement which dates back to the food production lease (Kuthakappatorn) of 96 acres during 1947. The Muthuvans from the Pinavoor kudi and the Nellimala kudi traditionally used the Hamalakandam valley which was excellent reed forests for shifting cultivation of rice. When the settlers started coming in, the Muthvans moved elsewhere. Actually the first settlers used the Muthuvans to build reed sheds and clear the forests for virippu (cultivation of hill paddy by the slash and burn method). In the initial year 33 households came in and now more than 500 households are settled in over 600 acres. During 1964, the forest department worked this settlement as a supply coupe for the extraction of plywood and other valuable species and latter a sale coupe was organised. The timber extraction created a network of roads in the forests which facilitated more migration and expansion of the settlement. It must be pointed out that extraction activity of the forest department such

as the sale coupe in Uamalakandam bring in very low returns and at the same time create accessibility which ignite a chain of land use changes. This sale coupe involving more than 500 acres fetched the Government about Rs. 60,000 which is just Rs. 120 per acre.

The FRL marking in Uettanappara indicates that 60 households consisting of 233 persons have to be evicted from the submergible area. The breakup is Karyad 36 households with 144 persons '(86 adults and 58 children), Chamappara 6 households with 24 persons (15 adults and 9 children) and Enaippara 2 households with 7 persons (4 adults and 3 children). At Eanippara the PRL marking has a gap. It appears that a saddle dam is contemplated although there is no indication in the project report. In the absence of the saddle darn, more houses in the Muthvan settlement may be affected. Also a road leading to Pinavoor is proposed from Mettanappara which cuts across the Eanippara Huthuvan settlement. This road will displace a few more houses at Eanippara.

It is not clear whether eviction will be restricted to the houses situated below the IRL line. To prevent siltation in the reservior, it may be necessary to clear households occupying the fringe of the proposed reservoir also. Then, the number of households and population that have to be evicted at Hettanappara will be substantially higher than what is indicated.

The land use in Mettanappara was dominated by lemon grass cultivation till a few years back. There are two reason for this. Firstly, its proximity to Wamalakandam which was an important centre

of lemon grass production. Secondly, lemon grass cultivation required very little investment and the returns start, from the 90th day and the yield can be obtained after every 45 days continuously for 20 years or so. A small distilling equipment can make a household self reliant in the production of lemon grass oil which will fetch a good price and can be easily transported out. The availability of plentiful firewood is a pre-requistie for the production process. When the standing tree growth in the forest is depleted firewood costs increase it makes more sense to replant with rubber coconut, acreanut etc. than with firewood trees to continue production of lemon grass oil. Another reason for the preference of lemon grass cultivation by encroachers in the forests is that it can withstand occasional attempts by the forest department to destroy crops and perennial trees to control or check encroachments. Crops like coconut, rubber, pepper etc. are usually cultivated only after securing some kind of protection from raids by the forest department. Protection can be obtained by organised resistance, court stays, political patronages etc. However, long years of familiarity with the functionaries of the forest department can also serve as temporary protection. Unlike perennial tree crops like coconut or rubber, lemon grass cultivation cannot be used to substantiate any claim on the length of occupation of a forest land which often becomes crucial for securing "pattayam" or permanent title to the land. Lemon grass, being a native species, was included as a minor forest produce and the HFP contractor was permitted to engage workers for its extraction and set up distillation units inside the forests. Therefore it was quite a legitimate activity distinct from encroachment. In Hettanappara a few lemon

grass distilling units continue to operate with small scattered plots of lemon grass. (Plate 12) Most of the Raryad region have diversified into rubber, pepper, arecanut, ginger, tapioca etc. As shift to rubber, coconut etc. requires a much greater investment and a longer waiting period, the rich farmer have an edge over the others. It is only natural that the tribal holdings have less proportion of perennial crops.

Uettanappara settlement is surrounded by reed forests. Host tribal households are engaged in reed mat production. Many small holder non triabl housholds are also engaged in mat production. Reed cutting for the Bamboo Corporation and the Kerala Newsprint Limited is also an important source of income for the people of Mettanappara.

Kurathy kudi

Kurathykudi is an isolated and exclusive settlement of Muthuvas on both sides of the stream at the valley bottom. Below the FRL there are 59 households with 249 persons (120 adults and 129 children). Another 39 families with 158 persons (76 adults and 82 children) live in Kurathykudi just above the water line. As this is a compact intergrated settlement, partial eviction of only those under the water line is not practical or desirable. Further, those living below the water line have land above and vice versa. Therefore when the reservoir is formed all the households consisting of 407 persons have to be shifted.

There is a fair weather road running right through Kurathykudi which was built in 1977-78 for extraction of timber from Anakulam before the distribution of plots for resettlement. This road joins Averkutty from where there is an outlet to Aram Mile on the Main road.

The Muthuvans of Kurathykudi were origianlly settled in Nellimala a few kilometers off doing field rotation type of shifting cultivation in the reed forests. The fallows soon reverted to reed and mature reed areas were essential for the continuance of their agricultural cycle. The abundance of reed in Nellimala attracted the Punalur Paper Hill to this area. The reed allotment policy favoured the industry and the triabl hamlet was shifted to Kurathykudi under the initiative of the forest department. The new settlement boundaries were demarkated in 1969. This was just the begining of their problems. The MFP contractor licensed by the forest department set up his collection depot in the hamlet. Yery soon he initiated a massive lemon grass cultivation within the tribal Settlement promising them Rs. 100/-per acre as rent.

It is reported that the MFP contractor brought in about 300 households of non-tribals to do the cultivation and distillation of lemon grass oil. They had altogether about 40 distillation units. In 1973 legal proceedings were initiated by the contractor and his men to get rid of the tribals who were the owners of the land from Kurathykudi. Fortunately for the tribals, sympathetic revenue and forest officials, in a rare and sustained action helped to restore the tribal settlement to the triabls and the non tribals were evicted in

1981. However, the protracted legal battle which went all the way from the Devikulam Magistrate's Courth to the High Court at Cochin drained the financial resources of the tribals. The continuous cropping of lemon grass without adding any inputs have also drained the soil of useful nurtrinets which the tribals cannot afford to replenish. Worevoer. they are unused to high imput agriculture which require pruchase of fertilisers, plant protection chemicals and also a sophisticated level of water management. Now, a tall weed known locally as "karachi grass" covers a good part of the settlement. There is a small extent of levelled rice field at the valley bottom and small and scattered patches of pepper, arecanut, cashew, coconut and jack trees can be seen.

