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Research Article

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Hydro-chemistry, water quality status and bacteriological analysis of Pazhayar river in Kanyakumari District, India

Elangovan Anantha Krishnan[1], Karuppiya Ganesan[2*], Sutha Shobana[3], Sundaram Arvindnarayan[1] and Jeyaprakash Dharmaraja[4]

[1]*Department of Civil Engineering, K. N. S. K. College of Engineering, Therekalputhoor, Nagercoil, Kanyakumari District, Tamil Nadu, India*
[2]*Department of Civil Engineering, Sudharsan Engineering College, Sathyamangalam, Kulathur, Pudhukottai*
[3]*Faculty of Science and Humanities, Rajas International Institute of Technology for Women, Ozhuginasery, Kanyakumari District, Tamil Nadu, India*
[4]*Faculty of Science and Humanities, Sree Sowdambika College of Engineering, Chettikurichi, Aruppukottai, Tamil Nadu, India*

ABSTRACT

Seasonal dissimilarity study of hydro–chemical analysis in Pazhayar River, Tamilnadu was carried out in June–July(dry) till October–November(wet) 2014.The river water quality was studied at three selected stations namely Boothapandi (S1), Thuckalai (S2) and Kuzhithurai (S3) to signify unlike localities with changeable anthropogenic discharge. The in–situ water quality and hydro–chemical parameters of the samples were measured for pH, temperature, electrical conductivity (EC), total alkalinity (TALK), total dissolved solids (TDS), dissolved oxygen (DO), salinity, Ammoniacal nitrogen (NH_3–N), biochemical and chemical oxygen demand (BOD & COD), suspended solids (SS), nitrate and phosphate following standard methods and then compared with WHO standards. Bacteriological analyses were also carried out for the same period of time. Introduction of sewage into the river plays a noteworthy responsibility for bacterial contamination. The results indicate that some sort of integrated river water management and good agriculture practice scheme should be implemented.

Key words: Pazhayar river, Hydro–Chemical parameters, BOD, COD and Bacteriological.

INTRODUCTION

The total length of the Pazhayar river is about 37 Km and it passes through Boothapandi, Thazakudi, Putheri, Ozhuginaseri and Suchindrum finally joins with the Arabian Sea. The early kings constructed 11 check dams along the course of the river. Pazhayar river is flowing through Kanyakumari District of Tamilnadu which is in the Southernmost tip of Peninsular India; it is the place where three oceans namely Indian, Arabian and Bay of Bengal congregate and is the head quarters of the Kanyakumari District in Tamilnadu, also referred to as the feet of Bharat Mata. The river Pazhayar is of medium size and mentioned in Sangam classics as it's an extent of Pahruli in Kanyakumari District and it gains through both south–west and north–east monsoons. It begins at the Southern slopes of the Mahendragiri hills which are a part of southern tip of the Western Ghats [1]. At Chrulakode (Shorlacode or Surulacode) is a place about 18 Km north–west of Nagercoil, here a number of tiny streams or odai (like Nachukal & Eassakkuthottam) confluences and form the origin of the river Pazhayar southwardly via. Thovalai, Ananthanar and Nanchinad Puthanar Channel. The tail end of this river empties into the Arabian Sea at Keezha Manakudy Estuary, 12 Km south of Nagercoil. This river Pazhayar contains a number of Principal tributaries like Tharuvayar, Ulakkaruviar, Alathuraiar, Koyu odai, Poigaiar, etc. This river feeds water from Petchiparai and Perunchani dams through channels and many ponds in Kanyakumari District [2,3].

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

The aim of this present study is to assess present status of Pazhayar river water quality in different localities of anthropogenic impacts as well as to determine seasonal variation such as atmospheric precipitations influences on aquatic ecosystems [4]. Scientific results, oceanic substances interrelate with the ecosystems which acquire challenges [5,6]. Introduction of sewage into the river plays a noteworthy responsibility for bacterial contamination. The location on map sampling site in Kanyakumari District as presented in Fig. 1.

