

# Chapter – 2

## Physical Features

### 2.1 Geographical disposition

The Par-Tapi-Narmada link canal, its proposed seven reservoirs, three weirs, feeder canals and command area are located in the basins of west flowing rivers from Par to Tapi, Tapi and Narmada, in Gujarat & Maharashtra. The link traverses between Par and Narmada from south to north.

### 2.2 Topography of the basins, reservoirs and command area

The link canal passes through Par, Auranga, Ambica, Purna, Mindhola, Tapi and Narmada basins. Each of the basin is described below separately :

#### 2.2.1 Par basin

The catchment area of the river Par comprises of the hill ranges of the Nasik district of Maharashtra and Valsad district of Gujarat and slopes westward towards the Arabian Sea. Physiographically, the basin can be divided into five units as given below.

- ( i ) Hill tops and hill slopes.
- ( i i ) Hill terraces and plateaus ( up lands).
- ( i i i ) Upper and lower foot slopes (medium lands).
- ( i v ) Valley plains and local depressions ( low lands).
- ( v ) River and stream banks.

The basin is part of the Western Ghats portion in Maharashtra and Gujarat and is covered by deccan traps.

#### 2.2.2 Auranga basin

Auranga basin is adjacent to the Par basin and lies on northern side of it. Its catchment area also comprises of the hill ranges of the Nasik district and Valsad district but hills are comparatively less steep in comparison to that of Par basin. Physiographically, this basin can also be divided into the same five groups as in case of Par basin.

### **2.2.2.1 Ambica basin**

The Ambica basin which is adjacent to the Auranga basin can be divided into two prominent physiographic zones. The eastern part comes under a rugged mountain chains of the Sahyadri Western Ghats and descending on the western side to the edge of the uplands of Surat district. This region is situated at a general elevation ranging from 1050 m to 100 m. The western part, consisting of hills and valleys generally lie below 100 m elevation.

### **2.2.2.2 Purna basin**

The Purna basin is adjacent to the Ambica basin. It can be divided into three prominent physiographic regions, i.e. (i) eastern parts, (ii) the middle reaches and (iii) the coastal zones. The eastern parts of the basin cover a chain of rugged mountain ranges of the Western Ghats running at an elevation of above 1300 m and descending to an elevation of about 100 m at the edges of uplands of the Surat district. The middle reaches of the basin area marked by high relief zone with ridges and valleys. The hilly zone then merges into the plains through an undulating piedmont coastal zone running parallel to the sea.

### **2.2.2.3 Mindhola basin**

The whole Mindhola basin can be divided into three sections. The first 25 km reach drains the areas of uplands where the elevation is between 400 m to 70 m. In the middle section, the river passes through both steep and moderate slopes. The general elevation of the basin in this section is from 70 m to 5 m. The remaining portion of the basin in the west is subject to inundation in high tides of the sea.

### **2.2.6 Tapi basin**

The Tapi basin is bounded on the north by the Satpura range, on east by the Mahadeo hills, on the south by the Ajanta range and the Satmala hills and on the west by the Arabian Sea. The basin has an elongated shape with a maximum length of 587 km east to west and maximum width of 201 km from north to south. The basin has two well-defined physical regions, viz. the hilly region and the plains. The hilly region covers the Satpuras, the Satmalas, the Ajanta and the Gawilgarh hills with good forests. The Khandesh and the Gujarat plains are broad and fertile areas suitable for cultivation. The Tapi basin consists mainly of black cotton soils. The coastal plains in Gujarat are composed of alluvial clays with a layer of black soil on the surface.