The case of Kurathykudi can be seen as a typical example of how state policies aimed at development end up marginalising, dispossessing and pauperising communities that exist on the periphery of the dominant economy. At Nelliamala the Muthuvans were self sufficient in food. The minor forest produce supplemented their food and was also a source of revenue. When the paper industry staked a claim to the reed forests the trials were pushed out. They were again on the verge of being evicted a second time when the MFP contractor usurped their lands for commerical production. Now the Pooyamkutty Scheme continues the process.

Pinavoor

Pinavoor is thee site for the proposed power house and staff colony of the Pooyamkutty project. This area comes under the

Neryamanagalam range. Unlike in the submergible area where the FRL line has been clearly demarkated by cutting foot paths, at Pinavoor the boundaries of the land to be used for the project cannot be easily located as the land is more or less level. From the records available at Range Office, 36 plots belonging to the tribal households are to be acquired. 17 families belonging to Muthvan, Arayan and Ulladan tribes are reported to be affected. The KSEB's rehabilitation programme however mentions that theere are 34 families with 152 members to be evicted.

Among the tribal settlements around Pooyamkutty this kudi has the highest proportion in perennial crops in their lands. Coconut, arecanut, pepper and coffee are seen in most compounds. The Pinavoor kudi has an interesting history. Upto early 70's this was an exclusive Wuthuvan settlement. Since then outsiders including Arayan and Ulladan tribes started purchasing land from the Muthuvans and have settled here. Currently there are about 79 Muthuvan households, 51 Ulladan households and 36 Arayan households. Of these, Arayan are agriculturally most advanced and their lands are intensively cultivated.

As in Hettanappara, lemon grass was the most important crop upto some 8 years back. Non-tribals had leased in much of the tribal land with the promise of a lease rent of Rs. 100/- an acre. Many tribal households also had lemon grass cultivation. A forester took the initiative and evicted the non-tribal lemon grass cultivators. However, non-tribals still do small scale cultivation of ginger and paddy in the tribal land on lease.

The Pinavoor kudi, which is to be evacuated for the power house, tells the tale of another resettlement some **40** years back. The Muthuvans were originally settled in Rnacherry where they were doing field rotation type of shifting cultivation of rice in the reed forests. Knacherry was assigned to plain's people during the gorw more **food** campaign an6 the Muthuvans were relocated to Pinavoor. All the reed forests in Knacherry was cleared for permanent cultivation by the immigrants. The Muthuvans were continuing their traditional form of cultivation at Wettanappara and Mamalakandam which also have been occupied by others. As the tribals have no pattayam or permanent title to land their fallow land gets occupied by others who settle there permanently.

The Muthuva households facing eviction at Pinavoor are acutely frustrated. They say that it is the first time in their tribe's history that they have invested **so** much in growing perennial crops. Now when these have started yielding they are asked to **go** elsewhere. Wore than the yield from the perennial crops in their land, it is the loss of natural forests in their vicinity that they are worried most. The forests provided them roots, honey and other food to tide them over difficult period. Already the agricultural oriented migration from the plains and the intensified extraction of reeds and other **MFP** by other groups have cut into their supplies and sources of money income. The reservoir and the construction of other infrastructure will complete the process, they say.

Reed mat production is now an important econoomic activity in most households in Pinavoor kudi.

Resettlement Proposals

The resettlement proposals of the KSEB focus only on the tribal resettlement aspects. Anakulam and Xettanappara which come in the submergible area, have not been included in the rehabilitation scheme. 56 families from Kurathy kudi and 34 families from Pinavoor totalling 379 members are to be shiffted to the "Kavitha and Vanitha' plot at the 58th mile of the old Alwaye-Xunnar road in Mankulam village. This is the resumed private forests in the Kannan Devan Concession Land, which is managed by the Revenue Department.

Xach family is to obtain 1 ha of land and a house costing approximately Rs. 10,000/-. They can also claim compensation for improvements in their holding and a mobilisation advance of Rs. 2,000/- each. A school, a dispensary and a community hall are also proposed.

It is to be seen how far even this limited proposal can be carried out in the light of the forest (conservation) act 1980. Although the proposed rehabilitation site is now under the control of the Revenue Department, it will still be considered as 'Forest land' according to the definition provided in the Act. Further, it has been

specifically clarified by Government of India that permission to use forest land for construction of houses will not be granted.[4]

It is not clear whether the KSEB has any proposal to rehabilitate the households that are to be evicted form Anakulam and Mettanappara.

The Government of India guideline under the Forest Conservation Act. 1980 stipulates that the social cost of rehabilitation of the outsee (in addition to the cost likely to be incurred in providing residence, occupation and social services to him) be worked out as 1.5 times of what he should have earned in two years had he not been shifted, is also to be calculated and included in the cost benefit analysis of the project. This is not seen complied with.

Settlements in the catchment Area

The human settlements in the catchment of the Pooyamkutty river consists of exclusive tribal settlements at Edamala kudi and Varrium, mixed tribal and non tribal settlements in the Anakulam-Mankulam belt and the predominantly non-triabl settlements at Mamalakandam. All

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4 Letter No/ 8-6 FRY (Cons) dated 21.12.1982 from Minister of Agriculture and Rural Development, GOI, to the Chief Minister, Kerala.

"The Central Government is of the view that in principle no forest land should be used for construction of houses or office buildings and it should be possible for the state Government to make available non-forest land for such purposes"

these settlements have come up during the last 40 years. it is important to trace the history and pattern of colonisation in this region in order to appreciate potential future changes.

