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Sediment Quality and Seasonal Variation of Trace Metal in Tamirabarani Estuary, East Coast of Tamilnadu, India

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Abstract

The physical parameters and heavy metals along the tributaries of Tamirabarani River are studied. Nearly sixteen water and sediment samples are collected along the tributaries in and around Mukkani and river mouth. Physical parameters like pH (7.8-9.5), Ec, (468-27950), TH (40-5920), TDS (303-33050) and trace metals in sediment samples like Cu(2.2-59.89 μg g^{-1}), Ni (1.88-70.59 μg g^{-1}),Cr (6.67-145.5 μg g^{-1}), Cd (1.41-19.26 μg g^{-1}), Pb,(3.48-46.05 μg g^{-1}) and zinc (9.3-81.12 μg g^{-1}). The constant variation of metals in sediment and water samples is due to the linking of industrial and un-classified anthropogenic influences. The combined and collective consequences go in front to a serious risk to the entire estuarine environment.

Keywords: Tamirabarani River, river sediments, physical parameters, trace metals, pre monsoon, post monsoon.

Introduction

The river and streams are dynamic ecosystem in which several physical and chemical processes operable, and the suitable sedimentary deposits, which can provide valuable data concerning modern human effects on the geological cycle were studied by various researchers[1,2]. The metals in the earth are usually taken as the background value of sediments[3]. As per the estimations made, the Indian rivers contribute 30% of sediments transported by World Rivers[4]. The accumulation of trace metals into the environment, which contaminate is a serious problem to the society. So trace metal concentration in sediment can be used to reveal the history and intensity of local and regional pollution[5,6]. The aim of the present work is to assess the geochemistry of Tamirabarani river sediments to establish the possibility of secondary pollution of the sediments, which is drained with a significant amount of waste containing toxic metals, which help us to determine the effects of heavy metal due to natural and anthropogenic activity, which affects the tributaries and estuaries in Tamirabarani estuarine sediments.

Material and Methods

Study area: Tamirabarani River originates from western ghat hills in the western part within the study area and confluences in the east coast of Bay of Bengal. Tamirabarani River discharges fall in the part of Thirunelveli and Thoothukudi districts, east coast of Tamilnadu state, India. It lies in the top sheets' Nos. 58 L/2 published by survey of India and located in between 8˚25N and 9˚10N latitudes and 77˚ 10 E and 78˚ 15'E longitudes figure 1. The study area is blessed with deltaic system with different functioning and inactive distributaries; the western part is dominated by forceful river and tide dominated distributaries are along the coast[7] (figure 2).

Sample collection: In the study area, almost sixteen sediment and water, samples were collected at the river mouth, tributaries up to Mukkani. The sampling points were identified and collected from upstream and downstream side within the study area and closely fifteen samples were collected. At each sample distribution point, water and sediment, samples are collected in clean rinsed polyethylene bottles. The physical parameters like pH and temperature water samples are recorded during the field immediately after collection. Sediment samples were collected with Eckman grab sampler at each point. Sediment samples were wrapped with polythene bags, kept on ice and subsequently, transported to the laboratory.

Physico-chemical parameters: A pre-calibrated portable multi parameter kit PC TESTER 35(Multi-Parameter) was used for pH, Temperature and Electrical Conductivity (EC) measurements. Total Dissolved Solids (TDS) were estimated according to the suggested standard analytical methods[8]. Total Hardness was determined by titrating water samples with typical EDTA titrant with Eriochrome black-T as an indicator according to standard methods table-1. In the laboratory, the collected samples were deep frozen at -4^{o} to avoid soil contamination and dried in a hot-air oven at 40^{o}C, and after homogenization dry sieved with a 200mm sieve. The sieved samples are weighed and stored in polyethylene bags for further analysis[9,10].

The samples were digested before the samples were subjected for analysis to the determination of trace metals using AAS with specific flame and wavelength Atomic Absorption Spectrometer (Elico) by using a series of solution over the range 2-10mg/l. table2.

