CHAPTER - I

GENERAL PHYSIOGRAPHIC ELEMENTS

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CHAPTER - I
GENERAL PHYSIOGRAPHIC ELEMENTS

1.0.0  Introduction:

The river Varada which is the tributary of the river Tungabhadra rises at Varadamula near Ikkeri in Sagar taluk of Shimoga district in Karnataka State. Geographically the basin extends from $74^\circ 45'$ to $75^\circ 45'$ E. longitude and $14^\circ 5'$ to $15^\circ 05'$ N. latitude. The total area of the basin is about 5,354 sq.kms. The Varada river is the tributary of the Tungabhadra, which in turn joins the Krishna river which joins finally the Bay of Bengal. This river system originates at the sight of the Arabian sea but joins the Bay of Bengal. The Western Ghats are the main watershed area for the Varada river which is joined by four main tributaries, namely, Dandavati, Dharma, Mavin hole and Doddahalla. The Varada river flows in a northeastern orientation (Fig. 1 & 2).

Geologically the Varada river basin forms the southern part of Deccan trap of Karnataka plateau in the peninsular block. The basin has varied geological characteristics under the Archaean complex or crystalline complex consisting of the Dharwar system and gneissic complex. Dharwar as narrow NNW and SSE trends forms the oldest formation of the
Pre-Cambrian period. The contour maps (see II chapter) of the Varada river basin reveal the undulating topography and rounded hills in the southern part of the basin, towards north east the basin extends on gentle rolling plain. The general elevation or altitude of the basin varies from 515 to 850 metres (Fig.3) and its general slope is from southwest to northeast. The source region of the Varada river has rugged mountainous topography where contour crosses 621 to 681 metres. In the south of the basin near Talaguppa about 5 km. from the basin boundary, the river Sharavati flows and forms the famous Jog falls before finally joining the Arabian sea. Within a short distance of around 5 kms. rivers flow in opposite directions due to structural control and river piracy. The south-western side of the basin rests upon the Western Ghats called the Sahyadri. The evolution of drainage has also been of great importance in the study of the regional geomorphic history.

Administratively the Varada river basin covers five taluks of Dharwad district and one full and one part taluk of Shimoga district and part of two taluks of Uttar Kannada district.

1.1.0 Physiography:

The location of the Varada river basin is of considerable geomorphic significance. The whole area
comprises two main physiographic divisions of Malnad and Maidan regions, covering about 2,910 and 2,444 sq.km. respectively. These two main types of physiography characterise the plateau. Each is having distinctive characteristics in the Indian peninsula (Fig. 2).

1.1.1 Malnad Region:

The south and north west part of the basin lies in Malnad area. The general elevation ranges from 545 to 850 metres. Malnad, a hilly and mountainous country with thick vegetative cover forms the edge of Western Ghats. The south and south-western side of the basin rests upon the Western ghats called the Sahyadri. It is deeply dissected, heavily forested and is in a stage of extreme youth. It is also a region of heavy rainfall and intensive erosion (Radhakrishnan, B.P., 1966). This fact is confirmed by the rainfall distribution map (Fig. 4). The Western Ghats are having steep and precipitous slope to the west and a gentle slope to the east. Area covering in Sirsi and Siddapur taluks few hills and low hills stretches in planes which is fairly wooded and dotted with rice fields, sugarcane and garden land. These extend in the deep moist valleys between hills covered by semi ever-green forest. The major part of Malnad covered by Sagar and Sorab talukas is crossed by a
chain of hills. The range extends from Alhawadi (Sagar Taluk) to westwards through Ikkeri (where Varada takes its birth) upto Talaguppa. The conspicuous hill of Sorab taluk in the west is the Chandragutti hill with a height of 848 metres (Photo 4014). Along the 640 metres contour, it may be seen that Sorab taluk, except Chandragutti hill (Chandragutti habli), has gently undulating. The area covering Malnad of Hanagal taluk is undulating in nature. Clusters of hillocks exist in the north west.

