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ASSESSMENT OF SPATIAL AND TEMPORAL VARIATIONS IN THE RIVER WATER QUALITY

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ABSTRACT
The present study was conducted to assess the pollution of surface river water in the vicinity of Mettupalayam in Tamilnadu, used by various pollution indicators such as physico-chemical, biological, heavy metals and pesticide concentration. The samples were collected during the late winter and early summer season (December 2017, January 2018 and February 2018) at three different location viz., Kallar (N $11^0$21'408" E $76^0$51'280"), Bhavani location 1 (N $11^0$17'388" E $76^0$53'321") and Bhavani location 2 (N $11^0$17'264" E $76^0$55'334"). The samples were analysed for various physic chemical and biological parameters. The BOD value from December to February ranged 10.60 to 13.45 mg L^{-1} and the COD from 22.95 to 28.11 mg L^{-1}. This variation might be due to agricultural runoff and high rainfall received during the sampling period. The heavy metals like Cr, Ni and Cd were below the detectable limit except for Pb, which was recorded only in sampling location 2 (L3). The biological properties of water samples from sampling location 2 (L3) showed higher bacterial count compared to Kallar (L1) and Bhavani Location1 (L2). The probable source of Pb and bacterial population could be from agricultural runoff and human activity near the river bank. However, the Physico-chemical parameters and heavy metal concentrations of the studied stream were below the acceptable limit as per CPCB standards.

KEYWORDS: Bhavani River, Water quality, Pollution, Heavy metal, Pesticides.

INTRODUCTION

Surface water constitutes about 0.3 percent of the total fresh water available on earth. Lakes serve as the largest source of surface water accounting for about 87 percent, while rivers contribute a meager 3 percent. India has 16 percent of the global population with only 4percent of the world's freshwater (Chakraborty *et al.*, 2016). Owing to the increase in population and the resulting urbanization and industrialization, tremendous pressure has been imposed on the surface water resources for meeting the human needs and demands. Land use change and pollution greatly alter the quality and quantity of fresh water available for human consumption. Freshwater sources in the form of rivers are essential for the sustenance and well-being of the society.

Rivers play a major role in integrating and organising the landscape and moulding the ecological setting of a region (Kumarasamy *et al.*, 2013). River water quality is highly variable, which depends not only with regard to their spatial distribution but also over time. Flow in rivers is a function of many factors including precipitation, surface runoff, interflow, groundwater flow, pumped inflow and outflow and seasonal variations of these factors have a strong effect on flow rates and in turn on the concentration of pollutants in the river water (vega *et al.*, 1998). According to Kaushik *et al.* (2009), in India, the majority of the developmental activities are still dependent on rivers for cleaning as well as disposal purposes.

Rivers close to industries and agricultural areas receive significant loads of heavy metals and pesticides through effluent and runoff respectively. They serve as a corridor for heavy metal by transporting them to hundreds of kilometres along the hydrological gradient in a short period of time. These pollutants find its way into the fatty tissues of aquatic organisms and get amplified as they pass through the food chain, ultimately affecting the human beings .

In this scenario, it is necessary to study the status of river pollution with respect to various human activities. Hence, constant monitoring of river system is required to evaluate the effects of environmental factors on water quality for proper utilization and sustainable development, which paved way for the present study. In the current study, spatial and temporal changes through various parameters were analysed to assess the quality of river water.

MATERIALS AND METHODS

Water samples were collected from three locations along the Bhavani River which pass through the Mettupalayam region. Mettupalayam is a taluk in Coimbatore Rural district, located to the north of the city of Coimbatore at latitude 11°18'000" N and longitude 76°57'000" E. The average annual temperature and average rainfallis 28.6 °C and 1134 mm respectively. The river has ample flow during the monsoon season (October to September) which reduces substantially during the dry season (March to May). The first sampling location was Kallar River which is a tributary of river Bhavani. The other two points are located on the course of the river Bhavani.

The samples were collected from the following sampling locations (Fig. 1):

L1-Kallar River (11°20'480" N and 76°51'280" E): Samples were collected from Kallar River at the foothills of Ooty near the Government Horticulture Farm.

L2-Bhavani river (11°17'388"N and 76°53'321"E):The second sampling was done at the Bhavani river near Vanabadrakali Amman Temple.

L3-Nandhavanam (11°18'264"N and 76°55'334"E): The third sample was collected from Bhavani River at Nandhavanam. This area is located close to the point of confluence of river Kallar and Bhavani.

