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PRINT: ISSN 0970-9274 ONLINE: 2456-6608
J. Hum. Ecol., 10(1): 29-34 (1999)
DOI: 10.31901/24566608.1999/10.01.04

Impact of Anthropogenic Activities on the River Water Quality Along Pilgrimage Centres at Dakshina Kannada

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KEY WORDS Piligrimage Tourism. Carrying Capacity. Coliform Count. Ecosystem Health.

ABSTRACT A baseline study was conducted to determine the impact of anthropogenic activities on the physico-chemical and microbial characteristics of a few riverine stations located in the vicinity of major temples of Dakshina Kannada district, Karnataka. It was observed that the impact of human activity was severe on all physico-chemical parameters analysed during summer in comparison with other two seasons. The present study shows high organic pollution load in these waters at all the times. The MPN values exceded the tolerable limits in almost all the seasons except a few months. It was observed that the main cause of deterioration in water quality was due to the lack of proper sanitation, unprotected river sites and high anthropogenic activities.

INTRODUCTION

In Dakshina Kannada district Subramanya, Dharmasthala, Kateel, and Kollur are the four major pilgrimage places situated near the rivers on the foot hills of Western Ghats. Thousands of piligrims visit these temples everyday, throughout the year. The increased piligrimage actvities will definetely induce changes in the surrounding environmental systems. Many studies have been carried out in evaluating the impact of humans at different aquatic ecosystems. (Ramesh et al.,1992; Israili et al.,1993; Pandey et al.,1992, 1993; Desai, 1995). Even though many studies have been conducted on water quality of different rivers, lakes, estuaries etc., meagre information is available on the quality of waters in the vicinity of Temple town. Recently some investigators (Sinha Manojkumar et al., 1992 ; Parvateesam et al., 1992 ; Subbamma et al., 1992 ; Bahura et al., 1993) have reported polluted nature of Indian temple tanks and ponds. Bacterial contamination in different water bodies had been reported by different authors (Bhattacharjee et al., 1989; Panda et al., 1993 and Sivasubramani and Mahadevan, 1995). In the present study an attempt has been made to evaluate the conditions of the rivers situated near the major temples of the Dakshina Kannada district of Karnataka.

MATERIALS AND METHODS

The Dakshina Kannada district lies between 12°27' and 13°58' North latitude and 74°35' and 75°49' East longitude. The rivers in the district originate in the foot hills of Western Ghats and flow towards Arabian sea travelling along different terrain and ecological segments influenced by different human settlements. The district receives the heavy rainfall during south-west monsoon (June-September) which accounts 85-90 per cent. Four sampling sites have been selected for the study purpose - T1 station at Kumaradhara river near Subramanya temple, T2 station at Nethravathi river near Dharmasthala temple, T3 at Nandini river near Kateel temple, and T4 at Sauparnika river near Kollur temple (Fig. 1). Water samples were collected from 1 km downstream the active human impact site. All the rivers are West-flowing, open into the Arabian sea along with other 2-3 rivers. The water samples were collected every month in plastic containers in triplicate during the second week of each month of the year between 9.00 A.M. to 12.00 noon.

Water temperature was recorded by Celcius thermometer and pH by digital pH meter Systronics 361. For the dissolved oxygen the samples were fixed on the site itself and was analysed in laboratory by Azide modification of Winkler's method. Nitrate was estimated photometrically by using an Ion Analyser Merck SQ 118. Phosphate was estimated by Stannous chloride method. Silicate by Molybidosilicate

method and Sulphate by Turbidimetric method and are measured using Camspec-M350 Double beam UV-Visible Spectrophotometer. Organic nitrogen was measured using Kjeldhal's method. For bacterial analysis the water samples were taken in presterilised BOD bottles in ice box to laboratory. The Most Probable Number (MPN) of coliforms were estimated using multiple tube fermentation technique according to standard methods (APHA-AWWA-WPCF, 1989; Trivedi and Goel, 1986).