1.1.2 Maidan Region:

As we pass eastwards, the hilly wooded country gives place to a gently rolling open plateau called the Maidan, meaning a featureless plain country. It is a true plateau and a product of erosion, the elevation ranges from 515 to 636 metres. With its monotonous and varied relief the Maidan presents a senile topography. The basin area covers about 2,444 sq.km. along the boundary which demarcates it from Malnad region, where the transition of climate is observed. The Maidan gently slopes towards north-east. In the present cycle it has reached an advanced stage of maturity. The rainfall decreases from north-west to north-east of the basin. The soil is characteristically black and mixed. Geologically, the region is formed of horizontally-bedded quartzites and greywackes, shale of lower Pre-Cambrian and
recent spreads of basic lava viz. dolerite dykes.

The Maidan region covers Haveri, Savanur, Byadgi talukas and part of the east of Shiggaon and Hanagal talukas. The physiography of the region is explained talukwise to understand its micro-level character.

Shiggaon taluk, physiographically, the area is gently undulating, having low mounds and hills with intermittent shallow valleys. The region forms a transition zone between the hilly western ghats and the vast plains extending to the east of the basin. The elevation ranges from 575 to 666 metres. Savanur taluk forms more or less a plain country. In general, the elevation of the area ranges from 533.40 to 640.00 metres above mean sea level. Few clusters of hillocks exist in the northern part of the taluk. South of Savanur and Bankapur begin the lower levels of the Varada basin, with their red soil expanse.

Haveri taluk is bordered by the river boundary in the north. The terrain is generally flat-lying with very gentle slopes. The area towards north and south is elevated and the general slope is towards south-east. There are three groups of small hillocks in the north-east, south-east and south-west corners of the taluk. The general elevation falls between 1750' and 1850' mean sea level, with a
maximum elevation of 2,315 ft. River Varada flows on from west to east for a length of about 52 miles and has a meandering course amidst a flat landscape mostly covered by thick black soil. The river is broad and has a gentle gradient.

Byadgi taluk has a varied topography. There are three chains of low mounds running NE-SW surrounded by gently undulating plains. The undulating topography gets pronounced towards the western portion of the taluk. The hill ranges have a flat base and rounded topography. Landscape here is much influenced by drier climatic conditions. The area generally lies in between 11850 ft. to 2100 ft. above sea level.

The east of Hanagal taluk extending in Maidan region on the east of the Sahyadrian region marks a characteristic of transition from the wet environment of the Sahyadris to the dry conditions of the black soil tract.

1.2.0 Climate:

Climate is a basic environmental factor. A study of the behaviour of the climatic elements i.e., temperature, pressure, winds, rainfall etc. forms a study of the climate of the region. In the broadest sense, climate is the
characteristic condition of the atmosphere near the earth's surface at a given place or over a given region. Though climate is the function of natural agencies, it influences the natural and cultural environment.

The Varada river basin is situated in the tropical zone. Its climate is described as tropical monsoon climate, because of the influence of two air masses, south-west and north-east monsoons. The following four seasons recognised by the climatologists for Karnataka are also applicable to the Varada river basin.

1. Cold-weather period or cool and dry (January to February).
2. Hot-weather period or hot and dry (March to May).
3. South-west monsoon period or main rainy season (June to September).
4. North-east monsoon period or a subsidiary rainy season (October to December).

Due to the lack of availability of information regarding climatic elements the researcher has to depend on the basis of the generalisations on the records of Gadag, Shimoga, Honnavar and Dharwad meteorological observatory, specially for the temperature, humidity and wind speed. Rainfall data are used in a detailed scale because they are available for several rainguage stations in the study area.
### Table - 1 : Climatic Elements

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<tr>
<th>Station</th>
<th>Jan</th>
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<td>34.4</td>
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In general, it is observed that the area, on the basis of Koppen's classification, occupies a place in the Bsh* and AW* climates. In the Thornthwaite* classification the study area come under A+ and B+ climates.

