CHAPTER 1

GENERAL INTRODUCTION

1.1 INTRODUCTION

Rivers are the major geological agents in tropical and sub-tropical regions. Year by year, rivers transport about 37000 km$^3$ of water (Meybeck, 1976) and $13.5 \times 10^9$ tonnes of sediments (Milliman and Meade, 1983) from terrestrial environments to the world oceans. During transportation, water and sediments undergo considerable changes in their physico-chemical properties depending on terrain characteristics and climate of the region through which the river flows (Gibbs, 1977a; Lal, 1977; Subramanian, 1979; Sajeev et al., 1992; Walling, 1999; Somayajulu et al., 2002; Ankers et al., 2003; Turner and Rabalais, 2004). It is now well understood that river transport of particulates, nutrients and minerals plays a major role in maintaining the productivity of the coastal and the nearshore environments of the world. rivers and its estuaries provide connectivity between terrestrial and marine environments and also act as corridors for free movement of aquatic organisms among various sub-environments. But, unfortunately, increased human interventions consequent to the economic development in recent years have imposed tremendous pressure on the river systems. Several studies reveal that human interventions have caused worldwide increase in river input of geochemical constituents, especially nutrient elements to the coastal ecosystem by many folds leading to ‘imposed eutrophication’ incidences in many parts of the coastal areas. Construction of engineering structures like dams, spillways etc. are also responsible for changes in natural processes of river environments. The scenario is being complicated further by the huge discharge of toxic contaminants from point and non-point sources. All
these, in one way or the other, have negatively affected the natural productive capacity of
these life support systems of tropics and sub-tropics.

The situation is not so different in the river systems of Kerala, especially in the
Periyar and Chalakudy rivers draining, respectively, the industrial and cultural capitals of
the State. Discharge of pollutants from urban, agricultural and industrial sources,
indiscriminate mining of construction grade materials (clay and sand) from instream and
floodplain areas, damming of rivers, inter-basin transfer of water etc., have adversely
affected the natural processes of these river systems. The recurring incidences of fish
diseases and ecosystem disorders are signals of man-imposed stresses in these
ecosystems, which obviously need immediate attention and corrective measures based on
careful observations and studies.

The present study is an attempt to address certain aspects of the sediment and
water systems of the Periyar and the Chalakudy rivers flowing through Idukki,
Ernakulam and Thrissur districts of Kerala. The study includes a systematic analysis of
sediment properties like texture, mineralogy and geochemistry and also the quality of
overlying waters of these river systems. An attempt has also been made to evaluate the
pollution status of the area.

1.2 STUDY AREA

1.2.1 Location

The area selected for the present study, the Periyar and Chalakudy river basins,
falls within the central part of Kerala (Fig.1.1) and lies between North latitudes 9°15'50"
- 10°32'53" and East longitudes 76°07'38" - 77°24'32". The area spreads in the Idukki,
Ernakulam and Thrissur districts and comprises 16 taluks – 5 in Thrissur, 7 in Ernakulam
and 4 in Idukki.
Study area
Periyar and Chalakudy river basins

