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Preparation of a GIS database on Riparian Systems in Periyar Tiger Reserve

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Contents

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Abstract

River systems play an important role in the ecology of Periyar Tiger Reserve. The main components are Periyar, Mullayar, Azhutha and Pamba rivers and reservoir. Topographic and riverine features are examined section wise. Catchments of these rivers receive rainfall from both monsoons. Rain fall for the past twenty years is tabulated year and station wise and included in the data base. Rainfall data show that different parts of the reserve are not similar in terms of rain received and its temporal distribution. Water level for the previous years is tabulated, analysed and included in the database. A software has been written for entry, retrieval and graphic presentation of this data. Water availability in the reserve was analysed in terms of proximity to streams. A buffer of 100 m was generated around streams for this purpose. On the basis of this, it is seen that there is water scarcity in summer in few sections.

The reserve is divided into high, medium and low elevation zones and the riverine tree diversity analysed in detail. Plant diversity in three elevations categories was analysed. Marshes have mostly grasses and sedges, where 26 species of grasses, 39 species of sedges and 54 species of other herbs were identified using details given in flora of the reserve. River banks had 19 species of herbs, 11 species of shrubs and 58 species of trees. Some of these are restricted to riverine habitat, while others are found in riverine and non-riverine habitats. Most mammals use the riverine habitat, but only the otter and fishing cat were found to be directly linked with it. Twenty species of birds have been found using the riverine habitat extensively. They include herons, darters, king fishers, etc. Land use in general and at various submersion levels in the reservoir is also analysed.

The data is also brought into a self contained CD ROM with a user-friendly graphical user interface, search engine and data.

Preparation of a GIS database on Riparian Systems in Periyar Tiger Reserve

1. Introduction

River systems play an important role in the ecology of Periyar Tiger Reserve. The main components are Periyar, Mullayar, Azhutha and Pamba rivers and reservoir. Catchments of these rivers receive rainfall from both monsoons. The water gets stored in the reservoir and is released as per requirement. This project brings together data on the main components of the riverine system into a computer compatible database. The main components are

1) Rain fall
2) Water level in reservoir
3) Watersheds
4) Vegetation
5) Fauna

These components are summarised in this report. The data is also brought into a self contained CD ROM with a user-friendly graphical user interface, search engine and data. Land use in general at various submersion levels in the reservoir is also analysed. The reserve is divided into high, medium and low elevation zones and the forest structure and tree diversity analysed in detail. Hydrology of the constituent streams and their watersheds are examined in relation to topography and landuse.

The Periyar Tiger Reserve, one of the well known wildlife sanctuaries in peninsular India, is situated in the Cardamom Hills and Pandalam Hills of the South Western Ghats. The present Periyar Wildlife Sanctuary was constituted in 1950 and was brought under Project Tiger in 1978 as Periyar Tiger Reserve. The study area is located between 9^0 15' to 9^0 40' North latitude and 76^0 55' to 77^0 25' East longitude in the South Western Ghats and in generally known as the Periyar Plateau. Periyar Tiger Reserve is a having a significant position in the global tourism map, providing sizable revenue from tourism to state government and livelihood for hundreds of people.

1.1. Administrative Units

Administratively, Periyar Tiger Reserve falls in Idukki and Pathanamthitta Districts of Kerala. Periyar is divided in two divisions, Periyar East with three ranges under it- Periyar (376 km^2), Thekkady (99 km^2) and Vallakkadavu (143 km^2) and Periyar West with two ranges under it- (Azhutha 68 km^2) and Pamba (91 km^2). The Periyar Tiger Reserve consists of 3 reserves, Periyar lake reserve (600.50 km^2), Mount plateau (163.17 km^2) and Rattendan Valley (12.95 km^2).

The Periyar Tiger Reserve was divided into three ranges, Vallakkadavu, Tourism and Thekkady till 2001. The area has recently been reorganized into two division and five ranges. Details of sections after reorganization are shown below. Each section is taken up for discussion later individually with map.

Periyar Tiger Reserve is divided into two territorial divisions, Periyar West and Periyar East with HQ at Thekkady and Peerumedu respectively. The criteria for bifurcation are not land area per se, but the intensive managerial necessities associated with Sabarimala Pilgrimage and certain issues regarding the reservoir tourism. The socio-cultural background of the area also form another criterion. Periyar West Division is divided into two ranges Azhutha range and Pamba range. Azhutha range is divided into four sections Moozhikal, Choozhy, Sathram and Uppupara. Pamba range is divided into five sections Pambavalley, Puthusserry, Karimala, Sabarimala and Pachakanam.

