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

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***Abstract*-Aquatic sediments absorb persistent and toxic chemicals to levels many times higher than the water column concentration. Sediment investigations are descriptive studies, simply designed to investigate the spatial and temporal distribution of contaminants, for state of the environment reporting, for compliance monitoring, or to guide management actions. The heavy metal prominence, the amount and different forms of phosphorus present in suspected contaminated sites of Periyar river will be studied and reported in this paper.**

***Keywords*- Contamination, Sediments, Samples, Phosphorus fractions, Metals**

I. INTRODUCTION

Sediments are the ultimate repository of most of the contaminants that enter waterways and therefore it is appropriate that regulatory attention addresses the ecological risks that sediment contaminants might pose. There is increasing public awareness of and concern for, the health of our waterways and an expectation that water quality will be improved, but 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.

The sediments of many of the urban river systems, estuaries and near-shore coastal waters worldwide have high contaminant loads, derived largely from past industrial discharges and urban drainage. In many instances, there are elevated concentrations of nutrients, metals and metalloids and organic contaminants. Where regulations are adequate and met, the licensing of discharges has effectively controlled contaminant concentrations reaching surface waters from point sources; however, their concentrations in sediments often remain a concern. In many developing countries, regulations are weak and often not enforced. In highly urbanized areas, urban drainage, including road runoff, continues to represent a major source of contaminants that ultimately accumulate in sediments.

A. Periyar River

Periyar is the longest river and the river with the largest discharge potential in the Indian state of Kerala.

It is one of the few perennial rivers in the region and provides drinking water for several major towns. The Periyar is of utmost significance to the economy of Kerala. It generates a significant proportion of Kerala's electrical power via the Idukki Dam and flows along a region of industrial and commercial activity. The river also provides water for irrigation and domestic use throughout its course besides supporting a rich fishery. Due to these reasons, the river has been named the "Lifeline of Kerala". Kochi city, in the vicinity of the river mouth draws its water supply from Aluva, an upstream site sufficiently free of seawater intrusion. Twenty five percent of Kerala's industries are along the banks of river Periyar. These are mostly crowded within a stretch of 5 kilometers in the Eloor-Edayar region (Udhyogamandal), about 10 kilometers north of Kochi harbor. The Periyar has a total length of approximately 244 kilometers and a catchment area of 5,398 square kilometers, of which 5,284 square kilometers is in Kerala and 114 square kilometers is in Tamil Nadu. The source of the Periyar lies high in the Western Ghats. It is variously claimed to be located in Kerala and in the neighbouring state of Tamil Nadu. The lower reaches of the Periyar are heavily polluted. Industries in the Eloor industrial zone discharge waste into the river. Greenpeace India describes the lower Periyar as "a cesspool of toxins, which have alarming levels of deadly poisons like DDT, endosulfan, hexa and trivalent chromium, lead, cyanide etc. Several studies have pointed out that the riverbed has deposits of heavy metals like lead, cadmium, mercury, chromium, nickel, cobalt and zinc and the ecosystem of the river has many dead zones. Some of the major recommendations are ensuring zero effluent discharge from the industrial units in the Eloor-Edayar stretch and zero emission from companies. Pollution of the river and surrounding wetlands has almost wiped out traditional occupations, including fishing and farming. (https://en.wikipedia.org/wiki/Periyar (river)).