1.2.1 Temperature:

The average temperature varies from place to place and from season to season. The meteorological stations which are selected, two from Maidan (Dharwad and Gadag), one from Malnad (Shimoga) and one from Coastal region (Honnavar), are located in the north, south west and south east of the basin respectively. A summary of the average monthly maximum and minimum for representative stations is given in Table - 1. From November to February high temperature is found except in Honnavar station which is located in the coastal belt. Next period observed low temperature from July to September at that time high rainfall is registered and correspondingly in the same period high relative humidity is also recorded. The above fact reveals that temperatures are controlled very much by the rainfall. The behaviour of temperature is distinct in the dry and the wet

* Bsh: Semi-arid steppe climate, AW: Tropical Savannah type
+ A: perhumid, B: Humid.
periods. In March and April temperature increases appreciably. The day temperature shows greater rise and the diurnal range increases. The relative humidity is lowered further. Haveri, Shiggaon, Savanur and Byadgi talukas come under semi-arid tract. The temperature varies from 28° to 33° C. Hangal taluk comes under Malnad tract, the average temperature would be 26° C. The temperature record of Hannavar, from 1931 to 1960, (Mines and Geology Report of 1978) varies from 14.2° C to 22° C. minimum temperature, whereas the maximum temperature ranges from 22° C to 37.8°. The distribution of temperature from the above figures is applicable to Sirsi and Siddapur taluk and same is observed in Sagar and Sorab taluks (Table – 1). These talukas come under Malnad tract. In general its temperature is modified by the following factors:

1. The Altitude, 2. Distance from the sea and 3. Monsoons.

The marked fluctuations of temperatures in different seasons initiate the weathering process.

1.2.2 Winds:

Wind is a potent element of climate in the process of the landform development especially in tropical and semi-arid regions of the basin. Depending on the wind speed and its frequency, soil erosion takes place, different sizes of soil particles exhibit different rates of movement. The
bare cultivated sites of Maidan in the basin wind effect leads to movement of more particles. This is observed in the field on the crops like cotton and groundnut where plants are spoiled due to this effect. This effect is less in the Malnad region of the basin because of thick vegetative cover. Winds are generally light in the basin with increase in force during the SW monsoon season. This is clear from Table No. 1, where wind speed is high from June to August. Highest wind speed is recorded in the month of July (12.3 km. per hour).

1.2.3 Rainfall:

Within the basin marked differences are found in rainfall distribution both in terms of space and time. The nature and amount of rainfall is also significant in the study of weathering. Most of the rainfall is received during June - September (Table No. 2). The rainfall data for thirty stations have been collected. The South-West monsoon breaks by the middle of June; it has profound influence. The Malnad is characteristically a region of heavy and reliable rainfall decreasing from 35-000 mm. to 1,000 mm., from south-west to north-east in the basin (Fig. 4). Towards the Maidan it decreases up to 500 mm. The distribution of rainfall and rainy days at different rain gauge stations
Table 3: Normal rainfall in mm. Monthly Percentage of the Annual and average number of Rain-days.

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<th>Station</th>
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</table>

(a) Normal Rainfall in mm. (b) Monthly Rainfall as Percentage Annual. (c) Average No. of Rainy Days.

These normals are based on data up to 1940 (1901-1940).

Source: Gazetteer of Bombay State, Dharward District (Revised edition) 1951.

Normals and Extremes of Rainfall

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<th>Station</th>
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<th>Mar</th>
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<th>Jun</th>
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(a) Normal Rainfall in mm. (b) Average No. of Rainy-days (days with rainfall of 2.5 mm or more).

Rainfall Data Collected from 1901 to 1950.