### **2.2.7 Narmada basin**

The Narmada basin is bounded on the north by the Vindhyas, on the east by the Maikalu range, on the south by the Satpuras and on the west by the Arabian sea. The basin has five well defined physiographic regions. They are:(1) The upper hilly areas covering the districts of Shahdol, Mandla, Durg, Balaghat and Seoni;(2) The upper plains covering the districts of Jabalpur, Narsimhapur, Sagar, Damoh, Chhindwara, Hoshangabad, Betul, Raisen and Sehore: (3) The middle plains covering the districts of East Nimar, part of west Nimar, Dewas, Indore and Dhar; (4) The lower hilly areas covering part of the west Nimar, Jhabua, Dhulia, Narmada and parts of Vadodara and (5) The lower plains covering mainly the districts of Narmada Bharuch, and parts of Vadodara. The hill regions are well forested. The upper, middle and lower plains are broad and fertile areas, well suited for cultivation. The Narmada basin mainly consists of black soils. The coastal plains in Gujarat are composed of alluvial clays with a layer of black soils on the surface.

### **2.3 Geology of the basins**

The major part of the 'Par-Tapi' portion of the link canal and its enroute command areas are covered by Deccan trap basalts with isolated deposits of laterite. The geological formations in Par and Auranga basins where Mohankavchali, Paikhed and Chasmandva dam sites lie, belong to the Precambrian, melipozoice, tertiary and quaternary ages. Deccan traps which occupy major portion of upper reaches are of two prominent types, one being dark grey to bluish black which are hard, compact and massive and the other being light brown to pink which are soft.

Like in Par and Auranga basins, Deccan traps with dykes occupy most of the areas of Ambica basin in which Chikkar and Dabdar dam sites are proposed. The geological formations found in Ambica basin include those of the Quaternary and Tertiary ages. The middle ranges have developed on the Deccan traps and the intermediate amphitheatres have developed out of the alluvial debris washed out from the hills. The lower reaches of the basin contain mainly alluvial plains upto coastal margins.

Deccan traps also occupy most parts of Purna basin in which Kelwan dam site is proposed. In the east, there are high ridges and deep valleys and towards the west, they merge into the lower reach composed of recent and sub-recent alluvium and sand. The stratigraphical sequences of the rocks found in the basin are Neogene, Paleogene and early Paleogene.

## **2.4 River system and catchment area**

Each river system and its catchment area intercepted by the Par-Tapi-Narmada link and is described below separately :

### **2.4.1 Par basin**

The Par river is one of the important west flowing rivers in the region, north of Mumbai and south of the Tapi river. The river rises in the Sahyadri hill ranges at an elevation of about 1100 m above mean sea level in Nasik district of Maharashtra state and traverses a distance of 131 Km before draining into the Arabian sea. The Par basin lies in the states of Maharashtra and Gujarat and has a total catchment area of 1664 sq km. The percentages of the area of the basin in the states of Maharashtra and Gujarat are 46.45% and 53.55% respectively. The effective drainage area of the river in Gujarat is 875 sq km since 16 sq km area near the mouth is low-lying and cannot be beneficially utilised. The Par river travels mostly through hills covered with forest and patches of cultivated lands on banks of river.

One diversion point viz. Mohankavchali has been identified across Par river. In addition a hydro-electric Project site viz. Jheri has also been identified upstream of Mohankavchali site on Par river. The free drainage area of Par river below Jheri dam site upto Mohankavchali dam site is 206 sq km of which 79 sq km is in Maharashtra state and 127 sq km is in Gujarat state. The drainage area of the Par basin upto Jheri dam site is 425 sq km which lies entirely in Maharashtra state.

The Nar river is a Northern tributary of Par river. The Nar river rises at an altitude of 980 metres in the Sahyadri hill ranges in Surgana taluka of Nasik district in the state of Maharashtra. Nar river flows towards west through Surgana taluka for its initial length of about 39 km. After forming the boundary between Maharashtra and Gujarat for a length of about 4.5 km, it enters the Dharampur taluka of Valsad district in the state of Gujarat and after flowing for about 39.5 km in south westerly direction, it joins the Par river near village Veribhavad at R.L. 72.0 m. The total length of river Nar is about 83 km.

The catchment area of river Nar upto its confluence with Par river is spread over an area of 418 sq km which is about 25.12% of the catchment area of entire Par basin. The catchment area in Maharashtra state is 269 sq km and that in Gujarat state is 149 sq km.