Among the oldest inhabitants of the Pooyamkutty catchment is the Muthuvans at Kurrthy kudi. Their settlements, are in the in the submergible area of the dam and their present condition has already been discussed. There are nearly 50 scattered hamlets of the Muthuva tribe in the catchment of Pooyamkutty at present. Although they belong to the same tribe three distinct sub groups exist. Kurathy kudi, Pinavoor, Mettanappara, Elamplasseri, Padicup etc. form the first group and they have the longest history in these parts. Warrium, Runjippara, Oriyampety, Kallolimed, Thera etc. form the second group and the settlements in Edamala kudi, Kozhivila, Company kudi, Plamala, Veliampara etc. form the third. The boundaries of these sub group roughly correspond to the range boundaries. Neryamangalam, Kuttampuzha and Devikilam. There are differences between their dialect, religious festivals, presiding diety, offerings etc

There is wide agreement that the Muthuvans were originally plains people belonging to Madurai area and were forced to flee to the forests during the Pandian wars. They settled in the thick forest of Idukki district leading a life of hunter gatherers and doing shifting cultivation of ragi. Perhaps, as a protection from wild animals particularly elephants, they chose very steep areas right on top of the mountains to do their cultivation changing their residence according to the field rotation. They always built their houses close

together and invaribly settle upstream of everybody else.

Contact with Hannans, another tribe occupying areas around Hannankandam introduced them to hill paddy cultivation. The distinction between the three groups of Muthvans in Pooyamkutty cannot be easily explained. Contact between the groups is not firquent and marriages are rare. One possible explantation is that the Xuthvans came over during different periods so that the earliest immigrants have lost touch with their kinsmen. Or the other possibility is that they moved in different directions in search of food and that they lost contact after a period. Both appear plausible. The settlements on the eastern periphery continues contacts with Tamil people while those on the western periphery interact with the Halayalee population.

The Xuthuvans of Kurathy kudi and Pinavoor were cultivating the forests of Nelliamala and Knacherry respectively for a very long period. Bourdillon (1893) mentions that the existence of pure patches of reed forest in these parts is an indication of shifting cultivation. How the industrial extraction of reeds pushed them out of Nellimala and the immigration of outsiders displaced those at Koacherry has been mentioned earlier.

It was again a similar process in Pooyamkutty, Kallolimed etc. that pushed the original Muthvan Settlements to the interior at Kunjippara, Varium etc. The displacement of the tribals by non-tribals is usually a gradual and imperceptable process. Three different sequence of displacement can be identified. The first is

immigrants continuously occupying the fallow land of the tribals. The second is by leasing of tribals land by promising them an attractive rent. And the third is by providing credit. The net result of all these is that the tribals will move to a new area and the process continues.

The Edamalakudi Huthuvan settlement which now consists of more than 24 scattered hamlets with over 312 households covering about 35,000 acres in the Edaaala vally was uninhabited before 1951. It is worth noting that one of the important cause of this colonisation was the displacement of the tribals consequent on the construction of another hydro electric project.

The Edamala kudi settlement was colonised by Huthuvans who were originally settled in Shengulam. When roads were developed for the Pallivasal Project, there was a rush of encroachers to the area. This was the time when the Kerala Government under Shri Pattom Thanu Pillai was encouraging colonisation of the forests of the present Idukhi district on the eve of the re-organisation of states according to linguistic boundaries. The Idukhi region with undeveloped accressibility had very low population density. Several large European tea and cardamom estates had come up in Munnar and Peermede areas drawing their labour force from Tamil Nadu. Later Tamil planters also started opening estates. As the access was from the Tamil Nadu side , it was natural that the population was predominantly Tamil. It was possibly a Government policy to reverse the population balance in the area to preempt any claim by Tamil Nadu on Idukki district that a very massive colonisation drive was a launched into

these forests. These forests being the natural home of cardamom and pepper, important foreign exchange earners, attracted enterprising farmers from the plains. Long term leases for cardamom cultivation was offered in open auctions in the Cardamom Bills Reeserve and adjoining areas. The Grow More Food Campaign started during the second world war to meet the food shortage was intesified with more forest areas being thrown open to cultivators. The high range colonisation scheme opened up forests in Nedumkandam, Ayyappancoil and other places. Along with all these Government sponsored colonisation, wherever accessibility was developed waves of encroachers entered and cleared the forest for virippu which yielded bumber harveests and when circumstances permitted they quickly shifted to tapioca and mixed cropping of cardamom, coffee, pepper, arecanut, coconut and a variety of other crops.

In this highly dynamic situation of forest colonisation the original inhabitants of the forest retreated or were displaced. Some groups continued on the fringes of the lands they once used for MFP collection and the more lucky among them found their way to the more remote areas and continued their old life style of living off the forests.

Accordingly to what we could reconstruct of the migration of Edanala kudi, the influx of outsiders to the Muthuvan's exclusive preserve in Shenkulam overawed them. Many families moved to Suryanelli, Marayur and Lakkam settlements occupied by their kinsmen.. Those who remained represented to the Chief Minister, to settle in

some other forest. The request was granted and a group of seven elders with the help of the Range Officer, Devikulam, surveyed the forests of Pettimudi, which continues to be inaccessible even today, and formed the Parappar kudi in 1951. After 3 years at Parappar kudi they moved further interior and settled at Valliya kudi. The valliya kudi attracted others from Shengulam who had scattered to Suryanelli, Kundela, Lakkam etc. Valliya kudi was thier major settlement for another 15 years when suddenly a 'fever' which claimed '50 lives within 10 days' led to desertion of the kudi; some moving to Mali kudi, others to Weenkuthy, Puthu kudi, Chempukulam, Villakasam etc.

The Muthvans of Shengulam were familier with cardamom collection from the forests and they were traditionally delivering cardamom and other WFP to the forest office at Santhampara. Some of them had in fact owned small cardamom gardens near Kallar which was lost to plains people due to indebtedness or due to their inability to retain the garden in auction for longterm leases. In 1954 the first cardamom graden was started in Edamala kudi at Mali kudi. Subsequently most households have started cardamom grandens by augmenting the natural growth and clearing the undergrowth. Now all except migrants during the last 5 years have some cardamom holding from half an acre to more tham 20. Cardamom is the main source of cash income of this settlements. There about 50 cardamom curing sheds in Edamalakudy.

There is a tribal co-operative functioning at shed kudi since 1976 which has the exclusive right to buy the minor foreest produce, mainly cardamom and insense (Black dammer) collected by the tribals. Last year the co-operative collected about 6,000 kg of dried cardamom

and 10 HT of black dammar. Private traders also visit the settlements during the cardamom season and do brisk busineas as they usually pay a higher price. The co-operative also functions as a ration and general provision store. 232 households have ration cards.

