

Chapter 2

Physical features

2.0 General

The Godavari (Janampet) - Cauvery (Grand Anicut) link project envisages diversion of 7000 MCM (247 TMC) of Godavari waters (including unused waters of Chattisgarh in Indravati sub basin of Godavari basin) available at proposed Janampet barrage, to water short Krishna, Pennar and Cauvery basins. The project will provide enroute irrigation to an area of 9.37 lakh ha in Bhadradi Kottagudem, Khammam, Suryapet and Nalgonda districts in Telangana, Guntur, Prakasam, Nellore and Chittoor districts in Andhra Pradesh and Tiruvallur, Kancheepuram, Tiruvannamalai, Vellore and Cuddalore, districts of Tamil Nadu. In addition to the enroute irrigation, a quantum of 1305 Mm³ will be let into Cauvery at Grand Anicut for downstream use in Cauvery delta region. The link comprises of three reaches i) Godavari (Janampet) - Krishna (Nagarjunasagar), ii) Krishna (Nagarjunasagar) – Pennar (Somasila) and iii) Pennar(Somasila) - Palar - Cauvery(Grand Anicut).

The present chapter deals with physical features such as geographical disposition, topography & physiography, geology of the basin areas, river system and the command area benefitted under the link project.

2.1 Geographical disposition

The proposed Godavari (Janampet) - Cauvery (Grand Anicut) link canal takes off from the proposed barrage near Janampet in Pinapaka mandal of Bhadradi Kothagudem district of Telangana. It traverses through the States of Telangana, Andhra Pradesh and Tamil Nadu. The proposed barrage, balancing reservoirs (Nagarjunasagar, Somasila) tunnels, pump houses, power house, feeder canals and command area are located in the basins of Godavari, Krishna, Gundlakamma, Streams between Gundlakamma & Pennar, Pennar, Streams between Pennar & Palar, Palar, Streams between Palar & Cauvery and Cauvery. The Godavari basin lies between latitudes 16^o 16' N to 22^o 43' N and longitudes 73^o 26' E to 73^o 26' E. The Krishna basin lies between latitudes 13^o 07' N to 19^o 25' N and longitudes 73^o

21' E to 81° 09' E while the Cauvery basin lies between latitudes 10° 09' to 13° 30' and longitudes 75° 27' E to 79° 54' E.

Total length of the link canal is 1251.59 km, crossing major rivers like Krishna, Pennar, Palar enroute. The link traverses between Godavari and Cauvery from north to south. Index map showing rivers, basin boundaries, state boundaries, major dams etc is appended at **Plate 1.3**.

2.2 Topography of the basins, reservoirs and command area

The proposed barrage on Godavari river is located at latitude 80° 09' 11" N and longitude 80° 44' 24" E near Janampet village in Bhadradi Kothagudem district of Telangana, for diversion of the surplus waters into the proposed link canal. The major existing reservoirs Nagarjunasagar on Krishna river in Nalgonda district of Telangana, Somasila on Pennar river in Nellore district of Andhra Pradesh act as balancing reservoirs and facilitate regulated releases to the needy command areas and further transfer to Cauvery. The Grand Anicut on Cauvery in Thanjavur district of Tamil Nadu is the tail end structure of the link system.

The proposed link project including its command area lies in i) Godavari basin ii) Krishna basin iii) Gundalakamma basin iv) Basin of streams between Gundlakamma and Pennar v) Pennar basin vi) Basin of streams between Pennar & Palar vii) Palar basin viii) Basin of Streams between Palar & Cauvery and ix) Cauvery basin.

2.2.1 Topography and Physiography

The topography of these nine basins is described briefly in the following sections.

(i) Godavari Basin

The Godavari basin lies between latitudes 16° 16' N and 22° 43' N and longitudes 73° 26' E and 83° 07' E. The basin extends over an area of 312813 Km² which is nearly 10% of the total geographical area of the country. The basin

comprises areas in the States of Maharashtra, Madhya Pradesh, Chhattisgarh, Telangana, Andhra Pradesh, Karnataka and Odisha. The Catchment area of Godavari upto Janampet barrage is 273126 Km². The Godavari basin is bounded on the North by the Satmala Hills, the Ajanta Range and the Mahadeo Hills, on the South and East by the Eastern Ghats and on the West by the Western Ghats. It is roughly triangular in shape and the main river itself runs practically along the base of the triangle. Except for the hills forming the watershed around the basin, the entire drainage basin of the river Godavari comprises of undulating country, a series of ridges and valleys interspersed with low hill ranges. Large flat areas which are characteristic of the Indo-Gangetic plains are scarce except in the delta. The Sahyadri range of Western Ghats forms the Western edge of the basin. The interior of the basin is a plateau divided into a series of valleys sloping generally towards the East. The Eastern Ghats, which form the Eastern boundary, are not so well defined as the Sahyadri range on the West. The Northern boundary of the basin comprises of tablelands with varying elevation. Large stretches of plains interspersed by hill ranges lie to the South. The State-wise distribution of the drainage area is given in **Table 2.1**

Table 2.1 State-wise distribution of the area of the Godavari basin

State	Drainage area in km ²	Percentage of total Drainage area
1. Maharashtra	152199	48.7
2. Telangana	57829	18.4
3. Andhra Pradesh	15372	4.9
4. Karnataka	4406	1.4
5. Madhya Pradesh	31821	10.2
6. Chhattisgarh	33434	10.7
7. Odisha	17752	5.7
Total	312813	100.00

The hydro meteorological map of Godavari basin is shown in **Plate 2.1**.

(ii) Krishna Basin

The Krishna basin extends over an area of 258948 Km², which is nearly 8% of total geographical area of the country. Catchment area upto Nagarjunsagar reservoir is 220705 Km². The basin comprises area in the States of Maharashtra, Karnataka, Telangana and Andhra Pradesh. The Krishna basin is bounded on the north by the common ridge separating it from Godavari basin, on the south and east by the Eastern Ghats and on the west by Western Ghats. Except for the hills forming the watershed round the basin, the entire drainage basin of the river comprises of rolling and undulating country and a series of ridges and valleys interspersed with low hill ranges. Large flat areas of the type seen in the Indo - Gangetic plains are scarce except in the deltas. The interior of the basin in its middle reaches is a plateau, the greater part of which is at an elevation of 300 to 600 m. Its general slope is eastwards. Great undulating plains divided from each other by flat topped ranges of hills are the chief characteristics of this plateau. The hill sides are marked by conspicuous, wide terrain except in the southern part of the plateau where the hills are frequently crowned with great 'tors' or rounded hummocks of bare rock as a result of constant weathering. The State-wise distribution of the drainage area is given in **Table 2.2**.