Fig. 1.1 Location map of the study area
1.2.2 Drainage

Periyar river

The Periyar river otherwise called the \textit{Poorna nadi}, is the longest river of Kerala and also the largest in water discharge potential (Kerala State Gazetteer, 1986). Fig 1.2 depicts the drainage characteristics of the river which has a length of about 244 km and a catchment area of 5398 km$^2$; out of which a total of 5284 km$^2$ lies in the Kerala State and rest in the Tamil Nadu State. The river originates from the Sivagiri hills at an elevation of about 1830 m above mean sea level (msl) and flows through highly varied geologic and geomorphic regions. The major channel supplying water and sediments to Periyar river are the Muthirapuzha, Perinjankutty, Edamalayar and Mangalampuzha tributaries. The river bifurcates near Aluva township into two major distributaries: the southwesterly branch is called as the Marthanda Varma distributary (flowing through Eloor-Kalamassery industrial belt) and the northwesterly branch as the Mangalapuzha distributary. Both the distributaries debouches into the Lakshadweep Sea either directly (Mangalapuzha distributary) or through backwaters (Marthanda Varma distributary); (Annexure I). The drainage density and stream slope are 0.21 km / km$^2$ and 7.14 m / km, respectively. The important reservoirs in the Periyar river basin are Bhoothathankettu, Idukki, Lower Periyar, Kallarkutti, Ponmudi, Mullaperiyar, Mattupetti, Anayiragal, Kundla and Idamalayar. Table 1.1 summarises the relevant details of some of these reservoirs whose information is available in published accounts. The longitudinal profile of the river is depicted in Fig. 1.3a. The river is perennial and generally exhibit a dendritic drainage pattern.

Chalakudy river

The Chalakudy river is a comparatively smaller perennial river than the Periyar. Though Chalakudy river in strict geological sense is a tributary of Periyar river, for all
Fig. 1.2 Drainage map of the study area (Periyar and Chalakudy river basins)
Table 1.1 Important reservoirs in the Periyar and Chalakudy river basins

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of Reservoir</th>
<th>Year of completion</th>
<th>Height of dam (m)</th>
<th>Length (m)</th>
<th>Volume of content (&gt;1000m³)</th>
<th>Area at FRL (km²)</th>
<th>Gross capacity (million m³)</th>
<th>Effective capacity (million m³)</th>
<th>Designed spill way capacity (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I PERIYAR RIVER BASIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Kundala</td>
<td>1946</td>
<td>32.30</td>
<td>259</td>
<td>54</td>
<td>0.47</td>
<td>7.79</td>
<td>7.65</td>
<td>184.06</td>
