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Water Quality Status of Kabini River in and around Nanjudeswara Temple in Nanjangud, Mysore

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Abstract: The physico-chemical, bacteriological and algal analysis was carried out to assess the water quality of Kabini river in and around Nanjudeswara temple in Nanjangud (Mysore) and the results are presented in this paper. Water quality of this holy place was found impaired with mass bathing and offerings made in this river, which cause organic pollution. Different physico-chemical and bacteriological parameters were measured by standard method. From the obtained data, it is found that parameters like colour, turbidity, acidity, DO, BOD, COD, total bacterial count, coliform and *E. coli* exceeds the permissible value for organized out door bathing use of water in this river, whereas other parameters were found within limits or below limits. Metal concentration in river water and algal were found higher in summer followed by winter and rainy seasons. In the present observation, there was significant metallic level in river water at effluent mixing zone, which directly correlates with metal concentration in algal species which may significantly reduce the biotic community and trophic level in river in ecosystem. Based on this study, this paper provides the scientific information to the concerned for the implementation of river restoration plan and conservation of water body.

Key words: Pollution, water quality, physico-chemical parameter, Kabini river.

Introduction

Nanjangud is a famous religious place near Mysore and one of the ancient places of pilgrimage in Karnataka. The pilgrimage and tourist spot range from temples and Kabini river. One of such pilgrimage sites is Nanjundeswara temple. Nanjundeswara temple is situated at a distance of 22 km from Mysore. Samples of the river water were collected from 10 km in and around Nanjundeswara temple. The detailed sample collection plan of Kabini River is shown in Table 1.

River systems are subjected to undue pollution loading in the form of industrial and domestic discharges. Prevention and control of pollution to rivers in India often follow the obsolete "end-of-pipe" treatment methods.

River Kabini receives pollution load due to discharge of sewage, industrial effluent, disposal of solid waste and agricultural run off water from its catchment area. The river water is widely used for organized bathing, drinking, agricultural activity and Industrial purposes at many places along its stretch. Further, because of organic contents of offerings and pollution added due to bathing, nutrients are available to water and growth of algae takes place. In the present study, Kabini river in and around the temple is extremely polluted due to the daily offering of wheat, rice, diyas, food, flowers, ghee, etc. Moreover, organic pollution of the river water increases many folds at the time of mass bathing, during religious festivals throughout the year. Hence, it is evident that the water of the river is contaminated with disease causing bacteria

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and thus, the bathing use of it may give rise to harmful effects to public health. The Kabini river water in around Nanjundeswara temple was analysed for bathing and potable purposes. In terms of physico-chemical and bacteriological parameters, for better understanding of extent and nature of pollution, diagnosis of suitable treatment methods, proper use of resource potential and after all, the development of proper management action plan to keep the river area as environmentally health is imminent. If proper measures are taken for the treatment of this untreated sewage and restriction of various anthropogenic activities, the whole and pristine quality of the holy river Kabini will be restored and its environmental health will improve. The maintenance and restoration of wholesomeness and pristine quality of river Kabini is the responsibility of individual, social and state as well.

Water Quality Monitoring

The domestic waste water from the Nanjangud town is discharged into the river Kabini. The Nanjundeswara temple and temple complex are located on the banks of this river. This attracts tourists all around the year and there is a high floating population. There is a bathing ghat close to temple complex at the eastern side of the river. The sewage effluents of the town are also let into the river. The stretch of the study area of river is shown in Table 1. This necessitated detailed water quality evaluation both upstream and downstream of the river for an assessment of water quality.

The samples were collected during monsoon, winter and summer season from the mid streams as well as from 10 km in and around Nanjundeswara Temple and 0.3 metre below surface were taken as the standard depth for sampling to avoid surface micro layer. The samples were collected in plastic containers and glass bottles. The samples for analysis of heavy metal physico-chemical were collected in 2 litre polythene, narrow mouth bottle and preserved by adding 1 ml HNO_3 to have final pH < 2. The spot test for temperature, pH and DO were done instantly just after collection of samples at the sampling sites.

