Section A-Research paper

SEASONAL VARIATION IN PHYSICO-CHEMICAL CHARACTERIZATION OF SURFACE WATER IN PAZHAYAR RIVER, KANNIYAKUMARI DISTRICT, TAMIL NADU, INDIA

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ABSTRACT

River systems are the primary means for disposal of waste, including effluents and pesticides from industries and agriculture. The most common critical problem in developing countries is improper waste management caused by various human activities. Water quality characteristics of aquatic environments arise from a multitude of physical, chemical, and biological interactions. The geochemical characteristics of water bodies like rivers, lakes, and estuaries are continuously subjected to a dynamic state of change. In the present study, seasonal variations in physic-chemical analysis of water sample in the river water at various sites like Puthery, Ozhuginasery, Kothaigramam, Suchindram, Kakkamur south, Thamaraikulam north, Near the salt pan 2, Near the mangrove forest, Near the salt pan 1 and Sea mouth. The quality of Pazhayar river water is assessed through the assessment of parameters likepH, temperature, EC, TDS, TH, DO, BOD, COD, TA, SO4, NO3, PO4, Ca, Mg, Na, K and Cl. It was found that all the parameters were exceeding or below the permissible limit of standards (WHO and ICMR), so that the water in the study area is not suitable for drinking purposes. The pH and temperature were within the limit. The present study suggests the distinct nature of different bodies of river water; these distinct natures, however, depend on geographical location and seasonal variations. Seasonal variations were observed in the river, which was due to catchment characteristics and point or nonpoint sources of pollution.

Keywords: Pazhayar River, Physico-Chemical characterization, River water analysis, River pollutions.

INTRODUCTION

Water is the most natural chemical element resources and is crucial for the survival of all biotic organisms, the fact of water pollution, main environmental problems in south region of Tamil Nadu, India. India is one of the wettest nations. However, few states including Tamil Nadu (Natarajan *et al.,* 2017). Tamil Nadu, one of the peninsular states of India, comprises only 2.50 percent of the water resources of the country. Agriculture is the principal source of livelihood for more than 40 % of the population of the state, more than 95 %of the surface water and 80 % of the ground water (Chinnadurai, 2018; EAT, 2014; ENVIS, 2018). There are multiple causes for the water contamination in the Pazhayar River surface, which has been identified as one of the polluted rivers in Kanniyakumari District, Tamil Nadu. River surface water contributes a considerable amount of agricultural production to the biotic food system and mainly supplied to agricultural fields by irrigation.

People on globe are under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of water (Patil *et al.,* 2012). Industry generation of the industrial effluents, and if untreated in water, sediment and soil pollution. The rivers in the urban areas of the countries are the ends of effluents discharged from the most of the industries (Patil *et al.*, 2012). It is very essential and important to test the physico-chemical characterization of the water before it is used for drinking, domestic, agricultural or industrial purpose. In the aim of present study, assess the seasonal variation in physico-chemical characterization of surface water in the Pazhayar River, Kanniyakumari district, Tamil Nadu, India, from 2016 was examined.

MATERIALS AND METHODS

Location of sample Collection

The Pazhayar river surface water sample was collected from Kanniyakumari district, Tamil Nadu, India, in the year of 2016. Samples were collected from Pazhayar river during the period of pre-monsoon, monsoon and post-monsoon. It was done at about 0.5m depth from the water surface, in pre-cleaned 2L plastic containers, after rinsing sufficiently in the same water. The samples were collected from ten different station points in each season. The water pH and temperature were analyzed immediately on the station points. All the sample bottles were stored in ice boxes till brought to the laboratory for analysis.

Table 1: Location of water sample in Pazhayar river, Kanniyakumari district, Tamil Nadu, India.

S. No.	Station ID	Water sample collected place
1	**S1**	Puthery
2	**S2**	Ozhuginasery
3	**S3**	Kothaigramam
4	**S4**	Suchindram
5	**S5**	Kakkamur south
6	**S6**	Thamaraikulam north
7	**S7**	Near the salt pan 2
8	**S8**	Near the mangrove forest
9	**S9**	Near the salt pan 1
10	**S10**	Sea mouth

Physiochemical parameter

The methods used for the analysis of various physic-chemical parameters were the same as given in Standard Methods for the Examination of water (APHA, 1967, 1980; APHA-AWWA-WPCF, 1976); Golterman *et al.*,(1978) and National Environmental Engineering Research Institute (NEERI, 1986).