Source: Gazetteer of India, Karnatakas State, Shigmo District, 1975.
(year 1901 - 1940 and 1901 - 1950) exhibit high variations. In Malnad area viz. Sagar, Sorab and Hangal both rainfall and total rainy days are high. This leads to more water flow to streams, greater intensity of erosion and sediment flow. Because of this variation of rainfall the sub-streams and Varada river main channel are more perennial in nature in Malnad area than in the Maidan region. The taluk-wise rainfall distribution is as follows - Haveri, Byadgi, Shiggaon and Savanur range from 600 to 900 mm, Hangal 900 to 1500 mm, Sirsi, Sagar and Sorab 1500 to 2700 mm. Siddapur is 3000 mm and above.

The rainfall during the south-west monsoon period is orographic in nature. The distribution of the rain is controlled by (a) the intensity of the monsoon winds and (b) the relief of the Western Ghats. The basin covering on the edge of the Western Ghats of Sahyadri hills, is situated in rain-shadow area. In this study an attempt has been made to test the rainfall variability in relation to topography. I have selected thirty-two (Table - 4) rainguage stations in the basin and height of each station above the sea level as representative height of the area. The correlation co-efficient of rainfall and height of the stations in the basin shows the value of -0.2941. The result shows that the rainfall decreases as height increases. After 't' test
it shows that the relationship is not significant. While testing the same correlation coefficient for Maidan and Malnad the value is 0.5495 and -0.0371 and shows the significant and insignificant relationship respectively. This may be due to local conditions like pressure, temperature and relief. Within basin area transition of climate, rainfall with different nature of topography are observed.

The overall analysis of weather elements shows that the area lies within the tropical monsoon climate of a morphogenetic region in the tropical zone of the world. It is the rainy season which is the period of intensive erosion for major morphological shapings. The fluctuations in the temperature and precipitation add much to this aspect. The basin comes under the world's broad groups of erosional classification of 50 to 100 tonnes/km² (Gregory and Walling). Soil creep and rock decomposition are associated with the rainy season.

1.3.0 Natural Vegetation:

There are a variety of vegetation types in the Varada river basin (Fig. 5). These forms reflect the climatic and soil characteristics of this region. The vegetation is a function of climate and environment. Geographers analyse the
National Atlas and Thematic Mapping Organisation
Department of Science and Technology, Government
of India, Calcutta, 1982.
environment in which the plant grows the climate, the soils and the topography and also the effect of humans on the total environment (Palm, R.S., 1978).

Natural vegetation of the Varada river basin has been divided into three broad groups of forest types (Fig. 5). These are semi-evergreen forest, tropical moist deciduous and scrub and grassland. The malnad forms a vast area of the first two groups. The total forest area in the basin is about 97,793 hectares. The tropical semi-evergreen forest and tropical moist deciduous forest grow because of heavy rainfall and total number of rainy days per year is also high. It is an important factor for this luxuriant growth of vegetation (Photo 1 to 5).

The evergreen forest is confined to the Sagar part of Sorab and Siddapur talukas. Many of the hills are covered with heavy forests while valleys and ravines produce luxuriant trees known for their great height and size. Some of the important evergreen species of this belt are dhupa (Veeradiaidica, Linn), ballagi (Poeclioneourn indicum, Bedd hebbalasu Bedd), Kiralbhogi (Hopea paraviflora, Bedd) nagasampige (Mesua ferra, Linn), halasu (Artocarpus integrifolia, Linn) mova (Majiferia indica, Linn), Karimara (Diospyros ebonum, Koeshin) holematti (Lagerstroemin flos-Reginae Retz) and others. The moist deciduous forest is confined to the north
west of the basin and the Kanas of Sorab. It is producing timber forest and sandalwood. The prominent moist deciduous species of this belt are Sagavani (Tectona grandis, Linn.f), bete (Dalbergia latifolia, Roxb.), honne (Pterocarpus marrupium, Roxb), Matti (Terminalia tomentosa, W4A).

