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Research Article

Physico-chemical Characteristics of Sediments in Distributaries of River Cauvery, Tiruchirappalli, Tamilnadu

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Abstract: The present study was undertaken to determine the physico-chemical characteristics of the sediments of five channels of river Cauvery in Manachanallur and Lalgudi taluks, Tiruchirappalli. The trace metal concentrations were low and they were in order of Pb>Cr>Cu>Zn>Cd. The sediment of Koolayar channel at Thirumangalam was found to be slightly contaminated by the surface run-off followed by Panguni channel at Alangudi.
Keywords: Trace metals, anthropogenic activities, run-off, Manachanallur and Lalgudi taluk

INTRODUCTION

Sediment is the loose sand, silt and other soil particles that settle at the bottom of a body of water [1]. It can come from soil erosion or the decomposition of plants and animals. Agricultural land drainage schemes include channelization of water courses that can have a considerable impact on hydrology, sediment load, water temperature and aquatic biology [2].Sediment is an integral part of aquatic ecosystem, providing habitat, feeding, spawning and rearing areas for many aquatic organisms. Protecting sediment quality is an important part of restoring the biological integrity of water bodies as well as protecting aquatic life, wild life and human health. Sediment serves as reservoir for pollutants and therefore a potential source of pollutants to the water column, organisms and ultimately humans who consume those organisms[3].

The organic compounds, which may originate naturally from vegetative decay or organic discharge from municipal and industrial sources, have a remarkable affinity and capacity to bind minerals [4].Pollutants reach aquatic systems from air, soil or on-land via precipitation, surface run-off, solid wastes and leaching of rocks [5]. Sewage, industrial wastes, mineral exploitation and agricultural chemicals are the main causes of surface water pollution [6].

The sediment contamination can cause lethal and sub-lethal effect in benthic and other sediment associated organisms [1]. It may impact stream communities through various processes, including reduced light penetration, smothering, habitat reduction and introduction of absorbed pollutants (pesticides, metals and nutrients). It can reduce or eliminate species of recreational, commercial or ecological importance, either through direct effects or by affecting the food supply [7].

Heavy metals enter these aquatic systems mainly through natural inputs such as weathering and erosion of rocks and anthropogenic sources including urban, industrial and agricultural activities, terrestrial runoff and sewage disposal [8].Numerous studies have demonstrated that the concentrations of metals in sediments can be sensitive indicators of contaminants in aquatic systems [9, 10, 11, 12, 13].

The distributaries of river Cauvery namely '*Ayyan*', '*Peruvalai*', '*Pullambadi*', '*Panguni*' and '*Koolayar*' are running through Manachanallur and Lalgudi taluks. They originate near from upper-anicut and run through these taluks to either confluencing points with Coleroon river or end up as lakes (Map1). The length of each of these channels from their origin till the endpoint ranges between about 20 and 50 km. These channels support the irrigation of entire agriculture fields and promote the economy of this region. These channels are very important fresh water systems for drinking, agricultural activities and recreational purposes in Manachanallur and Lalgudi taluks to support life activities of 447,523 people(Census, 2011) in both taluks. The anthropogenic activities (laundering, vehicle washing, refuse dumping, open defecation by human and livestock) influence the water quality of these channels. The suspended and dissolved materials can settle down to the bottom of the channels from the local run-off. Consequently, these activities affect the characteristics of sediments.

The present study was undertaken to determine the characteristics of sediments in distributaries of river Cauvery at Manachanallur and Lalgudi taluks.

