CHAPTER 2
CLIMATE, PHYSIOGRAPHY AND GEOLOGY
OF NEYYAR RIVER BASIN

2.1 CLIMATE OF NEYYAR RIVER BASIN

2.1.1 INTRODUCTION

The region lies in tropical climatic zone. Comparatively cold climate exists in the highland region throughout the year while the rest of the region has temperate climate with a high humid climate in the plains. The climatic condition of the river basin is mainly dependent on the South-West (June to September) monsoon and North-East (October to December) monsoon. The region receives 30 to 40 cm rain annually. It is a highly vegetated area. Rich forest and valuable trees are seen in the area. Temperature, humidity and wind vary slightly with the influence of South-West and North-East monsoons.

2.1.2 RAINFALL

The basin receives rain during the South-West and North-East monsoons. Highland region receives 30 to 40 cm rain annually. Neyyar reservoir is filled to its full capacity during the early part of the monsoon season. The basin is blessed with South-West monsoon and to some extent by the North-East monsoon. The total rainfall estimated annually is 1475.18 mm. The abstracted rainfall data for the period of ten years is given in the Table 2.1. From the Figure 2.1 it is inferred that the station Perumkadavila has recorded low rainfall whereas Ottasekharamangalam and Parachal exhibit the highest rainfall in the study area. Isohytal map prepared with the rainfall data for the Neyyar river basin is given in Figure 2.2.
Plate 2.1. Thick forest of Agasthyamalai.

Plate 2.2. Vegetation formed bars of Neyyar River.
Fig 2.1 Rainfall in mm of selected gauging station from upstream to downstream of Neyyar river basin
Fig. 2.3 GEOLOGY OF THE AREA
<table>
<thead>
<tr>
<th>Month</th>
<th>Vlahankara station 1</th>
<th>Olaithanni station 2</th>
<th>Perumkadavila station 3</th>
<th>Parachal station 4</th>
<th>Ottasekharamangalam station 5</th>
<th>Kallikkad station 6</th>
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<td>January</td>
<td>24.6</td>
<td>17.2</td>
<td>19.2</td>
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<td>10.5</td>
<td>30.7</td>
<td>73.96</td>
<td>55.2</td>
<td>19.1</td>
<td>50.6</td>
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<td>23.55</td>
<td>23.4</td>
<td>42.175</td>
<td>49.3</td>
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<td>83.15</td>
<td>82.9</td>
<td>67.31</td>
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<td>173.0</td>
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<td>454.6</td>
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<td>0.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>22.6</td>
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<td>36.7</td>
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<td>2.2</td>
<td>247.4</td>
<td>139.4</td>
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<td>24.1</td>
<td>36</td>
<td>-</td>
<td>54.0</td>
<td>71.5</td>
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2.1.3 VEGETATION

The Neyyar river basin is a highly vegetated area due to the South-West and North-East monsoons. The upstream side is rich in thick forest with valuable trees like Sanda, Venga, Teak, Mangium, Mahagani etc. The Agasthyamalai (1866 m) flourishes with different varieties of orchydes and highly valued medicinal plants. Vegetations in downstream side include tapioca gardens, coconut plantation and thick growth of bamboo trees and rose wood on either side of the river banks.

2.1.4 LAND USE AND HORTICULTURE

Development of agriculture is more pronounced in the area. The upstream portion is covered by thick forest (Plate 2.1) and the total area under cultivation is more. The major crops grown are paddy, plantain, tapioca, coconut, coffee and rubber. Neyyar river basin is more rural than urban in land use. People here are not illiterate, but need counselling as regards the economic potential of their agricultural produce.

2.1.5 ACCESSIBILITY

Accessibility to Neyyar upstream is possible by random walk. Upstream is very difficult to access because of thick jungles and steep gradient. Downstream is easily approachable by roads. Most of the locations are well connected by local transport facilities.

2.1.6 TEMPERATURE

Temperature data from Indian Meteorological Department shows hottest weather grids in the area during March and April. March is the hottest month
with mean daily maximum temperature of 32.5°C and means daily minimum of 18.5°C. The coolest month is December with mean daily maximum temperature of 27.1°C and the mean daily minimum temperature is 17.1°C.