EXPERIMENTAL SECTION

Sampling Activity

Water samples were collected from three selected stations namely Boothapandi (S1), Thuckalai (S2) and Kuzhithurai (S3), located along the Pazhayar river June–July (dry) till October–November (wet) 2014. River water samples were collected about 10cm below the water surface using 1litre HDPE and glass bottles. The temperatures of the samples were measured in the field itself at the time of sample collection as per the standard method [7]. Samples were stored in a cool box filled with ice packs at temperature approximately of 4ºC before transferring for further laboratory analysis. Standard methods that were used in this chemical study are Ammoniacal Nitrogen (Salicylate Method), Biochemical Oxygen Demand (Incubation Method as BOD5), Chemical Oxygen Demand (Reactor Digestion and Colorimetric Determination), Suspended Solids (Gravimetric Method), Nitrate (Cadmium Reduction Method) and Phosphate (Ascorbic Acid Method). Ammoniacal–N, Chemical Oxygen Demand, Nitrate and Phosphate were determined by using a spectrophotometer: Electronic absorption spectra were recorded with a Hitachi U-2000 double beam spectrophotometer in the 200–1100 nm range at a specified wavelength [8] and the mean value of analytical data parameters among the three stations were compared and tabulated.

RESULTS AND DISCUSSION

In-situ Measurement

In this study, mean value of pH for Boothapandi station were 7.3(dry) and 8.2(wet) was obtained within the standard limit of World Health Organization [9]. Higher values of the pH at this station were as a consequence of acid–forming substances such as sulphate, phosphate, nitrates discharge into the river basin. These substances are as abundance in fertilizer usage, might have altered the acid–base equilibria: resulted in the reduced acid–neutralizing capacity and hence raising the value of pH.

The physical characteristics of Pazhayar river water during the period of study were presented in Table 1. Mean value of temperature for Boothapandi station were 32.21 (dry) and 25.35(wet) °C season respectively. Lowest value of temperature was recorded; this condition was highly expected since this station was in the vicinity of forest, none agriculture and low human anthropogenic activity during time of sampling. In addition, present status of temperature in Pazhayar river were not much differ with atmospheric condition since Kanyakumari District was considered having cool climate, with temperatures no higher than 35°C during day time. Mean value of conductivity of Pazhayar River in Putheri station was obtained significantly increased during the time of sampling for wet season. Highest conductivity recorded at this station caused by domestic effluent discharges and surface run–off directly into river basin thus might have increased the concentration of ions. Higher values of rainy season also possibly came off from precipitation of ionic species that brings numerous dissolved conducting minerals into river water. This problem was force support by an increasing of dissolved solids concentration during the period of study. In Boothapandi station, this condition was normally occurring since high precipitation will bring more stream flow higher than average water flow. The threshold range for Pazhayar river is 3–5 mgL^{-1}. Highest concentration of dissolved solids was obtained at Putheri station for both seasonal periods is due to poor vegetation, highly active cultivation activity and precipitation that contribute much more soil loss runoff or leachate, consequently brings pollutant from the farms with dissolved conducting minerals at this station.

Laboratory Analysis

Hydro–chemical parameters that were analyzed in this study consist of suspended solid, biochemical and chemical oxygen demand, Ammoniacal nitrogen, nitrate and phosphate. Result of the analysis was also standardized with Environment Water Quality Index Classification (WQI) as presented in Table 1. Mean concentration of biochemical Oxygen Demand (BOD) in Pazhayar River was obtained slightly high during dry rather than in wet season. This phenomenon was considered normal in most fresh water system since dilution effect was occurring into water catchment. Highest concentration of this parameter was recorded at Putheri station for both dry and wet season which may be due chemical usage in fertilizer effluents. Nevertheless, the mean values of BOD for both seasons found still far below than WHO limit (10 mgL^{-1}) (Fig. 2).