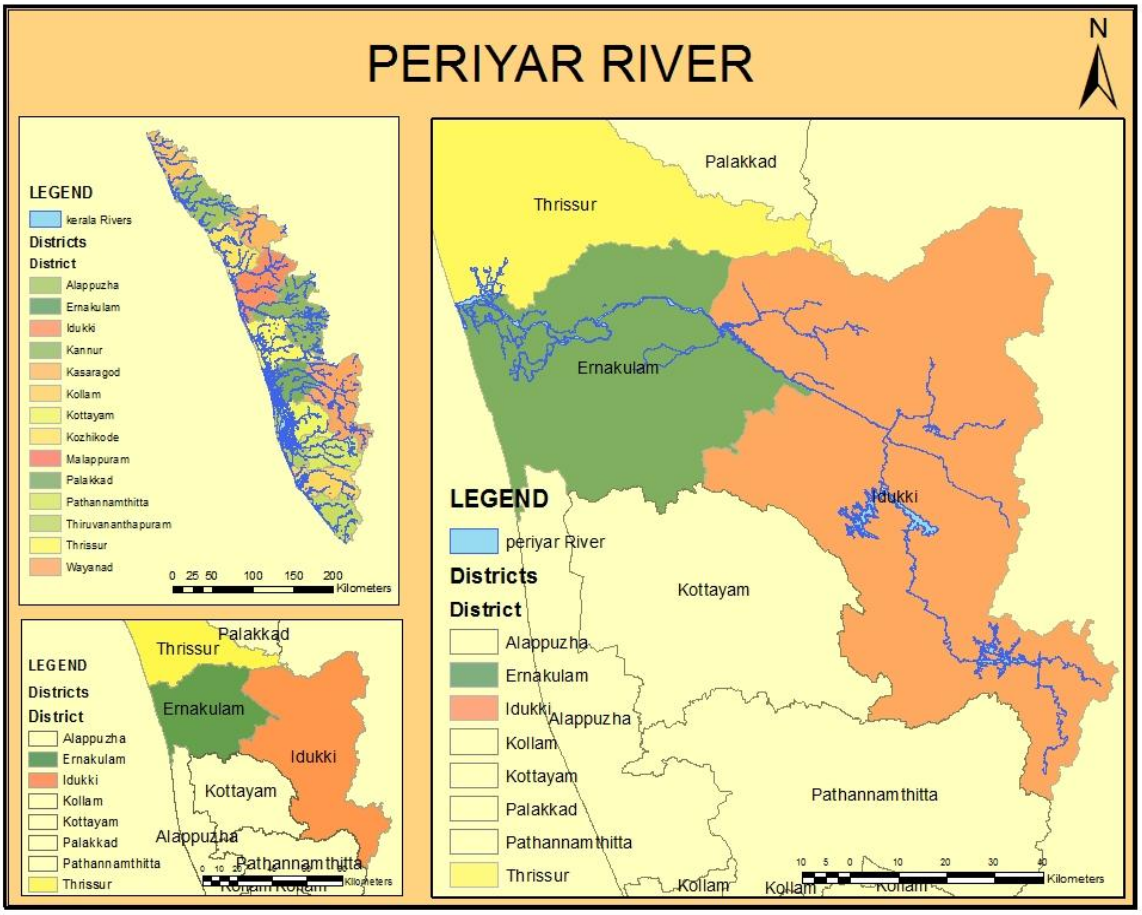


Fig.1 Periyar river

TABLE. I

SAMPLING STATIONS OF PERIYAR RIVER WITH LATITUDE AND LONGITUDE

SI No:	Sampling stations	Latitude (in decimals)	Longitude (in decimals)
1.	Manjaly	10.151454	76.270148
2.	Kothad	10.046834	76.277093
3.	Edayar	10.079816	76.300361
4.	Eloor	10.087939	76.398145
5.	Aluva	10.119469	76.356310
6.	Chowara	10.122298	76.382205
7.	Kalady	10.163442	76.440722
8.	Malayattoor	10.184356	76.507210

II. METHODOLOGY

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 sieved, dried, powdered and transported to laboratory. 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 determined using iodometric method. Distribution of lead and cadmium was determined using atomic absorption spectrophotometer.

A. Assessment according to United States Environmental Protection Agency (USEPA).

The chemical contaminations in the sediments were evaluated by comparison with the sediment quality guideline proposed by USEPA. These criteria are shown in TABLE II.

TABLE II

EPA GUIDELINES FOR SEDIMENTS (MG/KG DRY WEIGHTS)
(Javed Iqbal and Munir H Shah,2014)

Metal	Not polluted	Moderately polluted	Heavily polluted
Fe	<17000	17000 -25000	>25000
Mn	<300	300 -500	>500
Zn	<90	90-200	>200
Cu	<25	25-50	>50
Pb	<40	40-60	>60
Cd	-	-	>6

B. Assessment of pollution by calculating contamination factor, degree of contamination and pollution load index.

Contamination factor (C^i_f) and the degree of contamination (C_d) are used to describe the contamination of given toxic substance and is given by

$$C^i_f = C^i{}_{0\text{-}1} / C^i_n$$

and $C_d = \Sigma^n_{i=1} C^i_f$

Where $C^i{}_{0\text{-}1}$ is the mean content of the substance; C^i_n is the reference shale value for the substance. The contamination factor C_f and the degree of contamination will be used to determine the contamination status of the sediment in the present study. The degree of contamination (C_d) is defined as the sum of all contamination factors. Sediment pollution load index (PLI) is calculated using the equation, PLI = (product of n number of C_f values)$^{1/n}$, where, C_f is the contamination factor, n is the number of metals and world average concentration of elements reported for shale is taken as their background values. The PLI values for each of the stations will be calculated. The PLI value of >1 is polluted whereas < 1 indicates no pollution. (Moonampadiyan Shiji et.al,2015).

TABLE III

CONTAMINATION AND THEIR DESCRIPTION
(Moonampadiyan Shiji et.al,2015).

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

C. Assessment according to Geo-accumulation index (I_{geo})

A common criterion to evaluate the heavy metal pollution in sediments is the geo-accumulation index (I_{geo}), which is originally defined by Muller (1979) to determine metals contamination in sediments, by comparing current concentrations with pre-industrial levels and can be calculated by the following equation (Muller 1979).

$$I_{geo} = \log_2 [C_n / 1.5\ B_n]$$

Where, C_n is the concentration of element 'n' and B_n is the geochemical background value.

The factor 1.5 is incorporated in the relationship to account for possible variation in background data due to lithogenic effect (P. K. Saha and M.D. Hossain,2011). Muller has defined seven classes of geoaccumulation index ranging from Class 0($I_{geo} \leq 0$, unpolluted) to Class 6($I_{geo} > 6$, extremely polluted).