2.1.7 HUMIDITY

The absolute humidity of a given air mass is the number of grams of water present, in a cubic meter of air. At any given temperature, air can hold a maximum amount of moisture, i.e. the saturation humidity. This is proportional to the temperature of the air. The relative humidity for an air mass is the percentage ratio of the absolute humidity to the saturation humidity, for the temperature of the air mass. Evaporation ceases at 100% of relative humidity. As regards the study region the relative humidity of the area increases from May onwards to reach a maximum of 92% in July. Minimum relative humidity is recorded during February. The distribution of relative humidity values in the basin is controlled by proximity to the sea and by the monsoonal climate as well.

2.1.8 WIND

The maximum wind speed is usually associated with monsoons. Wind blow from North-West quadrant, from April to the end of September every year. In the winter season, wind flows from South-West direction. The wind velocity seems to be very low during winter.

2.2 PHYSIOGRAPHY

2.2.1 INTRODUCTION

Neyyar river basin (493 km²) is located in the Kerala state, Southern part of Indian Peninsula. It borders on the Eastern side with Western Ghats and the
Lakshadweep sea on West. Physiographically Neyyar basin is divided into four zones such as a, b, c and d (Fig. 1.4)

2.2.2.1 ZONE 'a'

The zone ‘a’ starts from mean sea level and extends upto 20 m altitude. Sand bars of 4 m to 8 m width are common in the central and the lateral parts of the Neyyar river. Established islands with vegetations are also seen (Plate 2.2). Here the bars divide the stream into separate channels during low flow season. These bars are seldom submerged during the high water line. In overall plan, however, the channel course of the braided Neyyar river is less sinuous.

2.2.2.2 ZONE 'b'

In this zone the elevation ranges from 20 m to 400 m. The dominant relief features in this zone are laterite capped mesas and lateritic ridges. The river valley contains colluvium and alluvium of variable thickness. This elevation range corresponds more or less to the lowland zone of Kerala (Soman, 1980). The mesas and ridges have their twigs set on the slopes of the latter. It seems that the structure of the bed rock does not control the trend of the laterite cappings.

2.2.2.3 ZONE 'c'

The elevation of this zone ranges between 400 m and 1000 m. This zone can be equated with the midland zone (Soman, 1980). The area with this elevation is observed in the south central margin of Neyyar river basin. The midlands are differentiated from low land by appearance of monadnocks (Samsuddin, 1980). Highly resistant hard rocks with laterite cappings are observed
in this region. A major lineament trending NW-SE, passing through Edamalaitodu, Neyyar dam reservoir and to Karamana basin is clearly observed.

2.2.2.4 ZONE ‘d’

The zone ‘d’ - the high land region has an elevation ranging from 1000 m to 1866 m represents high hilly ranges of the catchment area of the Neyyar basin. The Talakketodu, Kallar, Mullar, Neyyar are the major tributaries in the highlands. The steep Westerly slopes in the highlands make Neyyar river descend very fast such as rapids and falls.

Neyyar basin can be divided into four different physiographic zones viz., coastal zone, lowland zone, midland zone and highland zone. The Agasthyamalai the highest peak (1866 m) the study area is the starting point of Neyyar. Midland and lowland cover the major part of the basin (60%). Coastal land covers the plain and has braided streams.

2.3 REGIONAL GEOLOGY

Rock formation of Kerala region is classified into four major rock types,

i. Crystalline rocks of Archaen age

ii. Sedimentary rocks of Tertiary age

iii. Laterite capping the crystalline and Sedimentaries and

iv. Recent to sub-recent sediments forming the low lying areas and river valleys.
The charnockite - khondalite suit of rocks along with granite, granite gneisses traversed by basic dykes constitutes the crystalline rocks of Archaen age. The charnockite with narrow bands of pyroxene, granulite constitute the high ranges of Western Ghats. The khondalite suit of rock comprises garnet-sillimanite gneiss with graphite, garnet - biotite gneiss, garnet quartz feldspar gneiss or granulites, calc granulites and quartzite. The other rock types are cordierite gneiss, quartz mica, schist, quartz schist, fuchite quartzite, tremolite, chlorite talc schist.

The regional strike of the crystalline rock is roughly NW-SE in the Southern part of the state while in the Northern part it swings to NE-SW strike of Nilgiris range. These crystalline rocks are highly folded. Basic dykes of dolerite, gabbro and basalt cut across these crystalline rocks.