RESULTS AND DISCUSSION

Water was bright and clear at all stations except during rainy season. Faecal smell emanated from the water at all the stations. The ranges and mean of the physico-chemical characteristics of the river waters are presented in table 1. The water temperature followed a seasonal pattern and is varied from 23.5° to 38.5° C. The temperature was higher at station T3 than the other 3 stations. T3 recorded comparatively higher pH. while other 3 stations recorded almost similar average values. Chloride shared a range of 6.46 to 98.19 mg/1 with T3 showing higher annual average value.

The mean dissolved oxygen content was 7.02, 7.33, 7.37 and 7.27 mg/1 at stations T1, T2, T3 and T4 stations, respectively. Interestingly at all the stations, during premonsoon season there was a drop in dissolved oxygen content, almost reaching anoxic conditions. The per cent saturation values of oxygen were below per-

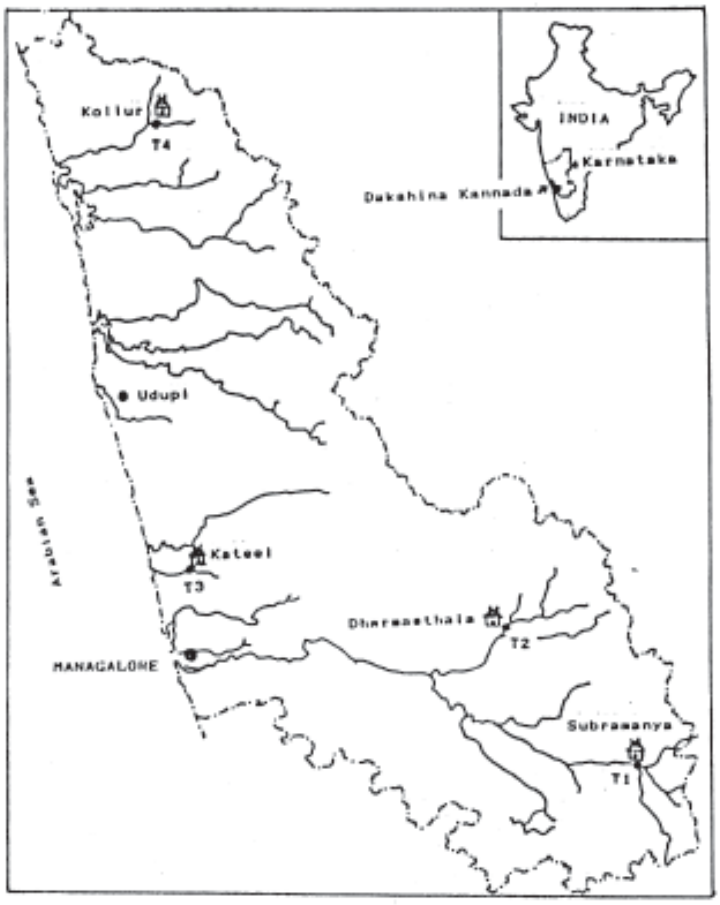

Fig 1 : Map showing sampling sites

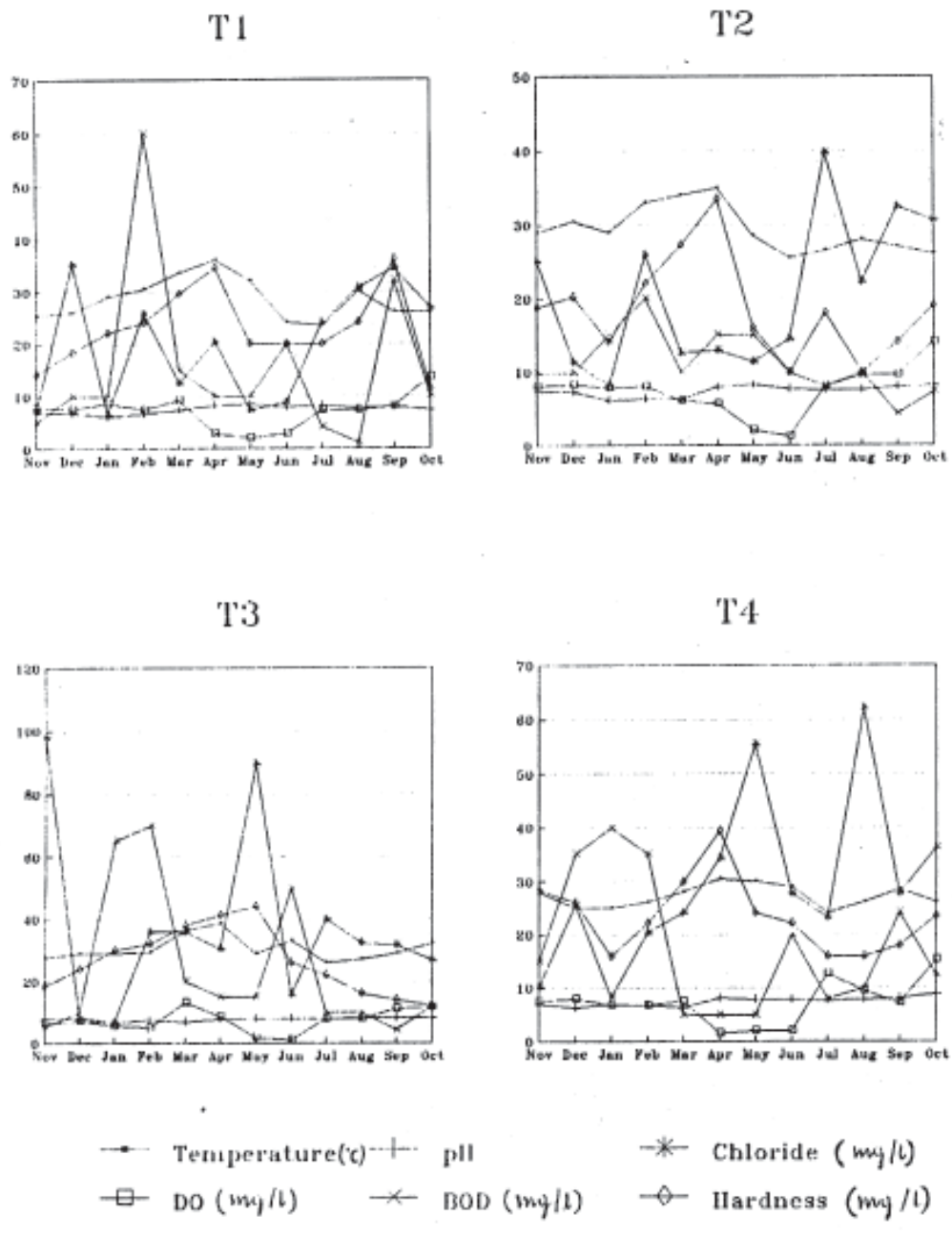

Fig. 2. Annual variation of different physico-chemical parameters along the 4 temple sites (units in parenthesis)

Table 1: Annual average and range of different physico-chemical parameters along 4 river stations [All values except Temperature (C) and Phosphate (ug/l) are expressed in mg/l]

