



Physico-Chemical Parameters and Micro-Nutrients Present in Sand Sediments along Cauvery and Kollidam River in Tiruchirappalli District, Tamil Nadu, India

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Abstract

Thirty sediment samples had been collected along the Cauvery River in Tiruchirappalli district, Tamilnadu, India, at different spots of each to a distance of 3-4 km from the previous one. The presence of micro-nutrients (Zn, Mn, Cu and Fe) and macro-nutrients (N, P and K) were determined by Atomic Absorption Spectrometer and chemical analysis respectively. Also, the physico-chemical parameters (pH and electrical conductivity) were estimated in same sediment samples. The mean value of pH is 7.99 which show that they are almost alkaline in nature. The electrical conductivity ranges from 0.13 dsm^{-1} to 0.25 dsm^{-1} shows the presence of ions in the sand samples. CaCO_3 is absent in the samples as it is washed away by the flowing water in the river as bicarbonates. Most of the nitrogen is not hold by the sand as it has a low cation exchange capacity and it ranges from 34.58 kg/hect to 17.29 kg/hect. The value of phosphorus shows no change in almost all the samples. Potassium occupies from 101.27 kg/hect to 76.57 kg/hect in the sediment samples. There is also a considerable amount of micronutrients present in the samples. These findings suggest that the obtained micro and macro nutrients are in low quantity and produce no eutrophication to the environment.

Keywords: Micro and macro nutrients, eutrophication, physico-chemical analysis, atomic absorption spectrometer, Tiruchirappalli.

Introduction

Sediments in the rivers are considered to be the natural sinks as the use of fertilizers for the agricultural lands, pesticides and mineralogical waste from the industries are drained in to it. The water acts as a carrier for the transport and migration of these pollutants, creates an imbalance in the ecology and environment. The metal pollution and toxicity of the degraded materials can be found by sediment analysis. The physico-chemical parameters, the type of rocks and soils present along the river determine the chemical composition of the sediments¹. The physical and chemical properties depend on the physical topography, climate, temperature, vegetation and microbial activities^{2,3}. Generally sand shows a low conductivity as it depends on the moisture content, size and texture⁴. The elements with mass density greater than 4.5 g/cm^3 are considered to be heavy metals and they are malleable and good conductors of heat and electricity in both solid and in liquid phase⁵. Increase in the ratio of heavy trace metals such as iron [Fe], copper [Cu], manganese [Mn] and zinc [Zn] causes pollution to the environment drastically and also affects the ecology of the system. Fertilizers that find it way in to the rivers and lakes cause algae to bloom usually to the detriment of other life. Herbicide and pesticide run-off kills freshwater organisms more directly; it has the same effect on them as on the animals and plants at which it is mean to be targeted⁶. Polluting the environment by anthropogenic sources include sediment sands pose a major threat to the ecology^{7,8}. The presence of trace

metals are also needed for the vegetation and living organisms, but the accumulation by the discharge of pollutants in various factors and forms is considered to be a pathway for the human exposure in the agricultural areas where the water from the river is used for agricultural and irrigation purposes^{9,10}. These elements are easily soluble and thus they can be penetrated into the internal organs of human beings and animals¹¹. The river sediments act as a medium and analyzing it will provide useful information on environment associated with human health¹².

Study area: The river Cauvery originates from Kodugu hills of Karnataka in Western Ghats and flow towards East of about 765 km from its origin and drains in to Bay of Bengal. It flows through two states and enters Tamil Nadu through Hogenakkal and flows to east irrigating many districts in Tamil Nadu. Agriculture is sustained by the river. The present study covers an area of 83 km in Thiruchirappalli district where two dams are constructed across it namely kollidam and kallarai. The geographical co-ordinates extend from latitude N- $10^{\circ}57'$, E- $78^{\circ}12'$ to N- $10^{\circ}52'$, E- $78^{\circ}54'$. The river becomes wide in the district with a sandy bed from Sriramasamudram to Vathalai and splits in to two rivers namely Cauvery and kollidam that forms an island namely Srirangam. The district has a fertile alluvial soil from west to east and a poor quality of black soil occupies the south. The cretaceous rocks, archean rocks and granite occupy the Thiruchirappalli city. The spots where the samples have been collected in the district to an approximate distance of