Table 2.2 State-wise drainage area of the Krishna basin

Sl.no.	Name of the State	Drainage area (km ²)	Percentage of total basin area (%)
1.	Maharashtra	69425	26.8
2.	Karnataka	113271	43.7
3.	Andhra Pradesh (including Telangana)	76252	29.5
	Total	258948	100.0

The hydro meteorological map of Krishna basin is shown in **Plate 2.2**.

(iii) Gundlakamma basin

The river Gundlakamma is the largest of the small independent east flowing rivers between the Krishna and the Pennar. The Gundlakamma basin lies in Deccan

plateau. The basin is arcshaped. The basin lies between the East longitudes $78^{\circ} 43'$ to $80^{\circ} 15'$ and North latitudes $15^{\circ} 13'$ to $16^{\circ} 21'$. The basin lies entirely in Andhra Pradesh covering an area of 8195 km^2 in parts of Guntur, Kurnool and Prakasam districts. The upper catchment of the basin is mostly hilly with dense forests. The middle portion comprises of small groups of hillocks and the lower portion is plain.

(iv) Basin area of the streams between Gundlakamma and Pennar

The basin area of the streams between Gundlakamma and Pennar comprises of mainly three independent east flowing rivers viz. the Musi, the Palleru and the Manneru. The three rivers in their upper reaches flow in the Velikonda hills and thereafter immediately enter the plains. To a limited extent, the upper reaches are covered with dense forests and the remaining area with moderate to low altitude hill range. The catchment area of the basin is fan shaped and the boundaries are Gundlakamma basin in the north, Pennar basin in the south and west, and the Bay of Bengal in the east. The basin lies in Andhra Pradesh covering an area of 9886 Km^2 in the districts of Prakasam and Nellore.

(v) Pennar basin

The Pennar basin lies between latitudes $13^{\circ} 16' \text{ N}$ and $15^{\circ} 52' \text{ N}$ and longitudes $77^{\circ} 04' \text{ E}$ and $80^{\circ} 10' \text{ E}$. The Pennar basin extends over an area of 55213 km^2 lying in the States of Karnataka and Andhra Pradesh. State wise breakup of the drainage area of Pennar basin is given in **Table 2.3**.

Table 2.3 :State-wise drainage area of the Pennar basin

Sl.no.	Name of the State	Drainage area (Km^2)	Percentage of total basin area (%)
1.	Karnataka	6937	12.6
2.	Andhra Pradesh	48276	87.4
	Total	55213	100.0

Drainage area of Pennar basin upto Somasila Dam is 50492.5 Km^2 .

The Pennar basin is a fan shaped basin and is bounded on the north by the Erramala hills, on the east by the Nallamala and Velikonda hills of Eastern Ghats, on the south by the Nandidurg hills and on the west by the narrow ridge separating it from Vedavati valley of the Krishna basin.

There are number of hills and peaks of varying heights in the Pennar basin. A few notable hill ranges are Nallamala to the east of the basin, Erramala on the north, Palkonda ranges to the south of river. The highest hill appears to be Horsely hill with an altitude of 1314 m. After Somasila gorge, the basin is moderately flat and then the coastal delta area begins. The interior of the Pennar basin has long ridges with isolated hills and small streams except in the deltas. The delta of the river Pennar is formed by deposits at the mouth of the river over the ages which consists of river borne alluvium. The hydro meteorological map of Pennar basin is shown in **Plate 2.3**.

(vi) Basin area covered by the streams between Pennar and Palar

There are seven river systems in the basin and these are grouped together to form the basin of streams between Pennar and Palar . They are (i) Kandaleru, (ii) Swarnamukhi (iii) small streams draining into the pulicat lake, (iv) Arani Ar (v) Kortalaiyar, (vi) Cooum and (vii) Adyar.

The basin of streams between Pennar and Palar has a total catchment of 17,104 Km². A major portion of 11335 Km² (66.3%) of the catchment area of the basin lies in Andhra Pradesh and balance 5769 km² (33.7%) is in Tamil Nadu. The stream wise/State wise drainage area is given in **Table 2.4**.

Table 2.4 Stream / State wise drainage area of the basin of streams between Pennar and Palar.

Sl. No.	Name of stream	State	Drainage area in km ²	Percentage to the total area
1	Kandaleru	Andhra Pradesh	3534	20.7
2	Swarnamukhi		3225	18.9

3	Small streams draining into Pulicat lake	Andhra Pradesh & Tamil Nadu	3063	17.9
4	Arani Ar		1290	7.5
5	Kortalaiyar	Tamil Nadu	3521	20.6
6	Cooum		942	5.5
7	Adyar		1529	8.9
	Total		17104	100.0

The basin is bounded on the north and west by the various ranges of eastern ghats like the Velikonda range, suddenly upheaved by volcanic action overlooking the valley with high precipitous cliffs. The prominent cliff popularly known as Nagari nose is conspicuous for miles around. The imposing Sheshachalam hills (Tirupati hills) over which the pilgrim centre Tirupati is located is perhaps one of the most picturesque spots in the basin.

There are three major topographical divisions in the basin. At the upper reaches the general topography of the basin is hilly and rather rugged with abrupt diverse slopes conducive to appreciable erosion. The coastal uplands have undulation to rolling topography while the delta is flattish and even trough shaped at places.

The catchment area of the basin is roughly rectangular in shape, having average length and breadth of about 173 Km and 94 Km respectively. The basin is bounded on the north by Pennar delta sub-basin and west by Lower Pennar sub-basin and Palar basin and south by Palar basin and east by Bay of Bengal.

(vii) *Palar basin*

The catchment area of the Palar basin lies between the latitudes 12° 15' N to 13° 37' N and longitudes 77° 53' E to 80° 10' E. The total length of the Palar river is 348 km and it drains an area of 17871 Km² lying in three States viz. Karnataka, Andhra Pradesh and Tamil Nadu. The State wise break- up of catchment area of the basin is given in **Table 2.5**.

