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Hydrology and Water Quality Assessment of Achencovil River in Relation to Pilgrimage Season

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Abstract- The present study deals with assessment of the water quality of the River Achencovil. Sabarimala is the largest annual pilgrimage in India with an estimated 45–50 million devotees visiting every year. The Achencovil River is a small river not more than 130 kilometers. Pilgrims use the water of Achencovil River for various sanitary purposes. The water quality is also disturbed by various other anthropogenic activities by the population living near the river. The microbiological and physico-chemical characteristics were studied and analyzed during July 2010 – April 2011 using standard procedures. The mid-stream part of the river is selected for the study. The results revealed that all the studied sites showed more pollution during the pilgrimage season (post monsoon) than the off seasons (monsoon and summer) and also showed fluctuations in microbiological and physico-chemical parameters. Pollution of river water can be reduced by providing proper sanitation facility to pilgrims and by providing proper methods for dumping of sewage and wastes. Almost all parameters showed significant ($P<0.05$) seasonal variation between segments and was determined by ANOVA.

Index Terms- Achencovil River, Microbiological analysis, Physico - chemical parameters, Sabarimala pilgrimage

I. INTRODUCTION

Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability (FAO, 1997). Surface Rivers have always been the lifelines of development and with the course of time have borne the impacts of development and industrialization in the form of abstractions of water besides other wastewater releases. River is being polluted by indiscriminate disposal of sewage, industrial waste and plethora of human activities, which affects its physico- chemical characteristics and microbiological quality (Koshy and Nayar, 1999).The quality of water usually described according to its physical, chemical and biological characteristics. Rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from water born diseases. It is therefore to check the water quality at regular interval of time. Consequent to the realization of the potential health hazards that may result from contaminated drinking water, contamination of drinking water from any source is therefore of primary importance because of the danger and risk of water borne diseases.

The Achencovil River is in Kerala, India, formed towards the southern tip of the peninsula from the streams of the Rishimala River, Pasukidamettu River, and the Ramakkalteri river of Western Ghats. This river enriches the Pathanamthitta district of Kerala state. It joins with the Pamba River at Veeyapuram, in the Alappuzha district of Kerala in South India. This is a small river not more than 130 kilometers. Sabarimala is the largest annual pilgrimage in India with an estimated 45–50 million devotees visiting every year The present investigation involves the analysis of water quality in relation to physico- chemical and microbiological parameters of mid-stream of Achencovil river during Sabarimala Pilgrimage season and off seasons. During Sabarimala pilgrimage season, devotees come to Pandalam in large numbers to worship the deity of Valiyakoikkal Temple near the Pandalam Palace. Pilgrims use the water of Achencovil River for various sanitary purposes. The water quality is also disturbed by various other anthropogenic activities by the population living near the river. (Prakasan V.R. and Joseph M.L.,2000).

II. MATERIALS AND METHODS

Pandalam and Thumpamon are situated on the banks of the River Achencovil and these segments of Achencovil river, which comprises the midstream of the river is selected for the study. The six study sites selected are:- i. Valiyakoikkal Temple Kadavu(S1) ($9^{o}14'02.21"N$ $76^{o}40'20.47"E$) ii. Kaipuzhakadavu (S2) ($9^{o}14'14.88"N$ $76^{o}40'08.36"E$) iii. Pandalam Mahadevur Temple Kadavu(S3) $9^{o}13'38.06"N$ $76^{o}41'51.22"E$ iv. Thumpamon Ambalakadavu (S4) $9^{o}13'44$ "N $76^{o}42'42"E$ v. Thumpamon Thazham Mannakadavu (S5) $9^{o}13'37"$ N $76^{o}41'58"E$ and iv. Thumpamon Polemannil Kadavu (S6). $9^{o}13'42"N$ $76^{o}41'56$ "E. The samples were collected at monthly intervals between July 2010 to June 2011, covering three seasons i.e. Monsoon-Before Sabarimala Pilgrimage Season (July to October 2010), Post Monsoon - Pilgrimage Season (November 2010 to February 2011) and Summer - After Pilgrimage Season (March 2011 to June 2011).