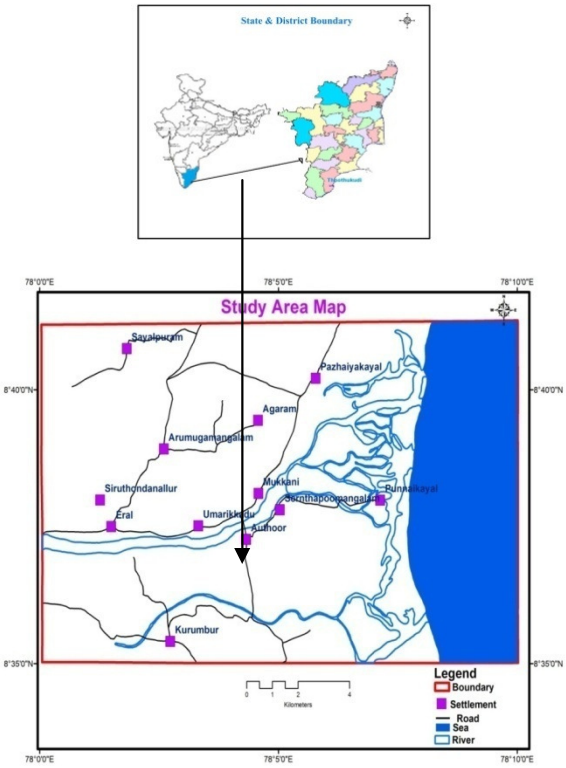


Figure-1
Location map of study area

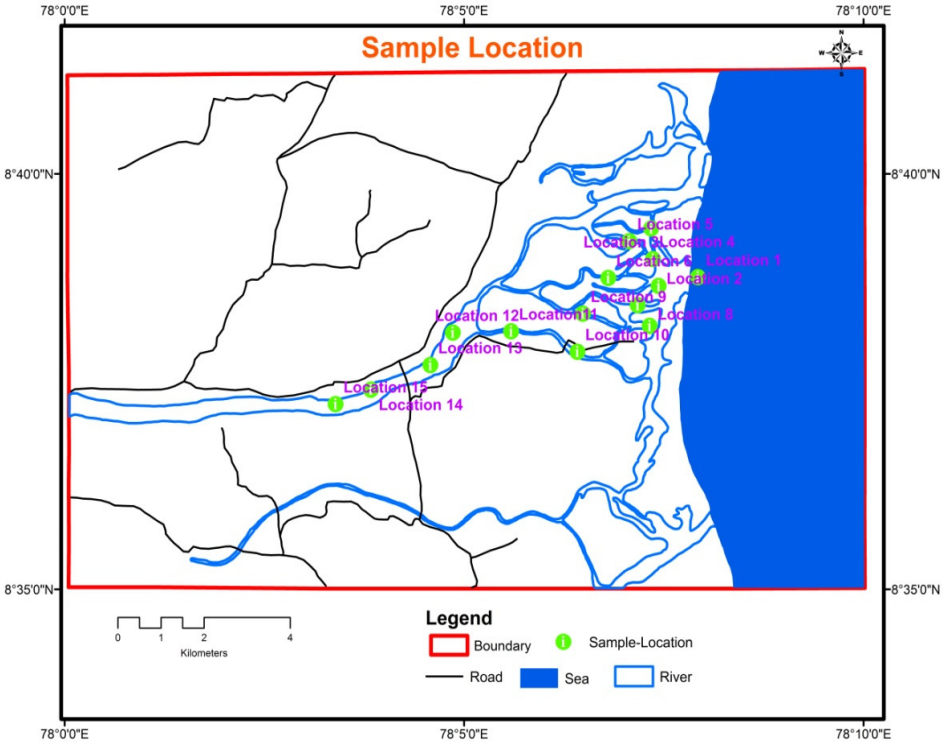


Figure-2
Showing sampling points along the study area

Results and Discussion

Physical parameter of the study like pH varied from 8.1- 9.5 and 7.8-9.5 during pre-monsoon and post-monsoon periods. The pH values of both monsoons were not within the desirable limit of BIS and WHO drinking water standards[11-13]. It is said that river waters with a pH of 5.5 and below are particularly at risk and mostly the pH was determined by the amount of dissolved carbon dioxide, which forms carbonic acid in water and also by organic acids from decaying vegetation and the dissolution of sulphide minerals[14-18]. In the present study, pH was considerably slightly higher in Tamirabarani river water, which may be due to greater input of effluents from different types of industries. EC values of the study area ranged from 468-16250 and 585-27950 in pre-monsoon and post-monsoon period, which indicate the presence of more salts in river water[19,20]. Total dissolved solids (TDS) in the study area are comparatively more during pre-monsoon and post-monsoon period, values range between 303-33050 and 380-18160. It is due to the industrial, domestic waste dumped and discharges into the river water ecosystem. Total hardness (TH) in the study area ranges from 40-3540 and 280-5920 during pre-monsoon and post-monsoon period is said to be more, which may be due to increase of salt in water figure-3.