3- 4 km and a collection of 30 samples are shown in the map. The places are as follows, Sriramasamudram, Sriramasamudram, Natham, Thirunarayanapuram, Mahendramangalam, Manamedu, Santhapalam (Musuri), Musuri, Savanthilingapuram, Aiyampalayam, Amoor, Vathalai, Jeeyapuram, Mutharasanallur, Kambarasampettai, Kudamuruti, Kondayampettai, Ponnurangam, Puthapuram, Thogur, Kallanai (cauvery), Koothur, Mukkombu, Kiliyanallur, Thudaiyur, Srirangarayapuram, No.1. Toll gate, Valadi, Thirumanamedu East, Kallanai (Kollidam)

Material and Methods

The sediment samples were collected manually from the specified spots using a peterson crab and polythene bags. The collected sand samples were off to a depth of about 10 cm from the top layer. They were then carried to the laboratory for estimation. The collected samples were initially washed with distilled water to remove the dissolved salts and placed in a hot - air oven for about 2 hours maintained at a temperature of 110°C.

The subjected samples were sieved with a 1mm mesh to make it a homogenous one. The amount of the hydrogen ion concentration and electrical conductivity in the samples were analyzed by ERMA-s 358236 pH meter and systronics conductivity meter-304 respectively. CaCO_3 was examined by chemical analysis. The macro-nutrient such as nitrogen was determined by alkaline potassium permanganate method, phosphorus by Olsen method and potassium by flame photometer. The micronutrients present in the samples such as Fe, Zn, Mn and Cu were estimated by atomic absorption spectrometer.

Results and Discussion

The analytical data of the collected sand samples in Tiruchirappalli district along the Cauvery and Kollidam river are as shown in table 1. The sampling spots from 1-22 lie in the Cauvery river where as the spots from 22-30 occupies the kollidam river.

Table-1
Presence of Hydrogen ion, Electrical Conductivity, Micro and Macro nutrients present in the sediments along the Cauvery and Kollidam River in Tiruchirappalli District, Tamil Nadu, India

S. No	pH	EC dsm^{-1}	N Kg/hect	P Kg/hect	K Kg/hect	Zn ppm	Mn ppm	Cu ppm	Fe ppm
1.	7.4	0.16	34.58	1.235	76.57	0.84	3.77	1.02	4.45
2.	7.1	0.17	31.12	1.235	76.57	0.86	3.93	1.01	3.82
3.	7.8	0.13	27.66	1.235	83.98	0.75	4.23	0.96	3.79
4.	7.9	0.17	24.20	1.235	86.45	1.22	4.27	1.62	3.86
5.	7.8	0.17	27.66	1.235	79.04	1.08	4.31	0.96	3.78
6.	8.0	0.17	24.20	1.235	79.04	1.06	4.29	1.02	3.87
7.	8.1	0.15	27.66	1.235	79.04	0.62	4.43	1.01	4.34
8.	8.2	0.16	20.74	1.235	76.57	1.09	4.39	0.94	3.87
9.	8.1	0.15	17.29	1.235	86.45	0.92	4.43	0.93	3.34
10.	8.2	0.16	27.66	1.235	81.51	1.08	4.39	0.98	2.74
11.	7.9	0.16	27.66	1.235	81.51	1.00	4.44	0.92	4.05
12.	8.5	0.15	24.20	1.235	79.04	1.02	4.45	0.96	3.79
13.	8.5	0.18	17.29	1.235	83.98	1.03	4.53	0.94	3.70
14.	8.4	0.16	20.74	1.235	81.51	0.98	4.53	0.93	4.04
15.	8.4	0.24	31.12	2.47	101.27	0.97	4.70	0.97	4.01
16.	8.4	0.13	27.66	1.235	79.04	0.89	4.51	0.93	3.83
17.	8.3	0.21	24.20	1.235	79.04	0.84	4.69	1.01	3.76
18.	8.2	0.25	31.12	1.235	93.86	0.97	4.50	1.00	3.92
19.	8.2	0.18	24.20	1.235	81.51	0.94	4.53	1.01	4.24
20.	7.9	0.14	31.12	1.235	79.04	0.94	4.50	0.96	3.82
21.	7.9	0.13	20.74	1.235	81.51	0.95	4.51	0.98	4.34
22.	8.4	0.16	27.66	1.235	88.92	0.85	4.53	0.97	4.08
23.	8.4	0.16	27.66	1.235	79.04	1.03	4.40	1.01	4.53
24.	8.5	0.16	27.66	1.235	81.51	0.89	4.75	1.01	4.18
25.	8.3	0.13	24.20	1.235	83.98	0.90	4.89	0.96	3.78
26.	8.0	0.13	20.74	1.235	79.04	0.90	4.67	0.89	4.03
27.	7.4	0.20	27.66	1.235	91.39	0.90	4.77	0.97	4.2
28.	6.6	0.20	31.12	1.235	79.04	0.98	4.98	0.83	3.91
29.	7.0	0.17	24.20	1.235	98.8	0.98	4.72	0.96	3.87
30.	8.0	0.14	24.20	4.94	79.04	0.90	4.53	0.98	3.81