Representative samples were taken from three locations (L1, L2 and L3) during the months of December, January and February. Samples were collected in a sterilised and cleaned (with 1N HCl) polyethylene terephthalate (PET) bottles. The containers were rinsed thoroughly with river water at sampling location before taking the samples. About 1000 ml of sample was collected from each sampling point and the bottles were properly labelled. The bottles were tightly sealed and transported to the laboratory within three hours of sample collection, for further processing and analysis. Parameters like pH, EC were immediately analysed and the samples were stored at 4^0C in cold storage until further analysis of other parameters. For BOD analysis the samples were fixed immediately after collection and transported to the laboratory for further analysis.

Analytical grade chemicals were used for the analysis of various water quality parameters. Millipore water was used for sample processing and preparation of reagents. All glass wares were subjected to acid wash followed by rinsing with Millipore water. The water samples were analysed for various quality parameters like pH, electrical conductivity (EC), Biological oxygen demand (BOD), Chemical oxygen demand (COD), calcium (Ca), magnesium (Mg), Sodium (Na), Potassium (K), Carbonate (CO_3), bicarbonate (HCO_3), chlorides (Cl), sulphates (SO_4) by the methods described by APHA (1999). The water samples were processed separately for heavy metal and pesticide analysis. Heavy metal contamination was quantified through AAS and pesticide residue was analysed through HPLC technique.

RESULTS AND DISCUSSION

The pH of the river water was slightly acidic ranging from 5.54 to 5.84 and EC varied from 0.24 to 0.36 dS m^{-1}. It carries a considerable amount of dissolved salts ranging between 145 and 248 mg L^{-1} and the highest salt content was recorded in the month of February in Kallar river sample (Fig.2). Electrical conductivity is a measure of the potential of water to carry an electrical current. This capacity is connected to the total amount of dissolved solids in the water. Hence water with high ions content tends to have higher conductivity, which is an indicator of high solid concentration dissolved in the water (Mitra and Reddy, 2016).

The concentration of dissolved oxygen regulates the distribution of flora and fauna. The results in the current investigation point out that the concentration of DO fluctuated between 6.3 and 7.0 mg L^{-1}. The concentration of dissolved oxygen was more during early winter season and least during summer. This observation is in agreement with the results of Kotadiya, et al. (2013) in rural freshwater body in Ghuma village, District Ahmedabad, Gujarat. The BOD value from December to February ranged from 10.60 to 13.45 mg L^{-1} and the COD from 22.95 to 28.11 mg L^{-1} (Table 1). This variation might be due to agricultural runoff and high rainfall received during the sampling period.

The calcium, magnesium, sodium and potassium concentrations fluctuated in the range of 19.70 to 22.90 mg L^{-1}, 12.00 to 22.90 mg L^{-1}, 5.0 to 8.98 mg L^{-1} and 1.1 to 2.1 mg L^{-1}, respectively. The chloride, sulphate, carbonate and bicarbonate concentrations varied in the range of 7.57 to 8.52 mg L^{-1}, 17.37 to 18.04 mg L^{-1}, 0, 100 to 1111 mg L^{-1}, respectively (Table 1). But the concentrations of all cationic and anionic species were found to be within permissible limits described by Central Pollution Control Board. The cationic spices *viz*., calcium, magnesium, sodium and potassium and the anionic species *viz*., chloride, sulphate, carbonate and bicarbonate in the river water samples collected from all three sampling locations showed an increasing trend from December to February. The present investigation is well correlated with the results of Mitra and Reddy (2016) in shivna river at Mandsaur, Mathya Pradesh, India and Bora & Goswami (2017) in Kolong River, Assam. However, the Physico-chemical parameters and heavy metal concentrations of the studied stream were below the acceptable limit as determined by CPCB.

Moreover, EC of the river sample was highly positively correlated with Total Dissolved Solids and Dissolved Oxygen and pH was moderately correlated with SO_4. Electrical Conductivity and TDS were highly negatively correlated with Biological Oxygen Demand (Table 2).

The heavy metals like Cr, Ni and Cd were below the detectable limit except for Pb, which was recorded only in Bhavani sampling location 2 (L2). The biological properties of water samples from Bhavani sampling location 2 (L2) showed higher bacterial count compared to L1 & L2 (Table 1). These results might be due to no industries activities were identified near the stream flow of study area. The probable source of Pb and bacterial population could be from agricultural runoff and human activity near the river bank. In the same way, other investigations by Reddy (2012) and Parmar and Reddy (2013) who reported that high turbidity in summer and monsoon compared to winter due to soil erosion which carries amount of salts, heavy metals and pesticides.

