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Quality Assessment of Sediments in Chalakudy River with Special Reference to Phosphate Fractionation and Metallic Contamination

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Abstract: The last decade has seen an exponential growth in our understanding of contaminants in sediments. Sediments play an important role in elemental cycling in the aquatic environment; it can be sensitive indicator for monitoring contaminants in aquatic environments. Phosphorus is often the limiting nutrient for algal growth and may limit productivity. Polluted sediments, in turn, can act as sources of heavy metals, imparting them into the water and debasing water quality. The heavy metal prominence, the amount and different forms of phosphorus present in Chalakudy river will be studied and reported in this paper.
Keywords: Sediments, Phosphorus fractions, Heavy metals, Contamination

1. Introduction

Sediments are materials formed due to transportation and deposition of organic and mineral matter found at the bottom of oceans, lakes, ponds and rivers. River sediments serve as a sink and reservoir for a variety of environmental contaminants. Sediment has an important role in the nutrient cycle of aquatic environments. In some cases, sediment is responsible for transport of essential nutrients as well as pollutants. Therefore, the assessment of sediment is more conservative than water quality assessment for determining the degree of contamination and toxicity. Phosphorus has been recognized as the most critical nutrient limiting lake productivity. Heavy metals contamination in aquatic environment is of critical concern, due to toxicity of metals and their accumulation in aquatic habitats. Trace metals in contrast to most pollutants, are non- biodegradable and they undergo a global ecological cycle in which natural water are the main pathways. Any improvement in water quality must address sediments as an important component of aquatic ecosystems and a source of contaminants to the overlying waters and to the ecosystem through the benthic food chain.

2. Literature review

Asibor Godwin et.al (2015) made a study on the characteristic of sediment quality was to evaluate the heavy metal content of Asejire Reservoir. Twenty stations were selected, sampled and analyzed using standard methods. Standard pollution indices such as I_{geo}, enrichment factor, contamination factor and pollution load index were deployed to assess the level of heavy metals contamination in the reservoir. The result showed that the sediment was slightly acidic across the study stations, with low conductivity and organic matter content. The heavy metals order of dominance was: Fe>Pb>Cu>Zn>Mn>Ba>Ni>Cr.

A.R. Karbassi and M. Pazoki (2015) investigated the concentrations of heavy metals (Ca, Zn, Cu, Fe, Mn, Ni) in the sediment of Shavoor river in Khuzestan province in Iran. After the library studies and field studies, six samples of water and sediment were taken from the river in order to evaluate heavy metal pollution in sediments.For quantitative assessment of the severity of contamination in the sediments, the geochemical indicators such as enriched factor (EF) and the geoaccumulation index (Igeo) were used. Also, the statistical analyses including methods such as correlation analysis and cluster analysis were conducted. The results of the experiments showed that the organic matter deposited varies with the average of 2.49 and ranges between 1.95% and 3.43%. Samples showed concentrations of metals such as calcium, iron, manganese and nickel at all the sampling points were below the global average, whereas the concentration of copper was slightly higher than the global scale.

Ebru Yesim Ozkan (2012) investigated the distribution, controlling geochemical factors and contamination status of heavy metals in inner Izmir Bay (Eastern part of Aegean Sea). 23 surface sediment samples were collected and analyzed for major elements (Al and Fe), heavy metals (Pb, Zn, Cd, Cu, Hg, Cr, Mn), organic matter, grain size composition, carbonate and Chl.-a. Metals controlling factors were elucidated

based on statistical methods such as the pearson product-moment linear correlation and factor analysis. The results illustrated that Pb, Zn, Cr and Cd are mainly controlled by organic matter and a lesser extent Fe. Pb also controlled by carbonate and Mn additionally.

Moonampadiyan Shiji et.al (2015) evaluated the characteristics of P fractions and heavy metal accumulation in sediments of Kavvayi Wetland of northern Kerala, India. The fractionation study concluded that organic phosphorus (OP) was the intensified fraction in Kavvayi lake sediments. The correlation analysis provides evidence on the inter dependence of different phosphorus forms, Fe, OC and TA. Heavy metals exhibit random distribution and follow the order Fe > Mn > Pb > Zn > Ni> Cu > Cd in Kavvayi lake sediments.Multivariate PCA and CA manifest dominantly anthropogenic contributions of Pb, Cd, Cu, Ni and Zn in the sediments. Out of 10 samples, KV-2 (mixing point of Kavvayi river into Lake), KV-6 (Ayittikadavu) and KV-11 (mixing point of Nileswar River into Kavvayi Lake) are considerably contaminated and their PLI values also show a high pollution load.

Claude Nambaje et.al (2016) assessed heavy metals like Fe, Mn, Cr, Cu, Ni, Co, Pb, Cd and Zn in core sediments of lower Gadilam River, Cuddalore district. Regarding their vertical distribution in chosen three sampling locations (river mouth, estuary and fresh water), some metals like copper are of higher concentration at greater depth due to water infiltration and some others like cobalt are of higher concentration at top layer because of their preference of oxidised layers. The relative decreasing order of all analyzed metals, in terms of their average concentrations, is the following order: Fe>Zn>Mn>Cu>Co>Pb>Ni>Cr>Cd.

