ENVIRONMENTAL PLANNING OF TWO SELECTED RIVER BASINS OF WESTERN GHATS BASED ON INVESTIGATIONS ON LAND USE PLANNING AND LAND CAPABILITIES

BY

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THESIS

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CERTIFICATE

Certified that this thesis entitled "Environmental Planning for two selected river basins" is a record of research work done independently by Shri Benoy T. Cherian under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

Vellayani,
Trivandrum

15th December 1967

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DECLARATION

I hereby declare that this thesis entitled "Environmental Planning for two selected river basins - Mangalam-Gayathripuzha and Aralam-Bavalipuzha in a bonafied research work done by me during the course of reseabch and that the thesis has not previosuly formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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INTRODUCTION

Rapidly changing socio-economic structure puts tremendous pressure on human society to find additional resources for its sustenance. Invariably, society turns to exploit natural resources often with scarce concern for preserving the quality of the environment. During the remainder of this century, man is likely to use as much of the earth's natural resources and tap as much energy as he has done during the whole previous course of human evolution. Hence mankind is faced with the serious problem of channelising the circulation of resources in a way that will serve the needs of humanity while respecting ecological processes. Our concern for the ecological balance is limited to the times we face a crisis episode like land slides or drought which is a consequence of irresponsible exploitation of natural resources.

The natural environment is a complex interacting system of physical, chemical and biological components. Modern society inspite of its recent debut on the global scene exerts a force comparable with or even stronger than the forces of nature and is hence capable of deviation, disturbances and sometimes total destruction of important portions of the biosphere with immediate or delayed effects being evidenced on a global scale.

The connection between the biosphere on the one hand and the land and soil are immediately obvious. Land and soil are however resources that are not infinite and cannot be exploited for ever by the unlimited greed of either an individual or a clan. Thus each soil has an optimum carrying capacity of human, grazing animals, crops and forests which can be sustained at an appropriate level of technology. However, when the demand exceeds the level of the soil capability then permanent damage is done to the land resource (Higgins and Kassam, 1981).

Defining the carrying capacity of various species of animal etc. have been fairly easy. However, defining the carrying capacity of man for a given area of land is problematic. It is a function of his food habits as well as his resource exploitative requirements.

In all terrestrial habitats the soil is of vital importance. The soil serves as an energy, water and nutrient storage system which smoothens the effect of fluctuations in rainfall and other climatic variables of the biosphere. It provides a habitat for organisms decomposing organic remains and recycling the substance they contain. In the soil there are complex interactions between biological and inorganic components of the systems. Soils depend on their living microflora and on the vegetation that covers them for their properties and have taken millennia to develop to maturity. This fragile

epidermis of the earth's crust is severely affected due to drastic changes in vegetation cover resulting in destruction of soils and losses of nutrients and fertility. This phenomenon was frequently recorded in the past and are still likely to accompany unwise development of new lands for cultivation.

Soil degradation has been defined by Leow and Gardiner (1982) as the reduction in soil fertility with the resultant decline in crop productivity. This may be due to physical removal of the soil cover or a progressive decline in fertility without actual loss of soil cover or a combination of both. Each centimeter of soil loss from the surface results in more than 1 percent loss in total productivity of a soil with the percent yield reduction increasing as a larger amount of surface top soil is eroded away.

The biosphere exerts a role in the physical state of the land and soil. Thus accelerated erosion depends very much upon the intensity of agricultural use and minimisation of this to a large extent depends on the nearness of the agro-ecosystem to a forest ecosystem. Tree crops are probably the best to achieve this end.

Conversely, the land and the soil exert their influence and imprint on the biosphere. The quality and quantity of terrestial bibiosphere depends on the soil and land.

Nature of land and availability of water are the two main components which govern the land use pattern of a region. The unique interlink between these two factors is typified in the river basins. The Western Ghat region, which covers 56 percent of the total geographic area of the State is the source of all the river systems that sustain the agro-economy of the State. With scarce regard for the ecological fragility of the region it is being continuously exploited thereby putting the ecological balance in jeopardy. Rapid deforestation has made the region highly susceptible to erosion. According to Menon Madhava (1984) ecological disturbances in the high ranges of the Western Ghats region will have serious and perhaps cumulative consequences in both the midland and low land areas.

For studying the extent and state of an environmental impact a well defined natural unit has to be selected. Based on the studies of this unit, it is possible to arrive at a comprehensive planning programme related to the preservation or enhancement of environmental quality.

Being a natural physical system where the land and water act as definite determinants of land use, river basins are the most appropriate unit for study.

The sub watershed and micro-water sheds are the accepted units for eco-development planning. There is a need for detailed studies in natural and agro-ecosystems in different watersheds in relation to the physical features of the land and soil characteristics. Such studies are required to plan microlevel aspects of eco-restoration and eco-development of watersheds.

The biophysical environment attributed by physiography, vegetation, soil and water having a direct bearing on man is systematised within a river basin (Nair and Chattopadhyay, 1985). The successive stages through which the river passes from the sources to the sink are closely interrelated that tampering of the system at any part would offset a chain reaction of far reaching consequence. Hence an eco-development planning which would strike a balance between conservation and development is necessary.

The realisation of this concept in Indian Planning has made the Indian planners to accept the watersheds as the micro unit for planning developmental programmes.

With these ideas in mind, the present work on a detailed study of the sub watersheds of Bharathapuzha and in Aralam puzha has been planned. The main objectives of the work are as follows:

(i) A study of the sub watersheds of Bharathapuzha and Aralam-puzha for relief morphology, drainage, geology, vegetation, climate, soil and land use.

(ii) A land capability assessment of both the river basins based on detailed soil studies and traversing of the area.

(iii) To evolve a set of recommendations for management of the two river basins.

REVIEW OF LITERATURE

Environmental problems, a consequence of modern techno-centric development have become a subject of serious concern throughout the world. The developmental planning so far followed in almost all the countries has perpetuated such serious imbalances in the ecosystem that the very existence of civilisation is being threatened. An alternative developmental strategy commonly known as eco-development has to be formulated keeping a balance between environmental conservation and resource utilization.

A large number of studies so far conducted or being conducted in recent years, bring out two divergent ideological themes (O'Riordan, 1981). These two views, ecocentric and technocentric, though apparently divergent, agree that the future development rests upon the successful management of the environment. The eco-development planning as formulated by UNEP highlights that problems of any region should be tackled in the regional context and solutions should have an *in situ* bias. In other words, the ecological reality along with socio-anthropological dimensions have to be considered for any planning attempt. As Menon Madhava (1984) has pointed out development plan for a region should be built upon the sum of a series of projects devised for the smallest economically significant unit of land or population, each such project having taken into full

consideration the ecological peculiarities and unique features involved. It is observed from the studies so far conducted throughout the world that the eco-development planning should includ environmental impact assessment as a planning tool (Carpenter & Dixon, 1985)

The existing studies are not sufficient in the context of an integrated natural unit for development. Environmental impact assessment in most of the cases attempts to study only the impact of a particular project. While it is no doubt necessary for assessing the impact of a specific project it is also a basic task to study the impact of the project in a more broader context namely the natural unit for ecological conservation. Because the projects which are location specific exert their influence in a broader region apparently unconceivable, the environmental planning as viewed in this study refers to a natural unit viz. river basin. River basins have been conceived as a planning unit in USA, with the establishment of Tennese Valley Authority (TVA) in the first half of the century. Damodar Valley Corporation (DVC) in our country conceived on the lines of TVA, as early as 1945, clearly indicates the far sightedness of some of our early planners. However, the failure of both TVA and DVC to achieve the desired results (Chakrabarty, 1979; Bagchi, 1981) proves that the approach should have a better perspective than currently practiced (Chattopadhyay, 1985). The id a of reckoning

river basins as merely a potential resource base only, has changed considerably. In the course of a river from its origin to its ultimate destination it passes through atleast three stages recognised as the upper, middle and lower reaches, each unique in its environmental condition and hosting different groups of people with varied economic interests and promoting different land uses. Integrated water shed management (Lall and Russel, 1981; Saha and Burrows, 1981) attempts to rectify some of the earlier problems and tries to use the water sheds as planning units both for development and conservation. Soil survey and conservation work of the National Bureau of Soil Survey and Land Use Planning and Soil and Water Conservation Research and Training Institute in our country are mainly conducted on the basis of water shed as the microlevel unit. However, all these studies are mainly related to the soil which is one of the components of the total environment. As a fundamental functional study unit, river basin offers a broader dimension to study a large number of parameters related to environmental planning (Charley, 1962; Gregory and Walling, 1976). Although at an academic level some studies have been conducted on the basis of river basins in other parts of the country, especially in Kerala it has almost been non-existent. Only in recent years, especially after 1984, some attempts in this direction have been initiated by the Centre for Earth Science Studies.

Land use:

Land use may be defined as the resultant of man's interaction with the environment (Vink, 1975). Land use of any region is the resultant of the inhabitants impact on the land in the light of their perception of land scape ecological factors in that region, developed through generations, along with their capacity for absorption of technological skills (Nair and Chattopadhyay, 1985).

Dumonski et al. (1984) said that the most important areas of concern in land use management can be summarised under three major categories, viz. land supply, land quality deterioration and the social or political problems of split Government jurisdiction.

Land being the carrier as well as part of the ecosystems (Vink, 1975), acts as the interface of all interacting systems and therefore it displays the phenomenological expression of their interaction in land use condition.

The response of land to various types of land use practice may be positive or negative depending upon the mode and degree of human intervention in preserving the integrity of any interacting systems having direct or indirect bearing on land. Therefore, in order to chalk out any tangible land use planning it is essential

to investigate the intricate relationship between the various components of landscape ecology and land use (Nair and Chattopadhyay, 1985).

Thiore et al. (1984) identified the levels of comparison for important site specific data to enable site comparisons of land use. These levels are based on the soils suitability for cultivation of selected crops. Site data are arranged according to increasing clay content, increasing hydromorphic nature and slope inclination to form similar ecological and technological series and grouped in relation to essential difference in their suitability for cultivation.

Roychowdhury et al. (1985) in a study of land form and land use in Nagpur district found that for proper utilization of land it is essential to know the environmental characteristics of each land form unit, their associated soils and present land use pattern. A suitable land use pattern taking into consideration the inherent characteristics of the land forms and associated environment can be suggested for optimal utilization of land resources of the area.

An equilbrium between man and the limited resources of semi arid and sub humid regions under demographic pressure cannot be achieved except within a clearly defined and applied economic and social policy. This could be overlooked in a long term planning

policy if land use is not defined according to human needs and production capacity. Land use should be determined by applying that speculation which will obtain the maximum yield compatible with its equilibrium in the natural environment (Kane, 1974).

Dopetrio (1981) found that any man made alteration in land use and vegetation within the water shed area will affect the flow of water and the quality and quantity of particulate and dissolved species carried downstream. It is also responsible for the reduction in storage capacity of reservoirs, productivity of deltas and estuaries and also to the degradation or channel bed and erosion of river banks.

Kim-Tae Um (1982) highlighted the method of soil survey and land use recommendation in Korea. On the basis of the detailed soil survey, a criteria of the land capability classification for management of upland and paddy soil and the land use recommendations were established.

Baker (1982) has highlighted land classification as a basis of land use planning in Hawaii. Sound land use decision making with proper provision for the environment and natural ecology, requires knowledge and measurement of this diversity. Land classification has

facilitated, efficiency in land use, has prevented costly mistakes in land use decision during development and growth and has given recognition to ecological suitability and environmental concern in land use planning and decision making.

Land classification studies in India are primarily related to agriculture. Fertility based classification is known in India since early days (Choudhary Roy, 1966).

Classification based on texture, productivity rating, colour and other physical properties have been adopted for revenue purpose in the 16th century (Rao, 1956 and Sethyanarayanan & Sankaran, 1970).

Classification based on crop suitability, yield rate, productivity, irrigation, soil fertility and soil capability has been attempted in different parts of the country by scientists of disciplines like geography, and agricultural sciences. The contribution of Rao (1956), Arunachalam (1959), Saha (1969), Siddiqui (1971), Bhattacharya (1975) and Das and Bhattacharya (1978) deal with various types of capability and productivity classification in their respective study areas primarily based on soil characteristics and land use.

The Canadian approach of ecological land classification in a hierarchical system (Davidson, 1982) is a significant contribution of integrated approach. The classification proposed by

Moss (1983) incorporates process data on the ecological units of Canadian system. It relies upon the potential productivity of each unit of land.

Geomorphology

Naik and Rao (1981) in a study of the geoenvironmental state of Manantoddy area found that the development of the area depends to a great extent on the availability of land, water and other natural resources. The slope morphometric studies indicate steep slopes which tend to be unstable. The valley flats filled with colluvial and alluvial material and other areas traversed by faults fractures and other lineaments are identified as potential areas suitable for ground water development in this hard rock area. The land morphometry is congenial for development of varied types of plantation crops.

Bojali and Hirekerur (1983) found that factors responsible for different land forms are also responsible for the formation and development of soils though the degree and extent of influence may differ. Geomorphological mapping plays an important role in the mapping of soils. The landscape units and soil units at any level of mapping may not always be continuous but there will be appropriate linkage between them which help in proper understanding and interpretation of soils. Hence establishment of relationship between

landscape and associated soil units become important in soil mapping and refining soil unit boundaries. Soil geomorphology relationship also helps in broad evaluation of the soil with respect to their problems.

Challa et al. (1983) found that a thorough knowledge of geomorphological history is essential for proper understanding of the soils and other edaphic conditions. There is a close relationship between the soils, various land forms and also the land use practised there.

Rao and Vaidyanadhan (1981) in a comparative study of land form map and land use map of the Krishna delta reveal that land form of an area controls. The crop pattern to a major extent.

Chowdhury et al. (1981) studied the physography - soil - crop relationship in Ahmednagar district under semi arid tropics. The study reveals the ridges, escarpments, table lands, mesas and buttes, pediment, intervening valley, piedmont and flood plan bear close and direct relationship with the soil and land use pattern.

Dhankar and Jain (1985) in a study of the landscape soil relationship in Ghazipur district found that the geomorphological features influences characteristics of the soil and have a bearing on their problems and potentials.

Pregitzer et al. (1983) investigated the relationship of topography to soils and vegetation in an upper Michigan eco-system. They found a strong correspondence between the distribution of plants, soil development and soil nutrient status, both of which in turn are strongly related to toposequence character.

Powar et al. (1982) in a study of the physical environment and land use pattern in Pravara basin, Maharashtra found that the utilisation of land for agriculture and cropping pattern is largely dependent upon the physical determinants of the environment namely lithology, land form and water resources.

Rudra and Bandhyopadhyay (1982) found that land utilization of the Ganga delta is a direct reflection of its physical environment.

Soils

Beck (1978) is of the view that soil information can play an important role in solving land use problems that farmers face in developing countries. To make a significant contribution data collection has to be problem oriented. The soil properties that should receive attention will depend on existing land use problem, the details of the study and the criteria for optimal land use. The most common criteria for optimum land use are favourable input-output relationships and conservation of the environment.

Soil series are an expression of all the physical factors (relief, parent materials, hydrology and climate) at any site and therefore provide an index of the local physical environment (Cruickshank, 1977).

Riquier & Garnet, (1970) found that the productivity of soils varies with the type of crop grown. Some plants are able to withstand soil drainage and soil fertility conditions which others cannot and to give economically satisfactory yields, where other plants cannot grow at all.

Cruickshank (1977) found that agricultural productivity of the land will be influenced by the physical environment of the site in the same way as the profile development has been. However, the genesis of a soil cannot be used directly as a measure of its agricultural value.

Pafali (1980) found that a proper soil survey interpretation provides information on soil potential, productivity and limitation in their sustained use.

Munir and Ahmad (1985) focussed attention on the importance of soil analysis and its impact on crop production in Madhuban village of Azamgarh district.

Rao et al. (1984) found that the well being of the human society is dependent upon the eco-systems of the hills including land, water, air, minerals, flora and fauna. But the hill eco-systems in the Eastern and Western Ghat ranges are presently subject to gross neglect, a mistake that cost India about 6000 million tonnes of top soil washed away annually from the hill slopes and plains. The deforestation of hills caused siltation of river beds, and irrigation dams and gave rise to floods rendering some 40 million ha of land unproductive in the plains.

Olson (1984) said that there is a shift in emphasis towards soil survey and presentation and interpretation of soil survey information for land use planning.

Leow and Gardiner (1982) in a study of soil degradation as a physical constraint for land use planning with reference to Northern Nigeria defined it as the reduction in soil fertility with resultant decline in crop productivity. This may be due to physical removal of the soil cover or a progressive decline in fertility without actual loss of soil cover or a combination of both. They found that there is a steady drain on soil fertility by continuous and semi continuous cultivation. The continued cultivation not only reduces the nutrient content but also affects the physical properties

of the soil. Cultivation has been shown to increase soil bulk density and cause structural degradation. High bulk density and poor soil structure affects the utilisation of applied nutrients and root penetration. Nutrient content may take several years to be depleted but the structural degradation may happen even one year after cropping.

Higgim and Kassam (1981) said that each centimetre of soil loss from the surface results in more than 1 percent loss in total productivity of a soil with the percent yield reduction increasing as a larger amount of the surface top soil is eroded away.

Spycher et al. (1983) in study of carbon and nitrogen in the light fraction of a forest soil found that the light fraction material accounted for 53 percent of the total carbon and 43 percent of the total N in the 0-3 cm layer. This proportion decreased abruptly in the next layer and then more gradually over the remainder of the 03 cm profile. They also found that the light fraction provides an important labile reservoir of carbon and nutrient elements in the forest eco-systems.

Climate:

Bishnoi (1981) in his studies examined in detail the influence of ecological factors, temperature, moisture, light, edophic and

biotic on distribution of plants. In order to make it more comprehensive he has described the distribution of important crops in tropics, sub tropics and in the intermediate climatic region on ecological basis. Major crops like rice, wheat, cotton, maize, millets, barley, groundnut, potato, coffee, bananas, cocao, vegetables and fruit crops have been discussed in detail in relation to their distribution with climatic edaphic and biotic factors.

According to Bishnoi and Ram Singh (1981) agricultural production may be increased by optimum use of water and land resources together with selection of crops most suited to the area. The crops should be selected in the light of existing agro climatic conditions of the area.

Kalita and Sarmah (1981) in a study of a probable effect of deforestation on the rainfall climatology of the erstwhile Lakhimpur district of Assam found that there is an inverse corelation of rainfall of Dibrugarh and raw material consumptions of the plywood factories which tend to show that deforestation may be one of the causes for diminishing rainfall in Dibrugarh.

MATERIALS AND METHODS

The basic approach in the present study is to investigate individual components and bring out their relationship with present land use. It will be possible to characterise the land units in terms of environmental suitability. A large number of components like geology though apparently unrelated to land use have to be investigated as they provide indirect but very important information for the evaluation of landscape ecology.

In this study, however two sub watershed basins one, Mangalam-Gayatripuzha, highly influenced by man and his activities and the other Aralam-Bavalipuzha, relatively less interfered by man were located for comparative purposes of the present study. Emphasis has been made on the study of geology, geomorphology and other aspects as related to soil that supports either natural vegetation or agriculture in the two sub water sheds.

Mangalam-Gayatripuzha is a sub-catchment of the Bharatapuzha basin and lies between 76° and 25' and 76° 50' East longitude and 10'" 45' and 10° 30' North latitude. It covers an area of about 1050 Km^2 of which 60 Km^2 lies in Tamil Nadu State. The basin covers forty revenue villages under the Palghat and Trichur districts.

Aralam-Bavalipuzha is a sub catchment of the Valapattanam river and lies between 70° 40' and 75° 60' East longitude and 11° 45' and 11° 50' North lattitude. It covers an area of 400 Km^2 in the North

Western flank of the Wayanad plateau in the Cannanore district. Around 30 Km^2 of its area falls within the jurisdiction of the Karnataka State.

Environmental components like relief, slope, morphology, drainage, geology, vegetation, climate and soil have been analysed by using standard methodology with respect to individual variables. The brief methodology adopted for each component is briefly detailed.

Relief:

Relief variation of any region has a significant contribution in the spatial distribution of land use. Information about the relief has been collected from topographical maps. To depict the relief variations, maps have been prepared for the two regions of study by depicting contour lines. The contour intervals were selected in such a way that they represent the erosional surfaces which are remnants of different erosional cycles, that operated throughout the geological history.

Slope:

Slope has an overwhelming dominance in land use pattern. Average slope at 5° interval for both the areas has been worked out by using Wentworth method. The working procedure under this method is elaborated below. To obtain average number of contour crossings per km. The entire area has been divided into square

grids of one Km^2 each, and subsequently the number of contour crossings along four sides of the grid have been computed and average worked out.

Thus each Km^2 has an average slope value in degree based on which 150 lines are drawn at suitable intervals.

$$\text{For} = \frac{\text{Average No. of contour crossings/km} \times \text{contour interval}}{0.6366 \times K}$$

where = Average slope in degrees

K = 1000 M in metric units and 5280 in mile scale

Geomorphology:

Both the study areas have been divided into a number of geomorphic units depending on the process involved in those units. This exercise is also carried out based on the use of toposheet, aerial photo, and landsat imagery. Detailed field work has been taken up to check the boundary of the units of key areas selected. The geomorphic units which are the products of gelogic structure and the erosional agents active in the particular area provides important information about the development of soil.

Drainage:

Information about drainage condition is obtained from the topographical sheet and aerial photographs. The drainage density worked out as length of drainage channels in Km/Km^2 area provides valuable information to understand the erosivity of the region. Analysis of drainage net work is also attempted by using Horton principle to understand the net work geometry, control of geological structure and condition of the river as a whole. This provides additional information about the relative distribution of erosional and depositional areas. Perrenniality and non-perrenniality of the drainage channels have also been investigated through field work.

Geology:

Geological mapping in regional scale has been conducted to identify the various rock types prevalent in the region. The regional geological map prepared through field observations has been supplemented by aerial photographs (1:50,000) and landsat imagery (1:100,000).

Vegetation:

Information about vegetation is obtained from maps of Forest Department, Govt. of Kerala. This is cross checked using aerial photographs and field checks.

Climate:

For understanding the climate, rainfall, temperature and evapotranspiration have been studied.

(a) Rainfall:

Rainfall data have been collected from the existing stations within the study region monitored by IMD, PWD and ICAR local units. Average monthly distribution of rainfall has been worked out for a set of data collected from Alathur, Chittur and Palghat in Mangalam-Gayatripuzha basin and Odenthode, Irikkur and Manantavady in Aralam-Bavalipuzha basin. From these monthly recordings season wise distribution of rainfall was worked out.

(b) Temperature:

Data pertaining to temperature is available only for Palghat in Mangalam-Gayatripuzha basin and Odenthode in Aralam-Bavalipuzha basin. From the daily recordings average monthly temperature has been worked out. To understand the combined effect of rainfall and temperature Omprothermic analysis is done by depicting rainfall and temperature on the same graph considering a proportion of 2:1 for rainfall in MM and temperature in °C. This helps to understand the dry and wet months in a year.

(c) Evapotranspiration:

Due to lack of monitoring stations, evapotranspiration has been worked out by using an empirical formula based on temperature. The formula is elaborated below.

$$Elm = \frac{T°F - 32}{9.5}$$

where Elm = Evaporation loss in mm

T°F = Temperature in degree farenheit.

Monthly evaporation loss obtained from this exercise is compared with the monthly rainfall. This provides a generalised idea about the dry months which require irrigation to promote agriculture.

Land use:

Land use the product of man's interaction with his environment normally displays man's capacity to utilise natural productivity. When land use of a river basin is considered it is observed that in the upper reaches of the basin it acts as a control system within the natural system and in the lower reaches it is the resultant. The land use of the region has been studied by analysing topographical maps aerial photos and supplemented by ground checks. To understand the agricultural land use crop statistics have been collected from taluk statistical office. This data has been

processed by using statistical techniques. Cropping intensity in village level has been worked out by using the formula

$$CI = \frac{\text{Gross Cropped area}}{\text{Net area}} \times 100$$

Soil:

Soil is a cumulative product of geology, climate and natural vegetation. Although soil is a renewable resource, for all practical purposes it has to be considered as a non renewable resource. This is because of soil losses by accelerated erosion compared to the slow rate of regeneration. Geomorphology has a very key role in soil formation. Therefore soil samples from each morphologic unit have been collected. Eleven profiles each from Mangalam-Gayatripuzha and Aralam-Bavalipuzha have been collected from different geomorphic units spread out throughout each basin. Standard procedures outlined by FAO were adopted in collection of soil samples and digging of profiles. The soil samples have been analysed to determine the percentage of sand, silt, clay and chemical characters like total N, P, K, Ca, Mg, pH and CEC.

Soil analysis:

Preparation of Soil Samples.

The soil samples collected from different depths in each profile were gently powdered and passed through 2 mm sieve and stored for

further analysis.

Textural composition:

The proportion of various size fractions of the soil was determined by carrying out mechanical analysis of soil as outlined by Jackson (1967).

Soil Reaction (pH):

The pH of 1:2.5 soil suspension was determined using a glass electrode (Piper, 1966).

Chemical Properties:

The soil samples were analysed for the following chemical parameters.

Total Nitrogen:

Total Nitrogen was determined using Microkjeldahl method (Jackson, 1967).

Total Phosphorous:

Total phosphorus was determined using Chlorostannous reduced molybdophosphoric blue colour method. Jackson (1967).

Total Potassium:

Total Potassium was determined using flame emission spectro photometry using sulphuric acid extract. Jackson (1967).

Total Calcium and Magnesium:

The total calcium and Magnesium were determined in perchloric acid extract of the soil. The extracts were fed into an Atomic Absorption Spectrophotometer and the spectrum of absorption was determined at the following wave lengths.

Calcium 422.7 m.

Magnesium 285.2 m

Details of the profiles and their locations are given below:

Profile Nos 1 to 11 were taken from different geomorphic units in Mangalam-Gayatripuzha Basin.

Profile No.1 was taken from Sitargundu situated at the foot hill of the Western Ghat. It has originated from forest loam which has been washed down after the removal of forest cover from the higher reaches of the mid slope and hill top.

Profile No. 2 was taken from Chemanempathi. It was situated in a field with gently rolling topography and it showed all characters of a typical black soil profile.

Profile No.3 was taken from Nemmeni on the way to Sitargundu estate. The profile was situated on the corner side of a hill which was considerably subdued due to erosion.

Profile No.4 was taken from Cheramangalam. The profile was situated on a terraced slope cultivated to upland rice and coconuts.

Profile No.5 was taken from Vandazy. The profile was situated on the convorse side of a hill near a stream.

Profile No.6 was taken on the way to Pazhyannur from a small hillock at the edge of a paddy field.

Profile No. 7 was taken from the crest of a subdued hill at Themarapadam.

Profile No. 8 was taken near Mopadam. It was taken from the mid slope region of a gently slping hillock.

Profile No. 9 was taken on the way to Pattiparamba from the crest of a small subdued hill.

Profile No.10 was taken on the way to Pallavur. It was situated on the toe region of a convex slope.

Profile No.11 was taken from Ganapathipalayam. It was situated on a convex slope under terrace cultivation.

Profile Nos 12 to 22 were taken from different geomorphic units in Aralampuzha-Bavalipuzha basin.

Profile No. 12 was taken from a rubber plantation just outside Aralam farm. It was located at the foot hill region of the Western Ghats.

Profile No. 13 is located on the way to Vellarivyal. It was taken from a road cut on a subdued hill.

Profile No. 14 was taken from Kottapuram Mala reserve forest. The site is situated in a considerably degraded tropical rain forest with sparse under growth.