</tr>
<tr>
<td>2</td>
<td>Mattupetty</td>
<td>1956</td>
<td>85.34</td>
<td>237</td>
<td>155</td>
<td>3.24</td>
<td>55.23</td>
<td>55.23</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Sengulam</td>
<td>1957</td>
<td>26.80</td>
<td>144</td>
<td>18</td>
<td>0.29</td>
<td>0.71</td>
<td>0.71</td>
<td>70.80</td>
</tr>
<tr>
<td>4</td>
<td>Kallarkutty</td>
<td>1961</td>
<td>43.00</td>
<td>183</td>
<td>40</td>
<td>0.65</td>
<td>6.88</td>
<td>6.51</td>
<td>1982.40</td>
</tr>
<tr>
<td>5</td>
<td>Ponmudy</td>
<td>1963</td>
<td>59.00</td>
<td>294</td>
<td>181</td>
<td>2.79</td>
<td>51.54</td>
<td>47.40</td>
<td>1416.03</td>
</tr>
<tr>
<td>6</td>
<td>Anayirangal</td>
<td>1965</td>
<td>34.00</td>
<td>292</td>
<td>462</td>
<td>4.86</td>
<td>49.84</td>
<td>48.99</td>
<td>348.00</td>
</tr>
<tr>
<td>7</td>
<td>Idukki</td>
<td>1974</td>
<td>168.90</td>
<td>366</td>
<td>46</td>
<td>59.83</td>
<td>1996.30</td>
<td>1459.50</td>
<td>5100.50</td>
</tr>
<tr>
<td>8</td>
<td>Cheruthoni</td>
<td>1976</td>
<td>138.20</td>
<td>650</td>
<td>1700</td>
<td>59.83</td>
<td>1996.30</td>
<td>1459.50</td>
<td>5100.50</td>
</tr>
<tr>
<td>9</td>
<td>Kulamavu</td>
<td>1977</td>
<td>100.00</td>
<td>385</td>
<td>450</td>
<td>59.83</td>
<td>1996.30</td>
<td>1459.50</td>
<td>5100.50</td>
</tr>
<tr>
<td>10</td>
<td>Idamalayar</td>
<td>1985</td>
<td>12.20</td>
<td>58</td>
<td>4</td>
<td>0.25</td>
<td>0.79</td>
<td>0.77</td>
<td>1014.00</td>
</tr>
<tr>
<td>11</td>
<td>Kallar</td>
<td>1989</td>
<td>20.00</td>
<td>146</td>
<td>16</td>
<td>0.97</td>
<td>5.35</td>
<td>5.09</td>
<td>507.00</td>
</tr>
<tr>
<td>12</td>
<td>Erattayar</td>
<td>1989</td>
<td>102.80</td>
<td>373</td>
<td>880</td>
<td>28.30</td>
<td>1089.80</td>
<td>1017.80</td>
<td>3012.80</td>
</tr>
<tr>
<td>13</td>
<td>Lower Periyar</td>
<td>1995</td>
<td>39.00</td>
<td>244</td>
<td>140</td>
<td>0.45</td>
<td>5.30</td>
<td>4.50</td>
<td>14200.00</td>
</tr>
<tr>
<td>II CHALAKUDY RIVER BASIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Peringalkutu</td>
<td>1957</td>
<td>36.90</td>
<td>366</td>
<td>63</td>
<td>2.85</td>
<td>32.00</td>
<td>30.30</td>
<td>2266.00</td>
</tr>
<tr>
<td>2</td>
<td>Sholayar- Maindam</td>
<td>1965</td>
<td>66.00</td>
<td>430</td>
<td>303</td>
<td>8.71</td>
<td>153.60</td>
<td>15.20</td>
<td>1825.00</td>
</tr>
<tr>
<td>3</td>
<td>Sholayar- Flanking</td>
<td>1964</td>
<td>28.00</td>
<td>259</td>
<td>44</td>
<td>8.71</td>
<td>153.60</td>
<td>15.20</td>
<td>1825.00</td>
</tr>
<tr>
<td>4</td>
<td>Sholayar-saddledam</td>
<td>1965</td>
<td>19.00</td>
<td>109</td>
<td>18</td>
<td>8.71</td>
<td>153.60</td>
<td>15.20</td>
<td>1825.00</td>
</tr>
</tbody>
</table>