Standard methods (APHA, 2005) were used for collection, preservation and estimation of water samples Physico-chemical parameters like Temperature, pH Dissolved Oxygen, Free Carbon Dioxide, Conductivity and Total Dissolved Solids were measured following APHA (2005) procedures. The microbiological parameters like Total plate count and Total coliform bacteria count were estimated by pour plate method. One liter of water sample from each location was collected in to pre-sterilized bottles. All samples were collected with precautions required for microbiological analysis, held on ice in an icebox and transported to the laboratory for microbial

analysis. The water samples are subjected to 10^{-3} serial dilution. The bacterial population in different samples was estimated by pour plate method on nutrient agar for Total Plate Count (TPC) and on McConkey agar for Total Coliform Count (TC). All specific media plates were incubated at 37^0 C for at least 24 to 48 h and final colonies were noted and counted. Typical colony characteristics are listed below:

- Nutrient Agar: All colonies grown on medium are counted as total viable count or total plate count.
- McConkey Agar: All pink colonies grown on plates are counted as total coliforms.

Surface water samples were collected in 1L sterilized plastic containers for physico-chemical analysis and analyzed according to the standard procedures of APHA (2005). Water temperature was estimated on the spot with a mercury thermometer. The DO was done within 3 hour after sampling of water.

Statistical procedures

Microbiological and physico-chemical parameters of the water samples were presented in terms of Mean ± SD. The descriptive statistics were conducted while statistical significance of differences ($P<0.05$) was determined by analysis of variance (ANOVA).Graphical representation is carried out by Microsoft Excel software.

III. RESULTS AND CONCLUSIONS

There is variation in the physico-chemical and microbiological characters of Achencovil River with Respect to different sampling sites and periods. Results are presented in Table 1.

A. Physico-chemical analysis

Temperature: In the present investigation the temperature showed drastic difference at all the sites in all the seasons. The temperature was high during summer i.e. before Sabarimala pilgrimages season and least during post monsoon i.e. during Sabarimala pilgrimage season and it was after a long monsoon period. In the present study, water temperature ranged from 25.5^{o}C to 35.4^{o}C at various study sites. Temperature is an important physical parameter of water quality which has a direct effect on aquatic life as because it reduces the dissolved oxygen (DO) concentration in the water making oxygen less available for respiration. Temperature controls behavioral characteristics of organisms, solubility of gases and salts in water (P.S Welch, 1992). Temperature also affects chemical reactions and reaction rates within the water, thereby influencing its suitability for use (Metcalf and Eddy, 2003). The marked temperature difference in four season showed high anthropogenic disturbances.

pH: The pH range suitable for the existence of most biological life is quite narrow and critical, and is typically 6-9 .The pH levels were within the limits, set for protection of aquatic life (6.5 to 9.0) (USEPA ;1975), irrigation(5.5 to 9.0) and domestic use (7.0 to 9.0) ICMR ;1975). pH of natural water is governed by the carbonate – bicarbonate -carbon dioxide equilibrium. High carbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in solution (Bauder et al., 2004). In the present study, pH values in the water samples of river ranged from 6.9 (Summer i.e. After Pilgrimage Season, S5) to 7.3 (Post monsoon i.e. Pilgrimage Season, S1). During the study period water changes to slightly alkaline conditions. The higher pH is in the post monsoon season (7.3) may be due to the consumption of CO_2 by the algal population during the process of photosynthesis due to increased pollution. The pH values of all the surface water sources during the sampling period were within the prescribed limits (6.5-8.5) as per BIS with respect to the drinking water standard.

Dissolved oxygen (DO): Mean dissolved oxygen concentration ranged from 5.4 to 6.8 ml/L in the study. The highest DO concentration recorded in monsoon season (6.5 ml/L) indicates less chance of pollution. Lowest D.O is recorded during post monsoon season in all the sites (5.4 ml/L to 6.2 ml/L). The WHO suggested standard of DO >5.00 ml/L . On the whole DO content of water of studied site in all the seasons are within the suitable range. Dissolved oxygen is one of the most important factors for aquatic life and most species become distressed when DO levels drop to 4-2 mg/L (Francis-Floyd, 2003). The low levels of DO concentration in the fresh water aquatic systems is an indication of high levels of pollution (Yayýntas et al., 2007).

Free Carbon Dioxide (CO_2): The free CO_2 was high during summer in almost all segments. . Before the pilgrimage season (monsoon season) and during the pilgrimage season (post monsoon) the value is between 0.8ml/L and 1.2 ml/L in all the sites. The free CO_2 value for all the sites after the pilgrimage season (summer) ranges between 1.11ml/L and 1.29 ml/L. Similar works were done by Kaur *et al* ,2000 in Kanjili wetland. The amount of carbon dioxide determines the pH of water.