Along the Dharma river trees are grown and roadside trees are prominent in Haveri taluk i.e., from Havanur to Haveri, and from Haveri to Shiggaon (NH4) mostly neem and Hunsi trees. In Haveri, Savanur, Byadgi and east of Shiggaon taluka vegetation is scrubby with sparse growth of trees. Talukewise distribution of forest is as follows:

<table>
<thead>
<tr>
<th>Taluk</th>
<th>Forest area in hectares</th>
<th>Taluk</th>
<th>Forest area in hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byadgi</td>
<td>4,889</td>
<td>Sagar</td>
<td>4,078</td>
</tr>
<tr>
<td>Hangal</td>
<td>8,376</td>
<td>Sorab</td>
<td>26,262</td>
</tr>
<tr>
<td>Haveri</td>
<td>3,422</td>
<td>Sirsi</td>
<td>23,721</td>
</tr>
<tr>
<td>Shiggaon</td>
<td>8,640</td>
<td>Siddapur</td>
<td>17,604</td>
</tr>
<tr>
<td>Savanur</td>
<td>801</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The distribution of forest is mainly determined by the general climate and soil conditions. In recent years forest cutting is fast for fuel and timber purpose. In Sagar
and Sorab talukas most of the valley-side forest has been cut for the purpose of agriculture. The step-like farms of patch lands, where paddy is growing, are observed. The conservation of this resource is very important to maintain the ecological balance and helps to preserve excessive erosion. It is observed that trees grow along the sides of the Dharma river and cause less lateral erosion. Therefore it is suggested that more trees should be grown along river banks and valley slopes to preserve good environment and to control soil erosion and also for soil conservation.

1.4.0 Geology:

Geological structure has a bearing not only on relief and landforms of a region, but also on the distribution of minerals, rocks and soils (Reddy, N.B.K. and Murthy, 1967). Geology is the base on which various geographical factors operate to create varying landscapes and patterns of activity (Misra, R.P., 1973). To understand and appreciate the geographical peculiarities of the area, we must take into account its geological past (Table - 6).

The land now occupied by the state of Karnataka forms part of that ancient land mass called pangaea which broke into
several blocks some 3,000 million years ago to form the nuclei of the continents we have today. One such block was the Gondwanaland which drifted slowly and steadily only to further sub-divide itself into smaller blocks, one of which now forms peninsular India. As the rock material forms these blocks and they are Archaean in nature. Archaean rocks of peninsular India are often termed the 'Crystalline Complex' and it consists of two groups of rock formations: the one gneissose and the other schistose. Most of the part of the Varada river basin is covered by rock formations of Dharwar group or Dharwar schists. Pichamuthu (1967) peninsular gneiss complex was originally considered to be the basement on which the Dharwar lavas and sediments were deposited. It was later thought that the gneisses were intrusive into the Dharwar and so younger in age. Radhakrishna (1964) has adduced certain reasons for regarding the gneiss as the basement. The age and origin of this formation is still in question.

The basic materials, which form Archaean rocks are as old as the earth itself, are made of the first solidified crust of the earth as it cooled from its fluid state. Both the Dharwar schists and the peninsular gneisses are together subjected to intense diastrophism with the result that they are now interbedded and interfolded.
ROCKS AND MINERALS

MINERALS

- Iron Ore
- Limestone
- Clay
- Soap Stone
- Metamorphic Rocks
  Schists, Phyllite, Shale,
  Lime Stone, Quartzite
- Igneous Intrusives
  Granite Granodiorite
  Pegmatite

Geologically, the Yarada river basin consists of the most ancient rock formations of Archaean complex, which are composed chiefly of two systems: gneissic system and Dharwar system (usually called Dharwar schist). Nearly two-thirds of the basin area covered by the Dharwar system (Fig. 6).

