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Original Research Paper

Water Quality Index of River Bhavani at Erode Region, Tamil Nadu, India

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ABSTRACT

Bhavani is one of the important rivers in Tamil Nadu. Many industries, particularly textile processing units, tanneries, sugar factories and distillery units, are situated on the banks of Bhavani river. These industries let out untreated and partially treated effluents into the river stream. It is, therefore, decided to study the quality of water and to estimate its pollutional load in the River Bhavani. Samples of water were collected at selected points and physcio-chemical and biological examinations were carried out. A simple, comprehensive water quality index system, devised by NSF of USA and an alternative method adopted, were applied and the water quality assessed at every point. It was observed that at the start of monsoon season the water quality in the Bhavani river was good, but showed a progressive decline from its origin to further distances as it passes through human settlements and industrial areas.

INTRODUCTION

The Bhavani river originates in the upper regions of the Nilgiris of Western Ghats. It flows across three districts of Tamil Nadu, Nilgiris, Coimbatore and Erode. The river confluences with Cauvery river at the town of Bhavani after it travels 185 km distance. About 90 per cent of the river water is used for agriculture. There are more than 100 textile units, 110 leather processing units, 2 sugar factories and 2 distillery units, which use Bhavani river water for their water requirements. Either directly or indirectly, all their effluents reach Bhavani river causing severe pollution, affecting agriculture and causing environmental damage. It has been, therefore, decided to make a study on the quality of water in the Bhavani river during rainy and summer season. This paper deals with the study of quality of water in River Bhavani in July 2008 at the beginning of north east monsoon.

Brown et al. (1970) developed a Water Quality Index (WQI) for National Sanitation Foundation (NSF) of USA of the form:

$$WQI = \sum_{i=1}^{n} w_i q_i \rightarrow 1$$

Where, q_i = the quality of i^{th} parameter, a number between 0 and 100 (from the quality curves)

w_i = the unit weight of i^{th} parameter, a number between 0 and 0.17

n = 15, the number of parameters

WQI a unitless number ranges from 0 to 100. It refers to the overall quality of surface water at a sampling point. WQI is a useful tool for non-technical personnel, policy makers and common man. Magudeswaran et al. (2006) proposed an alternate method of calculating WQI which suits the pre-

vailing conditions of Western regions of Tamil Nadu. This method has used six water quality parameters, omitted BOD, nitrates and temperature, which were included in NSF method and weighing factors were distributed to other six water quality characteristics.

MATERIALS AND METHODS

The samples were collected at 5 selected sampling points based on their pollutional effect at 9 a.m. every day continuously for one month period. For chemical, biological and microbiological examinations, standard methods of collection and handling were adopted.

Tables 1 and 2 represent the sample stations and the standard methods of determination of water quality parameters. The reagents used were of analytical grade. The physico-chemical analyses and biological tests were performed using the standard procedural methods (APHA 1998).

RESULTS AND DISCUSSION

In an earlier study, the various water quality parameters of River Bhavani were analysed and reported by Gopalswamy et al. (2003). It was observed that the Bhavani river water was highly polluted. Its water could not be used for drinking purposes without thorough disinfection. Another study by Kumaresan (2006) in the same sampling stations of Bhavani river confirmed that its water quality had shown improvement. In the present study during July 2008, the same sampling stations were chosen and physico-chemical examination and biological investigation have been carried out. The results are presented in Table 3.

WQI Calculation: Stream water index was calculated using nine parameters which were measured for samples from the rivers for one month (July 1 to July 31, 2008) period. The mean value of each parameter was calculated. This mean value is referred to the standard weighing chart available in text and the corresponding water quality value was noted from the chart. Using the Q values and their respective weight factors the overall water quality index was calculated.

WQI (NSF) = 0.07 × DO + 0.16 × FC + 0.11 × pH + 0.11 × BOD + 0.07 × TS + 0.011 × phosphates + 0.10 × TN + 0.08 × Turbidity

Alternative WQI, proposed by Magudeswaran et al. (2006), has been designed to suit the prevailing conditions of Tamil Nadu, especially its western parts. It takes into account only six water quality parameters. According to this new method,

WQI (New) = 0.23 × DO + 0.21 × FC + 0.14 × pH + 0.10 × TS + 0.13 × TN + 0.10 Turbidity

WQI value of both, NSF method and new method, are presented in Table 3. Dissolved oxygen (DO) is one of the most important parameters in assessing water quality. It reflects the physical and biological processes prevailing in the waters. It has been given a higher weighting factor while computing WQI. The sampling station, Pillur (S1) in the Nilgiris could be considered as 'source point' of Bhavani river in Tamil Nadu and it has greater DO value (96.3% saturation). As expected, as the river reached plains and travels a distance of about 150 km, the DO value started lowering and reached 71.2% saturation at Pallipalayam (S5). The reason for decrease in DO (96.3% to 67.9%) is owing to the discharge of industrial effluents and domestic wastewaters into the river stream, especially at Sathyamangalam (67.9%, S3) and Pallipalayam (71.2%, S5). A slight increase in DO value at Bhavani Kooduthurai (S4) (79%) may be due to its confluence with River Cauvery.

