CHAPTER -3

STUDY AREA

3.1 INTRODUCTION
The Western Ghats provide the principal geographical barrier in the path of the Arabian Sea branch of the southwest monsoon and are responsible for the heavy rainfall over the western coastal belt. The rivers in the Western Ghats region generally originate at an elevation ranging from 400 meters to 1,600 meters above the mean sea level, close to the Western Ghats ridge. The rivers generally flow westward and meet the Arabian Sea after a short run varying from 50 kms to 300 kms. The rivers are very steep in the upper reaches and fairly steep in the middle reaches. It is only near the sea that they have relatively flat gradients and some sort of flood plain.

The area under study includes a stretch of Western Ghats and the coastal plains of the western parts of India. It includes the state of Goa and the north western parts of Karnataka. The Goa coastal region is 105 km long with estuaries, alluvial plains, beaches and dunes. The Karnataka coastal region, which extends between the Western Ghats, edge of the Karnataka Plateau in the east and the Arabian Sea in the west, covers Uttara Kannada and Dakshina Kannada districts of Karnataka State. This region is traversed by several ridges and spurs of Western Ghats. It has difficult terrain full of rivers, creeks, water falls, peaks and ranges of hills. The coastal region consists of two broad physical units, the plains and the Western Ghats. The Coastal plains, represent a narrow stretch of estuarine and marine plains. The abrupt rise at the eastern flanks forms the Western Ghats. The northern parts of the ghats are of lower elevation (450-600 metres) as compared to southern parts (900 to 1,500 metres). The Coastal belt with an average width of 50 to 80 km covers a distance of about 267 kms from north to south.
There are eight major west flowing rivers which have been investigated together in this study. Besides these rivers, there are a number of free catchments, between the identified river basins, which have small streams directly draining into the Arabian Sea. These free catchments are close to the sea and are at lower elevation. In this study, two rivers from Goa i.e. Mandovi and Zuari and six other rivers from Uttara Kannada (called North Kanara till recently) and Dakshina Kannada districts of Karnataka state namely Kalinadi, Gangavali, Agnashini, Sharavati, Gangoli and Netravati have been investigated. Kalinadi, Gangavali, Agnashini and Sharavati are the prominent rivers of North Karnataka. Sharavati is the shortest river and is famous for the mighty Jog falls, the site of the hydel project. Hence, it would be relevant here to know in brief about the physiography, geology and climate of the region.

3.2 GOA

3.2.1 Physiography

The state of Goa is divided into two districts namely, North Goa and South Goa with their headquarters at Panaji and Madgaon respectively. Round between N 14° 18' to N 15° 48' lat and E 74° 20' to E 75° 40' long, the state covers a total surface area of 3,702 km². It is flanked on one side by the Arabian Sea and on the other side by the Western Ghats. Geomorphologically, the region can be delineated into three distinct zones from west to east.

i. The coastal plain, fringed with a coast line (105 km long), characterized by prominent marine landforms, alluvial plains, estuaries, beaches and dunes.

ii. Vast stretch plains and low dissected denudational hills and table land comprising the Ghats that include an intricate network of waterways and wetlands.

iii. A continuous range of highly dissected denudational hills in Western Ghats that rise about 1200m above MSL.

3.2.2 Geology

The area is largely covered by pre-Cambrian Dharwars represented by quartzites, phyllites, chlorite-schists, gneisses, metabasalts, metagreywackes and banded hematite quartzites. Besides, rocks belonging to Cuddapah age occur fringing the
northern stretch of the coast. A patch of Deccan Traps covers the crystalline rocks towards north-east. An important feature is the extensive lateritization over most of the region owing to the tropical, moist climate with vast seasonal changes. The laterites are associated with iron and manganese ores along a linear belt within the midland of the state.

The ancient Dharwarian rocks were peneplained before the outpouring of Deccan Traps. Later the coastal tract experienced epirogenic movements, headward erosion, recession of scarps, superposition of streams; lateritization; submergence, emergence; progradation and retrogression. The coast was subjected to submergence during Quaternary period followed by partial emergence during recent time. The configuration of the Goa coast line appears to have been controlled by a set of NNW – SSE fractures which have undergone lateral shifts along the NNE-WSW mega­lineaments traversing the peninsular shield (Prabhakar Rao, et al., 1985).

3.2.3 Climate
Goa enjoys a tropical maritime and monsoonal type of climate with profound orographic influence. There are three distinct seasons in a year viz. (i) Monsoon (June – September) (ii) Winter (October – January) and (iii) Summer (February – May).