The absorption of heavy metals in sediment samples is systematically given as copper (2.2-59.89 µg g^{-1}), Nickel (1.88ppm-70.59 µg g^{-1}), cadmium (1.41-19.26 µg g^{-1}), lead (3.48-46.05 µg g^{-1}) and zinc (9.3-81.12 µg g^{-1}) respectively. The above analysed heavy metals show higher concentration, than reported in Gulf of Mannar[21], but reported nil account of accretion of Cd, Ni, Pb and low concentration of Cu, (19.8), Zn (30.8) nearby the study area[22] (figure-4). During the post monsoon period observed higher concentration of Cu, Ni, Cd, Pb is due to industrial wastage and sometimes due to anthropogenic activities.

The chromium concentrations observed during the pre monsoon period is elevated due to anthropogenic activities, because it not originated from lithogenic sources. The concentration Cr ranges between (6.67-145.5 µg g^{-1}), the concentration is higher than the value reported in Gulf of Mannar[21] and Cd is reported absent from the study area[22]. After a long period of more than fourteen years, the gradual increase of Cd concentration is found within the study area, which indicate the study area is polluted. These metals are the major pollutants into the river; several of these elements are highly hazardous to the aquatic life and human's beings. Basically, these elements are not biodegraded and live for a long time in the environment[23].

Table-1
Comparison of pH, EC, TH and TDS values pre monsoon and post monsoon period

S.No	Pre monsoon				Post monsoon			
	PH	EC	TH	TDS	PH	EC	TH	TDS
1	8.6	468	60	370	8.2	18865	4886	11319
2	8.4	2470	630	1950	8.4	12925	2722	8401
3	8.2	3120	650	2300	7.91	22642	5920	14717
4	8.75	1560	340	1230	8.8	17569	4052	11419
5	8.1	16250	3540	33050	8.3	14311	2614	9302
6	9.5	1300	50	1026	9.5	1010	940	656
7	8.7	2275	390	1500	8.8	14300	2400	9295
8	9.3	2210	100	1745	9.01	940	890	611
9	8.5	2275	230	1800	8.8	19500	4080	12675
10	9.4	1040	40	821	9.2	27950	5920	18167
11	8.8	384	60	303	8.84	18850	2800	12252
12	8.3	2340	360	1847	8.34	4420	560	2873
13	8.85	1820	740	1438	8.59	1564	1998	1016
14	8.1	2210	630	1750	7.8	12842	2896	8347
15	8.6	559	210	440	8.1	14899	4012	9684

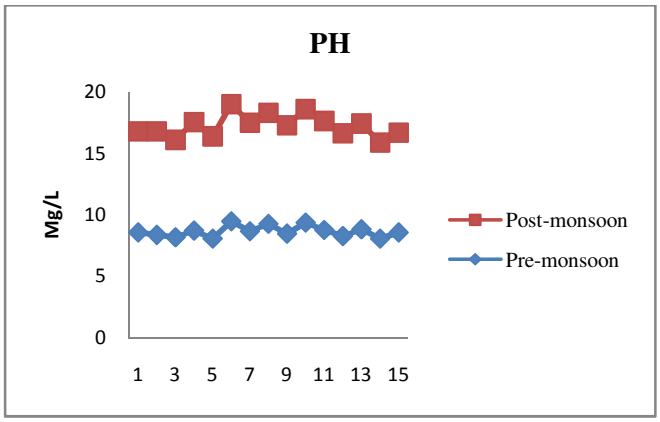
Table-2
Comparison of heavy metal concentration during pre monsoon and post monsoon period (in µg g^{-1})