Materials and Methodology

All the chemicals used in the study were of analytical grade and double distilled water was used throughout the study. All sample containers were thoroughly cleaned and finally rinsed with distilled water. Standard methods for the examination of water and waste water APHA (1998) and Bureau of Indian Standards (BIS), Trivedy and Goel (1986) were adopted as reference manual for analytical procedures.

Result and Discussion

The results obtained from physio-chemical and algal analysis of water collected from Kabini river at four stations in different seasons, and average density of individual species are shown in Tables 3 to 6.

The temperature ranges between 21 ºC–26.5 ºC. Higher temperatures were recorded at station 3 during summer season (Table 1). A suitable range of pH is necessary for fish survival. Acid waters reduce the appetite of fish and reduce growth. In this study pH ranged from 7.2–7.8, lower values recorded at station 3 during summer. Higher values were recorded at station 4 during winter. Higher pH favours the fish production. The NH^+ is shifted to more poisonous ammonia at high pH above neutrality. The EPA criteria for pH are 6.5–9.0 for fish water aquatic life. The findings of the study are similar with those of Kataria (1994), and Rama et al. (1984). Turbidity is caused due to the presence of suspended matters, clay silt, colloidal organic particles, plankton and other microscopic organisms. It is an expression of certain light scattering and high absorbing properties of water. It has significant effect and microbiological quality of drinking water and irrigation water. It may cause jaundice and polio in man. WHO recommended 5 NTU and Indian Standards are up to 10 NTU for drinking water (ISI 1983). High turbidity of river water was reported –85 NTU after confluence of industrial wastes by Upadhyay and Ray (1982). Kataria (1994) noted 12.8–180 NTU turbidity in Betwa River. In the present study turbidity has noted minimum at station 1 (6.2 NTU) and maximum of 10.6 at station 4

Table 1: Site location of sampling station

No.	*Station No.*	*Place*	*Location*
1.	1	Mallanmula Temple	Upstream of Nanjundeswara Temple (Mysore–Nanjangud Main Road)
2.	2	Iyappa Swamy Temple	Upstream of Nanjundeswara Temple, Nanjangud
3.	3	Nanjundeswara Temple	Near temple range, Nanjangud
4.	4	Parasurama Temple	Downstream of Nanjundeswara Temple, Nanjangud

