

Paravanar Basin

Introduction

In Tamil Nadu there are 34 rivers including one west flowing river. All these 34 rivers are grouped into 17 River basins for the purpose of hydrological studies for water resources planning and managing activities. Paravanar is one of the 17 river basins of TamilNadu. This chapter looks at the hydrological endowment including ground water potential, water resources demand for all sectors and the water balance of the basin.

The water demand for domestic, irrigation, industries, livestock, power generation and other uses are governed by socio-economic and agricultural factors, including the present and future population size, income level, urbanization, market facilities, remunerative prices, cropping patterns, etc. An analysis of the water availability, water utilisation and allocation plan for different competing water uses and water balance form the core of a river basin plan.

In Water Management Planning, in addition to mismatch problems between demands and supply, other important problems that hamper the safe water supply are water logging, salinity, pollution, environmental degradation, inefficient use of water, underutilisation of resources, seawater intrusion in coastal regions, natural calamities like floods and droughts, climate change etc. and health related problems. These problems are locally assessed at the basin level and possible solutions are evolved in the planning process for decision making at higher levels.

Water resource planning which is people oriented and resource based requires extensive data on Rainfall, Geology, Soil, Geomorphology, Hydrogeology, Hydrology, Climatology, Water quality, Environment, Socio-economic, Health, Agricultural, Population, Livestock, Industries, etc. Data availability on the above accounts is discussed below:

Location and Extent of Paravanar Basin

Paravanar River basin which is a leaf shaped river basin and second smallest river basin of Tamil Nadu lies within Cuddalore District of Tamil Nadu. The basin falls in the survey of India Topo sheet Nos.: 58M / 6, 58M / 7, 58M /10 &14 and 58M / 11 in scale 1:50,000 lying in between the latitude 11°18'' to 11°45'' North and longitude 79°18'' to 79°45'' East. Paravanar Basin is bounded on the North by Pennaiyar river basin, in the South and West by Vellar river basin

and on the East by Bay of Bengal. (Plate : PAR 01A). The Geographical extent of Paravanar basin is **872.34 Sq km**.

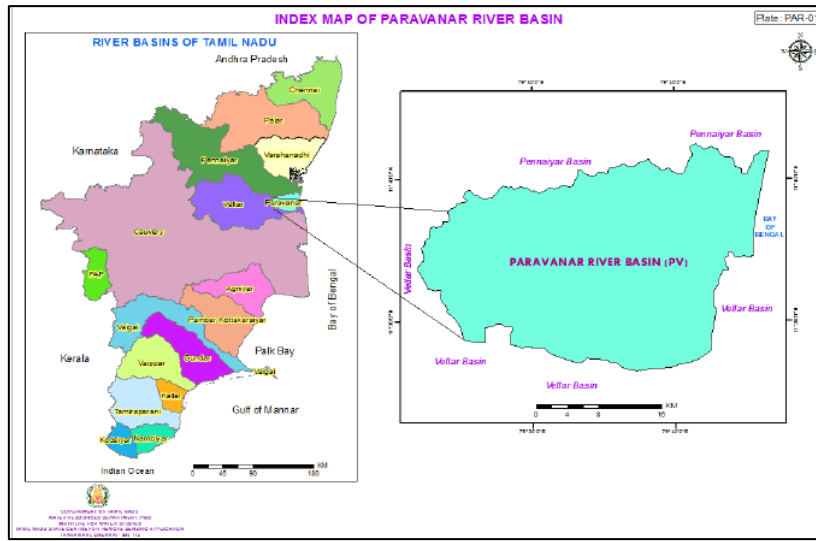


Fig. 1 Index map of Paravanar River Basin

In this basin, district and talukheadquarters, major towns are well connected with Road and Railway networks. The major settlements of this basin are Neyvelitownship, Kurinjippadi, Nellikuppam, Kammapuram, Vadalur, Karunguzhi, Kattugudalur, Valaiyamadevi, Erumbur, Kullanchavadi and Bhuvanagiri. The basin is typically covered by sedimentary rock types of Tertiary to Recent age. Mean annual rainfall is about 1197.70 mm. Maximum precipitation occurs during the North-East monsoon.

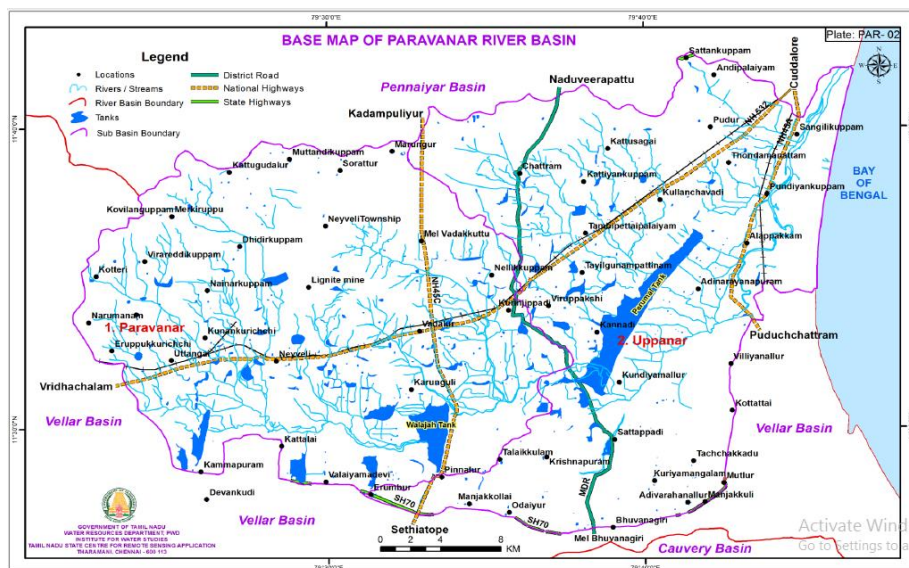


Fig. 2 Base map of Paravanar River Basin

The upper part of the basin is drained by river Paravanar and lower part of the basin drained by Uppanar. Based on this, two sub basins were delineated. The Paravanar sub-basin is 435.016 sq. km and Uppanar basin is 437.325 sq. km, totalling to 872.34 sq. km for the basin as a whole.

The “Neyveli Lignite Corporation” is located within this basin. There are three mines namely Mine 1, Mine 1 A and Mine 2 which are currently under operation. The ground water pumped from the mines flows to Perumal Tank via Walajah tank which is utilized for irrigation in both the tanks. Water and soil quality tests in Perumal tank command area indicated, that the mine drainage water used for irrigation in the tank command has no adverse effect on the soils to hamper the crop growth.

The general topographic trend is falling towards South and South East direction. The basin is a plain and upland terrain is devoid of any hill and related morphologies. There is a steady fall in the elevation, starting from 110 m in the highlands of Cuddalore sandstone area to 0.54 m near the sea.