RESULTS AND DISCUSSION

The rivers are the important sources of surface water and India is a blessed country and rightly referred to as Land of Rivers. The rivers of Pazhayar are a major source of anthropogenic activity such as human consumption, irrigation, and so on. The Pazhayar river flows from the slopes of the Mahendragiri hills. The catchment area of the river is 397 Sq.Km and the total length of the river is 40 kilometres. The Tambraparni and Valliyar river basins lie on the northern side of the Pazhayar River. There is one inter-basin canal connecting Tambraparni and Pazhayar basins to feed water for irrigation, etc. in Pazhayar basin, which is experiencing water scarcity (https://indiawris.gov.in/wiki/doku.php?id=pazhayar). The physicochemical parameters of individual surface water samples for pre-monsoon, monsoon, and post-monsoon during the period of 2016 and given in tables 2 to 4.

pH

pH is considered an important chemical parameter that determines the suitability ofwater for various purposes. pH of water is important for biotic communities because mostof the aquatic organism is adapted to pH level of around 0–14. The optimal pH range forsustainable aquatic life is pH 6.5–8.2. pH of an aquatic system is an important indicator ofthe water quality and the extent of pollution in the watershed areas (Kumar *et al*. 2011; Singh 2014). Pazhayar river surface water pH ranged from 7.1 (S5) to 8.2 (S1 and S6) in pre-

monsoon, 6.3 (S1) to 7.3 (S9 and S10) in monsoon and 7.4 (S6 and S7) to 8.3 (S9) in post-monsoon. Among the various season and station, the higher pH value was observed in station 9 of post-monsoon while lowest was observed in station 1 and 6 of pre-monsoon. The increasing pH appears to be associated within creasing use of wastewater in industrial areas but the pH of river water is within the standard limit.

Temperature

The most common physical assessment of water quality is the measurement of temperature. Temperature impacts both the chemical and biological characteristics of surface water. Temperature is known to influence the pH, alkalinity and DO concentration in thewater (Kumar et al. 2010). Pazhayar river surface water temperature (℃**)** ranged from 29.3 (S1 and S9) to 30.6 (S3) in pre-monsoon, 28.5 (S1 and S3) to 30.3 (S5) in monsoon and 25 (S9) to 29.3 (S7 and S10) in post-monsoon. Among the various season and station, the higher temperature value was observed in station 3 of pre-monsoon while lowest was observed in station 9 of post-monsoon. Yadav and Srivastava (2011) reported watertemperature of River Ganga at Gazipur that ranged from a minimum of 17 ± 0.55 °C atsite 1 in January 2006 to a maximum of 33.90 ± 0.58 °C in the month of June 2006.

Electrical conductivity (EC)

The most influential water quality guideline on crop productivity is the water salinity hazardas measured by electrical conductivity (EC) (Ahmed et al., 2002). The primary effect of high EC water on crop productivity is the inability of the plant to compete with ions in the soil solution for water (physiological drought). The higher the EC, the less water is available to plants, even though the soil may appear wet. Because plants can only transpire "pure" water, usable plant water in the soil solution decreases dramatically as EC increases. Water with EC less than 98.6 μS/cm is considered good and that with greater than 581 μS/cm is unsuitable for irrigation. Pazhayar river surface water EC (micro mho cm^{-1}) ranged from 3500 (S5) to 7960 (S10) in pre-monsoon, 1331 (S3) to 4000 (S6) in monsoon and 620 (S5) to 3980 (S9) in post-monsoon. Among the various season and station, the higher EC value was observed in station 10 of pre-monsoon while lowest was observed in station 5 of post-monsoon.