Relative to other tribal hamlets of our times the Edamala kudi is a fairy prosperous settlement. Host households have 'virippu' where they cultivate ragi, maize, thena and a few other crops including rice. Although they are not self sufficient in food, they can afford to buy food from the income from cardamom and dammar. Beyond the rations the co-operative supplies 10 quintals of rice per week and 16MT of ragi per year.

While at Shengulam rice was their major 'virippu' crop since the climate was conducive for it, at Edamala kudi ragi comes up better because mildew affects rice. Each family sow about 3 to 7 padi of ragi (1 padl = 2 liters) in the virippu along with other crops depending on the availability of land and household labour. For virippu cultivation only household labour is utilised, even the children join in. For cardamom on the other hand, depending on the size of garden, income of the household and availability of outside labour, hired labour is also used for harvesting. There exists a system where seasonal labour colonies are estabilshed within the settlement by Kankanis (labour contractors) who bring in labour from Tamil Nadu. The prevailing wage rate is Rs. 12 to 13. The kankani acts as a conductor for which he gets a wage and also takes half the earning of the workers under him for providing food and sheds to live in. The kankanis are mostly former traders who sold ragi in the

settlement. About 10 years back a group of Mannan tribes were brought in by the Huthuvans to work in the cardamom gardens but this practice was abandoned since the Hannans asked for land to cultivate.

In Warrium the ridge diving the Edamalayar and Pooyankutty river basins has been colonised by two groups of Huthuvans: One displaced from Kollolimed and the other from Mudissi across the Tamil Nadu boundary. There are 31 households in 3 hamlets. The first groupd was in Kilipparambu kudi for 30 years. Kilipparambu was cleared for the Edamalayar reservoir. Thalavachupara and Kollolimed to which they moved later was occupied by settlers from the plains. They shifted again to Kunjippara, Oriyampetty and Warrium. The other group from Mudissi stayed in Kudalar near Anakulam for a while before moving into Warrium.

Two groups of Hannans consisting of 26 households have also settled down just below the Huthuvan settlement in Warrium during the last 15 years. On group hails from Korangatti kudi near Adimali which is a resettlement colony established 40 years back. When plain's people were alloted the lands these people were cultivating in the Grow More food Scheme. The other groupd is from Tuopran kudi from where they were displaced by encorachers. This group stayed in Mankulam and Kudalar before reaching Warrium seven years ago. The Kunjippara Huthuvan kudi has 24 households. Lemon grass cultivation and distillation is the most important source of income. almost all households have 'virippu' cultivation and small cardamom gradens in the forests.

The other Huthvan settlements around Anakulam are Oriyampetty (19 households), Kozhivila kudi (24 households), Mangappara (7 households) and Boundary para kudi (6 households). In Wangappara cardamom gardens established by the tribals were destroyed during selection felling in 1984 in the Ooshimala coupe.

Around Perumpankuthu and Hankulam there are seven other Muthuvan settlements. They are Sheval kudi (40 households), Aram Mile kudi (35 households), Huthasari kudi (7 households), Company kudi (22 households) Planala (32 households), Veliampara kudi (11 households) and Subramoniyam kudi (10 households). Of these, the first three are old settlements and belong to the same groups as Kurathy kudi and Pinavoor described earlier. Old Veliampara hudi also belonged to this group but was completely wiped out by small pox some 30 years back. Sheval kudi was also abondened due to small pox but was recolonised by the survivors about 15 years.

Company kudi, Plamala, Veliampara and Subroamonian kudi are settlements which came up during the last 23 years. They belong to 'Pandi' Wuthuvans, the same group as those in the Edamalakudi. The Huthasari hudi is an off short of the Kurathi kudi.

There is also a Wannan hudi at Thalakandam. There are 176 families. They were originally at Wukkuda Purathode near the Kallarkutty dam. They were displaced by encorachers who came in when the accessibility developed. They had cardamom gardens and virippu. Some of them moved to Rajakad where they again developed cardamom gardens for which they were paying cardamom tax. In 1960 when open

auctions of cardamom gardens were conducted, plains men outbid the tribals and they lost their gardens. They were in Adimali, Korangatti kudi for a feu years and moved over to Hankulam in 1975. In 1980 Government distributed plots at Thalamkandam.

All the Hankulam area were forests belonging to the Kannan Deven Company which were resumed by the Government in 1974. Wankulam was encroached by waves of migrants soon after the resumption (Plate 13) and several evictions followed.. Finally in 1980 plots were distributed to the encroachers and agricultural loans were chanalised through a farming society. Adjoining the plots distribued to farmers, a large tract of forests have been handed over to the Kerala Forest Development Corporation to establish a cardamom plantations. (Plate 14) Beyond Hankulam it is all old private cardamom plantations towards Kallar and tea plantations of the Kannan Devan Hills Produce *Co.*, now Tata Tea Limited towards Munnar.

The other important settlements in the catchment of the proposed Pinimedu dam is Mamalakandam valley drained by the Thuduppi river (Plate 14). The settlers, mostly from Vazhoor in Kottayam District came in around 1950. It is said that a temple priest from Vazhoor practising in Adimali was instrumental in securing this lease from the Malayattur DPO who he knew. Earlier in 1942 a group of people from Kothamanagalam is also reported to have leased this valley for cultivation for an year. No evidence of their cultivation was found by the later arrivals prompting the rumour that it was only a facade for ivory poaching as these reed forests supported large herds of

elephants. It is the western fringe of this settlement that will be submerged at Wettanappara. The Muthuvan hamlets in this area are Elamplasseri kudi (60 households?, Padicuppa (35 households) and Eanippara (30 households).

Lemon grass is an indigenous species which developed as a regular crop only about 60 years back. Lemon grass oil had a high demand from pharmaceutical and perfume manufacturers in European countries. It was a 100 percent export oriented crop with a few European firms controlling the trade. The cultivation started near Odakali and spread to surrounding areas of Kurupampadi, Kuthattukulam, Kothaaanangalam etc. progressing rapidly into the forests, where land was cheap and firewood was free. The government encouraged lemon grass cultivation in the forests due to its status as a Minot Forest Produce and a foreign exchange earner. Reserved forests were leased for lemon grass cultivation even as late as 1950. However with fluctuating prices, depletion of firewood supplies and the relative profitability of other crops such as rubber and pepper encouraged the lemon grass cultivators to convert forest areas cleared for lemon grass to other crops.