Source: KSEB (1996), FRL- Full Reservoir Level
practical purposes it is treated as a separate river by Government and other agencies. The river joins the Periyar river near its mouth. It originates from the Anamalai hills of the Western Ghat mountain ranges and flows through the northern part of Periyar river. After draining through varied physiographic and geologic terrains of Tamil Nadu (minor portion) and Kerala (major portion) States, the river merges with the Periyar river at Elanthikkara located about 10 km upstream of the Periyar river confluence at Munambam. The Chalakudy river has a length of about 130 km and a catchment area of about 1704 km$^2$. Out of the total catchment area, about 300 km$^2$ lies in Tamil Nadu and the remaining in Kerala. The river is formed by the confluence of 5 major tributaries: Parambikulam, Sholayar, Kuriyarkutti, Karappara and Anakkayam. Out of these, the first two tributaries originate from the Tamil Nadu State and the remaining from the Kerala State. The Chalakudy river hosts several waterfalls, of which Peringalkuttu and Athirappalli are the major ones. The reservoirs constructed in the river basin are Peruvirippallam, Tunakadavu, Parambikulam, Sholayar and Peringalkuttu (Table.1.1). The river, in general, exhibits a dendritic drainage pattern. The longitudinal profile of the river is given in Fig.1.3b.

1.2.3 River discharge

Analysis of 8 years of water and sediment discharge data (1987/88 – 1994/95) collected from the offices of the Central Water Commission (CWC) located at Malayattoor-Neelkeeswaram (Ernakulam district) in Periyar river and Arangali (Thrissur district) in Chalakudy river reveals that, on an average, 6613 million m$^3$ of water and 346089 tonnes of sediment (sand = 83603 tonnes; mud = 262486 tonnes) are discharged through Periyar river every year. The corresponding water and sediment discharges of the
Fig. 1.3 Longitudinal profiles of Periyar (a) and Chalakudy (b) rivers; amsl- above mean sea level.
Chalakudy river are 1903 million m$^3$ and 59917 tonnes (sand = 13060 tonnes; mud = 46857 tonnes), respectively. The year-wise discharge of water and sediments during the period 1987/88 – 1994/95 are summarized in Table 1.2. Fig 1.4 depicts the monthly discharge of water and sediment through Periyar and Chalakudy rivers during the year 1987. From these figures it is very evident that about 60% of water and 65% of sediment discharge occur during southwest monsoon (June - August). Northeast (September-November) monsoon discharges only about 30% of sediment and water into the Lakshadweep sea.

1.2.4 Physiography

Physiographically, the study area can be broadly divided into 3 major zones - lowland (< 8m amsl), midland (8 – 75m amsl) and highland (>75m amsl); (Fig.1.5). Fig.1.6 depicts a detailed relief map of the region. The lowland has a width ranging from 10 to 15 km. The area close to the coast is dominated by a network of backwater channels. The midland region is characterized by an almost rugged topography comprising small flat-topped low mounts and broad valleys. The midlands are intensely cultivated. The highland is characterized by scarp, valleys, plateau and mountains. The highland host many reservoirs. The highest mountain peak in Kerala, the Anamudi run in a north-south direction in the eastern border of Periyar river basin. Plates 1 and 2 depict a few geomorphic features related to the Periyar and the Chalakudy river basins.

1.2.5 Geology

Kerala State forms a part of the peninsular shield, comprising the major rock units: Pre-Cambrian crystallines, Tertiary sedimentaries, laterites developed over the Pre-Cambrian crystallines, Tertiary sedimentaries and Recent to Sub-Recent (late Quaternary)
Table 1.2 Annual discharge of water and sediments through Periyar and Chalakudy rivers

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Year</th>
<th>Periyar river</th>
<th>Chalakudy river</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Water discharge (million m³)</td>
<td>Sediment discharge (tonnes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sand</td>
</tr>
<tr>
<td>1</td>
<td>1987- 88</td>
<td>4939</td>
<td>29540</td>
</tr>
<tr>
<td>2</td>
<td>1988-89</td>
<td>5569</td>
<td>70440</td>
</tr>
<tr>
<td>3</td>
<td>1989-90</td>
<td>7563</td>
<td>154545</td>
</tr>
<tr>
<td>4</td>
<td>1990-91</td>
<td>6074</td>
<td>41141</td>
</tr>
<tr>
<td>5</td>
<td>1991-92</td>
<td>6627</td>
<td>87648</td>
</tr>
<tr>
<td>6</td>
<td>1992-93</td>
<td>8062</td>
<td>144963</td>
</tr>
<tr>
<td>7</td>
<td>1993-94</td>
<td>6578</td>
<td>42470</td>
</tr>
<tr>
<td>8</td>
<td>1994-95</td>
<td>7495</td>
<td>98079</td>
</tr>
<tr>
<td></td>
<td><strong>Average</strong></td>
<td><strong>6613</strong></td>
<td><strong>83603</strong></td>
</tr>
</tbody>
</table>

*Source: Central Water Commission (CWC), Kochi*
Fig. 1.4 Monthly sediment and water discharges of Periyar and Chalakudy rivers
Fig. 1.5 Physiography of the study area (CESS, 1984)
Fig. 1.6 Relief map of the study area (CESS, 1984). Measurements are from the mean sea level (msl)
Plate 1: Some selected scenes from the Periyar basin.
   a) Muthirapuzha tributary - a distant view;
   b) Sand deposits within channel near Munnar;
   c) Sand deposit of Periyar near Kalady town
Plate 2 Some selected scenes from the Chalakudy river.
   a) The Athirappally water falls;
   b) Chalakudy river near Chalakudy town;
   c) Chalakudy river with luxuriant riparian vegetation near Kadukutty.
sediments. This geological suite is bounded by the Western Ghats on the east and the Lakshadweep Sea on the west.