1.4.1 Granitic gneiss peninsular:

The peninsular gneiss in the Archaean system forms the oldest rock of the earth's crust that has been found at the bottom of the stratified deposits. It forms the core of all the great mountain chains of the world and the foundations of all its great ancient plateaus (Wadia, D.N., 1966, p. 76). The Yarada river basin is situated in the Karnataka plateau. The Archaean rock system is often known by the names of the "fundamental Complex" the "Basement Complex", etc. The crystalline metamorphosed sediments and granitic gneiss are distributed in the Sagar and Sorab taluk of the study area (Fig. 6).

1.4.2 Dharwar Schist:

The schistose group constitutes the Dharwars or the Dharwar group of rocks which represent one of the oldest rock formations of Karnataka. In the study area it is composed of quartzites, shales, banded hematite quartzite,
Since the sedimentary rocks are deposited in geosynclinal basins separated by mobile belts, they have acquired the status of 'Gratan' (Sadashivaiah, M.S., Jan. 1981). The rocks of the Dharwar group are composed of both meta-igneous rocks and sedimentary pile and occur in Karnataka in linear belts trending NNW - SSE. The Dharwad - Shimoga belt is the extensive area of the basin. The stratigraphic position of the Dharwars in the Pre-Cambrian column is still unknown. Foote (1886) considered Dharwar as "Lower transitional system" unconformably overlying Archaean granitoid gneisses.

1.4.3 Dolerite Dykes:

Numerous dolerite dykes ramify in all directions through the Dharwar. They are subsequent in age to the general folding of the Dharwar. The dolerite dykes are traced in the basin near Haveri and at Kunemelhalli across Varada river (Photo. 6).

Haveri Taluk:

Geologically the area is made up of almost entirely of steeply dipping schistose graywackes. The general trend is NNW - SSE. The rock is fine to medium grained in texture and very much fractured and joined, weathering is seen
generally to extend to a depth. The graywacke formation is traversed by quartz veins and joints are usually filled with Kankar. Joints, cracks, and foliation planes provide channel ways for the movement of water.

**Byadgi Taluk:**

Geologically the area is made up of steeply dipping graywackes. The general trend is NNW-SSE. The rocks are fractured and formulated and are medium grained exhibiting a light grey colour. The fresher portions are compact, light green in colour and devoid of joints. Weathering is generally seen to extend upto 50-60' of an average. Joints are spaced at 2-3' interval and they are open in the upper region and get closed at depth. The gaping joints usually occur upto a depth of 30-35' after which the frequency of joints diminishes. Joints are noticed even upto 110' as seen in some of the borewells. The joint planes are usually filled up by Kankar in the weathered zone. Quartz veins are seen transversing the formations, parallel to the plane of foliation. In some places graywackes grade into shales which are ferruginous and alternate with bands of quartzites.

**Savanur Taluk:**

Geologically, the area is predominantly made up of phyllites and phyllitic schists of Pre-Cambrian age and
prominent outcrops are seen on the low ridges which are exposed to N 15° E and N 40° W of Savanur. Phyllites are noticed in the NNW-SSE direction with an easterly ranging from 70-80°. These are the original pediments derived from the basic volcanic rocks and were metamorphosed giving rise to pronounced schistosity. The rocks are traversed by vertical, horizontal and diagonal pattern of joints noticed upto 16 m. at depth. The joint planes are filled up with silicon and Kankary material. The weathered zone is noticed upto 20 m. around Savanur proper.

Exposures of shales are also noticed at Savanur and on the low ridge of Shirbadgi village. A basic dyke exposure is also seen at Savanur.

**Shiggaon Taluk:**

Geologically the area can be divided into three units, the northern portion consists mostly of shales, the western portion consists of laterite and lateritic clay and the rest constitute the schistose belt.

This consists of ferruginous quartzites and cherts. These are noticed between shale and greywackes. The formation trend is NNW-SSE direction with steep easterly dips. These rocks are well jointed with prominent inclined and horizontal joints. The joints are open and spaced at
0.6 to 0.9 m. Normally joints persist up to 18 m. (observed near Panigatti). Rock areas are weathered with average thickness and decomposed zone may be taken as 12 m.