during winter. According to WHO recommendations, it was beyond the permissible limits which may be aesthetically unsatisfactory for bathing at stations 2 and 4. The acidity ranged from 24.4–48 mg/L^{-1}, higher values were recorded at stations 3 and 4. While total alkalinity ranged from 102 to 142 mg/L^{-1} minimum were recorded at stations 1 and 3, during summer and winter. Total alkalinity is due to salt of weak acids and bicarbonates; highly alkaline water is unpotable. Alkalinity in this study in all the stations was under the permissible limits. Total solids contain different types of nutrients and it determines the suitability of drinking water. Increasing values of TDS indicates pollution by extraneous resources (Jain et al., 1996). In the present study, total solids, suspended solids and dissolved solids of water samples were within permissible limits. But depending upon the pH and solids concentration values the quality of water cannot be judged. Hardness is mainly caused from cations and of Ca^{++} Mg^{++}, Fe^{++}. Total hardness recorded in Jhelum river was between 80.6–203.6 mg/L^{-1} (Rama et al., 1984). Here, total hardness, Ca–H and Mg–H ranged from 109–153 mg/L, 70.2–126 mg/L^{-1}, 20.8–51.4 mg/ L^{-1} respectively. Chloride level of water, indicates the pollutional degradation of water. It is found in the form of Na, K and Ca salts. Higher concentration of chloride is hazardous to human consumption and creates health problems. Desirable recommended limit for chloride is 250 mg/L^{-1} (ISI 1983). In the present study it varied from 44.4–68.4. The findings are similar to those of Kataria (1994) and Mitra (1982). Kataria noted chloride range 50.4–120.4 mg/L^{-1} and Dwivedi and Sonar (2004) noted chloride range 20.4–56.8 mg/L^{-1}. In the present study chloride were found within prescribed limits in all stations during all the seasons. Nitrate concentration in water depends upon geochemical conditions such as the extent to which nitrogenous fertilizers are used in agriculture. Kataria (1994) noted nitrate range of 1.8–3.0 ppm in drinking water. In the present study nitrate ranged from 1.10–1.82 ppm. Phosphate is readily taken by phytoplankton. It varied from 1.32–2.52 ppm during all the seasons. Phosphate and nitrate are very essential plant nutrient. Phosphate may enter into surface water from man-generated wastes and land run-off. Domestic wastes contains approximately (1.6 kg) of phosphorous/ capita/year of which 64% is from P-builders used in synthetic detergents. Nitrate and phosphate and organic contents of offerings and pollution added due to bathing nutrients are available to water and growth of algal take place in station 2 and 4. Dissolute oxygen reflects the water quality. Depletion of DO in water is due to high temperature and increased microbial activity. Sedimentation of suspended solids can cause build up of decomposing organic mattes in sediments and dissolved NH_3 can contribute oxygen depletion of nitrification. EPA criteria for DO 5.0 mg/L^{-1}. In this study DO ranged from 5.4–6.6 mg/L^{-1}. Biochemical oxygen demand acceptable limit of 6.0 mg/L^{-1} – BOD_5 at 27 °C ranged from 3.86–4.4 mg/ L^{-1}. In the present study COD ranged from 12.6–19.4 mg/ L^{-1}. The limiting values of COD generally specified by various authorities in 250 ppm of nutrients (Cl^-, Ca^{2+}, Mg^{2+}, NO_3^-, and PO_4^-) that supports the growth of algae. High values of BOD and COD were found at station 1 and 3, which may be due to the daily offerings of wheat, flowers, milk, ghee, diyas, increased organic load from industries and mass bathing by a large number of devotees. The total bacterial count and coliform ranged from 706–1020 CFU/ml and from 430–598 per mg/L^{-1} respectively. *E. coli* were present in each sample of the river water except at station 1. The concentration of the bacteria in the present study was found much above the threshold limit as prescribed in bathing (CPCBC 1995; Fair et al., 1981), Hence, it is evident that the water of Kabini river in and around Nanjundeswara temple is contaminated with disease causing and thus, the bathing use of it may give rise to harmful effect to public health.

Phytoplanktons

All the phytoplankton identified were classified under Chlorophyceae, Desmids, Cyanophyceae, Bacillariophyceae and Euglenophyceae. In total 38 species were recorded from the four stations—of these 12 species belonged to Chlorophyceae, 5 species to Desmids, 7 species of Uglenophyceae, Bacillariophyceae, and Cyanophyceae (Tables 4 to 7). Chlorophyceae and Bacillariophyceae were dominant, compared to the other three. *Microcystis* sps (Cyanophyceae) was abundant. They formed this bloom on the water surface at stations 2 and 3. Associated with this species were, *Merismopedia* sp, *Spirogyra Closterium lunella* and *Cosmarium regnelli* (Desmids); *Navicula rhomboids, Cymbella aspera, Gomphorema tenellum Nitzschia palea* (diatoms). *Anabaena spiroides, Arthrospira platensis,* or *spirulina major* (Cyanophyceae) were also recorded. Based on their density, *Merismopedia convolute* (16) and *Arthrospira platensis* (15) occupies the first place at station 1, *Microcystis incerta*, (26) *Pediastrum duplex* (19) at station 2, *Microcystsis incerta* (18), *Phacustortus* (16) at station 3 and *Coelastrum Microporum* (15) *Oedogonium straita* (15) at station 4.

The considerable increase in calcium, total solid, DO, potassium, copper supported the growth of the phytoplankton during winter and summer at station 1. Carbon dioxide was absent throughout the study at all stations due to the alkaline nature of water (pH > 7.8) Similar observation was made by Kataria (1994).