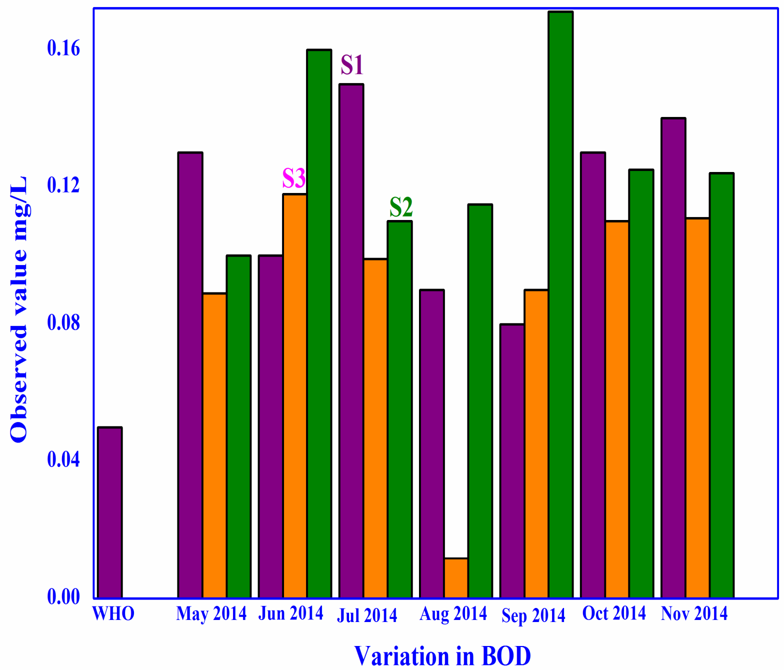

Fig. 2: Variation of BOD in three Stations during the study period

In the meantime, lowest concentration of Ammoniacal nitrogen (NH_3–N) was recorded at station Putheri in both seasonal periods as expected clean than others since this placed as non agriculture site. Mean concentration of nitrate (NO_3) in this river was obtained slightly high during dry rather than in wet season. These pointed out that continuously applied the common N–P–K fertilizer or chicken dung into agriculture scheme practice during early stage of cultivations will show the way much more potential of being nitrate leached or surface runoff into the river. Mean concentration of phosphate ((PO_4) in Pazhayar river was somewhat increased throughout wet rather than in dry season. Poor vegetation at Putheri station make it could not react as a P trap along agricultural area such as ploughing activities was taken place during time of sampling for dry season to the touching station (Thuckalai: S2). Consequently, it will make probable soil loss as runoff was continuously high. Further many manmade sources of which include domestic and industrial discharges or even changes in land use in areas where phosphorus is naturally plentiful in the soil would lead much more possible sources of pollutant.

Table 1: Hydro–chemical parameters with Water Quality Index (WQI) in Three Stations during the period October 2014– November 2014(wet)