**Hangal Taluk:**

The chief geological formations of the area are greywackes of Pre-Cambrian age. Prominent outcrops are seen in the form of low ridges which are to northeast, southeast and northwest of Hangal. Graywackes are noticed to trend in a NW to SE direction, with a high dip ranging from 50° to 80° westerly. Prominent outcrops of banded ferruginous quartzites are seen near Adur, Nitginkop and Jangurdikop and they are trending N 40° W. Clay deposits are also near Adur which are derived from Dharwarian shales. The rocks are traversed by minor joints and fractures. These formations are weathered up to a depth of 15 m. and at places the chief formations, the graywackes are traversed by quartz veins which range in width from 0.20 to 1.50 m.

**Sirsi Taluk:**

The geological formations encountered within the area are laterites, phyllites, shales, granite, schists and graywackes. Laterite is found in great abundance which consists of clay and has a perforated and cellular structure. Near
Banavasi area in the unconsolidated valley fills the laterite being underlain by the shales. The thickness of the laterite ranges from 2 to 10 m. The prominent outcrops are seen only along streams and also on ridges, striking NNW-SSE directions with dips ranging from $60^\circ$ to $80^\circ$ east. The graywackes are foliated and are light to dark green in colour. They are traversed by horizontal and vertical joints. The granitic gneisses have a dip of about $30^\circ$ striking NW-SE.

**Siddapur Taluk:**

Geological formations encountered within the area are graywackes and Migmatite-associated graywackes. Exposures of graywackes are seen in the stream or nalla cuttings around Kansur. The general strike is from northwest to southeast and dips to west with varying angles. Weathered phyllite is exposed near Avergupa, striking northwest - southeast and dipping $60^\circ$ south. Laterites are characterised by vesicular and tube-like structures. The tubes are filled with soft gray or brown to pinkish gray substances, sometimes even by silica.

**Sagar and Sorab Taluk:**

Geologically these talukas consist of the most ancient rock formations of Archaean complex which are
composed of chiefly two systems, the Dharwar system and gneissic system. The Shimoga belt extends in the eastern part of Sorab. This belt is made up of chiefly chloritic and in places mica cons of hornblendic associated with volcanic rock types. Along with them are found highly altered sedimentary rocks such as quartzites, champion gneiss, banded ferrugineous quartzites and iron ores.

The remaining part of Sagar and Sorab taluks is covered by gneissic system and it is much younger than the Dharwar system, which chiefly consists of granitic gneiss. The outcrops of gneisses are noticed along the western part of Sorab taluk. The rock, which is rounded, consists of ferruginous quartz. Some of the laterites contain ferruginous and manganese patches in western part of Sorab taluk.

1.5.0 Soils:

Soil is a natural body consisting of mineral matter, decaying organic matter and of micro-organisms. It is a living body and reacts in different manner to different climatic factors. Soil is a product of the action of climate and living organisms upon the parent material through ages and it is conditioned by local relief (Arakeri, H.R.,
Murthy, D.V., Seshadry, A., 1960). The final product, which is termed soil is a result of weathering and soil forming processes. Weathering processes include mechanical, chemical and biological processes. The soils become adjusted to conditions of climate, landform, and vegetation and will change internally when those controlling conditions change (Strahler, A.N., 1973). Its utility and capacity to depend on the parent materials and processes involved in it. Soils form the root of the present civilization.

The soils, that cover the basin, exhibit a marked diversity in different parts of the area, (Fig. 7) depending upon the nature of the parent rock and the climatic conditions prevailing in the area. Descriptions of soil and its enclosing landscape are the essence of the physical geography of soil. The following main types of soil recognised in the study area are classified by the National Commission of Agriculture (*). The soil data are updated based on the recent soil survey carried out by the authors in the different landscape of the State (Soils of Karnataka, 1979-80).