Mahmud Hassan et.al (2015) undertaken a study to assess the levels of heavy metals and the extent of pollution in the surface water and sediments from the Meghna river. Water and sediment samples were collected by the standard methods and processed and analyzed for heavy metals using flame atomic absorption spectrophotometer (FAAS). The mean concentrations of heavy metal found in the river water were in the order of: Fe (1.0224 mg L^{-1}) > Zn (0.0364 mg L^{-1}) > Cr (0.0346 mg L^{-1}) > Mn (0.0088 mg L^{-1}) > Cd (0.003 mg L^{-1}) and in the sediments in the order of: Fe (1281.416 mg kg^{-1}) > Mn (442.596 mg kg^{-1}) > Zn (79.021 mg kg^{-1}) > Ni (76.116 mg kg^{-1}) > Cr (31.739 mg kg^{-1}) > Pb (9.4702 mg kg−1) > Cd (0.230 mg kg−1). Pb and Ni were found below detection limit in river water.

3. Chalakudy river

Chalakudy River or Chalakudy Puzha is the fifth longest river in Kerala, India. The river flows through Palakkad district, Thrissur District and Ernakulam District of Kerala. The total drainage area of the river is 1704 km². Out of this 1404 km² lies in Kerala and the rest 300 km² in Tamil Nadu. The length of the river is 145.5 km. Though Chalakudy river in strict geological sense is a tributary of the Periyar river, for all practical purposes it is treated as a separate river by government and other agencies. The river has gained its name, since it flows along the banks of the Chalakudy Town, the major settlement along the course of the river. The famous waterfalls, Athirappilly falls and Vazhachal falls, are situated on this river.

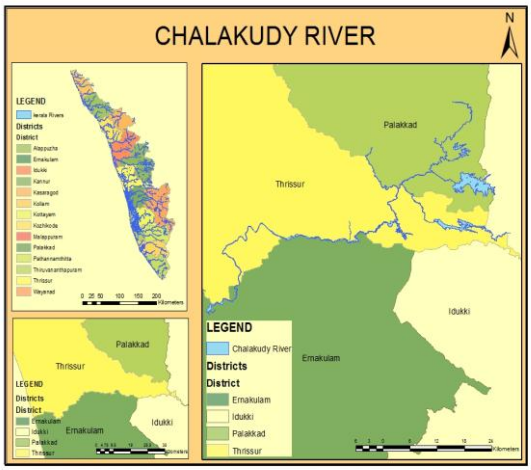


Figure 1: Chalakudy river

Table 1: Sampling stations of Chalakudy river

SI No:	Sampling stations	Latitude (in decimals)	Longitude (in decimals)
1.	Kadukutty	10.257222	76.317222
2.	Vynthala	10.268888	76.299444
3.	Muringur	10.291111	76 .340833
4.	Vettukadavu	10.305277	76.348888
5.	Meloor	10.305752	76.393687
6.	Thumboormuzhi	10.296848	76.452996
7.	Pariyaram	10.285583	76.561201
8.	Vazhachal	10.302686	76.593270

4. Materials and Methods

4.1 Materials used

The surface sediment samples were taken at a depth of nearly 10 cm and placed in polythene bags, preserved in ice and transported to laboratory. The sediment samples were dried, powdered and sieved for chemical analysis. Eight sampling stations were selected for assessment of sediments.

Figure 2:Sediment collected in polythene bag

4.2 Methodology

Sediment pH was measured electrometrically with glass electrode pH meter in water. Total alkalinity was measured using acid base titration. The wet oxidation method of Walkley and Black was used to determine the organic carbon content in the sediment samples. The sediment particle size was determined using sieve analysis. Fractionations of phosphorus in the sediment samples were done using the Williams method. Iron content is determined using titration with permanganate solution followed by measurement using spectrophotometer. Manganese and zinc were determined using EDTA titrimetric method. Copper was also determined using titrimetric method. Distribution of lead and cadmium was determined using atomic absorption spectrophotometer.

5. Results and Discussions

5.1 Plotting of sampling points

Sampling stations of Chalakudy river were plotted using ArcGIS 10.3.1 software.

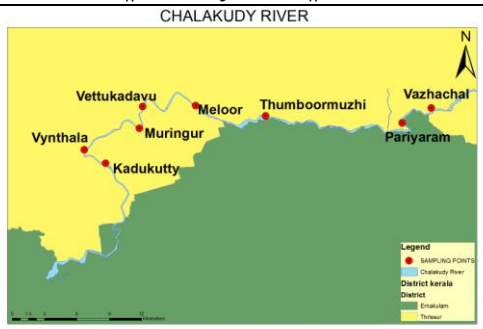


Figure 3: Sediment sampling stations of Chalakudy river

5.2 Preliminary test results

pH values of Chalakudy river ranged from 6.14-7.53. pH values in almost all stations are near neutrality. The highest values of total alkalinity content in the study area were found in station 3. Sediment organic content is an important determinant of the fate of nutrients in aquatic systems. The organic content of samples ranged from 0.6 to 1.9 with an average of 1.075 %. The highest organic content was found in stations 1 and 3. Stations 5 and 6 also have comparatively high organic content. High organic carbon concentrations should correlate with aquatic productivity or anthropogenic output. Sediment grain size may be a good indicator of a variety of physical characteristics, including current conditions. Sand was the predominant form, followed by silt. Clay was generally low at all stations and slight increase could be seen in station 3.

