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SEASONAL DISSIMILARITIES STUDY IN RIVER PAZHAYAR AT ESTUARIES OF KALKULAM AND AGASTHEESWARAM TALUKS IN KANYAKUMARI DISTRICT, SOUTH INDIA

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Abstract: An essential amenity and universal solvent that is shared by inhabitants is water. The nourishment of all life depends on rivers which are crucial and susceptible freshwater ecosystem. It is thus a matter of concern that declining of water quality threatens the sustainability of such a freshwater ecosystem. The southernmost tip of peninsular India of Kanyakumari District has insufficient and seasonally varying physico-chemical and in situ water quality parameters over its freshwater ecosystem. Our aim of this work is to examine the seasonal dissimilarities in River Pazhayar during June 2011-June 2013 at three sampling stations namely; Colachel, Manakudi and Vattakottai estuaries and try to relate its quality to our ecosystems. The obtained results were compared with permissible standards. River Pazhayar has high salinity and BOD in summer whereas the pH value remained alkaline throughout the entire seasons. An extensive range of variation was found in DO concentration and toxic heavy & trace elements present in the water samples are within the limits except Pb and Hg. There were a noteworthy spatial and temporal variations and high value in the concentration of nutrients. So the use of unhygienic water proliferates to water borne diseases, it is consequently to verify the water value at regular interval of time.

Key words: River Pazhayar, Estuaries, Seasonal dissimilarities, Physico-chemical parameters, Toxic elements.

INTRODUCTION

Generally, water is a key parameter for all the living beings and its quality is essential for healthy and developmental process of the entire living organisms (De, 2003). Due to the rapid progress in human and industrial side, the qualities of our water necessities have led to the deterioration. Recently, the river water source is contaminated by the discharge of indiscriminate disposal of modern city sewage, agricultural and wastages from industry (Elizabeth, 2005; Soundarapandian, 2009) which leads the river water is considered as the casualty of harmful impact of urbanization of all types of living organisms on the earth. Hence, the constant monitoring of water quality parameter becomes essential in order to protect it (Soundarapandian, 2009).

Study Area

The Southernmost tip of peninsular India holds one of the most significant divine situates for Hindus is named as Kanyakumari (in British - Cape Comorin), it is the place where three oceans namely Indian ocean, Arabian sea and Bay of Bengal congregate (Dharmaraja, 2012). The district (longitude: 77°15' - 77°36' E, latitude: 8°03' - 8°35' N) is also known as "The District of Ponds" or "The Lands End". It covers an area of about 1,675 sq. km. and it is a thickly populated district of south Tamil Nadu in India. It is administratively divided into 4 taluks, 9 blocks and 88 villages (Fig. 1). The river Pazhayar is a medium size river in Kanyakumari District and it gains through both south-west and north-east monsoons. This river Pazhayar contains a num-