Geologically, the Periyar and Chalakudy river basins are occupied by a spectrum of rock types, which include crystalline rocks of Pre-Cambrian age and the sedimentaries of Tertiary and Quaternary Periods (Fig. 1.7). More than 95% of the study area is covered by Pre-Cambrian crystallines. The crystallines are comprised of quartz-feldspar-hypersthene granulites (charnockites), charnockite gneiss, hypersthene-diopside gneiss, hornblende gneiss, hornblende-biotite gneiss, quartz-mica gneiss and pink granite. A large part of these crystalline rocks have undergone polymetamorphic and polydeformational activities. At many places, acidic and basic rocks intrude the Pre-Cambrian crystallines. Pegmatitic intrusions are recorded at many places. Tertiary sedimentaries occur as sub-surface formation especially in the coastal area. The Pre-Cambrian crystallines and Tertiary sedimentaries are covered at many places by laterites. Recent to Sub-Recent sediments of Quaternary age overlie the Tertiaries in the lowland, especially near coastal zones.

1.2.6 Sub-surface geology

Boreholes drilled by Central Ground Water Board (CGWB) reveal that a greater part of the Periyar and Chalakudy river basins is composed of Pre-Cambrian crystallines such as charnockites (major occurrence), hornblende gneiss, garnet biotite gneiss and biotite gneiss (minor occurrence). Sedimentary rocks of Tertiary and Quaternary ages occur in the coastal tract (Soman, 2002). The studies of ONGC in the offshore basin of Kerala indicate that sedimentary thickness increases steadily from north to south. As per CGWB (1993), the Tertiaries are represented mainly by Warkalli, Quilon and Vaikom
Fig. 1.7 Geology of the study area (after GSI, 1995)
Formations (Fig.1.8). Minor occurrence of Quilon Formation is recorded at the Chellanam borehole. The Tertiaries overlay laterites at many places. The thickness of Quaternary sediments varied between 20 m and 54.3 m. The Tertiaries and Quaternaries are composed of alternate layers of sand and clays.

1.2.7 Structure and tectonics

The crystalline rocks of Kerala were polyphasedly deformed. In the present area, fairly tilted isoclinal folds with NW-SE axial orientations can be demarcated on a regional scale. These folds seem to be of second generation whose orientation has been modified by folds of the third generation. The later fold system is manifested in the form of large upright synforms and antiforms whose axial traces trend NW-SE (Nair, 1990).

The Kerala region covers a significant part of the western continental margin of India and the major lineaments here are considered to represent deep fractures or shear zones. Three major lineament orientations are observed, namely, WNW-ESE, NW-SE and NE-SW. The NE-SW sets, which maintain an orthogonal relationship, can be considered as conjugate pairs and also seems to be younger, as it displaces the NW-SE set. It may be that the NE trending ones were reactivated at a later stage (Chattopadhyay and Chattopadhyay, 2004).

There is rough parallelism between the general trend of lineaments and the foliation. The NW trending foliation in the central part of the area runs parallel to the NW trending major lineaments. In the southern part of the area, to the south of intersection of the NE and NW oriented major lineaments, the foliation has a N to NE trend. In the area of maximum intersection of the lineaments, a major synclinal structure is defined by the foliation.
Fig. 1.8 Geological cross section along the coast; Quaternary includes laterite also. (after Nair and Padmanabha, 2003)
In regard to the relationship of the lineament with the geology, it is seen that the major lineaments are either located at the boundaries of the rock formations or they cut across the rock formations. The composite gneiss trending NW-SE and the granite bodies elongated in the NE-SW direction are sub-parallel to the major lineament directions. The basic dykes are parallel to the WNW-ESE trending lineaments (Sinha Roy, 1981).