The Tertiary sediments (Miocene age) consist chiefly of varigated sandstone clays with lenticular seams of lignite known as Warkalai beds. These are underlined by more compact sands and clays with shell fragments, and thin beds of limestone called as Quilon beds.

2.4 GEOLOGICAL SETTING: NEYYAR RIVER BASIN

2.4.1 INTRODUCTION

The discussion on the geology of the basin (Fig. 2.3) is based on previous works and published geological map of Kerala and on the survey carried out by the author for a period of about six months between 1992-1994. Besides the geological map of Kerala has also been referred to.
2.4.2 DISTRIBUTION OF ROCK TYPES

A large part of the Neyyar basin is made up of crystalline rocks of Archean age comprising of gneisses and charnockite - khondalite suite blanketed by fairly thick laterite cappings with lenses of graphite, alluvium and soil. The thickness of laterite capping increases from higher altitude to lower altitude (Samsuddin, 1980).

The main rock types in this area are charnockite, khondalite with veins of pegmatite, pyroxene granulite, garnet - biotite gneiss, garnet sillimanite gneiss, calc-granulites and quartzites. Dykes of dolerite and gabbroic composition follows the major structural trends.

2.4.3 DESCRIPTION OF ROCK TYPES

The brief account of the megascopic and microscopic feature of the dominant rock types is given in the following pages.

2.4.3.1 CHARNOCKITE

The origin of charnockite or the 'charnockite series' of Holland (1900) evoked a lot of controversy. Holland believed that the acid, intermediate and basic ultrabasic types as he classified were different magmatic differentiates. He grouped typical charnockite in the acid end and pyroxene granulite as basic charnockite. The term charnockite underwent further modification acquiring a status of group. Subramaniam (1959) redefined the term charnockite, and according to him, the acid group included alaskites, birkremite, enderbite and hypersthene - quartz syenite, the basic division included pyroxene granulites and their variants with no genetic link. The hybrid rocks were those resulting from
partial assimilation and incorporation of pyroxene granulite by charnockite magma. These differences led to the expression of Pichamuthu (1953) "Charnockites and Charnockites" indicating that there are more than one way of charnockite formation. However, in recent years the general practice has been to describe charnockite as either felsic or basic.

The lower Precambrian rock, Charnockite occurs in highland area and in some parts of midlands, charnockite occur as a coarse to very coarse grained rock. The charnockites in highland and midland regions intruded by granites, dolerites and pegmatites. Charnokite in the highland region shows granoblastic texture than those from the middle and lower regions. Sometimes it is almost free of mafic minerals. In such cases the grain boundaries are often difficult to recognize in hand specimen because of the melting together of grains due to recrystallization. Coarse pegmatitic variety either free of mafics (alasksites) or with porphyroblasts of pyroxenes are frequently observed.

The predominant minerals such as quartz and feldspar, often occur as xenoblasts Quartz grains show strain shadows. Hornblende, biotite diopside and hypersthene constitute the mafic minerals. In addition opaque mineral like magnetic sulphides like pyrite, pyrrotite and rarely chalcopyrite do occur.

2.4.3.2 PYROXENE GRANULITE

The hornblende - biotitic gneisses are highly migmatized and quite frequently enclose palaeosomes of charnockite and pyroxene granulite. Under the microscope the rock is predominantly composed of quartz and feldspars essential
minerals and clinopyroxene transforming to homblende in subordinate amounts. In addition biotitic also occurs in this rock.

2.4.3.3 KHONDALITE

Khondalite is a group of para schists and gneisses including garnetiferous quartz-sillimanite rocks, garnetiferous quartzite, calciphyres and graphitic schists interbeded with charnockite and granitic gneiss. Khondalites are the most widely seen rock types in the Kerala khondalite belt with a mineralogy of quartz + biotite sillimanite + feldspar + graphite ± cordierite ± spinel ± rutile. Modal analyses of minerals in khondalite are garnet (10-25%), biotite (20-40%), sillimanite (5-25%), feldspar (10-35%) and graphite (0.2-1%). Cordierite may be present in a varying proportion of 2 to 15%. Textural evidence suggests that two generations of cordierite are present. The first generation cordierite is parallel to the metamorphic foliation. The second generation cordierite occurs as coronas over embayed garnet grains. Hercynite (spinel) bearing khondalite occurs usually in highly migmatised zones. Khondalites are variously described as representing metamorphosed weathering crust (Dash et al., 1987) or acid volcanics and fluffs.