Sl.No.	Division	Range	No. of sections	Area (Km2)
1	Periyar East	Thekkady	5	99
2	-do-	Periyar	12	376
3	-do-	Vallakkadavu	5	143
4	Periyar West	Azhutha	4	68
5	-do-	Pamba	5	91
		Total	31	777

Periyar East Division

Periyar East Division is divided into three ranges Thekkady, Periyar and Vallakkadavu. Thekkady range is divided into five sections Thekkady, Edappalayam, Nellikkampetty, Mullakudy and Medakanam. Periyar Range divided into twelve sections Kottamala, Thamara, Randattinkara, Manalar, Eravangalar, Mavady Thannikudy, Mlappara, Ummikuppan, Moolavaiga Sundaramala and Periyar. Vallakkadavu range is divided into five sections Thondiyar,Vallakkadavu, Kozhikanam, Kallaradichan and Aruvioda. Riverine features of Ranges and sections are dealt in detail under separate chapter. Brief description follows.

Thekkady Range

Thekkady range consists of Edappalayam, Thekkady, Medakanam, Nellikampetty and Mullakudy sections. Of these Medakanam section is the largest and Thekkady is the smallest. Most of the mainstream tourism related activities are in the Thekkady section. This range was earlier called as Tourism range, which consisted of Edappalayam, Thekkady, Nellikampetty sections. Thekkady section is surrounded by forest on all sides except Kumily region. On the northern side forests of Tamil Nadu are located. The interstate boundary forms the northern boundary of

the section. On the eastern side watershed between streams is the boundary. Southern boundary also runs along watershed. The canal forms the western boundary. The Division and Range offices and several public buildings such as rest houses, quarters and KTDC hotels are situated inside this area. The northern side is Forests of Tamil Nadu and Medakanam section is on the eastern side, Nellikampetty section is on the southern side and Kumily town is on the western side. The section headquarters is at Kokkara.Edappalayam section is situated west of Nellikampetty and Thekkady section. On the western side there are cardamom estates and inhabited areas. The eastern boundary is along the marshy area through which the canal pass. Edappalayam is one of the sections that adjoin inhabited areas. In this case adjoining areas are mostly with mixed cultivation of coffee, pepper, tapioca etc. Head quarters of this section is at Mullayar.

Nellikampetty section is situated south of Thekkady section, west of Medakanam section, north of Kozhikanam sections and east of Vallakkadavu and Edappalayam section. Nellikkampetty proper is a hill near Edappalayam. Most of the area is covered by arms of the reservoir. There are several island of forest inside the reservoir. The corridors between the islands are usually marshy areas which get submerged only at high water level. The Nellikkampetty section starts immediately opposite to the boat landing. The dam site itself is situated in the south west corner of the section. Regions near Manakavala are accessible by boat in a round about way. Boat route start from boat landing and go past Edappalayam and take a sharp bend and come near the Deer Island. The head quarters of Nellikkampetty section is at Karadikavala. The Mangaladevi road deviates from this point. There is no gate at this junction. Medakanam section is an important section with state border on one side. Several major streams originate from this area. Grasslands, deciduous forest and evergreen forest are present. Mullakudy section is accessible by road and boat. Grassland, deciduous and evergreen forests are present. Few bamboo brakes are also present. Most of the main stream tourism related activities are in the Thekkady section.

Vallakkadavu Range

Vallakkadavu range consists of five sections, Thondiyar, Vallakkadavu, Kozhikanam, Kallaradichan and Aruvioda. All these sections have grassland and eucalyptus plantations. Cardamom estatesa and tea estates are situated on the western side. The Vanchivayal tribal settlement, is on the periphery of this section. This section has large stretch of grassland and evergreen forest. Some of the eucalyptus plantations are still seen. On the eastern side, the section extends up to the reservoir. This section is situated to the right side of Periyar river down stream of the Dam.