Table 2: Preliminary test results of Chalakudy river sediments

Parameters	Unit	Value Reported							
		1	2	3	4	5	6	7	8
pH	pH units	6.8	6.26	7.53	6.14	6.54	6.3	6.9	7.2
Total alkalinity	mg/kg	289.5	200.6	716.5	198.8	254.2	226.9	350.3	396.5
Organic carbon	%	1.9	0.8	1.85	0.75	1.22	1.02	0.6	0.46
Particle size Sand	%	53.4	55.0	54.1	54.9	55.2	53.2	54.0	53.7
Silt		42.5	41.2	40.8	41.7	42.2	43	42.9	43.2
Clay		2.8	2.6	4.2	2.8	2.1	3.2	2.0	2.2

(1) Kadukutty (2) Vynthala (3) Muringur (4) Vettukadavu (5) Meloor
(6) Thumboormuzhi (7) Pariyaram (8) Vazhachal

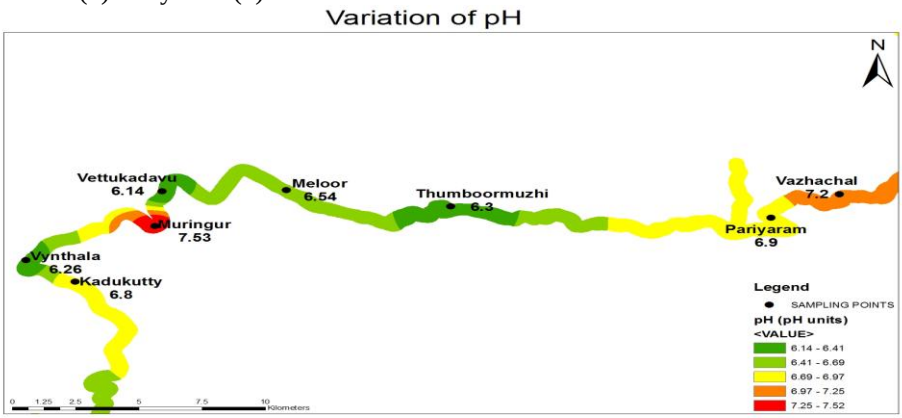


Figure4: Variation in pH values in sediments of Chalakudy river

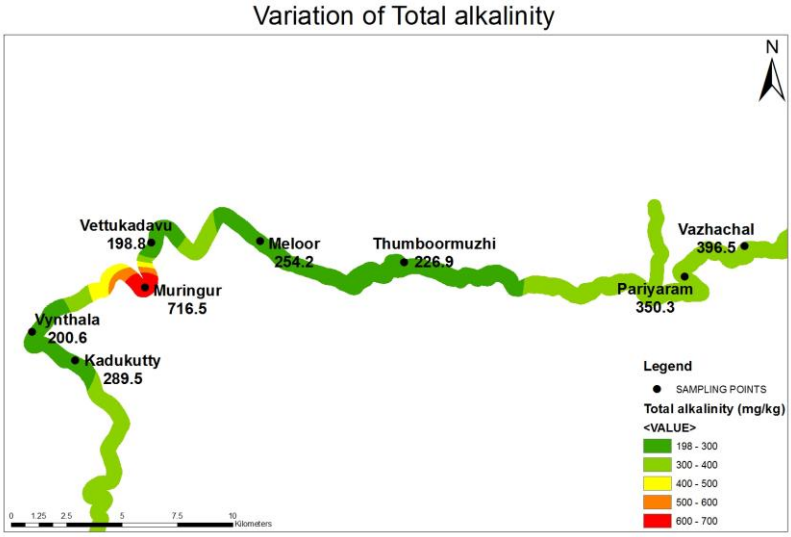


Figure 5: Variation in total alkalinity values in sediments of Chalakudy river

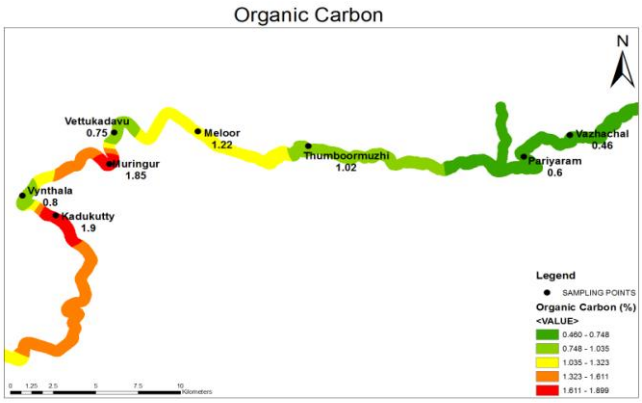


Figure 6: Spatial distribution of organic carbon (in %) in sediment samples of Chalakudy river