Table 2.5 State wise drainage area of the Palar basin

Sl. no.	State	Area falling in the basin in Km²	Percentage to the total area of the basin
1	Karnataka	2813	15.7
2	Andhra Pradesh	5018	28.1
3	Tamil Nadu	10040	56.2
	Total	17871	100.0

There are three major topographical divisions in the basin i) the hilly ranges at the upper reaches separating the Pennar and Ponnaiyar basins ii) the table land or the plateau region and iii) the coastal plains. At the upper reaches and the area separating the Cheyyar with Palar, the general topography is hilly, rocky and rather rugged with abrupt diverse slopes conducive to appreciable erosion. The plateau has undulation to rolling topography with occasional hillocks while the coastal plains are flattish and even trough shaped at places. Among the hills present in the basin, the famous are Javadi, Elagiri, Kalrayan etc.

The catchment area of the basin is roughly rhombus in shape with broader width in the middle reach and narrow width at the upper and lower reaches. The basin is bounded by Pennar basin in north “Streams between Pennar and Palar” basin in the north-east and Bay of Bengal in the east and by the “Streams between Palar and Cauvery” basin on the west and south.

(viii) Basin area covered by the streams between Palar and Cauvery

This basin area comprises of the combined catchments of four rivers viz. Ongur, Varahanadi, Ponnaiyar and Vellar draining the entire area lying between Palar and Cauvery river basins with each of them draining independently into the Bay of Bengal. Ponnaiyar and Vellar rivers with their tributaries are the two major rivers in this basin area. The area lies between latitudes 11^o 11' and 13^o 30' North and the longitudes 77^o 34' and 80^o 08' East. It is bounded on the north by the Palar river basin, on the west and south by the Cauvery river basin and on the east by the Bay of Bengal.

This basin area with a total catchment of 27048 Km² is spread over parts of Tamil Nadu, Karnataka and Andhra Pradesh States besides Union Territory of Puducherry. The State -wise break-up of the catchment area is given in **Table 2.6**.

Table 2.6 State-wise drainage area of the basin of the streams between Palar and Cauvery

Sl. No.	State/District	Area of the State within the basin in km ²	Percentage over total basin area
1	Andhra Pradesh	133	0.5
2	Karnataka	3545	13.1
3	Tamil Nadu	23076	85.3
4	Puducherry	294	1.1
	Total	27048	100.0

The shape of this basin area resembles the letter ‘L’ with maximum width of 250 Km in the western portion and 100 Km in the eastern side. This basin has a coastal line extending over 125 Km.

Cauvery basin

The Cauvery is the fourth largest river in the Peninsular India flowing east and draining into the Bay of Bengal. The Cauvery basin lies between latitudes 10° 05' N and 13° 30' N and longitudes 75° 30' E and 79° 45' E. The catchment area of the basin is 81155 Km² spread in the States of Karnataka, Kerala, Tamil Nadu and Union territory of Puducherry. State wise breakup of the drainage area of Cauvery basin is given in **Table 2.7**.

Table 2.7 State-wise drainage area of the Cauvery basin

Sl.no.	Name of the State	Drainage area (km ²)	Percentage of total basin area (%)
1.	Karnataka	34273	42.2
2.	Kerala	2866	3.5
3.	Tamil Nadu	43867	54.1
4.	Puducherry (U.T)	149	0.2
		81155	100.0

Drainage area of the basin up to Grand Anicut is 70129 Km².

The Cauvery basin is bounded on the north by the ridges separating it from Krishna and Pennar basins, by the Eastern Ghats on the east and south and by Western Ghats on the west. The upper reach of the basin is covered with hill ranges of the Western Ghats and the sub basin areas are broad and open with gently undulating country. In the north-west and south, there are a number of hill ranges which have steep slopes. The maximum length of Cauvery basin from west to east is 540 Km. The maximum width from north to south is 255 Km.

The hydro meteorological map of Cauvery basin is shown in **Plate 2.4**.

2.3 Geology of the basins, reservoirs and command area

(i) *Godavari basin*

The main geological rock formations of the catchment are older crystalline rocks of archean age, lower gondwana of lower permian to upper permian age, deccan traps of upper cretaceous to lower eocene age and sub-recent to recent laterite and alluvium. The crystalline peninsular granites occur as small patches. Pink Granites, Grey Granites, Pegmatites and Quartz veins are also associated. Of these, Porphyritic Granites are noticed predominantly in the area. The sedimentary rock formations belonging to the Gondwanas are reported to overlie with an erosional unconformity. These are in turn overlain by Deccan traps. Recent to sub-recent laterite and alluvium are developed over all these rocks. Gondwanas are mainly represented by Barakar and Kamthi formations of lower- Gondwanas group. The predominant rocks of Barakar formations are white feldspathic Sandstone, Shales and Clays. Kamthi formations are represented by yellowish brown variegated ferruginous sand stones, silt stones and variegated clays and shales invariably overlying the Barkar formations. A considerable part of the area is covered by Deccan traps and intertrappean beds. The Deccan trap consists of layers of basaltic lavas varying from amygdaloidal basalt to massive basalt which are hard, compact and medium to fine grained. The rocks are generally dark grey to dark greenish grey in colour. The vesicular basalts are comparatively soft. Laterite is seen as capping over the Deccan traps, Kamthi formations and gneisses at places.

Generally, it is redish brown in colour and is hard with the thickness varying from a few cm to 8 m. Alluvium consists of gravels, sands, silts and clays which are found to occur only along the nallahs and river courses. The thickness of the alluvium is very limited and varies from place to place.

(ii) *Krishna basin*

The Krishna basin consists largely of Archaean formations, part of which are covered by Deccan trap lavas, Cuddapah and Vindhyan series and faulted blocks of Gondwanas. Hydrogeological investigations in the Krishna basin carried out by the Groundwater Departments of the respective States and the Central Ground Water Board indicate that groundwater occurs in all the geological formations and the occurrence and movement of groundwater in these rocks is controlled by the nature and extent of weathering and presence of joints and fractures. In areas underlain by crystalline rocks like granites, the quality of water is unsuitable for domestic purposes due to the presence of fluorides in excess of the prescribed safe limits.

(iii) *Gundlakamma basin*

The Gundlakamma basin is underlain by various rock types of different age groups ranging from Archaean to recent. The Archaeans comprise various types of granites and charnockites occurring as intrusives in the highly folded and metamorphosed sedimentary rocks represented by khondalites, mica-schists etc. Among the Algonkians, there are metamorphosed sedimentary rocks represented by phyllites, slates, shales and quartzites belonging to the Cuddapah system of Precambrian age.