Total dissolved salts (TDS)

Total dissolved solids levels less than 500 mg/L are considered to be good. Total dissolved solids indicate the amount of chemical substances dissolved in the water. At increasing levels, palatability decreases. Levels in excess of 1000mg/L may produce abad taste. Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved salts. Salts are present in irrigation water in relatively small but significant amounts. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals. These salts are carried with the water to wherever it is used. In the case of irrigation, the salts are applied with the water and remain behind in the soil as water evaporates or is used by the crop. A salinity problem exists if salt accumulates in the crop root zone to a concentration that causes a loss in yield. Yield reductions occur when the salts accumulate in the root zone to such an extent that the crop is no longer able to extract sufficient water from the salty soil solution, resulting in a water stress for a significant period of time. If water uptake is appreciably reduced, the plant slows its rate of growth. Water with TDS less than 450ppm is considered good and that with greater than 2000ppm is unsuitable for irrigation purpose. The present study showed that the Pazhayar river surface water TDS (ppm) ranged from 1830 (S1) to 4940 (S10) in pre-monsoon, 781 (S3) to 2710 (S8) in monsoon and 520 (S5) to 1980 (S4) in post-monsoon. Among the various season and station, the higher TDS value was observed in station 10 of pre-monsoon while lowest was observed in station 5 of post-monsoon. The total solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt and other particles. The effect of presence of total solids is the turbidity due to silt and organic matter.

Total hardness

The Pazhayar river surface water total hardness (TH) (ppm) ranged from 987 (S2) to 1521 (S4) in pre-monsoon, 444 (S4) to 869 (S8) in monsoon and 655 (S5) to 777 (S2) in post-monsoon. Among the various season and station, the higher TH value was observed in station 4 of pre-monsoon while lowest was observed in station 4 of monsoon. The maximum limit of total hardness for drinking water is 300ppm (WHO, 1984). This may be due to the addition of calcium and magnesium salts from detergents and soaps.

Dissolved oxygen

Dissolved oxygen (DO) has significant importance to the respiration activities of the aquatic organisms and effluents, and very low DO may have a negative impact on the

sustainability of the rivers in the basin. Pazhayar river surface water DO (ppm) ranged from 1.2 (S9) to 4 (S8) in pre-monsoon, 0.7 (S10) to 6.3 (S5) in monsoon and 3.4 (S1) to 5.2 (S8) in post-monsoon. Among the various season and station, the higher DO value was observed in station 5 of monsoon while lowest was observed in station 10 of monsoon.

Biological Oxygen Demand

Biochemical Oxygen Demand (BOD) depends on temperature, extent of biochemical activities, concentration of organic matter and such other related factors. Pazhayar river surface water BOD (ppm) ranged from 23 (S4) to 40.1 (S7) in pre-monsoon, 12.6 (S6) to 36.1 (S10) in monsoon and 13.8 (S8) to 19.4 (S1) in post-monsoon. Among the various season and station, the higher BOD value was observed in station 7 of pre-monsoon while lowest was observed in station 6 of monsoon. This is in accordance with the study by Onojake *et al*., (2015) in Calabar river.

Chemical Oxygen Demand

Pazhayar river surface water COD (ppm) ranged from 34 (S9 and S10) to 66 (S7) in pre-monsoon, 17.8 (S6) to 56 (S10) in monsoon and 21.4 (S10) to 32 (S1) in post-monsoon. Among the various season and station, the higher COD value was observed in station 7 of pre-monsoon while lowest was observed in station 6 of monsoon.

Total alkalinity

Alkalinity of water is its acid neutralizing capacity and it is primarily a function of carbonate, bicarbonate and hydroxide content of water. It is taken as an indication of the concentration of these constituents in water. The level of TA (ppm) Pazhayar river surface water ranged from 110.6 (S9) to 319.9 (S3) in pre-monsoon, 113.2 (S10) to 131.2 (S5) in monsoon and 126.2 (S3) to 216 (S1) in post-monsoon. Among the various season and station, the higher TA value was observed in station 3 of pre-monsoon while lowest was observed in station 10 of monsoon. Similar observations were made by Onojake *et al*., (2015) in New Calbar River.

Calcium

Calcium is naturally present in water and is directly related to hardness and is the chief cation in the water. Pazhayar river surface water Ca (ppm) ranged from 231 (S5) to 292 (S7) in pre-monsoon, 208 (S3) to 251 (S8) in monsoon and 117 (S5) to 143 (S3) in post-monsoon. Among the various season and station, the higher Ca value was observed in station 7 of pre-monsoon while lowest was observed in station 5 of post-monsoon.