TABLE IV

MULLER'S CLASSIFICATION FOR GEO-ACCUMULATION INDEX
(P. K. Saha and M.D. Hossain,2011)

I_{geo} 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

D. Data analysis.

Xlstat software will be used for the statistical interpretation. Pearson correlation coefficients will be calculated in order to study inter-elemental relationship with their sediment properties. Principal component analysis (PCA) will be used for evaluation and characterization of analytical data. The PCA will be performed using varimax normalized rotation on the dataset. The principal component analytical (PCA) method, which is widely used to detect the hidden structure of sediment sources and to distinguish natural and anthropogenic inputs, can be applied here to explore the origin and geochemical factors influencing their distribution. Analytical results were elaborated by using the Geographical Information System(GIS) application, ArcGIS 10.3.1 software. It was used to show geochemical indices and spatially explain the contaminated areas in the form of interpolated maps (Moonampadiyan Shiji et.al,2015).

III. RESULTS AND DISCUSSIONS

A. Plotting of sampling points

Sampling stations of Periyar river were plotted using ArcGIS 10.3.1 software with the help of latitude and longitude.

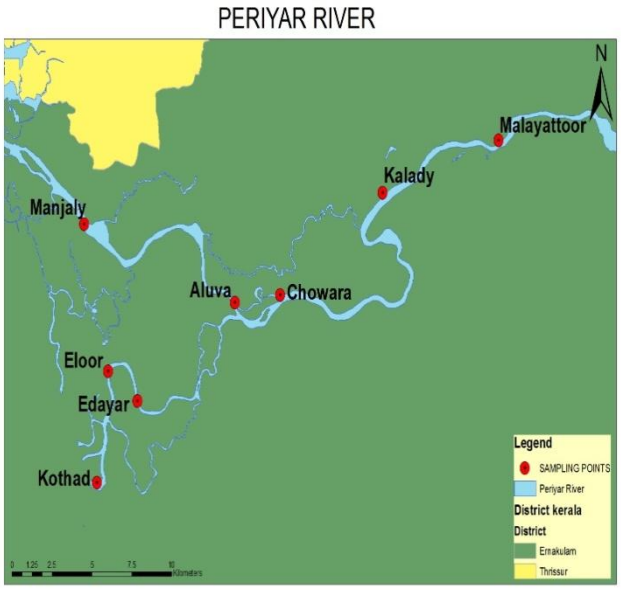


Fig.2 Sediment sampling stations of Periyar river

B. Preliminary test results

pH and alkalinity are sensitive indicators of sediment biogeochemistry. Each model sediment has its own characteristic pH and alkalinity signature. pH in Eloor -Edayar region was observed to be acidic. Total alkalinity values ranged from 155.8 to 610.5 mg/kg. Organic carbon determinations are typically requested with contaminant analyses as a part of ecological risk assessment data package. The organic content of samples ranged from 0.23 to 1.25 % with an average value of 0.691%. Particle size is a fundamental property of any sediment, which can provide important clues to nature and provenance. Sediments have a high percentage of sand, followed by silt and clay. Slightly higher concentration of clay is observed in station 1(Manjaly).