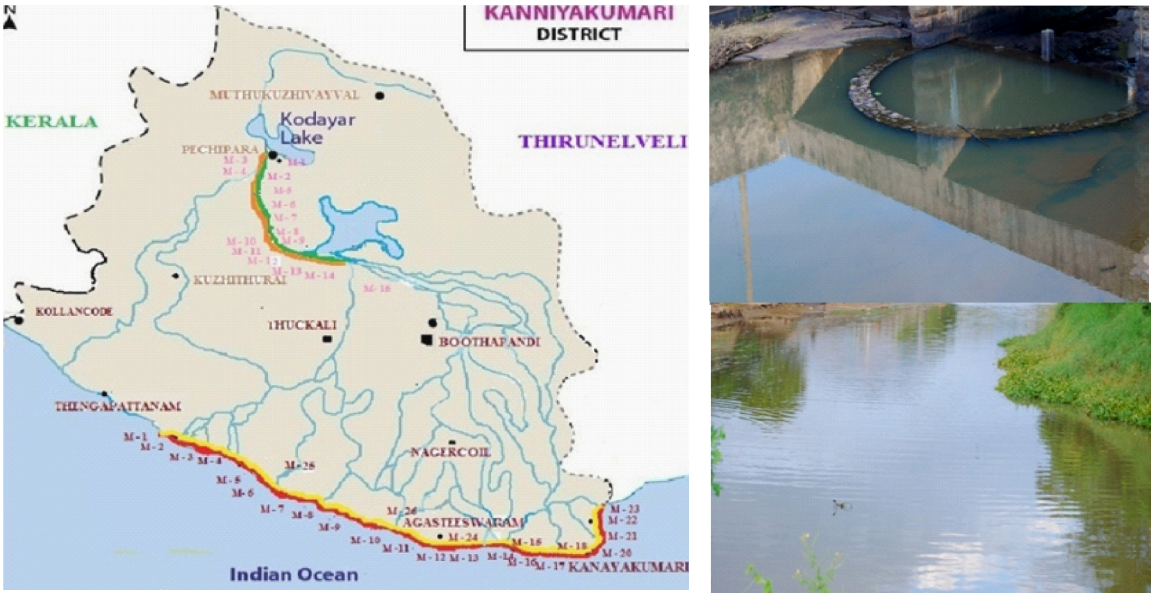

Fig. 1. Location of sampling stations at River Pazhayar in South Tamil Nadu, India

ber of principal tributaries and it feeds water from Petchiparai and Perunchani dams through channels and many ponds in this district. The river is being polluted here by much city sewage along with industrial effluents from chemical, leather and small industries.

Sampling Stations

Three sampling stations were selected namely Colachel, Manakudi and Vattakottai estuaries of Kalkulam and Agastheeswaram Taluks along with river Pazhayar.

MATERIALS AND METHODS

Water samples were collected from the river Pazhayar at 21 stations from Colachel to Vattakottai estuaries for physico-chemical analysis and handling were adopted based on the standard methods (Indian standard Methods, 1998; Standard Methods for the Examination of Water, 2005; WHO, 1993, 2004, 2011). The distance between two sampling stations was kept more than 300-500 m. After collection the samples were analyzed by both classical and

Table 1. Determination of Water quality parameters

No	Water quality parameter	Determination methods	Permissible Std	Agency
1	pH (Hydrogen Ion Concentration)	pH– metry: digital pH meter (Elico LI 127)	6.5–8.5	WHO
2	EC (Electrical Conductivity: μscm^{-1})	Conductometry: Elico CM 180 bridge,0.01 M KCl calibrant	300	BIS
3	TALK (Total Alkalinity as Ammonia $mEql^{-1}$)	Titrimetry (Nesselarization)	600	BIS
4	TH (Total Hardness as $CaCO_3$ mgl^{-1})	Complexometric titration using EDTA (Vogel 1978)	500	WHO
5	TDS (Total Dissolved Solids as $CaCO_3 mgl^{-1}$)	Evaporation	1000	WHO
6	Na^+ & K^+ (Sodium & Potassium ions mgl^{-1})	Flamephotometry	200 & 12	WHO
7	Cl^- (Chloride ions mgl^{-1})	Argentometric Titration	250	WHO
8	NO_3^- & SO_4^{2-} (Nitrate & Sulphate ions mgl^{-1})	Spectrophotometry	45 & 150	WHO & BIS
9	DO (Dissolved Oxygen mgl^{-1})	Winkler's Titration	6	WHO
10	BOD (Biological Oxygen Demand mgl^{-1})	After 5 days Incubation at 20° C– Titrimetry	5	ICMR

automated instrumental methods prescribed by the standard methods (Indian standard Methods, 1998; Standard Methods for the Examination of Water, 2005; WHO, 1993, 2004, 2011) and the mean value of analytical data parameters among 7 stations of the each Taluk were compared and tabulated.

In continuation of our recent report (Dharmaraja, 2012), the present study bears the collection of water sample at three sampling stations in river Pazhayar during June 2011-June 2013 in southern Tamil Nadu, India. We have to characterize the various physico-chemical properties of profile during the study era of three years (June 2011 - June 2013) and the reports were compared with the standard WHO values.