Magnesium

Magnesium is responsible for water hardness. The Mg (ppm) concentration of Pazhayar river surface water ranged from 715 (S1) to 910 (S6) in pre-monsoon, 225 (S4) to 621 (S7) in monsoon and 538 (S5) to 677 (S9) in post-monsoon. Among the various season and station, the higher Mg value was observed in station 6 of pre-monsoon while lowest was observed in station 4 of monsoon.

Sodium

The Na (ppm) of Pazhayar river surface water ranged from 1710 (S4) to 12620 (S10) in pre-monsoon, 768 (S1) to 14315 (S8) in monsoon and 1028 (S1) to 12117 (S10) in post-monsoon. Among the various season and station, the higher Na value was observed in station 8 of monsoon while lowest was observed in station 1 of monsoon.

Pottasium

Potassium as in the form phosphate content may be varied due to rain, surface water runoff, agriculture run off; washer man activity could have also contributed to the inorganic phosphate content. Pazhayar river surface water K (ppm) ranged from 49 (S4) to 67 (S6 and S7) in pre-monsoon, 29 (S6) to 67 (S1) in monsoon and 34 (S1) to 56 (S4 and S9) in post-monsoon. Among the various season and station, the higher K value was observed in station 6 and 7 of pre-monsoon and station 1 of monsoon while lowest was observed in station 6 of monsoon.

Sulphate

Sulphate occurs naturally in all kinds of water. Drainage wastes are the main source of high sulphate concentration. Excess sodium and magnesium sulphate may cause cathartic action. Pazhayar river surface water SO_4 (ppm) ranged from 56 (S3) to 83 (S8) in pre-monsoon, 65 (S9) to 416 (S7) in monsoon and 34 (S7) to 66 (S4) in post-monsoon. Among the various season and station, the higher SO_4 value was observed in station 7 of monsoon while lowest was observed in station 7 of post-monsoon.

Nitrates

Nitrate is an essential nutrient but at high concentration it is toxic and is capable of disturbing the aquatic environment (Mohan Raj et al., 2013). Pazhayar river surface water NO_3 (ppm) ranged from 0.9 (S10) to 11.7 (S1) in pre-monsoon, 6.2 (S5 and S8) to 22.3 (S10) in monsoon and 0.1 (S5) to 4.9 (S6) in post-monsoon. Among the various season and station, the higher NO_3 value was observed in station 10 of monsoon while lowest was observed in station 5 of post-monsoon. Studies have shown that excess utilization of fertilizer in agriculture and sewage discharge result in the increase of nitrogen and phosphorous levels in

the estuary (Adeyemo, 2003). Increase in the concentration may be due to the anthropogenic sources like domestic sewage, agricultural wash offs and other waste effluents containing nitrogenous compounds. The same trend was observed by Muduli Bipra Prasanna and Panda Chitta Ranjan, (2010).

Phosphate

Phosphorus is the main limiting factor of productivity in water bodies and has been highlighted as the main factor responsible for the artificial eutrophication of these ecosystems; that is, there is a greater production of organic matter than its consumption and decomposition. Phosphorus can originate from natural sources (present in the composition of rocks, carried by surface runoff of rainwater, particulate material present in the atmosphere and resulting from the decomposition of organisms of allochthones origin) and artificial sources, such as domestic sewage, removal of sand from the riverbed, and deforestation of riparian forests, thereby having a very large impact on aquatic biota (Braga et al., 2022). Pazhayar river surface water PO_4 (ppm) ranged from 0.3 (S5) to 9.8 (S10) in pre-monsoon, 0.4 (S4 and S7) to 1 (S3) in monsoon and 0.1 (S3 and S4) to 0.4 (S1, 2 and S10) in post-monsoon. Among the various season and station, the higher PO_4 value was observed in station 10 of pre-monsoon while lowest was observed in station 3 and 4 of post-monsoon.

Chloride

Discharge of domestic sewage is the main source of chloride in water. Chloride is the indicator of contamination with animal and human waste. Chloride is a common constituent of all natural water and is generally not classified as harmful constituent. Pazhayar river surface water Cl (ppm) ranged from 410 (S1) to 1789 (S9) in pre-monsoon, 264 (S2) to 697 (S10) in monsoon and 268 (S3) to 1023 (S10) in post-monsoon. Among the various season and station, the higher Cl value was observed in station 9 of pre-monsoon while lowest was observed in station 2 of monsoon.