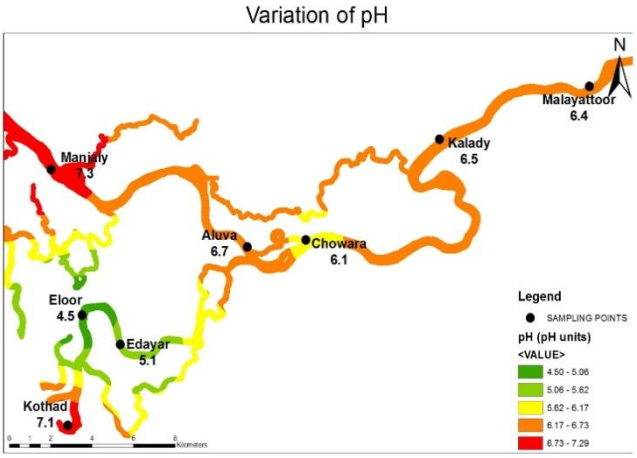


Fig.3 Variation in pH values in sediments of Periyar river

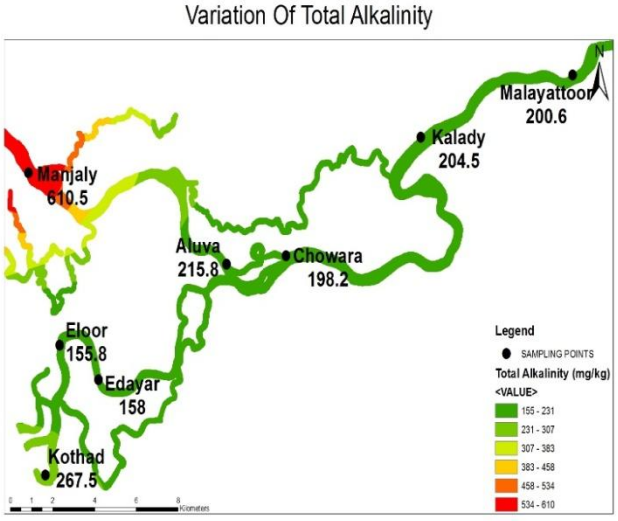


Fig .4 Variation in total alkalinity values in sediments of Periyar river

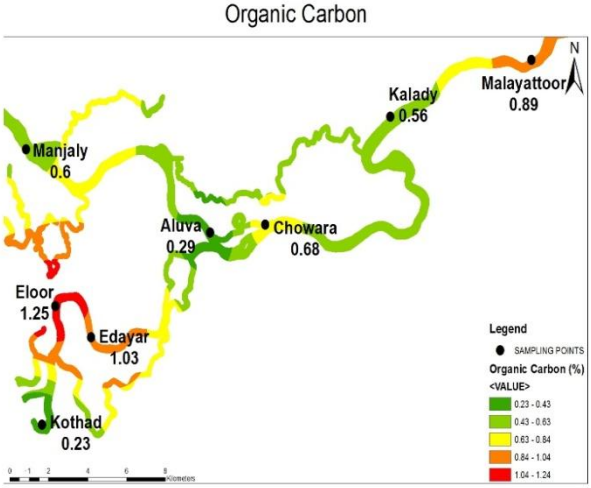


Fig.5 Spatial distribution of organic carbon (in %) in sediment samples of Periyar river

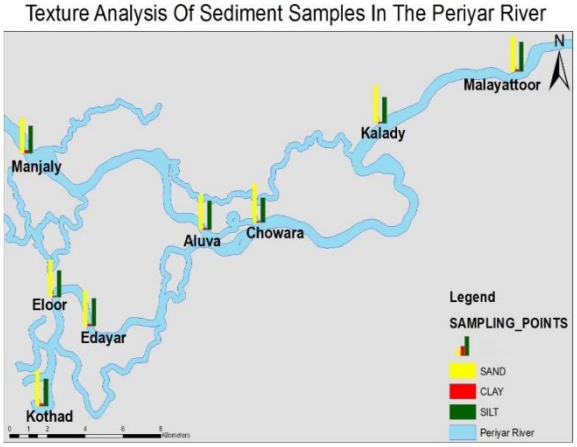


Fig.6 Texture analysis of sediment samples in Periyar river

TABLE V

PRELIMINARY TEST RESULTS OF SEDIMENTS IN PERIYAR RIVER

SI No.	Parameters	Unit	Values Obtained							
			1	2	3	4	5	6	7	8
1.	**pH**	pH units	7.3	7.1	5.1	4.5	6.7	6.1	6.5	6.4
2.	**Total alkalinity**	mg/kg	610.5	267.5	158	155.8	215.8	198.2	204.5	200.6
3.	**Organic carbon**	%	0.6	0.23	1.03	1.25	0.29	0.68	0.56	0.89
4.	**Particle size**	%								
	Sand		53.0	54.0	53.9	56.7	52.9	58.7	57.5	51.8
	Silt		41.3	41.1	42.1	40.5	43.8	38	39.9	44.7
	Clay		4.9	3.9	2.9	2.1	2.8	2.2	2.0	2.9

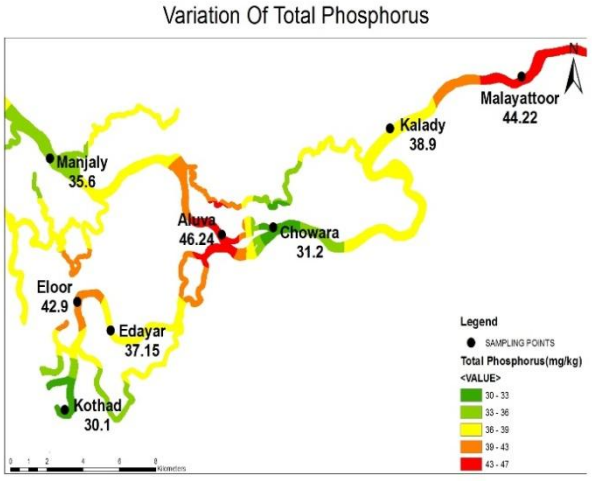
C. Phosphorus fractionation of sediment samples

TABLE VI

PHOSPHORUS FRACTIONATION OF SEDIMENTS IN PERIYAR RIVER

SI No.	Sampling stations	Phosphorus fractions(mg/kg)				
		TP	Fe-Al P	Ca-P	OP	IP
1	**Manjaly**	35.6	4.1	0.13	29.2	1.12
2	**Kothad**	30.1	4.4	ND	24.13	1.3
3	**Edayar**	37.15	4.97	ND	28.28	1.13
4	**Eloor**	42.9	5.18	0.27	34.01	1.6
5	**Aluva**	46.24	5.87	0.29	37.89	1.69
6	**Chowara**	31.2	5.5	0.22	23.7	1.5
7	**Kalady**	38.9	5.02	0.21	31.07	1.34
8	**Malayatoor**	44.22	5.64	0.30	35.99	1.74
	Average	38.288	5.085	0.236	30.533	1.427

Total phosphorus content in sediments of Periyar river ranged from 30.1 - 46.24 mg/kg with an average value of 38.288 mg/kg. The concentration of NaOH-P can be used for the estimation of short term and long term available P in sediments and is a measure of available algal P. Significant concentrations of Fe-Al P was found in all stations with an average value of 5.085 mg/kg. Ca-P is the least fractioned phosphorous form in Periyar river sediments and its average value is 0.236 mg/kg. Increased concentrations of organic phosphorus were observed in all sampling stations and highest concentration was observed in sediments collected from Aluva. Inorganic phosphorus values ranged from 1.13 -1.74 mg/kg.