Parameters	*Stations*				*Permissable limit for drinking water*	
	T1	*T2*	*T3*	*T4*	*ISI (1982)*	*ICMR*
Temperature	28.5±3.79 (23.5 - 36.0)	29.33±3.04 (25.5 - 35.0)	30.5± 3.65 (26.0-38.5)	27.17 ± 2.02 (24.0 - 30.5)	40	-
pH	7.37 ± 0.71 (5.97 - 8.40)	7.33 ± 0.69 (6.1 - 8.25)	7.74 ± 0.48 (6.74 - 8.30)	7.48 ± 0.78 (6.25 - 8.90)	6.5-8.5	7.0 - 8.5
Chloride	19.96 ± 10.54 (6.46 - 35.16)	20.58 ± 9.75 (8.27 - 39.81)	37.67 ± 27.28 (6.72 - 98.19)	33.78 ± 20.20 (8.27-77.78)	-	250
DO	7.02 ± 3.08 (2.0 - 13.64)	7.33 ± 3.26 (1.2 - 13.96)	7.37 ± 3.48 (1.2 - 13.20)	7.27 ± 3.97 (1.6 - 15.28)	6.0	5.0
BOD	15.6 ± 15.47 (1.22 - 60.0)	11.2±4.12 (4.2 - 20.0)	23.87 ± 22.59 (4.4 - 70.0)	17.87 ± 12.29 (5.0 - 40.0)	2.0	-
Hardness	22.8 ± 7.13	18.55 ± 6.48	26.5 ± 10.27	23.42 ± 6.62	100	300
Phosphate	5.6 ± 3.5 (1.0 - 14.0)	1.0 ± 1.0 (0.4 - 4.2)	8.0 ± 6.0 (0.2.0)	1.0 ± 1.0 (0.1-3.5)	-	-
Sulphate	99.8 ± 166.8 (0.2 - 456.9)	115.9 ± 165.1 (0.6 - 496.9)	152.7 ± 249.5 (0.5 - 668.7)	143.8 ± 288.1 (1.2 - 1030.7)	-	-
Silicate	1.07 ± 0.52 (0.12 ± 1.9)	0.94 ± 0.57 (0.004 - 1.73)	0.95 ± 0.45 (0.13 - 1.79)	1.01 ± 0.47 (0.14-1.55)	-	-
Org. N_2	3.77 ± 2.13 (1.04 - 8.62)	3.91 ± 1.59 (0.8 - 6.04)	17.49 ± 36.85 (2.8 - 139.4)	6.49 ± 2.65 (3.48 - 12.96)	-	-

missible limits during peak summer season. The values of Biological Oxygen Demand (BOD) ranged from 1.2 to 70.0 mg/1 and higher BOD values were recorded during premonsoon season.

The total hardness of water ranged from 10.0 to 44.0 mg/1. The water was hard during summer and soft in rest of the months. Among the inorganic nutrients, the average values of inorganic phosphate ranged from 1.0 to 6.0 µg/1. The sulphate values ranged from 0.19 to 456.86 mg/1 at T1 ; 0.57 to 496.94 mg/1 at T2, 0.45 to 668.67 mg/1 at T3 and 1.21 to 1030.68 mg/1 at T4 stations. The average organic nitrogen values were 3.77, 3.91. 17.49 and 6.49 mg/1 at T1, T2, T3 and T4 Stations, respectively.

BACTERIAL ANALYSIS

The mean values of Most Probable Number (MPN) index values were depicted in table 2. The average annual MPN values being 573.33, 706.08, 567.42 and 456.00 at T1, T2, T3 and T4 stations respectively. Among all the 4 temples, inflow of piligrims to Dharmasthala temple is more. All the stations studied have recorded maximum MPN values during premonsoon followed by post and monsoon seasons. The downstream of the same stations of the same river showed a decreased MPN, which clearly indicates that the stretches along the temple vicinities are much affected by the anthropogenic indulgences and defection on the banks.

Table 2: Spatio-temporal variation of coliform organisms (MPN index) per 100 ml

Months	*Stations*			
	T1	*T2*	*T3*	*T4*
November	50	<2	30	11
December	280	6	30	2
January	70	22	40	<2
February	6	26	26	280
March	23	>1600	1600	500
April	>1600	>1600	>1600	>1600
May	>1600	>1600	>1600	900
June	>1600	>1600	>1600	>1600
July	17	33	90	27
August	17	34	70	33
September	17	350	33	17
October	>1600	>1600	>90	500

Permissible Limits for Drinking Water :
WHO (1984) & EEC -----> 0/100 ml.
ISI (1992) & ICMR --->1/100 ml.
For Bathing Water :
BIS (1992) ----------->500/100 ml.