Geologically this basin is made up of Sedimentary formations. About 70% of the basin area is occupied by Cuddalore sandstone of Tertiary Age, consisting of laterite, sandstone, clay, silt, sand, etc. The remaining 30% of the basin area is covered by river alluvium and coastal alluvium of recent age.

The Paravanar River is not a matured river and is seasonal and ephemeral. It originates from the streams in the highlands at northwest of Neyveli lignite corporation area, i.e. from Semmakottai Reserve forest, at an altitude of about 100 m above MSL near Raghavankuppam and Kovilankuppam villages respectively. There are a number of small streams (Odai's) joining the river Paravanar in the upper reaches and flows towards east and drains into the Walajah Tank. The Sengal Odai originates near Mulaikuppam village and Kanniyakovil odai originates at South East of Neyveli Township. These two odais merge at West of Ellaikudi village, where river middle Paravanar originates and flows in to Perumal tank.

From the Walajah tank, few streams flow towards East and flows into Satapadi tank. The surplus of the tank forms Uppanar river. On its course, towards North East, the river receives surplus water of Perumal tank near Periyapakkam, Anniyampettai and Pundiyanakuppam Villages. The Uppanar river confluences with Bay of Bengal on the North of Semabadakuppam South of Cuddalore O.T. The length of the Uppanar river course is about 24 Km.

There are 37 tanks in the basin under the control of WRD / PWD, out of which 16 tanks have ayacut more than 100 hectares. The major tanks which receive Neyveli Lignite mine water and cater to the irrigation throughout the year are Walajah and Perumal Tanks.

Groundwater occurs in both shallow and deep water confined aquifers. Layers of potential confined aquifers occur below the lignite seams. Artesian aquifers occurred around Neyveli in yesteryears. First two confined aquifers occur immediately below the lignite seams within the depth range of 122 m B.G.L and the third aquifer occurs between 122 m and 305 m B.G.L.

The land use and land cover classification of the Paravanar river basin for the year 2015 is shown in the Table 1

Table. 1 Landuse Classification

Sl. No.	Landuse Category			Area (Sq km)	Percentage (%)	
	I Level	II Level	III Level			
1	Built up Land	Settlement	Urban	21.513	2.467	
			Rural	65.250	7.480	
		Factory	Factory	8.729	1.001	
2	Mining	Mining	Open cast mining	76.380	8.756	
3	Agriculture	Wet Crop / Irrigated Land	Paddy, Sugarcane, Banana and harvested Land	456.703	52.354	
			Dry crop/Rainfed land	Cholam, Kambu and Groundnut	14.444	1.656
			Plantation	Cashew plantation	114.110	13.081
			Groves	Groves - Coconut, Mango	6.400	0.734
4	Fallow	Current Fallow	Current Fallow	1.593	0.183	
		Fallow	Fallow	1.041	0.119	
5	Forest	Reserved forest	Reserved forest	14.220	1.630	
		Forest Blanks	Forest Blanks	3.488	0.400	
6	Barren/ Uncultivable/ Waste Land	Barren land	Barren land	1.956	0.224	
		Scrub land	Scrub land	35.115	4.025	
		Salt affected / Sandy area	Salt affected / Sandy area	10.731	1.230	
7	Water body/Wetland	Water body	Tank	35.220	4.037	
			River/Streams/Canals	4.630	0.531	
		Wetland	Water logged area	0.815	0.093	
				872.341	100.00	

Agriculture in this area depends on both surface and groundwater. The groundwater in Paravanar basin occurs in both confined and unconfined aquifers of which the Neyveli artesian aquifer plays a major role in providing water for various human needs. This confined aquifer is pumped out continuously to keep the hydrostatic pressure low. The pumped water is diverted to thermal power station tanks and two other irrigation tanks, viz., Walajah tank and Perumal tank. These tanks are the major water bearers in the basin and the cultivation depends mainly on them. Both wet and dry crops are grown in this basin.

A comparison of areas occupied for different agriculture purposes for the years 2004 and 2015 has been made and is shown in the following graph. This shows a significant increase in the wet crop in 2015 than 2004 and except this all the other crops were grown in comparatively larger area in 2004 than that of 2015. The variation in the crop cultivation is primarily because of the dry 2004 (Drought year) and comparatively good rain received in 2015.

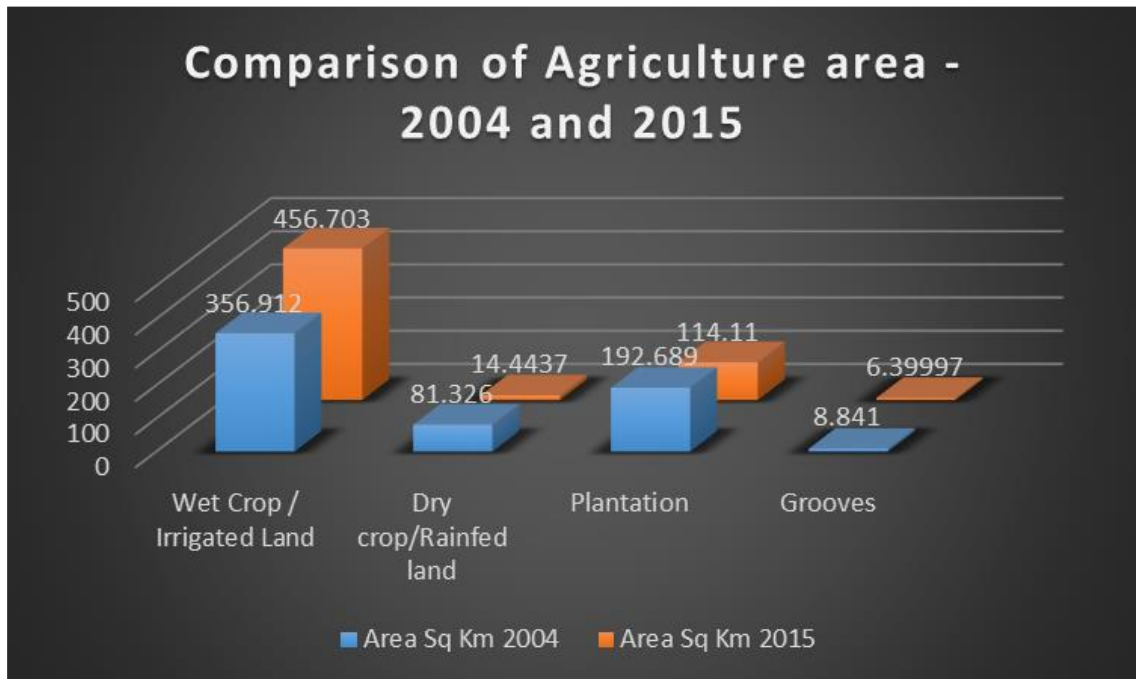


Fig 3. Comparison of Agricultural area – 2004 and 2015

Table 2. Type of soils in the basin

Texture	Area in Sq.Km	Area in %
Clay	229.606	26.33
Clay loam	90.443	10.37
Loamy sand	51.446	5.90
Sand	0.642	0.07
Sandy clay	20.397	2.34
Sandy clay loam	263.344	30.20
Sandy loam	7.540	0.86
Silty loam	18.001	2.06
No soil	190.923	21.85
Total	872.341	100.00