MATERIAL AND METHODS

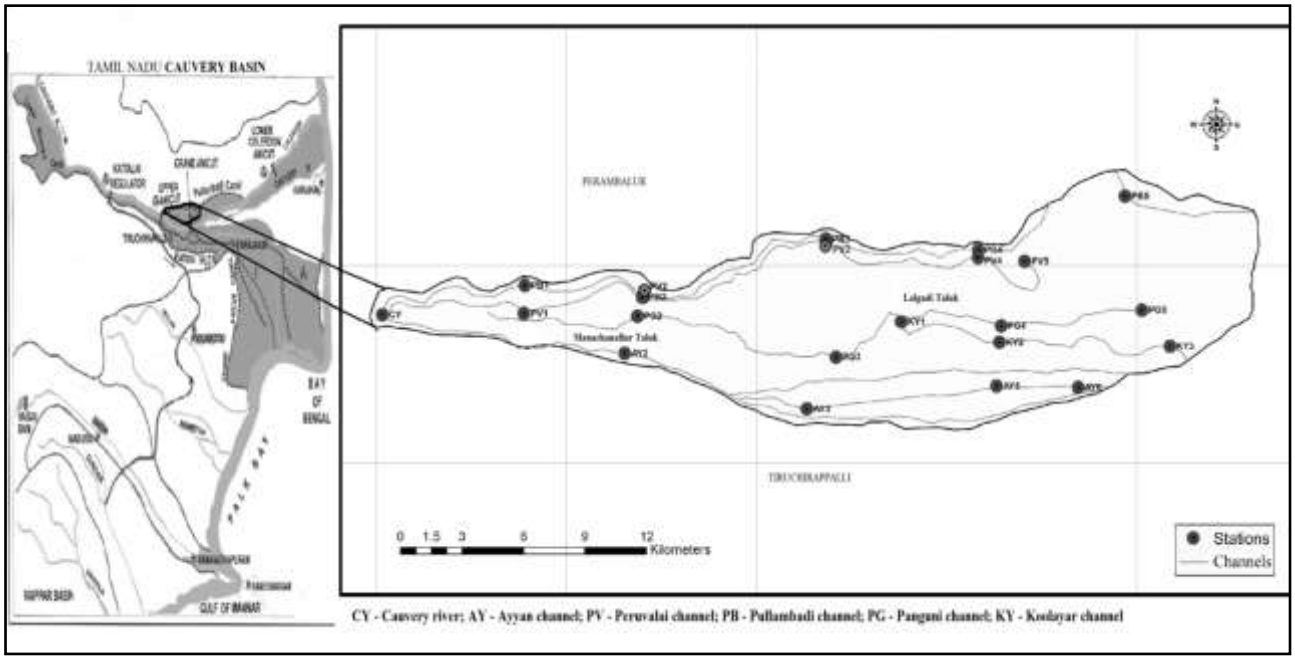
Sampling and Analysis

The sediment samples were collected from 22selected stations of five channels during the summer season (April and May, 2013). They were collected at about 15cm depth of the channel bottom and transferred to the laboratory in polythene bags. The samples were air dried for 1 week and grounded into fine particles using pistil and mortar and sieved through 2mm sieve. The physico-chemical parameters (pH, Electrical Conductivity, Alkalinity, chloride, total organic matter, phosphate, total nitrogen, sodium and potassium) were determined [14]. The extraction of metals from sediment was done using mixed acid digestion technique as prescribed by [3,15,16]and the concentration of trace metals (Cd, Cr, Cu, Pb and Zn) was determined in AAS (Sensaa GDC Sci. Equipment).

RESULTS AND DISCUSSION

The physico-chemical characteristics including trace metal concentrations of sediments are presented in table 1. The observed pH of the sediment samples, ranged from 7.2 to 8.0 in all stations. Highest pH was observed in AY3 (Ayyan) at Thirumanamedu. The conductivity of the samples varied from 72 to 2500 µS/cm. The highest EC value was found in KY1 (Koolayar) at Thirumangalam. Water in this region was found to be stagnant due to the presence of a check dam. Water from Upper channel was also confluences in this site. These could be the reason for high EC. The organic matter content of all stations ranged from 0.64 to 14.14 %. The variations in organic matter may be due to variation decomposition of organic matter by bacteria [17]. The highest value of organic matter was found in PG5 (Panguni) at Alangudi, as all suspended and dissolved solids finally settle here in the Panguni Lake. A sugar factory is located at a distance of few km in the upstream to this station, which discharges effluent occasionally. The determined chloride values in all stations ranged from 0.012 to 0.062%. The determined total nitrogen values were not high in all sampling stations. The maximum value of sodium (0.098%) was found in AY5 (Ayyan channel) at Athikudi and maximum potassium (0.071%) was observed in Panguni channel at Alangudi of Lalgudi taluk. Phosphate in all sampling stations ranged from 0.009 to 0.040%.

Metal concentrations did not vary much in all sampling stations. It may be due to the alkaline nature of the sediments, which affects metal speciation, metals solubility and leaching [3]. The maximum Pb (0.386mg/Kg) value was observed in KY1 at Thirumangalam. The reason for high Pb concentration in KY1 could not be ascertained. However, the metal concentrations were low in all other sampling points and they were in order of Pb>Cr>Cu>Zn>Cd.



