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Pollution studies of River Bhadra at Industrial town Bhadravathi, Karnataka, India

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Abstract

Bhadra river supplies water for irrigation, drinking and industrial zone of Bhadravathi town. Water samples were collected from two different sites along the river. Physical and chemical parameters were studied during January to December 2010. The main aim of the study was to determine the pollution status of Bhadra river and the suitability of water for domestic and other purposes. The study revealed that there is indication of pollution at station-B and the river water at the station-A is fairly good and is free from pollution. There is an urgent need of action plan for the conservation of the river at station-B.

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Keywords: *Bhadra river, Biodegradation, Physico-chemical parameters, Pollution, Sewage load, Western ghats*

Introduction

Water is precious for every living being on this planet. In India 80% of the surface water is vulnerable to pollution as more than 95% of the sewage in the country is not treated (Manjappa *et al.*, 2008). Pollution is as old as man himself. Rivers are considered to be lifeline for most of the developing countries as they meet drinking water needs. Most of the perennial rivers and their tributaries are being used as a site for disposal of domestic and industrial waste in India which impairs their water quality (Chandanshive *et al*., 2008). Studies on physico-chemical dynamics of lotic water bodies were reported by (Nataraja *et al.*, 2009; Patil *et al*., 2009; Sayeswara *et al*., 2010). Lotic water bodies like rivers and streams play very important role in maintaining the biodiversity and over all ecological balance in nature. However, the water quality of fluvial systems is deteriorating due to increase in the amount of raw sewage entering the rivers. The increase of pollution is caused by population growth and increasing urbanization. Indiscriminate use of fertilizers and pesticides in the irrigated lands has significantly contributed to the non point sources of pollution (Prakash *et al.*, 2005). Now-a-days, increasing effects of pollution have become a serious threat. Thus, periodic monitoring of river water quality is necessary to access its suitability for drinking and other purpose. Bhadravathi is a growing town of Karnataka. The position of town on the globe is on latitude 13^{o} 50' N and longitude 75^{o} 40' E. With rapid growth of the Bhadravathi town both in urban and industrial areas, the pollution load in the river Bhadra has increased. The Bhadra river rises from Varsha hills at a place called Ganga moola in the Western ghats about 24 km west of kalasa in Chikamangalore district. After flowing for about 190 kms, it joins the River Tunga at Kudli, 14 kms east of Shivamogga city and becomes Tungabhadra river which is a major tributary of Krishna river. The Bhadra basin gets rain both from the South-West monsoon (June-September) and North-East monsoon (October-December).

The Bhadra river can be considered as lifeline of this area, which fulfills the needs of hundreds of villages, situated along the banks of the river. Due to anthropogenic activities, rapid industrial growth, domestic and agricultural activities of the region, the river water is being polluted, which is the case

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with almost all major rivers of the country. The present investigation highlights the effects of pollution on the physico-chemical aspects of water of the Bhadra river at Bhadravathi town in different months at two different sampling stations.

Materials and Method

In the present investigation, we have selected two stations based on the pollution sources.

Station-A: This is located near Sunnadahalli, 6.2 km away from Bhadravathi town. It is without human disturbances.

Station-B: This is located near down stream of New Bridge near Bus stand which is at the distance of 8.3 km away from station-A. It is partially fed by municipal sewage water from the adjacent areas. The human disturbances include disposal of garbage and organic wastes.

The study was carried out during January, 2010 to December, 2010. The water samples were collected once a month by immersing a wide mouth bottle at the subsurface level during the morning hours between 7:00 to 9:00 A.M. Water temperature was recorded on the spot. The samples for dissolved oxygen fixed immediately on the field itself. The remaining parameters were analyzed as per the standard methods (APHA, 1998).

Results and Discussion

The values of various physico-chemical characteristics of station-A and station-B of Bhadra river at Bhadravathi town have been tabulated in Table-1 and Table-2 and depicted in Fig. 1 (A-H). The water temperature depends on the season, solar radiations and other climatic conditions. The temperature directly influences the changes in dissolved oxygen, alkalinity, salinity and the taste of water (Hosetti and Venkateshwarlu, 1991). Values of water temperature ranged from 22.1 to 27.3 ^{o}C at Station-A and 21.9 to 28.1 ^{o}C at Station-B. The temperature difference might be either due to difference between the collection times or due to the geographical difference in the locations (Pejaver and Gurav, 2008).