pH: The pH is the main parameter to be considered in sediments as it controls the heavy metal transfer¹³. The hydrogen ion concentration (pH) of 30 samples at different spots collected along the rivers in the district ranges from 6.6 to 8.5 and the mean value of pH is 7.99 which show that the collected sediment samples are almost alkaline in nature. The variation in pH at different spots along the rivers is tabulated in table-1. The sample site at 28 shows the sediment has a lower pH value is slightly acidic in nature which is due to anthropogenic activities. The sample sites 12, 13 and 24 show a pH of 8.5 reveals that they are alkaline in nature. The distribution of pH in the samples is shown in figure-2. The variation of pH is primarily due to the types of soils nearby and anthropogenic activities.

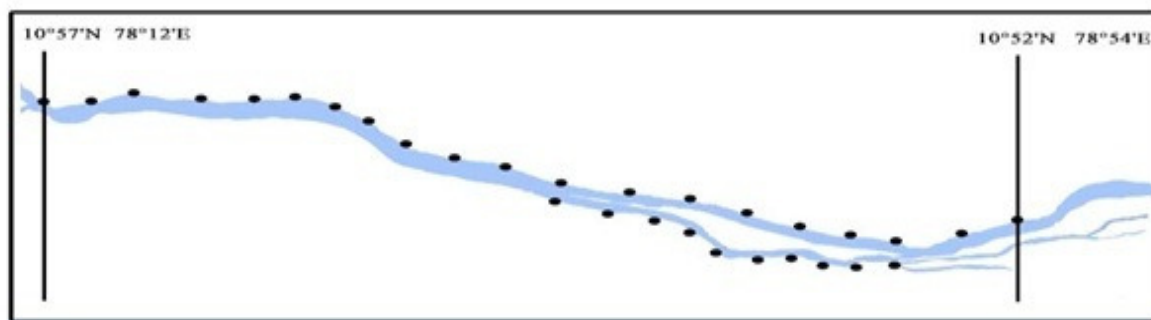
Electrical Conductivity: Electrical conductivity depends on the percentage of ions present in the sand like potassium, sodium, calcium, magnesium, chloride, etc¹⁴. The sediment samples at the sites occupied by these types of ions ranges from 0.13 dsm^{-1} to 0.24 dsm^{-1} . The values of EC for the 30 samples in the district are shown in the table-1. The sample at the site 18 has a maximum EC value of 0.24 dsm^{-1} shows that the site has more amounts of soluble salts and a low level of silicate. Samples at the sites 3, 16, 21, 25, 26 have high levels of silicate and a low level of ions, and EC value of about 0.13 dsm^{-1} . Figure-3 shows the distribution of ions present at the sites that promotes EC at different spots. The EC of other samples lie in between them as shown in figure-3.