Profile No. 15 was taken from Aralam farm. It was located on a gently undulating lateritic mesa.

Profile No. 16 was taken from Aralam farm. It was located in a saucer shaped basin on lateritic area.

Profile No. 17 was taken from Pazhetthapoya. It was situated on the mid slope of an undulated hill side under tea plantation.

Profile No. 18 was taken from Periya. It is located on a steep hill side under eucalyptus plantation.

Profile No. 19 was taken from Periya. This profile was situated in a valley bottom and was under cardamom plantation.

Profile No. 20 was also taken from Periya. It was situated on the mid slope of a hill under coffee plantation.

Profile No. 21 was taken from Kakkayangad. The profile is situated on the mid slope region of a gently undulating hill side.

Profile No. 22 was taken from Pallachura on the foot hill of the Western Ghat. The profile site was located on a stream bank.

LOCATION MAP

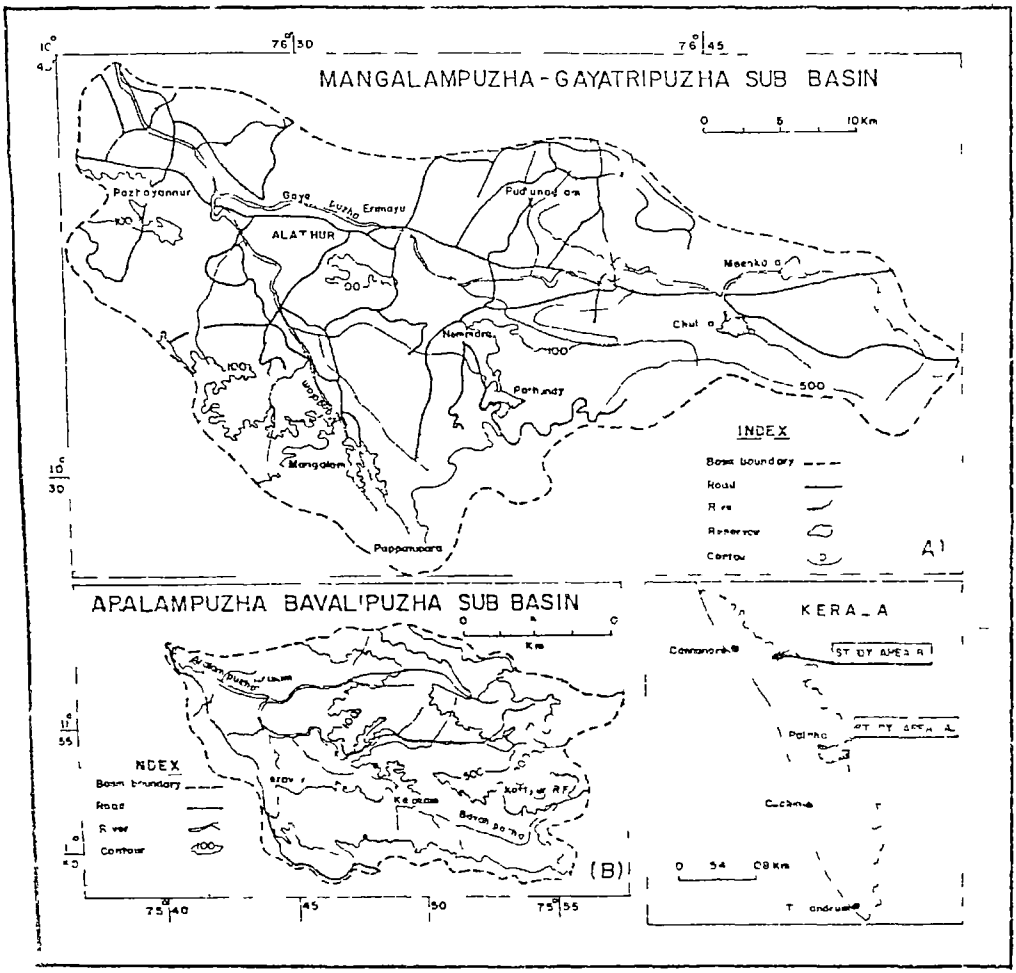


FIG 1

RESULTS AND DISCUSSION

Mangalam-Gayatripuzha Basin

Figure 1 presents the location of the Mangalam-Gayatripuzha sub basin. This is a sub-catchment of the Bharatapuzha basin and covers an area of about 1050 Km^2 of which nearly 60 Km^2 lies in the Tamil Nadu State. The basin covers forty revenue villages under the Palghat and Trichur districts. A significant feature of the basin is that human interference is very high. There are four irrigation projects namely Mangalam, Pothundy, Chulliar and Meenkara, constructed in the different tributaries of Managalampuzha-Gayatripuzha system. These projects cater to the needs of nearly 200 Km^2 and contribute to enable a second crop of paddy. A considerable area of the plateau scarp has lost forest cover. Deforestation has been made mostly for establishing plantations of tea, coffee and rubber according to the suitability of the location and soil.

Relief:

Figure 2 presents the relief characters of Managalampuzha-Gayatripuzha sub basin located at the southern flank of the Palghat Gap. This area has unique relief characteristics. Along the

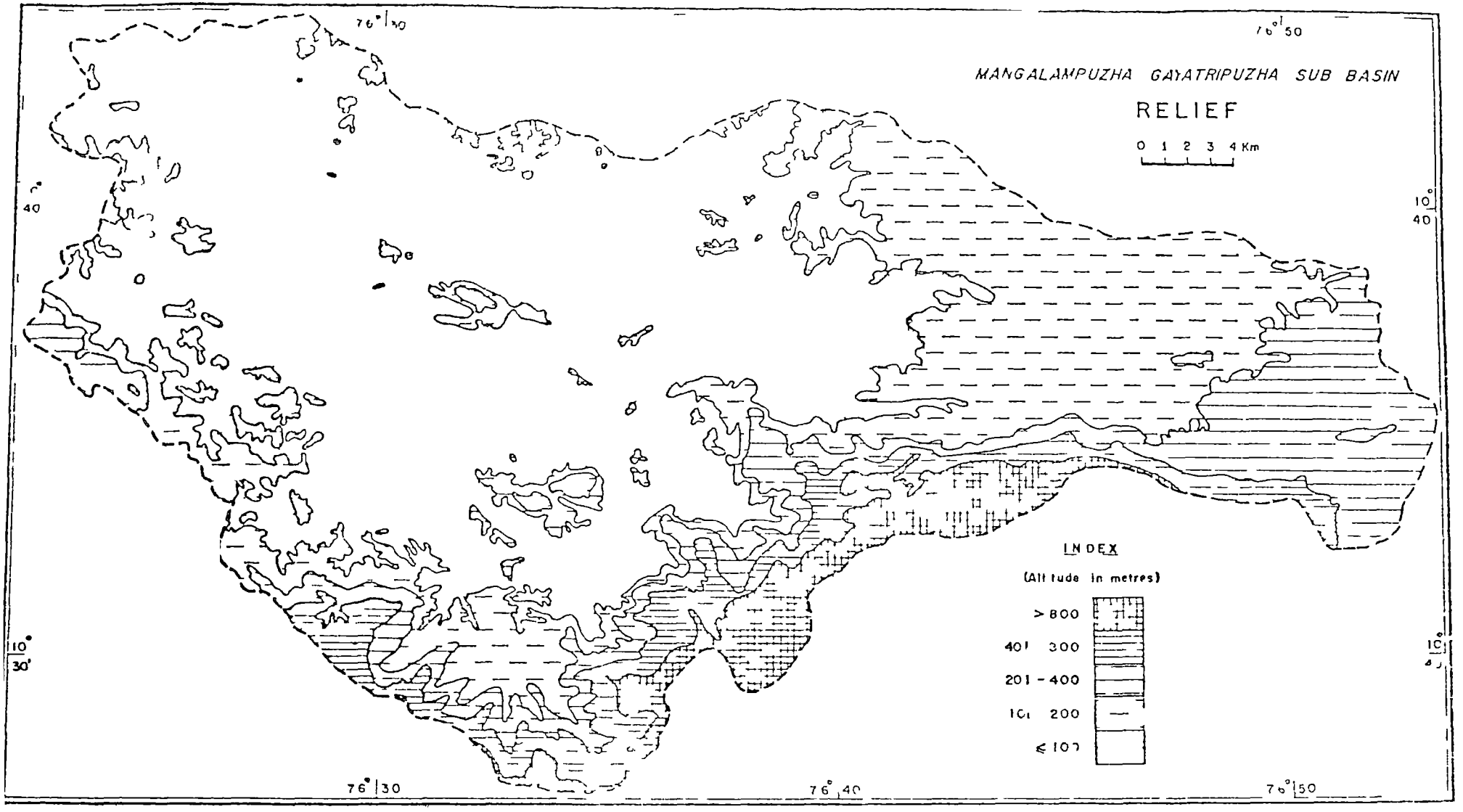

MANGALAMPUZHA GAYATRIPUZHA SUB BASIN
RELIEF
0 1 2 3 4 Km
INDEX
(Altitude in metres)
> 800
401 - 300
201 - 400
101 - 200
≤ 100
76°30
76°40
76°50
10°40
10°30

FIG 2

river valleys in the North Western part the elevation is less than 40 m and it ranges upto more than 1000 m along the scarp face of the Nelliyampathi plateau in the southern fringes. The highest point in this area is Meenampara mala (1633 m) followed by Padagirimala (1527 m) and Pullalamala (1444 m). The elevation of the chain decreases towards the west. From the relief map we can conclude that the area is mainly dominated by low relief. Nearly 48 percent of the total area is below 100 m contour. The coverage under different altitudinal zones decreases with increasing elevation. The nature of the cropping pattern also changes according to topography.

Table 1: Area under different altitudinal ranges and cropping patterns

Altitudinal range (in metres)	Area (Km^2)	Cropping pattern
100	47.70	Paddy, sugarcane, Pulses Tapioca and Tree crops
100-200	23.82	Paddy, Millets, Pulses, Groundnut and tree crops
200-400	9.00	Paddy, Millets, tapioca and tree crops
400-800	7.22	Rubber plantations, tree crops, eucalyptus plantation
800	6.26	Tea, coffee and cardamom plantations

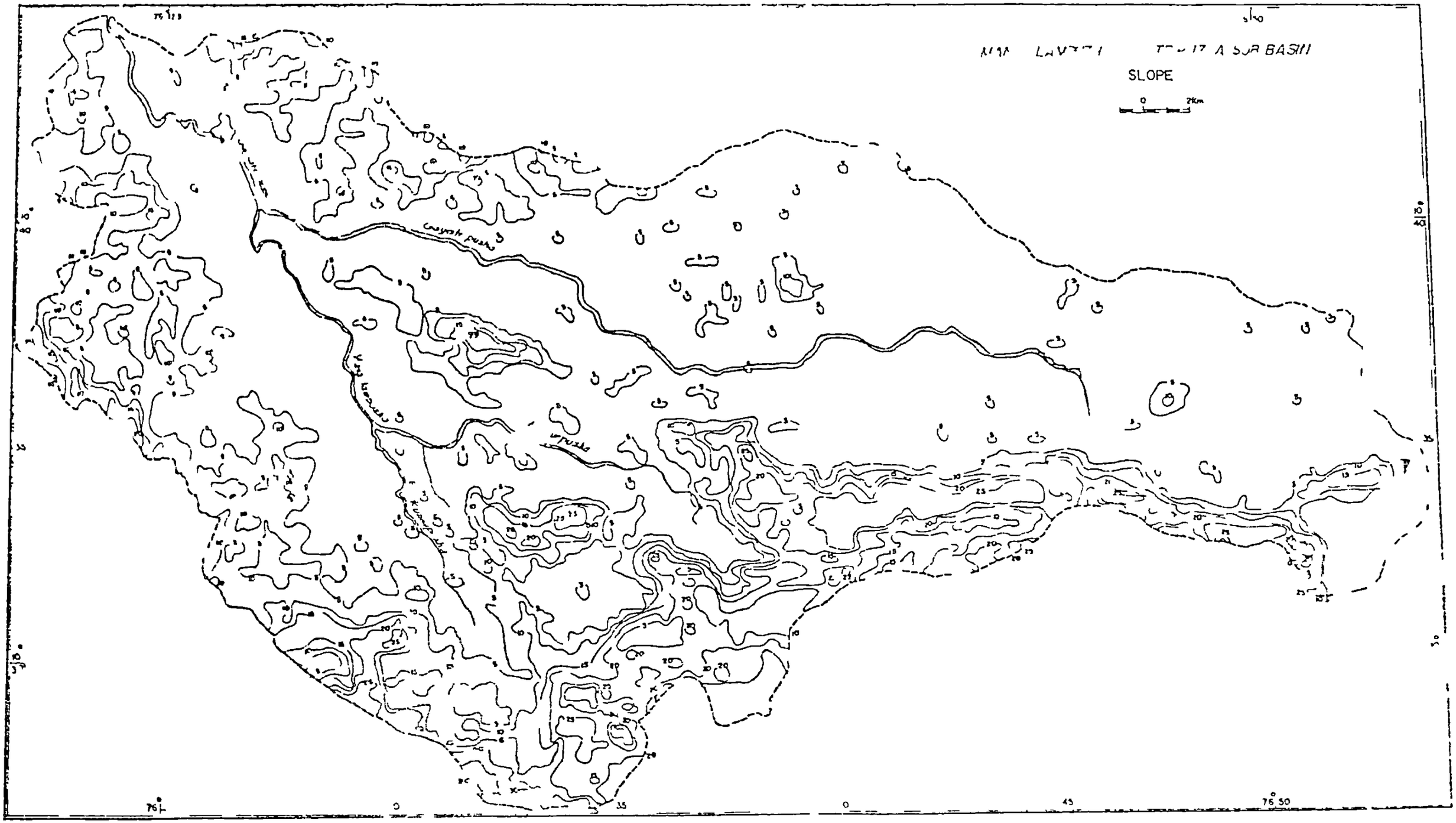


FIG 3

Isolated hills with elevation ranging from 200 to 400 m are marked throughout this region. It can be inferred from the relief map that the region has undergone prolonged erosion and that it has achieved a more or less stable position in the recent period. It is clear from the east-west cross section of the relief map that it is a gradually sloping land while the north south section is characterised by an abrupt slope fall along the 400 m contour. This sharp fall in slope within a short distance has significant impact on the soil formation and also on land use practices.

Slope:

Slope is one of the important landscape elements which govern the land use pattern. The slope maps (figure 3) of the study area has been prepared by following the Wentworth method (Monkhouse and Wilkinson, 1976) at 5° interval.

A considerable portion of this study area has a slope of less than 5°. The major slope direction is towards the north-west. A higher degree of slope is marked towards the hilly western part and southern fringes. The maximum slope of 25° is marked in the plateau scarp. The slope rises abruptly from the foot hill to the watershed boundary suggesting the influence of the structrual control in evolving this landscape. Isolated hilly patches have a slope ranging from 5° to 25°. However, it is mostly between 5° to 10°. Such hilly patches are distributed throughout the region

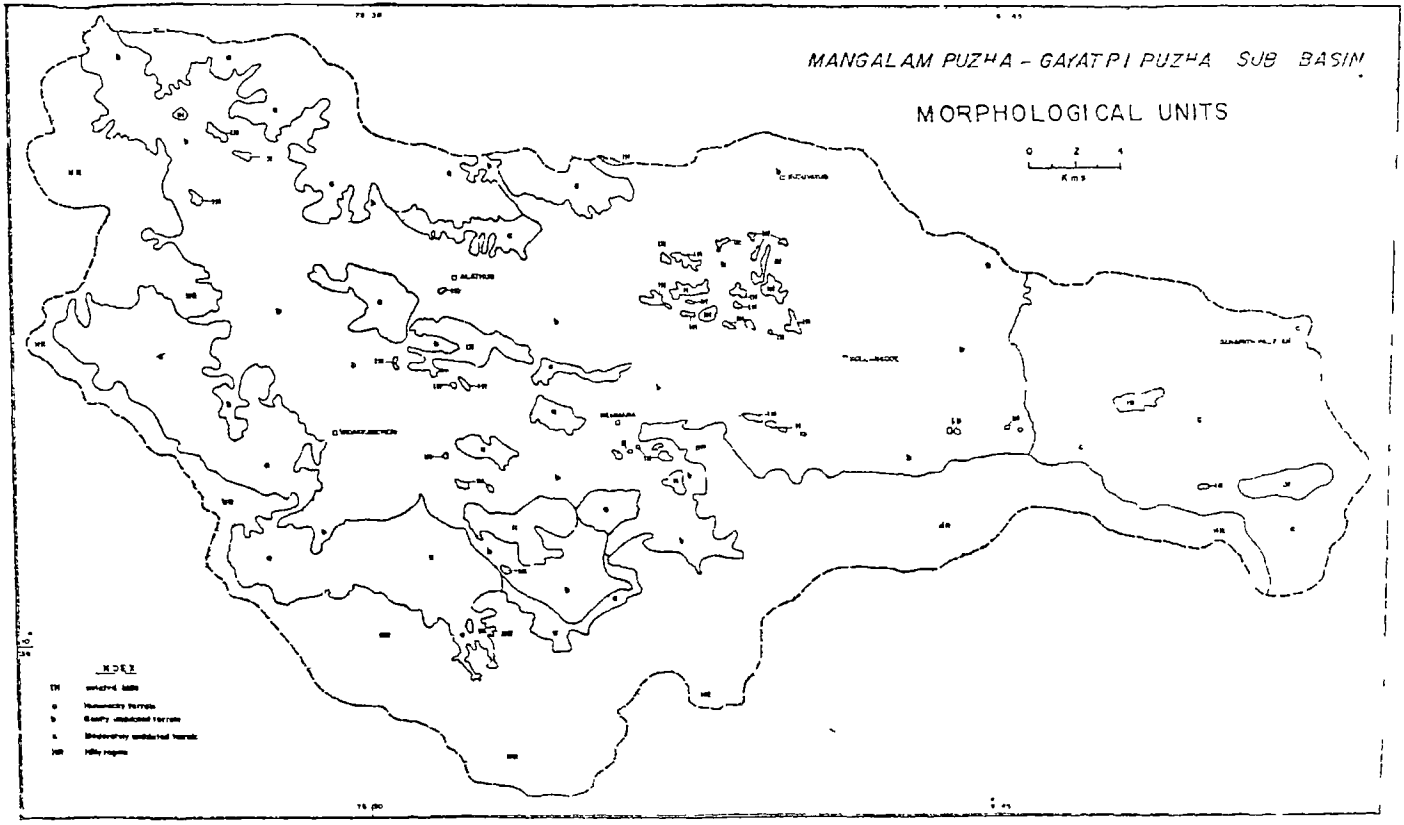

MANGALAM PUZHA - GAYATPI PUZHA SUB BASIN
MORPHOLOGICAL UNITS
0 2 4
Kms

FIG.4

giving it a hummocky appearance. The hummocky terrain controls the run off direction and plays an important role in the planning of irrigation canals. The southern border of the study area exhibits an abrupt increase in slope and hence expansion of agricultural fields in that direction is restricted. Since considerable part of this area has a slope above 20° it has an unstable character.

The slope is almost vertical in some cases giving little scope for soil formation. Even when formed they get washed down. Just below the crest line of the south eastern part a continuous line of exposed rock is marked. The slope character changes considerably both in alignment and amount towards the western part. This part has experienced intensive erosion and hence is highly subdued in character. Laterite capped flat topped hills having less than 5° slope are also marked in this part. The slope is generally of a retreading nature suggesting the dominance of aggradational surface. Land use in the lower slopes is dominated by the cultivation of seasonal crops while plantation crops account for the major land use in the higher slopes as has been indicated in earlier discussion on relief. Existing forests are also confined to the higher elevation only.

Morphology:

Integrating the relief and slope characteristics of the basin five morphological units have been identified (Figure 4). The

area is unique in having morphological features of strong structural control, subsequently modified by fluvial agents. The study area has extensive alluvial plains both young and old. Alluvial fans are also encountered extensively. Other prominent features are steep scarp plateau slopes in the southern border, subdued hills in the south western part and residual hills scattered throughout the area. Due to prolonged erosion and deposition nearby as a result of sudden drop in slope part of the area appears to be hummocky. The five morphological units and their characteristic features are provided in Table 2.

Table 2: Morphological units and their characteristic features

Morphological units	Plantation stages	Description
Hilly Region	Degradational surface	Represents erosional surface above 580 m level and scarp plateau slope
Isolated hill	"	Remnants of erosional surface between 150 m to 380 m and above
Hummocky undulated terrain	Degradational-cum-aggradational surface	Small encircled elevated areas characterised by laterites and occasional rock out crops
Moderately undulated terrain	"	Mainly depositional in character with alternate low and slightly elevated areas. Completely covered by thick soil horizon.
Very gently rolling terrain (5° slope)	Aggradational surface	This represents another planation surface of the gap proper. Both alluvial fans and flood plains are marked and are mostly below 150 m.

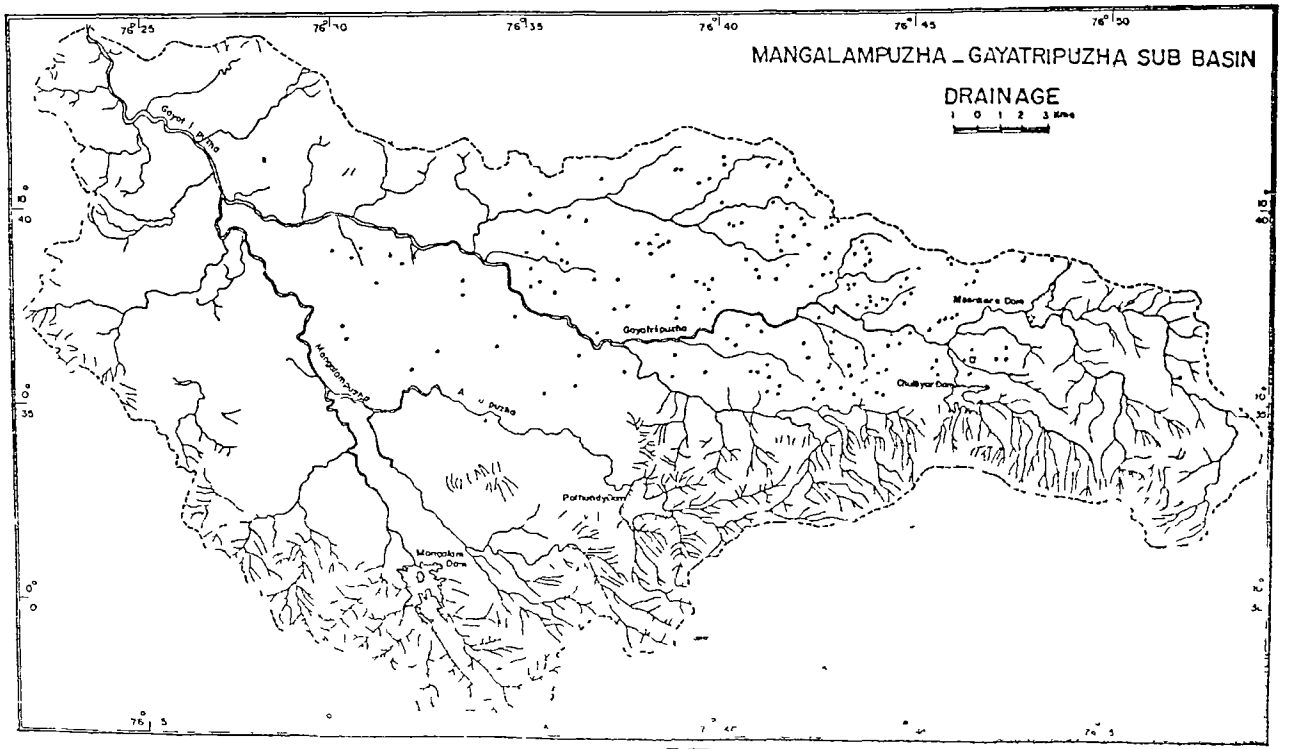

MANGALAMPUZHA _ GAYATRIPUZHA SUB BASIN
DRAINAGE
1 0 1 2 3 Kms
76°25
76°30
76°35
76°40
76°45
76°50
Gayatripuzha
Mangalampuzha
Parthundyam
Mangalam Dam
Meenkara Dam
Chulliyar Dam

FIG 5

A comparison of the morphology map with the relief map brings out that the southern part under hilly region rises abruptly from 200 m to 1300 m in height. The western hilly region is subdued in character and has a height of about 300 m. Throughout the region we can find isolated hills which bear the imprints of severe erosion under tropical climate. However, such isolated hills are concentrated mostly in the central part of the study area. Hummocky undulated terrain in the western and northern part of the study region is mostly marked. Moderately undulated terrain is mostly restricted to the eastern part of the study area having a average height of more than 200 m. Nearly sixty percent of the total area is covered by very gently rolling terrain along with moderately undulated terrain. These morphological units are constituted by older and younger flood plains and also by alluvial fans developed in the foot hill zone due to sudden reduction of slope.

Drainage

Figure 5 gives the drainage map of Mangalam-Gayatripuzha sub basin. Gayatripuzha, a seventh order river, having a length of 91 km is the major river of the study area. Originating from the eastern flank of the southern hill region of the study area it joins the Bharathapuzha river near Kuthenpilly. Gayatripuzha is unique in character as it originates at a lower elevation than any of its

MANGALAMPUZHA GAYATRIPUZHA SUB BASIN

GEOLOGY

1 0 1 2Km

LEGEND

- SYENITE
- HIOTITE SCHIST
- BIOTITE GNEISS
- HORNBLENDE GNEISS
- CHARNOCKITE
- 40 FOLIATION
- RIVER
- BASIN BOUNDARY
- Alathur

FIG 6

tributaries. The major tributaries are Mangalampuzha, Malampuzha, Chuliar and Meenkara. The drainage pattern is dentritic but in sub regional level sub parallel and sub dentritic patterns are also marked. This variation in pattern is attributable to the land form and geologic characteristics of the area. The rivers are non-perennial recording a wide variation in seasonal discharge. Due to ground water seepage the main drainage lines show only a meagre flow. Severe fluctuation in flow rates and high fluctuation in rain fall impose limitation on the use of water for irrigation purposes. Hence the agricultural practices currently adopted are suited to an unirrigated system.

To solve the irrigation problem four irrigation reservoirs namely Meenkara, Chuliar, Pothundy and Mangalam have been constructed by the Government of Kerala. Due to the abrupt decrease in the slope on the southern periphery of the basin, a large number of intermittent rivers have developed, which brings down and deposits considerable amount of silt on the lower reaches of the foot hills. These reservoirs are thus threatened by the vexing problem of fast siltation rate and reduction in storage capacity.