In pooyamkutty-Kuttampuzha areas the first agriculture oriented migrants came in for lemon grass cultivation. This was only some 40 to 50 years back. Almost all the old areas have switched over to settled mixed cropping agriculture. Currently lemon grass cultivation is confined to the interior parts, often within and adjoining tribal hamlets.

While the area under lemon grass ha6 been almost fully phased out and the forests irrevocably lost, cardamom expansion is being continued by the tribal population where suitable forest exist. All the tribal hamlets in Edamalakudi have cardamom gardens in the adjoining forests: so do the hamlets at Warrium, Kurathy and Mankulam. All these cardamon cultivation is now in inaccessible areas. Considering the history of this crop in other forest areas, it is inevitable that with the development of accessibility, increase in cost of inputs, fall in price of cardamom or just plain indebtedness of thee tribal cultivators the cardamom gardens will get allienated to new non-tribal owners, who would clear the forest to switch over to pepper wben the relative prices change as is currently happening in the Cardamom Hill Reserve in spite of all the penal provisions aginst it.

Discussion

Forest managment options can be broadly divided into two: utilisation and conservation. Utilisation within certain narrow limits and at low intensities can be compatible with forest conservation. Although conservation has universal relevance, its importance can vary according to the nature of the forests and the relative abundance of forest in a region. In a situation of forest abundance, utilisation of the resource for sort term benefits can be easily justified. In a situation of forest scarcity or rapid depletion of the forest, conservation has to be given utmost priotity, so that short term benefits do not compromise the future flow of the benfits and the value of the forests in the long run.

Given the multiplicity of resources and the multiplicity of potential utilisational avenues, different utilisational sequence or patterns are possible. Often utilisation in a particular manner may be incompatible with utilisation for other benefits. Decision to utilise a forest in one particular manner often forecloses the opportunity to realise other benefits. Therefore a trade off between the different uses and users is necessary. The distributional effects of different are uses are quite different. One type of use may benefit one section of the population and it may deprive another section from enjoying some other benefit.

A range of intensities in utilisation is also possible with different implications on the substainablity of the activity and the externalities in space and time. Different intensities of production

can be considered according to the market situation which will have affected the future yields differently. For example, selection felling of the standing timber crop can be limited to 10 trees or 20 trees per hectare or reed cutting limited to one third or two third of the growing stock. A more intensive extraction strategy enhances the short term production while the long run yield may decline.

In the context of the utilisation of Pooyamkutty forests, three types of resrouces can be Identified. They are (1) The standing crop, (2) The potential productivity of the land, and (3) The hydro power potential. The standing crop consists of timber, reeds, cardamom and other minor forest produce.

Given the resource endowments different utilisation options can be considered. If the power project is sanctioned, the reed extraction has to find other areas and the present tribal an nontribal settlers have to be shifted to new sites.

In the case of reeds, the present extraction is mostly from the area earmarked for the reservoir. Extraction can continue only if suitable reed areas exist above the level of the reservoir. It is seen that the resource is not found in sufficient density in the non-submergible areas. An extensive reed tract in the adjoining valley of Edamalayar was submerged a few years back by the Edamalayar Hydro Electric Project. With the loss of the Edamalayar forests, the reed extraction has been intensified in the Pooyamkutty forests. The traditional sector obtains about half, and the modern sector about a quarter of their requirement from the Pooyamkutty forests. It is not

possible to find alternative source of reed supplies to make good the loss if the Pooyamkutty area is submerged.

The agriculture oriented colonisation of the Pooyamkutty forests started with a coupe of Muthuva halmets a few centuries back. Since their activities were limited no permanent destruction of forest took place. Neither did they develop accessibility. Permanent land use changes followed the granting of the large forest tract to European plantation companies on the upstream side of the Pooyamkutty catchment. The Kannan Devan Hill Produce Company which was the name adopted by the European consortium, started initially with cinchona and coffee but settled down to large scale tea plantations. Their access was from the eastern (Tamil Nadu) side and the forests downstream were not affected until a road down to the Kerala coast was formed around 1920. This road which passes through the proposed dam site at Pindimeu attracted farmers from the Kerala side. Expansion of lemon grass cultivation into the forests where firewood and water were plentiful was gaining momentum during this period . Being a minor forest produce, the forest department was also encouraging lemon grass cultivation by giving annual leases. During 1942 Government distributed about 2,00 acreas of forests on both sides off this road at Kuzhimplai, Kuttampuzha and Pooyamkutty as "Sawjanya pathivu" (Free grant) ostensibly for the landless but benefiting mostly the rich. This was followed by another grant to ex-servicemen "("pattla pathivu") from Kuttanchal to the PWD Bungalow at Pooyamkutty. Since 1947 under the Grow More Food Scheme food production lease for about 100 acres each were granted at Thattekad, Nyayippally, Kuttampuzha, Pooyamkutty, Kallolimed, Wanikandachal, Mamalakdam, Kochu Knacherry and Vlaliya Knacherry. As

the allotment precaded survey and boundary demarkation, these settlements expanded rapidly into the adjoining forests. These leases were renewed from time to time and new settlers came in large numbers and continued their encroachments into the forests. Attempts at eviction were not always successful and several committees were formed to recommend suitable measures. Although partial eviction was suggested by these committees with different base years, nothing was done to revert the colonised land back to forests. Even now there is no distinct forest boundary in many parts. In 1952 the leased areas were transfered to the Revenue Department and the Forest Department awarded salvage felling contracts to remove the standing timber in tbese lands. These salvage felling were followed by contracts for plywood timber extraction from the adjoining forests and along the old Alwaye-Munnar road. Accessibility was developed by the contractors to enable truck transport of cut timber. Roads to Kurnnummed, Kara pocket and the Kuttampuzha-Pinavoor road was developed during this time.

The development of accessibility attracted the Punalur Paper Hills rho started reed extraction from the road sides. After exhausting the accessible areas they built their own roads to reach the reed areas in the interior. The road to Vellaramkuthu, the Aram Mile-Averkutty road etc. were made by them. The Gwaloir Rayons also came in for bamboo extraction for a short period. They were followed by the Hindustan Newprint Limited, who continues the process.

Clearfelling at Anakulam to allot land for resettling encroachers in Wankulaa bring 1977-78 resulted in connecting Anakulam to

Neryamanagalam via Averkutty. Ooshimala and Kadalar selection felling coupes during 1984-86 extended the road network beyond Anakulam.