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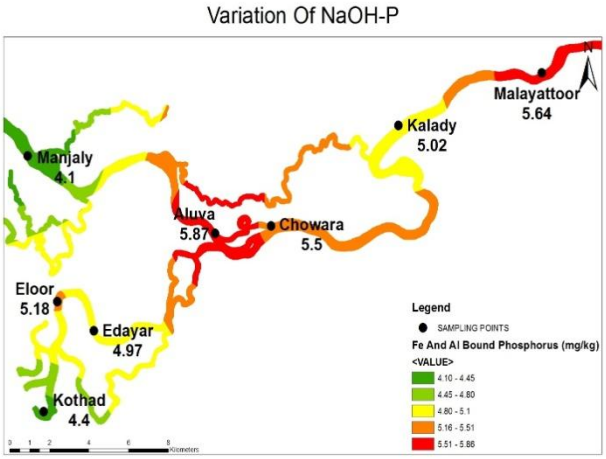

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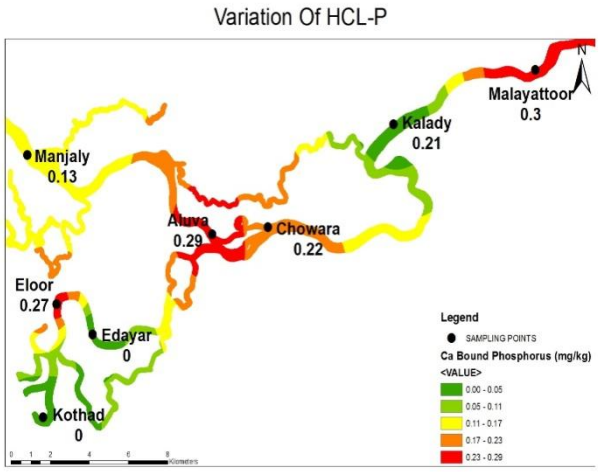

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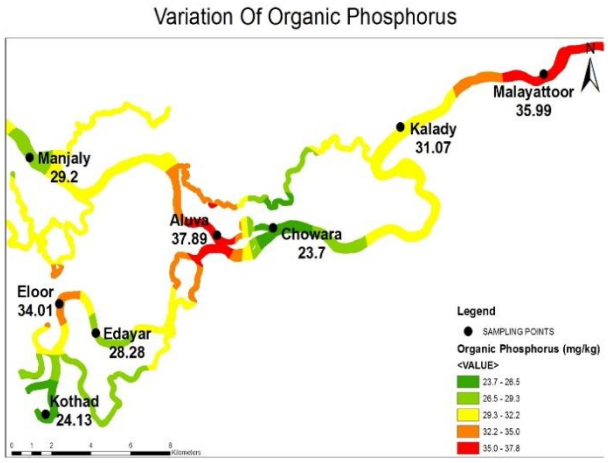

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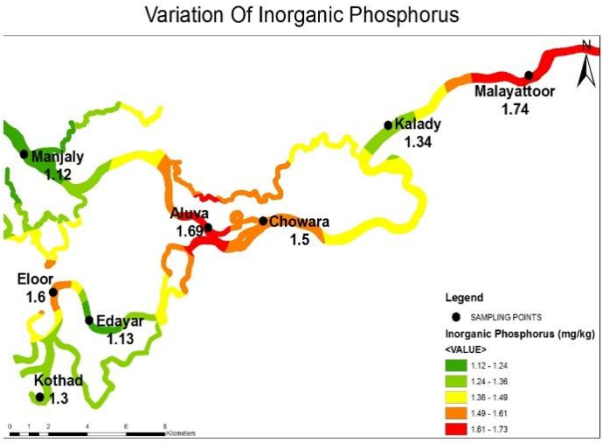


(e)

Fig.7: Spatial distribution of (a) TP (b) NaOH -P (c)HCl-P (d) OP (e) IP in sediment samples of Periyar river

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

TABLE VII

CORRELATION COEFFICIENT MATRIX SHOWING CORRELATION OF DIFFERENT PHOSPHORUS FRACTIONS, OC, FE, PH AND TA

Variables	Fe-Al P	Ca-P	OP	IP	TP	OC	Fe	pH	TA
Fe-Al P	1	-	-	-	-	-	-	-	-
Ca-P	0.714	1	-	-	-	-	-	-	-
OP	0.553	0.705	1	-	-	-	-	-	-
IP	0.837	0.843	0.633	1	-	-	-	-	-
TP	0.613	0.701	0.989	0.636	1	-	-	-	-
OC	0.147	0.174	0.186	0.084	0.288	1	-	-	-
Fe	-0.018	-0.052	0.104	-0.265	0.208	0.718	1	-	-
pH	-0.316	-0.106	-0.143	-0.159	-0.271	-0.858	-0.793	1	-
TA	-0.693	-0.205	-0.166	-0.500	-0.269	-0.311	-0.174	0.633	1

The results of the correlation analysis indicate that organic carbon exhibited weak positive correlation with phosphorus fractions. Iron showed positive correlation with organic carbon (r =0.718). pH showed negative correlation with phosphorus fractions, OC and Fe.TA showed positive correlation with pH (r=0.633).