Conductivity (EC) And Total Dissolved Solids (TDS): Electrical conductivity (EC) is a measure of the ions present in water, and therefore a surrogate for total dissolved solids (TDS). The conductivity values in the water samples ranged from 0.031ds/m (Summer, S4) to 0.037 ds/m (Monsoon, S2). The maximum value in the monsoon season indicates the presence of ions in the water. The TDS values in the water samples varied from 20.3 mg/L (Summer, S4) to 26.5 mg/L (Monsoon,S6). The EC and TDS of the water samples were with the permissible limit as prescribed by WHO i.e. EC of 0.7 dS/m (700 mS/cm) and a TDS concentration of less than 450 mg/L.

The Physico-chemical features of river showed moderate to adequate levels of parameters. Sohani et al., (2002), Kulkarni et al., (2001), Sakhare and Joshi (2003), Trevedi and Gupta (1995), Tamlurkar and Ambore (2006) have carried exhaustive study on physicochemical characteristics of water. Similar works were carried out by Dulo et al ., 2008 in Nairobi River, Kenya,Joseph et al ., 2010 in Pennar River of Kerala, India ,Yadav et al ., 2011 in Kosi River of Rampur District, Uttar Pradesh, Sharma Shraddha et al.,2001 in Narmada River**.**

The seasonal variation in water temperature, pH, Dissolved Oxygen and Free Carbon dioxide Conductivity EC And Total Dissolved Solids TDS were statistically significant ($P<0.05$).

B. Microbiological analysis

Total Plate Count (TPC) and Total Coliform Count (T.C):

Total Plate Count, also termed as Total Viable Count (TVC), gives information about the number of aerobic bacteria present in

a sample. All the samples were found to have TPC. Commonly, the Total Coliforms (TC) gives the information about the Coliform bacteria. In this study, the TPC and TC was higher in all the studied segments of river Achencovil during the Sabarimala pilgrimage season (post monsoon season) compared to off seasons. TPC gives information about the number of aerobic bacteria present in a sample .The most common indicator organisms used for monitoring water quality are total coliform. In the present study TPC ranged from 1.1($x10^3$) mL^{-1} (Monsoon i.e. Before Pilgrimage Season, S4) to 9.4($x10^3$) mL^{-1} (Post monsoon i.e. Pilgrimage Season, S1) and TC ranged from 0.6($x10^3$) mL^{-1} (Monsoon , S4) to 6.6($x10^3$) mL^{-1} (Post monsoon , S1). In all the seasons Valiyakoikkal Temple Kadavu (S1) shows highest TPC and TC because pilgrims use this site mainly for sanitation purposes. The low rate of pollution at other site is due to less anthropogenic disturbances. Monsoon season showed lowest bacterial density due to dilution and it is less polluted as it is the period before pilgrimage season. During the post monsoon season the water is much polluted as it is the peak period of pilgrimage season.

Results of the study indicate that the water of Achencovil River is highly contaminated especially during Sabarimala pilgrimage season than the off season because pilgrims use the river water for various sanitary purposes. It was revealed that deterioration of quality of water was more at S1 during all the studied seasons. This is due to high anthropogenic disturbances associated with Sabarimala pilgrimage. TPC and TC count were so high making the water not suitable for drinking, domestic and other recreational purposes.

The biological characteristics of water and wastewater are of fundamental importance to human health, in controlling diseases caused by pathogenic organisms of human origin, and because of the role that they play in the decomposition of waste (Metcalf and Eddy, 2003). Similar works were done by Karikari et al. ., 2004 in Densu River of Ghana , Maciej Walczak., 2008 in Vistula and Barda rivers , Kumarasamy P. *et al*. ., 2009 in Cauvery River,South India, S. S. Patki *et al*.., 2007 in river Alaknanda from Badri Kedar.

Like, in gangetic river sites witness holy dip and mass bathing by a large number of pilgrims as an old age ritual in India, which is a constant source of contamination of water bodies. (Semwal and Akolkar, 2006). As is universally accepted, higher sewage contamination would lead to increase numbers of Coliforms in natural waste bodies. Normally faecal pellets contain several species of bacteria including human pathogens. Hansen and Bech (1996) clearly suggest the proliferation of allochthonous microflora in the river environment. The E.coli and coliform were prevalent in river water as well as in effluent sample (Ramaiah *et al*., 1994; Ramteke and Tewari, 2002). McLellan *et al*,. 2001 stated that fecal pollution indicator organism can be used to a number of conditions related to the health of aquatic environments. The seasonal variation in water TPC and TC were statistically significant ($P<0.05$).

IV. CONCLUSION AND RECOMMENDATION

In conclusion the water of Achencovil River is highly contaminated especially during Sabarimala pilgrimage season than the off season because pilgrims use the river water for various sanitary purposes. From this study it was revealed that deterioration of quality of water was very high at Pandalam during all the studied seasons. This is due to high anthropogenic disturbances associated with Sabarimala pilgrimage. Among the different studied seasons, monsoon season showed improved water quality.