RESULTS AND DISCUSSION

Water samples were collected from Colachel, Manakudi and Vattakottai estuaries of Kalkulam and Agastheeswaram Taluks along with river Pazhayar of Kanyakumari district, South India from June 2010 to June 2013 in every month and the results were compared with the World Health Organization (WHO 1993, 2004, 2011). Kanyakumari district has monthly rainfall varies from 44.0 mm (minimum - February) to 220.0 mm (maximum - October) and the mean annual rainfall will be 185.54 mm for the period of our study. The monthly temperature varies with a maximum of 39 0C in the month of May & June to a minimum of 24°C in December. From the observed electrical conductivity of water sample of river Pazhayar is somewhat high due to the presence salinity which also affects the taste of the potable water.

In present work, the measured hardness values range from 85 ppm to 73 ppm in summer and 120 ppm to 95 ppm in Monsoon and 99 ppm to 80 ppm in Winter Season i.e., an moderate hardness is observed throughout our study periods. The river Pazhayar has high BOD content in summer whereas the pH value remained alkaline throughout the entire seasons. Also TS, DO, TDS, TSS, TH, Cl, Na+, K+ and TN (Total Nitrogen) value contents of Pazhayar river were found within or slightly higher than the WHO permissible limit (WHO 1993, 2004, 2011). An extensive range of variation was found in DO concentration and toxic heavy & trace elements present in the water samples are within the limits except Pb and Hg. This variation is probably due to various factors such as trace metal contents of the soil and crops, geographical location, fertilizers and fungicides applied in the area, environmental pollutions due to automobile emissions, industrial effects, weathering of rocks and other agricultural activities. Due to the seasonal variation and discharge of the untreated sewage waste from industries and human development process into the river, the water quality of the river is entirely changed which leads to severe lose in the portable water sources of Pazhayar River during June 2011-June 2013 are given in Table 2 and depicted in Fig. 2.

Table 2. Mean value and standard deviation of the physico-chemical parameters determined for three Stations of Pazhayar river during June 2011–June 2013

Parameters	Units	WHO values	Colachel				Manakudi				Vattakottai			
			Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max	Mean	Standard deviation
pH	--	6.50–8 .50	7.31	7.90	7.6	0.29	5.87	8.27	7.07	1.2	7.19	7.47	7.33	0.14
EC	mmho/cm	--	0.06	0.08	0.07	0.01	0.07	0.08	0.075	0.005	0.18	11.78	5.98	5.8
TDS	mg / L	1000	888	1119	1003.5	115.5	757.2	857.1	807.1	49.95	712.9	966.2	839.5	126.6
TSS	mg / L	--	89.9	188.2	139.05	49.15	67.1	208.7	137.9	70.8	75.91	211.7	143.8	67.8
DO	mg / L	--	2.9	5.21	4.06	1.15	3.79	4.49	4.14	0.35	3.66	4.31	3.98	0.32
BOD	mg / L	5.0	8.43	9.9	9.17	0.73	8.49	11.52	10.0	1.51	8.39	11.55	9.97	1.58
TH	mg / L	500	217.8	224.4	221.1	3.3	214.3	244.9	229.6	11.6	218.1	240.21	229.15	11.03
Cl^-	mg / L	250	162.6	227.9	195.25	32.65	178.1	281.8	242.2	15.3	187.21	202.6	194.90	7.64
Na^+	mg / L	200	144.77	161.71	153.93	8.49	211.2	240.39	225.7	14.5	152.7	175.92	164.31	11.6
K^+	mg / L	--	5.98	11.41	7.89	2.83	6.39	13.4	9.89	5.57	6.91	11.88	9.39	2.48

Total Hardness (TH)

The observed average total hardness value was 221.1 mg/L, 229.61 mg/L and 229.151 mg/L for Colachel, Manakudi and Vattakottai stations respectively. Higher values of hardness in Manakudy can be attributed to low water level and high rate of evaporation of water and addition of calcium and magnesium salts. Also it is due to addition of sewage, detergents and large scale human use might be the cause of elevation of hardness (Mahanta *et al.,* 1996).