One diversion point is identified across Nar river near village Paikhed at about 14 km upstream of its confluence with Par river. The drainage area of Nar

catchment upto Paikhed dam site is 315 sq km, out of which 269 sq km lies in Maharashtra and 46 sq km lies in Gujarat state.

#### **2.4.2 Auranga basin**

Like the Par, the Auranga is also one of the important west flowing rivers in the region north of Mumbai City and south of Tapi river. The river is known as Auranga after the confluence of its two tributaries the Man and the Tan. Both tributaries originate in the Sahyadri hill ranges in the Nasik district of Maharashtra state. The river traverses a distance of about 30 km from confluence of the tributaries before draining into the Arabian Sea. The Auranga basin extends over an area of 787 sq km, out of which 150 sq km is in Maharashtra state and 637 sq km is in Gujarat state. The effective drainage area of the basin in Gujarat state is 598 sq km since 39 sq km area near the mouth is low-lying, marshy and cannot be beneficially utilised. The area is hilly and covered with forest in the upstream reaches, while the area down-wards from about 15 km upstream of confluence of the Tan and the Man rivers can be described as plain with cultivated lands.

The Tan river rises at an elevation of about 645 m and the elevation where it meets the Man river is about R.L. 50 m. The length of the river upto its confluence with Man river is 52 Km. The Tan river flows in South direction for a distance of about 2 km in the initial reach. Thereafter it takes a U turn and travels in North West direction in zigzag fashion for a distance of 14 Km upto village Nirpan where it enters the Valsad district of Gujarat state. The first 16 Km length is in Surgana taluka of Nasik district of Maharashtra state. The river forms border between Dharampur taluka of Valsad district and Vansda taluka of Navsari district for a length of 25 Km and then forms border between Dharampur taluka and Chikhli talukas (Navsari district) for further length of 11 Km where it meets the Man river. In this total 36 Km reach in Gujarat state, it travels 20 Km in south west direction, further 5 Km in North west direction and the last stretch of 11 Km in West direction.

The area upto common border with talukas Vansda and Chikhli is hilly, covered with forest while the area further downstream is plain and consists of cultivated lands. The catchment area of the Tan river upto its confluence with Man river is 289 sq km, out of which 68 sq km lies in Nasik district of Maharashtra state and the balance 221 sq km lies in the Valsad and Navsari district of Gujarat state. One diversion point has been identified in the basin near village Chasmandva across river Tan. The drainage area of Auranga basin upto Chasmandva dam site is 89.25 sq km, out of which an area of 61.65 sq km lies in Maharashtra state and 27.60 sq km lies in Gujarat state.

### **2.4.3 Ambica basin**

The Ambica which is a west flowing river rises in the Sahyadri hill ranges in the Nasik district of Maharashtra state at an elevation of about 1050 m above M.S.L. and after traversing a total distance of 164 Km joins the Arabian Sea in the state of Gujarat. The basin extends over an area of 2830 sq km out of which 102 sq km lies in Maharashtra while 2728 sq km is in Gujarat. The effective drainage area of the river is 2685 sq km since 145 sq km area near the mouth is low-lying, marshy and can not be beneficially utilised. The important tributaries of the Ambica river are Kapri, Kaveri and Kharera rivers.

The Kapri river rises at an altitude of 1030 m in Sahyadri hill range in Ahwa taluka of Dang district in the state of Gujarat and joins the river Ambica near village Milan at an elevation of 100 m. The length of river Kapri is about 80 Km. The Kapri catchment upto its confluence with Ambica river is spread over an area of 537 sq km which is about 19% of the total catchment of the Ambica basin. Two diversion points proposed in Ambica basin are, one across river Kapri near village Dabdar and the other across river Ambica near village Chikkar. The drainage area of Kapri river upto Dabdar dam site is 482 sq km i.e. about 17% of basin area, which lies entirely in Gujarat state. The catchment area of basin upto Chikkar dam site is 323 sq km which is 11.4% of the area of the Ambica basin, out of which 102 sq km lies in Maharashtra state while 221 sq km lies in Gujarat state.