E. Principal component analysis of phosphorus fractions

TABLE VIII

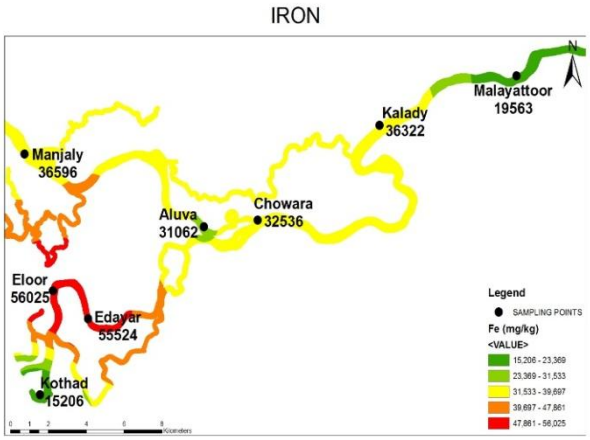
COMPONENT LOADINGS OF PHOSPHORUS FRACTIONS

Variables	Component	
	PC1	PC2
Fe-Al P	0.839	-0.404
Ca-P	0.900	-0.157
OP	0.882	0.467
IP	0.895	-0.354
TP	0.894	0.432
% of Variance	77.834	14.371

PCA rendered two PCs explaining 92.205 % of the total variance of the data set. PC1 explaining 77.834% of total variance has strong positive loadings (>0.70) on Fe-Al P, Ca-P, OP, IP and TP, thus covering phosphorus fractions having origin both in natural and anthropogenic sources.PC2, explaining 14.371% of the total variance, has a moderate positive loading on OP and TP.

F. Distribution of metals in sediments of Periyar river

The total metal concentrations for each sampling site found in sediments of Periyar river are shown in Table IX. On the average basis, the metals follow a decreasing order: Fe >Mn>Pb>Cu>Zn> Cd. Concentration of iron observed was higher than the shale value in sediments collected from Edayar(55524mg/kg) and Eloor(56025mg/kg). Increased concentration of iron may be due to anthropogenic sources like the iron and steel industry, sewage and dust from iron mining, fertilizer and herbicide industry etc. The average concentration of manganese was 150.762 mg/kg and none of the sampling stations showed a value higher than the shale value. Zinc showed a variation from 6.8 to 153.95 mg/kg. Concentration of zinc was higher than the average shale value (95mg /kg) in sediment samples collected from Edayar (153.95 mg/kg) and Eloor (145.18 mg/kg). It can be mainly from industrial activities such as mining, coal and waste combustion, steel processing etc. High concentration values of copper were observed in station 3-Edayar (129.8 mg/kg) and station 4-Eloor (132.6 mg/kg), the toxic hot spot regions in Ernakulam. In station 5-Aluva, concentration (72.8mg/kg) is higher than the shale value(45mg/kg). Lead poisoning has been recognized as a major public health risk, particularly in developing countries. All samples showed significantly higher concentration, greater than the average shale value (20 mg/kg) of lead. Cadmium is a naturally occurring toxic heavy metal with common exposure in industrial workplaces, plant soils and from smoking. Cadmium concentrations are very high in the industrial cluster of Eloor-Edayar region.



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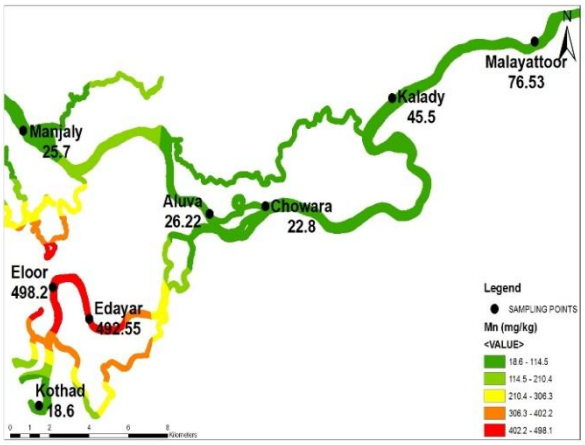