Table 3. Demographic details of Paravanar River basin is given below

S. No	Name of the District	Population as per census 2011			Population as projected to 2016		
		Rural	Urban	Total	Rural	Urban	Total
1.	Cuddalore	0.461	0.324	0.785	0.491	0.358	0.849
	Total	0.461	0.324	0.785	0.491	0.358	0.849

Source: Census 2011

Table 4. Sub Basin wise population in million in the Paravanar River Basin

S. No	Name of Sub basin	As per census 2011			As projected to 2016		
		Rural	Urban	Total	Rural	Urban	Total
1.	Paravanar	0.188	0.120	0.308	0.200	0.133	0.333
2.	Uppanar	0.273	0.204	0.477	0.291	0.225	0.516
	Total	0.461	0.324	0.785	0.491	0.358	0.849

Source: Census 2011

Table 5 Details of Literacy level in Paravanar River Basin
(Population in Million)

Sl. No	Name of the Sub Basin	Literacy Population			Total Population			% Literacy of Population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
1	Paravanar	0.125	0.100	0.225	0.169	0.164	0.333	74.06	60.98	67.62
2	Uppanar	0.183	0.153	0.336	0.259	0.258	0.516	70.69	59.42	65.19
	Total	0.308	0.253	0.562	0.427	0.422	0.849	72.19	60.03	66.14

Source: Census 2011

Industrial employment and water Utilization

Neyveli Lignite Corporation, a Public Sector enterprise provides employment to around 13000 people. Around 2782 handicrafts units such as jewellery, wood works, ceramic, leather, pottery, garment making etc., are functioning in the Cuddalore district providing employment to about 5000 persons.

There are 108 small scale industries, 7 medium scale industries and 40 large scale industries in Paravanar River Basin. The water requirement for the industrial purpose for large & medium and small scale industries are estimated as 73.009 Mcum and 0.186 Mcum respectively.

Seven rain gauge stations positioned in and around the basin are considered for analysis. These Rain gauge stations are maintained by Public Works Department & Revenue Department. Climate Data for analysis are taken from the station adjacent to Paravanar basin, which is maintained by PWD, since this Basin does not have a climate station in it.

Raingauge stations considered for analysis

Sl. No.	Name of subbasins	Subbasin area (Sq.Km.)	No. of Raingauge stations	Name of Raingauge station
1	Paravanar	463.562	4	Panruti, Virudhachalam, Srimushnam, Sethiathope
2	Uppanar	415.900	3	Cuddalore, Vanamadevi, Annamalai University
Total		879.462		

Dependable Rainfall

The 25%, 50%, 75% and 90% dependable rainfall for Paravanar River Basin are tabulated below in **Table 6**

Table 6 Annual Dependable Rainfall in mm – Paravanar Basin

Sl. No.	Sub basin	25%	50%	75%	90%
1	Paravanar	140.56	102.45	82.61	66.45
2	Uppanar	149.01	149.01	90.21	64.39

Maximum, minimum and average rainfall

The maximum, minimum and average annual rainfall for the two sub basins have been analysed and tabulated.

- Maximum Annual Rainfall of this basin is 2026.20 mm in Uppanar Sub basin (2015-16)
- Minimum Annual Rainfall of this basin is 510.00 mm in Paravanar Sub basin (2016-17)
- Average annual rainfall of the Paravanar River Basin is 1227.02 mm

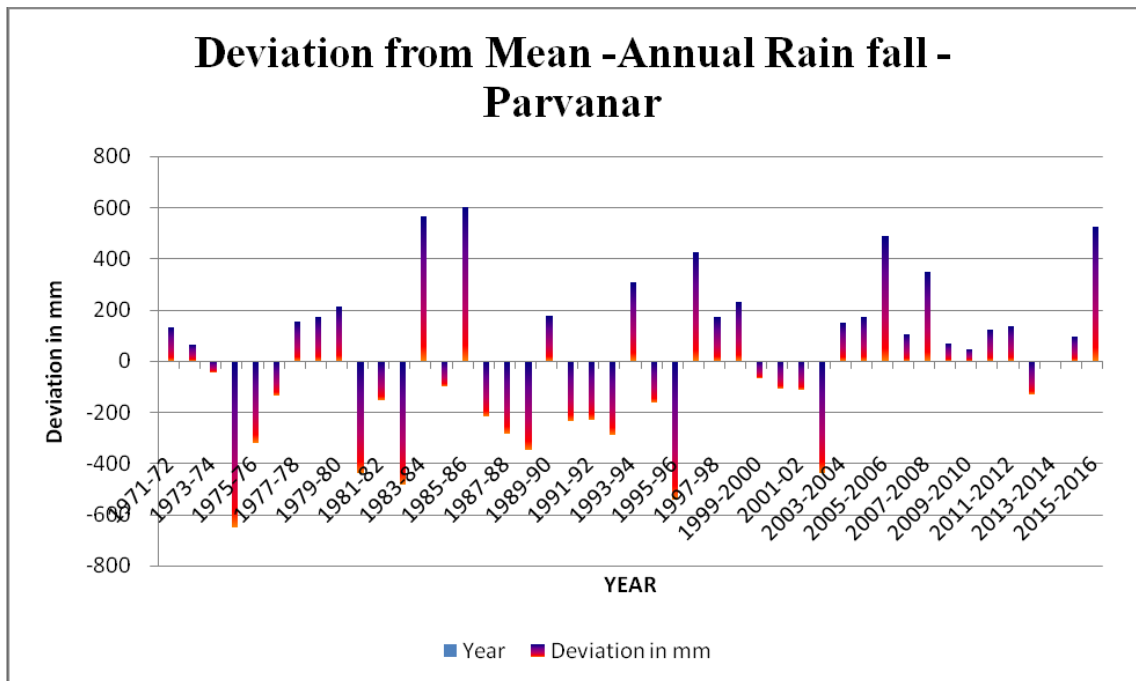


Fig 4 Deviation from mean annual rainfall

The deviation of south-west and north-east rainfall from their respective mean revealed the fact that the trend of south west monsoon is decreasing compared to that of North East monsoon over this basin. This Pattern is influencing on Annual rainfall pattern over this basin.