Table 2: Physico-Chemical characterization of surface water in the Pazhayar River, Kanniyakumari district, Tamil Nadu, India, during the pre-monsoon season - 2016.

Stations		Parameters (Pre-monsoon season 2016) *All the values are expressed in ppm except pH, Temp (°C) and EC (micro mho cm-1)																
		pH	**Tem.**	**EC**	**TDS**	**TH**	**DO**	**BOD**	**COD**	**TA**	**SO_4**	**NO_3**	**PO_4**	**Ca**	**Mg**	**Na**	**K**	**Cl**
S1		8.2	29.3	4530	1830	1006	2.9	25.1	54	213.2	70	11.7	0.4	291	715	1860	54	410
S2		7.6	29.5	3879	3100	987	2.9	25.1	50	319.7	67	1.9	0.8	256	731	2170	56	449
S3		7.6	30.6	4620	2130	1071	2.9	24.1	49	319.9	56	1.4	0.7	277	794	1980	51	461
S4		7.8	30.1	4250	2150	1521	2.7	23	45	223.2	63	1.5	0.6	248	773	1710	49	550
S5		7.1	29.8	3500	2600	1042	3.8	33.1	65	224.4	58	4	0.3	231	811	10200	60	789
S6		8.2	29.8	4400	2800	1176	3.3	34.1	56	312.5	67	3.2	0.4	266	910	11400	67	784
S7		8.1	30	4100	2002	1153	2.9	40.1	66	212.3	67	2.9	4.5	292	861	11620	67	794
S8		7.7	30.3	4030	2130	1133	4	26.1	54	116.5	83	3.2	7.2	253	880	11942	61	1089
S9		7.9	29.3	4840	2520	1037	1.2	25.8	34	110.6	80	3.7	7.6	258	779	12140	60	1789
S10		7.2	29.6	7960	4940	1154	1.6	24.6	34	115.3	82	0.9	9.8	276	878	12620	59	1023
Minimum		**7.1**	**29.3**	**3500**	**1830**	**987**	**1.2**	**23**	**34**	**110.6**	**56**	**0.9**	**0.3**	**231**	**715**	**1710**	**49**	**410**
Maximum		**8.2**	**30.6**	**7960**	**4940**	**1521**	**4**	**40.1**	**66**	**319.9**	**83**	**11.7**	**9.8**	**292**	**910**	**12620**	**67**	**1789**
Standards (*All the values are expressed in mg/l except pH and Temp.)																		
WHO	**Ac**	7.0-8.5	Nil	-	-	300	5	3	10	30	200	50	0.1	75	50	175	-	250
	Al	6.5-9.2	Nil	-	-	600	-	5	20	150	400	100	1.0	150	150	200	-	1000
ICMR	**Ac**	7.0-8.5	Nil	-	-	200	-	-	-	-	200	20	-	75	50	-	-	200
	Al	6.5-9.2	Nil	-	-	600	-	-	-	120	400	100	-	200	200	-	-	1000

*Ac=Acceptable; Al=Allowable; 1ppm equal to 1mg/l; TA equal to HCO_3.

***** All the values are expressed in ppm except pH, Temp (**°C)** and EC (micro mho cm^{-1})

Table 3: Physico-Chemical characterization of surface water in the Pazhayar River, Kanniyakumari district, Tamil Nadu, India, during the monsoon season - 2016