Hydro-geological investigations carried out by Central Ground Water Board indicate that in crystalline rocks the groundwater occurs under unconfined condition in shallow weathered mantle and semi-confined to confined conditions in fractured zones. In these rocks, the occurrence and movement of groundwater are controlled by depth and intensity of weathering with primary porosity and joints, fissures and other structural features. The weathered zone is fairly thick along the valley portions where water table is shallow. The weathered zone becomes thinner at higher elevations. In these crystalline rocks the groundwater is mainly developed

by open wells, dug-cum-bore wells and bore wells both for drinking and irrigation purposes.

(iv) *Basin area of the streams between Gundlakamma and Pennar*

Hydro-geological studies carried out by Central Ground Water Board in the districts falling in the basin area indicate that the geological formations in the basin area vary widely ranging from the oldest Archaeans to recent laterite and alluvium.

The granites and gneisses, granetiferous biotite gneisses etc. together with migmatites, which represent the Archaean, occupy the central part of the basin, as detached hills covering Kanigiri, Podili and Darsi taluks. Rocks having charnockite affinity have been reported to occur at places in the northern part of the basin .

Dharwars occur mainly as, two north-south elongated bands in the central part of the basin, one along the eastern margin of Cuddapah district and the other between Kanigiri and Kandukur taluks of Prakasam district. The Cuddapah formations represented by the Nallamalai and Kistna series occupy the western margin of the basin. The Upper Gondwana formations occur as isolated patches in the Kandukur taluk. Laterite occurs in parts of Kandukur and Ongole taluks of Prakasam district and Kavali taluk of Nellore district capping Gondwanas and crystallines. Alluvium occurs in the eastern portion of the basin.

In this basin, groundwater occurs in all the geological formations from oldest crystalline to recent alluvium. Groundwater occurs under the water table condition in Archaeans and lower Precambrian formations in the weathered zone and semi confined and confined conditions in joints, fissures and other weaker planes. The depth of wells in the crystallines varies from 3 to 27 m below ground level and the depth of water level ranges from 1.5 to 14.5 m below ground level. The yields of the domestic and irrigation wells observed by CGWB vary from 1 to 15 m³ per hour. Groundwater occurs under unconfined to confined condition in Cuddapah formations. The depth of the wells varies from 5.84 to 14.5 m below ground level and depth of the water level ranges from 5 to 12 m below land surface. The laterite occurs as discontinuous patches in the Ongole and Kandukur taluks of Prakasam

district and Kavali taluk of Nellore district fringing the Archaeans. As the formation is highly permeable, it is expected that the yield should be high.

(v) *Pennar basin*

The basin consists mainly of red, black, sandy and mixed soil. The important rock formations are hard or crystalline rocks of Archaean age Dharwar super group, Cuddapah series of rocks belonging to Proterozoic age, Kurnool series comprising of Guvalacheruvu quartzites, Vempally dolomites, limestones and shales of Papagni series and Cheyyeru series. The Nallamala series comprise of Cumbum shales, which are metamorphosed to slates and phyllites.

Hydrogeological studies in the Pennar river catchment have been carried out by the Groundwater Departments of respective States and the results are similar to those observed in Krishna basin.

(vi) *Basin area covered by the streams between Pennar and Palar*

The northern and central portion of the basin is predominantly covered by granite gneisses, Cuddapah formations of Archaeans belonging to Dharwarian system with basic intrusive and the southern region with Gondwanas. Alluvial deposits are found all along the coastal belt comprising of marine and riverine deposits.

(vii) *Palar basin*

In the upper reaches of the basin, it is predominantly covered by granite gneisses, Gondwanas, Cuddapah formations of Archaeans belonging to Dharwarian system with basic intrusive. The central portion of the catchment is covered by archaean crystalline hard rock and sedimentary rocks. Alluvial deposits are found all along the coastal belt and Palar river course, comprising of marine and riverine deposits. Due to uplift of landmasses and tectonic activities, the archaean Dharwarian hard rocks were subjected to deformation into folds and faults and also resulted in shifting of river courses in basin area.

(viii) Basin area covered by the streams between Palar and Cauvery

The geology of the basin is rather varied. The main rock types encountered in this basin area are charnockites, Granite gneiss (Peninsular gneiss) of Archaean age, Cuddalore sand stone of Miocene and Pliocene and cretaceous age and alluvium of recent age. The widely exposed charnockites is more prominent which is exposed in the hill ranges. It is massive and also well foliated. The gneiss is medium to coarse grained and generally, less massive and is highly prone to weathering. The Cuddalore sand stone occurring in South Arcot district of this basin includes lignite deposits, which are being mined presently by open cast method at Neyveli. They are overlain in the coastal tract and in the river valleys by alluvium and coastal sands.

(ix) Cauvery basin

The Cauvery basin consists of charnockites in large, high grade schists, migmatites, green stone belts and consolidated gneiss of Archaean age. In the upper part of the basin upto Grand Anicut, sand stone is generally lateritised and ferrugeneous and occurs in wide stretch in southern parts of the basin. Ground water occurs in the hard rocks normally in under water table conditions in the weathered mantle and under semi – confined to confined conditions in fractures, fissures, joints and shear planes.

2.3.1 Geology of the command area**(i) Godavari to Krishna**

In the initial reach from Godavari (Janampet) to Krishna (Nagarjunsagar), command area falls in Bhadradi Kothagudem, Khammam, Suryapet and Nalgonda districts. The major part of the command area receives its rainfall from South-west monsoon. The area falling in these districts consists of oldest rock types of Achaean age comprising peninsular gneissic complex. The Granite and Biotite gneiss of the peninsular complex occupies larger part of the area. Bands of relatively younger coarse grained gneiss also occur in small patches. The dyke encountered in the area belongs to dolorite minerals. Major soil types encountered along the alignment and

the command area are black cotton, red, red sandy, red loamy, forest and deltaic alluvium.