Map1: Sediment-sampling stations in distributaries of river Cauvery at Manachanallur and Lalgudi taluks

Table-1:Physico-Chemical Characteristics of sediments in five distributaries of Manachanallur and Lalgudi taluks

	Parameter	pH	EC	Alkalinity	TOM	Cl^-	TN	Na^+	K^+	PO_4^{3-}	Cu	Cd	Cr	Pb	Zn
S.No.	St. Code		µS/cm	meq/100g	%	%	%	%	%	%	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
1	CY	7.8	233	1.75	1.29	0.027	0.3	0.014	0.004	0.015	0.015	0.001	0.001	0.043	0.011
2	PV1	7.5	217	1.00	1.29	0.031	0.2	0.017	0.004	0.020	0.014	0.001	0.016	0.042	0.011
3	PB1	7.6	350	1.00	1.93	0.016	0.3	0.012	0.006	0.024	0.008	0.001	0.016	0.043	0.011
4	AY2	7.5	72	1.00	0.64	0.012	0.2	0.002	0.001	0.016	0.014	0.001	0.001	0.043	0.011
5	PG2	7.5	170	0.75	0.64	0.022	0.4	0.011	0.003	0.011	0.031	0.001	0.110	0.185	0.041
6	PV2	7.8	336	1.50	3.86	0.019	0.2	0.011	0.008	0.026	0.019	0.002	0.016	0.040	0.011
7	PB2	7.8	517	1.25	5.14	0.017	0.2	0.012	0.008	0.027	0.008	0.001	0.020	0.049	0.012
8	AY3	8.0	89	1.00	1.93	0.016	0.2	0.005	0.004	0.023	0.018	0.001	0.074	0.046	0.020
9	PG3	7.5	482	1.00	4.50	0.022	0.2	0.012	0.008	0.025	0.030	0.001	0.075	0.041	0.034
10	PV3	8.2	125	1.00	3.86	0.016	0.1	0.007	0.006	0.030	0.020	0.002	0.017	0.041	0.012
11	PB3	7.2	366	1.00	0.64	0.015	0.2	0.008	0.005	0.038	0.009	0.001	0.020	0.052	0.020
12	KY1	7.2	2500	1.25	7.71	0.062	0.3	0.051	0.019	0.020	0.020	0.002	0.094	0.386	0.029
13	AY5	7.2	300	0.75	5.78	0.026	0.4	0.098	0.015	0.035	0.016	0.003	0.041	0.216	0.021
14	KY2	7.8	102	0.75	0.64	0.017	0.3	0.006	0.001	0.024	0.021	0.002	0.045	0.323	0.016
15	PG4	7.6	558	1.50	5.14	0.029	0.4	0.022	0.018	0.030	0.031	0.002	0.082	0.062	0.038
16	PV4	7.8	325	1.25	3.86	0.030	0.3	0.017	0.011	0.026	0.020	0.002	0.021	0.052	0.013
17	PB4	7.6	410	1.00	3.21	0.017	0.2	0.012	0.006	0.022	0.021	0.001	0.031	0.055	0.021
18	AY6	7.4	325	0.75	3.86	0.019	0.2	0.050	0.002	0.026	0.016	0.003	0.042	0.122	0.015
19	KY3	8.0	184	1.25	1.93	0.025	0.2	0.011	0.002	0.017	0.003	0.000	0.035	0.197	0.008
20	PG5	7.8	630	2.00	14.14	0.024	0.3	0.047	0.071	0.016	0.035	0.001	0.111	0.200	0.042
21	PV5	7.8	496	1.50	4.50	0.024	0.3	0.033	0.036	0.009	0.032	0.002	0.047	0.202	0.029
22	PB5	7.5	605	1.25	7.71	0.010	0.2	0.011	0.007	0.040	0.016	0.002	0.003	0.208	0.013