### **2.4.4 Purna basin**

The river Purna which is also a west flowing river, rises in the Sahyadri hill ranges of the Western Ghats at an elevation of about 1300 m in the Ahwa taluka of Dang district in the state of Gujarat and after traversing a distance of 180 km, it outfalls into the Arabian sea. The total drainage area of the basin is 2435 sq km, out of which 58 sq km lies in Maharashtra state and 2377 sq km lies in the state of Gujarat. The effective drainage area of the river is 2193 sq km since 242 sq km near the mouth is low-lying and cannot be beneficially utilised. The important tributaries of the Purna river are Girra, Jankhari and Damaskhadi rivers. One diversion point has been identified in the basin near village Kelwan across the river Purna. The level of the river bed drops steeply from 1300 m at source to about 115 m at the dam site as the river in this reach passes through hilly area covered with dense forest and patches of cultivated land. The drainage area of Purna basin upto Kelwan dam site is 733 sq km. The entire area lies in Gujarat state.

#### **2.4.5.1 Mindhola basin**

The river Mindhola is a small west flowing river with its catchment lying entirely in Gujarat state. The basin has a drainage area of 1180 sq km. The

effective drainage area of the river is 1056 sq km since 124 sq km near the mouth is low-lying, marshy and affected by tides. The important tributaries of the river are Khalikhadi, Vijarakhadi, Ghabai Nadi and Chickkhadi rivers.

#### **2.4.5.2 Tapi basin**

The river Tapi which is the second largest west flowing inland river of the peninsula rises near Betul district of Madhya Pradesh at an elevation of 752 m. In the head reach for a distance of about 241 km, the river traverses through an open and partially cultivated plain before plunging into a rocky gorge in the Satpura hills. The Tapi basin extends over an area of 65,145 sq km and is situated in the Deccan plateau. The basin covers a drainage area of 9804 sq km in Madhya Pradesh, 51,504 sq km in Maharashtra and 3837 sq km in Gujarat. The important tributaries joining from the left are the Purna, the Vaghur, the Girna, the Bori, the Panjhra and from the right the Aner. The drainage area of the Tapi basin upto Ukai dam is 62,225 sq km of which 9,804 sq km in Madhya Pradesh, 51,504 sq km in Maharashtra and 917 sq km in Gujarat. The Tapi basin consists of mainly black soil. The coastal plains in Gujarat have alluvial soil with black soil on the surface.

### **2.5 Basin characteristics**

#### **2.5.1 Par basin**

##### **2.5.1.1 Rainfall**

The Par basin is mainly influence by south-west monsoon commencing from the second week of June and continuing till the end of September. 93% of the annual rainfall occurs during this period. The average annual rainfall in the basin is 2076 mm.

##### **2.5.1.2 Temperature**

The monthly mean maximum and minimum temperature observed at IMD station, Valsad varies from 32.8 ° c in the month of May to 12.7 ° c in the month of December.

##### **2.5.1.3 Relative humidity**

The humidity during monsoon season is high and above 75%. The humidity is low during winter season which varies from 42% to 69%.

#### **2.5.1.4 Wind speed**

The mean daily wind speed is maximum (10 km/hr to 12.3 km/hr) during the months May to August and comparatively low (4.3 km/hr to 7.3 km/hr) in other months.

### **2.5.2 Auranga basin**

#### **2.5.2.1 Rain fall**

The basin receives most of the rainfall from South-West monsoon during June to September. 95% of annual rainfall occurs during the monsoon season. The maximum, minimum and average annual rainfall in the basin are 3457 mm, 995 mm and 2160 mm respectively.

#### **2.5.2.2 Temperature**

The meteorological stations at Valsad and Dharampur are in the vicinity of the Auranga basin. Monthly mean temperature in the basin varies from 12.7° c in December to 40.4° c in May.