(ii) Krishna to Pennar

The new command area proposed enroute under the link project in its reach between **Krishna (Nagarjunsagar) - Pennar (Somasila)** falls in Prakasam and Nellore district of Andhra Pradesh in the “Basin area covered by the streams between Gundlakamma and Pennar”. The major part of the command area receives its rainfall from South-west and North-east monsoons. This terrain is mostly plain. The soils available in the command area are predominantly red earth, red sandy and black cotton soils. Hydro-geological studies carried out by Central Ground Water Board in the districts falling in the basin area indicate that the geological formations in the basin area vary widely ranging from the oldest Archaeans to recent laterite and alluvium. The granites and gneisses, granetiferous biotite gneisses etc. together with migmatites, which represent the Archaean, occupy the central part of the basin, as detached hills covering Kanigiri, Podili and Darsi taluks. Rocks having charnockite affinity have been reported to occur at places in the northern part of the basin . Dharwars occur mainly as two north-south elongated bands in the central part of the basin, one along the eastern margin of Cuddapah district and the other between Kanigiri and Kandukur taluks of Prakasam district. The Cuddapah formations represented by the Nallamalai and Kistna series occupy the western margin of the basin. The Upper Gondwana formations occur as isolated patches in the Kandukur taluk. Laterite occurs in parts of Kandukur and Ongole taluks of Prakasam district and Kavali taluk of Nellore district capping Gondwanas and crystallines. Alluvium occurs in the eastern portion of the basin. In this basin, groundwater occurs in all the geological formations from oldest crystalline to recent alluvium. Groundwater occurs under the water table condition in Archaeans and lower Precambrian formations in the weathered zone and semi confined and confined conditions in joints, fissures and other weaker planes. The laterite occurs as discontinuous patches in the Ongole and Kandukur taluks of Prakasam district and Kavali taluk of Nellore district fringing the Archaeans. As the formation is highly permeable, it is expected that the yield should be high.

(iii) *Pennar to Cauvery*

The command area of the link from Pennar (Somasila) to Cauvery (Grand Anicut) is spread over Chittoor district of Andhra Pradesh and Tiruvallur, Vellore, Kancheepuram, Tiruvannamalai, Villupuram, Cuddalore districts of Tamil Nadu State and Puducherry (U.T). The climate of command area is characterized by oppressive hot weather during summer in the area lying in Chittoor, Tiruvallur, Vellore, Kancheepuram and Tiruvannamalai districts. The major part of the command area receives its rainfall from South-west and North-east monsoons.

The predominant rock groups found in command area are the granite gneisses, Gondwanas, Cuddapah formations of Archaeans belonging to Dharwarian system with basic intrusive, Charnockites, Cuddalore sand stone, etc.

The main soils in the command are red loamy soils, brown sandy soils, red sandy clay loam soils, coastal sands, black clayey soils, forest soils and alluvial soils. Red loamy soils have developed from granite – gneissic complex and at times from quartzites and coarse – grained stones. At present, irrigation to the crops is provided from the wells and tanks in the proposed command area of the link project.

2.4 River system and basin characteristics

2.4.1 Godavari basin

(a) River system

The river Godavari is the second largest in the country and the largest in Southern India. It rises in the Sahyadri hills at an altitude of about 1067 m near Triambakeswar in the Nasik district of Maharashtra State and flows across the Deccan plateau from the Western Ghats to Eastern Ghats. Rising in the Western Ghats about 80 km from the shore of the Arabian sea, it flows for a total length of about 1465 km in a general South-Eastern direction through the States of Maharashtra and Andhra Pradesh before joining the Bay of Bengal at about 97 Km south of Rajahmundry in Andhra Pradesh.

The major tributaries joining the Godavari are the Pravara, the Purna, the Manjra, the Maner, the Pranhita, the Penganga, the Wardha, the Wainganga, the Indravati and the Sabari.

(b) Basin characteristics

Like most of the parts of India, the Godavari basin receives major portion of its rainfall during the south-west monsoon period. The other rainy seasons are not so well defined and well spread as the south-west monsoon season. They contribute only about 16% of the total annual rainfall in the Godavari basin.

i) Rainfall

Four distinct seasons prevail in the Godavari basin viz (i) the cold weather (ii) the hot weather (iii) the south-west monsoon and (iv) the post monsoon. The cold weather season in the entire basin, from mid October to mid February is generally pleasant, the western and the north eastern regions being colder than the rest of the basin. In the hot weather, the heat is unbearable in the central, northern and eastern regions. The weather is comparatively hotter in the western most parts of the basin.

The south west monsoon sets in by mid June and ends by mid October. During this period, the basin receives about 88% of its total annual rainfall. The Godavari basin receives the maximum rainfall during the months of June to September due to southwest monsoon. The Godavari basin receives annually a rainfall of about 1062 mm on an average. The normal rainfall over the basin has a minimum of the order of 500 mm over parts of Nashik and Ahmednagar districts of Maharashtra, the area being far away from the Bay of Bengal and the Western Ghats posing a barrier for moisture inflow from the Arabian Sea. Westward of Nashik, the annual normal rainfall increases progressively and is about 1600 mm over extreme western parts of the basin. Eastward of the line connecting Ahmednagar to a point about 40 km west of Aurangabad, the normal annual rainfall again increases gradually to more than 1500 mm over extreme eastern parts of the basin.

ii) Temperature

At all the IMD observatories the temperature is maximum in May and minimum in December except for Jagdalpur observatory. For Jagdalpur observatory the temperature is maximum in May and minimum in January. The Godavari basin has a tropical climate. The mean annual surface temperature in the Western Ghats area is about 24° C, and it increases gradually towards the East and attains a maximum of 29.4° C on the East Coast. During January, which may be taken as a typical winter month, the mean daily minimum temperature going from West to East, increases from 15° C, on the Western Ghats to about 18° C on the East Coast. The mean daily maximum temperature generally exceeds 30° C in the western part of the Godavari basin and it is only slightly less than 30° C in the Eastern part.

iii) Relative humidity

The relative humidity is high in the basin during the southwest monsoon season. With the withdrawal of the monsoon, humidity gradually decreases and in summer the air is generally dry. The climate generally remains dry for about 7 months in a year from November to May. The maximum relative humidity is generally recorded during July / August and the minimum during April / May. The maximum relative humidity in the basin varies between 60% and 89%, the average being 83.3%. The minimum relative humidity ranges from 15% to 29.5%, the average being 22%.

iv) Wind speed

Winds are generally light to moderate with increase in speeds in the later part of summer and during the southwest monsoon season. Wind blows mostly from southwest to northwest during the monsoon season and in post monsoon season it blows from the northwest to north direction. In the cold season the wind blows from northwest to southwest. Maximum wind speed in the basin varies between 10.6 kmph and 22.5 kmph, the average maximum wind speed being 14.7 kmph over the basin. The minimum wind speed varies between 1.3 kmph and 5 kmph, the average being 3.2 kmph.

v) Cloud cover

The skies are heavily clouded and overcast during the southwest monsoon season. During the rest of the year, clear and lightly clouded skies prevail. The maximum cloud cover in the basin varies from 6.9 to 7.7 oktas, the average being 7.3 oktas. The minimum cloud cover ranges from 0.5 to 1.5 oktas, the average being 1.0 oktas.