Climate

As there is no climatic station within the Paravanar basin, the weather station at Lekkur in Lower vellar sub-basin was used.

The climatological values of this river basin are given in the following Table 8

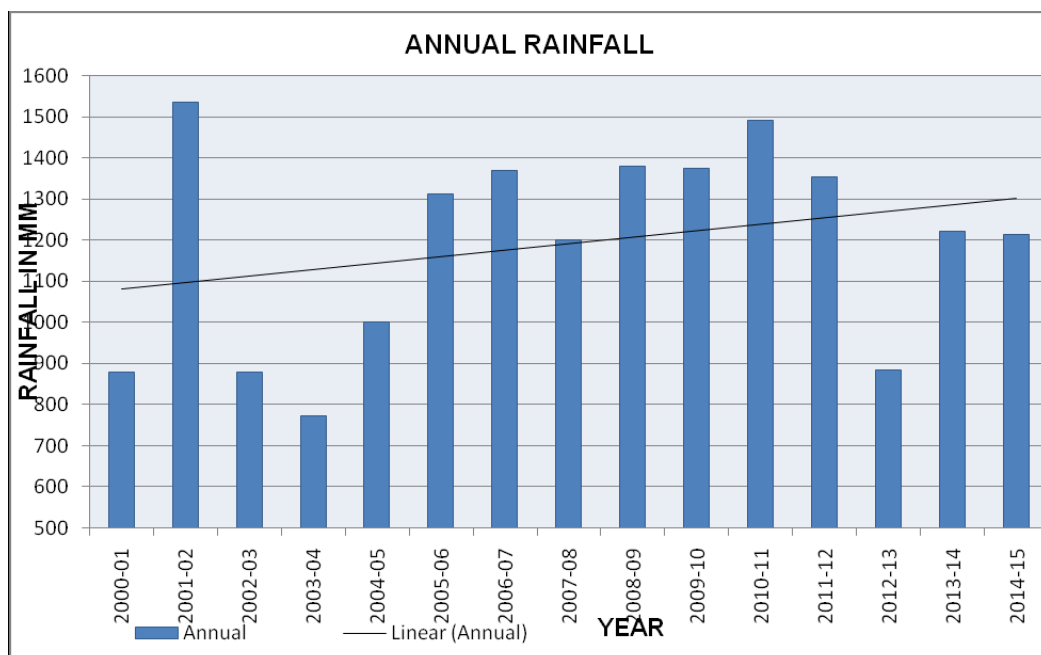
Table 8 Climatological Parameters

S. No	Climatological Parameter	Lekkur
1	Average monthly temperature max. / min. in. ⁰ Celsius	34.20 / 25.32
2	Average mean temperature in ⁰ Celsius	29.76
3	Average relative humidity in %	64.72
4	Average wind velocity in km/hour	2.85
5	Average pan evaporation in mm / month	167.71
6	Average Sunshine hours / day	6.68

The potential evapotranspiration using Penman-Monteith method gives a value of 1645 mm annually. There is not much variation from month to month in potential evapotranspiration. The average daily evapotranspiration works out to 4.506 mm.

Eto values (mm/month) of FCS for Paravanar basin													
Name of the basin & FCS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average
Paravanar basin - Lekkur FCS	124.0	134.4	176.7	186.0	195.3	186.0	170.5	170.5	150.0	120.9	102.0	108.5	152.2

The annual rainfall and the number of rainy days are shown in Fig. 5



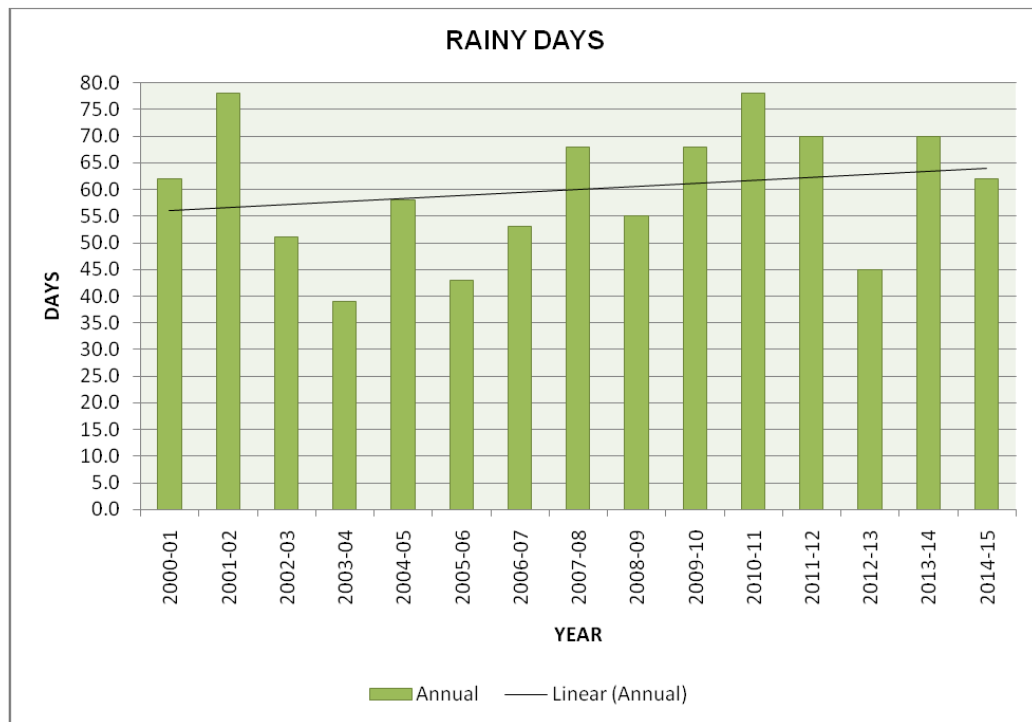


Fig. 5 Results of climatic data – Palur (2000-2015)

In general, Paravanar basin, receives more rainfall in North East monsoon than South West monsoon. There is only one Rain Gauge station in Uppanar sub basin and Paravanar sub basin does not have any rain gauge station and it is suggested to have one station since the area of the sub basin is nearly 500 Sqkm.

Both the sub basins have average annual rainfall of above 1000mm. The highest rainfall of 1213.48mm was received in Uppanar sub basin. Similarly lowest rainfall of 1181.91mm was received in Paravanar sub basin. On viewing the climatic pattern, it is observed that there is increase in number of rainy days, marginal increase in summer & winter maximum temperature and reasonable increase in summer & winter minimum temperature.

IRRIGATION AND AGRICULTURE

The command (ayacut) area of tanks in Paravanar river basin is **11,711.41 Ha** (ayacut of both system and non-system tanks). In the year 2014-15, gross area irrigated is 0.52 lakh Ha and gross area sown is 0.75 lakh Ha. The main crops cultivated are Paddy, Sugarcane, Groundnut, Fruits & Vegetables, Banana, Blackgram, Cumbu and Cashew.