Geology

The geological features of the area have been mapped and are presented in Figure 6. Field investigation on topography and drainage

indicate that the geology of the region has a very significant role in carving out the regional pattern of surface morphology. Geological characteristics of the region influences, the land building process through the parent materials, soil characteristics and the hydrological regime, all of which in turn influence the land use pattern significantly. The area mapped is composed of a pure combination of crystalline rocks and their weathered products. The major rock types of the area are biotite genesis, hornblende gneiss and charnockites. A few patches of biotite schist, syenite, pink feldspathic gneiss of granitic composition and pegmatites are also present. There are no sharp contacts between the rock types. Actually gradual variation from one type to the other is observed. The most abundant rock type in this region is biotic hornblende gneiss. It is medium to coarse grained holo crystalline rock. The materials that can be identified visually are quartz, feldspar, biotite and hornblende. Biotite is characterised by its flakey nature and hornblende by its prismatic habit. Hornblende gneiss is seen as large patches within the biotite gneiss with gradational margin. Charnockites are exposed in and around Eland, Cholakkara, Mayannur near Vadakancherry, Kalpancherry, Ayalur and near Nemmara, as three distinct patches in the study area. Biotite schist is found in two small patches on the way to Chuliyar dam and the other near Thattamangalam. The syenite intrudes charnockites and hornblende

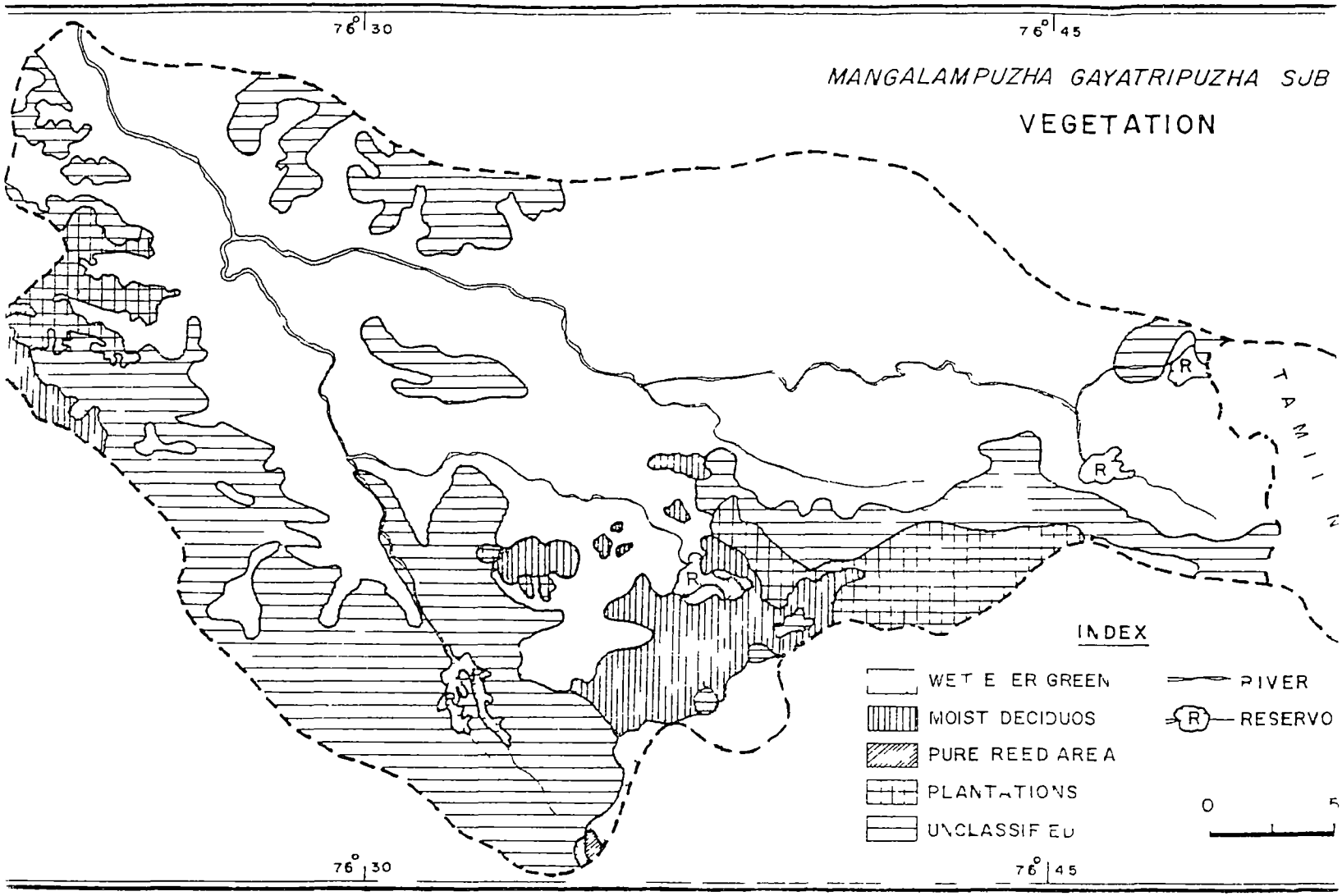

76°30
76°45
MANGALAMPUZHA GAYATRIPUZHA SUB
VEGETATION
R
R
R
INDEX
WET E ER GREEN
MOIST DECIDUOS
PURE REED AREA
PLANTATIONS
UNCLASSIF ED
RIVER
RESERVO
0
5
76°30
76°45

FIG 7

biotite gneisses. They are found exposed at two locations in the study area one at Kizhakkancherry and the other at Marapara. Pyenite is medium to coarse grained and shows sharp contact with the country rocks. Pegmatites of granitic composition are seen intruded in the country rock. There are both light and pink coloured pegmatites in the area. They contain large crystals of quartz, feldspar and flakes of biotite.

Vegetation

The vegetation map (Figure 7) depicts the vegetation types as identified by Forest Department, Govt. of Kerala. The principal vegetation types encountered in the area are wet evergreen and moist deciduous with patches of pure reed area. The natural vegetation cover at present is confined to the southern part of the study area adjacent to Nelliyampathi plateau. Rest of the area covering isolated hills and the south western hilly area, which was previously under forest cover have now been converted into plantations. The wet evergreen vegetation is marked in the Nelliyampathi plateau fringe around Pothundy reservoir. The moist deciduous type covers more area than wet evergreen and is distributed in Pothundy dam area, Athanadumala, Nagermala, Kalakuthumudichu, Ayalamudi and in the western part around Manippara hills. Pure reed area is marked in patches in the upper catchment of the Mangalam dam. The area marked as unclassified is actually covered by plantations of teak,

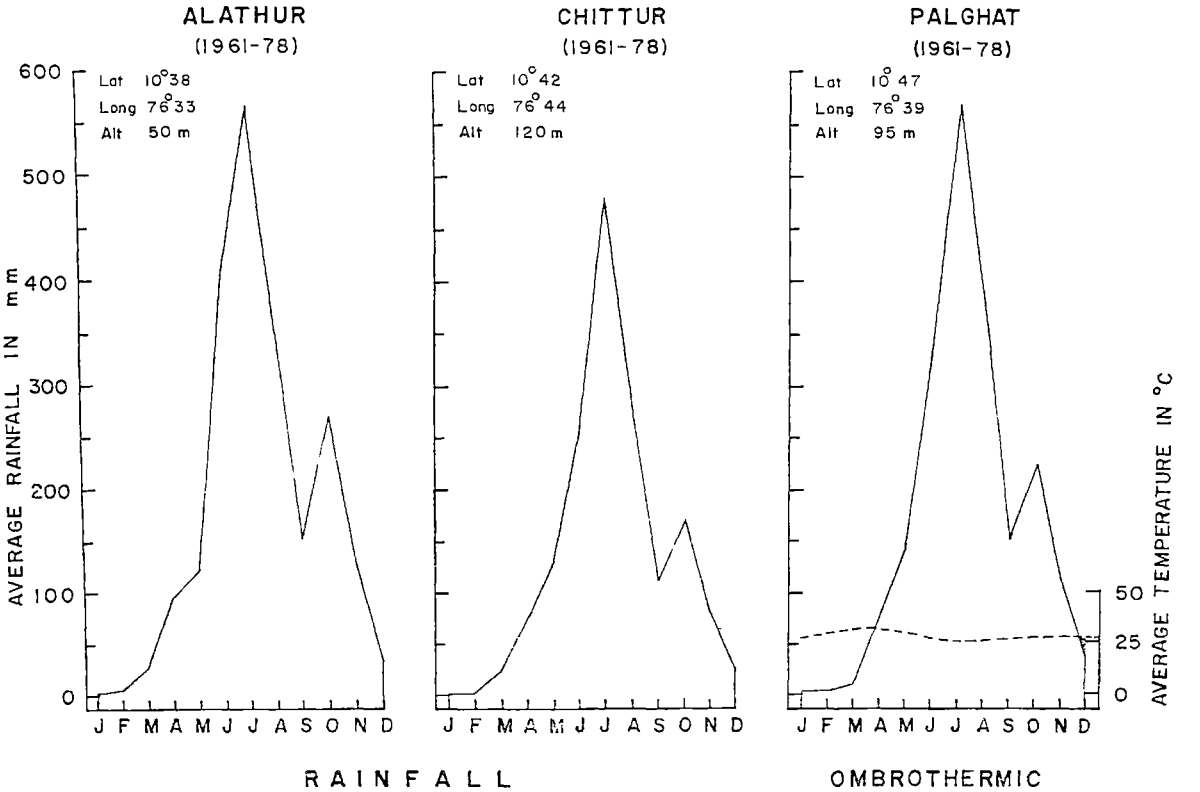

ALATHUR
(1961-78)
Lat 10°38
Long 76°33
Alt 50 m
CHITTUR
(1961-78)
Lat 10°42
Long 76°44
Alt 120 m
PALGHAT
(1961-78)
Lat 10°47
Long 76°39
Alt 95 m
AVERAGE RAINFALL IN mm
600
500
400
300
200
100
0
J F M A M J J A S O N D
AVERAGE TEMPERATURE IN °C
50
25
0
RAINFALL
OMBROTHERMIC

FIGURE 8

rubber, eucalyptus and small scrub and thorny bushes. Isolated hills and portions of the hummocky regions are covered by this group.

Climate

The climatic data available at three locations Alathur, Chittur and Palghat for seventeen years (1961 to 1978) have been studied and is presented in Figure 8.

Being a part of the Palghat Gap this area differs from the rest of the State in climatic characteristics. The impact of the gap is more noteworthy in its rainfall characteristics, temperature distribution and wind pattern. Average annual rainfall of the study area is around 2000 mm. Rainfall varies from 1642 mm in Chittur to 2167 mm in Alathur. Spatial distribution of rainfall indicates that the southern and south western parts being adjacent to the Nelliampathy plateau receive higher amount of rainfall compared to other parts of the study area. Dryness increases towards the north east. The rainfall curves for all the three stations indicate that rainfall increases from the month of March and attain the peak rainfall in the month of July. After having a decreasing trend from August to September, the rainfall again increases in the month of October, which is the period of North Western Monsoon. The entire

area thus experiences two rainfall peaks in a year. Lowest rainfall is recorded in January-February. Average monthly temperatures show that March-April are the hottest months recording more than 30°C temperature on an average. July being the peak rainfall month records the lowest average temperature of 25.26°C. The temperature is considerably low in the Nelliampathi plateau area due to its higher altitude. Agro-climatic condition of a particular area depends upon the rainfall-temperature relationship. Ombrothermic diagram has been drawn for Palghat area (Fig. 8) by plotting rainfall and temperature in a single graph considering a relationship of 100 mm rainfall equivalent to 50°C. By analysing this graph it is observed that the dry period prevails from December to April when the soil moisture is not sufficient to promote agriculture. Although rainfall sharply increases from March to May the dryness prevails due to extensive evaporation loss as a result of high temperature. Evaporation loss for Palghat Station in all the months have been calculated using Khosla's formula

$$Elm = \frac{T°F - 32}{9.5}$$ (where Elm = Evaporation loss in mm and T°F = temperature in degree Farenheit)

By comparing monthly rainfall data with evaporation loss given in Table 3, it can be discerned that evaporation loss exceeds

rainfall from the month of November to April. In the month of May the loss is little below the rainfall received. High evaporation loss due to higher temperature supplemented by dry winds, restricts the agricultural season to six months (May-October) in the year. Therefore, irrigation facilities have to be enhanced in order to increase agricultural intensity.

Table 3: Average monthly distribution of rainfall and evaporation loss in Palghat

Months	Rainfall in mm		Evaporation loss in mm
January	2.63		181.06
February	4.16	139.19	139.19
March	24.23		148.34
April	81.13		148.34
May	132.86		139.95
June	333.04		127.25
July	537.80		121.67
August	334.12		123.95
September	137.89		128.52
October	222.52		130.81
November	106.55		132.33
December	31.4		130.05

Soil

Soil is one of the most important factors that influence agricultural land use considerably. Gently undulating terrain with moderate to low slope in most areas favour in situ development of soils. However, alluvial deposits along the rivers and alluvial fans in the foot hill zone are examples of transported soil. Parent rocks are gneisses, lateritised gneisses and laterites throughout the region. The major types of soil found in this region are laterites, red loam, riverine alluvium, black soils and forest loam. Laterites and red soils cover a major part of the study area. Riverine alluvium is found on either side of the river.

Black soils also referred to as black cotton soils, are found in small patches, near Chittur and forest loam on the foot hills of the mountains in the southern and south western part of the study area.

Table 4: Physical and chemical properties of Profile No.1

Table 4 a. Physical properties

Depth	Coarse sand	Fine Sand	Silt	Clay
0-25 cm	10.9	30.3	30.2	28.6
25-50 cm	10.7	13.1	37.7	38.5

Table 4 b. Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Me%/100 g
0-25 cm	2.02	0.144	0.015	0.077	0.049	0.035	6.2	6.9
25-50 cm	2.61	0.183	0.012	0.062	0.037	0.033	5.9	7.2

The data presented in Table 4 (a) and 4 (b) presents the physicochemical and other characters of the various horizon of the profile taken from Sitargandu situated at the foot hill of Western Ghats. The site characteristics and morphological characteristics are indicated in appendix.[1] The land is occupied by settlers, who have clear felled the forest and have done intensive cultivation. It is at present under coconut-groundnut intercrop. The profile dug in the present location at the valley bottom has originated from forest loam which has been washed down after the removal of forest cover from the higher reaches of the mid slope and hill top. Due to the alluviation process the profile is found to be very deep greyish coloured (5 YR 4/1 dry). Horizon distinction is not very clear. The upper horizon has lesser organic matter is lighter in colour and is sandy while the lower horizons are rich in clay and organic matter.

The data presented in Table 4 (a) shows that coarse sand and fine sand decreases with depth but the variation in the content of coarse sand between the horizon is less while that of fine sand is more. Silt and clay also shows an increase in percentage with depth. Hence the variation in percentage between the horizon in the case of clay is more than that in the case of silt. In a normal

profile the percentage of organic carbon gradually decreases. However in the present profile the trend is reversed and percentage organic carbon increases with depth (Table 4 b). The profile being situated in a valley bottom has a high organic matter content for its soils. This soil material has been buried by the accelerated soil wash especially organic matter rich top soil eroded from the adjoining forest area recently denuded by deforestation. Thus the original organic matter rich A horizon has now become the B horizon of the present profile while the A horizon itself again is the organic matter rich alluviated layer. Due to intensive cultivation some of the organic matter has been lost. Thus though both A and B horizons are rich in organic matter content, there is an increase in percentage of organic matter with depth.

The percentage of total nitrogen shows a strong correspondence to the percentage of organic carbon and hence decreases with depth. Total P_2O_5 decrease with depth. The value of P_2O_5 is low and there is not much variation between the horizons in the value of P_2O_5. Total K_2O, Ca and Mg also decrease with depth. The profile is acidic and the value of pH decreases with depth. Cation exchange capacity shows an increase with depth.

Table 5: Physical and chemical properties of Profile No.2

Table 5 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-15	15.5	17.7	15.9	50.6
15-35	5.5	12.7	18.6	63.2
35-100	5.3	8.7	19.4	66.6

Table 5 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC meq/100 g
0-15	0.44	0.036	0.021	0.182	1.05	1.02	8.0	-29.3
15-35	0.31	0.022	0.022	0.173	1.15	1.10	8.1	28.1
35-100	0.21	0.019	0.021	0.166	0.96	0.90	8.2	27.5

Table 5 (a) and (b) presents the physiochemical characteristics of the soils of the various horizons in Profile No.2 located at Chemanampati. The location features and morphological characteristics are indicated in Appendix 2 . This profile is taken from a typical black cotton soil field. Here the coarse sand decreases with depth between the first horizon and the second horizon and there is great variation in the percentage of coarse sand fraction. This is because the percolation of water to the lower horizons is low and because surface run off in the case of black cotton soil is high and the run off carries with it the finer fractions. Between the second horizon and third horizon there is not much variation in the percentage of coarse sand fraction.

Fine sand fraction decreases with depth. This is a typical behaviour observed for the fine sand fraction with depth. Silt and clay fraction increases with depth. The clay fraction is high in this profile. It is as high as 50.6 percent in the upper horizon and increases upto 66.6 percent in the lower horizon.

The organic carbon content of this profile decreases with depth. There is no abrupt change in the percentage of organic carbon content and the decrease is observed to be steady. Similarly the total nitrogen content also decreases steadily while P_2O_5 content shows a slight increase followed by a decrease. There is not much variation in the total P_2O_5 content of the three horizons. Total K_2O decreases

steadily with depth while Calcium and Magnesium show a slight increase followed by a decrease with depth. However, Ca and Mg contents are quite high Being Black cotton soils. The soil is alkaline in nature and the pH increases with depth while the CEC decreases with depth.

Table 6: Physical and chemical properties of Profile No.3

Table 6 a: Physical properties

Depth	Coarse sand	Fine Sand	Silt	Clay
0-20	28.1	26.5	20.4	25.0
20-60	23.6	27.2	19.2	30.0
60-110	21.3	26.5	17.1	35.1
110-150	16.2	32.3	16.2	35.3

Table 6 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	C.E.C Meq/100 g
0-20	0.28	0.022	0.040	0.027	0.019	0.012	5.0	5.0
20-60	0.21	0.021	0.056	0.024	0.021	0.013	5.2	5.15
60-110	0.21	0.025	0.031	0.021	0.027	0.017	5.1	5.30
110-150	0.17	0.020	0.025	0.010	0.017	0.010	5.2	6.25

Table 6 (a) and 6 (b) presents data on the physico-chemical characters of the Profile No.3 situated at Nemmeni, on the converse side of a subdued hill under pasture. The important site characteristics and meso morphology are described in Appendix [3]. Rock out crops are seen in the upper parts of the hill indicating the action of erosion. The profile is observed to be in situ developed, deep, moderately well drained and gravelly throughout. Root distribution is normal and is concentrated in the upper 20 cm of the profile. The parent material is laterised gneiss. Here the coarse sand fractions ste dily decreases with depth. The fine sand fraction increases and decreases alternately with depth. The concentration of fine sand in the 2nd horizon is due to the movement of the fraction from the upper horizons, while the concentration of fine sand in the lowest horizon may be attributed to the generation of the fraction by the disintegration of the parent material. Silt fraction steadily decreases with depth while the clay fraction shows a steady increase.

The percentage of organic carbon steadily decreases with depth. The value of organic carbon in this profile is low (0.28%). The percentage of the total nitrogen shows an alternate decrease folowed by an increase with depth. This has a relation with the percentage of fine sand. In the horizon where the percentage of fine sand is high the total nitrogen content is low and vice versa. This reveals the association between high N and high clay content. The

total P_2O_5 content increases followed by a decrease while K_2O shows a steady decrease with increasing depth. Total calcium and magnesium shows an increase followed by a decrease with increasing depth. The profile is generally acidic. Though the values for pH does not vary much there is an alternate increase and decrease. The CEC increases with depth.

Table 7: Physical and chemical properties of Profile No.4

Table 7 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-25	32.2	26.5	24.2	17.1
25-50	28.4	26.2	20.1	25.3
50-100	20.1	18.3	18.5	43.1
100-130	16.1	17.7	32.1	34.1

Table 7 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC meq/100 g
0-25	0.72	0.063	0.012	0.005	0.045	0.032	6.4	5.45
25-50	0.36	0.327	0.015	0.006	0.042	0.029	5.5	5.35
50-100	0.17	0.022	0.010	0.006	0.035	0.024	5.7	8.30
100-150	0.17	0.021	0.009	0.007	0.026	0.019	5.7	8.10

The physicochemical characters of Profile No.4 is given in Tables 7 (a) and 7 (b). The profile was taken from a terraced field situated on a subdued hill near Choramangalam. The major site characteristics and morphology are presented in Appendix 4. The field was cultivated to upland rice and coconut and there is evidence of sheet erosion and imperfect drainage due to the formation of a clay pan in the profile. Coarse sand and fine sand decreases steadily with depth while silt fraction decreases steadily followed by a sudden increase in the last horizon. There is accumulation of clay in the third horizon.

Total organic carbon and total nitrogen decreases steadily with depth. Total P_2O_5 shows an increase followed by a decrease with increasing depth. There is not much variation in the total K_2O of the different horizons but it shows a steady increase with depth.

Total calcium and Magnesium decrease with depth. The profile is generally acidic and the pH shows a decrease followed by an increase with depth. The CEC shows an increase with depth.

Table 8: Physical and chemical properties of Profile No.5

Table 8 a: Physical properties

Depth	Coarse sand	Fine Sand	Silt	Clay
0-25	26.4	20.7	19.6	33.3
25-100	17.1	29.2	18.6	35.1
100-150	15.3	27.2	16.9	40.6

Table 8 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-25	0.65	0.046	0.063	0.030	0.047	0.038	6.0	8.6
25-100	0.28	0.043	0.077	0.065	0.039	0.027	6.1	8.15
100-150	0.21	0.034	0.075	0.028	0.032	0.024	6.3	8.50

Table 8 (a) and 8 (b) presents the physiochemical characters of Profile No.5.

The profile was situated on the converse side of a subdued hill under pasture near Vandaey. The profile showed all the characteristics of a typical in situ developed profile. Other major site characteristics and morphological features are given in Appendix 5. The coarse sand fraction decreased with depth while the fine sand fraction showed a increase followed by a decrease. The silt fraction decreased steadily with depth while the clay fraction showed a steady increase. The percentage organic carbon was fairly high in the upper horizon. This is due to the grassy vegetation in this area. This steadily decreases with depth. The total nitrogen content also decreases with depth. The total P_2O_5 shows an increase followed by a decrease with increasing depth. Total K_2O also shows a similar behaviour while total calcium and magnesium decreases with depth. The profile is generally acidic with the pH showing slight increase with depth. The CEC shows an increase followed by a decrease with increasing depth.

Table 9: Physical and chemical properties of Profile No.6

Table 9 a: Physical properties

Depth	Coarse sand	Fine Sand	Silt	Clay
0-10	34.0	26.5	20.3	19.2
10-30	29.2	20.3	19.7	22.8
30-65	23.2	28.3	17.9	30.6
65-150	16.0	30.3	16.5	37.2

Table 9 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-10	0.65	0.052	0.083	0.183	0.141	0.070	6.4	5.5
10-30	0.34	0.023	0.075	0.063	0.540	0.028	6.2	5.75
30-65	0.23	0.011	0.071	0.037	0.097	0.049	5.5	9.10
65-150	0.21	0.013	0.070	0.035	0.070	0.056	6.0	8.60

Table 9 (a) and 9 (b) presents data on the physiochemical properties of Profile No.6.

The profile is situated on the converse side of a subduced hill on the edge of a paddy field near Pazayannur. The site characteristics and morphological features are shown in Appendix 6. The parent material is found to be laterite. There is ample evidence of sheet erosion and consequently the upper horizons had a leached appearance, and coarse fraction was high. The percentage coarse sand was found to decrease with increasing depth and the percentage of fine sand showed a steady increase with increasing depth. The silt fraction showed a steady decrease while the clay fraction showed a steady increase with increasing depth. The percentage of organic carbon in the upper horizon was fairly high and it showed a steady decrease with increasing depth. The total nitrogen content showed a steady decrease with an increase in the lowest horizon. Total P_2O_5 and K_2O showed a steady decrease with increasing depth, while total calcium showed an increase followed by a decrease. There is a concentration of total calcium in the second horizon. Total magnesium showed a decrease followed by an increase with depth. The profile is generally acidic. The pH steadily decreases with depth and in the last horizon it shows a sudden increase. The CEC increases with depth and then decreases suddenly in the last horizon.

Table 10: Physical and chemical properties of Profile No.7

Table 10 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-30	35.6	31.4	16.3	16.7
30-70	29.1	31.3	13.3	26.3
70-120	23.5	36.9	11.8	27.8

Table 10 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-30	0.80	0.062	0.008	0.047	0.039	0.031	6.7	5.3
30-70	0.36	0.021	0.015	0.035	0.035	0.028	5.4	6.15
70-120	0.16	0.013	0.013	0.033	0.027	0.022	5.6	7.2

Table 10 (a) and 10 (b) presents data on the physicochemical characters of Profile No.7.

This profile is situated in the upper part of the rolling hillock. It is an in situ developed profile. The indications are that the tract has been subjected to intensive erosive action. Rock out crops near the profile sites indicate that the action of the erosive forces have been prolonged over a long period of time. The features and morphology are presented in Appendix 7. The sand fraction in the profile is found to be high throughout the profile. Coarse sand fraction decreases with depth while the fine sand fraction increases with depth. Silt shows a steady decrease with depth while the clay fraction increases with depth. The percentage of organic carbon shows a decrease with increasing depth. The upper horizon is fairly rich in organic carbon due to the decomposition of plant residues. Corresponding to the organic carbon content the total N also decreases with increasing depth. The total P_2O_5 shows an increase followed by a decrease while the total K_2O shows an steady decrease with increasing depth. Total calcium and magnesium also shows a steady decrease with increasing depth. The profile in general has an acidic nature and pH decreases with depth. The CEC shows a steady increase with depth.

Table 11: Physical and chemical properties of Profile No.8

Table 11 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-20	31.7	30.7	17.1	20.5
20-40	23.2	38.2	16.2	20.4
40-150	13.7	41.9	10.5	33.9
150 +	10.8	32.4	11.0	45.8

Table 11 b. Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-20	0.65	0.061	1.08	0.164	0.210	0.017	6.3	5.0
20-40	0.34	0.032	0.093	0.022	0.473	0.407	6.1	5.15
40-150	0.26	0.021	0.072	0.065	0.117	0.102	4.5	7.6
150 +	0.21	0.017	0.081	0.035	0.093	0.082	5.4	6.35

The physicochemical characters of profile No.8 is given in Table 11 (a) and 11 (b). Its morphological and seto characteristics are shown in Appendix 8.

The profile is taken from a mid slope region of a rolling hillock near Mepadam. The profile has originated from laterite and lateritic colluvial outwash. Though the percentage coarse sand is as found in a typical in situ developed horizon, the fine sand, silt and clay content show some variation. The coarse sand fraction shows a steady decrease with increasing depth, while the fine sand increases followed by a decrease in the last horizon. Silt fraction shows a steady decrease followed by an increase in the last horizon. Clay fraction does not show much variation between the two upper horizons. However, there is a slight decrease followed by an increase with increasing depth. The total organic carbon content is found to decrease with increasing depth. Similarly the total Nitrogen content also decreases with increasing depth. The total P_2O_5 decreases followed by a sudden increase in the last horizon. The K_2O content shows an alternate decrease and increase with depth. Total calcium and magnesium shows an increase followed by a decrease with increasing depth. In both these cases, there is a concentration of calcium and magnesium in the second horizon. The profile is generally acidic and the pH steadily decreases followed by an increase in the last horizon. In the case of CEC it increases followed by a decrease in the last horizon.

Table 12: Physical and chemical properties of Profile No.9

Table 12 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-25	32.4	26.3	17.1	24.2
25-60	28.5	24.2	19.6	27.7
60-90	19.3	22.6	23.2	34.9

Table 12 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-25	0.47	0.036	0.075	0.024	0.019	0.015	5.3	3.85
25-60	0.23	0.019	0.072	0.021	0.013	0.011	5.2	4.25
60-90	0.21	0.017	0.065	0.009	0.009	0.007	5.0	5.10

Table 12 (a) and 12 (b) presents the physiochemical data of profile No.9.