2.4.2 Krishna basin

(a) River system

The Krishna is the second largest river in the Peninsular India flowing east and draining into the Bay of Bengal. The river rises in the Mahadev range of the Western Ghats near Mahabaleshwar at an altitude of about 1337 m above mean sea level and flows through the States of Maharashtra, Karnataka and Andhra Pradesh. The total length of the river from source to its outfall into Bay of Bengal is about 1400 km of which 305 km is in Maharashtra, 483 km in Karnataka and 612 km in Andhra Pradesh. The important principal tributaries of the Krishna are the Bhima, the Ghataprabha, the Malaprabha and the Tungabhadra upstream of Nagarjunasagar project and the Musi, the Palleru and the Muneru downstream of it.

(b) Basin characteristics

The Krishna basin lies in the Deccan plateau and extends over an area of 258948 Km² which is nearly 8% of the total geographical area of the country. The basin lies between latitudes 13° 07' and to 19° 25' N and longitudes 73° 21' E and 81° 09' E. The catchment area of the river Krishna upto Nagarjunasagar dam site is 220705 km² and lies in the States of Maharashtra, Karnataka and Andhra Pradesh.

i) Rainfall

The Krishna basin receives the major portion of its rainfall during south-west monsoon period i.e from mid June to mid October. During this period, the basin receives about 80% of its total annual rainfall. The rainfall during the non-monsoon period is not significant. The annual rainfall over the catchment varies from 377 to 3048 mm

ii) Temperature

The climate of the catchment remains dry except in the monsoon months. The mean daily maximum temperature in the basin varies from 27.7° C to 40.4° C and the mean daily minimum temperature varies from 20.6°C to 27.2° C.

iii) Relative humidity

The mean relative humidity is high during the monsoon period and comparatively low during the post-monsoon period. In summer the weather is dry and the humidity is low. The relative humidity in the basin ranges from 17 to 92 percent.

iv) Wind speed

Winds are generally light with some increase in force during the later half of the summer. The catchment is influenced by winds from the south-west during the monsoon season. In the post-monsoon season, they blow from north-west to north direction. In the winter season the winds blow from north-west and south-west direction. The mean wind speed in the basin varies from 4.0 to 21.7 km/hr.

v) Cloud cover

Sky is generally heavily clouded during the monsoon season. During the post-monsoon months cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the basin varies from 0.8 to 8 oktas .

2.4.3 Gundlakamma basin

(a) River system

The Gundlakamma rises in the surrounding area of Gundlabrahmeswar, the border area between Nandyal and Atmakur taluks of Kurnool district at an elevation of about 800 m in Nallamala hills. After reaching plains, it forms two large tanks, one at Cumbum and other at Markapur in Prakasam district and flows in north-easterly direction and enters Guntur district. Then it changes the direction towards south-east and finally joins the Bay of Bengal near Ulichu village. Chamavagu, Rallavagu, Pogullavagu, Duvvaleru, Jampaleru, Tigaleru, Koneru and Chilakaleru are the tributaries of the river Gundlakamma. The length of the river is about 220 km.

(b) Basin characteristics

i) Rainfall

The basin receives rainfall from both the monsoons viz., the south-west and the north-east. The average annual rainfall in the basin varies from 607 to 846 mm.

ii) Temperature

The mean daily maximum temperature in the basin varies from 28.6°C to 41.5° C and the mean daily minimum temperature varies from 16.6°C to 28.6° C. Generally, day temperatures are higher by 3° to 5° C in summer and night temperatures are lower by 2° to 3° C in winter in the interior than in coastal parts.

iii) Relative humidity

The coastal region is humid throughout the year, while the interior is humid during July to November. In the interior, the humidity in the afternoon becomes as low as 30 to 40 per cent during December to May.

iv) Wind speed

Winds are generally light to moderate except in the late summer and early south-west monsoon season, when they strengthen. From November to January the winds generally blow in north and northeasterly direction. The average wind speed in the basin varies from 3.8 to 21.3 km/hr.

v) Cloud cover

The sky is generally heavily clouded to over cast during the south-west monsoon season. There is moderate cloudiness in the north-east monsoon season. In the rest of the year sky is mostly clear or lightly clouded. The cloud cover in the basins varies from 1.1 oktas in February to 6.6 oktas in the month of August.

2.4.4 Basin area of the streams between Gundlakamma and Pennar**(a) River system**

Three independent east flowing rivers viz. the Musi, the Palleru and the Manneru joining the Bay of Bengal, are the major streams in the area in between the Gundlakamma and Pennar rivers. The Musi river rises in Velikonda range hills near Thadivaripalli village of Podili taluk in Prakasam district. The length of this river is 122.5 km. Gajjaleru, Dondieru, Atleru and Inagaleru are the tributaries of the Musi river. The Palleru river rises in Velikonda range hills near Vedula Cheruvu of Kanigiri taluk in Prakasam district. The length of this river is 112.5 km. Dommaleru, Narellavagu, Makeru and Gadisaleru are the tributaries of the Palleru river. The Manneru river rises in the north of Pillipalli village of Kanigiri taluk in Prakasam district. The length of this river is 130 km. Dokkalavagu, Uppuvagu, Pillaperu and Upputeru are the main tributaries of the river Manneru.

(b) Basin characteristics

i) Rainfall

The basin is under the influence of both the monsoons viz., south-west and north-east. June to December is considered as monsoon period. The maximum, minimum and average annual rainfall of the basin are 1022, 594 and 752 mm respectively

ii) Temperature

The monthly average maximum and minimum temperatures for Cuddapah station are 40.8° C in the month of April and 18.9° C in the months of December /January respectively.

iii) Relative humidity

The maximum and minimum values of relative humidity observed in the catchment are 84 and 36 per cent respectively.

iv) Wind speed

The basin is influenced by winds from the south-west during the monsoon season. The maximum wind velocity is 11.6 km/hr in June and minimum is 4.3km/hr in December.

v) Cloud cover

The sky is heavily clouded during the south-west monsoon. During the remaining part of the year, clear or lightly clouded sky prevails. The maximum cloud amount is 6.7 oktas in the month of July while minimum is 1.5 oktas in the month of January.

2.4.5 Pennar basin

(a) River system

The river Pennar rises in the Chennakesava hill of Nandidurg range at an altitude of about 1000 m in Kolar district of Karnataka State. After flowing for about 597 km in a generally north west and south east directions through the States of Karnataka and Andhra Pradesh, the river falls into the Bay of Bengal. After traversing for about 69 Km from its source, the Pennar receives the waters of the Kumudvathi tributary from its left and a short distance lower down the Pennar receives Jayamangali from its left at a distance of 82 Km from its source.

