

## Physico-Chemical Parameters of River Bhavani in Three Stations, Tamilnadu, India

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**Abstract:** The study on some physico-chemical characteristics of River Bhavani at its source and Mettupalayam and Sirumugai has been calculated for the period of one year (July 2007 to June 2008). The sampling points were selected on the basis of their importance. For surface water determination of water quality index becomes essential and pre-requisite. Analysis of some physico-chemical characteristics like water temperature, colour, electrical conductivity, transparency, total suspended solids, total dissolved solids, p<sub>C</sub>, dissolved oxygen, BOD, total alkalinity; total hardness has been done during the investigation period. Increase in temperature, turbidity, pH, electrical conductivity, total solids, suspended solids, dissolved solids, BOD values were higher in Sirumugai station, whereas the increase in total hardness, bicarbonate values were higher in Mettupalayam due to the intensity of expulsion of contamination. The dissolved oxygen values higher in Pillur dam station owing to unpolluted water. The Bhavani river has been facing severe anthropogenic activities, mostly due to municipal sewage and industrial waste and dense population etc.

**Key words:** Electrical conductivity • BOD • COD • Turbidity • Bhavani River • Anthropogenic activity

### INTRODUCTION

River Bhavani is fresh water originates from Western Ghats, Nilgiri district and second largest river in Tamil Nadu and passing through Mettupalayam and Sirumugai to the distance of 217 km before merging with the Cauvery. Long Perennial River fed mostly by the southwest monsoon season prevails during June to August while the North East monsoon season follows from September to December. The post monsoon season has a brief winter (January to February) and summer follows afterwards, characterized by warm humid conditions. Its watershed drains an area of 6,200 km<sup>2</sup> spread over Tamil Nadu (87%), Kerala (9%) and Karnataka (4%). The main river courses through entire of the North-Western Erode district of Tamil Nadu. About 90 per cent of the river's water is used for agriculture irrigation. 6 million people live along its banks. The river's headwaters are on the eastern slopes of the Western Ghats range, in the Attappadi Reserve Forest, in Palakkad district of the state of Kerala and the Kunda hills in the south west corner of the Nilgiri Hills of Tamil Nadu. The Upper

Bhavani has been dammed creating the large Bhaktavatsalam Sagar reservoir. The river flows northwest, into Karnataka, draining the south slope of the Nilgiri Hills, flowing for a few kilometers southward it enters Kerala through a deep gorge and continues south for another 20 km, between two high, forested ridges till Mukkali. 12 major rivulets join Bhavani draining the southern Nilgiri slopes. The west and East Varagar tributaries coming from the Nilgiris are the largest and each have dams in Tamil Nadu. At Mukkali, Bhavani takes an abrupt 120° turn towards the northeast and flows for another 25 km through Attappady plateau and for 7 km along the inter-State border. It gets reinforced by The Kunda river coming from the north, drains an extensive part of the Nilgiris and forms the boundary between Kerala and Tamil Nadu for 5 km. It joins the Bhavani on its left bank in western Tamil Nadu at a place called Athikadavu. The Siruvani river a perennial stream of Coimbatore District and the Kodungarapallam river, flowing from the south and southeast respectively join the Bhavani at Koodappatti on the Kerala-Tamil Nadu border. Pillur dam located on Bhavani River, 88 m high

dam has a catchment area of 1,191 km<sup>2</sup>; the dam is 357 m long and the mean annual flow to the dam is 685 MCM. The reservoir has a live storage capacity of 28 MCM at FRL 427 m and the MDDL is at 396 m.