The profile is a typical lateritic profile situated on the upper part of a subduced hill on the way to Pattiparamba. The morphological features and site details are presented in Appendix 9. The profile is shallow and the percentage of coarse fraction high. The coarse sand and fine sand fraction showed a steady decrease with increasing depth. However, silt and clay was found to increase with increasing depth. The percentage of organic carbon is low and it decreases with depth. All the other chemical parameters like total nitrogen, P_2O_5, K_2O, Calcium and Magnesium showed a decrease with increasing depth. The profile is generally acidic and the pH decreases with depth. The CEC of the profile is low and increases with depth. This profile is a highly eroded profile with low agricultural value.

Table 13: Physical and chemical properties of Profile No.10

Table 13 a: Physical pro erties

Depth	Coarse sand	Fine sand	Silt	Clay
0-10	27.8	18.2	25.0	29.0
10-30	20.8	20.9	23.7	34.6
30-100	10.7	21.8	22.3	36.2
100-150	14.1	23.7	19.8	42.4
150 +	12.6	25.6	15.6	46.2

Table 13 b. Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100g
0-10	0.68	0.055	0.082	0.147	0.022	0.136	6.0	6.15
10-30	0.41	0.039	0.015	0.117	0.513	0.323	5.9	6.20
30-100	0.36	0.033	0.011	0.102	0.121	0.077	4.8	8.15
100-150	0.22	0.025	0.014	0.125	0.092	0.060	5.5	7.2
150 +	0.16	0.018	0.048	0.129	0.013	0.086	5.3	7.35

Table 13 (a) and 13 (b) presents the data on the physico chemical characters of Profile No.10. This profile is situated at the top region of a hill on the way to Pallavum and has originated mainly from the colluvic outwash. The morphological features and site details are presented in Appendix 10 . Though colluvic in origin the profile does not show any inversion and all the physical parameters are distributed in a uniform fashion. The coarse sand is found to decrease with increasing depth while the fine sand fraction shows a steady increase with depth. Silt fraction steadily decreases with depth while the clay fraction shows a steady increase with depth. All these indicate that the profile has attained a stable condition. The organic carbon content and total bitrogen content of the profile shows a steady decrease with increasing depth. Total P_2O_5 shows a steady decrease followed by a sudden increase in the last two horizons. Similarly K_2O also shows a steady decrease followed by an increase in the last two horizons. Total Ca and Mg show a sudden increase followed by a decrease. There is a concentration of Ca and Mg in the 2nd horizon. The profile is acidic in nature and pH decreases followed by an increase in the last two horizons. The CaC also shows an increase followed by a decrease with depth.

Table 14: Physical and chemical properties of Profile No.11

Table 14 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-25	36.2	18.2	20.6	25.0
25-75	27.1	24.6	18.1	30.2
75 +	23.6	34.7	16.9	24.8

Table 14 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC meq/100 g
0-25	0.49	0.036	0.043	0.024	0.21	0.014	5.0	4.15
25-75	0.21	0.019	0.068	0.021	0.15	0.010	5.2	4.35
75 +	0.18	0.016	0.057	0.013	0.13	0.008	5.0	5.2

The physicochemical characters of Profile No.11 is given in Table 14 (a) and 14 (b). The site morphological features of the profile is given in Appendix 11 .

The profile is situated as a terraced hill side at Ganapattipalayam and is cultivated to groundnut. The profile is shallow and has a fairly high coarse fraction in it. Coarse sand fraction decrease with depth while the fine sand fraction increases with depth. The silt fraction shows a steady decrease with depth while the clay fraction shows an increase followed by a decrease. The mid horizon in this profile shows an accumulation of clay fraction.

Though the profile is situated in a cultivated field the organic carbon content in the profile is very low. Total nitrogen decreases with depth while P_2O_5 shows a steady increase. The total K_2O content of the profile is low and it shows a steady decrease with increasing depth. Total calcium and Mg also have a very low value and decreases with increasing depth. The profile is acidic in nature. Though there is not much variation in pH, it shows an increase in the mid horizon followed by a decrease. The CEC increases steadily with depth.

Land use

Mangalam Goyatripuzha Basin

From the topographical maps (1:50,000) and aerial photographs twenty eight land use units have been identified in the study area (Figure 9). The various units and their respective coverage are given in Table 15.

Table 15: Land use

Units	Area (in percent to total geographical area)
A. Agricultural area	
1. Cultivable land (Seasonal agriculture)	44.39
2. Coconut	0.08
3. Tree crops	0.04
B. Settlement Area	
1. Concentrated Settlement	0.90
2. Settlement with mixed crops	2.83
3. Settlement with scattered trees	8.10
C. Plantations	
1. Coffee	0.26
2. Orange	0.19
3. Cardamom	0.14
4. Rubber	0.03
5. Tea and Cardamom	0.01
6. Coffee and Cardamom	0.01
7. Tea coffee and cardamom	0.12
D. Forest Plantation	
1. Teak	1.03
2. Eucalyptus	0.12

E.	Forest	
	1. Fairly Mixed Jungle	14.17
	2. Open scrub	7.24
	3. Dense Scrub	4.13
	4. Open mixed jungle	3.74
	5. Scrub	0.94
	6. Open mixed jungle mainly Bamboo	0.33
F.	Waste Land	
	1. Rock out crops etc.	1.03
G.	Water bodies	
	1. Reservoirs	0.94
	2. Tanks	0.06

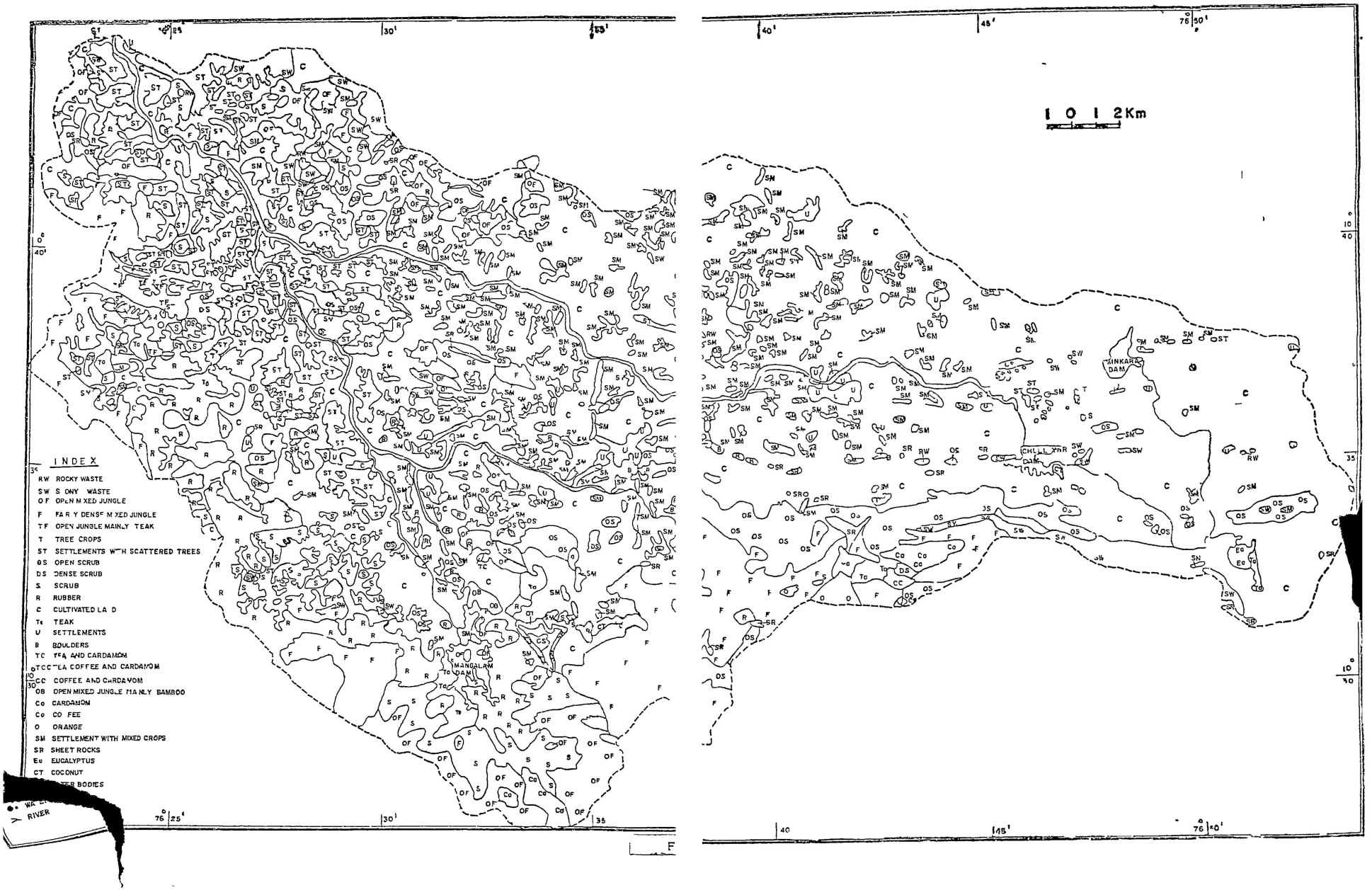
Due to the differences in elevation diverse agro climatic condition prevails in the area. The region hosts land use practices which are closely related to the agro-climatic condition of the region Land use classification data have been collected from the village office and taluk statistical offices. The land use classification is given in Table 16. From the data it is observed that there is a good relation between land use and physical characteristics of the study area.

Table 16: Land use classification

Classes	Area in ha.	Percent to total area
Building and Court yards	1953.61	2.01
Non agricultural use	8413.83	8.67
Barren and uncultivable	5652.20	5.83
Pasture and grazing	137.55	0.14
Miscellaneous tree crops	4041.41	4.14
Cultivable waste	7443.57	7.67
Current fallow	3052.26	3.14
Other fallow	3410.33	3.52
Area under cultivation	62791.17	64.88
	96945.51	100.00

Agricultural Land use:

Paddy is the major crop of the basin and it covers 77.61% of the total cropped area. Topographic and soil characteristics of the basin is favourable for rice cultivation, since the area has considerable portions under alluvial soil. Tapioca is the most important crop and it covers 5.91% of the total cropped area followed by millets (2.36%) and pulses (2.12%) in the seasonal group. Depending upon the


INDEX
RW ROCKY WASTE
SW SANDY WASTE
OF OPEN MIXED JUNGLE
F FAIRLY DENSE MIXED JUNGLE
TF OPEN JUNGLE MAINLY TEAK
T TREE CROPS
ST SETTLEMENTS WITH SCATTERED TREES
OS OPEN SCRUB
DS DENSE SCRUB
S SCRUB
R RUBBER
C CULTIVATED LAND
Te TEAK
U SETTLEMENTS
B BOULDERS
TC TEA AND CARDAMOM
TCC TEA COFFEE AND CARDAMOM
CC COFFEE AND CARDAMOM
OB OPEN MIXED JUNGLE MAINLY BAMBOO
Ca CARDAMOM
Co COFFEE
O ORANGE
SM SETTLEMENT WITH MIXED CROPS
SR SHEET ROCKS
Eu EUCALYPTUS
CT COCONUT
RIVER
MANGALAM DAM
MINKARA DAM
CHILLIYAR
1 0 1 2Km
76° 25'
30'
35'
40'
45'
50'
10° 40'
35
30
40
76° 10'

physical characteristics of the village, distribution of the crops vary from one village to the other. Oil seeds are cultivated in the eastern part of the study area and covers only 0.65% of the total cropped area. Vegetables and fruit crops occupy only a very limited area.

Tree crops are included among perennial crops. It is dominated by coconut which accounts for 34 of all the tree crops. Arecanut occupies 22% followed by fruit crops 15%. Palmyra 14.6 and Tamarind 9%. Other perennial crops are rubber, coffee, tea etc. Rubber accounts for 5.74% of total cropped area. Table 17 given below provides the area under principal crops.

Table 17: Area under principal crops

Crops	Area in ha	% of total area
Seasonal and annual crops:		
Paddy	63,824.74	77.61
Tapioca	4,861.97	5.91
Millets	1,939.34	2.36
Pulses	1,744.60	2.12
Fruits and Vegetables	753.89	0.92
Oil Seeds	530.81	0.65
Other seasonal crops	295.38	0.36
Tree/Perennial crops:		
Rubber	4,723.81	5.74
Plantation Crops	918.87	1.12
Fruit Crops (Trees)	310.18	0.38
Oil Seeds	191.49	0.23
Other Trees	2,141.08	2.60
Total	82,236.19	

The basic land use pattern of the region has undergone a series of changes and this has a direct impact on the landscape system of the region. Forests have been cleared for accommodating plantation crops. Coffee, Tea and oranges occupy the high ranges while rubber occupies the lower elevation. During the turn of the century the study area had good forest cover in the south, south west and western part covering the hilly areas. Deforestation had started in these regions during the last century itself and by 1973 as much as 49% of the forests had given way to plantation crops. In 1993 the forest area accounted for 75.63 sq/km or 6.82 percent of the total geographical area.

Lack of irrigation facilities was a major limiting factor for agriculture and it was primarily a monocrop even though the area was suitable for cultivation round the year. With the inception of four irrigation projects, namely Mankara, Chulliyar, Pothundy and Mangalam the crop intensity has increased. As much as 30 percent of the area under seasonal crops have come under irrigation and is the reason for the area being one of the major rice producing region of the State.

Aralamouzha-Bavalipuzha Basin:

This basin is a sub catchment of the Valapattanam river system and covers about 400 km^2 of area in the North Western flank of the Wayanad plateau in the Cannanore district. Around 30 km^2 of its area fall within the jurisdiction of the Karnataka State. Bavalipuzha, the principal perennial tributary of Valapattanam river originates from Chapmala in the Wayanad plateau and follows Bavali lineament. This area was originally covered by moist deciduous forests having few patches of low level wet ever green type. Being enclosed by plateau scarp the basin appears like an amphitheatre and provides a sheltering effect for the survival of low level wet ever green forests. In recent years the forest types have suffered considerable depletion and degradation. The steep scarp areas also record severe soil erosion and occasional landslides in the monsoon months. The land use is mainly dominated by different plantations and tree crops. Wet land paddy cultivation along the river valleys is also a notable feature. It appears that there is a good correlation between land use and geomorphic set up of the study area. Although the rivers are not directly interrupted by irrigation projects, like dams, human intervention is widespread on the landscape particularly

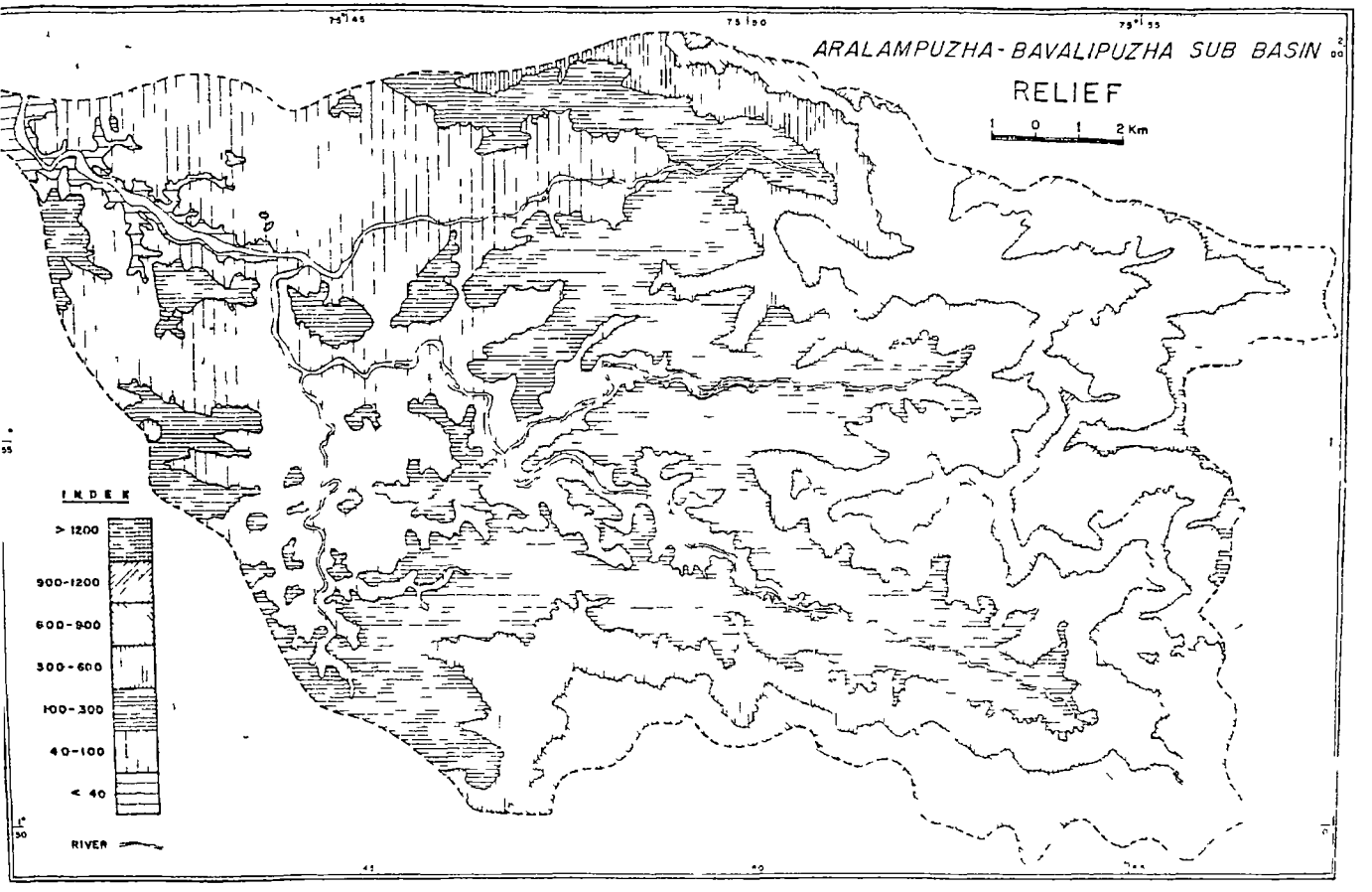

ARALAMPUZHA - BAVALIPUZHA SUB BASIN
RELIEF
1 0 1 2 Km
INDEX
> 1200
900-1200
600-900
300-600
100-300
40-100
< 40
RIVER

FIG. 10

in the forest area. Agricultural practices even on steep slopes have brought the region to a precarious condition and this has significant impact on the river discharge, silt load and other hydrological parameters. This area supports a population of 82,000 with an average density of around 200 person/sq. km.

Relief

Relief of Aralampuzha Davalipuzha basin is unique in character because of its location in the north western slopes of the Wayanad Plateau. The area is marked with an abrupt rise in elevation towards east from less than 40 m along the river valleys to more than 1400 m along the plateau fringe. The elevation in this part is marked to be 1408 m in Ithimala, 1361 m in Suryamudi, 1156 m in Cherimudi, 1226 m and 1166m near Valiakottencheri and 1030 m in Katti Betta. Elevation of the watershed boundary decreases towards west and north west from 1000 m to a level of 300 m. The abrupt rise and fall in altitude within a short distance can be correlated with alternate ridges and deep valleys respectively. The relief map (Fig. 10) of the area indicates 6 altitudinal zones. More than 70 percent of the total area falls in an elevation zone of above 200 m. The western margin of the study area is low with an elevation of 40 m. Isolated patches of hills ranging from 100 m to 350 m in height are distributed throughout the western margins. The area with altitudinal range of

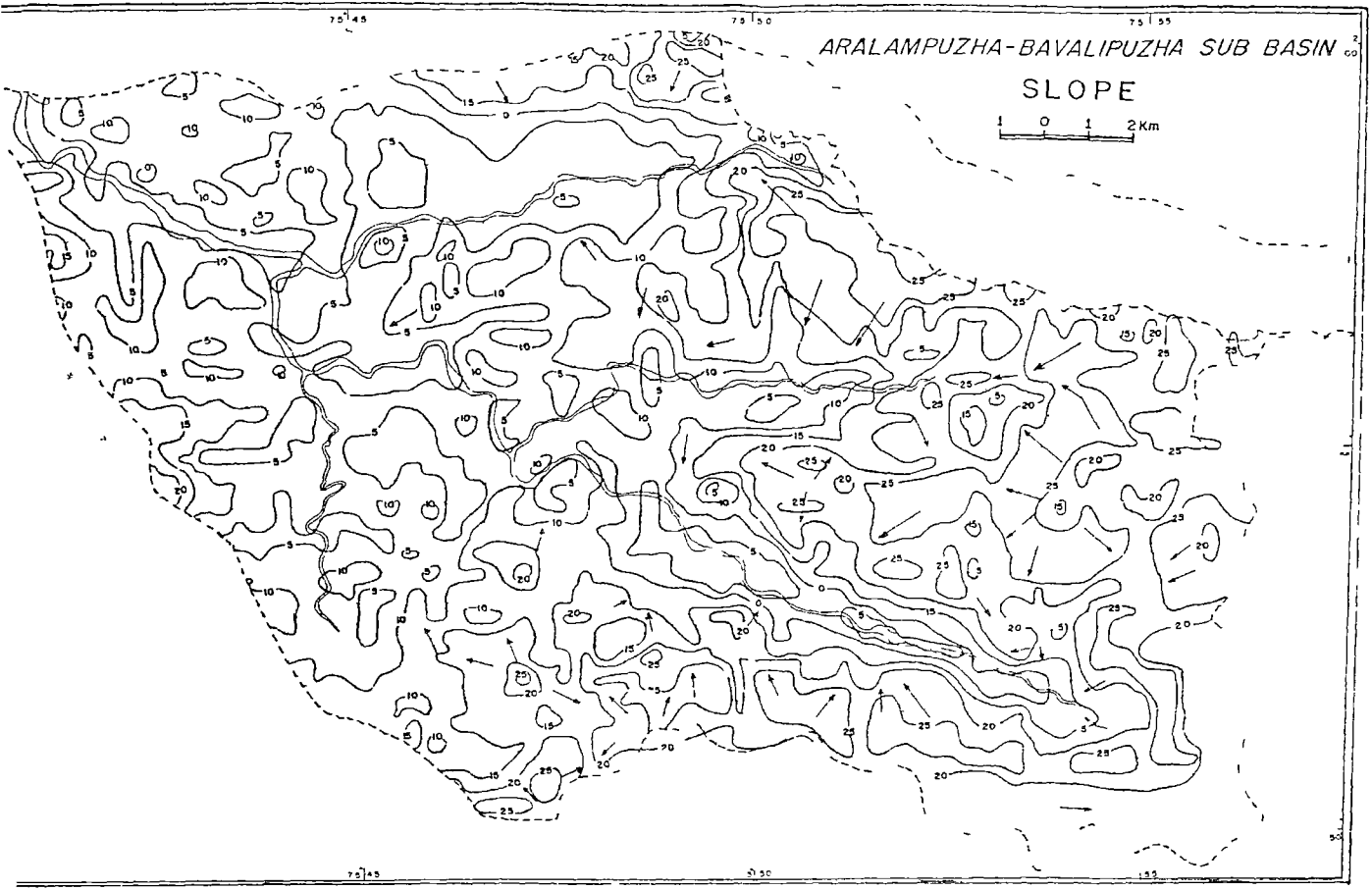

ARALAMPUZHA-BAVALIPUZHA SUB BASIN
SLOPE
1 0 1 2Km
75 45
75 50
75 55

FIG II

600 to 1200 m is covered by dense forests. Most of the isolated hills and those below 400 m area dominated by plantation crops of rubber, cashew etc. The relief of the study area clearly indicates that this region had been subjected to major geological activities like faulting with subsequent upliftment and erosion. The subdued nature of the hills and development of lateritic zones at various altitudes are in all probability, the results of peneplanation in different geological periods.

Slope

Slope is one of the most important topographic elements which controls land use pattern. This can be singled out as the most important factor in the context of present study area having high relief variation within short distances. It is observed that the average slope is more than 25° in the southern, eastern and north eastern parts of the basin along the Wayanad plateau scarp (Fig. 11). The direction of slope follows that of the river courses in general. The slope of the valleys of Bavalipuzha in its upper reaches is considerably steep. The upper reaches of Bavalipuzha show sudden steepness of slope on either side of the river due to faulting. The river Urutipuzha passes through a relatively flat area for most of its course. The western part of the region shows close contours which indicate isolated hilly areas some of which are lateritic mesas,

ARALAMPUZHA BAVALIPUZHA SUB BASIN
ENVIRONMENTAL MORPHOLOGY

1 0 1 2 Km

75°45' 75°50' 75°55' 11°55' 11°50'

INDEX

FLUVIAL SYSTEM

1 FLOOD PLAIN/LOWLEVEL FLUVIAL TERRACE
2 MODERATE SLOPE ADJOINING TO THE FLOOD PLAIN/RIVER COURSE
3 ALLUVIAL FLOOD PLAIN SLIGHTLY AWAY FROM THE MAIN CHANNEL
4 FLUVIAL CHANNEL
5 STEEP SCARP PLATEAU SLOPE ADJOINING TO THE MAJOR FLUVIAL VALLEY
6 HIGH LEVEL FLOOD PLAIN

LAND SYSTEM

1 GENTLY SLOPING TERRAIN (AROUND 5° SLOPE)
2 UNDULATED TERRAIN
3 HIGHLY DISSECTED TERRAIN
4 HILLY REGION
5 PROMINENT ISOLATED HILLS
6 HUMMOCKY UNDULATED TERRAIN
7 MESA

MAN MADE SYSTEM

A1 MAJOR CONCENTRATED SETTLEMENT
A2 TERRACED CULTIVABLE FIELDS
A3 PLANTATION

FIG 12

having flat topped surface. It is also observed that topographic fall varies from less than 100 m/km to 500 m/km. The slope map clearly brings out the topographic ruggedness of the region. The entire region is characterised by alternate deep valleys and high hills. The surface is mainly erosional. Aggradational surfaces are very limited in extent. Though the area represents peneplanation, equilibrium between aggradational and degradational surfaces are yet to be acnieved.

Morohology

Figure 12 brings out the morphologic systems of the Aralam-Bavalipuzha basin. The soil, land use and cultural land scape are primarily controlled by the geomorphology of the study area. Hence the geomorphology of this basin has been studied based on identification of land units under the different processes operative in carving out these units.

The different processes involved in the carving out of the land units are fluvial system, land system and man made system. Sixteen units have been demarcated under the above systems (Fig. 12). The attributes of landscape system namely relief, topographic roughness, slope, terrain condition, valley character, man made modification of the terrain etc. are considered in delineating these units. The uniqueness of this approach is that each unit indicates the dominant

process operative in it along with its present condition and, therefore, it focusses on the dominant factor to be investigated in order to develop particular areas under a particular unit. From the map, it is observed that about 50 percent of the total area comes under T5 category or hilly region which includes the plateau scarp. Within the Wayanad plateau area around Chapmala high level flood plain is marked. This high level flood plain at about 900 m height sustains paddy cultivation. It may be pointed out here that this type of strip like flood plain is widely developed throughout the Wayanad plateau surface. The unit T3 (alluvial flood plain slightly away from the main channel) has been marked as few patches. These in all probability represents the old river deposition which has now become isolated due to change in base level. Development of flood plain (T1) is quite restricted to the major rivers only, mostly as strips. This indicates that large part of the area is still in its late youth to pre-mature stage. The T7 (Mesa) unit represents hard crust lateritic surface and can be considered as remnants of planation surfaces developed in various erosional cycles, during various geological periods. The thickness of the land crust sometimes attain several metres followed by soft clay. Each unit is unique and form a successful base towards environmental planning.