Vallakkadavu section is situated below the Thondiyar section on the left side of the river. The Vallakkadavu-Pachakanam road forms another boundary. On the east

the forest extends upto the lake. Some of the Ceylon repatriates are resettled near Pachakanam.The forests of Kozhikanam section extend from the Pamba crest line to the lake edge. Aruvioda section is the largest section in Vallakkadavu range. Major area of the section is covered by thick evergreen forest with reeds as the main under growth. Lake side is mostly moist deciduous forest. Away from the lake, vegetation changes to semi evergreen and evergreen type of forest. Aruvioda section contains some good eucalyptus plantations. This section is accessible from the Vallakkadavu region by Jeepable road. Road to Aruvioda deviates from the Vallakkadavu - Pachakanam road at 9th km. This road goes up to Aruvioda forest quarters covering about 20 km distance from the main road. Form the main road the mud road passes through the area of the Kozhikanam section up to the Aruvithode. Aruvithode is a perennial stream. Aruvioda station is located next to the Aruvithodu. The road crosses the Aruvithodu through a concrete bridge. The Aruvioda section area is also accessible by boat from the Dam site. The forest region of Aruvioda in the lower side of the Swamikayam mala is accessible from Mullakudy region by crossing the lake. After the Aruvithodu, thick evergreen forest starts. The Kumarikulam wireless station, Mangaladevi region and a major part of the lake are visible from the watch tower. Kallaradichan section is on the southern boundary of the range. It was mostly evergreen forest.

Periyar Range

Periyar range consists of 12 sections, details of which are tabulated below. Of these Thannikudy is the largest and Mavady is the smallest. Kottamala section forms the northern catchment area of Mullayar. It is a remote section. Thamara section is the catchment area of Mullayar on the left bank. Randattinkara section consists of valleys draining to Mullayar. Manalar is a large section situated on the northern side of Mullayar. It extends upto the inter-state ridge. This Section contains mostly evergreen forest. Grasslands are limited to few hilltops. Access is from Tamil Nadu and Mullakudy. Previous Mavady section has been split into Mavady and Eravangalar section. Eravangalar section is situated in the state border. Mavady is a small section situated north of Mullakudy. The section is accessible by road as the Kumily-Mullakudy road pass along the western side of the section. Thannikudy section consists of the grasslands and hills between Mullayar and Periyar. Mlappara section is situated on the left bank of Periyar River. This section has grasslands on the northern side and evergreen forest on the southern side. River Periyar is the boundary on the eastern side, Ummikuppan thodu form the boundary on the west side. Ummikuppan section is situated on the left bank of river Periyar. Moolavaiga section is situated between the Periyar River and interstate boundary. Sundaramala is one of the extreme regions from where Periyar originates. This section is also one of the most inaccessible areas in PTR. River Periyar originate from Periyar section. As can be

seen from the illustration, the section is one vast stretch of un broken evergreen forest. The forest can be classified under high elevation and medium elevation.

Periyar West Division

Periyar West Division is divided into Azhutha and Pamba ranges. Azhutha range consists of two sections and Pamba range of three sections.

Azhutha range

Azhutha Range consists of four sections. The main access to the present Moozhikal section is through Koruthode, where the section head quarters is located. Choozhy section is the second section. Sathram and Uppupara sections are also part of Azhutha Range. Moozhikal Section occupies the western most portion of PTR. On the northern side, forests of Erumeli Range are situated. Western and southern sides are inhabited. One of the routes to Sabarimala starts from this section. Forests of this section are situated between the Azhutha river and the Azhutha Pamba water shed. All the streams drain to Azhutha river. There are a series of hills situated at right angles to the river. This section has evergreen forest, semi evergreen forest, moist deciduous forest and grasslands. Evergreen forest and semi evergreen forest seen at low elevation is particularly notable. There are few cashew plantations inside the forest.

Choozhy Section contains good amount of undisturbed forest. The forest of the Erumely Range serve as a buffer. Sathram Section is notable for extensive grasslands which were converted into eucalyptus plantations. Eastern portion of the section is evergreen forest. The section gets its name from an abandoned camping place for Sabarimala pilgrims. Sathram Section is drained by streams joining Periyar and Sabarimala Thodu. The relatively plain areas of Uppupara is now brought under new section. The section is located on the right side of the road to Uppupara.