Table-1. Physico-chemcial characteristics of Bhadra River water at Station-A (Unpolluted station)

Parameters	Months-2010											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	22.3	23.4	26.1	26.8	27.3	25.2	23.7	25.4	23.3	24.1	23.8	22.1
pH	7.3	7.1	7.1	7.0	6.8	7.3	7.4	7.2	6.9	7.2	7.0	7.1
DO	6.9	7.2	7.3	6.3	6.2	6.5	6.9	7.1	7.8	7.3	7.1	7.2
BOD	1.9	2.8	2.9	2.7	2.9	3.1	2.6	2.7	2.3	2.1	2.4	2.9
CO_2	1.2	1.3	1.3	1.1	1.8	2.6	2.3	2.4	2.1	2.3	2.3	2.4
TDS	33.7	32.1	36.4	40.2	49.3	44.1	42.7	39.8	36.4	37.3	53.7	34.7
Alkalinity	82	76	53	59	60	70	72	61	68	65	73	71
Sulphate	4.1	4.3	4.9	5.2	5.1	4.8	5.1	5.3	5.4	5.1	5.2	5.7
Phosphate	0.063	0.071	0.068	0.073	0.080	0.079	0.093	0.091	0.089	0.083	0.068	0.071
Nitrate	1.1	0.82	1.1	0.93	0.69	1.2	1.3	1.1	0.99	1.2	1.3	0.97
Chloride	23.1	26.3	28.1	22.2	22.3	18.2	16.1	17.3	19.9	22.1	22.4	23.6

All values are expressed in mg/l except Temperature (^{o}C) and pH

pH refers to a scale of intensity of acidity or alkalinity. This is regarded as a measure of concentration of H^+ ions in water. The pH values ranged between 6.8 and 7.4 in Station-A and 7.0 and 7.9 in Station-B. pH values are slightly acidic to slightly alkaline and found within permissible limit of 6.5 to 8.5 as per the Bureau of Indian Standards (BIS). The pH is an important parameter in a water body since aquatic organisms are well adapted to specific pH range and do not withstand abrupt changes in it (George, 1997). Dissolved oxygen is another vital parameter regulating survival of aquatic life. The permissible standard of DO is above 5 mg/l (Perk and Park, 1980). Values of DO ranged form 6.2 to 7.8 mg/l at Station-A and 2.1 to 2.7 mg/l at Station-B. The sampling Station-B falls under polluted zone because in this zone there is entry of Bhadravathi town sewage rich in bacteria. So the bacteria utilize the dissolved oxygen in the process of decomposition. Due to the process of biodegradation, the DO has reach lowest level at Station-B. The variation of DO depends on

the primary production and respiration of aquatic organisms.

BOD is the measure of degradable organic matter present in water. BOD and other microbial activities generally increase by the introduction of sewage (Hynes, 1972). The BOD values ranged between 1.9 to 3.1 mg/l at Station-A and 6.6 to 9.9 mg/l at station-B. Higher values of BOD in Station-B indicate the higher consumption of oxygen and higher population load in river water. Higher values of BOD at Station-B during summer could be a result of reduced rate of water flow, degradation of organic matter and accumulation of wastes due to anthropogenic activities, while, low BOD values during monsoon could be attribute to the dilution of river water (Upadhyaya and Rana, 1991).

Carbon dioxide is added to aquatic system by directly being mixed from atmosphere. Carbon dioxide in water bodies is also contributed by therespiratory activity of organisms. CO_2 content was minimum in Station-A (1.1 to 2.6 mg/l) and maximum in Station-B (12.1 to 16.7 mg/l). Free CO_2 helps in buffering the aquatic environment against rapid fluctuations in the acidity or alkalinity and also regulates biological process of aquatic communities (Prassanakumari *et al.*, 2003).

Dissolved solids of the water are termed as Total dissolved solids (TDS).