Table 7 Sub Basinwise Number Of Operational Holding

Social Group	Paravanar	Uppanar	Total	%
Marginal (less than 1 Ha)	26572	24744	51316	79.41
Small (1 to 2 Ha)	4081	4354	8435	13.05
Semi medium (2 to 4 Ha)	1689	1885	3575	5.53
Medium (4 to 5 Ha)	222	264	486	0.75
Larger (5 Ha & above)	353	459	812	1.26
Total	32918	31706	64624	

Methodology to calculate irrigation demand

The block wise data on irrigated area for various seasons are collected from the Economics and Statistics Department. Average block wise crop area irrigated was transformed to the sub basin area by its block area proportion.. As the rainfed crops are purely dependent on rainfall only, rain fed crops are not considered for calculating crop water requirements.

Crop	Paravanar	Uppanar	Total
Cocunut - Per - Jan	260.90	450.21	711.11
Paddy - First Crop - June	12564.81	13012.81	25577.62
Paddy - Second Crop - Oct	4188.27	4337.60	8525.87
Cholam - Feb	0.00	1.70	1.70
Cumbu - Mar	396.20	504.88	901.08
Ragi - Jan	7.70	14.75	22.45
Maize - Jul	0.00	0.00	0.00
Red Gram - June	0.00	0.00	0.00
Black Gram - Jan	474.53	520.28	994.81
Green Gram - Jan	55.04	24.91	79.95
Other Cereals - July	152.65	173.93	326.58
Chillies - Jan	12.09	16.05	28.14
Onion-June	5.87	5.14	11.01
Fodder - Mar	396.79	607.86	1004.65
Condiments -Sep	0.00	0.00	0.00
Sugarcane - Dec	2599.33	2511.38	5110.71
Banana - Dec	471.96	1035.02	1506.98
Groundnut - Dec	1944.48	2602.33	4547.01
Cotton - Feb	16.47	26.37	42.84
Gingelly - Feb	689.25	876.49	1565.74
Fruits & Vegetables - June	372.99	392.04	765.03
Flowers - Per - June	73.22	86.45	159.67
Turmeric - June	3.14	1.07	4.21
TOTAL	24685.69	27201.47	51887.15

Table 8 Sub Basinwise Irrigated Area Of Crops (Ha) - Paravanar Basin

Sl. No.	Sub Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	Paravanar	4.92	6.28	8.81	7.85	7.33	69.50	26.70	18.44	1.24	11.67	4.61	7.33	174.68
2	Uppanar	4.81	8.48	6.78	11.95	9.22	64.68	14.85	35.83	1.92	15.58	4.77	7.93	186.81
	Total	9.73	14.77	15.58	19.80	16.55	134.18	41.56	54.27	3.16	27.25	9.38	15.26	361.49

The major crops cultivated in Paravanar Basin are Paddy, Sugarcane, Ground nut and Fruits & Vegetables. The irrigated area for the year 2014-15 in Paravanar Basin under different crops is 51887 Ha with paddy the main crop of the basin cultivated in 34103 Ha. In the remaining area, other crops are cultivated.

The distribution of rain also plays a vital role in crop productivity. Existing cropping pattern during normal rain year (+19% to -19% of normal rainfall) and suggested cropping pattern for Poor rain year (-19% to -59% of normal rainfall) for the Districts covered in this basin are given in the Table 10.

Areas	Existing cropping pattern	Normal year	Moderate drought year	Severe drought year
Tank fed areas	Rice (Aug-Jan) -Pulses (Jan-Apr)	Rice / Vegetables (Aug-Jan) - Gingelly/Pulses (Feb-May)	Pearl millet+clusterbean (Aug-Jan)-Pulses (Feb-Apr)	Fodder / Pulses (Nov-Feb)
Well irrigated areas	Sugarcane (Dec-Jan) – Ratoon sugarcane (Jan-Nov)-Rice (Dec- May) - Groundnut (June-Sep/Oct)	<ul style="list-style-type: none"> • Rice (Aug-Jan) – Groundnut (Feb-Apr)-Gingelly (Apr-Jun) • Maize (June-Sep) Marigold(Oct-Feb)-Pulses (Feb-May) • Vegetables (June-Oct)-Maize(Oct-Jan)-Pulses(Feb-May) • Sugarcane (Dec-Jan)-Ratoon sugarcane (Jan-Nov)-Rice (Dec-May)-Groudnut (June-Sep/Oct) 	Vegetables (May-July)-Maize/Sunflower (Aug-Dec)-Groundnut, Gingelly (Jan-Apr)	Pearl millet / sorghum (July-Oct)-Maize, varagu, Gingelly, Groundnut (Nov-Feb) – Cluster bean/bhendi/lab lab/watermelon (Feb-May)

Table 10 Cropping Pattern

With the existing area of cultivation in Paravanar Basin for some of the crops, by adopting Water saving techniques on cultivation, savings in water is given below:

Sl.No.	Crop	Cultivated area in Ha	Water requirement-conventional method (Mcum)	% of saving by adopting saving technique	Saving (Mcum)
1	SRI-Paddy	34103.49	255.05	40	102.02
2	SSI-Sugarcane	5110.71	52.90	40	21.16
3	Banana	1506.98	14.70	33.33	4.9
4	Coconut	711.11	6.01	63	3.79
5	Groundnut	4547.01	18.00	49.4	8.89
6	Vegetables	765.03	4.63	29	1.34
Total					142.10

Some of the salient points of present status of irrigated area of Paravanar Basin are as follows:

- The Gross irrigated area of crops in Paravanar Basin is reported to be 51887 Ha
- Irrigated area in Paravanar sub basin is 24686 Ha and in Uppanar sub basin is 27201 Ha.
- Out of the total area irrigated, about 66% is under paddy cultivation and 10% is under Sugarcane cultivation, remaining Pulses, Coconut and cashew.
- Net Irrigation demand of this basin at 75% dependable rainfall is 361.49 Mcum
- Net Irrigation demand of this basin at 50% dependable rainfall is 374.16 Mcum
- As per 2008 Paravanar study report, irrigation demand was given as 385.43 Mcumat 75% rainfall dependability with an irrigated area of 49,160 Ha.