In the past, the development of accessibility was considered desirable in all instances or it was not considered important to be analysed separately. Even forest working plans equate development of accessibility with development itself and the long term impact of this on forest conservation is rearly taken cognisance of. But with the reduction and degradation of the forest and the relatively unlimited demands on the forests by different sections of the economy including the revenue objectives of forestry, the long term effects of creation of accessibility is being recognised.

Although in some cases the activities that lead to creation of accessibility is of a short term or temporary nature (eg. selection felling of timber), the accessibility created is permanent. Before long, a chain of land use changes is induced (eg. teak plantation, agricultural colonisation etc.) Accessibility created once is irrevocable and universal access cannot be restricted particularly in a situation where human settlements have already come up in the interior.

the impact of accessibility development, often not only promote forest extraction activities and conversion of forest for other uses, it may even lead to forest loss in far off places. This is a very important feature which could be illustrated with any number of examples from all over Kerala. For example, the development of accessibility in far away Shenkulam for the Palliivasal Hydro Electric

Project bought in migrant farmers who displaced the resident tribal population. The tribal population in turn migrated to Edamalakudi, which was an untouched forest before 1951, and finding that it was ideal for their life style attracted others from many other hamlets. Currently about 35,000 acres of forests are being utilised by over 34 hamlets for cardamom cultivation and various other annual crops. Cardamom Kist (tax) is being collected for 2,413 acres by the Range Officer, Devikulam, which is an offical recognition of their activity.

It is perhaps possible, but rarely feasible to evict non-tribal settlers from the forests by giving them compensation alone. But tribals invariably have to be given alternative lands. The population pressure being what it is, in the non-forest areas of Kerala more forest will have to be opened to resettle them, in case they are to be evicted from one place.

The development of accessibility inside forests, therefore, has to be carefully controlled since, after accessibility is developed, control is rarely feasible. Pressure from various sectors including Governemnt Commitments to various industries, will intensify once accessibility improved. As mentioned earlier many of the settlements within forests do not have any fixed forest boundary. with the development accessibility these pockets are bound to expand rapidly and futher reduce the forests. Therefore, it has to be recognised that the impact of the proposed dam on the forests will be much more than the clearance of a few thousand hectares of forests. It would, by developing accessibility, induce far reaching land use changes which

will destroy much more forests than that used for the project as such. Displacement of people, as we have seen will trigger a chain of land use changes which is difficult to anticipate.

The impact of displacement has to be analysed at two levels. (1) The impact to the people involved and (2) the impact of the resettled population on the new site. The impact on the people will depend on the changes in resources available to them before and after the displacement. To an agricultural population the most important resoruce is land. The quality and extent of the land are the most critical issues. To the tribals, apart from land, nearness to good forests is also important not just for cultural reasons but also for compelling economic reasons. Mostly, their only skill and earning capacity is based on the knowledge of the nearby forests.

The resettlement proposal of the RSEB takes into account only the tribal population and that too partially. One hectare each is to be alloted to each family so resettled. However the site selected is another forest area which though controlled by the Revenue Department comes under the definition of forests as defined in the Forest (Conservation) Act *1980.* Government of India has repeatedly stated that the policy of the government is "not to release forest areas for rehabilitation purposes. The concerned state Government should either locate non forest land for the purpose or provide alternative means of employment to the affected persons. He have lost a lot of forest areas for such purposes in the past and every effort must be made to save and preserve what is still left of the valuable forests"[5]

5. Letter from Shri Rao Binendra Singh, Minister for Agriculture and Forests to Shri Veerendra Patil, Minister for Labour ad Rehabilitation, Govt. of India, No. 11-52/83 FRY (Cons).

How the non-tribal population living below the sumbersion level will be resettled find no mention in KSEB's proposal. An even more serious issue is that the human settlements are not confined to the submersion area alone and they are continuous and extensive. It has not bten clarified whether human settlements and cultivation will be permitted up to the edge of the reservoir. There surely must be some guidelines regarding this by the Central Board of Irrigation and power. If the settlers on the edge of the proposed reservoir is also to be cleared then the rehabilitation effort has to be many times more than what is envisaged.

The Forest (Conservation) Act 1980 requires that a cost benefit analysis be done for hydel projects involving forest lands. The guidelines issued for the same provides a thumb rule to make a quick assessment of the Enivronmental loss. It was that Rs. 126.74 lakhs is to be considered as the loss per hactare of fully stocked forest (density 1.0). The Divisional Forest Officer, Malayattoor in the Proforma submitted for clearance of forests for the Pooyamkutty.

Project dated 9.10.1986 estimates the environmental loss in 2125.59 ha falling in that Division as Rs. 2,15,183.22 lakhs using 0.8 as the density of stocking in natural forests and 0.5 in plantations. Adopting the same procedure for the rest of the project area falling in the adjoining Munnar Division which is 876 ha is given as Rs. 88839.76 lakhs. Therefore the total environmental loss in 3001.8 ha. of the project areas is Rs. 3034.65 crores according to the Goverment of India guidelines.

The alarming pace of forest destruction in Kerala during the last five decades have been reported by different agencies. The forest resource survey conduoted by the Forest Department reveals that between **1940** and **1970** the forest loss for agriculture, resettlement, reservoirs and hydel projects was **3450 sq**. km. and between **1960** and **1979** alone it was **1020** sq. km. (Chandrasekharan **1973).** The Centre for Earth Sciences Studies estimated that the forest loss between **1965** and **1973** was of the magnitude of **4100** sq. km. (Chattopadhyay **1984).** The Natioal Remote Sensing Agency reports that the loss of forest cover in Kerala between **1972–75** and **1980–82** was **1200 sq.** km. (CSE **1985)**

Rapid forest destruction will cause serious disruption in the environmental and economic health of Rerala. Considering the fact that encroachments into forests have been periodically regularised and that evictions from encroached forest areas are politically infeasible any project that develops accessibility into forests will induce new encroachment and consequent forest loss. Resettlement of those living in the project area will also necessitate forest clearance. Considering all these factors it is recommended that the Pooyamkutty Project which will result in the clearance of **3001** hectares and which will cripple the reed economy of Kerala be abandoned.