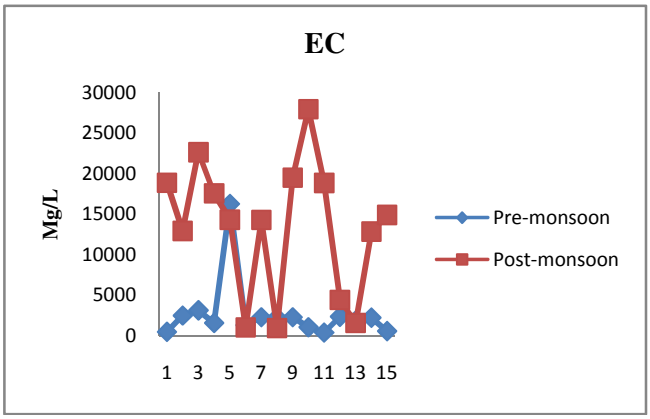
S.No	Pre-monsoon						Post-monsoon					
	Cu	Ni	Cr	Pb	Zn	Cd	Cu	Ni	Cr	Pb	Zn	Cd
1	2.2	ND	58.6	10.43	18.6	4.21	ND	ND	31.85	16.36	66.23	7.43
2	3.92	7.83	ND	12.93	9.3	4.92	33.6	14.18	8.88	24.24	19.79	19.26
3	3.74	ND	94.5	ND	ND	1.42	30.68	4..00	ND	42.42	24.66	19.15
4	5.44	ND	ND	5.26	20.27	2.81	37.98	70.59	7.4	13.33	38.65	13.33
5	15.85	ND	ND	ND	29.17	1.45	32.14	21.17	ND	15.75	42.39	5.92
6	13.86	15.2	112.3	ND	24.1	4.22	18.99	ND	ND	ND	81.12	11.11
7	9.78	11.8	ND	ND	12.66	2.88	ND	21.47	ND	ND	ND	10.37
8	2.18	ND	58.3	ND	74	1.41	40.9	6.58	ND	21.81	38.61	11.85
9	15.84	ND	120.4	3.48	30	2.11	ND	4.23	7.45	7.27	38.29	2.22
10	7.92	ND	103.3	ND	16.07	1.46	17.53	ND	6.67	3.02	ND	8.15
11	ND	11.9	145.5	5.36	39.74	2.88	ND	2.35	ND	46.05	48.67	14.07
12	17.82	12.5	ND	8.57	30.86	2.78	59.89	2.58	ND	4.84	17.84	2.25
13	10.85	ND	ND	ND	16.1	2.9	29.22	9.41	8.15	27.26	29.85	10.39
14	10.78	ND	ND	ND	47.77	2.22	11.69	ND	ND	ND	ND	7.4
15	ND	ND	84.4	6.96	26.63	1.48	ND	1.88	ND	ND	61.65	6.66

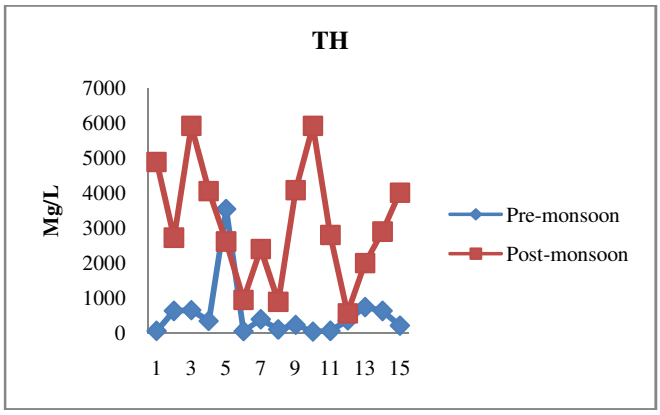
Table-3
Trace elements concentration in coastal sediments of the world [7, 21]