These are as follows:
1. Laterite soils
2. Laterite gravelly
3. Medium black soils
4. Red sandy soils
5. Deep black soils
The principal geological formations underlying the basin are igneous and metamorphic rocks. In addition, the characteristics of the geological formation are known as Dharwar schists.

Laterite soils covered 7.03% of the total basin area of the western part of Sagar taluk and eastern part of Siddapur taluk. These soils mainly occur on gently undulating, rolling and hilly topography along the strip of western ghats which is adjoining the south western part of the basin. The laterites are deep red to brown in colour usually formed under heavy rainfall and high temperature conditions causing intensive weathering and leaching of bases and silica; the later result in the accumulation of sesquioxides (Iron and Alum) (Soils of Karnataka and their fertility status, 1979).

The same conditions are observed in the study area; the annual rainfall averaging nearly 304.8 cms. (120 inches). The laterite soils occurring in patches especially on the convex upland regions of laterite soil that is mainly in Sorab taluk uplands and small hills like Kappegudda (Sorab taluk). The area covered by this group is 18.84 per cent of the total basin, covering Sorab taluk. These soils are shallow to moderately deep, with abundant ferruginous gravels and are distributed under scrub vegetation and forest with varying density. Laterite soils are highly leached, poor in bases with low water-holding capacity.
The red loamy soil covers the 17.24 per cent of the basin and is distributed in NW to SE strip of Sagar, a small strip of south to north of Sorab and in part of Sirsi Taluk of the basin. These soils occur on hilly to undulating topography on granite gneiss and Dharwar schist. It is situated on convex ridges steep side slope of Sagar taluk. Gently sloping undulating around Sorab to hilly landscapes of Sirsi taluk. The chief characteristics of the soil are shallow to medium in depth, red to pale brown in colour, underlain with pale coloured decomposed parent material, well drained, poor in bases and water holding capacity.

The red sandy soils, derived from granitic gneiss, cover an area of 11.43 per cent of the basin, distributed in the south of Hangal taluk, western part of Byadgi taluk and a small portion of Sorab taluk. The main characteristics of the soil are same as in red loamy soil. Major area falls under the dry agro-climatic region. The red sandy-soil-clay complex is dominated by kaolite and hydrous oxide clays, iron and alumina. These are well drained to somewhat excessively drained with rapid permeability.

Medium black soil occurs in western part of Byadgi, the northern part of Hangal and Shiggaon taluks covering about 18.47% of the basin area. These soils are moderately deep to deep (23-90 cm) dark to very dark grayish brown. The
texture of the surface horizon is usually clay. These soils usually occur on very gently sloping mid lands. The medium black soil is derived from schists, shales and traps. In the study area some parts are black soils and red soils and intermixed. These are moderately well drained with slow permeability. As these are moderately susceptible to erosion.

Deep black soil occurs on gently sloping to nearly level of flat topography of Haveri and Savanur talukas, covering 26.93% of the basin area. Deep black soils are found in a variety of (geological) parent materials, like graywacke, schists and shale, including transported soils occurring along river banks and near Ritti town where meander course of the river has been developed. These soils are closely related to the Maidan soils; they are very deep (more than 90 cm.) dark brown and dark grayish brown to dark in colour (Photo. 7). The texture is usually clayey throughout the profile. Surface cracks in summer and have high base status and good water holding capacity. These soils are moderately susceptible to erosion.

Another important feature observed in the study area is that there is a marked difference in the depth of soil, ranging from 0 to 300 cm. (see figure). The depth of soil* is an

* Agricultural Atlas of India, Plate No. 12, Govt. of India, Calcutta.
important factor for the growth of vegetation and for cultivation. The area covered with deep soil has less run-off (see Chapter – III), more water-holding capacity and less erosion activity.

6.0 Delimitation of the study area:

The Varada river basin has been formed mainly on the water divide line. For the convenience of data collection, the boundary has been demarcated and includes the taluk limits.
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