75 45
75 50
75 55
ARALAMPUZHA - BAVALIPUZHA SUB BASIN
DRAINAGE
1 0 1 2Km

Drainage

Figure 13 brings out clearly the dendritic pattern of the drainage system. This indicates that the bed rock is crystalline. The major river Bavalipuzha is structurally controlled and follows almost a straight course. Due to high rainfall and steep slopes it is natural that numerous streams of various orders have developed. The stream density is as high as 2 km to 5 km per sq. km. The major streams of the sub basin are Urutipuzha, Chikanipuzha, Bavalipuzha and Kanjirampuzha. Considering all the orders the total stream length in sub basin is 907 km of which 350 km show perennial character. Rivers being the major source of irrigation have a very significant role in controlling agricultural land use. The flood plain area along the perennial streams alone can accommodate a second crop. In recent years the perenniality of the rivers has been adversely affected by large scale deforestation activities in the catchment areas.

Geology

Figure 14 presents the geology map of the Aralam-Bavalipuzha basin. The structure and lithology strongly influence the drainage pattern and topographical aspects. The area is a part of the peninsular precambrian shield comprising granulites, gneisses and high grade schists. As the area is covered by laterites, fresh out crops of these rocks are not very common. High grade schistose rocks comparable to the Dharwar and Sangur groups occur as linear patches

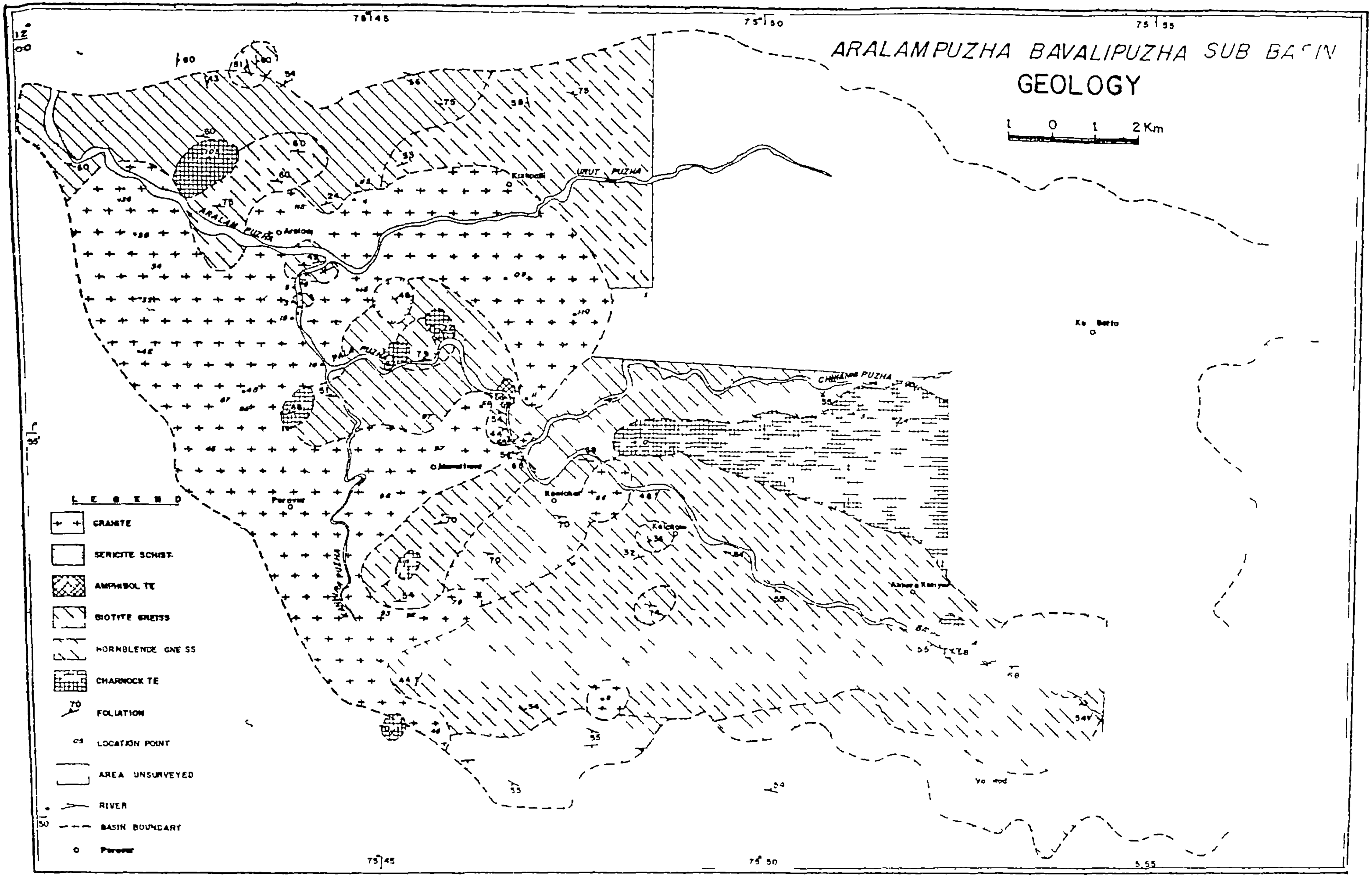

ARALAMPUZHA BAVALIPUZHA SUB BASIN
GEOLOGY
1 0 1 2 Km
ARALAM PUZHA
URUT PUZHA
PALA PUZHA
LEGEND
GRANITE
SERICITE SCHIST
AMPHIBOLITE
BIOTITE GNEISS
HORNBLENDE GNEISS
CHARNOCKITE
FOLIATION
LOCATION POINT
AREA UNSURVEYED
RIVER
BASIN BOUNDARY
75°45
75°50
75°55

FIG 14

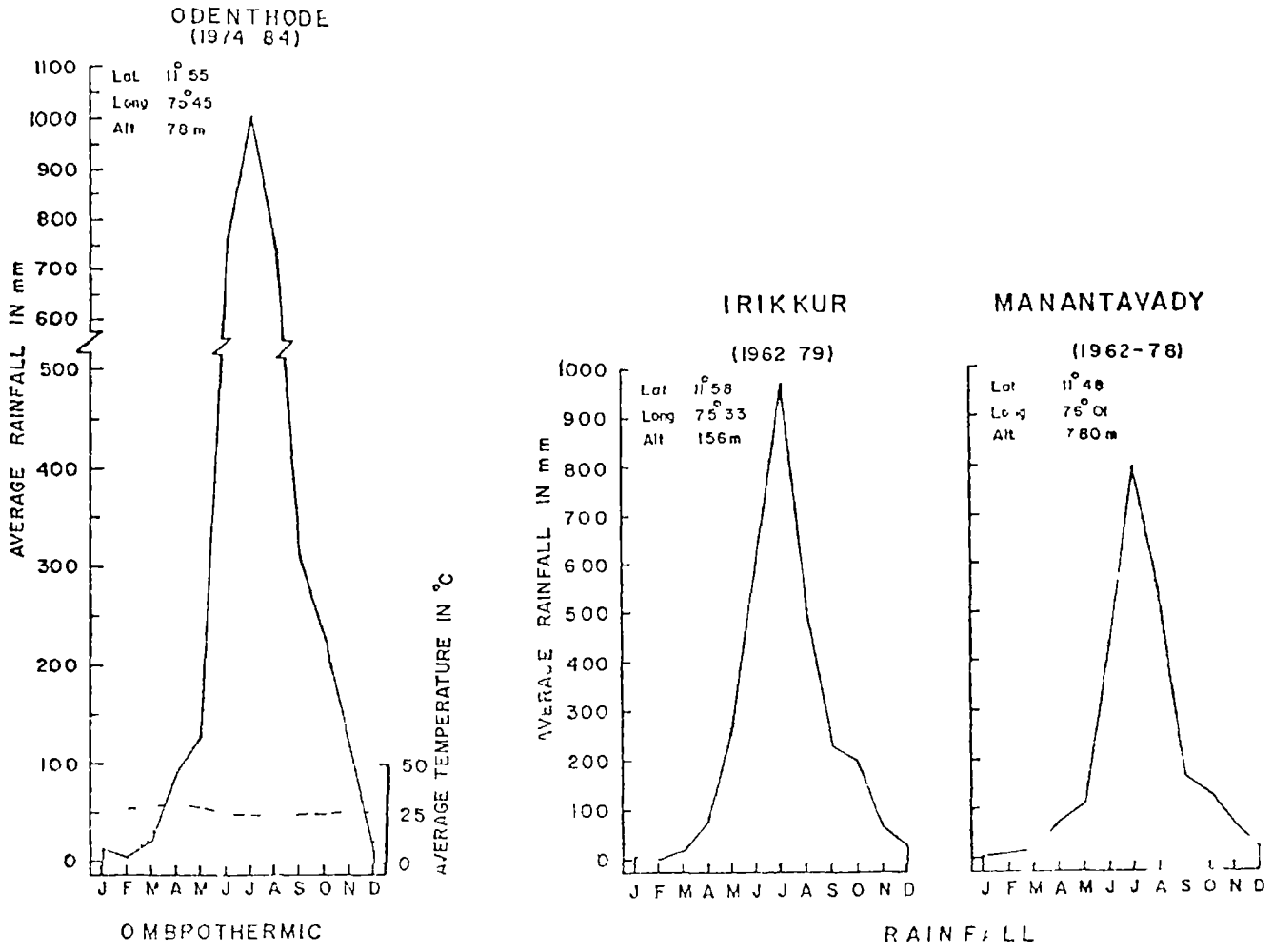

ODENTHODE
(1974 84)
Lat 11°55
Long 75°45
Alt 78 m
AVERAGE RAINFALL IN mm
AVERAGE TEMPERATURE IN °C
J F M A M J J A S O N D
OMBROTHERMIC
IRIKKUR
(1962 79)
Lat 11°58
Long 75°33
Alt 156m
MANANTAVADY
(1962-78)
Lat 11°48
Alt 780 m
RAINFALL

FIG 15

in the Cannanore and Wayanad districts of Kerala. According to Nair et al. (1979) hornblende gneiss is the dominant rock type to the south of Bavali lineament while an assemblage of gabbro-diorite and migmatitic gneisses and schists occur to the north of this lineament. The Bavali lineament which runs approximately parallel to the contact of the above litho units marks the zone of strong deformation where mylonites and pseudo-tachyllites (Sinha Roy and Devindra Kumar, 1985) have developed both from the hornblende gneiss and the gabbrodiorite suite of rocks. The dominant rock types in the area are precambrian crystalline rocks. They include gneisses, amphibolites and granulites. Granulites include pyroxene granulites and charnockites with its variants. Migmatitic hybrid gneiss also occur in many areas. Granite, pegmatites dolerite dykes and quartz veins form as intrusives.

Climate

Figure 15 presents the climatic features of the study area. Since the study area has only one meterological station at Aralam the data available from Manantavady in the South eastern part and Irikkur in the north western part were also collected, eventhough they fall outside the study area. Due to the sheltering effect of the plateau scarp the drainage basin experiences a unique climatic character. This is one of the few localities in Kerala where evergreen forest survives in lower elevation.

The average annual rainfall of the study area is around 2000 mm. It varies from 2355 mm in Manatavady to 2445 mm in Odenthode (Aralam). Comparing these three stations, it is observed that the central part of the region receives maximum rainfall which decreases towards the outer boundary of the region. Though Cannanore district is generally dry, this basin receives higher rainfall. The general trend of distribution of rainfall in Kerala shows that the foot hill areas receive higher amount of rainfall compared to the hill top. Manantavady, situated on the plateau proper receives low rainfall compared to the foothill regions. Figure 13 brings out that July accounts for the highest rainfall in all three cases. There is an abrupt increase in rainfall from May-June and also an abrupt fall from August to September.

The rainfall curves for this region is unique as it show only a single peak. January and February are the months of lowest rainfall for all the three stations. Most of the rainfall occurs during South West monsoon and the other periods are almost dry. Drought condition due to lack of rainfall hinder agricultural operations in other seasons.

The average monthly temperature varies from 23.67°C in the month of August to 29.02°C in April. The temperature records a decreasing trend from May corresponding with the increase in rainfall. Decreasing trend continues upto August and from September onwards it starts rising. The temperature of the Wayanad plateau is considerably less due to altitudinal impact. Cold humid condition of the upper

slopes along the plateau fringe and within the plateau proper has provided a climate congenial for tea, coffee and cardamom plantations.

Rainfall temperature relationship expressed through ombrothermic diagram (Figure 15) broadly gives an idea about the agro-climatic condition of the study area. The region experiences a dry spell from November to May and soil moisture is considerably low to promote seasonal agriculture. For all practical purposes it is only during the South West monsoon period that agricultural operations are successful. Although rainfall increases from March onwards, dryness prevails due to high evaporation loss as a consequence of high temperature. The monthly rainfall and calculated evaporation loss data are provided in Table 18.

Table 18: Average monthly rainfall and evaporation loss in Edenthode, Aralam farm (1973-1983)

Month	Rainfall in mm	Evaporation loss in mm
January	6.14	123.44
February	5.62	129.29
March	17.32	135.38
April	80.83	139.95
May	167.06	133.86
June	603.73	120.40
July	922.01	117.35
August	592.17	113.79
September	235.28	120.40
October	185.85	120.40
November	85.40	123.44
December	21.23	127.00

The Table indicates that evaporationn loss exceeds rainfall for six months (November to April) in a year. The gap between rainfall and evaporation loss is more than 100 mm for four successive months (December to March). From the agricultural point of view this is the driest period. The study area being devoid of irrigation facilities suffer considerably during this period. Even availability of drinking water is a serious problem for the local people as almost all the wells in the villages dry up in this period.

Soil

The geomorphic characteristics of the area strongly influences the development of soil. Due to overwhelming influence of surface morphology, soil character of this region has been studied primarily in accordance with the geomorphology. Weathering of laterised gneisses and also alluvial and colluvial deposition is the source of origin of most of the soils. Deep to very deep, well drained, brown to dark brown soils are developed on lateristised gneiss in hilly region.

Moderately deep dark brown soil of gravelly fine loamy to clayey texture has been developed on lateritised gneisses under forest cover. Due to the removal of forest cover the dissected plateau have been severely affected by erosion. As a result laterite outcrops along extensive hard crust laterite surfaces are evident.

Table 19: Physical and chemical properties of Profile No.12

Table 19 a: Physical properties

Depth	Coarse sand	Fine Sand	Silt	Clay
0-10	17.7	25.2	24.3	32.8
10-45	9.0	32.4	22.3	36.3
45-90	8.1	25.2	23.5	41.2

Table 19 b: Chemical Properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-10	3.17	1.31	0.075	0.245	0.3156	0.1735	5.6	6.2
10-45	1.74	0.77	0.073	0.039	0.0446	0.0368	5.3	6.5
45-90	1.30	0.62	0.066	0.025	0.0316	0.0239	5.1	7.1

Table 19 presents the physico-chemical characteristics of Profile No.12 taken in Arolam-Davidsudia basin. This profile is taken from a rubber plantation just outside Arolan farm. The site characteristics of the profile and morphological properties are presented in Appendix 12. The site represents the foot hill region of Kadayanallur. Though the profile seems to have originated from weathered gneiss, colluvial action also has influenced its development. The profile is fairly moist throughout and the upper horizon is rich in organic matter. The coarse sand fraction shows a steady decrease with increasing depth while the fine sand fraction shows an increase followed by a decrease. Corresponding to this the silt fraction shows a decrease followed by an increase while the clay fraction shows a steady increase with depth. The soil is rich in organic matter. The organic carbon is as high as 3.17 percent in the top horizon and it decreases with depth. The high organic carbon content can be attributed to the recycling of biomass in the rubber plantation. The total nitrogen content in the profile is fairly high and it decreases with depth. The total P_2O_5 also decreases with depth. The upper horizon is rich in total K_2O, Ca and Mg and shows a sharp decrease with depth. The profile is generally acidic and shows a decrease of pH with depth. The CEC shows an increase with depth.

Table 20: Physical and chemical properties of Profile No.13

Table 20 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-25	28.8	22.5	18.1	20.6
25-60	19.3	16.3	21.3	43.1
60-100	14.8	12.7	22.5	50.0

Table 20 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-25	0.67	0.04	0.08	0.07	0.07	0.053	6.0	7.1
25-60	0.34	0.03	0.02	0.03	0.028	0.026	6.2	7.3
60-100	0.23	0.01	0.03	0.03	0.019	0.022	6.3	7.6

Table 20 give the physicochemical characters of Profile No. 13 taken at Pallavaram from a road cut on the midslope of a subdued hill. The details of the site and morphological features of the profile are shown in Appendix 13 .

This is a laeritic profile and it is deep moderately well drained and gravelly throughout. The coarse sand fraction in this profile decreases steadily with depth and similarly the fine sand fraction also decreases with depth. The silt fraction shows a steady increase with depth. The percentage of clay also increases with depth. The organic carbon content shows a steady decrease with depth. The profile is not very rich in organic carbon. The total nitrogen content also is low and it decreases with depth. Though the total P_2O_5 content shows a decreasing trend, there is a slight increase in the total P_2O_5 content in the last horizon. Total K_2O, Ca and Mg also shows a decreasing trend with increasing depth. The profile is generally acidic and the pH increases with depth. The E.C also shows an increase with depth.

Table 21: Physical and chemical properties of Profile No.14

Table 21 a: Physical properties

Depth	Coarse Sand	Fine Sand	Silt	Clay
0-10	23.8	21.2	19.6	35.4
10-45	20.7	15.3	22.8	41.2
45-90	11.9	8.3	16.6	63.2

Table 21 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Mec/100 g
0-10	1.36	0.125	0.017	0.095	0.030	0.028	6.3	6.0
10-45	0.97	0.081	0.014	0.074	0.045	0.024	6.2	7.0
45-80	0.35	0.027	0.008	0.065	0.037	0.028	6.0	7.2

The physico-chemical characteristics of Profile No.14 taken in Aralampuzha-Bevalipuzha is given in Table 21. The details of the site and morphological features of the profile are shown in Appendix 14.

The profile is situated on a very gently sloping ground in a considerably degraded tropical rain forest of Kottapuram mala. The profile is moderately well drained and uniformly moist. The coarse sand and fine sand percentage decreases with depth. The silt fraction shows a slight increase followed by a decrease. The clay fraction increases steadily with depth. The concentration of fine fraction is more in this profile since it is a profile developed under forested conditions. The organic carbon content in this profile is fairly high. Being a degenerated tropical forest the organic carbon content is not as high as in other similar cases. The total nitrogen content of the profile decreases with depth. The total P_2O_5 content of this profile is low and it decreases with depth. The total K_2O also shows a steady decrease with depth. Total calcium and magnesium show an increase followed by a decrease. The profile is generally acidic and pH decreases with depth. The CEC is found to increase steadily with depth.

Table 22: Physical and chemical properties of Profile No.15

Table 22 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-10	27.8	28.3	15.4	28.5
10-35	16.7	32.4	19.3	31.6
35-70	21.8	19.2	18.6	37.4

Table 22 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	C.E.C Meq/100 g
0-10	0.51	0.037	0.042	0.104	0.055	0.034	6.3	6.9
10-35	0.35	0.023	0.055	0.035	0.023	0.027	6.0	6.1
35-70	0.41	0.027	0.029	0.072	0.017	0.013	5.9	6.4

Table 22 presents the physicochemical characters of Profile No.15 taken in Aralam-Bavalipuzha Basin. The details of the site and morphological features of the profile are given in Appendix 15 .

The profile is taken from a laterite and the site has a subdued character. The profile is not very deep. Being a well eroded profile the coarse fraction is higher. Coarse sand decreases followed by an increase while fine sand increases followed by a sharp decrease with depth. The percentage of silt in this profile is very low and it shows a slight increase followed by a decrease. The clay fraction shows a steady increase with depth. The percentage of organic carbon shows a decrease followed by an increase. Similarly the total Nitrogen shows a slight decrease followed by an increase. The total P_2O_5 shows an increase followed by a decrease, while the total K_2O shows a steady decrease with depth. The profile is generally acidic and the pH steadily decreases with depth. The CEC shows an increase with depth.

Table 23: Physical and chemical properties of Profile No.10

Table 23 a: Physical properties

Depth	Coarse Sand	Fine sand	Silt	Clay
0-10	16.0	21.8	24.3	37.9
10-35	15.3	21.4	20.6	42.7
35-70	12.7	20.8	17.2	49.3

Table 23 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-10	0.84	0.062	0.023	0.044	0.127	0.006	6.0	6.1
10-35	0.63	0.055	0.019	0.027	0.063	0.062	6.1	6.7
35-70	0.47	0.041	0.009	0.021	0.071	0.052	6.3	6.9

Table 23 presents the data on the physico-chemical characters of Profile No.16 taken in Aralampuzha-Davalipuzha basin. The details of the site and the morphological features are shown in Appendix 16 .

This profile is situated in a partially saucer shaped basin on the mesa surface. Though the bed rock is laterite the profile has originated from lateritic colluvial outwash from the adjoining areas. The profile is very deep moist and well drained. The coarse fraction in this profile is low. However, sand decreases with depth. Though the fine sand fraction also decreases with depth there is very little variation between the profiles in the concentration of fine sand. The silt fraction shows a decrease with depth while the clay shows a steady increase with depth. The profile is fairly rich in organic matter and it steadily decreases with depth. The total nitrogen content also decreases with depth. The concentration of P_2O_5 in the profile is low and it shows a decreasing trend with depth. The total K_2O also shows a decreasing trend with increasing depth. Total Ca and Mg shows a decrease with depth. The profile is generally acidic and the pH shows an increase with depth. The CEC also increases with depth.

Table 24: Physical and chemical properties of Profile No.17

Table 24 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-10	27.8	21.3	19.4	31.5
10-25	25.7	19.8	18.6	35.9
25-60	24.5	18.2	16.2	41.1
60-110	22.4	17.7	23.7	37.2

Table 24 b: Chemical properties

Depth	O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC (me/100 g)
0-10	0.67	0.063	0.027	0.063	0.030	0.028	6.6	5.4
10-25	0.53	0.045	0.020	0.055	0.022	0.017	6.5	5.3
25-60	0.44	0.023	0.022	0.042	0.019	0.017	6.0	5.7
60-110	0.21	0.017	0.012	0.027	0.019	0.018	6.1	6.2

Table 24 brings out the physico-chemical characters of Profile No.17 taken from Teghotalapaya. The site characteristics and morphological observations of the profile are given in Appendix 17 .

The profile is situated on the mid slope in a road cut in the Wyanad Tea Plantation. The sand fraction in this profile shows a steady decrease with depth. Both coarse sand and fine sand decreases with depth. The silt fraction also shows a decrease with depth while the clay fraction shows a steady increase. The percentage of organic carbon decreases with depth. Total Nitrogen which is strongly related to the percentage of organic carbon also shows a steady decrease. The total P_2O_5 content in this profile is low and it decreases with depth. The total K_2O content also decreases with depth. The concentration of total Ca and total Mg is low in this profile and both these parameters show a steady decrease with depth. The profile is acidic in nature and the pH decreases with depth. The CEC shows an increase with depth.

Table 25: Physical and chemical properties of Profile No.18

Table 25 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-10	29.5	22.7	21.3	26.5
10-35	27.9	21.8	21.7	28.6
35-60	19.3	20.1	18.5	42.1

Table 25 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-10	1.13	0.092	0.015	0.023	0.119	0.053	5.7	6.2
10-35	0.77	0.065	0.007	0.035	0.120	0.026	5.5	6.6
35-60	0.45	0.052	0.013	0.044	0.019	0.022	5.5	7.1

The physico-chemical characters of Profile No.10 are given in Table 25. The site characteristics and morphological observations of the profile are given in Appendix 38.

The profile is taken from Periya and is located on a steep hillside under Eucalyptus plantation. The parent material is weathered gneiss. The profile is shallow and since it is located in an eucalyptus plantation the upper horizon is rich in organic matter. The coarse sand fraction decreases with depth but does not show much variation between the first two horizons while it decrease rapidly in the third horizon. The fine sand fraction also decreases with depth but there is less variation in its concentration between the horizons. The silt fraction shows a slight increase in the second horizon followed by a rapid decrease in the third horizon. The clay fraction also shows an increase with depth. The variation in the content of clay between the first two horizons is less but it increases abruptly in the third horizon. The profile is rich in organic matter and it decreases with depth. The total nitrogen also decreases with depth. The total P_2O_5 shows a sudden decrease followed by an increase while the total K_2O content shows a steady increase. The profile is rich in total calcium. It shows an increase in the second horizon followed by an abrupt decrease in the third horizon. Total magnesium decreases with depth. The profile is acidic and the pH decreases with depth. The CEC shows an increase with depth.

Table 26: Physical and chemical properties of Profile No.19

Table 26 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-15	11.4	28.7	34.2	25.7
15-30	12.2	20.1	32.1	35.6
30-70	9.3	17.7	29.4	43.6
70-110	10.5	15.2	26.5	47.8

Table 26 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-15	0.78	0.049	0.047	0.051	0.025	0.029	6.3	5.2
15-30	0.42	0.021	0.052	0.057	0.028	0.014	6.1	5.7
30-70	0.37	0.028	0.017	0.053	0.025	0.015	6.0	6.7
70-110	0.30	0.026	0.011	0.041	0.028	0.018	5.7	6.3

Table 26 presents the physico-chemical characters of Profile No.19 taken from a Cardamom plantation situated in a valley at Periya in Aralampucha-Bavalipucha basin. The details regarding the location of the profile and its morphological features are presented in Appendix 19 .

The profile is moderately deep in situ developed but imperfectly drained. The parent material is laterite. The coarse sand fraction shows a steady decrease with depth followed by a sudden increase in the last horizon. Both fine sand and silt also decreases with depth. The clay fraction shows an increase with depth. The profile is moderately rich in organic carbon and it decreases with depth. The total nitrogen content shows an alternate decrease and increase. The total P_2O_5 shows an increase in the second horizon followed by an abrupt decrease in the last two horizons. The total K_2O content shows an increase followed by a decrease with depth. Total Ca shows an alternate increase and decrease while total Mg shows a decrease in the second horizon followed by an increase in the last two horizons. The profile is generally acidic and the pH decreases with depth. The CEC shows an increase followed by a decrease in the last horizon.

Table 27: Physical and chemical properties of Profile No.20

Table 27 a: Physical properties

Depth	Coarse sand	Fine sand	Silt	Clay
0-10	15.2	22.3	30.5	32.0
10-30	13.6	21.4	27.3	32.7
30-75	13.5	20.1	24.8	41.6

Table 27 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100 g
0-10	0.72	0.063	0.025	0.077	0.055	0.034	5.8	6.1
10-30	0.51	0.042	0.035	0.062	0.022	0.027	5.5	6.7
30-75	0.63	0.057	0.028	0.046	0.017	0.048	5.9	7.0

Table 27 presents the physico-chemical characters of Profile No.20 taken from a coffee plantation at the mid slope region of a hillock at Periya in the Aralampucha-Bavalipucha basin. Site characteristics and morphological features are given in Appendix 20 .

The profile is moderately deep, in situ developed but have been influenced by colluvic action. The coarse sand fraction increases followed by a decrease. The fine sand fraction decreases steadily with depth. The silt also decreases with depth while the clay fraction increases with depth. The profile is moderately rich in organic carbon. The percentage of organic carbon shows a decrease followed by an increase in the last horizon.