Location	Fe	Mn	Cu	Cr	Co	Cd	Ni	Pb	Zn
Boston Harbor [24]	37 500	NA	112	231.5	NA	NA	34.7	135	176
Tokyo Bay [25]	37 700	1098	53.47	77.3	NA	0.99	32.63	50.68	322
Pichavaram [26]	32 482	701	32	141.2	NA	6.96	62	11.2	89
Pichavaram [27]	24 998	801	132.3	617	NA	34.74	252.1	143.8	106
Gulf of Manna r[22]	5756	128.4	19.8	NA	NA	NA	NA	NA	30.8
Gulf of Mannar [21]	12 600	305	57	177	15	0.16	24	16	73
Bay of Bengal [28]	39 000	529	26	84	NA	NA	64	NA	NA
South East Coast [29]	27 200	373	506.2	194.8	8.1	6.58	38.61	32.36	126.8
Palk Bay [30]	NA	NA	10.6	NA	NA	4.4	NA	44.1	17.7
Palk Bay [31]	3536.7	578.33	16.67	NA	NA	NA	NA	NA	40
Pondicherry [32]	NA	NA	34.59	NA	28.93	7.31	33.51	NA	104.6
East Coast Estuarine [33]	28 000	777	NA	318	12	NA	582	11	125
Krishna Estuary [34]	NA	6978	69	174	NA	NA	149	4	1482
Vellar Estuary [35]	1511	2156.5	36.5	NA	NA	NA	NA	NA	133.5
Pre monsoon (Present study)	-	-	17.82	145.5	-	4.92	15.2	12.93	74
Post monsoon (Present study)	-	-	59.89	31.85	-	19.26	70.59	46.05	81.12

(All parameters in ppm)







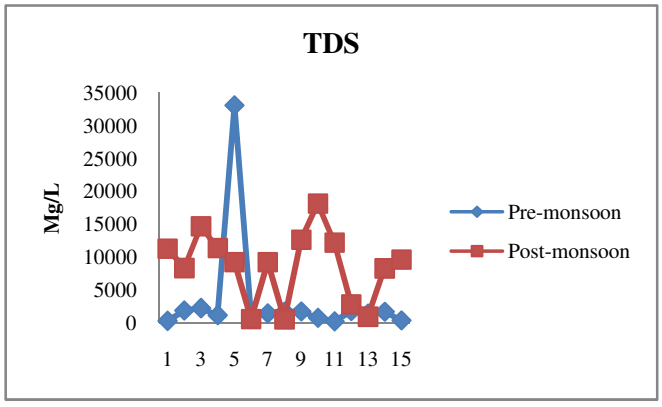
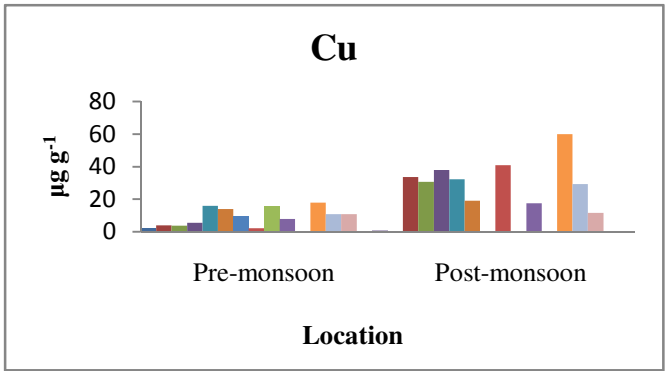
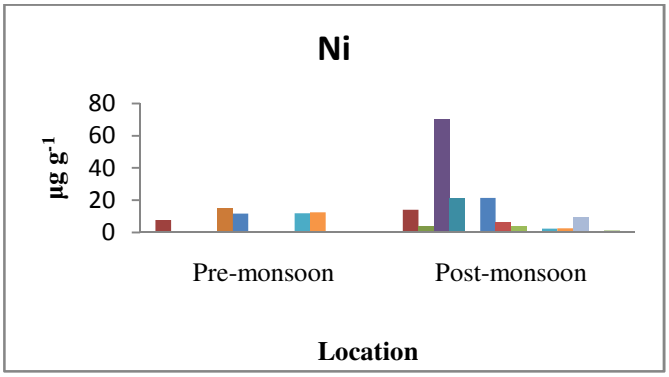
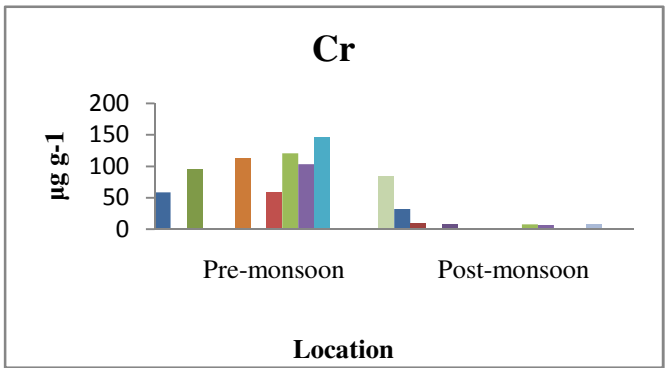
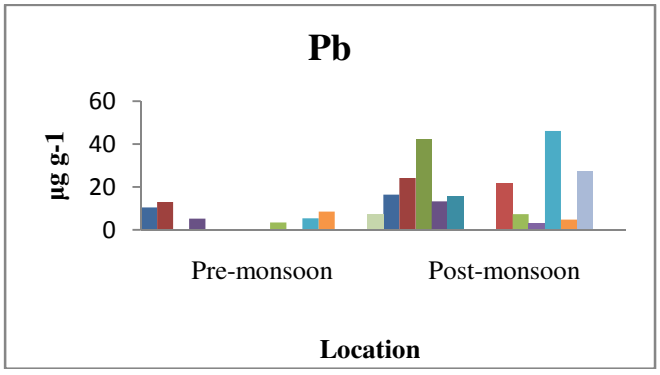