The water is also used for irrigation, culturing of fishes and drinking. However in recent years, with the advent of an industrial city, the river has started flowing almost full with the industrial effluent and municipal sewage effluents. At Mettupalayam, numerous slaughter houses, domestic sewage, industrial waste discharge of sewage and dyeing and United Bleaching factory effluents (UBL), add their waste to the of the town. Although numerous industries are located along the path of the river, The South India Viscose (SIV) factory although now shut, has completely damaged the lower basin, while textile, tanning and dyeing industries have further downstream of SIV. About 38,000 cubic meters of effluents and wastewater are dumped into the river. Apart from industrial waste, municipalities and untreated sewage from Mettupalayam, Sathyamangalam, Gobi and Bhavani towns are dumped into the river. Water accounting study conducted by the [1] for the lower Bhavani river basin shows that industrial water use (45 million cubic meter) is almost 2 per cent of total water use of 2341 Mm<sup>3</sup> of the basin and agriculture has the highest share more than 67 per cent or 1575 Mm<sup>3</sup>. [2-5]. Around ten industrial units, which include textiles and paper and pulp, are located in the Mettupalayam area. These water intensive units are basically large and medium scale units which meet their water requirement (around 10 million litre per day) directly from the Bhavani river. Most of the units discharge their treated / partially treated effluents (about 7 mld) on land ostensibly for irrigation. However, there is river water contamination due to the discharge of sewage from Mettupalayam municipality. The total annual pollution load discharged by the units is estimated, based on TamilNadu Pollution control board data (TNPCCB), to be 1,316 tonnes of Total Dissolved Solids (TDS), 94 tonnes of Total Suspended Solids (TSS), 169 tonnes of Chemical Oxygen Demand (COD) and 2 tonnes of oil and grease. In Sirumugai town, a major pulp and viscose rayon plant used to draw 54 mld water from the Bhavani river and discharge an equivalent amount of partially treated effluents into the river. Annual wastewater pollution load of Mettupalayam municipality constitutes 61 tonnes of TDS, 50 tonnes of TSS, 7 tonnes of BOD, 18 tonnes of COD, 19 tonnes of Chloride and 1 tonne of Sulphate, 494 tonnes/year of TDS, 22 tonnes/year of TSS and 24 tonnes/year of COD. [6]. Apart from industrial waste, municipalities also dump untreated sewage from Ooty, Coonor, Mettupalayam, Sathyamangalam, Gobi and

Bhavani towns are dumped into the river. At Mettupalayam, numerous slaughterhouses add their waste to the domestic sewage of the town. The Nilgiris mountain range is also an important centre for pesticide-dependant tea plantations. Pesticides from these tea estates find their way to the Bhavani. Tea estates and coffee pulp houses add an estimated 1.5 mld of effluents to the river every day. There are more than 100 textile units, 110 leather processing units, 2 sugar factories and 2 distillery units. All of them use Bhavani river water for their water requirements. Either directly or indirectly all their effluents reach Bhavani river and Kalingarayan canals causing severe pollution, affecting agriculture and causing severe environmental damage. The present study has been carried out to evaluate the physico-chemical parameter of river Bhavani by using standard method, which enables the common man to understand the quality of water.

## **MATERIALS AND METHODS**

Water samples from River Bhavani were from three stations, one at Pillur dam (N 11.26417 °E 076.80885°) received waters from the western ghats and other two are Mettupalayam (N 11.31759 °E 076.94669°) and Sirumugai (N 11.34219 °E 077.01141°). One year continuous monthly periods in the July 2007 to June 2008 were selected. The sample were collected from all the stations at 11 to 12 noon in both the seasons for physico chemical examinations, different methods of collection and handling were adopted based the standard procedures. [7] The instruments were used of accuracy and chemical used were of AR grade.

## **RESULTS AND DISCUSSION**

The physico-chemical characteristics of the three samples points were given in Table 1, 2 and 3 along with the respective values and the mean values with range values were given in the Table 4.

Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism. The temperature was ranging from 22°C to 29.5°C during the study period. Lowest water temperature was observed in the Pillur dam 22.0 °C. A study increase in water temperature in the course of River Bhavani was noticed. There was an increase in water temperature after the discharge of the effluents into the river. An increase in temperature was observed from upstream station to lower (Pillur to Mettupalayam and Sirumugai). This might be due to mixing of the effluents.