Chlorophyceae members showed a slight decrease in their growth with increase in pH, Calcium, Chlorides and TSS, Bacillariophyceae showed peak growth with increasing pH, temperature, phosphate, chloride and TSS, as was observed earlier by Patrick (1948), Zafar (1967) and Hegde (1983). However Euglenophyceae, Desmids and Cyanophyceae showed average growth except at station 1. This study revealed that the environmental variables such as temperature, pH and phosphate play a decisive role in altering the phytoplankton distribution and density. Anthropogenic activities are the main causative agents in the increase of nutrients (phosphate chloride and calcium) level in the river that supports the growth of *microcystis* sp at stations 2 and 4, whose presence in water will render it unfit for drinking with out treatment.

Heavy Metals

Seasonal variation in heavy metal concentration in river water and algae, at different sampling sites were observed. The heavy metal concentration was found to be considerably varied (Table 2). The concentration of all six metals was found to be within prescribed limits.

Significant number of heavy metals, contaminants in aquatic environment have been major concern for the environmentalists around the world. Many workers have studied metal in local riverine ecosystem (Say and Whitton, 1982; Singh and Mishra, 2007). Although riverine ecosystem desire trace elements due to extensive land water interchange, still the major source is the direct industrial discharges into the river. The present study found maximum concentration of Fe at station 4, minimum at station 1 (0.09); zinc maximum at station 1 (0.010) minimum at station 2 (0.002); cadmium completely absent at all the stations; copper maximum and minimum at station 1 (0.18) during monsoon and summer (0.04); nickel and lead were almost constant at all stations. The highest level of metals in summer months may be due to slow and reduced water level while lower concentration in rainy season might be due to dilution as a result of rain (Table 2). The concentration of heavy metals depends on organic matter content and pH of water plays an important role for their precipitation (most of heavy metals and precipitated at pH 7). Polprasort (1982) and Whitton (1985) quoted that stream with low pH favours high concentration of heavy metals. In the present investigation the accumulation of heavy metals by algal population may be as a result of either absorption by metallic means or adsorption by physical and ion-exchange phenomenon.

Similar observation was reported by Whitton (1985) on the higher level of metals in the environment. Based on the study, it was observed that the concentration of heavy metals at more polluted site subsequently evolves the level of metals in river water and their more uptake by algae, a producer in trophic level, which may ultimately pass to Planktivore fishes. Higher trophic level in animal and man reveals the role of metallic pollution in the river.

Conclusion

Findings of the present study clearly indicate that the stations 1 and 3 are moderately polluted due to the daily offerings of rice, diyas, food, flowers, ghee, etc. More organic pollution of the river water was observed during festivals and bathing of large number of devotees at that time and solar eclipse, or other such occasions. Trash removal, bath-area dredging aeration and mining of river water and bio-remediation of Kabini river seem to be the prime needs to stop ingress of pollutants so that the organic load is minimized and the resource can be recovered in a sustainable way. However, the presence of higher population of microbial fauns indicates that the water is contaminated and it cannot be used for organized bathing and sources of drinking water without conventional treatment. However, this water may be used for propagation of wildlife, fisheries, industrial cooling and irrigation purpose. If proper measures are taken for the treatment of this untreated sewage and restriction of various anthropogenic activities the wholesomeness and pristine quality of the holy river Kabini will be restored and its environmental health will be improved. Data of the findings can also be used for the scientific management of this water body. The response of algae to effluent pollutant varied greatly, sensitive species normally disappear as the water becomes polluted (Tables 3 to 6) while tolerant survive the pollution stress and readily recover down stream of the point of discharge.