Monson season experiences heavy precipitation brought in by south-west monsoon winds. The annual average rainfall is around 350 cm. Due to orographic influence rainfall increases towards the interior from around 300 cm near the coast to about 400 cm near the Ghats. Due to maritime influence, the diurnal range in temperature is quite low, being least (4-6°C) during monsoon, and maximum (10 -12°C) during February. However, the overall temperature depends on the seasons with summers experiencing the highest temperatures upto an average of 35°C and winters averaging 20°C.

Prevailing wind directions too change with time and season. Between October and April the winds in the morning are easterly to north- easterly changing to north or north east in May, while in the afternoon, they blow west or north-west due to sea
breeze effect. During the monsoon, winds are generally from west to south west throughout the day. Winds are fairly strong during monsoon and moderate during fair-weather.

3.2.4 Rivers

The state of Goa is naturally endowed with perhaps one of the best waterways network. There are seven main rivers in Goa out of which Mandovi and Zuari are the most important which are selected for this study. Together, they are considered “Life-Line” of Goa, and their basins cover 69% of the total geographic area of the state. They are mainly used as waterways to transport enormous quantities of iron and ferro-manganese ores in barges to the harbour at Mormugao throughout the year. They are also used for fishing activities, practically throughout the year and particularly during the monsoon months when the sea fishing gets suspended.

(i) Mandovi River

The Mandovi river basin has three sub basins and nine minor basins (Sriram and Prasad, 1979) which is the largest of all basins in Goa. It originates from the Parwa Ghat of Karnataka and after traversing a stretch of about 75 km joins the Arabian Sea through the Aguada bay near Panaji. Its width at the estuary is 3.2 km while, upstream, it narrows down to 0.25 km. It is fed by monsoon precipitation from the discharges from a catchment area of about 1150 km². The Mandovi river covers an area of about 1530 km² and constitutes about 42% of the land area of the territory. The rivers forming the sub-basins are Khandepar, Madei and Mapusa rivers. These three rivers join up to form Mandovi.

(ii) Zuari River

The Zuari river originates from the Dighi Ghat of the Karnataka part of the Sahyadri hills and after flowing through a stretch of about 67 km meets the Arabian sea near the Mormugao – Donapaula point. Its width at the mouth of the estuary is 5.5 km while, upstream it narrows down to less than 0.5 km. It is also fed by monsoon precipitation and receives discharge from a catchment area of about 550 km². The Zuari river covers an area of 973 km² in Goa and constitutes about 27% of the total land area of the territory. The quantity of freshwater discharge during pre and post
monsoon period is negligible (about 0.03 km$^3$/year) and therefore their flow during these seasons is regulated by tides of semidiurnal type having a maximum range of 2.3m. The basin extends from Netravali to Panjim. It has two sub-basins formed by Kushavati and the Guloli/Sanguem rivers, both having north-westerly flow. The drainage in Goa is due to the west coast faulting in the post Deccan Trap period and has evolved in the mid-tertiary (Prabhakar Rao et al., 1985).

3.2.5 Geology of Mandovi and Zuari River

The geology of Mandovi and Zuari rivers comprises of iron-ore, manganese ore and bauxite ore bearing formations. Other lithology units that cover the basin to varying degree are argillites, metagreywackes, quartz-chlorite schist and variegated phyllite, granitic and felspathic gneiss, tilloid, banded ferruginous quartzite, pink ferruginous phyllite and limestone. The rocks belong to the Goa group of the Dharar Super Group. The area south of Sanvordem consists of manganese-ore deposits. The area north of Usgaon consists of entirely of iron-ore deposits, and between Usgaon and Sanvordem consists of iron-ore and some manganese-ore deposits which comes between the Mandovi and Zuari rivers.

3.2.6 Mining in the Mandovi and Zuari river basins

Mining contributes significantly to Goa. It is estimated that 651.75 km$^2$ of land possess mineral deposits. Active mining is in process only on 5.7% of the total land area. The important minerals found in this region are iron, manganese, bauxite ores, limestone, silicate and quartzite. Figure 3.1 shows the rocks and minerals map of Goa.
Figure 3.1: Rocks and minerals map of Goa.