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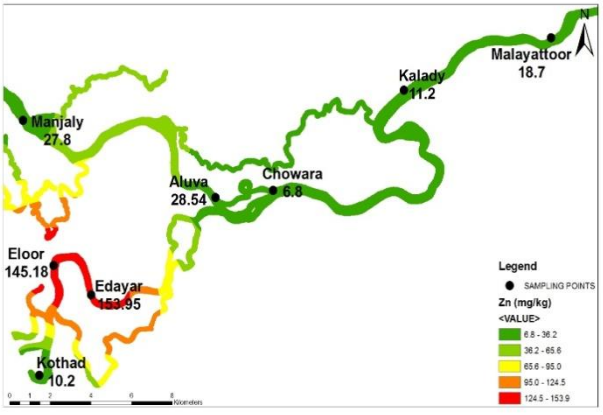

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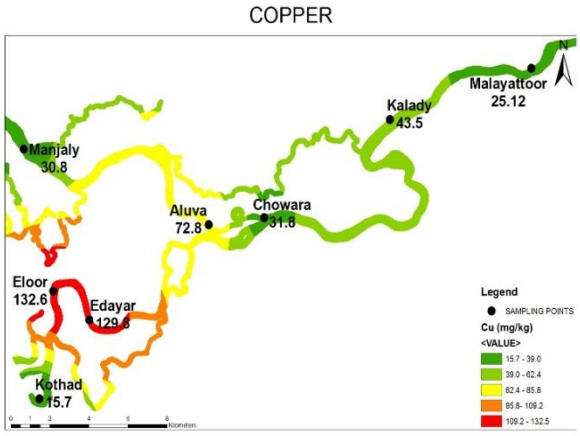

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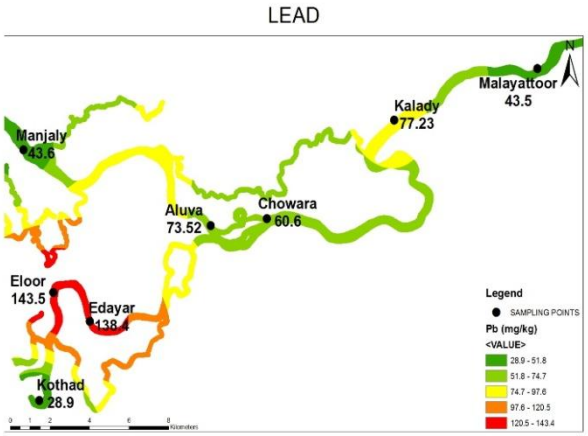

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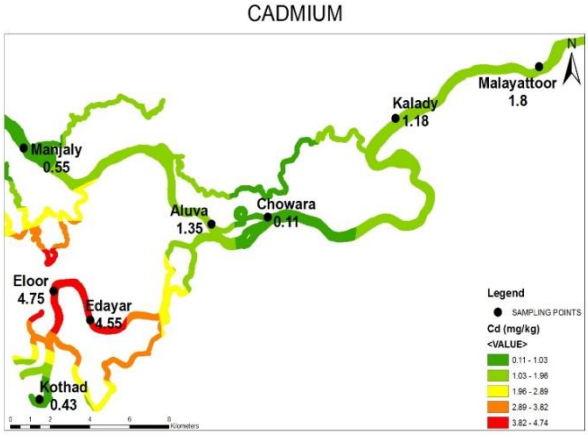

(f)

Fig.8 Spatial distribution of (a) Fe (b) Mn (c) Zn (d) Cu (e) Pb (f) Cd in sediment samples of Periyar river

TABLE IX

DISTRIBUTION OF METALS IN SEDIMENTS OF PERIYAR RIVER

SI No.	Sampling stations	Heavy metals(mg/kg)					
		Fe	Mn	Zn	Cu	Pb	Cd
1	Manjaly	36596	25.7	27.8	30.8	43.6	0.55
2	Kothad	15206	18.6	10.2	15.7	28.9	0.43
3	Edayar	55524	492.55	153.95	129.8	138.4	4.55
4	Eloor	56025	498.2	145.18	132.6	143.5	4.75
5	Aluva	31062	26.22	28.54	72.8	73.52	1.35
6	Chowara	32536	22.8	6.8	31.8	60.6	0.11
7	Kalady	36322	45.50	11.2	43.5	77.23	1.18
8	Malayatoor	19563	76.53	18.7	25.12	43.5	1.8
	Average	35354.25	150.762	50.296	60.265	76.156	1.84
	Average shale value	46700	900	95	45	20	0.3

G. Sediment quality guidelines

As per TABLE II, contamination status of metals in Periyar river are shown in Table X. River is clearly showing symptoms of grave pollution. Eloor-Edayar area has been selected as one of the priority sites needing immediate restoration.