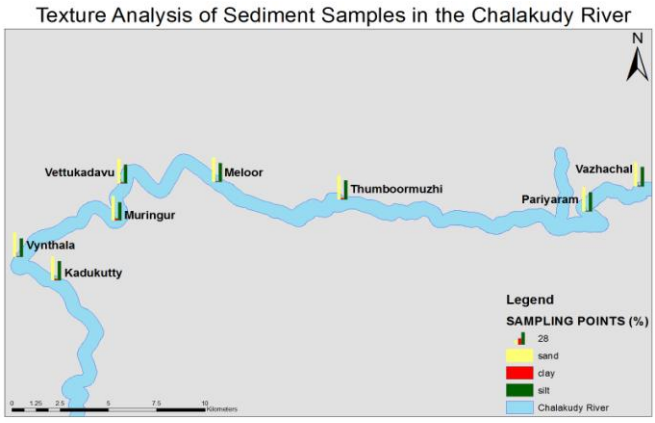


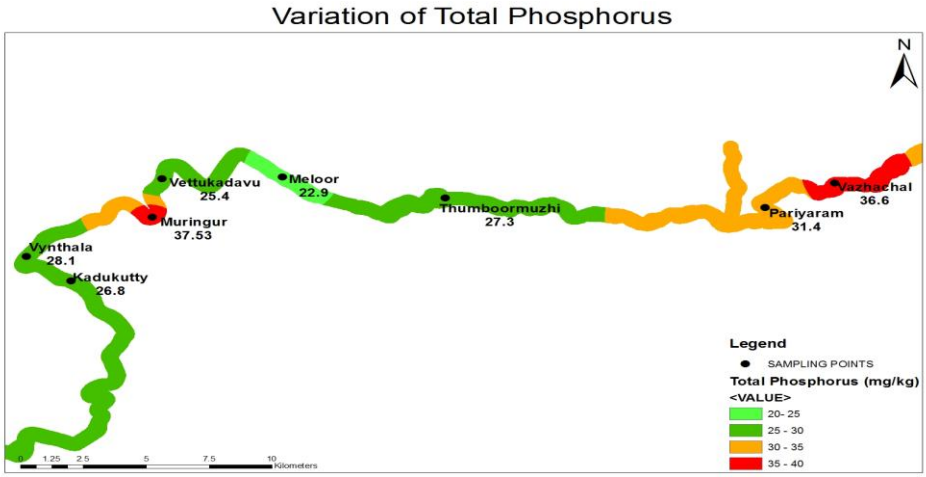
Figure 7 : Texture analysis of sediment samples

5.3 Phosphorus fractionation of sediment samples

Table 3: Phosphorus fractionation of sediments of Chalakudy river

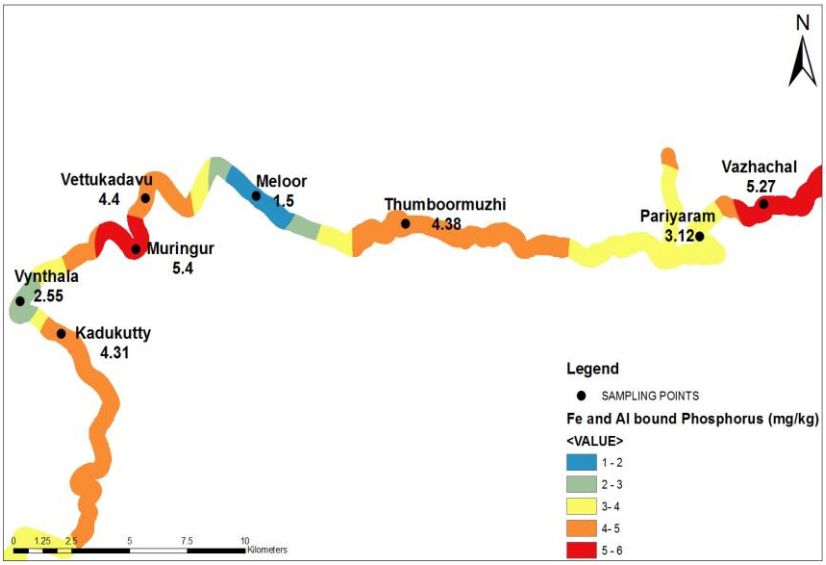
Sampling stations	Phosphorus fractions(mg/kg)				
	TP	Fe-Al P	Ca-P	OP	IP
1	26.8	4.31	0.14	18.4	1.1
2	28.1	2.55	0.15	23.6	0.8
3	37.53	5.4	ND	30.1	ND
4	25.4	4.40	0.10	17.6	0.92
5	22.9	1.5	ND	19.7	1.11
6	27.3	4.38	0.11	17.9	1.12
7	31.4	3.12	0.16	26.9	0.77
8	36.6	5.27	0.22	28.8	ND
Average	29.503	3.866	0.16	22.875	0.97

P is primarily obtained to the riverine system from weathering of phosphate rock. But, phosphorus inputs from animal waste, fertilizers and detergents exceed by far the phosphorus generated from rock and mineral weathering. Based on the data obtained for the analysis of sediment samples, the average TP concentration of the sediments was 29.503 mg/kg. Comparing TP in all stations, maximum concentration was observed in station 3(Muringur) and minimum in station 5(Meloor). Among the inorganic phosphorus fractions, NaOH-P was found to be the major fraction in all the samples. The NaOH-P represents P bound to metal oxides, mainly of Al and Fe, which is exchangeable again with OH^- and inorganic P compounds soluble in bases and can be used for the estimation of both short-term and long-term available P in sediments. It is a measure of algal available P. When the anoxic conditions prevail at the sediment-water interface, Fe-Al P will be released for the growth of phytoplankton. The Fe and Al bound phosphorus is released during NaOH extraction and its average concentration was 3.866 mg/kg. Higher concentration of NaOH-P (5.4 mg/kg) was observed in station 3(Muringur). Calcium bound P (CaP) is a relatively stable fraction of sedimentary P and contributes to a permanent burial of P in sediments. CaP is the least fractioned phosphorus form in Chalakudy river sediments. CaP showed the range of not detected to 0.22 mg/kg with maximum in the station 8(Vazhachal). Among the four fractions, organic phosphorus (OP) is the intensified fraction in sediments of Chalakudy river.OP contributes 65.56%- 85.66% of the total phosphorus. Maximum concentration (30.1mg/kg) was observed in station 3(Muringur) and minimum concentration (17.6 mg/kg) in the sample collected in station 4(Vettukadavu). The average concentration of organic phosphorus observed was 22.875mg/kg. The high percentage of organic bound phosphorus indicates that the mineralization of phosphorus is less in the sediment samples. The inorganic phosphorus(IP) content in the sediment samples ranged from 0.77 to 1.12 mg/kg and maximum value was found in the sample collected from station 6(Thumboormuzhi). Phosphorus contamination may be due to poorly treated stormwater, soil erosion,pet wastes, mishandling of leaves and grass clippings, misapplication of fertilizer ,phosphorus containing detergents etc. The interpolated maps were created using ArcGIS 10.3.1. It describes the distribution of sediment bound phosphorus forms along the sediments of Chalakudy river.