DO

The average dissolved oxygen was 4.06 mg/L, 4.14 mg/L, 3.98 mg/L for Colachel, Manakudi and Vattakottai stations respectively. The maximum dissolved oxygen in 5.21 mg/L was recorded in Colachel in post monsoon and 2.9 mg/L was recorded in summer. This can be ascribed to addition of effluents including oxidizable organic matter leads to consequent biodegradation and decay of vegetation at higher temperature leading to consumption of oxygen from water. Concentration below 5 mg/L may adversely affect the functioning and survival of biological communities and below 2 mg/L may lead to fish mortality. Water without adequate DO maybe considered waste water. Presence of DO in water may be due to direct diffusion from air and photosynthetic activity of autotrophs. The DO values obtained in the present study are slightly increased compared to WHO standards.

BOD

It is the measurement of the amount of biologically oxidizable organic matter present in the waste. The increased levels of BOD indicated the nature of chemical pollution. The average BOD was 9.17 mg/L, 10.0 mg/L and 11.55 mg/L for Colachel, Manakudi and Vattakottai station respectively. The increased level 11.55 mg/L was found for Vattakottai station. The BOD values obtained in the present study are not within the WHO standards.

pH

pH is one of the most important factors that server as an index for the pollution. The average pH values of the water were 7.90, 8.27 and 7.47 for Colachel, Manakudi and Vattakottai station respectively. The average value for three seasons are taken into account the water body was found to be slightly alkaline (Swarnalatha *et al.,* 1993).

Chloride

It occurs in all types of natural waters. The high concentration of chloride is considered to be a sign of pollution due to high organic waste of animal origin [10a]. Chloride value obtained in the study was 195.25 mg/L, 281.8 mg/L, and 194.90mg/L for Colachel, Manakudi and Vattakottai station respectively.

Total Dissolved Solids (TDS)

The total dissolved solids in water was found to be 1003.5 mg/L, 807.1 mg/L, 839.5 mg/L for Colachel, Manakudi and Vattakottai station respectively. The concentration is at Colachel station, which may be due to addition of solids from runoff water, sewage and some effluents.

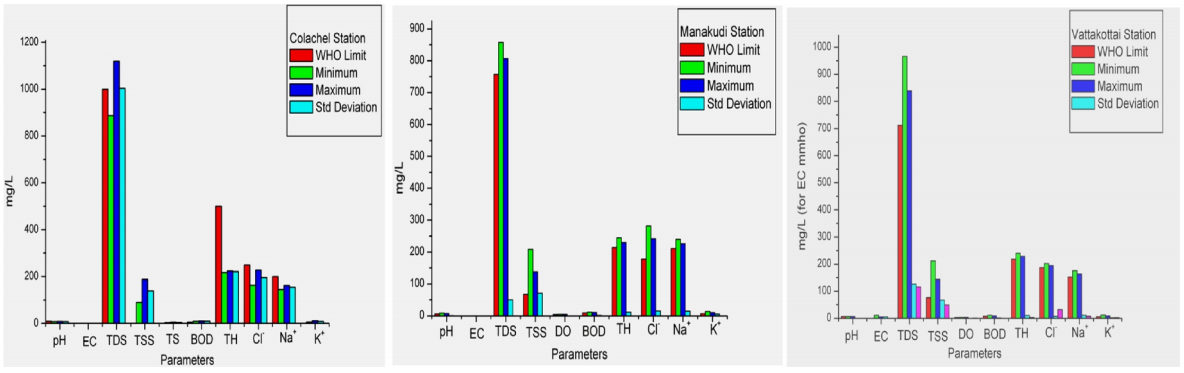

Fig. 2. Physico–chemical parameters determined for Colachel, Manakudi and Vattakottai Stations of Pazhayar River during June 2011–June 2013

Sodium and Potassium

Regarding Na and K minimum was recorded during the monsoon and maximum during the summer season. Regarding station wise variation, Manakudi station having maximum val ues 240.39 mg/L due to the mixing of sea water when the sand bar opens during northeast monsoon season (October to January).