Figure 3.2: Industries map of Goa.
3.2.7 Industries & Minerals in Goa

The various industries and minerals in Goa are as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of small scale units (31-3-1996)</td>
<td>5118</td>
</tr>
<tr>
<td>No. of medium, large industries (31-3-1996)</td>
<td>80</td>
</tr>
<tr>
<td>Estimated average no. of workers employed daily in small scale industries (1995)</td>
<td>32,000</td>
</tr>
<tr>
<td>Mineral production ('000' tones)</td>
<td>17,307</td>
</tr>
<tr>
<td>Iron ore</td>
<td>17,173</td>
</tr>
<tr>
<td>Manganese ore</td>
<td>9</td>
</tr>
<tr>
<td>Ferro-manganese ore</td>
<td>59</td>
</tr>
<tr>
<td>Bauxite</td>
<td>65</td>
</tr>
</tbody>
</table>

Source: www.nic.in

Figure 3.2 shows the industries map of Goa.

3.3 KARNATAKA

Situated on a tableland where the Western and Eastern Ghats ranges converge into the Nilgiri hill complex, the State of Karnataka is confined roughly within 11.5 degree North and 18.5 degree North latitudes and 74 degree East and 78.5 degree East longitude.

The State is bounded by Maharashtra and Goa States in the North and North-West; by the Arabian sea in the West; by Kerala and Tamilnadu States in the South and by the State of Andhra Pradesh in the East. The State extends to about 750 kms. from North to South and about 400 kms. from East to West, and covers an area of about 1,91,791 km². Karnataka's total land area is 1,91,791 km². It accounts for 5.83 percent of the total area of the country (32.88 lakh km²) and ranks eighth among major States of the country in terms of size. As per 1991 Census, the State's population was 448 lakhs. It was 5.3 percent of the total Indian population of 8,443 lakhs.
3.3.1 Climate

The state enjoys three main types of climates. For meteorological purposes, the state has been divided into three sub-divisions namely

1. Coastal Karnataka (Dakshina Kannada and Uttara Kannada districts),
2. North Interior Karnataka (Belgaum, Bidar, Bijapur, Dharwad, Gulbarga and Raichur districts) and
3. South Interior Karnataka (the remaining districts of Bangalore Rural, Bangalore, Bellary, Chikmagalur, Chitradurga, Kodagu, Hassan, Kollar, Mysore, Mandya, Shimoga and Tumkur districts)

The Tropical monsoon climate covers the entire coastal belt and adjoining areas. The climate in this region is hot with excessive rainfall during the monsoon season i.e., June to September. The southern half of the State experiences hot, seasonally dry tropical savana climate while most of the northern half experiences hot, semi-arid, tropical steppe type of climate. The climate of the State varies with the seasons. The winter season from January to February is followed by summer season from March to May. The period from October to December forms the post-monsoon season. The period from October to March, covering the post-monsoon and winter seasons, is generally pleasant over the entire State except during a few spells of rain associated with north-east monsoon which affects the south-eastern parts of the State during October to December.

The months April and May are hot, very dry and generally uncomfortable. Weather tends to be oppressive during June due to high humidity and temperature. The next three months (July, August and September) are somewhat comfortable due to reduced day temperature although the humidities continue to be very high.

3.3.2 Temperature

Both day and night temperatures are more or less uniform over the state, except at the coastal region and high elevated plateau. They generally decrease south-westwards over the State due to higher elevation and attain lower values at high level stations. April and May are the hottest months. In May, mean maximum temperature shoots
upto 40 °C over the north-eastern corner of the State, decreasing south-westwards towards the Western Ghats region and the Coastal belt. The highest temperature recorded at an individual station in the State is 45.6 °C at Raichur on May 23, 1928 which is 6°C. higher than the normal for the warmest months. December and January are the coldest months. The lowest temperature at an individual station was 2.8 °C on December 16, 1918 at Bidar.

3.3.3 Rainfall
The annual rainfall in the State varies roughly from 50 to 350 cm. In the districts of Bijapur, Raichur, Bellary and southern half of Gulbarga, the rainfall is lowest varying from 50 to 60 cm. The rainfall increases significantly in the western part of the State and reaches its maximum over the coastal belt. The south-west monsoon is the principal rainy season during which the State receives 80% of its rainfall. Rainfall in the winter season (January to February) is less than one per cent of the annual total, in the hot weather season (March to May) about 7% and in the post-monsoon season about 12%. South-West monsoon normally sets in over the extreme southern parts of the State by about 1st of June and covers the entire State by about 10th of June. The rainy months July and August account individually to about 30% and 18% of annual rainfall. There are about 26 rainy days (with daily rainfall of at least 2.5 mm) in the south-west monsoon begins from the northern parts of the State around 2nd week of October and by the 15th October monsoon withdraws from the entire State.