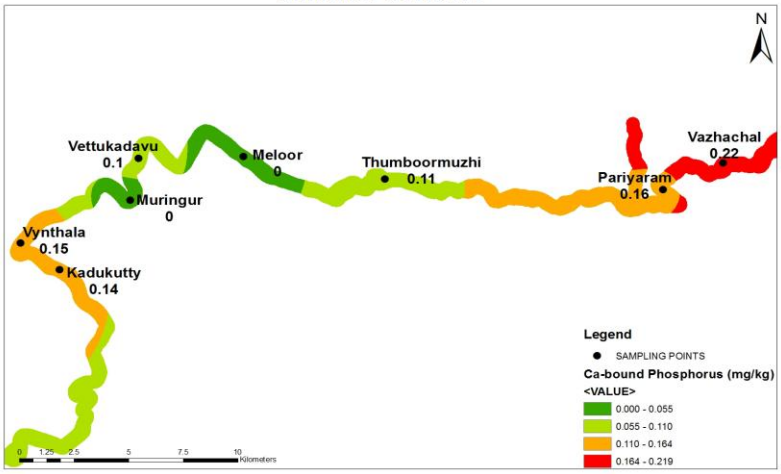
(a)

Variation of NaOH-P



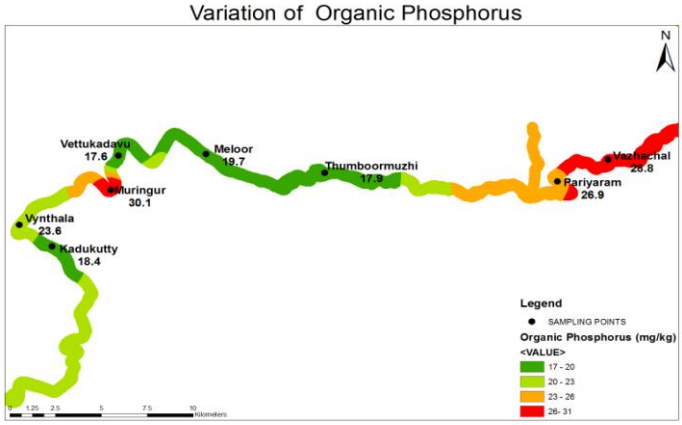
(b)

Variation of HCL-P



(c)

Variation of Organic Phosphorus



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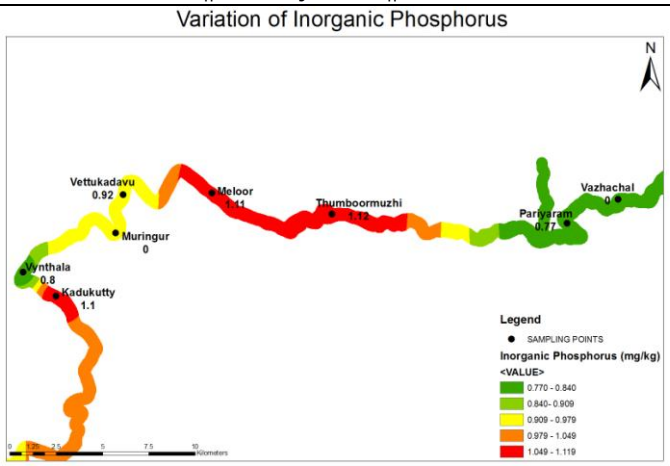


(e)

Figure 8: Spatial distribution of (a) TP (b) NaOH -P (c) HCl-P (d) OP (e) IP in sediment samples of Chalakudy river

5.4 Correlation of different phosphorus fractions versus organic carbon, iron, total alkalinity and pH

Table 4: Correlation coefficient matrix showing correlation of different phosphorus fractions, OC, Fe, pH and

Variables	Fe-Al P	Ca-P	OP	IP	TP	OC	Fe	pH	TA
Fe-Al P	1	-	-	-	-	-	-	-	-
Ca-P	0.224	1	-	-	-	-	-	-	-
OP	0.317	0.128	1	-	-	-	-	-	-
IP	-0.604	-0.110	-0.895	1	-	-	-	-	-
TP	0.676	0.220	0.908	-0.940	1	-	-	-	-
OC	0.166	-0.597	-0.117	0.068	-0.020	1	-	-	-
Fe	0.257	0.092	0.305	-0.232	0.375	0.664	1	-	-
pH	0.498	-0.067	0.816	-0.795	0.842	0.333	0.576	1	-
TA	0.538	-0.335	0.774	-0.794	0.820	0.439	0.451	0.914	1

TA

Statistical analysis has been carried out by Pearson's correlation coefficient between different phosphorus fractions, organic carbon, iron, pH and total alkalinity to find out the interdependence among the components. The results of the correlation analysis indicate that iron showed positive correlation with organic carbon (r =0.664). This suggests that as the organic carbon in the sediment sample increases, the iron content also increases. OC showed weak positive correlation with Fe-Al P and IP, but insignificant correlation with Ca-P, OP and TP. pH showed significant correlation with OP, TP and Fe. TA showed strong positive correlation with OP, TP and pH.