Map-1: India



Map 2: Tamil Nadu



Map-3: Sample Locations at Tiruchirappalli District along Cauvery and Kollidam River

Figure-1

Map. Sample spots along the rivers in Tiruchirappalli district

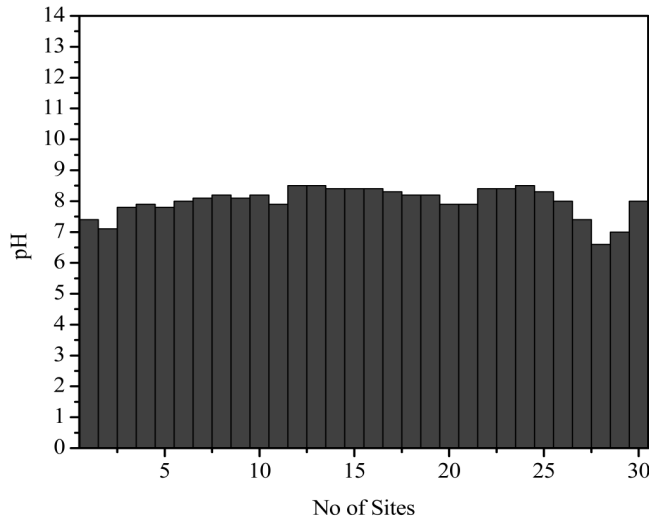


Figure-2

Hydrogen ion concentration in sediment samples

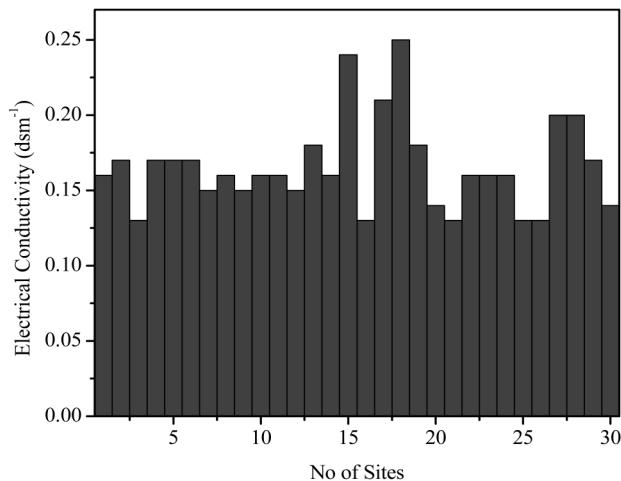


Figure-3

Electrical conductivity of sediment samples

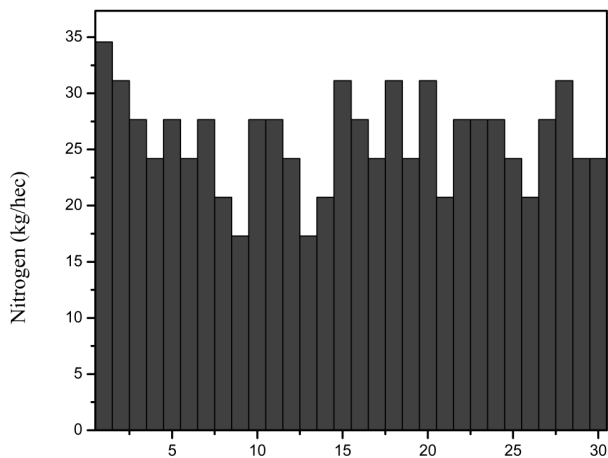


Figure-4

Presence of nitrogen in sediment samples

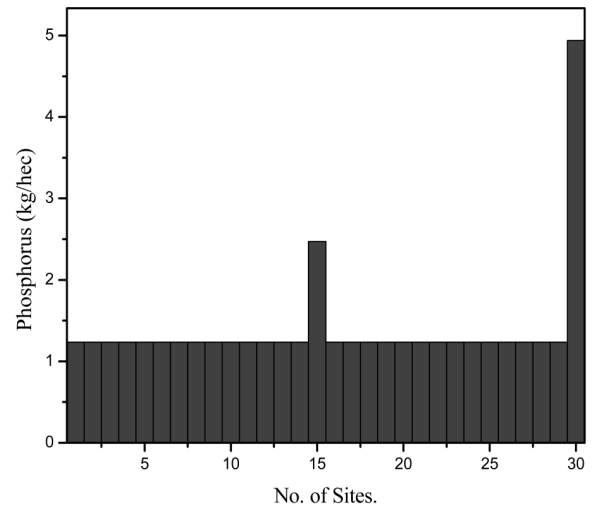


Figure-5

Presence of phosphorus in sediment samples

Nitrogen: The presence of nitrogen in the sediment sand is minimal. It also depends on the storage and discharge of water in dams and reservoirs. If the water in the dams is stored for a long time and the discharge is minimal, it promotes denitrification and sedimentation of nitrogen¹⁵. The samples collected have nitrogen content that lie between 34.58 kg/hect and 17.29 kg/hect. The value of nitrogen present in the samples is displayed in table-1. A Maximum of 34.58 kg/hect is observed in the sample spot 1, which may be due to the excess addition of fertilizers rich in nitrogen content like urea for the growth of plants. At the sample sites 9 and 13 a minimum of 17.29 kg/hect is present. The presence of nitrogen in the sand samples is recorded in figure-4. Moderate amount of nitrogen is present along the Kollidam river than in Cauvery River. The value of nitrogen in other spots lie between them and are shown in table-1 and in figure-4. The mean value of nitrogen in 30 samples is 25.93 kg/hect. The main cause for the presence of nitrogen in the sediments is due to fertilizers and herbicides. The values pretend to the very low and hence they tend to no eutrophication and are not harmful to the aquatic environment.