The total nitrogen also shows a decrease followed by an increase in the last horizon. The total P_2O_5 content shows an increase followed by a decrease. The profile is fairly rich in total K_2O and it shows a steady decrease with depth. The total Ca content also shows a decrease with depth while the total Mg content shows a decrease followed by an increase in the last horizon. The profile is generally acidic and it decreases with depth. The CEC shows an increase with depth.

Table 28: Physical and chemical properties of Profile No.21

Table 28 a: Physical properties

Depth	Coarse Sand	Fine sand	Silt	Clay
0-20	19.7	18.2	26.8	35.3
20-60	15.6	17.1	27.7	39.6
60-110	10.8	14.3	20.2	54.7

Table 28 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Meq/100g
0-20	0.56	0.047	0.021	0.031	0.170	0.122	6.6	6.1
20-60	0.31	0.028	0.019	0.045	0.032	0.024	6.2	6.3
60-110	0.29	0.025	0.022	0.018	0.025	0.019	6.1	5.7

Table 28 presents the physicochemical characters of Profile No.21 taken from the mid slope region of a hill at Kankayangad. The locational characteristics and morphological features of the profile are given in Appendix 21 . The parent material is weathered gneiss and the profile is very deep with poor horizon differentiation. Sand fraction in this profile is very low. Coarse sand and fine sand decreases with depth. The silt fraction shows a slight increase followed by a decrease with depth. The clay fraction increases with depth. The total organic carbon in the profile is low and it decreases with depth. The total nitrogen also shows a decrease with depth. The total P_2O_5 content shows a slight decrease followed by an increase. The total K_2O shows an increase followed by a decrease. Total Ca and total Mg is high in the first horizons and it shows an abrupt decrease with depth. The profile is acidic and the pH decreases with depth. The CEC shows an increase with depth.

Table 29: Physical and chemical properties of Profile No.22

Table 29 a: Physical properties

Depth	Course sand	Fine sand	Silt	Clay
0-15	22.2	25.4	10.3	42.1
15-50	24.6	26.1	9.0	40.3
50-110	26.3	28.3	12.6	32.8

Table 29 b: Chemical properties

Depth	% O.C.	Total N	Total P_2O_5	Total K_2O	Total Ca	Total Mg	pH	CEC Me/100 g
0-15	0.44	0.035	0.034	0.025	0.091	0.031	6.7	5.0
15-50	0.55	0.063	0.028	0.036	0.045	0.012	6.5	6.3
50-110	0.73	0.059	0.017	0.019	0.020	0.017	6.1	6.6

The physicochemical characters of Profile No.22 is given in Table 29. The details of the site characteristics and morphological features are given in Appendix [22] .

The profile is situated at Pallachura on a small reclaimed basin of a riverlet at the foot of a hill. The profile is deep and has originated through colluvic action. The coarse sand fraction increases with depth but shows a decrease in the last horizon. The sand fraction also shows an increase followed by a decrease in the last horizon. The silt fraction shows a decrease in the second horizon followed by an increase in the last two horizons. Clay fraction decreases followed by an increase in the last horizon.

The organic carbon increases steadily with depth and decreases suddenly in the last horizon. The total Nitrogen content increases in the second horizon followed by a decrease in the last two horizons. Total P_2O_5 and K_2O decreases with depth. Total calcium shows a decrease followed by an increase in the last horizon. Total Mg decreases in the second horizon followed by an increase in the last two horizons. The profile is generally acidic and pH decreases with depth. The CEC increases and then shows a decrease in the last horizon.

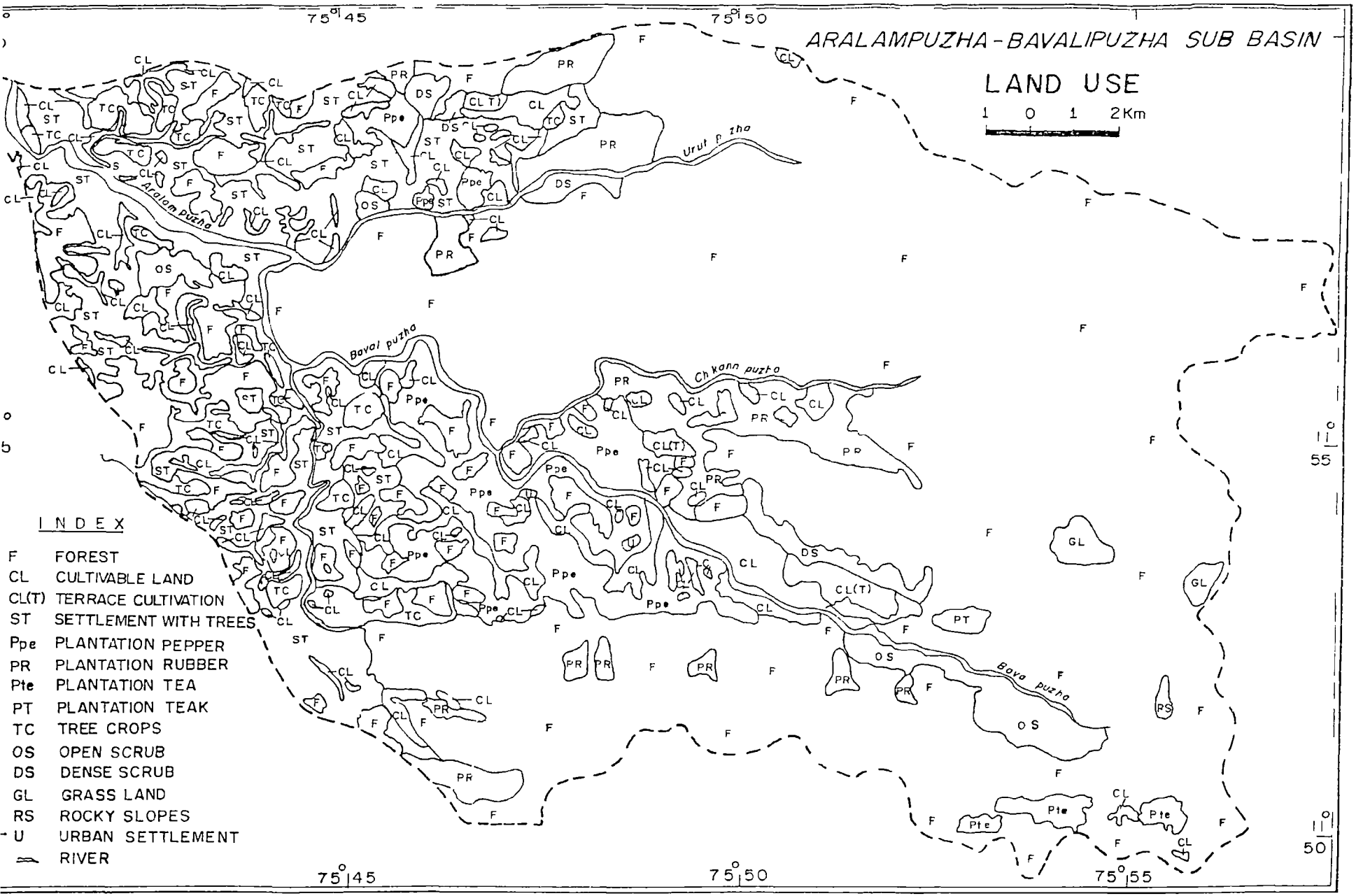

ARALAMPUZHA - BAVALIPUZHA SUB BASIN
LAND USE
1 0 1 2Km
75°45
75°50
75°55
11°55
11°50
Urut puzha
Aralam puzha
Baval puzha
Chkann puzha
Bava puzha
INDEX
F FOREST
CL CULTIVABLE LAND
CL(T) TERRACE CULTIVATION
ST SETTLEMENT WITH TREES
Ppe PLANTATION PEPPER
PR PLANTATION RUBBER
Pte PLANTATION TEA
PT PLANTATION TEAK
TC TREE CROPS
OS OPEN SCRUB
DS DENSE SCRUB
GL GRASS LAND
RS ROCKY SLOPES
U URBAN SETTLEMENT
RIVER

FIG 16

Land use

From the topographical maps (1:50,000) and aerial photographs supplemented by field checks thirteen categories of land use ranging from forests to concentrated settlements have been identified (Fig. 16). The various land use units and their areal extent are given in Table 30 below:

Table 30: Land use and their areal extent

Land use types		Area in percent to total area
A.	Agricultural area	12.15
	1. Cultivable Land (Seasonal Agriculture)	9.99
	2. Terraced Cultivable land	0.60
	3. Tree Crops	1.56
B.	Settlement area	11.88
	1. Settlement with trees	11.88
C.	Plantations	9.61
	1. Rubber	5.25
	2. Pepper	3.92
	3. Tea	0.44
D.	Forest Plantation	0.15
	1. Teak	0.15
E.	Forest	66.14
	1. Dense mixed jungle and isolated forests	62.85
	2. Open Scrub	2.14
	3. Dense Scrub	0.55
	4. Grass Land	0.29
F.	Waste Land	
	1. Rock outcrops etc.	0.07

Depending upon the microtopography there is considerable variation in the land use pattern from the higher slopes in the eastern part to the flood plain area in the western and north western part of the basin. Geomorphic condition has a very important relation with land use pattern. Impact of the land use pattern on the environment is pronounced in this region. Though 66.14 percent of the total area is said to be under forests, considerable area within the forest boundary have been deforested. Large scale deforestation combined with the rugged nature of the topography has accelerated the erosional process to a considerable extent. Large areas along the plateau scarp in the southern and eastern part of the basin are highly erosion prone. The catchment area of Urutipuzha and the interflow of Urutipuzha-Bavalipuzha have lost forest coverage to the extent of 40 percent to 50 percent. Consequently soil erosion and surface runoff is very high and the sediment load in the river has been considerably increased. Urutipuzha which was once perennial has now lost its perenniality. Forests which act as regulators in the hydrological regime have been removed thereby disrupting the ecological balance.

In recent years land slides are reported from the southern part of the basin. Small streams which develop on the lateritic surface gradually cuts down the river bed and touches the soft clay below the hard crust laterite. On reaching that soft layer

vertical as well as lateral erosion increase manifold particularly during the monsoon months. This causes the upper surface to collapse leading to heavy damage.

Depending upon the geomorphic condition the land use pattern varies from village to village. Area under cultivation is as high as 90 percent in Vellarvolli, whereas in Keezhur it is 59 percent. Table 31 given below gives land use classification

Table 31: Land use classification

Class	Area in hectares	In percent to total area
Building and Courtyards	343.57	1.09
Other non-agricultural use	1304.41	4.14
Barren and uncultivable	423.84	1.34
Miscellaneous tree crops	142.23	0.45
Pastures and grazing	28.15	0.09
Cultivable waste	767.35	2.43
Other fallow	139.45	0.44
Current fallow	623.35	1.98
Area under cultivation	27773.33	88.04
	31545.68	100.00

Like in other parts of the State forests have given way to plantations. But due to the rugged nature of the topography in many cases it has lead to erosion and exposure of land crust laterite. Such lateritic outcrops are seen throughout the region. A typical example is that of Aralam farm. A considerable area of virgin forest was cleared for establishing the Central State Farm. Since adequate conservation measures were not taken many parts of the farm is now barren, and the rest mainly under cashew.

Critical discussion of the soil features

Coarse sand in most of the profiles taken from both the river basins, Mangalamboorthu-Jayathripuzha and Aralampuzha-Pavalipuzha, decreases with depth. This is, however, a general behaviour of coarse sand in a typical profile. A variation from this pattern is seen in profile Nos. 4, 8, 9 and 11, taken in Aralam-Pavalipuzha Basin. In Profile No.4 of Aralam-Pavalipuzha basin the coarse sand fraction decreases followed by an increase with depth while in 8, 9 and 11 it shows an increase followed by a decrease. One significant observation is that there is no variation from the typical pattern of behaviour of coarse sand in any profile taken from Mangalam-Jayathripuzha basin. This must be because most of the profiles have been developed in situ. The land forms of this region

is mostly of a subdued nature due to prolonged degradation and denudation. In Aralam-Bevalipuzha basin interference by man has been relatively recent and the topography provides enough scope for abrupt changes in its form. The land form of the area from which profile Nos. 8, 9 and 11 have been taken is hilly and their physiographic positions are valley, mid slope and foot hill regions respectively. In all these situations there has been significant interference by human agency. This must have disturbed the typical behaviour shown in the distribution of coarse sand. Addition of organic matter and also the deposition of the finer fractions in the upper horizons from the higher reaches must have led to the decrease of coarse sand percentage in the upper horizon. Profile No.4 is situated inside Aralam farm. The physiographic position of the site is laterite mesa, and the land form is gently undulating. This site has been subject to prolonged erosion and degradation. It was earlier under a rich forest cover which was removed suddenly for establishing the Aralam Farm under the State Farming Corporation. Intensive cultivation without sufficiently replenishing the soil with organic matter has led to rapid deterioration and in the course of less than a decade the surface soil has been lost and laterite outcrops are seen in the surrounding region. Due to the loss of the fine fraction in the upper horizon the coarse sand fraction is unduly high in the surface horizon. The subdued nature of the site

has facilitated movement of fine fraction to the mid-horizon thereby leading to the decrease in percentage of coarse sand in this horizon. Besides this the profile is young and has not had much time for stabilising.

In the case of fine sand also most of the profiles show a decreasing trend with increasing depth. In the case of Profile Nos. 3, 6, 7 and 11 of Mangalam-Gayatripuzha basin fine sand shows an increasing trend with depth. All these profiles were situated on the converse slope of subdued hills, which were subject to prolonged erosion. The profiles contain large quantities of the parent material in various stages of disintegration. Gravel content is high in all the cases. The increase in fine sand fraction with depth is found only in Mangalam-Gayatripuzha and is a character of old in situ profiles where the washing out of this fraction is faster than its formation and movement upward from the lower horizon. Profile Nos. 5 and 8 of Mangalam-Gayatripuzha basin and 1, 4 and 11 of Aralam show an increase of fine sand percentage followed by a decrease. The profile Nos. 5 and 8 of Mangalam basin are situated on the converse side of a hill. These profiles have originated from laterites and have been influenced by colluvial deposits from the hill top. Hence the percentage of fine sand in the upper horizon has been reduced. Profile Nos. 1, 4 and 11 of Aralam also show an increase of fine sand followed by a decrease. The physiographic

position of profile Nos. 1 and 2 is in the foot hill. There is ample evidence of colluvial deposition in both these sites. Profile No.4 is situated on a flat lateritic mesa where colluvial action is less. The concentration of fine sand in the profile is less because of erosive forces that have removed this fraction from the upper horizon.

Silt in majority of the profiles decreased with depth. It is observed that while silt decreases with depth in profile Nos. 3, 5, 6, 10 and 11 of Mangalam-Gayatripuzha basin it shows similar behaviour only in Profile Nos. 8 and 9 of Aralam-Bavalipuzha basin. Profile Nos. 2 and 5 of Aralam and 1, 2 and 9 of Mangalam show an increase of silt with depth. In Profile Nos. 3, 4, 7, 10 and 11 of Aralam basin there is an increase followed by a decrease. In Profile Nos. 1, 6 and 11 of Aralam and 4, 7 and 8 of Mangalam there is a decrease followed by an increase in percentage of silt. In Profile Nos. 3 and 6 of Mangalam-Gayatripuzha basin, the silt fraction decreases with depth. The profiles are under pasture and the sites have a subdued nature. Being under pasture the generation of silt fraction is high and there is a gradual downward movement of this fraction. Profile Nos. 5 and 10 have originated from colluvial action and this is the reason for the percentage of silt being higher in the upper horizon. Profile No.11 is situated in a terraced field. The higher percentage of silt in the upper horizon of this profile is due to the addition of organic matter for cultivation and the decay of plant residues.

In Aralam basin Profile Nos. 8 and 9 showed a decrease of silt with depth. Profile No. 8 is situated at a foot hill and is enriched by decaying organic matter and plant residues. Hence there is an abundance of silt in the upper horizon compared to the lower horizons. Profile No. 9 is situated at a mid slope and besides being enriched by decaying plant residues it is also influenced by colluvial action which must be the main reason for the abundance of silt in the upper horizon compared to the lower horizons in this profile.

Profile Nos. 2 and 5 of Aralam basin and 1, 2 & 9 of Mangalam basin show an increase of silt with depth. Profile No.2 of Aralam basin is situated at a site which was subjected to prolonged erosion and degradation. Hence the value of silt in the upper horizon is less and increases with depth. Profile No.5 of Aralam basin is situated in a saucer shaped basin on a lateritic mesa. Hence the reason for the percentage of silt being higher in the lower horizon in the colluvial action which has had to the origin of the profile. In Mangalam basin Profile No.1 is situated at the foot hill of a forest and the profile has developed from colluvial action. Due to intensive cultivation the silt fraction in the upper horizon is less and hence shows an increase of silt with depth. Profile No.2 is situated in a field with typical black cotton soil. Intensive cultivation with inadequate replenishment has reduced the silt content in the upper horizon of this profile. Profile No. 9 is situated on a

considerably degraded hill. Due to the action of erosive forces the content of silt in the upper horizon is very low. Hence the value increases with depth.

Clay fraction increased with depth in most of the profiles This is the typical behaviour of clay with depth in a typical profile. Only Profile Nos. 6 and 11 of Arralam and 4 and 11 of Mangalam show a variation from this pattern. In Profile No.6 of Arralam basin clay fraction shows an increase followed by a decrease with increasing depth. The profile is situated on a mid slope. The area was under forest cover which was removed for establishing tea plantation. The sudden exposure to erosive force must have caused an outward and downward movement of clay and hence its low value in the upper horizon and its accumulation in the mid horizon. Profile No.11 of Arralam basin is situated at a foot hill and owes its origin to colluvial action. Hence there is a decrease followed by an increase of clay fraction with depth. The deposition of clay on the upper horizon is the reason for that horizon having a higher value for clay than the horizons below. In Profile No.4 and 11 of Mangalam basin clay fraction showed an increase followed by a decrease with increasing depth. Both these profiles were taken from a terraced field under cultivation. Intensive cultivation has caused the downward movement of clay from the upper horizon resulting in an accumulation of clay in the mid horizon.

Table 32: Land Capability assessment - Mangalampuzha-Gayatripuzha

S.No.	Morphological units with description	Map Unit	Area %	Soil	Land capability	Existing land use	Recommendations
1.	Very gently rolling terrain (flood plain old and new, alluvial fans), depositional surfaces	b	41.91	Sandy clay loam to loam texture. Regularly replenished by deposition from upper slopes and from floods. Organic matter decreases with depth	Highly productive, dryness during non-monsoon months	Seasonal such as paddy, sugarcane pulses and tapioca on the	Dryness could be reduced with canal irrigation with sufficient discharge facilities. Slopes not to be cultivated with tapioca
2.	Moderately undulated terrain (denudational cum depositional surface with alternate low and moderately elevated areas)	c	11.74	Characteristic black soil with clayey texture alkaline in reaction, clay increases with depth, organic matter, low	Medium productivity, wet in basin areas only dry in non-monsoon months	Paddy, millets, pulses, groundnut and tree crops	Productivity could be increased through irrigation with open, large diametr wells and tub wells in fracture zone
3.	Hummocky undulated terrain (denudational-cum-depositional surface with isolated elevated areas, characterised by laterites and occasional rocky out crops)	a	14.02	Sandy clay loam texture, organic matter medium, coarse fraction increases with slope in the valley, bottom soil is loamy.	Low productivity, erosion prone, dry in non-monsoon months	Seasonal crops in flat areas tapioca on the slopes, and tree crops.	Productivity could be increased with irrigation through open large diametre wells & in fracture zones, on slopes, only Perennial crops recomm

(Table 32 contd...)

4.	Isolated hills (remnant of erosional surface between 150 and and 380 m and above)	IH	9.08	Sandy loam texture, mostly lateritic soil, organic matter medium, shallow in the upper slope.	Low productivity for seasonal crops but high for plantations erosion prone	plantation and tree crops	Soil conservation is a must. Remaining forest patches are to be preserved and afforestation programmes are to be started
5.	Hilly region (represents the erosional surface above 580 m)	HR	23.25	Forest loam texture, organic matter high, Coarse fraction low,	Highly capability for tea, coffee and cardamom plantations and forests. Highly susceptible to erosion	Tea, Coffee Cardamom, plantations and forests	Soil conservation practices to be intensified. Conservation and afforestation and regeneration of forests to be made.

Table 33: Land Capability assessment - Aralampuzha-Bavalipuzha

S.No.	Morphological units with description	Map Unit	Area %	Soil	Land capability	Existing landuse	Recommendations
1.	Flood plain/low level fluvial terrace (depositional surface)	F_1	7.66	Regularly replenished by silt deposits, mostly silty clayey loam texture.	Suitable for wet land agriculture, flood prone, dry in non-monsoon months	Seasonal crops and perennial crops (paddy, banana, sweet potato, coconut, arecanut and cocoa	Due to scarcity of land, measures are to be taken to increase the productivity, canal irrigation facilities to be improved
2.	Moderately sloping terrain, adjoining flood plain areas (denudational surface)	F_2	3.65	Derived from laterites, gravelly clay texture	Not suitable for seasonal crops but suitable for tree crops	Tree crops, mixed crops, pepper, settlements	Tree crops to be protected from river bank erosion, settlements not recommended, aforestation programmes to be initiated
3.	Alluvial old flood plains, away from the main channel	F_3	0.66	Alluvial and colluvial deposits, silty clay loam texture.	Highly productive for wet land agriculture	Wet land agriculture (paddy, pulses, millets) & tree crops	Irrigation facilities to be developed through lift irrigation from the main channel, land not to be converted for tree crops

(Table 33 contd ....)

4.	Steep scarp plateau slope adjoining major fluvial channel denudational surface	F_5	0.71	Colluvic in origin, sandy clay loam texture with uniform moisture	Low productivity, most suitable for tree crop culture, highly prone to erosion	Open Scrub	The slopes to be stabilized to prevent land slides
5.	High level flood plain (depositional character, part of an extensive plateau)	F_6	0.11	Colluvic alluvium in origin, loamy soil.	Medium productivity, most suitable for wet land agriculture	Paddy, tree crops, eucalyptus, tea, cardamom, etc.	Irrigation facilities to be developed through lift irrigation, should not be diverted for perennial crops
6.	Gently sloping terrain (5% slope, depositional cum denudational surface)	T_1	1.44	Derived from laterites, gravelly clay loam texture	Medium productivity, suitable for free crops and settlements, scope for canal irrigation	Tree crops cashew, rubber, pepper and settlements	Canal irrigation should be developed, ecologically viable free crops could be introduced
7.	Undulated terrain (depositional cum denudational surface)	T_2	5.77	Derived from laterites, gravelly clay loam texture.	High productive for tree crops and plantations suitable for development of settlements	Tree crops cashew, rubber, pepper and settlement	The area promises development. Crop intensity, could be increased throu ecologically viabl tree crops

(Table 33 contd....)

. Highly dissected terrain (denudational surface)	T_3	5.75	Derived from laterites, gneiss, gravelly, clay loam texture with uniform moisture	Medium productivity, highly susceptible to erosion	Cashew, tree crops, settlements, and forest	Afforestation programmes recommended, contour bunding and other soil conservation measures required
. Hilly region (15° denudational-cum -depositional surface)	T_4	62.46	Derived from laterite gneiss, silty clay loam texture	Low productivity for seasonal crops but high for plantations. Highly susceptible to erosion	Tea, cashew eucalyptus, teak and forests	Existing forests to be preserved No more introduction of plantation crops
0. Prominent isolated hills (inselberg), denudational surface product of previous cycle of erosion	T_5	0.53	Derived from laterite gneiss, silty clay loam texture.	Low productivity for seasonal crops but high for plantations, erosion prone	Rubber forest	Existing forests to be preserved soil conservation essential
1. Hummocky undulated terrain (denudational depositional conditions nearly balanced)	T_6	8.58	Colluvic alluvium in the flat areas and in-situ in the elevated areas, coarse fragments more, silty clay loam texture.	Medium productivity suitable for tree crops	Seasonal crops, pepper on slopes, tree crops and settlement	Irrigation facilities to be developed with proper drainage to protect the land form salinization, lift irrigation fortne tree crops on the higner elevation

(Table 33 contd....)

12.	Mesa (remnants of plantation surface developed in various erosional cycles, denudational-depositional condition nearly balanced)	T_7	0.90	Developed by colluviation of soils, higher clay proportion with uniform moixture	Medium to high productivity in places with thick soils in duricrust areas the productivity is very low.	Cashew/ grass	Productivity can be increased by providing irrigation through tube wells, etc. in hard crust areas fodder crops could be raised

CONCLUSIONS

Physical determinants of environment like relief, slope, drainage, soil, climate, etc. have played very dominant roles in shaping the pattern of land use in the two basins - Mangalam-puzha-Gayatripuzha (M-G) and Aralampuzha-Kavalipuzha (A-K). Socio economic characteristics of these basins also did have profound influence in determining the land use pattern within the natural framework provided by the physical determinants of environment.

1. The two basins have broad similarities and dissimilarities of physical determinants of environment. The M-G basin has a mature landscape with less diverse geomorphic units, whereas, the other basin exhibits a youthful landscape with more diverse geomorphic units. In both the cases, the drainage pattern and stream directions are controlled by geologic structures. Comparatively, more rainfall with almost uniform spatial distribution is experienced in the A-K basin, whereas, the M-G basin receives less rain fall with wide variation in distribution. The eastern part of the M-G basin is almost dry.

The soil is mainly alluvium in the M-G basin, whereas it is laterite in A-K basin. Soil fertility is moderate with no marked variation in both cases.

2. The aforesaid factors have, divergently, influenced the type, extent and quality of landuse; crops and cropping pattern; agricultural economy; socio-economic characteristics of the population; irrigations potential; erosion proneness of the land etc. and therefore, the general ecology of these basins.

3. The major controlling factors of the landuse are topography, micro relief and rainfall distribution. Further, high population density, smaller land holdings and above all, the low per-capita income of the people have put the land to great stress. In such situations what is an ecologically viable landuse-based on land capability-becomes subservient to what may be called as a subsistence landuse, much divorced from an ecologically viable one. This is true, not only in these two basins, but also throughout the other basins of Kerala.

4. Crop intensity is quite nigh in both basins. Monocrop villages show high crop intensity, since crops like paddy could be cultivated thrice a year.

Foodcrops dominate the agricultural scenery in the M-G basin, whereas, cash crops take over in A-G basin. Therefore, it can be said that the M-G basin economy is food crop based, whereas the A-G basin economy is cash crop based.

Intercropping and mixed cropping are observed in both basins. Conversion of wetlands for various landuse purpose, other than paddy cultivation, is quite common.

5. Canal irrigation is developed quite well in M-G basin, whereas, in the A-B basin, barring a few minor irrigations, no canal irrigation facility is available. In this context, it is to be noted that, since crop intensity- both seasonal and annual crops - being higher in the A-B basin than in the M-G basin, development of minor irrigation facilities in the former assumes importance from the point of view of agricultural development.

6. It is quite well known that the entire Western Ghat region of Kerala is facing severe soil erosion problem, largely due to d forestation and improper landuse practices. These two basins are no exception to it. The southern part of the M-G basin having near vertical slope is vulnerable to erosion even in normal conditions. This situation has been aggravated by large scale deforestation; a glaring example being the Nelliampathy scarp. Landslips are also quite common, mainly, by way of failure of water-saturated overhanging slopes by the side of ghat roads, during monsoons.