6. Conclusion

1. Reeds from the forests of Pooyaakutty is an important raw material both for the modern sector paper industry as well as the traditional mat and baket weaving sector.

The annual extraction of reeds from the forests is around 23,500 tonns which provides about 2.6 lakhs man days of employment annually for reed extraction and 20.6 lakhs man days for processing which makes a total of 23.3 lakhs man days per year.

About 43 percent of the annual reed supplies of the Kerala State Bamboo Corporation and about 26 percent of the requirement of the Hindustan Newsprint Limited is met from the Pooyamkutty forests.

Apart from the mats produced from the reeds collected by the KSBC local production of mats in Pooyamkutty is around 52 lakhs square feet annually.

The availability of reeds both for the modern as well as the traditional sector is much below their current requirements. Therefore it is not possible to make good the shortfall in supply if the Pooyamkutty forests is submerged by the proposed reservoir.

The traditional sector provides relatively more employment both per unit volume of reed extracted and per unit volume of reed processed. Even the wage income per tonne of reed processed is about four times more in the traditional sector.

The traditional sector has better claim to the reeds from Pooyamkutty both as a welfare measure and as a forest conservation measure. Therefore the reed areas of Pooyamkutty should be reserved for the traditional sector.

2. There are three human settlements in the submergible areas of the proposed dam. They are Anakulam, Wettanappara, and Kurathy kudi. Together they comprise 233 households with 931 members. The power house site is located at Pinavur kudi where 34 families with 152 members face eviction. The resettlement proposal of the Kerala State Blectricity Board covers the affected population only partially..

It has to be clarified whether evictions can be restricted to the people below the FRL line or whether the settlers on the edge of the reservoir are also to be evicted. If so the resettlement effort has to be substantially higher.

Euman settlements in the catchment consists of both tribal and non tribal people. Most of the tribal households have been displaced from their original homes when non-tribal colonised their land following development of accessibility for earlier power projects and during the Grow Hore Food Leases to nontribals.

The non tribal settlers have come in for lemon grass cultivation, following the opening of the old Alwaye-Munar Road, land grants, Grow Hore Food leases added to the encroachments.

3. A historical review of the forest use in Pooyamkutty indicates that development of accessibility intensified extraction of forest produce and promotes forest land use changes.

The impact of the proposed dam on the forests will be much more than the clearance of the few thousand hectares. By developing accessibility, it would induce far reaching land use changes and forest destruction in a much larger area than required for the project.

4. According to the guidlines issued by Govt. of India in the calculation of enirronmental loss from forest clearance under the Forest (Conservation) Act 1980 the environmental loss in the clearance of 3001.8 ha. of forests in Pooyamkutty is estimated as Rs. 3034.65 crores.

5. Considering the pace of forest loss during the last five decades and the increasing demands on the forest for different end uses it is desirable that the Pooyaakutty Hydro Electric Project be abandoned.

8. EOCLOGICAL STUDIES JN THE PROJECT AREA - A SYNTHESIS OF THE FINDINGS

Highlights of the project proposal

The Pooyamkutty hydroelectric project envisages construction of a set of dams for power generation in two stages.

Stage I involves construction of a dam across Pooyamkutty river at a place near Pindimedu, situated in the Devicolam Taluk of Idukki District. Construction of a 148 m high main dam and 50 m high saddle dam will create a reservoir with an effective storage capacity of 1021 million m^3. The catchment area of the first phase of the project will be 272 km^2 and the submergible area 28 km^2 (2800 ha). The estimated cost of the project is Rs. 250 crores. Water from the reservoir is to be diverted to the power house proposed at Pinavoor through a tunnel across the hill on the left bank of Poooyamkutty river. The firm power potential has been estimated at 73.5 MU, with two units of 120 MU operating at 30% load factor.

Stage 11 envisages harnessing the streams in the upper reaches of Pooyamkutty and Idamalayar by constructing a set of 5 additional dams and utilising them in an integrated manner to increase the installed power generation capacity to 750 MW.

The database

At the time of initiating our study, the second stage of the project was still at the investigation stage. Therefore, the study focussed on the area covered by stage I, except in the case of landuse and floristic studies which extended into the upper reaches.

Based on the expertise available in the Institute, studies were made on the landuse pattern, status of vegetation, plant diversity, soil properties, erosion rates, status of larger mammals, reed economy and the human settlements in the area.

The results of these studies have been described and discussed in detail in the various sections and a summary is given at the end of each section. The results are therefore not repeated here. Being a major project located in a forest area, the impoundment of water and other project related activities are expected to trigger a series of environmental changes. The attempt here is to speculate on the course of such changes. It must be understood that some of these changes, like submersion of areas and human displacement are sure to occur, but others such as qualitative changes in vegetation in adjacent areas, impact on wildlife, etc. are more unpredictable at our present level of understanding.

Possible impacts

Impacts of the Pooyamkutty Hydroelectric Project can be classified into two major kinds - **(1)** direct impacts, ie, those that occur **as** a direct result of the dam either immediately or over **a** period of time and which cannot be prevented and **(2)** indirect impacts, which can be prevented, at least in theory. Since the study was focussed on stage **I** of the project, most conclusions that follow are applicable only to the area covered by stage I.

Direct impacts

1. The most obvious direct result of the dam is submersion of the natural landscape. **As** noted earlier, the Pooyamkutty dam envisaged in Stage I will result in submersion of about 2800 ha of land. This in turn will lead to the following effects.

a. Trees in the submergible area and construction sites will have to be felled and removed. This will fetch an immediate revenue, but sustained yield of timber and other forest products will no longer be available from the area.

b. The plant community in the above area will be completely submerged. This consists of natural forests, mainly tropical moist deciduous forests. The moist deciduous forest in the area is in a degraded state with many rocky and barren patches, invasion of weeds, and repeated annual fires. Other vegetation formations in the submergible area consist of some patches of semievergreen forest, one patch of

evergreen forest at Anakulam and luxurient riparian ecosystems. There are also some pure reed brakes, in addition to reed occurring as an understorey in the moist deciduous and semievergreen forests.