Table 1: Physico-chemical characteristics of river Bhavani at Pillur dam for one year (July 2007 to June 2008)

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Temperature (C)	26.0	26.1	26.0	24.0	22.5	22.0	23.0	24.5	26.1	26.2	26.1	25.5
Colour	B	C	C	C	B	C	C	C	C	C	C	B
Turbidity (N.T.U)	21.0	19.4	19.3	20.0	19.5	19.6	18.0	18.1	19.6	19.0	19.2	20.0
Electrical Cond (mMho)	190	190	180	320	310	320	310	310	200	200	190	180
Suspended Solids (Mg/l)	2360	2370	2370	2000	1900	2000	1900	1900	2360	2375	2375	2360
Dissolved Solids (Mg/l)	1240	1240	1240	1500	1300	1500	1310	1315	1250	1240	1240	1240
Total Solids (Mg/l)	3600	3610	3610	3500	3200	3500	3210	3215	3610	3615	3615	3600
Ph	7.4	7.5	7.5	7.4	7.6	7.4	7.6	7.7	7.9	7.8	7.5	7.3
D.O (Mg/l)	7.9	7.9	7.9	8.3	8.3	8.1	8.4	8.4	7.7	7.6	7.9	7.9
B.O.D	1.6	1.5	1.6	1.0	1.6	1.0	1.5	1.5	1.7	1.6	1.6	1.6
BCO <sup>3</sup> (Mg/l)	2.6	2.5	2.6	6.5	6.0	6.3	6.8	6.5	2.7	2.6	2.7	2.5
Total Hardness (Mg/l)	26.2	27.3	23.6	45.2	56.8	43.9	60.1	51.6	27.4	28.5	26.6	23.4

\*B-Brownish, C-Colourless, G-Greenish.

Table 2: Physico-chemical characteristics of river Bhavani at Mettupalayam for one year (July 2007 to June 2008)

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Temperature (°C)	26.5	28.5	28.5	25.0	23.0	24.0	24.0	25.5	26.6	28.6	28.5	28.0
Colour	B	B	B	B	B	B	C	C	C	C	C	C
Turbidity (N.T.U)	20.5	20.3	20.1	22.2	20.1	20.2	20.0	20.1	20.6	20.1	20.2	20.0
Electrical Cond (mMho)	920	980	970	910	920	910	900	900	930	990	990	960
Suspended Solids (Mg/l)	2050	2040	2040	2000	2300	2000	2100	2110	2060	2045	2040	2034
Dissolved Solids (Mg/l)	1230	1235	1235	1540	1250	1545	1160	1165	1235	1240	1240	1240
Total Solids (Mg/l)	3280	3275	3275	3540	3550	3545	3260	3275	3295	3285	3280	3265
pH	7.5	7.8	7.7	7.9	7.6	7.8	7.5	7.6	7.8	7.9	7.6	7.4
D.O (Mg/l)	6.9	6.6	6.6	6.7	6.8	6.8	6.6	6.7	6.6	6.5	6.6	6.8
B.O.D	1.7	1.7	1.8	3.2	4.1	3.1	4.0	3.9	1.6	1.8	1.8	1.8
HCO <sub>3</sub> (Mg/l)	2.5	2.6	5.1	7.0	8.0	6.8	7.9	7.5	2.6	2.7	5.2	5.0
Total Hardness (Mg/l)	32.2	32.8	28.6	56.7	50.2	56.7	65.3	68.1	33.5	32.4	32.4	28.4

\*B-Brownish, C-Colourless

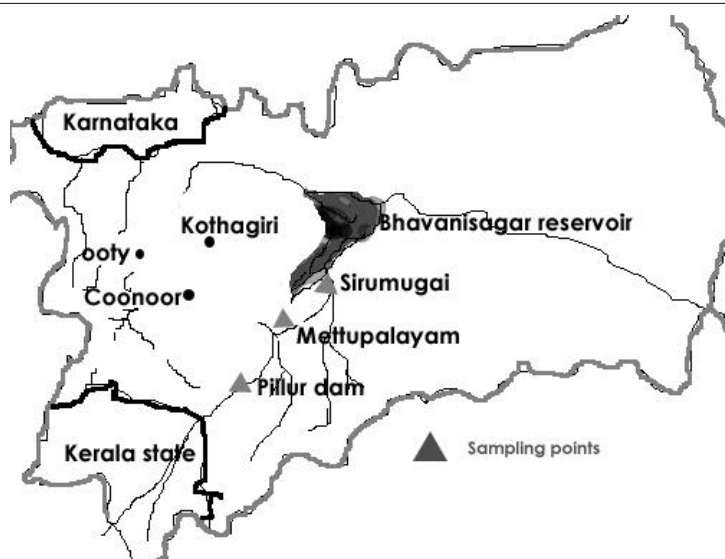
Table 3: Physico-chemical characteristics of river Bhavani at Sirumugai for one year (July 2007 to June 2008)