Pamba Range

Pamba Range consists of five sections. They are Pambavalley, Puthussery, Karimala, Sabarimala and Pachakanam sections. Pachakanam and Puthursserry sections are the largest. Sabarimala and Pachakanam sections of Pamba Range are very important considering the vegetation and pilgirimage to Sabarimala temple. The Pambavalley section lies on the right bank of Pamba River, down stream of Sabarimala and upstream of Pamba-Azhutha sangamam. Notable features of this section are 1) evergreen forest 2) grass lands 3) semi-evergreen and deciduous forests 4) Pilgrims route 5) Settlements in Pambavalley. Head quarters of the section is at Pambavalley. Areas near the river are inhabited, Udumpara is a small patch of forest on hill top surrounded by cultivation on all sides. Sabarimala section is important in three respects. First the well known Ayappa temple is located with in this section. Secondly, there is a good stretch of evergreen forest in this section. Thirdly the region contains stretch of grassland. Pachakanam section is situated to the east of

Sabarimala section. The entire section is drained by tributaries of Pambar river. One the northern side, the water shed to the Periyar form the boundary. This section is notable in two respects. The first is presence of evergreen forests in highly steep terrain. Chenthamara kokka is one such region were the altitude fall from about 1200 m to 1100 m. Tributaries of Pamba flowing through this gorge create a scenic waterfall. This section is also notable for the grasslands in Uppupara region. One of the pilgrim routes to Sabarimala pass through this area. The Jeepable road forms one of the boundaries. The eucalyptus, due to repeated harvesting and degrading factors has practically disappeared and are now grasslands. There are several sholas of evergreen forests in valleys of these grasslands. Part of Poonkavanam, which is sacred forest for Sabarimala pilgrims also fall with in this section. Detailed description of the sections follows. Description of boundary, maps, topography and vegetation are described.

Sl.No.	***Division***	***Range***	***Section***	***Area km^2***
1	Periyar East	Thekkady	Edappalayam	18
			Thekkady	13
			Nellikkampetty	32
			Medakanam	8
			Mullakudy	28
		Periyar	Kottamala	29
			Thamara	22
			Randattinkara	13
			Manalar	49
			Eravangalar	15
			Mavady	7
			Thannikudy	55
			Mlappara	39
			Ummikuppan	45
			Moolavaiga	46
			Sundaramala	31
			Periyar	25
		Vallakkadavu	Thondiyar	22
			Vallakkadavu	16
			Kozhikanam	26
			Kallaradichan	18
			Aruvioda	61
2	Periyar West	Azhutha	Moozhikal	15
			Choozhy	26
			Sathram	16
			Uppupara	11
		Pamba	Pambavalley	11
			Puthusserry	26
			Karimala	8
			Sabarimala	20
			Pachakanam	26
			Total	777

1.2. Riverine system

a) Major rivers

The four major rivers draining Periyar Tiger Reserve are Mullayar, Periyar, Azhutha and Pamba. For the purpose of the study, the river systems seen in PTR are classified under high elevation, medium elevation and low elevation. Mullyar and Periyar come mostly under high elevation, Periyar (tail water of Mullaperiyar Dam) under medium elevation and Azhutha and Pamba under low elevation. On the western side there are two rivers, Azhutha and Pamba. Azhutha river forms the northern boundary of western side of Periyar Tiger Reserve. The river Pamba forms the south western boundary of PTR. On the southern side of the lake is Pamba Periyar divide, a chain of hills about 1200 m in elevation, the northern side draining to Periyar basin and the southern side draining to Pamba basin. Unlike the streams in high altitude, some of the streams feeding Azhutha and Pamba dry up in peak summer.

b) Lake

A masonry dam was constructed near Thekkady in 1895 creating a lake of about 26 km^2. The catchment area of the lake is 603 km^2. Water level in the lake fluctuates between a maximum of 46 m. to a minimum of 32 m. The two main river systems, Mullayar and Periyar join together near Mullakudy thus draining their water into this lake.

c) Catchment

Kottamala forms the main catchment area of Mullayar in the northern region. Thamara and Manalar form the other catchment areas. Regarding Periyar, the remote inaccessible continuous patch of forests of Sundaramala and Chokkampetty forms the main catchment units. On the southern side of lake is Pamba Periyar divide, a chain of hills of about 1200 m in elevation the southern side of this draining to the Pamba basin. Sathran region is its another catchment unit. Major contributory rivers are Njonangar, Kakkattar and Kallar. Peerumad mountains form the major catchment area of Azhutha. The Grambi area of the Kottayam Forest Division also contributes its water to Azhutha.