Stations		Parameters (Monsoon season - 2016) *All the values are expressed in ppm except pH, Temp (°C) and EC (micro mho cm-1)																
		pH	**Tem**	**EC**	**TDS**	**TH**	**DO**	**BOD**	**COD**	**TA**	**SO_4**	**NO_3**	**PO_4**	**Ca**	**Mg**	**Na**	**K**	**Cl**
S1		6.3	28.5	1662	879	482	4	22	36	116.1	212	21.5	0.7	245	237	768	67	267
S2		6.5	29.1	1781	974	457	3.2	19.2	29	116.4	113	14.2	0.9	215	242	876	56	264
S3		6.8	28.5	1331	781	453	4.1	17.4	22	121.3	234	10.2	1	208	245	978	34	312
S4		7.0	30.2	1900	1060	444	5.2	14.6	20.4	119.7	312	14.2	0.4	219	225	1034	45	309
S5		7.1	30.3	2400	834	746	6.3	15.4	20.6	131.2	364	6.2	0.8	221	525	1523	30	302
S6		7.1	28.7	4000	2400	864	5.7	12.6	17.8	127.8	402	8.4	0.8	247	614	1068	29	364
S7		7.2	28.7	1800	967	848	5.2	17.6	23	129.6	416	8.4	0.4	227	621	1025	40	312
S8		7.2	28.9	3070	2710	869	5.8	13.9	24	130.1	312	6.2	0.5	251	618	14315	45	378
S9		7.3	28.7	2700	1671	835	5.3	12.9	22	116.3	65	8.4	0.6	221	614	14100	32	689
S10		7.3	28.6	1800	854	851	0.7	36.1	56	113.2	72	22.3	0.6	246	605	14222	52	697
Minimum		**6.3**	**28.5**	**1331**	**781**	**444**	**0.7**	**12.6**	**17.8**	**113.2**	**65**	**6.2**	**0.4**	**208**	**225**	**768**	**29**	**264**
Maximum		**7.3**	**30.3**	**4000**	**2710**	**869**	**6.3**	**36.1**	**56**	**131.2**	**416**	**22.3**	**1**	**251**	**621**	**14315**	**67**	**697**
Standards (*All the values are expressed in mg/l except pH and Temp.)																		
WHO	**Ac**	7.0-8.5	Nil	-	-	300	5	3	10	30	200	50	0.1	75	50	175	-	250
	Al	6.5-9.2	Nil	-	-	600	-	5	20	150	400	100	1.0	150	150	200	-	1000
ICMR	**Ac**	7.0-8.5	Nil	-	-	200	-	-	-	-	200	20	-	75	50	-	-	200
	Al	6.5-9.2	Nil	-	-	600	-	-	-	120	400	100	-	200	200	-	-	1000

*Ac=Acceptable; Al=Allowable; 1ppm equal to 1mg/l; TA equal to HCO_3.

***** All the values are expressed in ppm except pH, Temp (**°C)** and EC (micro mho cm^{-1})

Table 4: Physico-Chemical characterization of surface water in the Pazhayar River, Kanniyakumari district, Tamil Nadu, India, during the post-monsoon season - 2016.

Stations		**Parameters (Post-monsoon season 2016)** *All the values are expressed in ppm except pH, Temp (°C) and EC (micro mho cm-1)																
		pH	**Tem**	**EC**	**TDS**	**TH**	**DO**	**BOD**	**COD**	**TA**	**SO_4**	**NO_3**	**PO_4**	**Ca**	**Mg**	**Na**	**K**	**Cl**
S1		7.9	28.2	2620	1513	770	3.4	19.4	32	216	55	2.7	0.4	138	632	1028	34	312
S2		7.8	26.3	2160	1920	777	3.5	17.1	30	155.5	54	2.5	0.4	142	635	1089	43	344
S3		8.1	28.2	2120	1960	772	4.4	14.3	23.4	126.2	46	2.7	0.1	143	629	1262	55	268
S4		7.8	25.8	2800	1980	729	4.3	15.2	23.4	127.5	66	0.4	0.1	142	587	1237	56	456
S5		7.8	26.5	620	520	655	4.2	14.3	22.8	139	53	0.1	0.3	117	538	1174	45	567
S6		7.4	28.7	1800	1200	719	3.9	18.7	30.7	128.2	45	4.9	0.2	127	592	1247	34	554
S7		7.4	29.3	2200	1400	759	4.8	17.6	24.7	165.7	34	2.5	0.2	130	629	11228	44	789
S8		8.2	25.1	2830	1510	748	5.2	13.8	23.6	151.3	55	2.4	0.2	125	623	11321	52	890
S9		8.3	25	3980	1670	755	4.5	14.7	22.7	153	53	2.7	0.2	128	677	11692	56	789
S10		7.8	29.3	3520	1620	744	4.1	16.2	21.4	144.5	55	4.3	0.4	125	619	12117	55	1023
Minimum		**7.4**	**25**	**620**	**520**	**655**	**3.4**	**13.8**	**21.4**	**126.2**	**34**	**0.1**	**0.1**	**117**	**538**	**1028**	**34**	**268**
Maximum		**8.3**	**29.3**	**3980**	**1980**	**777**	**5.2**	**19.4**	**32**	**216**	**66**	**4.9**	**0.4**	**143**	**677**	**12117**	**56**	**1023**
Standards (*All the values are expressed in mg/l except pH and Temp.)																		
WHO	**Ac**	7.0-8.5	Nil	-	-	300	5	3	10	30	200	50	0.1	75	50	175	-	250
	Al	6.5-9.2	Nil	-	-	600	-	5	20	150	400	100	1.0	150	150	200	-	1000