The Chitravati, a major tributary of river Pennar falls into the Pennar on its right at a distance of 336 Km from its source in the State of Andhra Pradesh. Near Kamalapuram, the Pennar receives the Kunderu on its left and the Papagni on its right within a reach of 3 km. At about 448 Km from the source, the Pennar receives the waters of Sagileru river from its left and just downstream of this confluence, it receives Cheyyeru river. Further, below Nellore anicut the river runs down to the sea through an alluvial delta formed over the ages by the mass of silt that has been deposited. The main tributaries of the river Pennar are the Jayamangali, the Chitravati, the Kunderu, the Pepagni, the Sagileru and the Cheyyeru.

(b) Basin characteristics

i) Rainfall

The catchment receives rainfall from both during the south-west and north-east monsoons. The rainfall during the non-monsoon period is not significant. The annual rainfall over the catchment upto Somasila project varies from 550 to 900 mm.

ii) Temperature

The mean maximum daily temperature in the basin varies from 40.8° C observed at Cuddapah to 36° C observed at Arogyavaram and the mean minimum

daily temperature varies from 20.7° C observed at Nellore to 15° C observed at Arogyavaram.

iii) Relative humidity

In general, the humidity is high during the monsoon period and moderate during the non-monsoon period. The relative humidity in the catchment ranges from 21 to 84 percent.

iv) Wind speed

Winds are generally light to moderate with some strengthening in monsoon season. The catchment is influenced by winds from south-west and north-west during May to September and from north-east and south-east during October to April. The average wind speed in the catchment varies from 4.3 to 21.3 km/hr.

v) Cloud cover

Sky is generally heavily clouded during the monsoon months. In the post-monsoon months cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the catchment ranges from 1.3 to 7.1 oktas.

2.4.6 Basin area of the streams between Pennar and Palar

(a) River system

There are seven river systems in the basin and these are grouped together to form the basin of streams between Pennar and Palar basins. They are (i) Kandaleru, (ii) Swarnamukhi (iii) small streams draining into the Pulicat lake, (iv) Arani Ar (v) Kortalaiyar, (vi) Cooum and (vii) Adyar.

(i) The river Kandaleru rises in the Velikonda range of the eastern ghats in Andhra Pradesh at an elevation of about 150 m and flows generally in easterly direction through Nellore district for a total length of 93 Km before outfalling into the Bay of Bengal near Mathukuru.

- (ii) The Swarnamukhi river rises in the eastern ghat ranges near Pakala in Andhra Pradesh at an elevation of 300 m and flows upto Chandragiri in a north-easterly direction, thereafter, it flows eastward for a distance of 50 km and just before Srikalahasti, changes its direction northwards to flow for a length of 13 km. Beyond this, it flows in a generally easterly direction and falls into the Bay of Bengal near Durgarajupatnam. The river has a total length of 130 km from its source to its outfall, through the districts of Chittoor and Nellore in Andhra Pradesh.
- (iii) There are a no. of streams, which drain into the Pulicat lake and among them, the Kalangi and Kaler rivers are the major ones. The Kalangi river rises in the eastern slopes of the Nagari and Nagalapuram hills at an elevation of 300 m near Olluru in the Chittoor district of Andhra Pradesh, flows in a northerly direction for a considerable distance and then turns east and south-east to outfall into Pulicat lake near Tada. The Kaler rises near Satyavedu at an elevation of 150 m and joins the Pulicat lake near Elavur.
- iv) The river Arani Ar rises from the eastern slopes of the eastern ghats at an elevation of 300 m and flows generally in easterly direction for a total length of about 108 km to join the Bay of Bengal near Pulicat.
- v) The river Kortalaiyar rises near Kaveripakkam in the Vellore district of Tamil Nadu at an elevation of about 150 m and flows generally in easterly direction for a total length of 131 Km through Chittoor district of Andhra Pradesh and Tiruvallur district of Tamil Nadu to join the Bay of Bengal near Ennur. The river is tapped to feed the Chembarambakkam tank and numerous other tanks, the most important being the Poondi reservoir, the Red hills and the Cholavaram tanks which are the main sources of water supply to Chennai city. The Nagari is the important tributary of the Kortalaiyar and joins it on the left. The river Kortalaiyar and stream Cooum are bifurcated with a saddle at Pudukesavaram to form an independent river Cooum.
- vi) The river Cooum flows through Kancheepuram, Tiruvallur districts of Tamil Nadu for a total length of 68 km in a generally easterly direction and joins the Bay of Bengal through Chennai city.

vii) The Adyar, a small stream flows for a total length of 39 km through the Kancheepuram district of Tamil Nadu, in a north-easterly direction to join the Bay of Bengal, just north of Tiruvanmiyur in the neighbourhood of Chennai city.

(b) Basin characteristics

i) Rainfall

The basin receives most of the rainfall from the south-west and north-east monsoons. The annual rainfall of the basin varies from 596 mm to 1684 mm.

ii) Temperature

The temperature in the upper reaches of the basin is lesser than that of the coastal plains in the summer season. The coastal area experiences high temperature and humid conditions for most of the period. The mean daily maximum and minimum temperature recorded at Chennai (Meenambakkam) IMD observatory are 33.5° C and 24.5° C respectively with maximum of 49.1°C recorded on 13.04.2001 and minimum of 15.7°C recorded on 27.01.1969.

iii) Wind speed

The monthly mean maximum and minimum wind speed data observed at the Chennai (Meenambakkam) IMD observatory are 10.2 km/hr in the month of June and 5.1 km/hr in the month of November respectively.

iv) Relative humidity

The relative humidity is high during the monsoon in the month of December and low in the non-monsoon period in the month of May. The coastal plains have more humidity than the upper reaches. The monthly mean maximum and minimum relative humidity values of Chennai (Meenambakkam) IMD observatory are 74% and 65% respectively.

v) Cloud cover

The sky is heavily clouded during the monsoon period and during the cyclone depressions. During the remaining part of the year the sky is clear and moderately clouded during afternoons. The maximum and minimum cloud cover values are 6.4 oktas and 2.6 oktas respectively.