Stations	Hydro–chemical parameters	Permissible Std (Sn)	Observed Value (Vn)	Unit Weight (Wn)	Quality rating (Qn)	WQI= ∑Wn. log Qn	Antilog (WQI)
S1	**pH (Hydrogen Ion Concentration)**	6.5–8.5	8.2	0.1333	240	0.3172	11.217/10 hydro–chemical parameters
	EC (Electrical Conductivity: µscm^{-1})	300	344	0.0033	114.6	0.0067	
	TALK (Total Alkalinity as $CaCO_3$ mgL^{-1})	600	72	0.00166	12	0.0017	
	TDS (Total Dissolved Solids as $CaCO_3$ mgL^{-1})	1000	231	0.001	23.1	0.00136	
	Ca^{2+} (Calcium ion mgL^{-1})	200	31	0.005	15.5	0.00595	
	Na^{+} (Sodium ion mgL^{-1})	200	37	0.005	18.5	0.00633	
	Cl^{-} (Chloride ions mgL^{-1})	250	61	0.004	24.4	0.00554	
	NO_3^{-}(Nitrate ions mgL^{-1})	29	1.9	0.0345	6.55	0.0281	
	DO (Dissolved Oxygen mgL^{-1})	6	2.5	0.1667	41.66	0.270	
	BOD (Biological Oxygen Demand $mgL^{-}1$)	5	5.8	0.2	116	0.412	
	WQI= 104.9 – Hence, >100: Unsuitable for beneficial usage						
S2	**pH (Hydrogen Ion Concentration)**	6.5–8.5	8.0	0.1333	200	0.306	
	EC (Electrical Conductivity: µscm^{-1})	300	341	0.0033	113.6	0.00678	
	TALK (Total Alkalinity as $CaCO_3$ mgL^{-1})	600	72	0.00166	12	0.00179	
	TDS (Total Dissolved Solids as $CaCO_3$ mgL^{-1})	1000	230	0.001	23	0.00136	
	Ca^{2+} (Calcium ion mgL^{-1})	200	32	0.005	16	0.00602	10.969/10 hydro –chemical parameters
	Na^{+} (Sodium ion mgL^{-1})	200	36	0.005	18	0.00627	
	Cl^{-} (Chloride ions mgL^{-1})	250	62	0.004	24.8	0.00557	
	NO_3^{-}(Nitrate ions mgL^{-1})	29	1.8	0.0345	6.21	0.0273	
	DO (Dissolved Oxygen mgL^{-1})	6	2.41	0.1667	40.16	0.267	
	BOD (Biological Oxygen Demand $mgL^{-}1$)	5	5.9	0.2	116	0.412	
	WQI= 104.02 – Hence, >100: Unsuitable for beneficial usage						
S3	**pH (Hydrogen Ion Concentration)**	6.5–8.5	7.8	0.1333	160	0.2938	10.62/10 hydro –chemical parameters
	EC (Electrical Conductivity: µscm^{-1})	300	349	0.0033	109.6	0.00673	
	TALK (Total Alkalinity as $CaCO_3$ mgL^{-1})	600	76	0.00166	12.66	0.0018	
	TDS (Total Dissolved Solids as $CaCO_3$ mgL^{-1})	1000	239	0.001	23.4	0.00136	
	Ca^{2+} (Calcium ion mgL^{-1})	200	38	0.005	19	0.00639	
	Na^{+} (Sodium ion mgL^{-1})	200	32	0.005	16	0.00602	
	Cl^{-} (Chloride ions mgL^{-1})	250	64	0.004	25.6	0.00563	
	NO_3^{-}(Nitrate ions mgL^{-1})	29	2.2	0.0345	7.58	0.03034	
	DO (Dissolved Oxygen mgL^{-1})	6	2.41	0.1667	40.16	0.2673	
	BOD (Biological Oxygen Demand mgL^{-1})	5	5.43	0.2	108.6	0.4071	
	WQI= 102.647 – Hence, >100: Unsuitable for beneficial usage						

Water Quality Index

Water Quality Index (WQI) of Pazhayar river throughout the seasonal periods of this study were determined based on six parameters as given by the following expression: WQI=0.22*S_I DO + 0.19*S_I BOD + 0.16*S_I COD + 0.15*S_I AN + 0.16*S_I SS + 0.12*S_I pH (whereby: S_I = Sub–index of each parameter; DO = Dissolved Oxygen; BOD = Biological Oxygen Demand; Chemical Oxygen Demand; AN = Ammoniacal Nitrogen; Suspended Solids; pH = Hydrogen ion concentration). WQI was then classified the water quality into five classes namely class I (WQI=0 to 25; excellent), class II (WQI 26 to 50; good), class III (WQI 51to 75; poor water quality), class IV (WQI 76 to 100; very poor water quality) and class V (WQI >100) based on beneficial use of the water [10,11].

The calculated values of WQI for all sampling stations in wet seasons are shown as in Table 1. In this study, WQI was 104.9 (wet season), 104.02 (wet season) and 102.65(wet season) for Boothapandi (S1), Thuckalai (S2) and Kuzhithurai (S3) stations respectively. Variation in the observed ions (Ca^{2+}, Na^+ and Cl^-) and Total Alkalinity (TALK) is given in Fig. 3.