ICMR	**Ac**	7.0-8.5	Nil	-	-	200	-	-	-	-	200	20	-	75	50	-	-	200
	Al	6.5-9.2	Nil	-	-	600	-	-	-	120	400	100	-	200	200	-	-	1000

*Ac=Acceptable; Al=Allowable; 1ppm equal to 1mg/l; TA equal to $HCO_{3.}$

***** All the values are expressed in ppm except pH, Temp (**°C)** and EC (micro mho cm^{-1})

Kataria *et al.* (1996) discusses that the maximum pH indicates high rate of photosynthesis, the present study that the higher pH value was observed in of post-monsoon in the Pazhayar river. Chang (2005) reveals that the DO (dissolved oxygen) changes that occur in the biological parameters due to aerobic or anaerobic phenomena signify the condition of the river water for the purpose of the living organism and Dara, (2002) reveals the adequate supply of dissolved oxygen is essential for the survival of aquatic organism. Chemical Oxygen Demand is a measure of the oxidation of reduced chemicals in water system it is commonly used to indirectly measure the amount of organic compounds in water (Hisseien *et al.,* 2015). The higher values of BOD and COD values are indicative of the presence of organic and inorganic pollutants in water system. The present study higher COD and BOD range was observed in pre-monsoon season in Pazhayar river surface water. The river water seemed to be of poor quality in downstream stretches probably due to the high anthropogenic activities associated with the region together with the cumulative effect of all the contaminants emerging from highland portion onwards and salt water intrusion from the sea (Badusha and Santhosh, 2017).

Pani (1986), studies have shown that domestic and industrial sewage, agricultural wastes have polluted almost all of Indian rivers. Magadum *et al.* (2017), reveals that the river pollution is a foremost issue with not only major river of India but also the minor rivers. The present study of Pazhayar River surface water uses the water quality index to express the quality of the water. This is one of the major indices used to assess pollution and one of the most effective ways to create awareness among the public about the environment.

The river water is polluted mainly due to anthropogenic sources: domestic effluents, hospital sewage, hotel waste discharges, and sand mining. The present study covers the seasonal variations (pre-monsoon, monsoon, and post-monsoon) in Pazhayar river surface water. The quality of Pazhayar river water is assessed through the assessment of parameters like EC, TDS, TH, DO, BOD, COD, TA, SO_4, NO_3, PO_4, Ca, Mg, Na, K and Cl. When compared with the standard values of WHO and ICMR the water samples are found to be in exceed the permissible limit at all stations. The pH and temperature were within the limit. Similarly, Ajesh *et al.* (2014) discovered significant variations in parameters while studying selected zones of the Neyyar River in Kerala.

CONCLUSION

In order to evaluate the physicochemical parameters of Pazhayar river, water samples were collected and analyzed the physic-chemical analysis of water sample in the river water at various sites like Puthery, Ozhuginasery, Kothaigramam, Suchindram, Kakkamur south, Thamaraikulam north, Near the salt pan 2, Near the mangrove forest, Near the salt pan 1 and Sea mouth. In this present investigation, it was found that the most of the parameters were exceeding or below the permissible limit of standards (WHO and ICMR), so that the water in the study area is not suitable for drinking purposes. The present study suggests the distinct nature of different bodies of river water; these distinct natures, however, depend on geographical location and seasonal variations. Anthropogenic factors also contribute to the physico-chemical properties, especially in industry. We recommend that strict measures should be taken, such as industrial wastewater and sewage water treatment, and to monitor their discharge into the environment to prevent the pollution of river.

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