5.5 Principal component analysis of phosphorus fractions

Table 5: Component loadings of phosphorus fractions

Variables	Component	
	PC1	**PC2**
Fe-Al P	0.703	0.246
Ca-P	0.263	0.923
OP	0.891	-0.230
IP	-0.963	0.171
TP	0.991	-0.046
% of Variance	65.331	19.929

Sum of first two factors accounted for 85.26% of the variance of the sediment data.PC1 showed 65.331 % of variance and was mainly related with Fe-Al P, OP and TP.PC2 accounting for 19.929 % of total variability was strongly related to Ca-P.

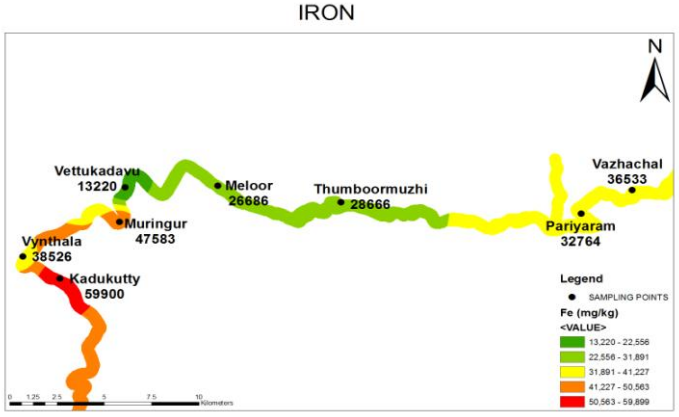
5.6 Distribution of metals in sediments of Chalakudy river

Table 6: Distribution of metals in Chalakudy river

Sampling stations	Heavy metals(mg/kg)					
	Fe	**Mn**	**Zn**	**Cu**	**Pb**	**Cd**
1	59900	24.8	65.21	28.8	121.5	5.8
2	38526	12	42.8	15.6	20.1	0.3
3	47583	35.68	55.21	44.3	95.6	4.1
4	13220	33.04	33.02	55.1	76.55	ND
5	26686	10.2	11.9	30.6	60.8	ND
6	28666	206	ND	25.8	92.3	0.1
7	32764	170	12.6	28.9	67.6	0.26
8	36533	114	ND	25.02	58.2	0.18
Average	35484.75	75.715	36.79	31.765	74.081	1.79
Average shale value	46700	900	95	45	20	0.3

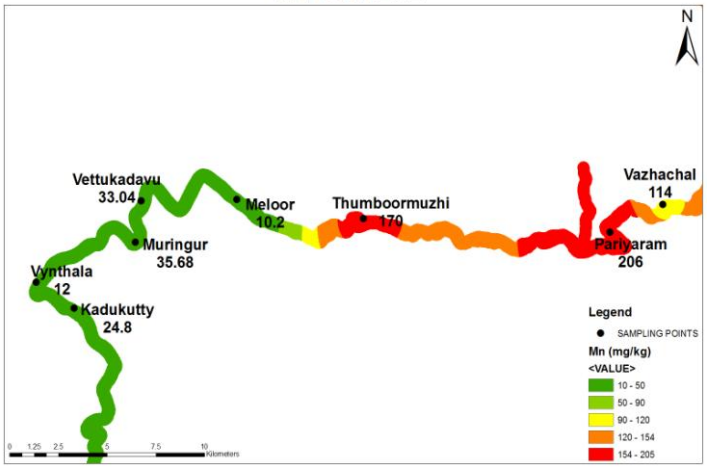
Heavy metal analysis data of the sediment samples of Chalakudy river revealed that mean level of Fe (35484.75 mg/kg) is dominant, followed by Mn (75.715 mg/kg) and lead (74.081 mg/kg), while the average concentration of Cd (1.79 mg/kg) is lowest. On the average basis, the metals follow a decreasing concentration order: Fe> Mn > Pb >Zn>Cu>Cd.

Iron concentration of samples varied from 13220 mg/kg to 59900 mg/kg with an average value of 35484.75 mg/kg. For station 1(Kadukutty), concentration of iron observed was higher than the shale value (46700 mg/kg). Geographic information system was used to create interpolated maps to explain the extent of heavy metal content in the collected sediment samples. Concentration of manganese in the samples ranged from 10.2 mg/kg to 206 mg/kg with an average value of 75.715 mg/kg. Highest concentration of manganese was observed in station 6(Thumboormuzhi)(206 mg/kg) and lowest in station 5(Meloor)(10.2 mg/kg). None of the samples observed showed a value greater than the shale standard (900 mg/kg). Zinc showed a variation from ND to 65.21 mg/kg with an average value of 36.79 mg/kg. All the values of Zn were less the than the average shale value.Copper showed a variation from 15.6 mg/kg to 55.1 mg/kg with an average value of 31.765 mg/kg.For station 4(Vettukadavu),concentration of copper observed was higher than the shale value(45 mg/kg). Lead concentration in samples varied from 20.1 mg/kg to 121.5 mg/kg with an average value of 74.081 mg/kg. All samples showed significantly higher concentration, greater than the average shale value (20 mg/kg) of lead. Cadmium in the samples varied from ND to 5.8 mg/kg with an average value of 1.79 mg/kg. Cadmium was not detected in stations 4(Vettukadavu) and 5(Meloor). Cadmium concentration in stations 1(Kadukuuty) and 3(Muringur) was higher than the shale value and in station 2(Vynthala) it was equal to shale value (0.3 mg/kg).