TABLE 1: Average water quality parameters of Bhavani river at three different location and three different period

S. No.	Parameters	Unit	December			January			February		
			Kallar (L1)	Bhavani location 1 (L2)	Bhavani location 2 (L3)	Kallar (L1)	Bhavani location 1 (L2)	Bhavani location 2 (L3)	Kallar (L1)	Bhavani location 1 (L2)	Bhavani location 2 (L3)
1.	pH	-	5.55	5.61	5.77	5.54	5.62	5.77	5.64	5.72	5.84
2.	EC	dS m^{-1}	0.33	0.24	0.26	0.34	0.25	0.27	0.36	0.27	0.28
3.	TDS	mg L^{-1}	220	145	166	232	154	165	248	161	166
4.	DO	mg L^{-1}	7.0	6.77	6.76	6.92	6.66	6.68	6.93	6.63	6.67
5.	BOD	mg L^{-1}	11.11	13.20	12.17	10.60	12.51	11.51	10.22	13.45	11.82
6.	COD	mg L^{-1}	24.45	29.20	26.37	22.95	27.96	23.78	23.25	28.85	28.11
7.	CO_3	mg L^{-1}	0	0	0	0	0	0	0	0	0
8.	HCO_3	mg L^{-1}	106.00	111.00	100.00	102.00	101.00	103.00	107.00	108.00	106.00
9.	Ca	mg L^{-1}	21.00	20.89	22.11	20.49	22.48	23.17	22.90	19.70	22.03
10.	Mg	mg L^{-1}	12.40	13.00	12.20	12.70	13.8	14.00	13.42	12.00	13.00
11.	Na	mg L^{-1}	8.9	5.0	5.7	8.8	6.0	5.8	8.98	6.59	6.30
12.	K	mg L^{-1}	2.1	1.1	1.2	1.5	1.1	1.2	1.62	1.32	1.28
13.	Cl	mg L^{-1}	7.57	8.76	8.52	8.22	8.28	8.05	7.99	8.40	8.05
14.	SO_4	mg L^{-1}	17.37	17.81	17.89	17.84	17.77	18.40	17.83	17.76	18.04
15.	Cr	ppm	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16.	Cd	ppm	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
17.	Ni	ppm	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18.	Pb	ppm	BDL	0.01	BDL	BDL	BDL	BDL	BDL	0.01	BDL
19.	Bacteria (cfu $ml^{-1)}$	x 10^6	1.0	4.0	2.7	1.3	2.7	2.3	1.0	2.7	1.3
20.	Fungi (cfu ml^{-1})	x 10^4	1.3	1.3	1.3	0.7	1.3	1.7	1.0	1.7	0.7
21.	Actinomycetes (cfu ml^{-1})	x 10^2	0.3	0.3	0.7	0.7	0.7	0.7	0.7	1.0	0.7

TABLE 2: Correlation coefficient matrix of water quality parameters of river Bhavani

	pH	EC	TDS	DO	BOD	COD	CO_3	HCO_3	Ca	Mg	Na	K	Cl	SO_4
pH	1													
EC	-0.44	1												
TDS	-0.51	0.99	1											
DO	-0.70	0.81	0.86	1										
BOD	0.28	-0.88	-0.88	-0.73	1									
COD	0.32	-0.79	-0.82	-0.69	0.91	1								
CO_3	-	-	-	-	-	-	1							
HCO_3	-0.11	0.01	-0.05	0.07	0.28	0.37	-	1						
Ca	0.36	0.00	0.02	-0.09	-0.39	-0.32	-	-0.39	1					
Mg	0.05	-0.08	-0.07	-0.18	-0.25	-0.22	-	-0.15	0.77	1				
Na	-0.56	0.97	0.96	0.81	-0.79	-0.72	-	-0.01	-0.14	-0.17	1			
K	-0.49	0.79	0.78	0.82	-0.61	-0.56	-	0.14	-0.20	-0.32	0.86	1		
Cl	0.15	-0.67	-0.61	-0.50	0.68	0.60	-	0.11	-0.24	-0.13	-0.69	-0.80	1	
SO_4	0.67	-0.30	-0.33	-0.55	-0.01	-0.10	-	-0.23	0.54	0.55	-0.48	-0.63	0.22	1

The pesticide residue concentration of Chlorpyrifos, Endosulfan, Dimethoate, Parathion, Profenophos, Malathion, Phorate, Quinalphos, Bifenthrin, Cypermethrin, Triazofos, Ethion, Spinosad and Thiodicarb were also found to below the detectable limit. These results indicating that the usages of pesticides in terms of agricultural activity were not affecting the water quality in study area. On contrary, detection of chlorpyriphos, ethion and dicofol in the river Deomoni from Terai region of West Bengal revealed that the pesticide application from nearby tea gardens affects the water quality (Singh et al., 2015).