1.2.8 Soils

Soils of the Periyar and Chalakudy river basins fall within 6 broad categories. They are: 1) lateritic soil 2) hydromorphic saline soil 3) brown hydromorphic soil 4) riverine alluvium 5) coastal alluvium and 6) forest loam. Of these, lateritic soils are the predominant soil type of the midland region. The brown hydromorphic soil is mostly confined to valley bottom of undulating topography of the midland. They are formed as a result of the deposition of material derived from the adjoining hills and slopes. A major portion of the upland is covered by forest loam having the surface layer rich in organic matter. The riverine alluvium occurs mostly along the river channels and their tributaries. The coastal alluvium is believed to be developed from marine and estuarine processes.

1.2.9 Climate

The study area is characterized by a tropical humid climate with summer season from March to May, and rainy season from June to September. Wet type of climate prevails in the higher hill ranges. The area receives an average annual rainfall of 3000 mm. The rainfall increases from west to east. Nearly 68.2% of the total rainfall occurs from June to August (southwest monsoon) period. The period September –November (northeast monsoon) contributes about 17.5 % of the total rainfall. A total of 13% of
Rainfall is received during March to May and the balance is obtained during January to February. Out of the total 133 rainy days 83 days are during southwest monsoon.

The relative humidity is higher during monsoon months. Wind speed records the highest mark during May (10.9 km/h). The area experiences almost uniform temperature throughout the year. However, the maximum temperature is in the month of March and minimum in December.

1.2.10 Landuse / land cover

The study area occupies landuse classes, like tea / coffee plantations, forests, open scrub, mixed crops, rubber plantations, paddy fields and water bodies (Fig 1.9). The landuse / land cover of the area can broadly be grouped into agricultural land, forest land, wastelands and water bodies.

The upper region consists of forest land, agricultural land, wastelands and water bodies. The forest land consists of forest plantations, ever green / semi-ever green forests, deciduous forests and degraded forests. Of the forest land, nearly 10% is covered by forest plantation, 12% by degraded forest, about 8% by deciduous forest and 5% by evergreen / semi evergreen forest. Nearly 40% of the upland is agricultural land, which is mainly under mixed agricultural / horticultural plantations. About 10% of upper region is wasteland which is occupied equally by barren rock and land with or without scrub. Rest of the area is occupied by water bodies.

The midland is occupied by agricultural land, forest land and wasteland. Nearly 85% of the area is agricultural land which is mainly under mixed agricultural / horticultural plantations. Forest land is occupied by evergreen / semi-evergreen forest and
Fig. 1.9 Landuse map of the study area (after KSLUB, 1995)
degraded forest. Rest of the area comes under wasteland, which is land with or without scrub.

The lowland is occupied by agricultural land and water bodies. Nearly 75% is occupied by mixed agricultural / horticultural plantations and about 15% by double cropped paddy lands. Rest of the area is occupied by water bodies.

1.2.11 Population

As per 1991 census, the total population in the Periyar and the Chalakudy basins comes to about 3.5 million. A total of 125 local bodies, including 6 municipalities fall within these basinal areas. In addition to these, a portion of Tamil Nadu State also falls within the eastern part of the study area. Of these 125 local bodies of Kerala State, 95 fall completely within the study area and the remaining comes only in part.

1.2.12 Environmental degradation

Population explosion and rise in demand for resources has lead to serious environmental problems in the river basins of Kerala, especially in the Periyar and Chalakudy river basins. The Periyar river near Eloor – Kalamassery regions hosts many fertilizer and chemical industries (Plate 3). All these industries together discharge an amount of about 260 million m$^3$ of liquid wastes into the river channel, annually (Dineshkumar, 1997). Additionally, an amount of 113000 tonnes/year of urban wastes is also added in Periyar and Chalakudy basins from various urban local bodies (CESS, 1999). The unscientific disposal of these wastes could enhance the level of pollution in the area. Analysis of secondary data from Agricultural Department, Government of Kerala reveals that an amount of 46000 tonnes/year of chemical fertilizers are applied for
Plate 3: Field photographs from Periyar and Chalakudy basins
(a) Cluster of industries in the Periyar basins;
(b) An arm of Idukki reservoir near Cheruthoni (Periyar river basin);
(c) Check dam constructed in the Chalakudy river near Chalakudy town.
enhancing the productivity of the area. It is a fact that substantial part of these chemicals will also be reaching these river channels in one way or the other.