Dissolved materials result from the solvent action of water on solids, liquids and gases. A large number of salts found dissolved in natural water. TDS values ranged form 32.1 to 53.7 mg/l in Station-A and 114.3 to 190.3 mg/l in Station-B. The values of both stations are within

Table- 2: Physico-chemcial characteristics of Bhadra river water at Station-B (Polluted station)

Parameters	Months, 2010											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Temperature	23.2	22.7	25.9	26.7	28.1	26.0	24.1	25.3	24.2	23.9	23.2	21.9
pH	7.2	7.4	7.1	7.2	7.1	7.4	7.8	7.0	7.7	7.9	7.4	7.5
DO	2.1	2.3	2.6	2.6	2.2	2.7	2.2	2.3	2.2	2.6	2.2	2.3
BOD	7.9	7.7	8.7	9.3	9.9	6.6	6.9	7.3	7.2	7.8	7.7	7.4
CO_2	14.3	15.4	16.7	16.3	17.4	11.3	12.1	13.4	14.3	13.7	12.9	13.7
TDS	114.3	121.6	132.1	190.3	181.4	179.2	162.4	168.3	149.1	156.3	162.1	167.7
Alkalinity	73	86	94	79	66	77	74	62	65	56	63	77
Sulphate	14.1	12.9	12.3	11.9	13.4	12.8	13.1	12.8	12.6	13.1	13.6	12.8
Phosphate	1.6	1.2	1.2	1.6	1.7	1.4	1.3	1.3	1.5	1.6	1.1	1.3
Nitrate	5.3	4.3	5.2	4.9	5.3	5.4	5.9	6.2	5.3	4.8	5.7	5.3
Chloride	163.1	150.3	161.1	147.2	149.1	136.3	132.7	135.2	141.2	138.3	143.1	144.7

All values are expressed in mg/l except Temperature (^oC) and pH

permissible limits of 1500 mg/l (BIS, 1982). High values of TDS and sulphates in drinking water are generally not harmful to human beings but high concentration of these may affect persons, who suffering from kidney and heart diseases (Guptha *et al*., 1980). Alkalinity in the water samples is primarily a function of carbonate, bicarbonate and hydroxide content. Alkalinity ranged from 53 to 82 mg/l at Station-A and 56 to 94 mg/l at Station-B. It is within permissible limit of 600 mg/l (WHO, 1991). Surface alkalinity may result from the discharge domestic wastes.

Sulphate is naturally occurring anion found in almost all kinds of water bodies. The sulphates are derived from the discharge of domestic sewage, surface and agricultural runoff (Trivedi and Goel,1995). Sulphate values fluctuated between 4.1 to 5.7 mg/l in water samples collected from Station-A and 11.9 to 14.1 mg/l in water samples collected from Station-B. Phosphorus occurs in natural water as various types of phosphates.

The most important sources of phosphates are the discharge of domestic sewage, detergents and agricultural runoff. Values of phosphate ranged form 0.063 to 0.093 mg/l in Station-A and 1.1 to 1.7 mg/l in Station-B. Phosphate concentration increases in water bodies that receive domestic waste (Nirmalkumari, 1984). Nitrate is a critical nutrient for the growth of algae in the aquatic realm. Nitrate level was maximum at Station-B (4.3 to 6.2 mg/l) and minimum at Station-A (0.69 to 1.3 mg/l). The increase of nitrate in Station-B indicates

the river receives very large amount of organic matter. Chloride is an important parameter in assessing the water quality. Chloride values fluctuated between 16.1 to 28.1 mg/l in water samples collected from Station-A and 132.7 to 163.1 mg/l in water samples collected from Station-B. The most important sources of chlorides in the fresh water are the discharge of domestic and industrial sewage. The concentration of chlorides is thus the indicator of water pollution. High chloride content indicates deterioration of water quality usually linked with sewage load (Mini *et al*., 2003).