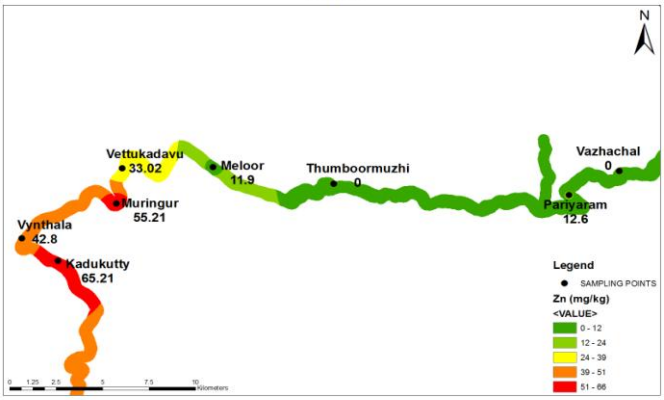
(a)

MANGANESE



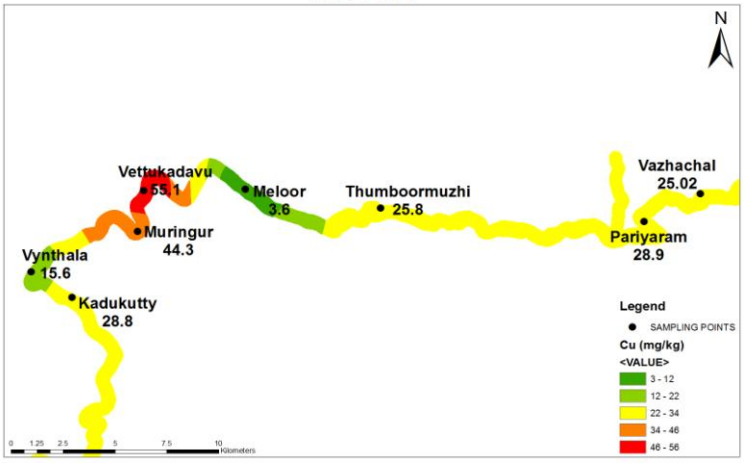
(b)

ZINC



(c)

COPPER



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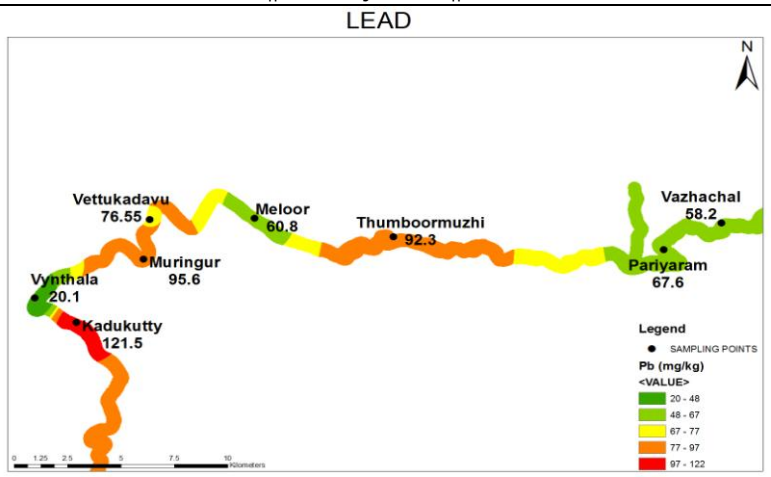

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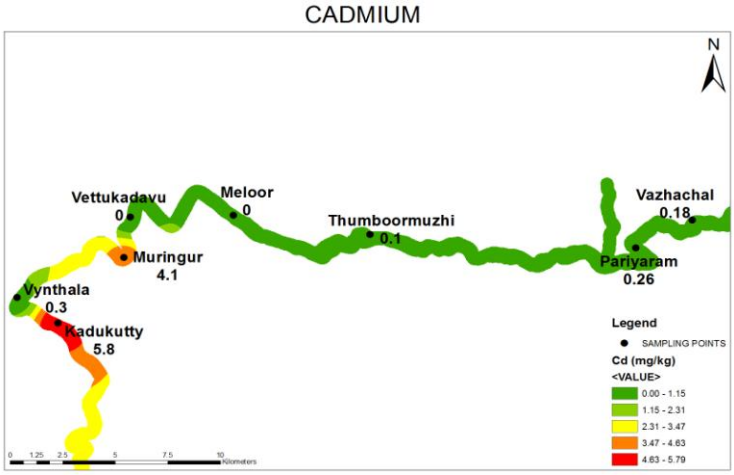

(f)

Figure 9: Spatial distribution of (a) Fe (b) Mn (c) Zn (d) Cu (e) Pb (f) Cd

5.7 Correlation study of metals and organic carbon

Table 7: Correlation coefficient matrix showing inter-element and element -organic carbon relationships in sediments

Variables	Fe	Mn	Zn	Cu	Pb	Cd	OC
Fe	1	-	-	-	-	-	-
Mn	-0.198	1	-	-	-	-	-
Zn	0.613	-0.681	1	-	-	-	-
Cu	-0.362	-0.232	0.243	1	-	-	-
Pb	0.400	0.127	0.339	0.418	1	-	-
Cd	0.854	-0.353	0.809	0.137	0.713	1	-
OC	0.664	-0.429	0.725	0.208	0.688	0.878	1

The correlation coefficient matrix of heavy metals and organic carbon is given in Table 4.2.6. Some heavy metals showed positive correlation with organic carbon, such as Fe (r= 0.664), Zn(r=0.725), Cu(r =0.208),Pb(r =0.688) and Cd (r=0.878).Humic materials have high adsorption influence on heavy metals .The correlation analysis reveals the formation of organic complexes with heavy metals as a ligand .However , Mn showed negative association revealing their opposing distribution in sediments. Significant correlation between Fe and Cd,Zn and Cd and Pb and Cd was observed. Close association of these metals confirm their identical

source or common sink in the sediments. Mn does not show significant correlation with other heavy metals suggesting its independent variations in the sediments.