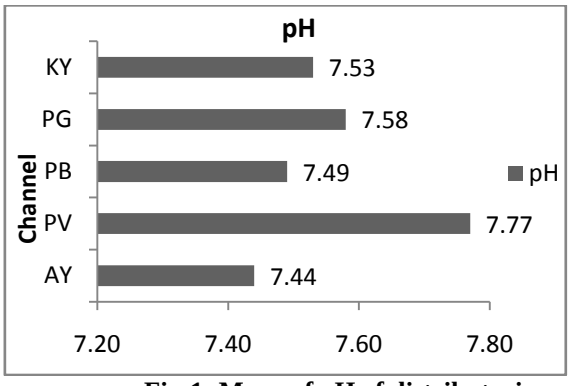


Fig-1: Mean of pH of distributaries

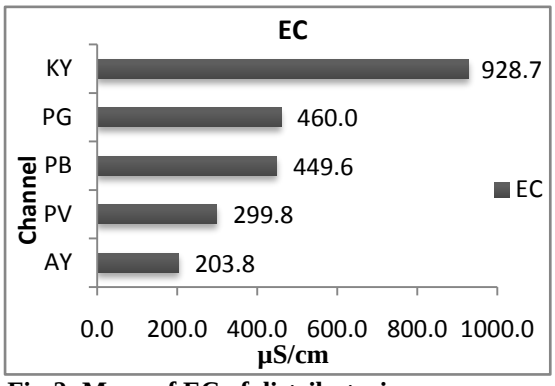


Fig-2: Mean of EC of distributaries

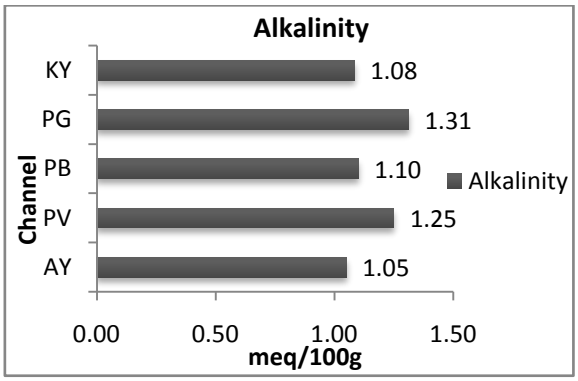


Fig-3: Mean of alkalinity of distributaries

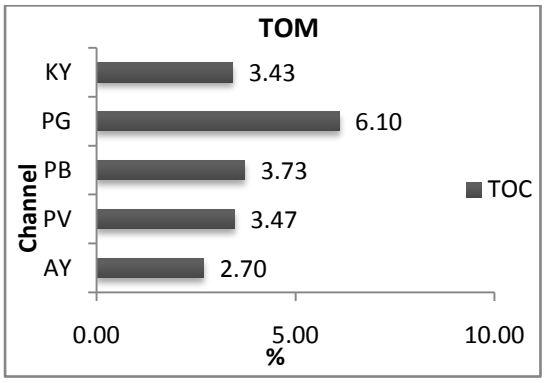


Fig-4: Mean of TOM of distributaries

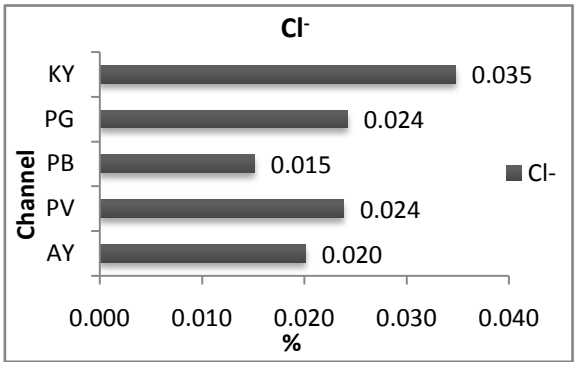


Fig-5: Mean of chloride of distributaries

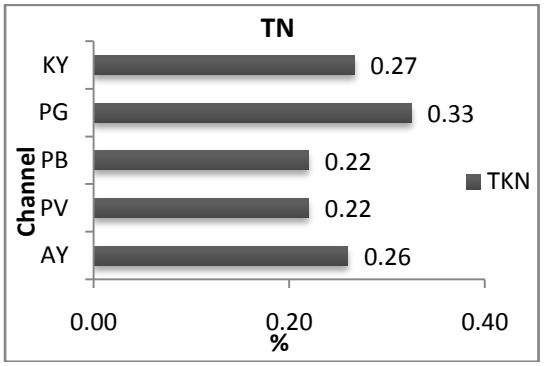


Fig-6: Mean of TN of distributaries

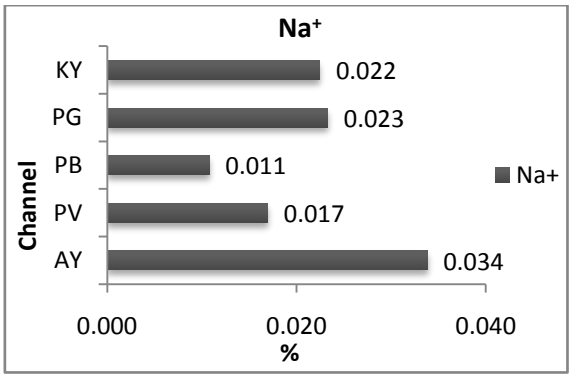


Fig-7: Mean of sodium of distributaries

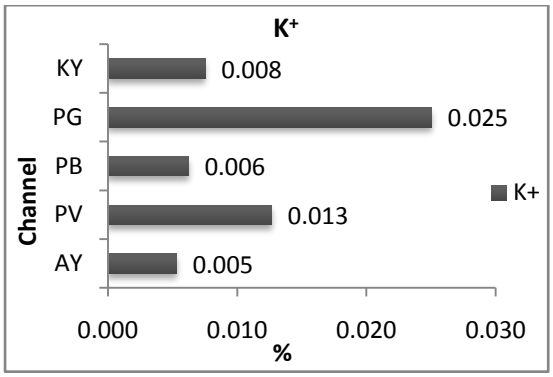


Fig-8: Mean of potassium of distributaries

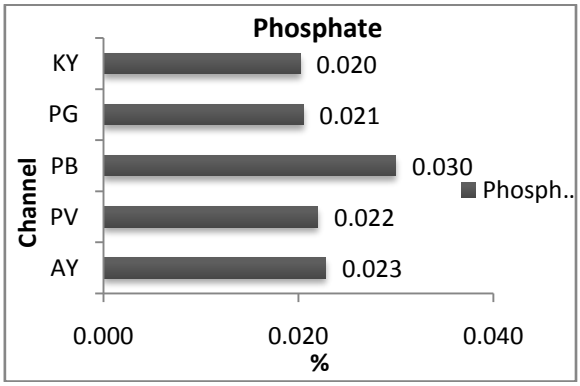


Fig-9: Mean of phosphate of distributaries

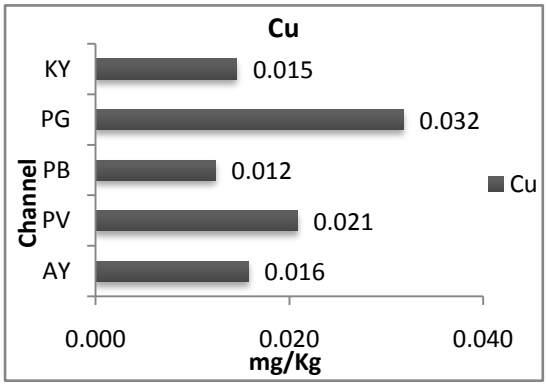


Fig-10: Mean of cupper of distributaries

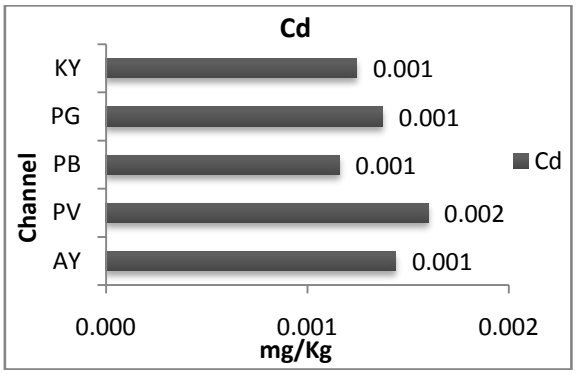


Fig-11: Mean of cadmium of distributaries

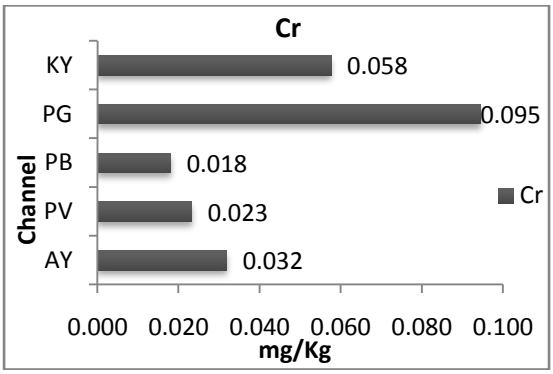


Fig-12: Mean of chromium of distributaries

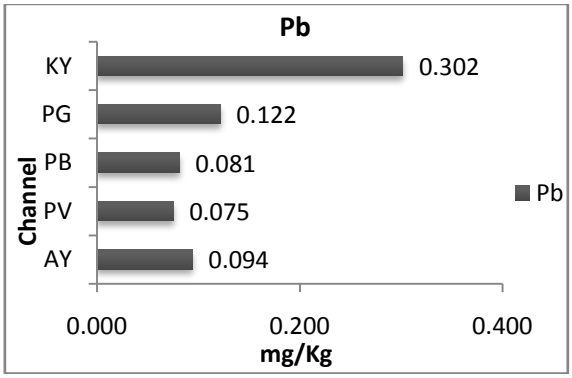


Fig-13: Mean of lead of distributaries

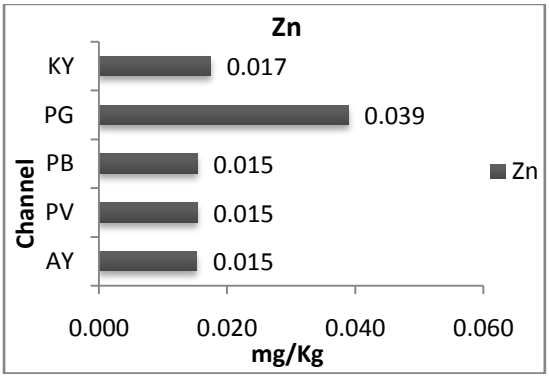


Fig-14: Mean of zinc of distributaries