The Existing Surface Water Supply System

There are no major reservoirs in this basin. Water needs of this basin are regulated by the two major tanks, namely Walajah and Perumal tanks and five small anicuts. The anicuts are,

1. SengalOdaiAnicut
2. ThambipettaiAnicut
3. RajakupamAnicut;
4. SedapalayamAnicut
5. MaruvaiAnicut

Walajah Tank

Walajah tank is the first major tank which lies at the end of Upper reaches of Paravanar basin. It is a system tank as it also receives water from Sethiathopeanicut, the last anicut across Vellar river through VellarRajan channel. VellarRajan channel also receives water from Veeranam tank through Veeranam New Supply sluices (VNSS) channel which empties into Vellar river in its right bank just about one Kilometer upstream of Sethiathopeanicut. When there is higher demand, a discharge upto 28 cumec could be drawn through VellarRajan Channel by increasing the depth of flow by 0.30m above the normal full supply depth. After feeding a direct ayacut of 12,222 ha through nine branch channels, it empties into Walajah tank. In the command area of Walajah tank there are 8 minor tanks, which act as buffer storage to irrigate the lands under Walajahtank . But at present there is no flow from VellarRajan Channel to Walajah tank. The major input to the tank is the pumping water from NLC mine II. There are 11 channels taking off from the tank sluices to feed the command area of 4612 Ha.

Perumal Tank

The source of supply of water to this tank is Walajah tank. It lies at the end of Middle reach of Paravanar river. The length of Middle Paravanar river which carries the surplus water from Walajah tank to Perumal tank is 9400m. Since this part of the river was very much silted up and encroached, improvements to Middle Paravanar was carried out by National water Management Project. The total command area of this tank is 2632 Ha fed by 11 channels taking off from the tank sluices. The total length of these channels is 60.36 km. But it is told by the farmers that the actual command area is still greater than this and this need to be verified. The tank has got a very lengthy bund and the length of the bund is 16 km. The discharge capacity of the surplus arrangement in the right bank of the tank is 13000 c/s. As the weirs are inadequate to dispose the maximum flood discharge of 18000 c/s an additional surplus regulator with 6 Nos. of vent size 5.00 m x 0.94 m each has been constructed at right side of Andarmullipallam sluice under National water Management Project to dispose the extra flood discharge of 5000 c/s. The length of new surplus regulator is 4830 m.

In Paravanar basin, there are 37 tanks of which Walajah and Perumal tanks are provided with shutters on the surplus weir. There are very few tanks with uncontrolled weirs. However, the surplus weirs of all the small tanks are uncontrolled.

Table 12 Tank Details of Paravanar River Basin

S.No	Name of the Sub basin	System Tank			Non System Tank		
		No	Capacity in Mcum	Ayacut in Ha	No	Capacity in Mcum	Ayacut in Ha
1	Paravanar	6	4.766	5716.75	10	3.412	1002.39
2	Uppanar	9	18.096	4254.07	12	2.15	673.15
	Total	15	22.862	9970.82	22	5.562	1740.59

The surface water potential at 75 % dependable rainfall is worked out by Monthly Run Off Simulation (MRS) Method is worked out and is presented below.

Table 13 75% Dependable Surface Water Potential by MRS method

Sl. No.	Name of Sub basin	75% Dependable Surface Water Potential in MCM			
		SW	NE	NM	Annual
1.	Paravanar	35.60	35.24	11.77	82.61

2.	Uppanar	24.75	63.25	2.21	90.21
Total		60.35	98.49	13.98	172.82
South West Monsoon Potential		60.35 Mcum (or) 60MCM			
North East Monsoon Potential		98.49 Mcum (or) 99 MCM			
Non Monsoon Potential		13.98 Mcum (or) 14 MCM			
Annual Potential		172.82 Mcum (or) 173 MCM			

Surface Water Potential of Paravanar Basin is 173 Mcum.

Quantity of water supplemented by VellarRajan Channel, off taking from Sethiathope across Vellar river in Vellar basin

The total command area fed by VellarRajan Channel is 19,466 Ha of which the direct command area is 12,222 Ha and the balance 7,244 Ha is the command area of Walajah tank and Perumal tank, which is only 37% of the total command area fed by VellarRajan channel. At present, as reported by the Executive Engineer, WRD, Coleroon Basin Division, Chidambaram, there is no flow from VellarRajan Channel to Walajah tank. Hence, the quantity contributing to the surface water potential of Paravanar basin is taken as Nil.

Pumped water from Neyveli Lignite Corporation Mining area

. The quantity of water that is being pumped from the Neyveli first mine cut, at an average rate of 2.432 m³/sec or 76.70 Mcum /annum. Subsequently water was also pumped from the Neyveli second mine cut. The quantity of water that is being pumped from the Neyveli second mine cut at an average rate of 3.648 m³/sec or 115 Mcum/annum. The total average pumped quantity of water from the two units works out to 192 Mcum/annum. This quantity has been considered for arriving the Water balancing of this basin..

The sub basin wise surface water potential for the basin is assessed using the following methods:

- 1. Rainfall – Run-off Co-efficient Method**
- 2. NWDA Approach 3.MRS Model.**

The Annual Surface Water Potential of Paravanar River Basin calculated using Rainfall – Run-off Co-efficient Method is 126.48 Mcum at 75% dependability and that by using MRS Model is 176.12 Mcum. Also the 75% dependable Monsoon yield (June to December) for the whole Paravanar river basin using NWDA approach works out to 224.97 Mcum.

There has been 15 to 20 percent reduction in storage capacity of tanks due to siltation, foreshore encroachment and poor tank structures.

GROUNDWATER RESOURCES AND WATER QUALITY

Paravanar Sub Basin

The data of twelve (12) observation wells were analyzed and found that ground water level during post monsoon varies from 0.25 m (OW11310: Jan 2012) to 93.76 m (MWS 31582: Jan 2004) and during pre-monsoon varies from 0.45m (OW11310: Mar 2012) to 95.72m (MWS 31582: Mar 2004) below ground level.

Uppanar Sub Basin

The data of seventeen (17) observation wells were analyzed and found that ground water level during post monsoon varies from 0.25m (OW11300: Jan 2012) to 25.75m (U33037: Feb 1996) and during pre-monsoon varies from 0.45m (OW11300: Mar 2012) to 32.50m (U33040: May 1988) below ground level.

Groundwater Level Scenario

i) Pre-Monsoon:

In upper and down region, groundwater level is shallow (0.00m to 24.60m) during July 1984, July 1994, July 2004 and July 2014. In top region, groundwater level is deep to deeper (29.20m to 77.50m) during July 1984, July 1994, July 2004 and July 2014. In tail end region, groundwater level is moderate (17.80m to 34.80m) July 1984, July 1994, July 2004 and July 2014).

ii) Post-Monsoon:

In upper region, groundwater level is shallow (8.20m to 27.30m) during January 1995, January 2005 & January 2015 and is moderate (21.06m to 30.35m) during January 1985. In down region groundwater level is shallow (7.40m to 27.30m) during January 1985, January 1995, January 2005 and January 2015. In tail end region the groundwater level is shallow (7.40m to 27.30m) during January 1985, January 1995, January 2005 and January 2015. In top region,

groundwater level is deep to deeper (30.35m to 82.50m) during January 1985, January 1995, January 2005 and January 2015. In tail end region, groundwater level is moderate (21.50m to 38.25m) during January 1985, January 1995, January 2005 and January 2015.