The retreating monsoon current i.e. the north-east monsoon (October to December) effects the eastern parts of South Interior Karnataka and accounts for about 30% of rainfall in this region. Out of the 14 heavy rainfall stations in India, with annual rainfall of more than 500 cm., four stations are situated in Karnataka. They are Agumbe in Tirthahalli taluk of Shimoga district (annual rainfall-828 cm) and Bhagamandala (603 cm), Pullingoth (594 cm) and Makut (505 cm) in Kodagu district.
3.3.4 Water Resources
Karnataka accounts for about six per cent of the country's surface water resources of 17 lakh million cubic metres (Meum). About 40 percent of this is available in the east flowing rivers and the remaining from west flowing rivers.

3.3.5 Uttara Kannada
Uttara Kannada with Karwar as the district headquarters is one of the three coastal districts of the State. It occupies an area of 10,291 km$^2$, lying between n latitude 13°55' to 15° 31' and E Longitude 74° 9" to 75° 31'. The district is bound by Belgaum in the north, Goa state in the northwest, Dharwar district in the northeast and Udipi district on south. Physiographically, the southern and eastern parts of the district, form the Maland region which has an average elevation of about 600 m and rises, in places to 900 m above msl. The western part of the district is mostly coastal plain. Parallel to the coast line on the inland, Western Ghats form a chain of ridges.

(a) Geology
The lithounits encountered in the area are basement gneisses of Peninsular Gneissic Complex, metavolcano–sedimentary sequences of Dharwar Supergroup and younger intrusive at granites. The Dharwar Supergroup of rocks unconformably overlying the Peninsular Gneissic Complex is divisible into lower Bababudan and the upper Chitradurga Groups. Lithosequence of Bababudan Group is represented by metabasalt and acid volcanics; orthoquartzite and quartz -mica schist and banded magnetite quartzite occur interbanded with metabasalt. The rocks of the Chitradurga Group in this segment is known as Shimoga belt and well exposed on the northern and eastern parts of the district. The younger granites locally called Karwar granite is intruded into the gneisses and schistose formations. The laterite cover is extensive in the area.

(b) Mineral Resources
Iron Ore: Iron ore deposits of economic interest are located in Anmod, Siddi hills, Ivoli, Hudsa, Illaiyadabe, hatkhaamba, Shirol, Kunang, Avarchi, Bedarhosahalli, Asparkonda areas, Talaginkere, Mavingundi and Kalche. The reserves are of the order of 80 million tonnes.
Manganese Ore: The manganiferous formations are associated with orthoquartzite-limestone and manganiferous cherts/quartzite. The important manganese deposits are located between Mirjan and Palda and Supa-Dandeli areas. The other important localities are Manigadde, Kodalgadde, Hebbarakumri belt, Arbail-Bisgod, joida, Hatkhamba, and Kumbeli.

Sulphide: Massive sulphide ore containing pyrite and pyrrhotite with subordinate amounts of chalcopyrite has been reported in Kaiga, Kadra, Motimakki areas.

Steatite: Steatite of good quality has been reported along the western flanks and foot of the hill about 1 km west of Dhareshwar and also about 5 km northeast of Karwar.

Limestone: Several bands of crystalline limestone varying in composition from high calcium to dolomite and sillicious type are found in the vicinity of Chinvalvi, Hebbal, Godemane, Natruge Nagihari, Ganeshgudi and Castle Rock.

Dolomite: A dolomitic limestone band exposed in the Nagiri valley is 1.5 km long and 100 m wide. Also exposed, about 5 km southeast of Ulvi temple in the vicinity of Chilmi, Hebbal, Godemane, Natruge, Barballi, north of Kalche and Kaula caves of Haliyal taluk.

Clay: It occurs at Castle Rock, Supa, Kumta and Bhatkal.

Titaniferous magnetite ore: Titaniferous/vanadiferous bearing magnetite associated with gabbro-anorthosite has been reported at Kaiga, Motimakki, Kanneri, Santepet, Suryakalyani gudda, Durga gudda and Gundal-Vagoli areas.