Tapioca, the second staple food of Kerala, and its cultivation along slopes by the marginal farmers with land holding of less than

1 hectare is a common feature. Under the existing physico-climatic conditions, the high rate of tapioca cultivation is degrading land beyond repair by way of soil erosion in both the basins. The declining productivity of tapioca due to continued cultivation and loss of top soil make people to cultivate it in more and more areas, including the virgin forest soils, which deteriorates the quality of environment, still further.

7. One third of the population are workers in both basins. In this, no wide variation is found at the village level. Both basins show more or less uniform pattern in occupational structure in which agriculture labour, cultivation and related work are main source of occupation

8. Forest coverage of the two basins, based on the 1965 survey, was 50.65% in the A- B basin and 9.74% in the M-G basin. In 1983, this has been reduced, respectively, to 22.85% and 2.51%. Presently, the forest areas are confined to the rugged hilly terrains of these basins, isolated hills, which were previously covered by natural vegetations, are now completely deforested.

As a natural factor, climatic climax in these basins could be cited as a reason for degradation of natural vegetation to a limited extent. However, human interference accounts for the removal of a lion's share of vegetation in the basins. Our studies

indicate that maximum d forestation was effected due to pl ntation activities, chiefly of tea, coffee and cardamom. Extent of deforestation has also significant relationship with the development of forest-based industries, communication avenues (roads), etc. The other factors that had influenced deforestation in the State such as human encroachment, forest fire, extraction of timber for fire wood, clear felling of forests, allotment of forest areas for non-forestry purposes, river valley projects, etc. have also contributed to the deforestation in these two basins.

RECOMMENDATIONS

1. In 1983, Mangalampuzha-Gayatripuzha (M-G) basin had a forest coverage of only 2.5% of its geographical area, whereas, the depletion rate of forest for the preceeding ten years was 3.11%. Correspondingly, in 1983, Aralampuzha-Bavalipuzha (A-B) basin had a forest coverage of 22.85% of its geographical area, whereas, the depletion rate for the same period was of the order of 8%. One of the secondary impacts of deforestation has been that it increased the peak discharge of the river systems and surface run off. As a consequence there occurs less and less of recharge to ground water aquifers resulting in drought conditions during lean seasons. Therefore, there are flash floods during rainy seasons and severe drought during summer in many areas of the basins. Needless to say that deforestation has caused enormous soil erosion in both the basins. It is, therefore, recommended that:

a) It is essential that no more clearance of existing forest be permitted in both the basins. On the other hand, afforestation programmes shall be expedited.

It is recommended that the talus slopes of Nelliampathy scarp of the M-G basin shall be immediately taken up for afforestation. In the case of A-B basin, afforestation is recommended for the south eastern and the north eastern border areas.

b) The forests now not included under the Brahmagiri biosphere reserve, in the A - B basin, shall also be included in the biosphere reserve.

c) It has been noticed that the forest cover, adjacent to the Wyanad plateau, is subjected to constant fire. Action should be taken to control the fire.

d) The families adjacent to forests shall be supplied with cooking fuel such that the necessity of meeting the requirement by themselves does not pose a direct threat to forest.

2. Most of the A-B basin has stabilised slopes and as such no severe soil erosion is noticed except in areas around Sanepathipalayam, where sheet erosion is a problem. On the other hand, the A-B basin has been experiencing severe soil erosion on account of the existing landuse practice made grave by low percapita availability of land. We recommend that:

a) The Government should ensure conservation of soil by regional conservation projects as against subsidy or other governmental assistances given to an individual farmer, as it is practised now. (Introducing soil conservation and its maintenance by a farmer would cost him money, whereas, his income hardly increases).

b) Comprehensive programmes must be formulated to bring the catchment of rivers under good perennial tree and fodder vegetation.

c) Tapioca cultivation, requiring greater tillage, on slopes should be discouraged or prohibited. Depending on the agro-climatic and the socio-economic conditions, an adoptable cropping system will have to be evolved, in such situations, such that the product of which could be harvested for such food crops.

3. Landslides are found to occur along Nelliampathy-Pothundy reservoir road in the M-G basin as well as along the Wyanad plateau scarps, causing loss of life and property, during monsoon periods. We recommend that the existing and the potentially landslide-prone areas be mapped and warning given to people about the hidden danger. Simultaneously, actions shall be initiated to stabilise the slopes of landslide-prone areas through providing drainage, excavation, removal of materials from the head of the unstable slope, afforestation on barren slopes, etc.

4. Because of enormous pressure on land arising out of increasing population, intensive landuse practices are witnessed in both the basins without regard to the carrying capacity of land. This

is particularly so in the case of the A-B basin, where, for instance, tapioca cultivation has gone up to a staggering 45% of the total cultivated area (TCA), that too, often on steep slopes. (In the existing socio-economic and political system, we doubt whether any drastic change in such land use practices could be brought about, overnight. However, at the same time, it is essential to look forward to future with optimism).

a) A detailed land capability assessment based on natural land use determinants has been worked out for the two basins and incorporated in this report. The procedure and recommendations suggested therein shall be followed for improvement/modification of the existing landuse of the two basins. We recommend the procedure for other basins of the Western Ghats for land capability assessments and eco-development.

b) Since a large section of people in the hilly areas of these basins are poor with no alternative means of subsistence other than what they get from their own small piece of land, it is imperative that we evolve imaginative hill slope agricultural programmes which would provide guaranteed subsistence for these people. One of the programmes could be putting hill slopes under perennial tree and fodder crops. High yielding, nutrient rich fodder crops should

enable the marginal farmers to rear more cattle population which would serve increasing the economy, besides, generating more employment opportunities. Soil conservation and, therefore, water management are two parallel, precious return from such practices.

c) The Social forestry programme, Rural Employemtn Programme, Integrated Rural Development Programme and other allied programmes should be geared to take up the above challenge of development consistent with environmental viability.

d) Plantations have been a viable economic sector in both the basins. However, it is doubtful whether it has brought any appreciable benefit to the large sections of the poor, particularly, the tribals, who were forced out of forest land by plantations, have been completely ignored by the sector. The state of affair needs change through appropriate planning and legislation.

e) It should also be ensured that economic consideration of plantation should not lead to further deforestation. Increase in productivity and profitability shall be achieved from the existing area of plantation through application of bio-technology and allied research.

5. To ensure irrigation water for the second crop and also for drinking purposes, groundwater should be exploited to optimum level. The existing irrigation facilities should be augmented and also new irrigation facilities introduced, of course, with due consideration

to the environmental issues of land, so as to avoid over irrigation or water logging, causing salinity. Minor irrigation should take into consideration the microrelief of terrains for optimum utilization of water. Drip irrigation practised in certain areas of these basins should be encouraged and popularized for irrigating tree crops.

8. Studying the present land use and the suggested land use based on the eco-development zones, keeping in view the conservational needs and developmental, potential it is interesting to note that the land use of Aralampuzha-Pavalipuzha a basin is well within its environmental viability. However, a few points need stress. The peripheral areas of the forests to the east of the basin is deforested and these slopes should be covered with tree crops, the present land use being open to dense scrub and terraced cultivable fields. The areas suitable for wet land agricultural is to be properly used. Further, agricultural productivity can be increased by intencifying wet land agriculture in the suggested areas.

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DESCRIPTION OF THE INDIVIDUAL PROFILES

Appendix I

Profile No.1

I. Information on the site.

(a) Profile No. - 1

(b) Soil Name - Lateritic soil

(c) Higher Category of clarification - Ultisol

(d) Date of examination - 25-1-1985

(e) Author - Benoy T.Cheriyan

(f) Location - Foothill of Gital_unda Estate.

(g) Elevation - 700 m

(h) Land form

(i) Physiographic Position - On foot hill

(ii) Land form of surrounding country - Hilly

(iii) Microtopography - Nil

(i) Slope on which profile is sited: Class 2. Gently sloping (2-6%)

(j) Land use: The land is cultivated to groundnut and coconut palm

(k) Climate: - Humid tropical

II. General information on the site:

(a) Parent material - Forest loam

(b) Drainage - Class 4. well drained.

(c) Moisture condition in profile - Moist below 15 cm

(d) Depth of ground water table - 5 m.

(e) Presence of surface stones, rock out crops - Class 0 - very few stones

(f) Evidence of erosion - Sheet erosion

(g) Presence of salt or alkali - Nil

(h) Human influence - Intensive cultivation without adequate conservation measures have caused the depletion of the surface horizon by severe erosion

III. Brief description of the Profile:

This profile was very deep greyish coloured with very less percent of gravel. Root distribution is normal with plenty of fine roots distributed in the top 30 cm of the profile. The upper horizon had less organic matter light colour and was sandy hence it was dry the lower horizon was rich in clay and organic matter and was moist.

IV. Profile Description:

Depth (cm) 0 - 25	Dark grey (5 YR 4/1) dry very dark grey (5 yr 3/1) moist; loamy moderate fine crumb; moist friable, dry loose, wet slightly sticky, plenty of fine roots, pH 6.2, boundary gradual and diffuse.

25-50		Dark geddish brown (5 YR 3/2) dry, (5 YR 2/2) moist, clay loam, moderate course subangular blocky, wet plastic, moist firm and dry slightly hard, slightly sticky, boundary gradual and diffuse, pH 5.8

Appendix 2

Profile No.2

1. Information on the site sampled:

(a) Profile Number - 2

(b) Soil name (series, phase or mapping index, etc.) - Black soil

(c) Higher category classification - Vertisol

(d) Date of examination - 25-1-1985

(e) Author(s) of description - Benoy T. Cheriyan

(f) Location - Chemmanampathi, behind the Community well

(g) Elevation (in meters or feet) - 400 m

(h) Land form:

(i) Physiographic position of the site - Convex slope

(ii) Land form of surrounding country - Gently rolling topography

(iii) Microtopography (if any) - The Profile was located in field

(i) Slope on which profile is situated - Class I Flat

(k) Climate - Humid Tropical climate

II. (a) Parent material - Colluvial material derived from granitic rocks

(b) Drainage - Class 3 - Moderately well drained

(c) Moisture conditions in the soil - Moist below 25 cm

(d) Depth of ground water table (in meters): 10.8 m

(e) Presence of surface stones or rock - Very few stones outcrops

(f) Evidence of erosion - Sheet erosion

(g) Presence of salt of alkali - Nil

(h) Human influence: Cultivated to field crops

III. Brief description of profile:

This profile was deep moderately well drained root distribution limited to the upper horizon. Presence of gravel less. Lower horizon very clayey and sticky, lime sheels present as small white flocks.

IV. Profile Description:

Depth (cm)

0-10 Very dark greyish brown (10 YR 3/2), dry, very dark brown (10 YR 2/2) moist; clayey; moderate medium sub angular blocky; dry firm, moist sticky and plastic; few fine roots, diffuse smooth boundary; pH 8.0

10-40	Very dark grey (10 YR 3/1) dry, black (10 YR 2/1) moist; clayey; moderate, coarse sub angular blocky; dry very firm, moist very sticky and plastic; few roots and lime shells found; diffuse smooth boundary; pH 8.1
40-110	Very dark grey (10 YR 3/1); dry black (10 YR 2/1) moist; clay; strong, very coarse subangular blocky; dry very firm, moist sticky and plastic; lime shells present; diffuse boundary; pH 8.2

Appendix 3

Profile No.3:

I Information on the site sampled:

(a)	Profile Number	3
(b)	Soil name (series; phase or mappint index, etc.)	Laterite
(c)	Higher category classification	Ultisol
(d)	Date of examination	26-1-1985
(e)	Author(s) of description	Benoy T. Cheriyan
(f)	Location	A few km from Nemmeni on the way to Sitargundu Estate

(g) Elevation (in metres or feet) - 650 m

(h) Land form

(i) Physiographic position of the site - Convex side of a hill

(ii) Land form of surrounding country - Rolling topography

(iii) Microtopography (if any) - Nil

(i) Slope on which profile is sited - Class 2, gently sloping

(j) Vegetation or land use - Pasture

(k) Climate - Humid tropical climate

II General information on the soil

(a) Parent material - Laterised gneiss

(b) Drainage - Class 3, Moderately well drained

(c) Moisture condition in the soil - Moist below 50 cm

(d) Depth of ground water table (in meters) - 7 m

(e) Presence of surface stones or rock - Fairly stony

(f) Evidence of erosion - Sheet erosion

(g) Presence of salt or alkali - nil

(h) Human influence - nil

III Brief description of the Profile:

This profile was situated on the mid slope of a hill whose side was cut away and soil removed for construction purposes. Rock out crops were seen in the upper parts of the hill as evidence of erosion. The profile is in situ developed, under pasture. It is deep moderately well drained and gravelly throughout the profile root distribution is normal and is concentrated in the top 20 cm of

the profile. Parent material was laterite with black biotite flecks prominently seen in it.

IV. Profile description:

0-20	Brown (7.5 YR 5/4) dry, dark brown (7.5 YR 4/4) moist; gravelly sandy clay loam; medium weak granular; moist friable; wet slightly sticky, dry firm; roots plenty; smooth boundary, pH 5.0
20-60	Yellowish red (5 YR 4/6) dry, dark reddish brown (5 YR 3/4) moist; gravelly, sandy clay loam; medium weak subangular blocky; moist friable, wet slightly sticky, dry slightly hard; clear smooth boundary; pH 5.15
110-150	Reddish yellow (7.5 YR 6/8) dry (7.5 YR 6/6) moist; sandy clay loam; moderate coarse subangular blocky; dry hard, moist firm wet sticky and plastic; common medium distinct mottles; clear distinct boundary; pH 5.2

Appendix 4

Profile No. 4:

I. Information on the site sampled:

(a) Profile Number - 4

(b) Soil name (series, phase or mapping index etc.) - Laterite

(c) Higher category classification - Ultisol

(d) Date of examination - 29-1-1985

(e) Author(s) of description - Benoy T. Cheriyan

(f) Location - Cheramangalam

(g) Elevation (in meters or feet) - 70 m

(h) Land form

(i) Physiographic position of the site - Terraced slope

(ii) Land form of surrounding country - Rolling

(iii) Microtopography (if any) - Terracing

(i) Slope on which profile is situated - Class 3

(j) Vegetation or land use - Cereals like upland rice and coconut cultivated

(k) Climate - Humid Tropical

II General information on the soil

(a) Parent material - Laterite

(b) Drainage - Class 2, Imperfectly drained

(c) Moisture conditions in the soil - Moist below 25 cm

(d) Depth of ground water table (in meters) - 5 m

(e) Presence or surface stones or rock out crops - Fairly stony

(f) Evidence of erosion - Sheet erosion evident

(g) Presence or salt or alkali - nil

(h) Human influence - Cultivated to field crops and coconut

III. Brief description of the Profile

This profile is situated on a sloping terraced hill side. The terracing is not sufficient to prevent surface run off. Thereby creating a loss of finer fractions. It has imperfect drainage due to the presence of a suspected clay pan in the lower horizon. It was cultivated to upland rice. The profile is moderately deep and gravelly throughout the profile. Root distribution is normal and parent material is laterite with coarse mottles.

IV. Profile description:

Depth (cm)

0-25 Reddish brown (5 YR 5/4), dry, (5 YR 4/4) moist; gravelly, sandy clay loam; coarse moderate crumb structure; moist friable, wet slightly sticky and non plastic; plenty or roots; clear smooth boundary; pH 6.4

25-50	Yellowish red (5 YR 4/6) dry, dark reddish brown (5 YR 3/4) moist; gravelly, sandy clay loam; medium moderate subangular blocky; moist firm, wet slightly sticky and plastic; roots few; gradual wavy boundary; pH 5.5
50-100	Yellowish red (5 YR 4/6) dry, dark reddish, brown (5 YR 3/4) moist; gravelly clay; coarse moderate subangular blocky; moist firm, wet sticky an plastic; diffuse wavy boundary; pH 5.7
100-150	Yellowish red (5 YR 4/6), dry, dark reddish brown, (5 YR 3/4) moist; gravelly clayey loam; coarse moderate subangular blocky; moist firm, wet sticky and plastic dry slightly hard; mottles common medium and distinct; clear boundary, pH 5.7

Appendix 5

Profile No.5:

1. Information on the site sampled:

   (a) Profile Number - 5

   (b) Soil name (series, phase, or mappint index, etc.) - Laterite

   (c) Higher category classification - Ultisol

(d) Date of examination - 30-1-1985

(e) Author(s) of description: - Benoy T. Cheriyan

(f) Location - Vandazhy on the way to Mangalam Dam

(g) Elevation (in meters or feet) - 150 m

(h) Land form

(i) Physiographic position of the site - Convex side of Hill

(ii) Land form of surrounding country - Rolling

(iii) Microtopography (if any) - Nil

(i) Slope on which profile is sited - Class 2, gently sloping

(j) Vegetation or land use - Pasture

(k) Climate - Humid tropical climate

II General information on the soil

(a) Parent material - Laterite with colluvial deposits from hill top

(b) Drainage - Class 4, well drained

(c) Moisture conditions in the soil - Moist below 25 cm

(d) Depth of ground water table (in meters) - 6 m

(e) Presence of surface stones or rock outcrops - Fairly stony, fairly rocky

(f) Evidence of erosion - Sheet erosion but not high due to grass cover

(g) Presence of salt or alkali - nil

(h) Human influence - Nil

III Brief description of the Profile

This profile was situated near a stream on the convex slope of a hill. The profile showed evidence of some colluvial deposition and also the influence of the stream. Regular striations were seen in the middle horizon indicating the concentration of some finer fractions. However, parent material found in the last horizon was laterite. Biotite fragments were seen in this horizon.

IV Profile Description:

0-25	Weak red (2.5 YR 5/2), dry (2.5 YR 4/2) moist; sandy clay loam; medium weak granular structure; moist friable, wet slightly sticky and slightly plastic, dry loose; roots plenty, diffuse boundary; pH 6.0
25-100	Yellowish red (5 YR 5/6)dry (5 YR 5/8) moist; sandy clay; fine moderate subangular blocky; moist friable, wet sticky and plastic, dry hard; clean smooth boundary; pH 6.1
100-150	Reddish yellow (5 YR 6/6) moist and dry; clayey; coarse, moderate subangular blocky; moist firm, wet sticky and plastic; few fine distinct mottles; clear smooth boundary; pH 6.3

Appendix 6

Profile No.6

I. Information on the site sampled

(a) Profile Number - 6

(b) Soil name (series, phase or mappint index, etc.) - Laterite

(c) Higher category classification - Ultisol

(d) Date of examination - 30-1-1985

(e) Author(s) of description - Benoy T. Cheriyan

(f) Location - On the way to Payyanur

(g) Elevation (in meters or feet) - 50 m

(h) Land form

(i) Physiography position of the sitec- Convex side of hill

(ii) Land form of surrounding country - Rolling

(iii) Microtopography (if any) - Nil

(i) Slope on which the profile is situated: Class 2 gently sloping

(j) Vegetation or land use - Pasture

(k) Climate - Humid tropical climate

II. General Information on the soil:

(a) Parent material - Laterite with colluvial deposits

(b) Drainage - Class 4 Well drained

(c) Moisture conditions in the soil - Moist below 500m

(d) Depth of ground water table - 5 m

(e) Presence of surface stone or rock outcrops - Fairly strong

(f) Evidence of erosion - Sheet erosion

(g) Presence of salt or alkali - Nil

(h) Human influence - Nil

III. Brief description of the Profile

This profile was situated on the edge of a paddy field. The parent material is laterite and sheet erosion is evident. The upper horizons had a leached appearance and the course fraction was more. The profile had plenty of gravel throughout and the lower horizon was highly mottled laterite. Root distribution was normal.

IV. Profile description:

0-13 Reddish brown (5 YR 4/3), dry (5 YR 4/4) moist gravelly; sandy clay; weak medium granular, dry slightly hard; moist friable, wet slightly sticky; abundant roots and laterite concretions present; smooth diffuse boundary; pH 6.4

13-30 Reddish brown (2.5 YR 4/4) dry, dark reddish brown (2.5 YR 3/4) moist; gravelly, sandy clay loam; weak medium sub angular blocky; moist friable, wet slightly sticky, dry slightly hard; abundant roots, clear distinct boundary, pH 6.2

30-65	Strong brown (7.5 YR 5/6) dry (7.5 YR 5/8) moist; gravelly, sandy clay loam; weak medium subangular blocky; dry slightly hard, moist friable, wet slightly sticky; clear diffuse boundary; pH 5.5
65-150	Reddish yellow (5 YR 6/6) moist and dry; gravelly, sandy clay; moderate course, subangular blocky; moist friable; wet slightly sticky; dry slightly hard; few faint mottles; clear distinct boundary; pH 6.0.

Appendix 7

Profile No.7

I. Information on the site samples:

a) Profile Number ... 7

b) soil name (series, phase or mappint index etc.) ... Laterite

c) Higher category classification - Ultisol

d) Date of examination - 31-1-1985

e) Author(s) of Description - Benoy T. Cheriyan

f) Location - Thamarapadam

g) Elevation (in meters or feet) - 150 m

h) Land form

(i) Physiographic position of the site - Upper portion of a rolling hill

(ii) Land form of surrounding country: Rolling

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Class 3 Sloping

j) Vegetation or land use - Pasture

k) Climate - Humid Tropical

II General information on the soil

a) Parent material - Laterite soil

b) Drainage - Class 4 well drained

c) Moisture conditions in the soil - Uniformly dry

d) Depth of ground water table (in meters) - 6 m

e) Presence of surface stones or rock out crops - Rock out crops exposed nearby

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - nil

h) Human influence - Intensively cultivated

III Brief description of the Profile:

This profile was situated in the upper part of a rolling hillock. Rock out crops were found exposed nearby, indicating that the profile site was subject to erosive action. The fine fraction in this profile was found to be low. Root distribution was normal mostly confined to the upper 20 cm.

IV Profile description:

Depth (cm)	
0-30	Reddish brown (5 YR 5/4) dry, (5 YR 4/4) moist; gravelly, sandy loam; medium moderate sub-angular blocky; moist firm, wet slightly sticky, dry slightly hard; roots abundant; gradual diffuse boundary; pH 6.7
50-70	Brown (7.5 YR 4/4) dry, dark brown (7.5 YR 3/2) moist; gravelly, sandy clay loam; coarse moderate, subangular blocky; moist firm, wet sticky and slightly plastic, dry slightly hard; roots few; gradual diffuse boundary; pH 5.4
70-120	Yellowish red (5 YR 4/6) dry and moist; sandy clay loam; coarse moderate, subangular blocky; moist firm, wet sticky and plastic; dry slightly hard; common faint fine mottles; boundary clear and distinct; pH 5.6

Profile No.8

I. Information on the site sampled:

a) Profile Number - 8

b) Soil name (series, phase or mappint index etc.) - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 1-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Near Nepadam

g) Elevation (in meters or feet) - 75 m

h) Land form

(i) Physiographic position of the site - Mid slope

(ii) Land form of surrounding country - Rolling

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Class 2, gently sloping

j) Vegetation or land use - Waste land, brick quarry nearby

k) Climate - Humid tropical climate

II. General information on the soil:

a) Parent material - Laterite and lateritic colluvium washed out from hill side

b) Drainage - Class 4, well drained

c) Moisture conditions in the soil - Uniformly dry

d) Depth of ground water table (in meters) - 6 m

e) Presence or surface stones or rock out crops - Fairly stony

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Nil

III Brief description of the Profile site

This profile was situated on the side of the road. It must have originated from the lateite outwash coming from the hill sides. It is deep well drained uniformly dry and very high content of gravel. Root distribution normal confined to upper 20 cm.

IV. Profile Description

Depth (cms)

0-20 Reddish brown (5 YR 5/4) dry, (5 YR 4/4) moist; gravelly, sandy clay loam; medium moderate sub-angular blocky; moist friable, wet slightly sticky and plastic, dry loose; gradual smooth boundary; pH 6.3.

20-40 Red (2.5 YR 4/6) dry, dark red (2.5 YR 3/6) moist; gravelly, sandy clay loam; medium moderate subangular blocky; moist firm, wet slightly sticky, dry firm, diffuse wavy boundary; pH 6.1

40-150 Dark reddish brown (2.5 YR 3/4) dry, (2.5 YR 2/4) moist; sandy clay loam; coarse moderate subangular blocky; moist firm, wet slightly sticky and plastic dry firm; clear smooth boundary; pH 4.5

150	X	Yellowish Red (5 YR 4/8) dry, (5 YR 4/6) moist;
	X	
	X	clayey; coarse strong subangular blocky; moist
	X	
	X	firm, wet sticky and plastic, dry firm; common
	X	
	X	fine distinct mottles; clear boundary; pH 5.4

Appendix 9

Profile No. 9

I. Information on the site sampled:

a) Profile No. - 9

b) Soil name (series, phases or mapping index etc.) - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 1-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - On the way to Pattiparamba

g) Elevation (in meters or feet) - 200 m

h) Land form

(i) Physiographic position of the site: Upper part of a small subdued hill

(ii) Land form of surrounding country: Rolling

(iii) Microtopography (if any): Nil

i) Slope on which profile is situated - Class 2, gently sloping

j) Vegetation or land use - Cultivated to tapioca

k) Climate - Humid tropical climate

II General information on the soil:

a) Parent material - Laterite

b) Drainage - Class 4, well drained

c) Moisture conditions in the soil - Moist below 50 cm

d) Depth of ground water table (in meters) - 27 m

e) Presence or surface stone or rock out crops - nil

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Cultivated to tapioca

III Brief description of the profile site:

This is a typical laterite profile situated on the upper part of a subdued hill. The profile was shallow and percent of course fraction very high. The parent material was quarriable type of laterite.

IV Profile description:

Depth (cms)

0-25 Reddish brown (5 YR 4/3) dry, dark reddish brown (3 YR 3/3) moist, gravelly, sandy clay loam; course moderate crumb; moist friable, wet slightly sticky; dry loose; roots plenty; clear smooth boundary; pH 6.1

25-60	Yellowish red (5 YR 4/8) dry, (5 YR 4/6) moist, gravelly, sandy clay loam; coarse moderate subangular blocky; moist friable, wet slightly sticky and plastic; dry slightly hard, clear smooth boundary; pH 5.4
60-90	Yellowish Red (5 YR 4/8)dry, (5 YR 4/6) moist; gravelly, clay loam; coarse moderate subangular blocky; moist friable, wet sticky and plastic, dry slightly hard; clear distinct boundary; firm quariable type of laterite found below, pH 5.0

Appendix 10

Profile No.10:

I Information on the site sampled:

a) Profile Number - 10

b) Soil name (series, phase or mapping index etc.) - Lateritic soil

c) Higher category classification - Ultisol

d) Date of examination - 2-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - On the road to Pallavur

g) Elevation (in meters or feet) - 80 m

h) Land form

(i) Physiographic position of the site: Toe of a convex slope

(ii) Land form of surrounding country: Rolling

(iii) Microtopography (if any): Nil

i) Slope on which profile is situated: Class 2, gently sloping

j) Vegetation or land use - Pasture

k) Climate - Humid tropical climate

II General information on the soil:

a) Parent material

b) Drainage - Class 4

c) Moisture conditions in the soil - Top 25 cm dry

d) Depth of ground water table (in metres) - 4 m

e) Presence of surface stones or rock out crops - Fairly stony

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Nil

III Brief description of profile site:

This profile was deep and originated from the out wash from the upper parts of the hill. Being situated at the toe region, the profile is colluvic in origin. Top 25 cm was dry and the rest uniformly moist. Root distribution normal, confined mostly to the top 40 cm, very less gravel present.