1.3. Database

A large number of ecological studies have been carried out in Periyar Tiger Reserve. Much data has accumulated on habitat, flora, fauna and anthropic factors. The next step would be to incorporate these into a computer based database so that information can be retrieved easily. Several techniques are available for this purpose. HTML based approaches are the most common. But this has the disadvantages that it is very tedious to update the contents. In this project a large number of essays prepared in MS Word format under topics such as administrative units, rainfall, water, vegetation, flora and fauna are kept together in a CD. A control program facilitates retrieval of required items. One advantage of MS Word is its wide availability and facility for keeping maps and pictures along with text.

1.4.Topography

Contour maps are an essential component in any mapping task. Contour maps help in the identification of hills, valleys and flow of rivers. At further level contour maps provide details of slope of terrain which can be related to status of vegetation and soil. Contour maps are also used for aligning roads and trek routes. Contours are also the starting point for generation of 3-d views of landscape.

In this mapping exercise contours are digitised at 3 levels of detail. For generating overall view of area 1:1,000,000 Survey of India (SOI) topo sheets were digitised. 1: 250,000 SOI topo sheets were digitised at 200, 300, 500, 1000, 1200, 1500 m. This was used for generating overall physiography maps. Detailed 3-d maps were generated from contours digitised at 100 m interval from 1: 50,000 SOI topo sheets. In all these cases topo sheets with grid markings were scanned using A4 colour scanner, a correspondence file generated by a custom program and resampled using a module of Idrisi. Further tracing of contours were carried out on this resampled map on screen, using a custom program or Map info.

Contour lines are traced from scanned and resampled topo sheets. These contours can be further processed as vector or raster. In the case of vector, selected number of points from the contours can be fed to programs such as Surfer. Surfer is capable of interpolation of points and generation of contours. Further steps in Surfer enable generation of 3 - d views and hard copy plotting. In the case of raster treatment, the contour lines has to be rasterized first. The contour values are assigned values between 0 and 255 for processing as 8 - bit images. Raster GIS programs such as Idrisi has routines for creating in between points by interpolation.

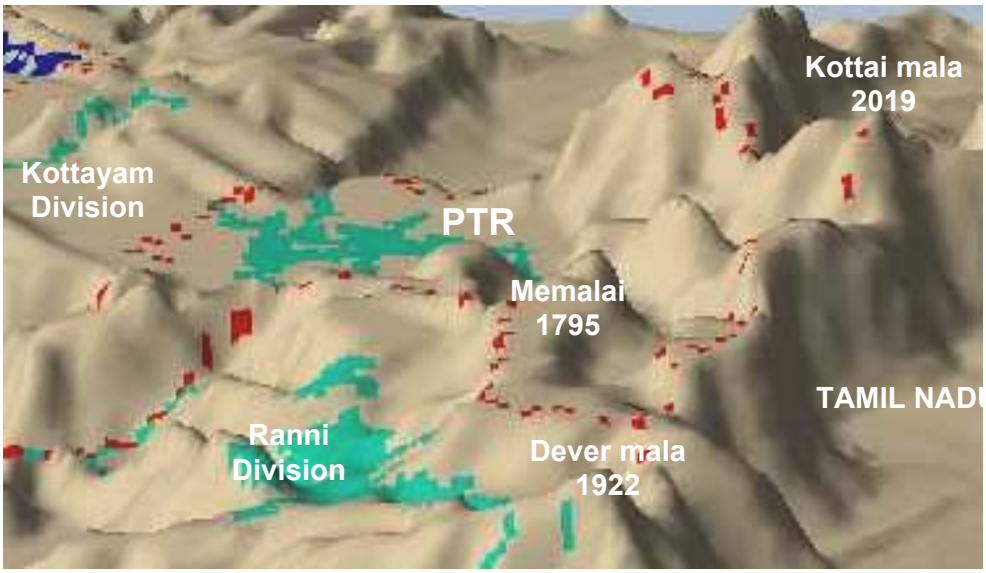

Fig 2. Computer generated 3-d view of the area.

The interpolated raster images is a crude Digital Elevation Model (DEM) and can be used for generating 3 - d views. In the present mapping exercise a program for 3 - d visualization was used. The program has facilities for selecting required area and defining view of angle parameters, assigning colours to different altitudes, overlaying layers such as streams or vegetation.