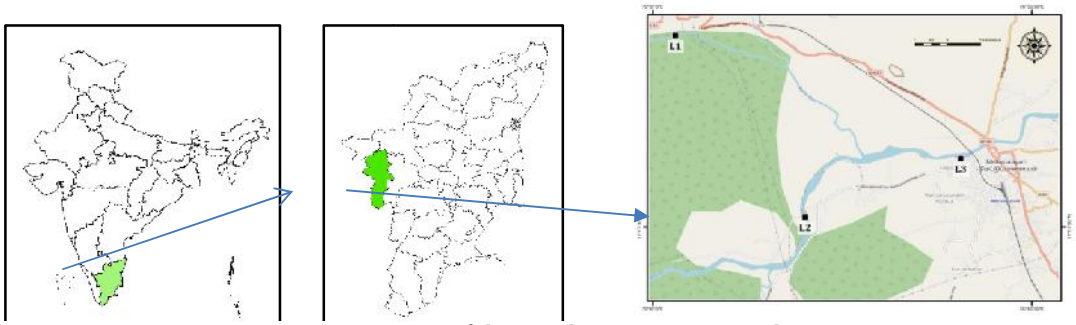

FIGURE 1: Location of the sampling sites in Mettupalayam region

Fig. 2a. pH of the samples

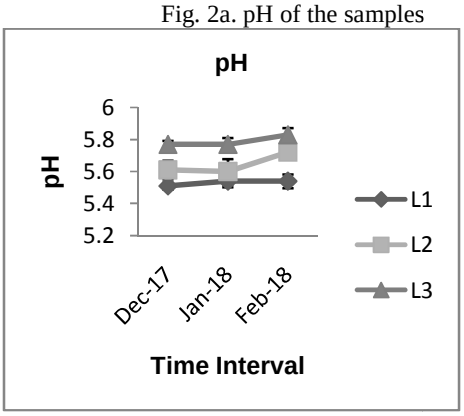

Fig.2b. Electrical Conductivity of the samples

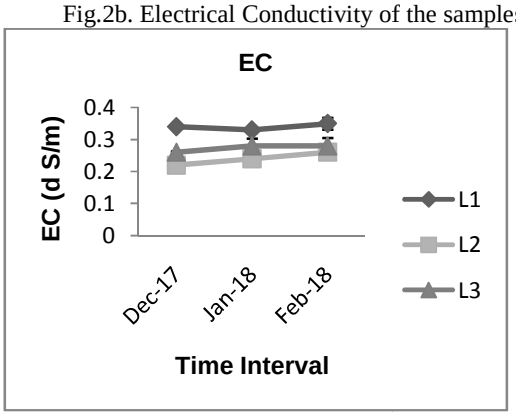

Fig 2c. Dissolved Oxygen content of the samples

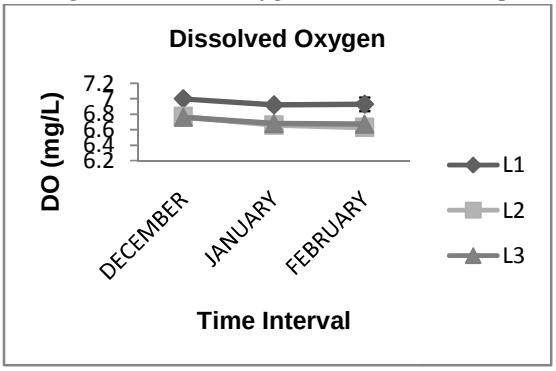

Fig. 2d. Rsidual Sodium Carbonate of the samples

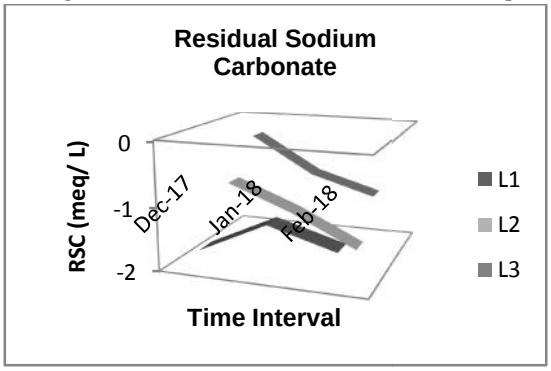

FIGURE: 2a, b, c &d). Important water quality parameters of Bhavani river at three different location and three different period

CONCLUSION

The study was conducted to evaluate the water quality of the Bhavani River and its tributaries. The outcome was that all the measured variables of water quality are well within the permissible limits as per Central Pollution Control Board. It indicates that the water is fit for any recreational activity and propagation of aquatic organisms. Keeping in mind restricted settlements and industrial activities nearby river bank, moreover proper sewage discharge should be considered to reduce future contamination loads in the river.

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