Table 14 **Summary of Categorization of Firkas**

Sl.No	Category	2011 Assessment
1	Safe	6
2	Semi Critical	2
3	Critical	1
4	Over Exploited	4

Table 15 Ground Water Potential Calculation as on March 2013

Name of District covered	Area covered in %	Net Ground Water available in Ha m	Ground water potential District wise in Ha m
Cuddalore	100.00	44950.83	44950.83
	TOTAL		44950.83

Total 44950.83 Ha.m
449.51 M.cum

PRESENT AND FUTURE WATER DEMAND

Domestic water demand:

Table 18 present basinwise projected population and projected domestic water demand for Paravanar River basin.

Table 18 Projected Population and Domestic Water Demand for Paravanar River Basin

Year		Population	Demand	
			MLD	MCM
2010	Urban	311000		
	Rural	392000		
2011	Urban	73419	5.13933	12.85
	Rural	751735	30.0694	
2017	Urban	82682	5.78774	13.97
	Rural	812309	32.4924	
2020	Urban	87743	6.14201	14.57
	Rural	844403	33.7761	
2030	Urban	106958	7.48706	16.76
	Rural	960825	38.433	
2040	Urban	130381	9.12667	19.29
	Rural	1093298	43.7319	
2050	Urban	158933	11.1253	22.22
	Rural	1244037	49.7615	

Industrial water demand:

Industrial water demand for small scale industries and large and medium scale industries and total industrial water demand are given in Table 22.

Table 22 WATER DEMAND CALCULATION FOR SMALL, MEDIUM AND LARGE INDUSTRIES BASED ON INDUSTRY CENSUS AS TAKEN FROM IWS

Sl. No.	Type of industry	Average Rate of Water consumption as given in IWS m ³ /day	2010		2017		2020		2030		2040		2050	
			No. of industry as per IWS	Water Demand	No. of industry	Water Demand	No. of industry	Water Demand	No. of industry	Water Demand	No. of industry	Water Demand	No. of industry	Water Demand
1	Small scale industry	2.5	5948	5.43	10194	9.30	12841	11.72	27723	25.30	59853	54.62	129217	117.91
2	Medium & Large scale industry	2500	35	31.94	60	54.74	76	68.95	163	148.86	352	321.38	760	693.83
Total Demand in M.Cum				37.37		64.04		80.67		174.16		375.99		811.74

Livestock water demand:

Livestock water demand is given in Table 25

Table 25 Projected Livestock water demand

Sl. No.	Name	Standard Norms in lpcd	Demand 2017	Demand 2020	Demand 2030	Demand 2040	Demand 2050
1	Cattle	110	14.59	14.78	15.41	16.07	16.76
2	Buffalo	150	0.32	0.28	0.18	0.12	0.07
3	Sheep	20	0.43	0.43	0.43	0.43	0.43
4	Goats	20	2.35	2.35	2.32	2.3	2.28
5	Horses & Ponies	150	0.02	0.02	0.02	0.03	0.03
6	Donkeys	40	0.003	0.003	0.003	0.003	0.003
7	Pigs	40	0.226	0.226	0.226	0.226	0.226
8	Dogs	15	0.239	0.239	0.239	0.239	0.239
9	Rabbits	15	0	0	0	0	0
10	Poultry	0.25	0.087	0.087	0.087	0.087	0.087
	Total		18.26	18.41	18.91	19.50	20.12

Water balancing:

Water balancing for Paravanar river basin at 75% dependability which includes water potential, demand and deficit for 2017 and the projected years is given in Table 28.

Table 28 Water Balancing for Paravanar River Basin at 75% dependability

Sl. No	Name of the basin	Area of the basin (in Sq.Km)	No. of Sub basins	Year	Demand of water in various sectors (MCM)						Water availability (MCM)					Surplus / Deficit in Mcum
					Irrigation	Domestics	Industries	Live stock	Others	Total	Surface water potential	Ground water potential as march 2013	Quantity of recycled water from Sewage	Quantity of water from desilting	Total	
1	Paravanar	864.059	2	2017	1738.65	13.97	64.037	18.26	-	1834.92	379.00	1284.95	-	3.686	1667.64	-167.29
				2020	1738.65	14.57	80.67	18.41	-	1852.30	379.00	1284.95	-	3.686	1667.64	-184.67
				2030	1738.65	16.76	174.16	18.91	-	1948.48	379.00	1284.95	-	3.686	1667.64	-280.85
				2040	1738.65	19.29	375.99	19.50	-	2153.44	379.00	1284.95	-	3.686	1667.64	-485.80
				2050	1738.65	22.22	811.74	20.12	-	2592.73	379.00	1284.95	-	3.686	1667.64	-925.10

Tank sedimentation:

Table 29 given below is a list of tanks in which sedimentation study is conducted.

Table 29 List of tanks in which sedimentation studies conducted

Name of the Tank	Initial capacity in Mcum.	Present capacity in Mcum	Capacity loss in Mcum	Annual silting rate in Mcum / year	Average annual silting rate in %	Average annual silting load/sq.km catchment Mm ³ /sq.km	Average annual silting load/sq.km of water spread Mm ³ /sq.km
Walajah Tank ****	2.5689	1.6714	0.898	0.01	1.11	0.000052	0.0021
Perumal Tank	17.768	14.979	2.789	0.08	2.86	0.00025	0.006

Source: Executive Engineer, Water Shed Management, Pollachi, WRD,PWD

Fish production:

Year wise inland fish production and yearwise marine fish production in Cuddalore District are given in Table 30 and 31.

Table 30 Year wise Inland Fish production (in Tonnes)

Sl.No	Districts	2009-10	2010-11	2011-12	2012-13	2013-14
1	Cuddalore	15641.84	15548.13	16656.03	16848.07	17382.35

Source: Statistical Handbook of Tamil Nadu

Table 31 Year wise Marine Fish production (in Tonnes)

Sl.No	Districts	2009-10	2010-11	2011-12	2012-13	2013-14
1	Cuddalore	22086.13	25531.73	25646.62	25820.68	25978.19

Source: Statistical Handbook of Tamil Nadu

Agencies responsible for Water Resources and its management:

Table 32 presents the main activities for the basin management and agencies responsible for it.