#### **2.5.2.3 Humidity**

The humidity during monsoon period is high and varies from 77% to 89%. The humidity is low during winter season varies from 42% to 69%.

#### **2.5.2.4 Wind speed**

The mean daily wind speed is maximum (10.0 km/hr to 12.3 km/hr) during the months May to August and low (4.3 km/hr to 7.3 km/hr) during other months.

### **2.5.3 Ambica basin**

#### **2.5.3.1 Rain fall**

The basin receives most of the rainfall from South-West monsoon during June to September. 95% of annual rainfall occurs during the monsoon season. The weighted maximum, minimum and average annual rainfall in the basin for the period 1903 to 1982 are 3165 mm, 870 mm and 1657 mm respectively.

#### **2.5.3.2 Temperature**

There are two meteorological stations at Valsad and Surat in the vicinity of the basin. The mean monthly temperature varies from 12.7 ° c during December, to 37 °.3 c in April.



### **2.5.3.3 Humidity**

The humidity during winter season is as low as 42% and during monsoon season is as high as 89% in the month of August.

### **2.5.3.4 Wind speed**

The mean daily wind speed is maximum (12.3 km/hr) during the months of June and minimum (4.3 km/hr) in December.

## **2.5.4 Purna basin**

### **2.5.4.1 Rain fall**

The basin receives most of the rainfall from the South-West monsoon during June to September. The weighted mean maximum, minimum and average annual rainfall of the basin for the period 1903 to 1989 are 2599 mm, 654 mm and 1431 mm respectively.

### **2.5.4.2 Temperature**

There climatological data the Valsad and Surat IMD observatories which are situated in the vicinity of the basin have been considered. The mean monthly temperature varies from 12.7<sup>o</sup> c during December to 37.3<sup>o</sup> c in April.

### **2.5.4.3 Humidity**

The humidity during winter season is as low as 42% in the month of February and as high as 89% in the month of August as observed at Valsad IMD observatory.

### **2.5.4.4 Wind speed**

The mean daily wind speed is maximum (12.33 km/hr) in the months of June and minimum (4.3 km/hr) in the month of December.

## **2.5.5 Mindhola basin**

### **2.5.5.1 Rainfall**

The basin receives most of the rainfall from the south-west monsoon during June to September. The average normal rainfall in the basin is 1,341 mm. Maximum and minimum annual rainfall of the basin for the period 1901 to 1997 are 1,936 mm and 777 mm respectively.

### **2.5.5.2 Temperature**

The climatological data of the Valsad and Surat IMD observatories which are situated in the vicinity of the basin have been considered. The mean monthly temperature varies from 12.7 ° C during December to 37.3 ° C during April.

### **2.5.5.3 Humidity**

The humidity during winter season is as low as 32 % in the month of February and increases with the onset of monsoon attains higher values upto 89 % in the month of August.

### **2.5.5.4 Wind speed**

The mean daily wind speed is maximum (12.33 km/hr) in the month of June and minimum (4.3 km/hr) in the month of December.

## **2.5.6 Tapi basin**

### **2.5.6.1 Rainfall**

The basin receives most of the rainfall from the South-West monsoon which sets in by the middle of June and withdraws by the first week of October. June to September is the period of heaviest rain. The normal rainfall in the Tapi basin near the Arabian Sea is 1000 mm and the maximum rainfall in the basin is about 1535 mm.

### **2.5.6.2 Temperature**

There are eight IMD observatories located in and around the basin. The mean minimum temperature varies from 11.1 ° C to 14.4 ° C and the mean maximum temperature ranges from 38 ° C to 42 ° C as observed in Surat observatory.

### **2.5.6.3 Humidity**

The maximum and minimum relative humidity values as recorded at the Surat IMD observatory is 89 % and 32 % respectively.

### **2.5.6.4 Wind speed**

The mean daily wind speed is maximum (12.33 km/hr) in the month of June and minimum (4.3 km/hr) in the month of December.