Nitrogen Content

Nitrate is an essential nutrient but at high concentration is toxic and is capable of disturbing the aquatic environment. Nitrate level less than 0.57 mg/L will not pollute the water. A nitrate value varies from 2 to 6 mg/L. The higher nitrate value recorded during monsoon season may be due to heavy rainfall, land runoff contaminated with fertilizers from the surrounding coconut gardens and paddy fields (Ayoola *et al.,* 2009)

Trace elements

The objectives of the present investigation are to find out the status of the trace elements in Pazhayar river water. For this purposes the following trace elements i.e. Ni, Cd, Al, Pb, As and Hg are classified as highly toxic and moderately toxic or less toxic in nature. The results of the analysis of trace elements in the study area are given in Table 3.

Mercury (Hg)

Mercury (II) has a physically powerful affinity for sulfhydryl groups in proteins, enzymes, hemoglobin and serum albumin. Since the abundance of slufhydryl groups in active sites of many enzymes, it is hard to set up exactly which enzymes are exaggerated by mercury in biological systems. The effects of mercury nearly disturb brain metabolic processes. The kidney is the primary target organ of mercury (II). Chronic exposure to inorganic mercury (II) compounds causes proteinuria. In case of mercury poisoning of any type, the kidney is the organ with the highest bioaccumulation of mercury. Excretion of inorganic mercury occurs through the urine and faces. The results in Table 3 point out that all the samples do not contain mercury. The present study has revealed that the concentration of Hg has varied from 0.021- 0.027 mg/L in water samples. The observed values are very low when compared with the guideline values.

Lead (Pb)

Lead is a minor element in the earth's crust but is widely distributed in low concentration in uncontaminated sedimentary rocks and soil. The World Health Organization has established 0.1 mg/L as a tentative limit for lead in water. However more significant contributions of lead come from atmosphere. Lead is toxic to aquatic organism but the degree of toxicity varies greatly, depending upon the characteristics of water as well as species being considered. Survey reveals that the inhabitants of the area are suffering from hardness, lassitude, slight abdominal discomforts, irritability and anemia, which are the symptoms of acute poisoning of the presence of high concentration of lead in water. The present study has revealed that the concentration of lead has varied from 0.11 to 0.95 mg/L in water samples. The observed values are very low when compared with the guideline values (Table 3).

Table 3. Toxic metals present in Pazhayar River during June 2011–June 2013.

Stations	Metals	Concentration in mg / L			
		WHO	Summer	Monsoon	Post monsoon
Colachel (Kalkulam Tk)	Ni	0.01	0.009	0.007	0.009
	Hg	0.02	0.025	0.021	0.027
	Cd	0.2	0.199	0.210	0.224
	Al	0.2	0.152	0.163	0.175
	Pb	0.05	0.082	0.094	0.095
Manakudi (Agastheeswaram Tk)	Ni	–	0.006	0.007	0.011
	Hg	–	0.021	0.022	0.037
	Cd	–	0.187	0.189	0.196
	Al	–	0.149	0.154	0.167
	Pb	–	0.079	0.084	0.097
Vattakottai (Agastheeswaram Tk)	Ni	–	0.009	0.007	0.009
	Hg	–	0.025	0.027	0.031
	Cd	–	0.199	0.12	0.134
	Al	–	0.152	0.16	0.175

CONCLUSIONS

The result revealed that there was significant seasonal variation in some physicochemical parameters and most of the parameters obtained were not within the WHO standards. It has been found that the water is unsuitable for drinking purpose in all seasons. Concentrations of nutrients in the estuaries show spatial variation. It is regulated by the fresh water flow and tidal mixing.

RECOMMENDATIONS

The groundwater resources at Kanyakumari district is currently abundance. Therefore there is a need for a regular monitoring & storage of river and rain water free from any pollutants. In addition, if proper measures are taken for the treatment of sewage before discharge and restrictions are enforced on various anthropogenic activities the health of the estuary can be maintained.

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