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Temperature (°C)	27.0	29.0	29.5	28.0	26.0	25.0	25.0	27.0	28.0	29.0	29.5	29.5
Colour	B	DB	DB	DB	DB	DB	DB	DB	B	DB	DB	DB
Turbidity (N.T.U)	21.5	21.5	21.2	23.0	25.0	22.5	24.0	24.0	21.7	21.6	21.3	21.0
Electrical Cond (mMho)	1100	1100	1200	1200	1300	1300	1300	1300	1400	1400	1200	1100
Suspended Solids (Mg/l)	2380	2380	2385	2100	2050	2150	2280	2280	2300	2370	2340	2320
Dissolved Solids (Mg/l)	1650	1650	1645	1100	1100	1150	1310	1310	1650	1650	1665	1640
Total Solids (Mg/l)	4030	4030	4030	3200	3150	3300	3560	3560	3950	4020	4005	3960
pH	7.2	7.6	7.6	8.0	7.9	8.0	7.8	7.7	7.3	7.6	7.5	7.7
D.O (Mg/l)	7.3	7.4	7.5	5.9	5.5	5.5	5.5	5.6	7.4	7.4	7.5	7.6
B.O.D	1.6	1.6	1.8	3.4	4.9	4.3	4.9	4.8	1.8	1.7	1.7	1.6
HCO <sub>3</sub> (Mg/l)	2.4	5.0	2.6	6.5	9.0	6.4	9.0	8.9	2.5	5.1	2.7	2.5
Total Hardness(Mg/l)	26.1	25.0	22.2	56.5	67.0	56.6	62.5	63.6	27.3	26.2	25.1	21.0

\*B-Brownish, DB-Dark brownish

Table 4: Physico-chemical characteristics of river Bhavani (Pillur, Mettupalayam, Sirumugai) at three stations(mean values for one year July 2007 to June 2008)

Physical characters	Pillur	Mettupalayam	Sirumugai
Temperature (°C)	24.83(22.0-26.2)	26.39(23.0-28.6)	27.67(25.0-29.5)
Turbidity (N.T.U)	19.39(18.0-21.0)	20.53(20.0-22.2)	22.35(21.0-25.0)
Electrical Cont (mMho)	241.66(180-320)	940.00(900-990)	1241.67(1100-1400)
Suspended Solids (Mg/l)	2189.16(1900-2375)	2068.33(2000-2300)	2277.91(2050-2385)
Dissolved Solids (Mg/l)	1301.25(1240-1500)	1275.42(1160-1545)	1459.16(1100-1665)
Total Solids (Mg/l)	3490.41(3200-3615)	3343.75(3260-3550)	3732.91(3150-4030)
pH	7.55(7.3-7.9)	7.67(7.4-7.9)	7.66(7.2-8.0)
D.O (Mg/l)	8.02(7.6-8.4)	6.68(6.5-7.9)	6.68(5.5-7.6)
BOD (Mg/l)	1.48(1.0-1.7)	2.54(1.7-7.1)	2.84(1.6-4.9)
BCO3 (Mg/l)	4.19(2.5-6.8)	5.24(2.5-8.0)	5.22(2.4-9.0)
Total hardness (Mg/l)	36.8(23.4-60.1)	43.18(28.4-68.1)	39.92(21.0-67.0)



Map -1. Location map showing the Bhavani River and three sampling points, TamilNadu.