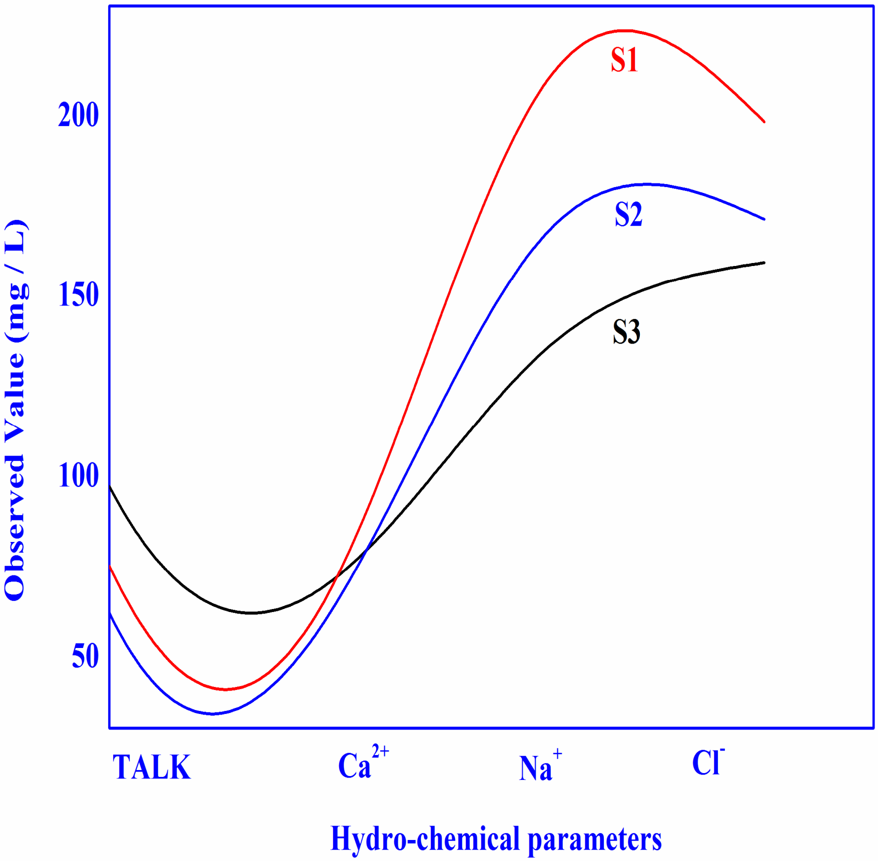

Fig. 3: Variation of Total Alkalinity, Ca^{2+}, Na^+ and Cl^- in three Stations during the period October 2014– November 2014(wet)

Table 2: Microbiological Analysis River Water Samples in three Stations

No	Sampling Stations	THC	TCC	SSC	VCC
1	WHO Standard	$1x10^2$	Zero per 100ml	Zero	Zero
2	EPA Standard	$1x10^2$	Zero	Zero	Zero
3.	Boothapandi Station(S1)	$1x10^6$	>1800	$2.7x10^4$	$4.2 x10^4$
4	Thuckalai Station (S2)	$2.02x10^6$	>1800	$2.3 x10^4$	$2.9 x10^4$
5	Kuzhithurai Station (S3)	$1.08x10^6$	>1800	$2.07x10^4$	$3.5 x10^4$

THC= Total Heterotrophic Count, TCC = Total Coliform Count, SSC = Salmonella–Shigella Count, VCC= Vibrio cholerae Count WHO= World Health Organization, EPA = U.S.

Bacteriological analysis

The high number of *Salmonella, Shigella sp and Vibrio cholerae* in river samples is not in agreement with EPA water standard [12] which states that these pathogenic organisms might not be present in water (Fig. 4), because they are of public health significance, having been associated with gastrointestinal infections: diarrhea, dysentery, typhoid, and other form of infection [12]. The non–detection of pathogen in the water samples may be a reflection on the depth of the river along with a number of other fundamental risk factors. The Most probable number (MPN) for presumptive total coliform count (TCC) of the water samples ranged from 1600 to >1800 MPN per 100 mL. Water samples from all stations have total coliform count greater than 1800 MPN per 100 mL (Table. 2**).**