IV Profile description

0-10	Greyish brown (10 YR 5/4) dry, (10 YR 3/4) moist; gravelly sandy clay loam; medium moderate subangular blocky; moist friable, wet slightly sticky, dry loose; clear smooth boundary; pH 6.0
10-30	Dark greyish brown (10 YR 5/6) dry (10 YR 4/4) moist; gravelly clay loam; coarse moderate subangular blocky; moist friable, wet slightly sticky, dry loose; clear smooth boundary; pH 5.9
30-100	Strong brown (7.5 YR 5/6) dry (7.5 YR 4/4) moist; clay loam; moderate medium subangular blocky; moist firm, wet stickly; dry loose, diffuse boundary; pH 4.8
100-150	Strong brown (7.5 YR 5/6) clay (7.5 YR 4/4) moist; clayey; moderate medium subangular blocky; moist firm wet sticky and slightly plastic dry loose; diffuse boundary; pH 5.5
150 +	Dark brown (7.5 YR 4/2) dry, (7.5 YR 3/2) moist; clayey; moderate coarse; subangular blocky; moist firm wet very sticky and plastic dry slightly hard; diffuse boundary; pH 5.3

Appendix 11

Profile No.11:

I. Information on the site sampled:

a) Profile Number - 11

b) Soil name (series, phase; or mappint index etc.) - Laterite soil

c) Higher category classification - Ultisol

d) Date of examination - 2-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Canapathipalayam

g) Elevation (in meters or feet) - 90 m

h) Land form

(i) Physiographic position of the site - Convex slope

(ii) Land form of surrounding country - Rolling

(iii) Microtopography (if any) - Terracing

i) Slope on which profile is situated - Class 3, sloping

j) Vegetation or land use - Groundnut cultivated

k) Climate - Humid tropical c

II General Information on the soil:

a) Parent material - Laterised gneiss

b) Drainage - Class 3, moderately well drained

c) Moisture conditions in the soil - Top 50 cm dry

d) Depth of ground water table (in meters) - 5 m

e) Presence of surface stones or rock out crops - Fairly stony. Rock out crops absent but surface tones high

f) Evidence or erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Highly cultivated to groundnut

III Brief description of the Profile site:

This Profile is a shallow one situated as a terraced hill side. The course fraction in the surface horizon is high. Parent material is laterised gneiss and the profile is uniformly dry.

IV Profile description:

Depth (cms)	
0-25	Reddish brown (5 YR 5/4) dry, (5 YR 4/4) dry; gravelly sandy clay loam; weak fine crumb structure; moist friable wet slightly stikky. dry loose; diffuse wavy boundary; pH 5.0
25-75	Reddish brown (5 YR 4/4) dry; dark reddish brown (5 YR 3/4)moist; sandy clay loam; moderate medium crumb structure; moist friable; wet slightly stiky and plastic dry loose, clear smooth boundary; pH 5.2.
75 +	Yellowish red (7.5 YR 5/8) dry; (7.5 YR 4/6) moist; gravelly, sandy clay loam; weak fine crumb structure; moist friable; wet sticky and plastic, dry loose; laterite concretions present clear smooth boundary; pH 5.0

Appendix 12

Profile No. 12:

I Information on the site sampled:

a) Profile Number - 12

b) Soil name - Lateritic soil

c) Higher category classification - Ultisol

d) Date of examination - 23-2-1985

e) Author(s) of description - Benoy P. Cheriyan

f) Location - In a rubber plantation just outside Aralam Farm

g) Elevation (in meters or feet) - 90 m

h) Land form

(i) Physiographic position of the site: Foot hill

(ii) Land form of surrounding country: Steeply dissected

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Gently sloping

j) Vegetation or land use - Cultivated to rubber

k) Climate - Humid tropical

II General Information on the soil:

a) Parent material - Weathered gneiss and colluvial deposits

b) Drainage - Class 4, well drained

c) Moisture conditions in the soil: Fairly moist throughout

d) depth of ground water table (in meters) - 4 m

e) Presence of surface stones or rock out crops - Nil

f) Evidence of erosion - Nil

g) Presence of salt or alkali - Nil

h) Human influence - Rubber plantation

III Brief description of Profile No.12:

This profile is situated on the foot hills of Kodagumala, in a rubber plantation just outside the Aralam farm. Though the profile seems to have originated from weathered gneiss colluvial action has also influenced its development. The profile is fairly moist throughout and the upper horizon is rich in organic matter. Root distribution normal and is concentrated in the top 20 cm of the profile. Parent material is laterised gneiss.

IV Profile description:

0-10	Dark greyish brown (10 YR 4/2) dry; very dark brown (10 YR 3/2) moist, silty clay loam, weak fine subangular blocky; moist slightly sticky; friable and loose; abundant live roots, clear, smooth boundary, pH 5.6
10-45	Yellowish brown (10 YR 5/4) dry; dark yellowish brown (10 YR 4/4) moist; sandy loam; moderate medium subangular blocky; moist sticky and firm; dry slightly hard; few fine roots; diffuse boundary; pH - 5.3

45-90 Yellowish brown (10 YR 5/4), dry and moist; clay loam moderate medium subangular blocky; wet sticky and firm dry slightly hard; gneissic stones present; diffuse boundary, pH 5.1

Appendix 13

Profile No.13

1. Information on the site sampled:

a) Profile number - 13

b) Soil name - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 23-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Kallara - On the way to Vellarivyal

g) Elevation (in meters or feet) - 85 m

h) Land form

(i) Physiographic position of the site - Road cut

(ii) Land form of surrounding country - Rolling

(iii) Microtopography (if any) - Nil

i) Slope on which profile is sited - Class 2 - gently sloping

j) Vegetation or land use - Cultivated to Cashew

k) Climate - Humid tropical

II General information on the soil:

a) Parent material - Laterite

b) Drainage - Class 3

c) Moisture conditions in the soil - Uniformly dry

d) Depth of ground water table (in meters) - 5 m

e) Presence or surface stones or rock out crops - Presence of hard crust laterite outcrops

f) Evidence of erosion - Moderate

g) Presence of salt or alkali - Nil

h) Human influence - Cashe plantation

III Brief description of Profile No.13

This profile is taken from a road cut and is located on the midslope of a hill. Laterite outcrops were seen nearby indicating the subdued nature of the hill. The profile is in situ developed and the parent material is laterite. It is deep moderately well drained and gravelly throughout the profile. Root distribution is normal being concentrated in the crop 20 cm of the profile

IV Profile Description

0-25 Greyish brown (?.5 YR 5/2) dry; dark greyish brown (2.5 YR 4/2) moist; sandy clay loam; weak medium subangular blocky; moist friable, wet slightly sticky and soft; laterite concretions present, roots abundant, gradual wavy boundary;

25-60	Yellowish brown (10 YR 5/4) dry, dark, yellowish brown (10 YR 4/4) moist; clay loam; weak medium subangular blocky; moist friable, wet slightly sticky and dry hard. Course roots present, boundary gradual and smooth, pH 6.2
60-100	Dark yellowish brown (10 YR 4/4); dry and moist; clayey; moderate medium subangular blocky; wet slightly sticky and firm; dry slightly hard; laterite concretions present; roots few; boundary diffuse, pH 6.3

Appendix 14

Profile No. 14

I. Information on the site sampled:

a) Profile Number - 14

b) Soil name - Lateritic soil

c) Higher category classification - Ultisol

d) Date of examination - 25-?-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Kottapuram Mala Reserve Forest

g) Elevation (in meters or feet) - 75 m

h) Land form

(i) Physiographic position of the site - Convex slope

(ii) Land form of surrounding country - Hilly

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Class 2, Gently sloping

j) Vegetation or land use - Considerably degraded tropical rain forest with sparse undergrowth

k) Climate - Humid tropical

II General information on the soil:

a) Parent material - Laterite

b) Drainage - Moderately well drained (class 3)

c) Moisture conditions in the soil - Uniformly moist

d) Depth of ground water table (in meters) - 5 m

e) Presence of surface stones or rock out crops - Nil

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Nil

III Brief description of Profile No.14:

This profile was situated on a very gently sloping ground in a considerably degrad d tropical rain forest of the Kottapuram Mala. The parent material is laterite and the

profile is moderately well drained and uniformly moist. Root distribution is normal being concentrated in the top 30 cm.

IV Profile Description:

0-10	Brown (7.5 YR 4/4) dry, dark brown (7.5 YR 3/2) moist; sandy clay; weak fine subangular crumb; wet slightly sticky; dry friable loose; clear smooth boundary, pH 6.3
10-45	Yellowish Red (5 YR 5/6) dry, (5 YR 4/6) moist; clayey; moderate medium subangular blocky; wet sticky firm, dry slightly hard; gradual smooth boundary; pH 6.2
45-60	Yellowish red (5 YR 4/6) dry; (5 YR 4/4) moist; clayey; moderate medium subangular blocky; wet sticky firm; dry slightly hard, lateritic concretions were found; smooth distinct boundary; pH 6.0

Appendix 15

Profile No.15

I. Information on the site sampled:

a) Profile Number - 15

b) Soil name - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 25-2-1985

e) Author(s) of description - Binoy T. Cheriyan

f) Location - Aralam Farm - Unit I /

g) Elevation (in meters or feet) - 100 m

h) Land form

(i) Physiographic position of the site - Lateritic mesa

(ii) Land form of surrounding country - Gently undulating

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Class I flat

j) Vegetation or land use - Cashew plantation

k) Climate - Humid tropical

II. General information on the soil:

a) Parent material - Laterite

b) Drainage - Moderately well drained

c) Moisture conditions in the soil - Top 15 cm dry; uniformly moist below

d) Depth of ground water table (in meters) - 6 m

e) Presence of surface stones or rock outcrops - Class 1 - Fairly rocky

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Cashew Plantation

III Brief description of Profile No.15:

This profile was situated on a gently undulating lateritic mesa. Lateritic outcrops were seen nearby and the location is subdued in nature due to prolonged weathering. The profile was not very deep but moderately well drained. Presence of organic matter and roots seemed to be high.

IV Profile Description

0-10	Brown (7.5 YR 5/4) dry, dark brown (7.5 YR 3/2) moist; sandy clay loam; weak fine, subangular blocky; moist friable; wet slightly sticky dry slightly hard; lateritic concretions present; smooth wavy boundary; pH 6.3
10-35	Reddish brown (5 YR 4/4) dry, dark reddish brown (5 YR 3/4) moist; sandy clay loam; moderate medium subangular blocky; moist friable, wet slightly sticky, dry slightly hard; gradual smooth boundary; pH 6.0
35-70	Yellowish red (5 YR 6/6) dry, (5 YR 5/6) moist; sandy clay; moderate medium subangular blocky; moist, friable, wet sticky, dry slightly hard; laterite concretions present; clear smooth boundary; pH 5.9

Profile No. 16:

I. Information on the site sampled:

a) Profile Number - 16

b) Soil name - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 25-2-1985

e) Author(s) of description - Benoy P. Choriyan

f) Location - Pralam Farm

g) Elevation (in meters or feet) - 75 m

h) Land form

(i) Physiolgraphic position of the site - Saucer shaped basin on lateritic mesa

(ii) Land form of surrounding country - Gently undulating

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Class 2 - Gently sloping

j) Vegetation or land use - Shrub land

k) Climate - Humid tropical

II General Information on the soil:

a) Parent material - Lateritic colluvial outwash

b) Drainage - Well drained

c) Moisture conditions in the soil - Upper 29 cm dry - Uniformly moist below

d) depth of ground water table (in meters) - 5.5 m

e) Presence of surface stones or rock out crops - Laterite outcrops overlooking the site

f)	Evidence of erosion	-	Nil
g)	Presence of salt or alkali	-	Nil
h)	Human influence	-	High - Clearing of natural vegetation from the surrounding areas have contributed to the formation of the profile

III Brief description of Profile No.16:

This profile was situated in a partially saucer shaped basin in the mesa surface. Though the bedrock is lateritic the profile has originated from lateritic colluvial outwash. The profile is very deep moist and well drained root distribution is normal but confined to the upper 50 cm depth.

IV Profile description:

0-15	Brown (10 YR 5/3) dry, dark greyish brown (10 YR 4/2) moist; clay loam; weak medium crumb structure; moist friable, wet sticky, dry slightly hard; abundant coarse and fine roots; diffuse boundary; pH 6.0
15-40	Yellowish brown (10 YR 5/4) dry, dark yellowish brown (10 YR 4/4) moist; clayey; moderate medium subangular blocky; moist friable, wet sticky; dry slightly hard; diffuse boundary; pH 6.1

40-100 0 Yellowish brown (10 YR 5/4) dry, dark yellowish brown (10 YR 4/4) moist; clayey; moderate medium subangular blocky; moist firm, wet sticky and plastic dry slightly hard; diffuse boundary; pH 6.3

Appendix 17

Profile No.17

I. Information on the site sampled:

a) Profile Number - 17

b) Soil name - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 26-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Tachetalapoya Ynadu

g) Elevation (in meters or feet) - 800 m

h) Land form

(i) Physiographic position of the site - Mid slope

(ii) Land form of surrounding country - Undulated Hill side

(iii) Microtopography (if any) - Terraced and cultivated to tea

i) Slope on which profile is situated: class 3 - sloping

j) Vegetation or land use - Tea plantation

k) Climate - Humid Tropical

II General Information on the soil:

a) Parent material - Laterite

b) Drainage - Well drained

c) Moisture conditions in the soil - Uniformly dry

d) Depth of ground water table (in meters) - 7 m

e) Presence of surface stones or rock outcrops - Class 1, Fairly rocky, Granite out crops nearby

f) Evidance of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Tea plantation

III Brief description of Profile No.17:

This profile is situated on the mid slope in a road cut in the Ayanad Tea Plantation. The parent material is laterised gneiss and lateritic concretions are distributed throughout the profile. The profile is deep well drained in situ developed and lower layers slightly moist. Root distribution is normal and is confined to the upper 50 cm.

IV Profile description:

0-10 Light yellowish brown (10 YR 6/4) dry; Yellowish brown (10 YR 5/4) moist, sandy clay loam; weak medium crumb structure; moist friable; wet slightly sticky, dry soft; clear smooth boundary; pH 6.6

10-25		Yellowish brown (10 YR 5/4) dry and moist; sandy clay; weak medium crumb structure; moist friable wet slightly sticky; dry soft; clear smooth boundary; pH 6.5
25-60		Yellowish brown (10 YR 5/6) dry, (10 YR 4/4) moist; sandy clay; moderate, medium subangular blocky; moist firm, wet sticky, dry slightly hard; diffuse boundary; pH 6.0
60-100		Yellowish brown (10 YR 5/4) dry, (10 YR 4/4) moist; gravelly clay; moderate medium subangular blocky; moist firm; wet sticky, dry slighkly hard; diffuse boundary; pH 6.1

Appendix 18

Profile No.18

I. Information on the site sampled:

a) Profile Number - 18

b) Soil name - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 26-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Periya in Wyanad

g) Elevation (in meters or feet) - 750 m

h) Land form

(i) Physiographic position of the site - Convex slope

(ii) Land form of surrounding country - Hilly

(iii) Microtopography (if any) - Terraced

i) Slope on which profile is situated - Class 4 Moderately steep

j) Vegetation or land use - Eucalyptus plantation

k) Climate - Humid tropical

II General Information on the soil:

a) Parent material - Weathered gneiss

b) Drainage - Class 4 - Well drained

c) Moisture conditions in the soil - Uniformly moist

d) Depth of ground water table (in meters) - 7 m

e) Presence of surface stones or rock out crops - Large out crop of gneiss seen nearby

f) Evidence of erosion - Gully erosion

g) Presence of salt or alkali - Nil

h) Human influence - Eucalyptus plantation

III Brief description of Profile No.18:

This profile is situated on a hill slope within an eucalyptus plantation at Periya in Wynad Plateau. The slope on which it is located is more than 20°. The parent material is weathered

gneiss. The surface horizon was rich in organic matter and pebbles increase with depth. The profile is shallow and susceptible to erosion.

IV Profile description

0-10	Brown (10 YR 5/3) dry, dark greyish brown (10 YR 4/2) moist; sandy clay loam; weak m dium subangular blocky; moist friable, wet slightly sticky, dry slightly hard; abundant coarse and fine roots; diffuse wavy boundary; pH 5.7
10-35	Dark brown (10 YR 4/3) dry, (10 YR 3/3) moist; sandy clay loam; moderate medium subangular blocky; moist friable, wet sticky, dry slightly hard; few coarse roots; diffuse wavy boundary; pH 5.5
35-60	Dark brown (10 YR 4/3) dry; (10 YR 3/3) wet; clayey; moderate medium subangular blocky, moist firm, wet sticky, dry slightly hard; smooth clear boundary; pH 5.5

Appendix 19

Profile No. 19

I. Information on the site sampled:

a) Profile Number - 19

b) Soil name - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 27-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Periya

g) Elevation (in meters or feet) - 650 m

h) Land form

(i) Physographic position of the site - Valley

(ii) Land form of surrounding country - Hilly

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Flat

j) Vegetation or land use - Cardamom Plantation

k) Climate - Humid Tropical

II General Information on the soil:

a) Parent material - Laterite

b) Drainage - Class 2, Imperfectly drained

c) Moisture conditions in the soil - Uniformly moist

d) Depth of ground water table (in meters) - 2 m

e) Presence of surface stones or rock outcrops - No rock out crops

f) Evidence of erosion - Rill erosion

g) Presence of salt or alkali - Nil

h) Human influence - Cardamom plantation

III Brief description of Profile No. 19:

The profile is located in a valley bottom within a cardamom plantation at Periya in Wayanad. The profile is moderately deep but imperfectly drained. The lower horizons are clayey. The parent material is laterite and the profile is in situ developed. Root distribution is normal and is concentrated in the top 20 cm of the profile.

IV Profile Description:

0-15	Greyish brown (2.5 YR 5/2) dry; dark greyish brown (2.5 YR 4/2) moist; loamy, weak fine subangular blocky; moist firm, wet slightly sticky, dry slightly hard; clear smooth boundary; pH 6.3
15-30	Light yellowish brown (2.5 YR 6/4) dry and moist; clay loam; moderate medium subangular blocky; moist firm, wet sticky, dry slightly hard; clear smooth boundary; pH 6.1
30-70	Olive yellow (2.5 YR 6/6) dry and moist; clayey moderate medium subangular blocky; moist firm, wet sticky and plastic; few coarse roots; diffuse boundary; pH 6.0
70-110+	Light yellowish brown (2.5 YR 6/4) dry and moist;

X clayey; moderate medium subangular blocky;
X
X moist firm, wet sticky and plastic; lateritic
X
X concretions present; distinct boundary; pH 5.7

Appendix 20

Profile No.20

I. Information on the site sampled:

a) Profile number - 20

b) Soil name - Laterite

c) Higher category classification - Ultisol

d) Date of examination - 27-2-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Periya

g) Elevation (in meters or feet) - 700 m

h) Land form

(i) Physiographic position of the site - Convex slope

(ii) Land form of surrounding country - Undulating

(iii) Microtopography (if any) - Terracing

i) Slope on which profile is situated - Class 3 - Sloping

j) Vegetation or land use - Coffee plantation

k) Climate - Humid tropical

II General Information on the soil:

a) Parent material - Weathered gneiss

b) Drainage - Class 4 - Well drained

c) Moisture conditions in the soil - Uniformly moist

d) Depth of ground water table (in meters) - 0 m

e) Presence of surface stones or rock outcrops - Gneissic boulders found nearby

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Coffee plantation

III Brief description of the Profile No. 20:

This profile situated on a small hillock and is taken from a coffee plantation in Wayanad. The profile was deep well drained and in situ developed. Parent material is weathered gneiss and root distribution is normal.

IV Profile description:

0-10 Dark yellowish brown (10 YR 4/4) dry and moist; clay loam; weak fine crumb structure; moist friable, wet slightly sticky, dry soft; fine and coarse roots; diffuse boundary; pH 5.8

10-30 Yellowish brown (10 YR 5/4) moist; and dry; clay loam; moderate medium subangular blocky; moist firm wet sticky, dry slightly hard; few coarse roots present; diffuse wavy boundary; pH 5.6

30-75	X X X X X X X y X	Yellowish brown (10 YR 5/4) dry and moist; clayey; moderate medium subangular blocky; moist firm, wet sticky, dry slightly hard; weathered gnelssic boulders present; clear distinct boundary; pH 5.0

Appendix 21

Profile No.21:

I. Information on the site sampled:

a) Profile number - 21

b) Soil name - Laterite soil

c) Higher category clas ification - Ultisol

d) Date of examination - 28-2-1985

e) Author(s) of description - Bency V. Cheriyan

f) Location - Kakkayangad

g) Elevation (in meters or feet) - 60 m

h) Land form:

i) Physiographic position of the site - Lower slope

ii) Land form of surrounding country - Gently undulati

iii) Microtopography (if any) - Nil

i) Slope on which pro.ile is situated - Class 2 Gently sloping

j) Vegetation or land use - Mixed crop, Cashew, Coconut, Pepper

k) Climate - Humid tropical

II General information on the soil:

a) Parent material - Weathered gneiss

b) Drainage - Class 4 - Well drained

c) Moisture conditions in the soil - Uniformly dry

d) Depth of ground water table (in meters) - 10.4 m

e) Presence of surface stones or rock outcrops - Very few stones and rocks

f) Evidence of erosion - Sheet erosion

g) Presence of salt or alkali - Nil

h) Human influence - Cultivated to mixed crop of cashew, coconut and pepper

III Brief Description of Profile No.21:

This profile is situated in the backyard of a house at Kakkayangad. The parent material is weathered gneiss. The profile is uniformly dry and very deep. Horizon differentiation is poor and root distribution is normal. The unique feature of the profile is the fineness of the texture and absence of lateritic concretions or pebbles within it.

IV Profile Description:

0-20 Brown (10 YR 5/3) dry, dark brown (10 YR 3/3) moist; clay loam; weak fine crumb structure; moist friable, wet slightly sticky, dry loose; abundant fine roots; diffuse boundary; pH 6.6

20-60	:	Yellowish brown (10 YR 5/4) dry, dark yellowish brown (10 YR 4/4) moist; clay loam; weak fine subangular blocky; moist friable, wet slightly sticky; dry loose; gradual smooth boundary; pH 6.2
60-100	:	Strong brown (7.5 YR 5/6) dry and moist; clayey; moderate medium subangular blocky; moist friable; wet slightly sticky, dry slightly hard; diffuse boundary; pH 6.1

Appendix 22

Profile No. 22

I. Information on the site sampled:

a) Profile Number - 22

b) Soil name - Laterite soil

c) Higher category classification - Ultisol

d) Date of examination - 1-3-1985

e) Author(s) of description - Benoy T. Cheriyan

f) Location - Pallachura

g) Elevation (in meters or feet) - 350 M

h) Land form

(i) Physiographic position of the site - Foothill

(ii) Land form of surrounding country - Hilly

(iii) Microtopography (if any) - Nil

i) Slope on which profile is situated - Class I Flat

j) Vegetation or land use - Cultivated to tapioca and Banana

k) Climate - Humid tropical

II General information on the soil:

a) Parent material - Alluvial & colluvial deposits

b) Drainage - Class 4, Well drained

c) Moisture conditions in the soil - Uniformly moist

d) Depth of ground water table (in meters) - 3 M

e) Presence of surface stones or rock outcrops - Stony and rocky

f) Evidence of erosion - Hill erosion

g) Presence of salt or alkali - Nil

h) Human influence - High - Cultivated to tapioca and banana

III Brief description of Profile No.22:

The profile is situated at Pallachura on a small reclaimed basin of a riverlet. The profile must have originated by colluvic deposition of the soil carried down from the hill sides. The profile is uniformly moist deep and root distribution is normal.

IV Profile Description

0-15	:	Dark yellowish brown (10 YR 4/4) dry and moist; sandy clay; weak fine crumb; moist slightly sticky; dry frieble and loose; abundant fine roots, gradual smooth boundary, pH 6.7
15-50	:	Dark brown (10 YR 3/4) dry and moist; sandy clay loam; weak fine subangular blocky moist; slightly sticky, dry friable and loose; few fine roots; diffuse boundary; pH 6.5
50-110	:	Very dark brown (10 YR 2/2), dry and moist; sandy clay loam; moderate medium subangular blocky; wet slightly sticky, moist friable dry loose; diffuse boundary; pH 6.1

ABSTRACT

Rapidly changing socio economic structure puts tremendous pressure on human society to find additional resources for its sustenance. Indiscriminate exploitation of the natural resource with scarce concern for the ecological balance has caused disturbances and sometimes total destruction of important portions of the biosphere with immediate or delayed effects being evidenced on a global scale.

Land and soil are not resources that are infinite and cannot be exploited for ever. This fragile epidermis of the earths crust is severely affected due to drastic changes in vegetation cover resulting in destruction of soils and losses of nutrients and fertility.

The quality and quantity of terrestrial biosphere depends on the soil and land. For studying the extent and state of an environmental impact a well defined natural unit has to be selected. Being a natural physical system where the land and water act as definite determinants of land use, and since it is a well defined natural unit, river basins were chosen as the units for study.

The sub water sheds and micro water sheds are the accepted units for ecodevelopment planning. There is a need for detailed studies in natural and agroeco systems in different water sheds in relation to the physical features

of the land and soil characteristics. Such studies are required to plan microlevel aspects of eco restoration, and eco development of water sheds especially in Kerala where environmental degradation has reached alarming proportions.

The main objectives of the work is as follows:

1. A study of the sub water sheds of Bharathapuzha and Aralampuzha for relief, morphology, drainage, geology, vegetation, climate, soil and land use.
2. A land capability assessment of both the river basins based on details soil studies and traversing of the area.
3. To evolve a set of recommendations for management of the two river basins.

The basic approach in the present study is to investigate individual components and bring out their relationship with present land use, that would help to maintain the ecological balance while sustaining human needs. For this two river basins Mangalam-Gayatripuzha and Aralam-Bavalipuzha were selected. The former highly influenced by man and the latter relatively less interfered were chosen for making a comparative study.

Environmental components like relief, slope, morphology, drainage, geology, vegetation, climate and soil have been analysed by using standard methodology with respect to individual

variables. On the basis of these studies land capability was assessed for each geomorphic unit and the present land use was also studied. Finally a set of recommendations were evolved for the judicious use of each geomorphic unit. With minimum degradation to it.

From the study it was found that the Mangalam-Gayatripuzha basin has a mature landscape in comparison with Aralam-Bavalipuzha basin with more diverse geomerphic units. The soil is mainly alluvial in Mangalam-Gayatripuzha basin whereas it is lateritic in Aralam-Bavalipuzha basin. Soil fertility is moderate with no marked variation in both cases.

High population density, smaller land holdings and low per capita income have put the land to great stress. Ecologically viable land use based on land capability has become subservient to subsistance land use. Food crops dominate the agricultural scenary in the Mangalam-Gayatripuzha basin whereas cash crops take more area in the Aralam-Bavalipuzna basin. Both the basins are suspectible to erosion and this has been aggravated by large scale deforestation and cultivation of tuber crops on the hill sides.

On the basis of these findings it is recommend that deforestation should be completely stopped and afforestation programmes expedited in order to conserve the ecology of both basins. Soil conservation measures should be taken up on a

war footing in the Aralam - Bavalipuzha basin with the entire cost borne by the government. Comprehensive programmes must be formulated to bring the catchment of the rivers under good perennial tree and fodder vegetation.

Tapioca cultivation requiring greater tillage on slopes should be discouraged or prohibited. A detailed land capability assessment based on natural land use determinates should be worked out for the two basins since large section of the people in the hilly areas are poor with no alternative means of subsistence. Imaginative hill slope agricultural programmes that guarantee subsistance for these people should be evolved.