Our property of water is that with change in temperature, its density varies and it becomes less with warming up and more with cooling [8]. The turbidity value was ranging from 18.0 N.T.U to 25.0 N.T.U. Highest turbidity value was noticed at Sirumugai 25.0 N.T.U and the lowest value was noticed in Pillur dam 18.0. N.T.U The mean value of turbidity in Pillur reservoir 19.39 N.T.U and Mettupalayam 20.53 N.T.U and Sirumugai 22.35 N.T.U.

The colour was noted at Pillur reservoir mostly colorless and Mettupalayam was brown in colour and the station. Sirumugai showed dark brown colour due to dilute Sulphuric acid and also heating bleaching processes in the factory. Coloured effluents are released of coloring materials like chromate, glaxol, coprol etc. The suspended solids, dissolved solids more due to usage of starch, gum, caustic soda, French chalk etc. The electrical conductivity of the water was ranging from 180 mMho to 1400 mMho. Highest electrical conductivity was recorded

at Sirumugai 1400 mMho and lowest at Pillur dam 180 mMho. The electrical conductivity was to be maximum at Sirumugai due to mixing of the factory effluents. The value of the total solids (suspended and dissolved) ranged between 3200mg/l and 4030 mg/l. lowest value was observed at Pillur dam 3200 mg/l. there was a sudden increase in the total solids at Mettupalayam 3550 mg/l and Sirumugai 4030 mg/l. The high amount of suspended, dissolved and total. solids adversely effects the quality of water and suitable for any purpose including irrigation.

The pH value ranged between 7.3 and 8.0. The River was found to be slightly alkaline at Pillur dam minimum of pH value was noticed 7.3 and compared to Mettupalayam and Sirumugai 7.9. The mean value of pH in Pillur reservoir 7.55 and Mettupalayam 7.67 and Sirumugai 7.66. pH is one of the most important factors that serve as an index of the pollution. The pH values of majority reservoir in India have been found between 6 to 9. The higher range of pH

indicates higher productivity of water. [9]. The dissolved oxygen value was found to be ranging from 5.5 mg/l to 8.4 mg/l. The amount of dissolved oxygen value was very high at Pillur dam (7.4 mg/l to 8.4 mg/l) the value were found to be decrease at Mettupalayam (6.5 mg/l to 7.9 mg/l) and consequently still reduced at Sirumugai (5.5 mg/l to 7.6 mg/l). Dissolved oxygen is an important parameter of the river, which is essential to the aerobic metabolism of all aquatic organisms [10]. Dissolved oxygen plays an important in water quality determination. Particular water body is greatly influenced by temperature photosynthetic activity and respiration [11].

The Dissolved oxygen percent saturation was low at Sirumugai. This is due to the addition of bleaching and dying effluents containing oxidisable organic matter and consequent biodegrading and decay of vegetation, which leads to consumption of oxygen present in water [12]. Bicarbonate value ranged from 2.4 mg/l to 9.0 mg/l lowest value (2.4 mg/l to 6.8 mg/l) was recorded at Pillur dam. The amount was increased at Mettupalayam (2.5 mg/l to 8.0 mg/l) and Sirumugai (2.4 mg/l to 9.0 mg/l). Value of total hardness ranged from 21.0 mg/l to 68.1 mg/l. Minimum amount of total hardness was observed (23.4 mg/l to 60.1 mg/l) at Pillur dam. An increase in the total hardness was observed at Mettupalayam (28.4 mg/l to 68.1 mg/l). a slightly decline in the value was observed at Sirumugai (21.0 mg/l to 67.0 mg/l). Hardness in water depends on the presence of principal cations  $Ca^{++}$  and  $Mg^{++}$ . BOD values were ranged from 1 mg/l to 1.7 mg/l. The value of BOD were decreased with low in the pollution level. [13] Pointed out that the minimum oxygen content in water for maintaining fish life healthy condition. An increase in the BOD was observed at Mettupalayam (1.7 mg/l to 4.1 mg/l) and further increased values could be noticed at Sirumugai (1.6 mg/l to 4.9 mg/l). The BOD level maximum at Mettupalayam due to usage of various chemicals for bleaching process.

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