(c) Geomorphology and Geohydrology
The western segment of the district bordering the coastal line is made up of coastal plain covering with lateritic soil and lateritic plateau. Western Ghats hill ranges lying further east are presently seen as denudational hills; banded cherts and granitoids form structural hills and tors. The general depth of water table is 3 m to 12 m. In most part of the district the yield per second is upto 10 lts. Figure 3.3 and 3.4 shows the geomorphological and geohydrological map of Uttar Kannada.
Figure 3.3: Geomorphological map of Uttara Kannada, Karnataka
Figure 3.4: Geohydrological map of Uttara Kannada, Karnataka
(d) Soil and Land Use
Laterite soil is the chief soil type of the district followed by red loamy and black soils. In parts of the coastal region, sandy alluvium is seen. Nearly 75% of the total area of the district is under different categories of forests and agriculture land constitutes about 15% of the area. The rest of the area is fallow and under grazing.

(e) Geotechnical Characteristics and Natural Hazards
According to geotechnologists, the four major geological provinces of the district are (i) coastal sediments of recent origin along the coastal plains followed in the east gradually, (ii) lateritic cover, (iii) deformed meta-sedimentaries and (iv) basement crystalline.

3.3.6 Dakshin Kannada
Dakshin Kannada district is located in the south western part of Karnataka which forms a part of coastal tract along the west coast covering 8,435 km². Physiographically, the eastern part of the district is occupied by a part of Western Ghats and a major portion of the ranges constitute thick forest lands and high hills. The western part of the district forms the coastal plain. The coastal plain from sea shore to the Western Ghats shows an average elevation of 75 m above msl.

(a) Geology
The rocks types of the district could be classified into (i) high grade schists of Sargur Group, (ii) migmatites, granites and gneisses of Peninsular Gneissic Complex and (iii) metal volcano-sedimentary sequence of Bababudan Group. Extensive lateritisation during the Tertiary Quaternary period has given rise to 15-20 m thick cappings of laterite on all the lithounits in the district. Coastal sands and “Teri” sands are seen in the coastal plains as parallel sand flats consisting of coarse sands mainly of quartz with limonite coating.

(b) Mineral Resources:
Bauxite: Aluminous laterites are exposed on some of the hillocks within the vast stretch of laterites. Bauxite is found at Kkudarka, Brelamana, Sampayee Kalamandkuru, Mudabidri and Baindur areas. Figure 3.5 shows the rocks and minerals map of Dakshin Kannada.
Clay: Occurrences of China clay are reported from Keyyuru, between Parave and Kuntur, between Belthangady and Ujre; Bala and Kulai, near Mangalore.

Corundum: Corundum occurs as irregular crystals admixed with quartz and kyanite near Sampyadi, about 10 km from Uppinagadi.

Garnet: Abrasive grade garnets are commonly found associated with the high grade gneisses of granulite suits of rocks.

Gold: Association of gold within the laterite patches and banded gneisses in the southern part of Dakshina Kannada is recorded.

Iron Ore: Occurrences of iron ore are reported from Arabadagudda, Butalgudda and Odalthmukh in Puttur taluk, Kanyana in Bantwal taluk, Keradi in Coondapur taluk and Nidle in Belthangady taluk. The iron ore is mostly haematite with iron content varying between 53% and 58%.

Lime Shell: These deposits occur in bedded form fringing the backwaters close to the sea and also along the banks of rivers. They are found near Cheruvatur, Mulki, Udayapur, Kalliyanpur, Hemmadi, Uppinakadur, Paduvarai, Kiri Manjeshwar, Padubbidri and Baindur.

Kyanite: Small deposits of kyanite are seen within the biotite schists in the south of Belthangadi and near the border of Belthangadi and Puttur taluks.

Sillimanite: Deposits of sillimanite are found within the kyanite – sillimanite to southwest of Subramanya in Sulya taluk.

(c) Geomorphology and Geohydrology
The western part of the district is a coastal plain featuring marine, fluvio- marine, fluvial and denudational geomorphic units. The eastern part forms the denudational hills of Western Ghats. The coastal lands form good aquifers and yield water in abundance.
(d) Soil and Land use
Laterite soil is the widespread type of soil found in the district. The valleys and rivers to the east of the coastal region is filled with alluvial soil.

(e) Geotechnical Characteristics and Natural Hazards
Major morphometric/morphotectonic units are coastal plains, a few small lateritic plateau and the remaining areas are dotted with hillocks of both regional and structural types. Coastal plains covered with recently formed unconsolidated sand and clay are with high permeability and low in bearing capacity and poor in foundation characters, whereas crystalline rocks posses high to moderately high compressive strength and desirable foundation characteristics.

(f) Industries
The various industries of Dakshin Kannada are shown in figure 3.6.