The stations under observation are situated in the head region of each river. A little upstream to the temple areas the river waters are clear and transparent. As these are holy places devotees take a dip before entering the temple. They also

use it for washing clothes and vehicle cleaning. The local people use these waters as sources for drinking, bathing and for agricultural purposes. Increased inflow of piligrims, decreased hygienic conditions and poorly maintained sanitation results in the deterioration of environmental health of the aquatic system.

From our studies the river water is found to be contaminated near the temple areas at least for more than a kilometer. The order of pollution load among the four stations studied is : T2 > T4>T3>T1. Among the physico-chemical parameters analysed D.O,B.O.D and percentage of oxygen saturation values did not meet the ISI standards. Higher BOD during summer may be attributed to the bathing activities, highwaste discharges and increased human activities in the vicinity of the temple. The poor flow during lean period coupled with deterioration of water quality with increased temperature resulted in the depletion of DO. Besides this, the mixing of organic wastes demanding oxygen might have induced drop in oxygen level (Mishra and Saxena, 1991). Since DO content of the stream is one of the parameters to reflect aquatic ecosystem's health, it is advisable to use this as litmus test to understand lotic system health. During monsoon there was considerable increase in levels of DO leading to supersaturation which may be due to the rain water. There should be adequate DO in all the seasons. The river with self purification capacity could assimilate the existing load (Lester, 1967). The pH of water body indicates degree of deterioration of water quality (Verma et al., 1984). The rise in pH towards alkaline range indicates mixing of sewage and other effluents from the surroundings (Mishra and Sexena, 1991). The hardness of river water is of considerable significance in connection with sewage effluents (Rai, 1974) as washings and bathing activities might have caused this increase in the present study. Lower phosphate values in the present study were similar to the values (0.005 - 0.07 mg/1) observed at river Jhelum (Shyamsunder, 1989). High summer values for sulphate also indicate the deterioration of water quality (Desai et al., 1995). The highest value (139.4 mg/1) of organic nitrogen was observed at T3 station during May1995 which may be due to the increased discharge of organic rich nitrogen wastes to the river when there was little flow. Thus all the stations studied have recorded maximum physico-chemical values during premonsoon followed by post and monsoon seasons.

With respect to the WHO, EEC and ICMR standards the MPN of coliforms/100 ml in samples collected from all the stations exceeded the prescribed limit of above said standards. The load of coliform bacterial contamination is found to be heavy. During the higher bather load days there was a temporal relationship between bather load and water quality indicator levels (faecal pollution) (James, 1996). Higher coliform counts clearly indicates lack of sanitation facilities on these stretches.

The influx of pilgrims to the temple towns brings enormous pressure on the basic requirement fulfillments like food, shelter and waste disposal. Naturally the immediate environment near the river banks are the places being utilised and also the river water for bathing and washing. Many a times primary sanitary requirements are also not available. Even if there is some provisions, the influx is far greater than the basic facilities available, and the carrying capacity of these temple towns are limited. Unfortunately not enough attentions and efforts are put to develop the infrastructure requirements and ultimately the receiving ecosystem is affected during most part of the year, probably except during the rainy season.

The temple towns are old and planned for a flow of limited devotees during the olden days. There is no proper sewage disposal system or sewage treatment plant, and there are solid and liquid organic biowastes generated without proper disposal systems. Ultimately they find their way into the nearby rivers thus increasing stress on them and decreasing the aesthetic value. The self purification capacity of the river could not purify all the load during the lean season resulting in deteriorated water quality in isolated patches of river water. Unless the authorities plan for the basic societal needs, such as proper waste disposal, increased accomodations, sanitary requirements, treatment of drinking water and separating bathing ghats from washing ghats, not only sacredness of the rivers is impaired but also hurts the feelings of the devotees. Basic requirements and proper maintenance to meet the inflow of devotees resulting in overall development of the carrying capacity of these piligrim centres are

warranted. This will help to accelerate the economic growth of these regions and also satisfy the devotees by promoting piligrimage tourism.

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