Calc-granulites and quartzites are veined by pegmatites in lowland and midland region of study area.

2.4.3.4 GARNET-SILLIMANITE GNEISS

The area is predominantly constituted by rocks of Precambrias age gamet-sillimanite gneiss. The gneisses abounding along the South and South-East of Trivandrum are highly migmatised. These rocks are intensely folded and sheared. In the study area, the pegmatites traverse gneisses at many places. Garnet
sillimanite gneiss pass into a garnet gneiss with the disappearance of sillimanite. With increase in the amount of feldspar with cordierite as an essential constituent, the rock becomes corderite garnet gneiss (Chatterjee, 1974).

This rock is seen in highland and midland region. This rock is leucochratic, coarse textured with porphyroblasts of pink garnet and sillimanite laths. These rocks also contain biotite flakes arranged parallel to the direction of foliation. Granitic materials permeate along the planes of foliations. Often the rock surface looks spotted due to the weathering of garnet grains.

Under microscope these rock exhibit the occurrence of minerals such as quartz and feldspar (microcline and microperthite). Quartz occurs as polycrystalline grains with strongly marked undulose extinction. Subordinate quantities of sillimanite, garnet, enstatite, amphibole, green mica and iron ore are also present.

2.4.3.5 GARNET-BIOTITE GNEISS

This is the most common rock type seen all over the study area. This semipelitic rock is equivalent of khondalite with significant absence of sillimanite. The rock contains irregular grains of quartz and feldspar with variable amounts of biotite and garnet. Graphite is common zircon, apatite and ilmenite as accessory minerals are recognisable only in thin section. Throughout the terrain garnet-biotite gneiss are seen at various stages of conversion to orthopyroxene bearing charnockite (Ravindrakumar et al., 1993).
2.4.3.6 CALC GRANULITES AND QUARTZITES

Khondalite of Kerala are granulate rocks, light coloured, fine to medium grained and foliated and comprise of garnet-sillimanite gneiss with graphite, garnet-biotite gneiss, cordierite gneiss, garnet-quartz-feldpathic gneiss with veined pegmatite. Calc granulite is found in lowland area of the Neyyar river basin. Quartzite is seen in midland and lowland regions.

2.4.3.7 LATERITE

Buchana (1807) designated the weathering products comprising the reddish ferruginous materials in Kerala region as laterite. The laterite caps in the low flat ridges and hills, covering the Tertiary sediments and the crystalline rocks between the foothills of Western Ghats and Arabian Sea.

Laterite is highly porous rock, and shows gradations from a ferruginous type that is almost free from alumina. The aluminous laterite is almost free from iron. Laterite occurs mainly in two geomorphic levels in Kerala namely (i) 60-90 m (North Kerala) (ii) 200-250 m (South Kerala). Sinha Roy (1979) demarcated laterites in two geomorphic levels at 30-70m and 90-110m in parts of Trivandrum district.

The borehole data from Central Ground Water Board reveals that the Quarternary formations of the Kerala basin buried by laterite capping of the Neogene sequence (Raghava Rao, 1975).

In the highland, midland and lowland regions of Neyyar basin, the laterite covers the crystalline rock as cap. The parent rocks and weathering conditions
control the mineral assemblages in the laterite profiles. Therefore, it is likely that high level laterite of older age is composed of more mature minerals than the low level laterite of older age is composed of more mature minerals than the low level laterite. Mineral analysis by X-Ray Diffraction method showed that high level laterite contains gibbsite, goethite and hematite but free of quartz. Kaolinite and anatase occur in small amounts and the low level laterite consist of minerals such as quartz as major constituents and minor amounts of feldspar, montmorillonite and anatase (Subramaniam and Mani, 1981).

2.4.3.8 ALLUVIUM AND KANKAR

Sediments of silt and clay sized particles of fluvial origin of recent age are classified as alluvium. The spare occurrence of alluvium is along the upstream sides than the downstream sides. The valleys of fifth and sixth order stream tributary are filled with the alluvial fills in the upstream side. Crust and block of hardly indurated, white to buff coloured, kankar composed chiefly of CaCO₃ (Calcium Carbonate) is found associated with soil on the Eastern part of the basin.