Uncontrolled use of chemical fertilizers and pesticides, unscrupulous dumping of domestic wastes are also the major causes of deterioration of water. Pollution of river water can be reduced by providing proper sanitation facility to pilgrims and also by providing proper methods for dumping of municipal sewage, domestic wastes etc. The quality of water is depleting rapidly with the change in human life style *i.e*., massive industrialization, construction activities, utilization of agricultural land and forest land for other developmental purposes. It is evident that water borne diseases are due to improper disposal of refuse, contamination of water by sewage, surface runoff, therefore programme must be organized to educate the general populace on the proper disposal of refuse, treatment of sewage and the need to purify our water to make it fit for drinking because the associable organisms are of public health significance.

Table 1: Values of physicochemical and microbiological parameters (Mean ± Standard Deviation, SD) of Achencovil river water

Parameters	Before Pilgrimage Season (Monsoon)						During Pilgrimage Season (Post monsoon)						After Pilgrimage Season (Summer)					
	S1	S2	S3	S4	S5	S6	S1	S2	S3	S4	S5	S6	S1	S2	S3	S4	S5	S6
Temperature(^{o}C)	28.6 ± 0.1	29.5 ± 0.1	28.6± 0.1	27.5± 0.4	27.1± 0.15	27.5± 0.5	25.7 ± 0.1	25.6 ± 0.1	25.5 ± 0.3	25.5 ± 0.1	25.8±0.1	25.8± 0.1	32.9± 0.5	35.5±0.3	35.4± 0.3	34.8±0.3	33.9±0.3	33.2±0.3
pH	7.0 ± 0.03	7.1 ± 0.02	7.0 ± 0.03	7.00 ± 0.1	7.0 ± 0.1	7.2 ± 0.1	7.3 ± 0.04	7.1 ± 0.05	7.1 ± 0.02	7.0 ± 0.02	7 ± 0.3	7.1 ±0.02	7±0.03	7± 0.03	7.1 ±0.02	7±0.03	6.9 ±0.01	7±0.03
Dissolved Oxygen ml/L	6.2 ± 0.1	6.3 ± 0.1	6.2 ± 0.1	6.4 ± 0.2	6.1 ± 0.02	6.5 ± 0.01	5.6 ± 0.06	5.7 ± 0.06	5.5 ± 0.01	5.4 ± 0.1	6.2 ± 0.1	6.0 ± 0.1	6.1 ± 0.01	6.2 ± 0.06	6.0 ± 0.05	6.1 ± 0.01	6.3 ± 0.2	6.1 ± 0.1
Carbon Dioxide ml/L	1.1 ± 0.01	1.2 ± 0.1	0.9 ± 0.1	0.8 ± 0.2	0.8 ± 0.2	0.9 ± 0.03	1.1 ± 0.02	0.9 ± 0.02	1.2 ± 0.02	0.8 ± 0.01	0.8 ± 0.1	0.8 ± 0.1	1.1 ±0.01	1.1 ±0.02	1.28 ± 0.06	1.2 ± 0.03	1.29± 0.03	1.11± 0.01
Conductivity (ds/m)	0.036± 0.001	0.037± 0.001	0.034± 0.1	0.033± 0.2	0.035± 0.1	0.038± 0.1	0.034± 0.001	0.035± 0.001	0.033± 0.001	0.032± 0.12	0.032± 0.1	0.036± 0.1	0.033± 0.001	0.034± 0.1	0.033± 0.2	0.031± 0.1	0.032± 0.1	0.035± 0.001
TDS (mg/L)	22.7± 0.12	23.7± 0.1	21.8± 0.2	21.1± 0.5	21.2± 0.1	26.5± 0.01	22.1± 0.1	22.4± 0.1	21.2± 0.2	20.5± 0.3	20.9± 0.1	24.5± 0.1	21.8± 0.1	23.1± 0.2	21.1± 0.2	20.3± 0.13	20.7± 0.1	23.3± 0.2
Total Viable (Plate) Count(x10^{3})mL^{-1}	5.7 ± 0.3	2.05± 0.5	3.60± 0.01	1.1 ± 0.6	1.25± 0.1	2.95± 0.3	9.4 ± 0.2	6.51± 0.2	7.94 ± 0.7	3.28 ± 0.2	5.92 ± 0.2	7.22 ± 0.2	8.34 ± 0.2	5.73 ± 0.2	6.7 ± 0.4	2.58 ± 0.7	4.14 ± 0.1	6.34 ± 0.1
Total Coliform Count(x10^{3})mL^{-1}	3.48 ± 0.1	1.3 ± 0.1	2.1 ± 0.3	0.60± 0.1	1.09± 0.1	1.62 ± 0.1	6.6 ± 0.1	4.46 ± 0.3	5.4 ± 0.2	2.46 ± 0.1	4.26 ± 0.2	4.78 ± 0.1	6.01 ± 0.1	3.10 ± 0.2	4.66 ± 0.7	1.72 ± 0.8	2.18 ± 0.1	3.54 ± 0.1

REFERENCES

[1] APHA, 2005. Standard methods for the examination of water and waste water (21st ed.). Washington, DC: American Public Health Association.