5.8 Principal component analysis of metals

Table 8: Component loadings of heavy metals in sediments

Variables	Component	
	PC1	PC2
Fe	0.790	-0.591
Mn	-0.514	-0.277
Zn	0.899	0.104
Cu	0.214	0.950
Pb	0.637	0.210
Cd	0.980	-0.108
% of Variance	51.823	23.262

PCA extracted two factors and the principal component loadings of the heavy metals in the sediments are given in Table 8.Two factors explain 75.085 % of the total variance for the surface sediment samples.PC1 (51.823 % variance)showed strong positive loadings (>0.75) on Fe ,Zn and Cd which are predominantly contributed by lithogenic processes, transportation activities, industrial wastes, untreated urban wastes and agricultural runoff.PC2(23.262 % variance)is manifested by the prominent loadings of Cu only.

5.9 Geoaccumulation index

Table 9: Muller's classification for geo-accumulation index

I_{eo} Value	Class	Sediment quality
≤ 0	0	Unpolluted
0-1	1	From unpolluted to moderately polluted
1-2	2	Moderately polluted
2-3	3	From moderately to strongly polluted
3-4	4	Strongly polluted
4-5	5	From strongly to extremely polluted
>6	6	Extremely polluted

Table 10: Geo-accumulation index values for the sediment samples of Chalakudy river

Sampling stations	Fe	Mn	Zn	Cu	Pb	Cd
1	-0.225	-5.766	-1.127	-1.228	2.017	3.688
2	-0.862	-6.813	-1.735	-2.113	-0.577	-0.584
3	-0.557	-5.241	-1.367	-0.607	1.672	3.187
4	-2.405	-5.352	-2.109	-0.292	1.351	ND
5	-1.392	-7.048	-3.581	-1.141	1.019	ND
6	-1.289	-2.712	ND	-1.387	1.621	-2.169
7	-1.096	-2.989	-3.499	-1.223	1.172	-0.791
8	-0.939	-3.565	ND	-1.431	0.956	-1.321
Average	-1.095	-4.935	-2.236	-1.177	1.153	-1.321

According to Muller scale, the calculated results of I_{geo} values indicate that for Pb, sediment quality is considered as moderately polluted ($1 \leq I_{geo} \leq 2$) while for Fe,Mn,Zn,Cu and Cd ,sediment quality was recorded unpolluted ($I_{geo} < 0$) . On the basis of the mean values of I_{geo} sediments are enriched for metals in the following order:Pb>Fe >Cu >Cd >Zn>Mn.

5.10 Contamination factor, degree of contamination and pollution load index

Table 11: Contamination factor and their description

C^i_f	C_d	Description
$C^i_f < 1$	$C_d < 7$	Low degree of contamination
$1 < C^i_f < 3$	$7 < C_d < 14$	Moderate degree of contamination
$3 < C^i_f < 6$	$14 < C_d < 28$	Considerable degree of contamination
$C^i_f > 6$	$C_d > 28$	Very high degree of contamination

Table 12: Contamination factor, degree of contamination and pollution load index of sediments

Sampling stations	Contamination factor(C^i_f)						Degree of contamination(C_d)	PLI
	Fe	Mn	Zn	Cu	Pb	Cd		
1	1.282	0.027	0.686	0.64	6.075	19.333	28.043	1.101
2	0.824	0.013	0.450	0.346	1.005	1	3.638	0.344
3	1.018	0.039	0.581	0.984	4.78	13.666	21.068	1.067
4	0.283	0.036	0.347	1.224	3.827	0	5.717	0.440
5	0.571	0.011	0.125	0.68	3.04	0	4.427	0.276
6	0.613	0.228	0	0.573	4.615	0.333	6.362	0.657
7	0.701	0.188	0.132	0.642	3.38	0.866	5.909	0.565
8	0.782	0.123	0	0.556	2.91	0.6	4.974	0.625

Sampling stations 2(Vynthala),4(Vettukadavu),5(Meloor),6(Thumboormuzhi),7(Pariyaram) and 8(Vazhachal) showed low degree of contamination. Sampling stations 1(Kadukutty) and 3(Muringur) have considerable degree of contamination. The PLI value of >1 is polluted whereas < 1 indicates no pollution.The PLI values showed high pollution loads in stations 1(Kadukutty) and 3(Muringur). The present study reveals that sediments of Chalakudy river are enriched with heavy metals. It could be due to the leaching of metals into water bodies from urban, agricultural, industrial runoffs etc.

6. Conclusions

This study evaluated the characteristics of P fractions and heavy metal accumulation in sediments of Chalakudy river.The fractionation study concluded that organic phosphorus (OP) was the intensified fraction in sediments.The correlation analysis provides evidence on the interdependence of different phosphorus forms,Fe,OC, pH and TA Heavy metal contamination was assessed based on sediment quality guidelines, geoaccumulation index, degree of contamination and pollution load index.The order of the mean concentrations of tested heavy metals follow the order: Fe> Mn > Pb >Zn>Cu>Cd. Humic materials have high adsorption influence on heavy metals.Out of 8 samples, sampling stations 1(Kadukutty) and 3(Muringur) are considerably contaminated and their pollution load index values show a high pollution load. Various sources of heavy metals should be closely monitored and discharge of industrial effluent and domestic sewage discharge should be reduced.

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