3.3.7 River Systems
There are seven river systems in Karnataka with their tributaries as given below:

<table>
<thead>
<tr>
<th>River Systems</th>
<th>Drainage Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000 km²</td>
</tr>
<tr>
<td>Godavari</td>
<td>4.43</td>
</tr>
<tr>
<td>Krishna</td>
<td>111.74</td>
</tr>
<tr>
<td>Cauvery</td>
<td>34.27</td>
</tr>
<tr>
<td>North Pennar</td>
<td>6.94</td>
</tr>
<tr>
<td>South Pennar</td>
<td>3.76</td>
</tr>
<tr>
<td>Palar</td>
<td>2.97</td>
</tr>
<tr>
<td>West Flowing Rivers</td>
<td>26.39</td>
</tr>
<tr>
<td>Total</td>
<td>190.50</td>
</tr>
</tbody>
</table>

The west flowing rivers (six rivers) have been selected for this study from the state of Karnataka are as follows:
(i) Kali River
The total length of the Kali river is 184 km. After winding in the south-eastern course for about 55 km, it takes a sharp turn to the south-west near the village Devikop. Beyond this point, it flows 66 km and takes an east-west course and then finally falls into the sea near Sadasivgarh, three km north of Karwar.

(ii) Gangavali River
The Gangavali river is formed by the confluence of two streams one by name Shalmala which has its origin near Someshwara temple, south of Dharwad and the other, the Bedti stream, originating in Hubli. These two join near Kalghatji and then, it is named the Gangavali/Bedti and flows for about 25 km westwards and enters the Uttara Kannada district, and after a fairly straight south-westerly course of about 32 km, falls into the sea about 32 km south of the Kali river. The united stream passes about eight km south-east to the border of Uttara Kannada district when it flows for a length of 96 km (out of its total length of 161 km).

(iii) Agnashini River
The Agnashini river or Tadri (total length 121 km) river rises at Manjguni near Sirsi and after an winding westerly course of about 70 km falls into the sea about 10 km south of the Gangavali river. It receives no feeder of any size throughout its course. It has two sources, the Bakurhole rising in a ponds at Manjguni about 25 km west of Sirsi and the Donihalla whose source is close to Sirsi. The streams meet near Mutthalli about 16 km south of Sirsi. Under the name of Donihalla it flows about 24 km south of Sirsi with a winding westerly course to the western face of the Sahyadris. From Uppinapattana it winds south-west and then north-west together about 13 km to Mirjan an old seat of trade. From Mirjan, it forms a lagoon or backwater which runs parallel to the coast, about 13 km long and 2 to 6 km broad, cut off from the sea by a belt of land with a nearly uniform breadth of about a mile. The river is known either as the Tadri or as the Agnashini river from two towns on the right and left banks of its mouth.

(iv) Sharavati River
The Sharavati river or Gersoppa or Banaganga river has its origin at Ambutirtha in Tirthahalli taluk of Shimoga district. After a northerly course of about 64 km from
Nagar, it forms the south-east boundary of Uttara Kannada for about 13 km and then passes about 32 km west or 128 km in all to join the sea at Honavar. About 30 km west, it reaches the ancient capital of Gersoppa. During the remaining 27 km to the coast, the river flows between richly wooded banks fringed with mangrove bushes, a broad tidal estuary, brackish in the dry weather but during the rains sweet even close to its mouth.

(v) Gangoli River
The river Gangoli is formed by several smaller streams that meet and form a broad estuary to the north of Coondapur town, and fall into the sea at Gangolli. Of the important streams forming, it may be mentioned the Kollur, Haladi and Chakranadi streams. As the Western Ghats are nowhere more than 40 km from the sea in Coondapur taluk, the course of this river is very short, but the quantity of water brought down is very large owing to the heavy rains.

(vi) Netravati River
The Netravati river rises in the Ghats to the east of Kudremukh and flows down the Bangadi valley past Belthangady, after which it is joined at Uppinagady by another river called the Kumanadhara, which comes from Kumara-Parvata near Subramanya. The combined stream passes over a rocky bed to Buntwal and through richly wooded banks to Mangalore.
ROCKS AND MINERALS

REFERENCES

ROCKS

- Unclassified crystalline (mainly gneisses)
- Granite, Granodiorite, Pegmatite
- Schists, Phyllite, Shale, Limestone
- Alluvium
- Charnockite

MINERALS

- Corundum
- China clay

Figure 3.5: Rocks and minerals map of Dakshin Kannada, Karnataka
Figure 3.6: Industries map of Dakshin Kannada, Karnataka