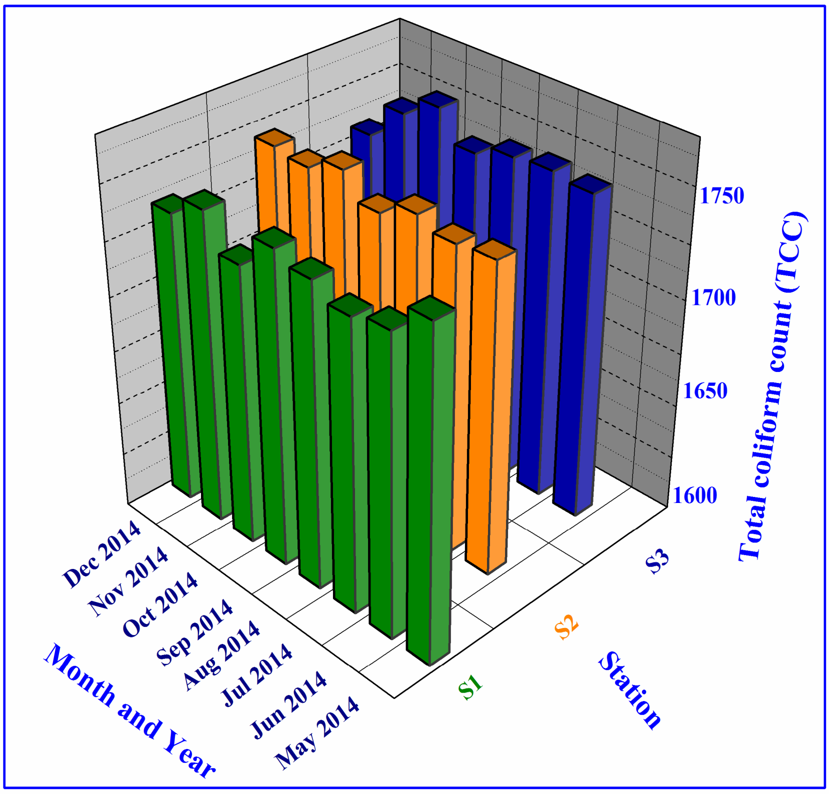

Fig. 4: Total coliform count (TCC) of the water samples in three Stations during the study period

Table 3: Microbial Species Identified from Water Samples in three Stations

No	Microbial Species	Boothapandi(S1)	Thuckalai (S2)	Kuzhithurai (S3)
1	*Pseudomonas sp.*	+	+	+
2	*Escherichia coli*	+	+	+
3	*Enterobacter aerogenes*	+	+	+
4	*Staphylococcus aureus*	+	+	+
5	*Salmonella typhosa*	+	+	+
6	*Shigella sp.*	+	+	+
7	*Vibrio cholerae*	–	–	+
8	*Proteus sp.*	+	+	+
9	*Klebsiella sp.*	–	–	+

\+ = *Pridictable*
– = *Non–predictable*

Results of the bacteriological analysis of the water samples are presented in Table. 2. The bacterial species isolated from all water samples such as *Staphylococcus aureus, Pseudomonas aeuruginosa, and Proteus sp.*. *Proteus sp.* is also of public health significance. *Staphylococcus aureus is* known to produce enterotoxin [13]. *Proteus sp.* belongs to the intestinal flora but is also widely dispersed in soil and water [14] *Enterobacter aerogenes* isolated from the water samples are examples of non fecal coliforms and can be found in vegetation and soil which gives out as sources by which the pathogens enters the water [14]. The British Standard Institute (The British Standard Institute: BSI, 1993) specified that counts greater than 104 are considered unsatisfactory for *Enterobacter sp.*. The bacteria isolated from water samples in this work incorporated *Escherichia coli, Enterobacter aerogenes, Pseudomonas spp., Staphylococcus aureus, Shigella sp., Proteus sp.,* (Table. 3). *V. cholerae, Klebsiella sp.* Were not isolated from Boothapandi and Putheri stations.

Recommendations

It can be concluded that, water quality of present Pazhayar river has degraded along seasonal change. This may have resulted from agricultural and domestic wastes either disposed directly or indirectly into the river. An effective management of possible soil erosion from land use change of urban development, agriculture activities and domestic waste in the vicinity of the Pazhayar river should be planned and enforced. Moreover, good agriculture scheme practices like rain shelter cultivation, limitation of fertilizer and pesticide should be considered in this area. Therefore, main purposes of freshwater ecosystem such as bathing, irrigation and other domestic essential can be continuously contributed by Pazhayar River.

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