2.4.7 Palar basin

a) River system

The Palar river originates from the neighbourhood of Kaivara village at an altitude of 900 m to the west of Ambojidurga and Rathamankhar peaks in Kolar district of Karnataka State. It flows south-eastwards through Kolar and Bangarpet taluks for about 93 Km and enters in Kuppam taluk of Andhra Pradesh. It flows about 33 Km distance in Kuppam taluk of Chittoor district and then enters Vellore district of Tamil Nadu near the village Gandalapalli. Running southwards, the Palar turns to north-east near Vaniyambadi and passes upto Vellore town where it turns eastwards upto Kanchipuram and further traverses south easterly before its confluence into the Bay of Bengal.

The tributaries of Palar and Poini, Malattar, Kavandinya Nadi and Cheyyar, of which Poini and Cheyyar are the two main tributaries, Poini joining from the left side of the river near Kanipet and Cheyyar joining the right side near Gurumancheri. The total length of the Palar river is 348 Km and it flows 93 km in Karnataka, 33 km in Andhra Pradesh and 222 km in Tami Nadu.

b) Basin characteristics

i) Rainfall

The basin receives most of the rainfall from the south-west and north-east monsoons. The annual average rainfall of the basin varies from 596 mm (Somayajapalli) to 1287 mm (Mahabalipuram).

ii) Temperature

The monthly mean daily temperature observed at Vellore IMD observatory, located in the Central region of the basin, ranges from 17.8⁰ C in the month of January to 39.1⁰ C in the month of May. The annual mean temperature varies from 22.2⁰ C to 38.9⁰ C with maximum of 45⁰ C recorded on 24.5.1990 and minimum of 8.4⁰ C recorded on 14.12.2000.

iii) Relative humidity

The relative humidity is high during the north-east monsoon and low in the non-monsoon. The coastal plains and uplands have more humidity compared to the upper reaches. The mean relative humidity varies from 41% in the months of March & April to 88% in the month of December as observed at Vellore IMD observatory.

iv) Wind speed

Winds are generally moderate with some increase in force in monsoon months. From May to September winds are generally south-westerly to westerly and on afternoons north-westerly. In October, wind blows from the north-east or east and these predominate in the period from November to January. Thereafter, there is a gradual clockwise shift of the wind direction, particularly in the mornings till April, when winds are mainly south-westerly to westerly in mornings and between north-east and south-east in the afternoons. The monthly mean maximum and minimum wind speed data observed at Vellore IMD observatory are 5.0 km/hr. during the month of June and 2.6 km/hr. during the month of October.

v) Cloud cover

The sky is heavily clouded during the monsoon period and cyclonic depressions. In the remaining part of the year, the sky is clear and moderately clouded during afternoons. The maximum and minimum monthly cloud cover (Annual mean) at Vellore IMD observatory are 5.0 oktas and 4.3 oktas respectively.

2.4.8 Basin area of the streams between Palar and Cauvery

a) River system

This basin area comprises of the combined catchments of four rivers viz. Ongur, Varahanadi, Ponnaiyar and Vellar draining the entire area lying between Palar and Cauvery river basins with each of the four rivers draining independently with their outfall into the Bay of Bengal. Ponnaiyar and Vellar rivers with their tributaries are the two major rivers in this basin area. The total catchment area of the basin is 27048 Km².

b) Basin characteristics

i) Rainfall

This basin receives most of the rainfall from the south-west and north-east monsoons accounting for 40.5% and 44.1% of the annual rainfall respectively. The annual rainfall of the basin varies from 702 mm to 1581 mm.

ii) Temperature

Three IMD observatories are located in this basin at Cuddalore, Kallakurichchi and Bangalore for which data is available from 1981 to 2010. The monthly mean of daily maximum temperature are 36.9⁰ C in June, 38.6⁰ C in May, 34.0⁰ C in April and the monthly mean of daily minimum temperature are 20.5⁰ C, 20.7⁰ C and 15.8⁰ C in January at Cuddalore, Kallakurichchi and Bangalore IMD observatories respectively.

iii) Relative humidity

The annual mean relative humidity varies between 52% to 80% at Bangalore IMD observatory; 57% to 77% at Kallakurichchi IMD observatory and 71% to 78% at Cuddalore IMD observatory.

iv) Wind speed

The maximum normal wind speed recorded at Cuddalore, Bengaluru and Kallakurichi IMD observatories are 8.3 km/hr., 8.4km/hr. and 8.6 km/hr in the months of June, July and June respectively. The minimum normal wind speed of 5.2 km/hr, 4.1 km/hr and 4.5 km/hr was recorded in the months of October, April & January at these stations respectively.

v) Cloud cover

The sky is very cloudy during the monsoon season and is lightly clouded in non-monsoon season. The monthly normal cloud cover (annual mean) varies from 4.8 oktas to 5.1 oktas at Bengaluru IMD observatory; from 3.1 oktas to 3.6 oktas at Kallakurichchi IMD observatory and the monthly normal cloud amount is 4.4 oktas at Cuddalore IMD observatory.

2.4.9 Cauvery basin

a) River system

The Cauvery rises in the Brahmagiri hills of Western Ghats in Kodagu district near a place called Talakaveri in Karnataka. The total length of the river from the source to its outfall in Bay of Bengal is about 800 km of which 320 km is in Karnataka, 416 km in Tamil Nadu and 64 Km is the common boundary between Karnataka and Tamil Nadu. The principal tributaries of the Cauvery are Lakshmanthirtha, Hemavathi, Harangi, Shimsha, Kabini, Arkavathi, Suvarnavathi, Bhavani, Amaravathi, Noyil and Ponnanaï ar.

b) Basin characteristics

i) Rainfall

The western side of the catchment mainly experiences the south-west monsoon from June to September and the eastern side gets most of the rain during north – east monsoon from October to December. The rainfall during the non-

monsoon period is not significant. The annual rainfall over the catchment varies from 574 mm to 3345 mm.

ii) Temperature

The climate of the catchment remains dry except in the monsoon months. The mean daily maximum temperature in the basin varies from 19.5 °C to 33.7°C and the mean daily minimum temperature varies from 9.1 °C to 25.2° C.

iii) Relative Humidity

The mean relative humidity is high during the monsoon period and comparatively low during the post-monsoon period. In summer, the weather is dry and the humidity is low. The relative humidity in the basin ranges from 49% to 86%.

iv) Wind speed

Winds blow mainly from the directions between the south–west and north–west during the south–west monsoon season. In the post monsoon season, wind blows mainly in the north easterly or easterly direction. During the rest of the year, wind blows from the direction between north and east. The mean wind speed in the basin varies from 5.4 km/hr. to 18.9 km/hr.

v) Cloud cover

Sky is generally heavily clouded during the monsoon season. During the post-monsoon months, cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the basin varies from 4.1 to 5.3 oktas.