Phosphorus: Sediments are considered to be the sinks for phosphorus and it depends on the immunological conditions and sediment compositions¹⁶. As if like nitrogen, phosphorus too produce blooms causes an eutrophication to the marine ecology¹⁷. Table-1 provides the information of phosphorus present at the sites. Figure-5 shows the amount of phosphorus present in the collected samples. The amount of phosphorus remains constant throughout the samples except at the sites 15 and 30. At the site 15 a small check dam is constructed across the river and at site 30 kallanai dam is located. Phosphorus occupies an amount of 1.235 kg/hect in all the samples expect at sites 15 and 30. The site 15 has a phosphorus value of 2.47 kg/hect and 4.94 kg/hect at the last sample site.

Potassium: Potassium concentration in sediments ranges from

101.27 kg/hect to 76.57 kg/hect. Generally the element K occurs as K^+ ions in water. The value of potassium is estimated for the sites and is listed in table-1. Higher the concentration of potassium of about 101.27 kg/hect is observed for the sample 15, where a check dam is constructed across the river and a lower value of 76.57 kg/hect at the sites 1, 2 and 8. Figure-6 represents the distribution of potassium at the collected sites.

Zinc: Zinc occurs in the form of silicates and oxides¹⁸. A small amount of zinc is considered to be an essential nutrient but proves to be toxic at its higher level of concentration to the aquatic organisms¹⁹. A low quantity of zinc intake by the human beings results in retardation of growth, anemia etc., and the rivers normally contain a zinc concentration between 5-10 ppb and in sea water it varies from 0.6-5 ppb. The zinc concentration of the present research work in Tiruchirappalli district is given in table-1. Site 1 has a low value of 0.84 ppm than the other values and it occupies a high level of concentration in the fourth sample of about 1.22 ppm, may be due to the type of rocks and soils present along the sampling sites. In the kollidam river, except at the first site, the zinc concentration is very low. The variation of zinc concentration is shown in figure-7. The critical toxic level of zinc is 100 ppm for plants²⁰. Even though the concentration is higher in Cauvery than kollidam river, the values are of very low when compared to the standard agricultural values.