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Table 2: Physico-chemical, biological and $CaCO_3$ (SI) parameters (12 samples)

	Station 1			*Station 2*			*Station 3*			*Station 4*		
	MS	*WS*	*SS*	*MS*	*WS*	*SS*	*MS*	*WS*	*SS*	*MS*	*WS*	*SS*
Temperature ^oC	24	23.2	26.2	23.4	22.6	26.8	23.8	22.5	25.6	23.6	22.5	25.6
pH	7.4	7.5	7.7	7.6	7.4	7.6	7.6	7.4	6.6	7.3	7.8	7.6
Turbidity (NTU)	7.3	6.2	8.3	9.4	8.6	8.4	8.6	9.5	8.3	9.6	10.6	9.2
Acidity	42.0	40	38.6	24.2	26.8	34.0	40.1	43.6	48.6	45	26	30
Total alkalinity	102	126	138	140	136	141	138	136	106	130	142	140
TDS	220	234	216	218	210	190	212	216	216	198	200	202
TSS	60	82	80	88	76	76	92	102	96	98	74	80
TS	280	316	296	306	286	266	304	318	312	296	274	282
Total hardness	144	123	116	138	146	144	146	162	152	138	150	161
Calcium	78.0	100.2	60.2	80.4	78.4	70.6	86	106	112	126	110	124
Magnesium	44.0	48.0	20.6	28.0	30.6	34.6	42.0	46.0	48.0	51.4	50.2	48.4
Chloride	48	44	38.0	24.0	28.0	30.6	50.8	48.0	52.0	56.8	44	46
Nitrate	1.14	1.20	1.6	1.12	1.21	1.30	1.12	1.10	1.16	182	1.66	1.74
Phosphate	1.44	1.30	1.56	1.26	1.36	1.38	1.44	1.20	2.32	2.52	2.30	2.44
DO	5.8	6.2	6.4	5.9	6.3	6.1	5.4	5.6	5.9	5.4	5.3	5.5
BOD	4.2	3.9	3.86	3.91	4.02	4.36	4.4	3.86	3.91	3.98	4.02	4.3
COD	12.9	12.6	13.6	19.4	12.96	14.6	16.5	18.6	17.4	16.8	18.4	17.6
Sodium	07	06	09	08	08	09	13.0	13.0	11	12	13	12
Potassium	02	03	03	02	04	06	05	03	04	05	06	04
$CaCo_3$ SI	+0.48	+0.66	+0.68	+0.84	+0.22	+0.63	+0.66	+0.55	+0.36	+0.86	+0.66	+0.67

Note: MS – Monsoon Season, WS – Winter Season, SS – Summer Season.
All parameters were mg/L^{-1} except pH, water temperature and tubidity.

Table 3: Heavy metal and bacteriological analysis (12 samples)

	Station 1			*Station 2*			*Station 3*			*Station 4*		
	MS	*WS*	*SS*	*MS*	*WS*	*SS*	*MS*	*WS*	*SS*	*MS*	*WS*	*SS*
Iron (Fe)	0.11	0.09	0.23	0.15	0.19	0.10	0.28	0.16	0.18	0.22	0.18	0.19
Zinc (Zn)	0.004	0.010	0.0021	0.002	0.004	0.006	0.007	0.008	0.006	0.005	0.004	0.006
Cadmium (Cd)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper (Cu)	0.18	0.11	0.04	0.19	0.13	0.07	0.09	0.08	0.19	0.14	0.13	0.12
Nickel (Ni)	0.006	0.007	0.005	0.0051	0.007	0.0005	0.0051	0.007	0.005	0.005	0.006	0.004
Lead (Pb)	0.0003	0.0005	0.0004	0.0001	0.0003	0.0007	0.0005	0.0006	0.0004	0.0005	0.0006	0.0004
Total bacteria count cfu/l	706	710	820	910	980	1022	860	980	990	960	1020	1016
Coliform 100 mg/L^{-1}	4.94	430	470	530	590	570	498	598	586	506	568	590
E. Coli	Absent	Present	present	present	present	Present	Present	Present	Present	Present	Present	Present

Note: MS – Monsoon Season, WS – Winter Season, SS – Summer Season.
All parameters were mg/L^{-1}.