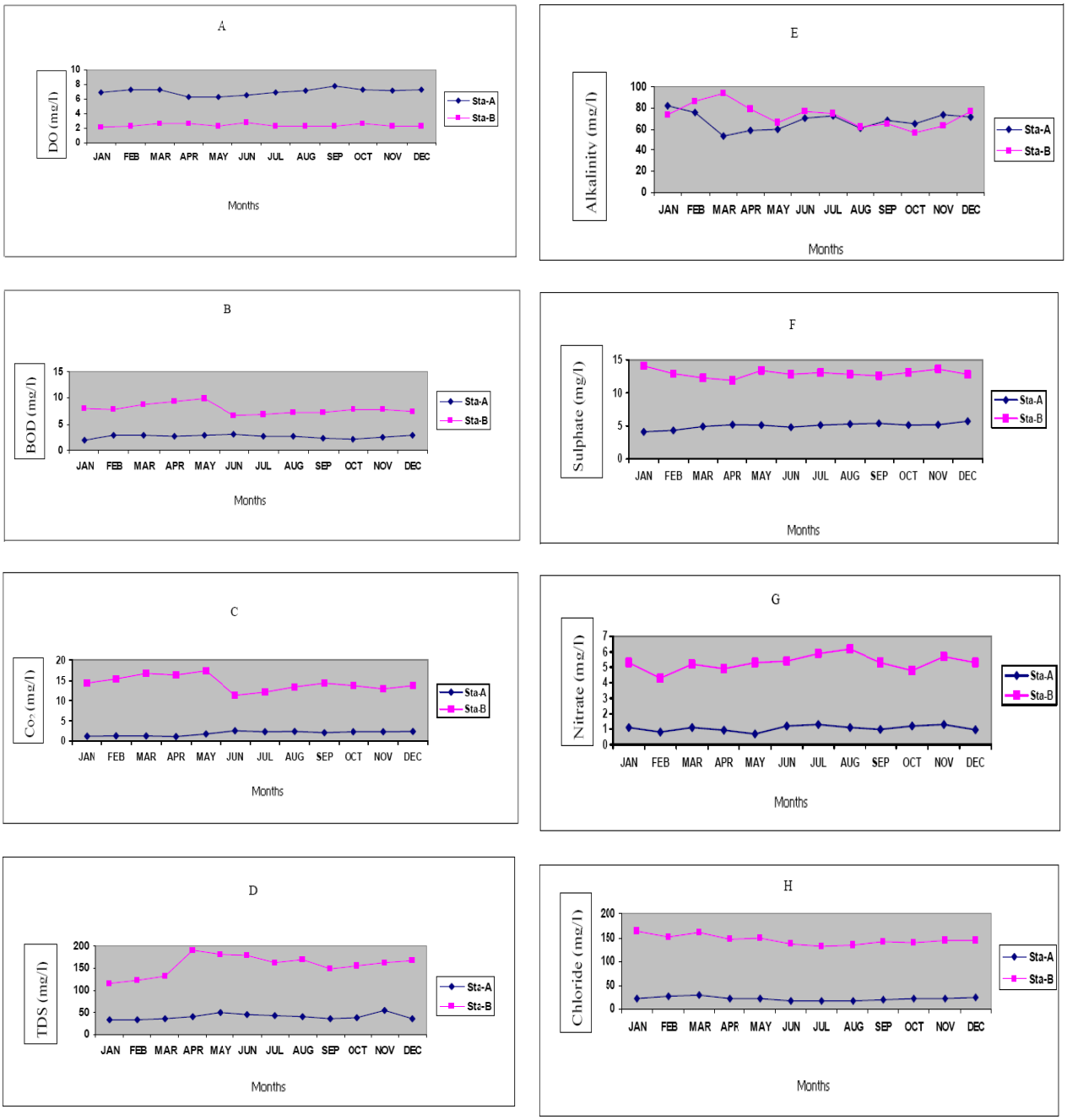

Fig.1 (A-H): Monthly variations in DO, BOD, CO_2, TDS, alkalinity, sulphate, nitrate and chloride at Stations A and B of Bhadra river.

Conclusion

The results of the physico-chemical analysis have revealed that the Station-B of Bhadra river is contaminated due to human disturbances. In the present investigation, most of the values of some physico-chemical parameters exceed the desirable limit according to BIS specifications at Station-B. It is advocated to take urgent steps by governmental and non governmental organizations to protect the river at Station-B. The river water quality at Station-A is fairly good and the data reveals that river at Station-A is free from pollution. This water can be used for the human consumption after proper treatment.

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