The mean physico-chemical characteristics of sediments of five channels are presented in figures1-14. Mean pH value were calculated as mean meq of H^+ concentration and then converted to 'mean pH' value. Except EC and Pb at KY1 (Koolayar) other parameters in all other places did not vary much. The highest value of EC (928.7 µS/cm) was recorded in Koolayar channel and lowest (203.8 µS/cm) in Ayyan channel. The high amount of lead (0.302 mg/Kg) was observed in Koolayar channel through it has exceeded the prescribed standard for inland surface water [18]. As Koolayar channel flows through agricultural lands and villages, it receives various pollutants by human activities during low water level. This could be reason for high EC and Pb values.

The physico-chemical characteristics of sediment of river Cauvery (Upper-anicut) was compared with mean values of physico-chemical parameters of five channels. It was found that only the alkalinity (1.75 meq/100g) was recorded higher than that of the five channels. The trace metals were found to be lower in sediment of river Cauvery than that of the distributaries.

Table 2: Correlation coefficient between physico-chemical parameters and trace metals

	pH	EC	Cl^-	Na^+	K^+	Cu	Cd	Cr	Pb	Zn
pH	1									
EC	-.420*	1								
Cl^-	-.297	.800**	1							
Na^+	-.473*	.363*	.438*	1						
K^+	.064	.307	.233	.441*	1					
Cu	.031	.139	.161	.175	.593**	1				
Cd	-.289	.258	.161	.619**	.167	.333	1			
Cr	-.119	.382*	.422*	.311	.516**	.689**	.135	1		
Pb	-.247	.554**	.483*	.459*	.300	.197	.348	.440*	1	
Zn	-.236	.309	.283	.283	.606**	.844**	.168	.888**	.289	1

*. Correlation is significant at the 0.05 level (1-tailed)

**. Correlation is significant at the 0.01 level (1-tailed)

The results of pearson correlation coefficient are presented in table 2. The highly positive correlation was observed between Cl^- and EC; Pb and EC. The positive correlation also occurred between Na^+ and EC; Cr and EC. However, some of other relationships cannot be chemically validated.

CONCLUSION

The present study concluded that the sediments of all distributaries of river Cauvery were not contaminated by the anthropogenic activities except that of KY1 (Koolayar) at Thirumangalam station. Settlement of total dissolved and suspended solids at the confluence of Panguni and Upper channels could be the reason for high organic matter in Thirumangalam. Trace metals concentration did not vary much. The highest values of certain physico-chemical parameters and trace metals were observed in KY1 (Koolayar) at Thirumangalam followed by Panguni at Alangudi.

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