Indiscriminate mining of minor minerals like sand, tile / brick clays, hard rocks / dimension stones, soil, etc. are also imposing severe environmental problems in Periyar and Chalakudy river basins. River sand mining is reported from the entire channel networks. A total of 40 local bodies of Periyar and 9 local bodies of Chalakudy river are engaged in sand mining. About 364 sand mining locations (locally known as ‘kadavus’) are identified in the Periyar (320 locations) and Chalakudy (44 locations) rivers. The total quantity of sand being mined from these locations amounts to 7.8 million tonnes / year. It is estimated that the sand mining sector sustains about 11500 laboures in two river basins.

There are many environmental problems related to indiscriminate mining of sand. The river bank is cut deeply at many locations (particularly downstream stretches) for the passage of vehicles into the riverbed. Incidents of river bank slumping, weakening of engineering structures, lowering of water table in wells adjacent to sand mining sites, etc., are common in the area (Padmalal et al., 2003). There are several reports of aggravated sea water ingressions consequent to lowering of river channel in areas close to river mouth. All these impose added stress to the physico-chemical and biological environment of the river ecosystem (Kondolf, 1994; Brown et al., 1998; Sheeba and Ann, 2003; Sreeja et al., 2003). Fig 1.10 depicts the riverbed lowering in the Periyar and Chalakudy rivers near the gauging stations at Malayattoor – Neelakswaram (Periyar river) and Arangali (Chalakudy river). Plate 4 portrays some selected scenes from the sand mining sectors of these two rivers.

Apart from river sand mining, indiscriminate clay mining from paddy fields for manufacture of roofing tiles, bricks and other clay articles is another serious
Fig. 1.10 Riverbed lowering of Periyar and Chalakudy rivers  
(Data source: CWC, Kochi)
Plate 4: Field photographs showing river sand mining from Periyar (a & b) and Chalakudy (c & d) rivers
environmental problem in the area. The process, generally confined to the wetland systems of the area, has a direct impact on paddy production of the State. From the borehole sampling and analysis, it is revealed that, tile and brick clay occur to about 5m below ground level, on an average level. Further, active clay mining is recorded from an area of about 0.96 km². About 135975 tonnes/year of clay is being scooped from the area and used by various industrial establishments (Padmalal et al., 2004a). Some selected scenes from clay mining sector of the Periyar and Chalakudy rivers are displayed in Plate 5.

1.3 OBJECTIVES OF THE PRESENT STUDY

Considering the significance of the socio-economic and environmental scenario of the two river basins and in the overall development of Kerala, a detailed investigation on the sediment and water quality aspects of Periyar and Chalakudy rivers have been attempted. The following are the specific objectives of the study.

- To investigate the textural and mineralogical characteristics as well as transportation and depositional mechanisms of the sediments of Periyar and Chalakudy rivers.
- To find out the geochemical variability of organic carbon, phosphorus and certain major (Na, K, Ca and Mg) and minor/trace (Mn, Pb, Ni, Cr, and Zn) elements in the bulk sediments and mud fraction of these rivers.
- To evaluate the status of heavy metal pollution registered in the sediments of these rivers.
- To assess the physico-chemical characteristics and water quality of Periyar and Chalakudy rivers.
- To estimate the dissolved nutrient flux through the Periyar and Chalakudy rivers into the receiving coastal waters.
Plate 5: Field photographs showing clay mining from Periyar (a & b) and Chalakudy (c & d) river basins