Table 32 Main Activities for Basin Management and Agencies Responsible

Sl. No	Main Activity	Department / Agency Responsible	Key functions
1	Water Resources Management.	Water Resources Department	<input type="checkbox"/> <input type="checkbox"/> Planning, Designing and Execution of New Irrigation Projects. <input type="checkbox"/> <input type="checkbox"/> Operation and Maintenance of Irrigation systems including tanks. <input type="checkbox"/> <input type="checkbox"/> Collection of Surface and Ground Water Data for effective Water Resources Management.
		Central Water Commission	<input type="checkbox"/> <input type="checkbox"/> Planning, Designing and Execution of New Irrigation Projects sanctioned by Central Government. <input type="checkbox"/> <input type="checkbox"/> Collection of Surface and Ground Water Data for effective Water Resources Management.
		Ministry of Water Resources (MoWR) & Ministry of	<input type="checkbox"/> <input type="checkbox"/> Clearance for New Irrigation Projects.
		Environment and Forest (MoEF), Government of India.	
		Institute for Water Studies, WRD	<input type="checkbox"/> <input type="checkbox"/> Develop broad principles for planning and management of water
		State Water Resources	<input type="checkbox"/> <input type="checkbox"/> Advise the Government of Tamil Nadu in water policies.

		Management Agency (SWaRMA)	<input type="checkbox"/> <input type="checkbox"/> Advise in regulating water allocation for bulk users. <input type="checkbox"/> <input type="checkbox"/> Review and approve state and River Basin master plans and to appraise all surface water resources in the hydrological boundaries. <input type="checkbox"/> <input type="checkbox"/> Develop a State water allocation data base. <input type="checkbox"/> <input type="checkbox"/> Prepare an annual Water Audit for each river basin in the state and to publish the same. <input type="checkbox"/> <input type="checkbox"/> Support and aid the enhancement and preservation of water quality within the State.
2	Ground Water Level and Quality monitoring.	State Ground and Surface Water Resources Data Centre, WRD.	<input type="checkbox"/> <input type="checkbox"/> Installation & Maintenance of Observation wells and Piezometers. <input type="checkbox"/> <input type="checkbox"/> Collection and Testing of water samples from Observation wells and Piezometers. <input type="checkbox"/> <input type="checkbox"/> Construction of Artificial Recharge Structures. <input type="checkbox"/> <input type="checkbox"/> Observation, Documentation and Supply of Ground Water Data. <input type="checkbox"/> <input type="checkbox"/> Accords Ground Water clearance for environmental, Institutional and financial point of view
		Central Ground Water Board	<input type="checkbox"/> <input type="checkbox"/> Monitors Ground Water Level and Quality
3	Surface Water and Hydrological data collection Surface Water and Hydrological data collection	State Ground and Surface Water Resources Data Centre, WRD.	<input type="checkbox"/> <input type="checkbox"/> Installation & Maintenance of Rain gauge Station, Climatic Stations, Automatic Weather stations and Gauge discharge station. <input type="checkbox"/> <input type="checkbox"/> Observation, Documentation and supply of Rainfall and Hydrometeorological data. <input type="checkbox"/> <input type="checkbox"/> Collection and testing of water samples from rivers at selected locations
		Indian	

		Meteorological Department (IMD)	<input type="checkbox"/> <input type="checkbox"/> Observation of Rainfall & Hydrometeorological data.
4	Providing Drinking Water and Sanitation facilities.	Tamil Nadu Water Supply and Drainage Board	<input type="checkbox"/> <input type="checkbox"/> Planning, Designing and Execution of New Drinking Water Schemes. <input type="checkbox"/> <input type="checkbox"/> Planning, Designing and Execution of New Under Ground Sewerage Schemes. <input type="checkbox"/> <input type="checkbox"/> Providing water supply for Rural, Urban and industrial needs.
5	Protecting the forest cover, according clearance for forest area, protecting the flora and fauna, Environmental protection.	Forest Department	<input checked="" type="checkbox"/> Conserving the forest wealth. <input checked="" type="checkbox"/> Undertaking control measures in watersheds. <input checked="" type="checkbox"/> In charge of social forestry works
6	Agricultural Development.	Agriculture Department	<input type="checkbox"/> <input type="checkbox"/> Providing facilities to the farmers including supply of subsidies like fertilizers, pesticides, seeds etc and suggests for suitable crop pattern. <input checked="" type="checkbox"/> Monitors the Agricultural activities.
7	Command area development including On Farm Development (OFD) works.	Agricultural Engineering Department	<input type="checkbox"/> <input type="checkbox"/> Executes watershed management works and control measures on soil conservation. <input type="checkbox"/> <input type="checkbox"/> Water Management through micro and sprinkler irrigation.

Strategic issues and action plan:

Table 33 provides strategic issues, remedial measures and action to be taken by the different departments.

Table 33 Strategic Issues and Action Plan

Sl.No	Issues	Strategies Recommended	Action to be Taken
1	No raingauge station is installed in Paravanar sub basin. Area of Paravanar Sub basin is 435.016 Sq.km	<ul style="list-style-type: none"> • A minimum of one raingauge station has to be installed for an area of about 500 Sq.Km. 	The Chief Engineer, SG&SWRDC
2	No gauging sites at the tail end point for assessing the Surplus outflow to sea	<ul style="list-style-type: none"> • Automatic flow measuring devices to be installed at all tail end. • Proposals for utilizing the surpluses of Paravanar suggested in Vision 2023 (list furnished separately) may be implemented. • Steps to utilize the surplus water in the upper reaches may be analyzed. 	The Chief Engineer, Chennai Region and Chief Engineer Plan Formulation. The Chief Engineer, SG&SWRDC
3	The surface system is sick and inefficient. The real problem is with the main distribution system. Drains carrying silt into the irrigation canals causes heavy siltation.	<ul style="list-style-type: none"> • The damaged and deteriorated conveyance systems including masonry structures are to be rehabilitated for their proper functioning 	The Chief Engineer, Chennai Region
4	No sampling location identified for the assessment of Surface water quality and its monitoring.	<ul style="list-style-type: none"> • Necessary steps to be taken for identifying the surface water sampling location. 	The Chief Engineer, Chennai Region and The Chief Engineer, SG&SWRDC
5	Managing future water need for irrigation.	<ul style="list-style-type: none"> • Change of cropping pattern during normal rain year and during drought rain year • SRI method cultivation for paddy and SSI method for Sugarcane may be implemented. 	Agriculture Dept., Horticulture Dept. and Agricultural Engg. Dept.

6	The size of waterways and water bodies of Paravanar basin are reduced due to weeds, plantation and siltation thereby the run off is get obstructed and causing flood. Also, NLC is pumping very large quantity of water and letting into water bodies in Paravanar basin	<ul style="list-style-type: none"> • Necessary actions to be taken for clear up the waterways of Paravanar course. 	The Chief Engineer, Chennai Region
7	No WUAs have been formed in Paravanar basin under IAMWARM project.	<ul style="list-style-type: none"> • Necessary action to be taken for setting up of WUAs in Paravanar basin 	The Chief Engineer, Chennai Region