Manganese: Manganese has not been considered to be too much hazardous and toxic but the concentration of it in a particular spot may vary the taste and even causes turbidity. The maximum permissible limit for manganese is 0.1 mg/L was set by World Health Organization WHO (2003). By atomic absorption spectrometer, the concentration of manganese is found to lie between 3.77 ppm to 4.98 ppm and the values of the samples are given in table-1. The values of the samples present along the Kollidam river in the district have high amount of Manganese than Cauvery river samples. The figure-8 clearly depicts the amount of the element present in the samples.

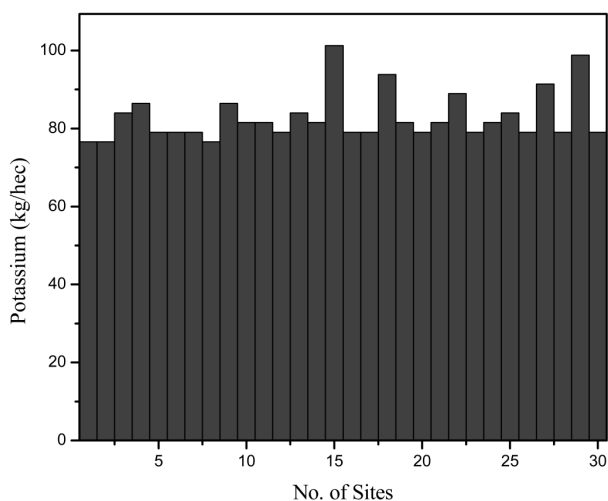


Figure-6
Presence of potassium in sediments

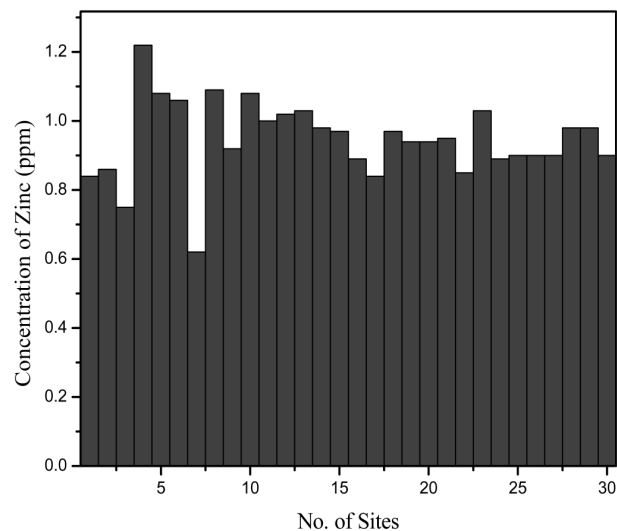


Figure-7
Presence of zinc in sediments

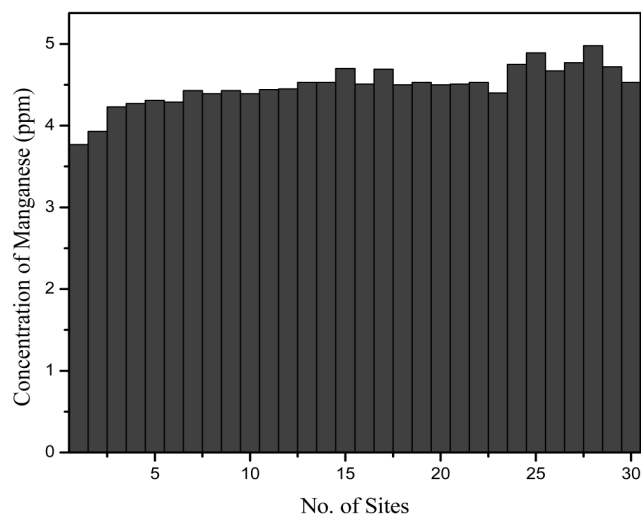


Figure-8
Presence of manganese in sediments

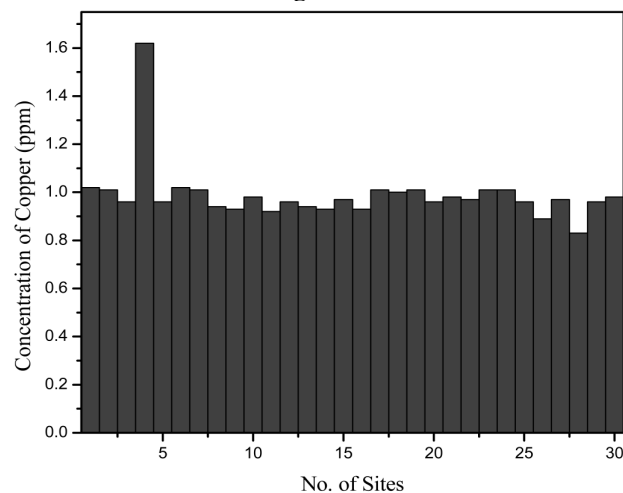


Figure-9
Presence of copper in sediments

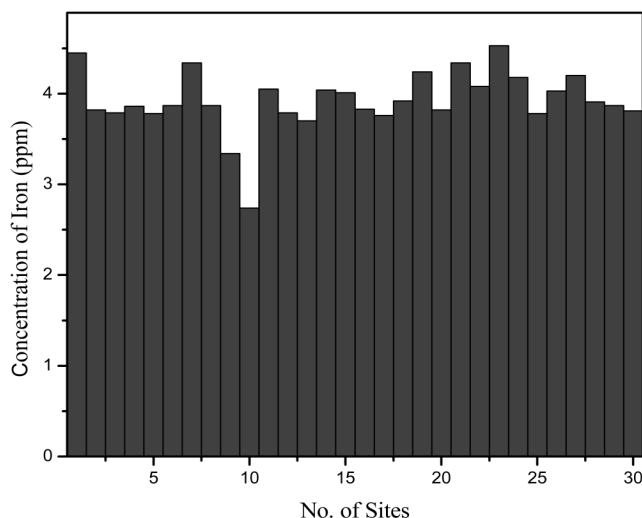


Figure-10
Presence of iron in sediment samples

Copper: Copper is considered to be an essential metal. The concentration of copper in marine sediments is well below 100mg/g²¹. The element copper reacts with organic matter in aqueous phase results in settling of the element in sediments²². Only a small amount of copper is present in all the sediment samples of which sample site 4 has a maximum value of 1.62 ppm is shown in figure-9. The concentration of copper in the sediments ranges from 1.62 ppm to 0.83 ppm. With an approximate value of 1.00 ppm of copper is present in the sediments except for the site 4. The values of the copper present in the collected sand samples are shown in table-1.