Altogether there are 340. species of angiosperms (flowering plants) of which 65 are endemic to Western Ghats south of Karnataka. Although these endemic species have been reported from outside the study area earlier, their present population status outside the study area is not known. Construction of dam will lead to destruction of vegetation formations in the area, ie, quantitative loss, but it is difficult to predict whether it will lead to species extinction, ie, qualitative loss.

c. Based on the limited study on larger mammals, the area is not rich in wildlife. No evidence was obtained for the occurrence of tiger and liontailed macaque. The avifauna was moderately rich. Since the construction of the dam will be a slow process preceded by severe habitat disturbance, the larger mammals and birds are likely to move to adjacent areas. No study has been made on the less mobile invertebrate fauna which will be destroyed on submersion.

d. A major impact of the submersion is the displacement of human population. The two tribal settlements of Muthuvans – one at Kurathikudi (59 households, 249 persons) and the other

at Wettanappara (60 households, 233 persons) as well as part of the nontribal settlement at Anabkulam (65 households 291 persons) totalling 773 persons will get displaced if the dam is constructed. These figures represent people settled below the Full Reservoir Level (FRL). In addition, those living at the fringes above the FRL as well as further away may have to be displaced, for which no estimate has been made except at Kurathikudy where 39 families with 158 persons live as part of a homogenous community above the PRL.

e. Another major effect of construction of the dam is disruption of supply of reeds. Pooyamkutty and the surrounding areas represent a rich habitat of reed. It has been estimated that 23,500 tons of reeds are extracted every year from the Pooyamkutty area meeting. 43% of the reed requirement of Kerala State Bamboo Corporation and a part of the requirement of Kerala Newsprint Limited. This generates 2.6 lakh man days of work in extraction. In addition, 20.6 lakh mandays of work is being generated for processing the reed. Disruption of reed supply to the Bamboo Corporation which sustains the traditional reed workers is a serious problem.

2. Construction of the powerhouse proposed at Pinavoor will result in displacement of 34 households with 152 persons belonging to Muthuva, Araya and Ulladan tribes, alongwith destruction of their cultivation sites. In addition, the area contains one of the few patches (about 15 ha) of low lying dipterocarp forests.

3. The impact of the dam on the catchment area is more difficult to predict. Improvement in ground water availability may bring in qualitative changes in the flora and associated fauna.

4. If both stage I and II of the proposed Hydroelectric Project are implemented, in addition to the loss of area under natural vegetation with its poorly studied genetic diversity, fragmentation of the forest area will result. The larger Pooyamkutty project area is one of the few large contiguous forests (about 400 Km^2) south of Palghat gap. Fragmentation of the area may iead to nonsustainability of some animal and plant species which require large areas to maintain stabilised and viable populations. The combined projects may also involve displacement of more people, loss of more of the typical evergreen forests, etc for which we have not made any assessment.

Indirect impacts

The indirect impacts arise due to unintended but unavoidable human influences and may consist of the following.

1. The large labour force introduced into the area for the project work will require fuel wood for cooking and will resort to indiscriminate felling of trees to meet this need. Even if arrangements are made to supply firewood or alternative fuels from elsewhere, unauthorised firewood cutting will take place as it is available free of cost. They are also likely to hunt wild animals for food.

2. Increased human activity in the area will lead to increased soil erosion.

3. Improved accessibility will trigger a series of uncontrollable landuse changes in and around the project area including deforestation, illegal occupation of forest land and its conversion for other purposes.

The history of other hydroelectric projects in relation to forest use and conservation in Kerala shows clearly that the indirect impacts of the hydroelectric projects are more detrimental than the direct impacts. This need not be so in theory, but this is happens in practice, due to various kinds of difficulties, including political, in implementing the safeguards.

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Plate 1. Pooyamkutty River above Pindimedu

Plate 2. Thuduppi falls and the vegetation in the background

Plate 3 A pure reed patch

Plate 4 Moist deciduous forest near Sishyanparappu

Plate 5 Riverine vegetation at Thalakkulam

Plate 6 Semi evergreen forest along Kunjiar

Plate Riparian vegetation along Thuduppi river banks

Plate 8 Reed and *Mikania micrantha* around Pindimedu

Plate 9. Origin of Thuduppi river and the surrounding vegetation

Plate 10. Forests around Pooyamkutty

Plate 11. Transport of reeds by water

Plate 12. Cultivation of Lemon grass at Mettanappara

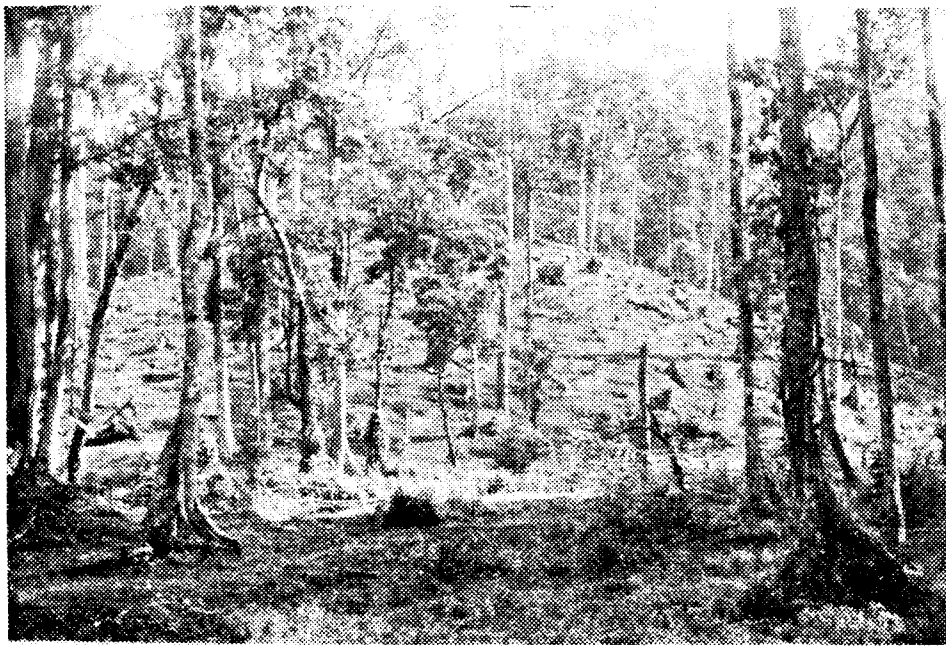

Plate 13. Encroachment at Mankulam

Plate 14. Cardamom cultivation under evergreen forest - Mankulam