Faecal coliforms (FC) count refers to the presence of domestic sewage concentration in water. It

shows the possibility of dangers from disease causing bacteria and pathogens which live in the same environment where faecal coliforms live. It is seen that there is a steady increase in concentration of faecal coliforms from station 1 to station 5 indicating that certainly domestic sewage is let into the river stream. At Pallipalayam, after Bhavani merges with Cauvery river, the maximum value of coliforms confirms that there is a free flow of sewage into the river.

Table 1: Sampling stations.

Sample Number	Sampling Station
1	Pillur
2	Bhavani Sagar Dam
3	Sathyamangalam
4	Bhavani Kooduthurai
5	Pallipalayam

pH is a measure of hydrogen ion concentration in water. Its value determines whether water is acidic or alkaline. For potable water, the BIS, WHO and ICMR standards have prescribed the limiting value of pH between 6.5 and 8.5. In all these samples, pH value ranges between 7.45 and 8.1. Though the river water could be taken for drinking purposes, it should be properly disinfected as it is contaminated with faecal coliforms.

Biochemical oxygen demand (BOD) reveals the content of microorganisms present in the sample and its organic matter load. Table 3 shows that in all the sampling stations, BOD has not exceeded the limited value (2-3 mg/L) represented by the national and international agencies. A gradual increase in BOD reflects that during the course of the river, it carries more and more organic pollutional load.

The total phosphates and total nitrates in a river is due to the mixing up of agricultural run off

Table 2: Water quality parameters and their methods of determination.

1.	Dissolved oxygen, DO in mg/L	Winkler titrimetric method
2.	Faecal coliform, MPN/100mL	Multiple tube fermentation method
3.	pH	Electrometric method
4.	Biochemical Oxygen Demand, BOD in mg/L	Oxygen difference method
5.	Total solids in mg/L	Gravimetric method
6.	Total phosphates in mg/L	Stannous chloride method
7.	Total nitrates in mg/L	Brucine method
8.	Turbidity, NTU	Nephelometric method
9.	Temperature, °C	1/10°C Sensitive thermometer

Table 3: Calculation of overall Water Quality Index (WQI).

Parameters WQI	S1	S2	S3	S4	S5	Weighting Factor NSF	Weighting Factor New Method
Dissolved Oxygen, DO in mg/L (% Saturation)	96.3(99)	71.2(77)	67.9(72)	79.0(86)	71.2(77)	0.17	0.23
Faecal Coliforms, MPN/100mL	1(99)	10(72)	60(50)	80(47)	100(44)	0.16	0.21
pH	7.59(92)	7.45(93)	7.45(93)	7.62(92)	8.1(80)	0.11	0.14
BOD, mg/L	1.2(93)	1.5(90)	1.8(84)	1.6(91)	1.9(82)	0.11	-
Total solids, mg/L	39(86)	82(85)	80(85)	230(69)	350(53)	0.07	0.10
Total phosphates, mg/L	0.06(98)	0.07(97)	0.06(96)	0.15(94)	0.24(88)	0.10	-
Total nitrates, mg/L	0.00(97)	1(96)	1(96)	1(96)	1(96)	0.10	0.13
Turbidity, NTU	1(96)	1.1(96)	1.3(95)	1.2(95)	2.11(93)	0.08	0.10
Temperature,°C	0.1(93)	0.5(91)	0.5(91)	0.5(91)	0.5(91)	0.10	-
WQI (NSF Index)	96	87	82	82	77		
WQI (New Method)	88	76	71	71	65		

Q values are given in parentheses.

during rainy reason. The values presented in Table 3 confirm that there is a steady increase in phosphate concentration, while the concentration of nitrates remains almost unaltered. It reflects that in both the sides of river banks, agricultural activities result in flowing of excess fertilizers into the river stream.

As expected the total solids and turbidity in surface waters show a moderate increase. This may be attributed to the dissolved solids and suspended solids especially during the monsoon reason. According to Harton (1965) the temperature has a detrimental effect to aquatic life when it exceeds 34°C. The Bhavani river recorded temperature between 22°C-25°C in all the reasons. Hence, it has not much influence over the water quality characteristics. The overall WQI presents a picture that there is a considerable steep decline in its quality (96 to 77) from Pillur to Pallipalayam. The new method of WQI calculation also corroborates the same trend (86 to 65).

CONCLUSION

The water quality of surface water, especially river water, has to be monitored periodically. It is common practice to determine the quality of river waters during summer and rainy seasons. This study has been done at the onset of monsoon. Both, NSF (USA) method and new method of WQI, point out that quality of water at Pillur is 'excellent' and at Pallipalayam it is 'good'. This may be attributed to two important factors (i) Bhavani river flow is tend to be maximum during this season which carried away all the pollutional load, (ii) The State Pollution Control Board (SPCB), Tamilnadu has initiated action against pollution causing industries, the prominent example is the closure of South India Viscose (SIV) factory and dyeing units, which were responsible for its poor quality in the past.

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