[2] Bauder, T. A., Cardon, G. E., Waskom, R. M., & Davis, J. G., Water Quality Criteria. http://www.ext.colostate.edu/pubs/crops/00506.html. 2004.

[3] Francis-Floyd, R. 2003. Dissolved Oxygen for Fish Production. Fact Sheet FA 27. Florida: Department of Fisheries and Aquaculture, Florida

Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

[4] Joseph, P.V.,& Claramma, J. 2010. Physicochemical characteristics of Pennar River, a fresh water wetland in Kerala, India. E-Journal of Chemistry, http://www.e-journals.net. 7(4): pp1266-1273.

[5] **ICMR. 1975.** Manual of standard of quality of drinking water supplies. Indian Council of Medical Research. Spe. REF. Sci. 44**:** pp 27-28.

[6] Kar,P.K., Pani,K.R., Pattanayak,S.K., & Sahu, S.K., 2010. Seasonal variation in physico-chemical and microbiological parameters of Mahanadi river water in and around Hirakud, Orissa, India. J. The Ecoscan. 4(4): pp 263-271.

[7] Karikari, A.Y., & Ansa-Asare,O.D., 2004. Physico-Chemical and microbial water quality assessment of Densu River of Ghana. West Afr. J. appl. Ecol. 1: pp23-34.

[8] Koshy, M., & Nayar, T.V., 1999.Water quality aspects of river Pamba. Pollut. Res., 8(1): pp501-510.

[9] Maciej Walczak 2008. Changes of microbial indices of water quality in the Vistula and Brda rivers as a result of sewage treatment plant operation ., International Journal of oceanography and Hydrobiology. Vol. XXXVII, No.2 : pp65-75.

[10] McLellan, S.L., Daniels,A.D.,& Salmore, A.K., 2001. Clonal population of thermotolerant enterobacteriaceaes in recreational water and their potential interference with faecal *Escherichia coli* counts. Applied Environ. Microbiol. 6(7): pp4934-4938.

[11] Metcalf & Eddy. 2003. Wastewater Engineering Treatment and Reuse, Forth Edition., New York, USA: McGraw Hill.

[12] Patki,S.S., & Lomte ,V.S., 2002. Microbiological analysis of holy water of the river-Alaknanda from Badri-Kedar.

[13] Pesce, S. F .,& Wunderlin, D. A., 2000. Use of water quality indices to verify the impact of C´ordoba city (Argentina) on Suqu´ıa River. Water Res., 34(11): pp 2915–2926.

[14] Sharma ,S., Vishwakarma, R., Dixit, S., & Jain,P. 2011. Evaluation of water quality of Narmada River with reference to physcochemical parameters at Hoshangabad city, MP, India. Research Journal of Chemical Sciences. 1(3).

[15] Semwal, N.,&Akolkar., 2006. Water quality Assessment of sacred Himalayan river of Yttarakhand. Curr. Sci.,9(1):pp 486-496.

[16] Srivastava, C. P., 1992. Pollutants and nutrient status in raw sewage. Indian J. Envl. Prot., 18(2): pp109–111.

[17] USEPA, (United States Environmental Protection Agency) 1975. Quality Criteria for water (Ed. R.E. Train) caste houe publication Ltd. Great Britain.

[18] WHO,1997 Standards for Drinking Water Quality. World Health Organization. Geneva.

[19] Yayyantas, O. T., Yilmaz, S., Turkoglu, M., Colakoglu, F. A., Cakir, F., 2007. Seasonal variation of some heavy metal pollution with environmental and microbiological parameters in sub-basin Kocabas Stream (Biga, Canakkale, Turkey) by ICP-AES. Environ. Monit. Assess. (13)4: pp 321-331.

[20] Yadav, S.S.., & Kumar, R., 2011. Monitoring Water quality of Kosi River in Rampur District, Uttar Pradesh, India. Advances in Applied Science Research. 2 (2): pp197-201.

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