Three - d images can be generated in several ways. In all the methods points in between contour lines are defined by extrapolation and each point recreated in three dimensional plane. Images are transformed for plotting on two dimensional media by fixing angle of view. Contour lines at 200, 300, 500, 1000, 1200, 1500 and 2000 and rivers are shown. There is low level forests (<500m) in Periyar Tiger Reserve in Vallakkadavu Range. This is situated between the Pamba and Azhutha rivers. Two other regions near PTR, but out side have altitude below 500m. One is on the eastern side in Tamil Nadu. The other is in the Cumbum valley. The drop in this location is used for generating electricity from water from Periyar Lake. The low elevation region inside PTR has an important type of evergreen association characteristic of low elevation. **Most of the Periyar lake and surrounding areas are at less than 1000m (Fig 2). Excepting a range of hills, remaining portion of Vallakkadavu range also fall in this category. Both Mullayar and Periyar are at less than 1000m, for several kilometres from the lake. There are few isolated hills around the lake. These regions have mostly savannah type of vegetation. The rest of the area, upstream areas of Mullayar and Periyar are mostly between 1000-1500 m in elevation. These regions contain medium and high elevation evergreen forest. There are few hillocks rising to more than 2000m in three locations Vellimala area, Chokkampatti area and region on the Ranni border. It is notable that even at this altitude, grassland shola associations are not common in this area.**

1.5. Vegetation

The vegetation of Periyar Tiger Reserve has been studied in detail. Chandrasekharan, in "Forest types of Kerala" gives general forest types and area under each of these. French Institute, Pondicherry has prepared a map of the vegetation at 1:250,000 scale. The flora of the reserve was studied in detail by Sasidharan (1998). In this study characterestics of forest was examined with the help of sample plots taken during the base line mapping. Tree composition from sample plots and profiles of vegetation are given separately. As part of the project supervised classification of forest using satellite imagery is attempted.

Fig 4. Aerial view of evergreen forest

Fig 5. Moist deciduous forest, Chevaloda

Chandrasekharan classifies the forest of the reserve into evergreen, deciduous, and grassland types. The evergreen forest occupy an area of 305 sq. km., semi evergreen 275 sq. kms., moist deciduous 98 sq. km. and grassland 12 sq. km. French Institute Pondicherry in their vegetation map prepared in 1997 classifies the forest into the following types. Evergreen is classified into high elevation, medium and low elevation. They also described savannah and deciduous type of forest. In evergreen forest the trees are high, canopy is almost closed and is made predominantly of soft-wood species. Common species found are *Mesua nagassarium, Elaeocarpus tuberculatus, Canarium strictum, Evodia lunu-ankenda, Nephelium longana, Cullenia exarillata,* etc. Reeds are found in wet areas. Undergrowth consists of *Strobilanthus sp., Psychotria sp., Laportea crenulata, Curcuma sp., Clerodendron sp.* etc. various climbers (canes, Accacia sp., pepper) are also present.

Deciduous forest is present only in few areas. Main trees are *Tectona grandis, Dalbergia latifolia, Lagerstroemia lanceolata, Pterocarpus marsupium, Terminalia bellirica, Terminalia paniculata, Terminalia chebula, Bridelia retusa, Emblica officinalis, Randia dumetorum, Grewia tiliaefola, Bombax sp., Anogeissus latifolia* etc. undergrowth consists of *Lantana camera, Eupatorium odoratum, Zizyphus sp*., etc. *Bambusa arundinacea* has flowered during 1970-77 and is gradually getting established in moist areas.

Hill tops like Kumarikulam, Chaverkuzhy and Kathiramudi have short grass of *Heteropogon contortus* and other species. The elephant grass *Cympogon sp*.

growing to two meters occupy vast regions in the reserve. Amidst these are fire resistant trees like *Anogeissus latifolia, Bridelia retusa*, *Emblica officinalis, Careya arborea, Kydia calycina, Grewia tiliaefolia*, etc. These were probably wooded regions earlier and has been reduced to grassland due to frequent fire. Marshes and lake shore have succulent grass like *Panicum sp*.

Fig 6. Evergreen forest, Upper manalar

Fig 7. Bamboo area - Mullakudy.