Table 4: Average density of individual species/ml (Station 1)

Organisms	*Monsoon*	*Winter*	*Summer*	*Total*
Coelastrum microporm	2	2	3	7
Oedogonium straitum	2	3	4	9
Oedogonium anomalus	3	4	3	10
Pediastrum tetras	1	3	4	8
Scendesmus armates	2	4	4	10
Closterium lunella	1	3	4	8
Closterium	1	3	4	8
Costerium turmdm	2	2	2	6
Cosmarium regnelli	3	4	4	11
Euglena elongate	4	5	4	13
Lepocinclies acuta	4	5	5	14
Trachelomanas bulla	2	2	2	6
Cymbella ospers	1	3	2	6
Cyclotella catenate	1	3	2	6
Gomphonema tenellum	2	2	2	6
Navicula rhomboids	1	2	2	5
Anabaena spiroids	1	6	6	13
Arthrospira platensis	3	4	8	15
Merisamopedia convolute	4	5	7	16
Spirulina major	4	4	6	14

Table 5: Average density of individual species/ml (Station 2)

Organisms	*Monsoon*	*Winter*	*Summer*	*Total*
Ankistrodesmus falcatus	3	4	4	11
Oedogonium straitum	2	4	4	10
Oedogonium anomalus	1	3	4	8
Pediastrum tetras	2	5	4	11
Pediastrum duplex	5	6	8	19
Scenedesmus bijugatus	4	5	3	12
Scenedesmus obliques	3	2	3	8
Cosmarium regnelli	3	2	3	8
Cosmarium obtusatas	3	1	1	5
Lepocinclies acuta	1	1	2	4
Euglena elastica	2	1	4	7
Euglena elongate	4	4	1	8
Cymbella aspera	3	6	7	16
Cymbella straita	4	7	6	17
Nitschia palea	3	3	2	8
Synedre ulna	1	4	2	7
Anabaena wisconsinese	1	4	2	7
Oscillotoria prinecps	1	3	4	8
Microcystsis incerta	4	10	12	26

Table 6: Average density of individual species/ml (Station 3)

Organisms	*Monsoon*	*Winter*	*Summer*	*Total*
Ankistrodesmus falcatus	4	6	7	17
Coclastrum scabrum	1	3	3	7
Oedogonium straitum	3	4	2	9
Spirosyra borgeans	3	2	2	4
Scenedesmus bijugatus	2	2	1	5
Closterium lunella	3	3	2	8
Euastrum spinulosum	3	4	2	9
Euglena elastica	4	4	2	10
Euglena Limnophyla	3	5	6	14
Phacus tortus	7	4	5	16
Trachclomonas robusta	2	6	7	15
Cymbella straita	2	5	2	9
Cymbella simulate	2	4	1	7
Navicula rhomboids	2	4	2	8
Pinnularia gibba	3	4	3	10
Arthrospira platensis	6	4	3	13
Spirulina major	2	3	4	9
Phormidium fragile	3	5	4	12

Table 7: Average density of individual species/ml (Station 4)

Organisms	*Monsoon*	*Winter*	*Summer*	*Total*
Ankistrodesmus falcatus	3	4	4	11
Coelastrum microporum	4	5	6	15
Oedogonium straitum	5	3	7	15
Oocystis gigas	2	7	6	15
Pediastrum duplex	3	6	4	13
Scenedesmus bijugatus	2	4	5	11
Zygnema gangeticum	1	4	3	8
Closterium lunula	2	3	4	9
Closterium validium	2	4	2	8
Cosmarium obtusatus	2	3	2	7
Euglena elastica	4	4	3	11
Euglena elongate	3	5	5	13
Lepocinclous ovum	3	6	5	14
Phacus curvicauda	2	8	6	16
Trachelomonas robusta	2	5	4	11
Cocoonies placentula	1	4	3	8
Cymbella cymbiformis	1	4	2	7
Gyrosigma granulates	2	3	2	7
Navicula rhomboids	3	4	2	9
Syndra ulna	3	3	4	9
Anabacna spiroides	2	3	4	9
Arthrospira platensis	5	6	5	16
Merisomopedia tenussima	4	6	5	15
Microcystsis incerta	3	4	4	11
Spirulibna major	2	4	4	10

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