Iron: Iron is an important nutrient for plants and animals. The deficiency of iron is a major problem for living beings and about 10-18 mg of iron content is required for adults per day²³. Iron, steel industry and sewage form the main source for anthropogenic activities. The concentration of iron lies between 4.53 ppm and 2.70 ppm. The concentration of iron in the samples is shown in the table-1. The sample site 23 occupies more amount of iron content than the other sites. Only of about 2.70 ppm of iron is present at the sample site 10. The distribution of iron at the sites is portrayed in the figure-10.

CaCO₃: Calcium carbonate estimated by 10% concentrated HCl proves the samples are free from it as they are dissolved in water as bicarbonate and carried away from the surface.

Conclusion

From the current research the accumulation of micro and macro nutrients present in the upper surface of the sediments in the Cauvery and Kollidam River in Tiruchirappalli district are studied. The mean value of pH is slightly alkaline in nature along the river sand beds. The chemical composition and anthropogenic activities play a major role in physico-chemical parameters of the sediments. Agriculture is the basic occupation

in the delta region, a non- industrial area along the river and hence the river is not polluted much, the presence of micro and macro nutrients is of low compared to the standards. The waste from the drainage, use of fertilizers, pesticides, herbicides and agricultural run-off are the major pollutants in the river. From the study it is confirmed that iron and manganese forms a major portion of trace metals than zinc and copper. It is recommended, in order to maintain the river with no harmful effects, the use of excess of fertilizers for crops, disposal of industrial waste and anthropogenic activities should be avoided and the natural sediments can be conserved and preserved.

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