Figure-3
Line diagram showing pH, EC, TH and TDS values of pre monsoon and post monsoon period









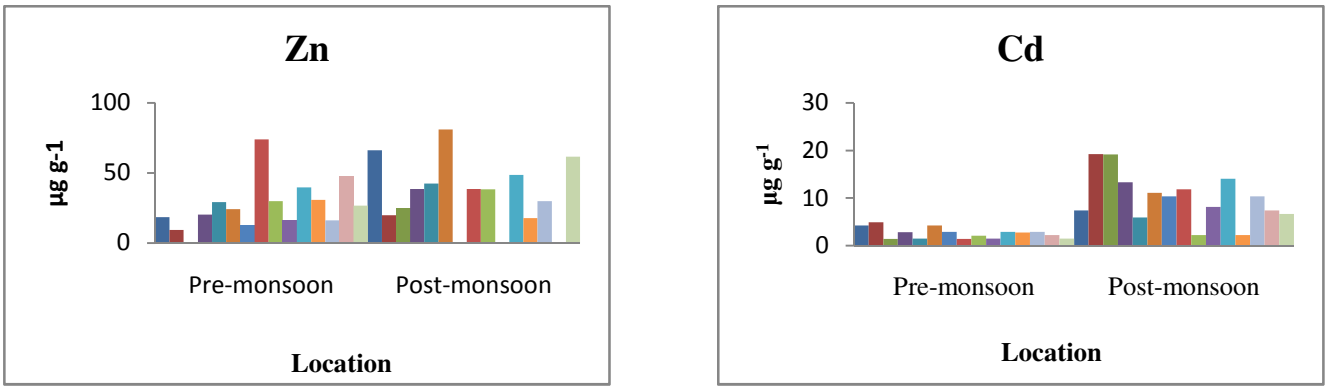


Figure-4
Bar diagram showing metal concentration during pre monsoon and post monsoon

Conclusion

In the present study, sediment analysis was made for the assessment and variation of pollution in different season by analyzing physical and heavy metals to quantify the present-day status of pollution in Tamirabarani River, as well as the fate of those heavy metals, which are important environmental scientific issues. The current study displays useful outfit method and index for the evaluation of sediment contamination, which show the way to safeguard the serious hazard to estuarine environment. Geochemical analysis of sixteen samples shows a higher proportion of pH, TDS, EC, TH which is due to the various sources of input of industrial effluents, which contaminates the sediments of river ecosystems. Heavy metals, especially Cu, Ni, Cr, Pb which can contaminate the sediments and reported higher amount during the post monsoon than the limits reported previously Cr concentration is high during the pre monsoon which is more than recorded values. The ultimate sink of heavy metals in the aquatic systems indicates that rivers are critically contaminated with respect to heavy metals and therefore, pose serious environmental distress. The prime sources are abandoned metal parts and effluents from industrial and commercial activities such as fishing (nets, hooks, etc.) shipping, and outboard engine boats influenced the levels of metals along the river, while domestic activities such as runoff, tidal and wave actions influenced the metal levels along the Tamirabarani River. The area is contaminated with heavy metals and requires a creation of awareness, periodic monitoring. It is concluded that industrial and to some extent, anthropogenic activities are the prime source for this biodegradable toxic metal in the sediment of Tamirabarani River.

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