TABLE X

CONTAMINATION STATUS OF METALS IN SEDIMENTS OF PERIYAR RIVER

Metals	Average values of contamination of metals(mg/kg)	Contamination status
Fe	35354.25	Heavily polluted (>25000)
Mn	150.762	Non-polluted (<300)
Zn	50.296	Non-polluted (<90)
Cu	60.265	Heavily polluted (>50)
Pb	76.156	Heavily polluted (>60)
Cd	1.84	Non-polluted (<6)

H. Correlation study of metals and organic carbon

TABLE XI

CORRELATION COEFFICIENT MATRIX SHOWING INTER-ELEMENT AND ELEMENT -ORGANIC CARBON RELATIONSHIPS IN SEDIMENTS

Variables	Fe	Mn	Zn	Cu	Pb	Cd	OC
Fe	1	-	-	-	-	-	-
Mn	0.843	1	-	-	-	-	-
Zn	0.864	0.988	1	-	-	-	-
Cu	0.894	0.926	0.948	1	-	-	-
Pb	0.929	0.925	0.921	0.975	1	-	-
Cd	0.793	0.972	0.960	0.930	0.915	1	-
OC	0.718	0.823	0.767	0.673	0.735	0.806	1

The correlation coefficient matrix showed strong positive correlation between OC and metals. Fe showed significant positive correlation with Mn (r =0.843), Zn(r=0.864),Cu(r=0.894), Pb (r =0.929) and Cd(r=0.793).Pb exhibited strong positive correlation with Fe(r=0.929), Mn(r=0.925), Zn(r=0.921) and Cu (r=0.975) suggesting they probably originated from some common sources. Mn exhibited strong positive correlations with Zn(r=0.988), Cu(r=0.926) Pb(r=0.925) and Cd(r=0.972). Other highly correlated pairs include Zn with Cu, Pb and Cd, and Cu with Pb and Cd.

I. Principal component analysis of metals

TABLE XII

COMPONENT LOADINGS OF HEAVY METALS IN SEDIMENTS

Variables	Component	
	PC1	PC2
Fe	0.917	0.375
Mn	0.976	-0.170
Zn	0.981	-0.124
Cu	0.979	0.046
Pb	0.978	0.132
Cd	0.962	-0.240
% of Variance	93.288	4.374

Sum of first two factors accounted for 97.662 % of the variance of the sediment data. Factor 1 was dominated by all the metals evaluated namely, Fe, Mn, Zn, Cu, Pb and Cd and accounted for 93.288 % of the total variance. Factor 2, accounts for 4.374 % of the total variance, with Fe exhibiting the highest loading.

J. Geo-accumulation index

Muller's geo-accumulation index is basically a single metal approach to quantify metal pollution in sediments. A positive I_{geo} value indicates significant anthropogenic contribution to the metal contents of the sediment while a negative value shows negligible or no contribution.

K. Contamination factor, degree of contamination and pollution load index

The contamination factor, degree of contamination and pollution load index were calculated for sediments in Periyar river and are shown in TABLE XIV.

Very high degree of contamination was observed in Edayar (sampling station-3) and Eloor region (sampling station-4) (C_d>28). Low degree of contamination were observed in sampling stations-Manjaly, Kothad and Chowara(C_d <7).Moderate degree of contamination were observed in sediment samples collected from Aluva ,Kalady and Malayatoor(7<Cd<14).

The PLI values showed high pollution loads in Edayar (sampling station-3) and Eloor(sampling station-4). Enrichment of heavy metals due to industrialization and urbanization was recorded in sediments in Periyar river. Eloor-Edayar region supports the largest industrial belt in Kerala with over 247 chemical industries. There are more than 30 effluent pipes spewing toxins into the river directly from the industry.

IV. CONCLUSIONS

The important suspected contaminated sites of Periyar river were selected. Samples were collected from eight sampling stations and their latitude and longitude were noted. Multivariate statistical techniques were done to evaluate and characterize the analytical data. Creation of spatial

distribution maps of phosphorus fractions and heavy metals using ArcGIS 10.3.1 software helped to identify the pollution sources and vulnerable sites. Periyar river is gradually undergoing eco degradation throughout its course of flow due to various anthropogenic stresses, which include indiscriminate deforestation, domestic- agricultural-industrial water pollution, excessive exploitation of resources, large scale sand mining, various interferences in the flow of water etc. Phosphorus fractionation and heavy metal analysis were performed for sediments in Periyar river. Increased concentrations of organic phosphorus were observed in all sampling stations and concentration of metals follow the order: Fe >Mn>Pb>Cu>Zn> Cd. The industrial belt of Eloor-Edayar region in Kerala is one of the world's top toxic hot spot, responsible for Periyar river's pollution. Pollution load index values in Edayar (sampling station-3) and Eloor (sampling station -4) were 2.613 and 2.640 respectively indicating intense pollution.Various sources of heavy metals should be closely monitored and discharge of industrial effluent and domestic sewage discharge should be reduced.

TABLE XIII

GEO-ACCUMULATION INDEX VALUES FOR THE SEDIMENT SAMPLES OF PERIYAR RIVER

SI.No	Sampling stations	Fe	Mn	Zn	Cu	Pb	Cd
1	**Manjaly**	-0.936	-5.715	-2.357	-1.131	0.539	0.289
2	**Kothad**	-2.203	-6.181	-3.804	-2.104	-0.053	-0.065
3	**Edayar**	-0.335	-1.454	0.111	0.943	2.205	3.337
4	**Eloor**	-0.322	-1.438	0.026	0.974	2.258	3.399
5	**Aluva**	-1.173	-5.686	-2.319	0.109	1.293	1.584
6	**Chowara**	-1.106	-5.887	-4.389	-1.085	1.014	-2.032
7	**Kalady**	-0.947	-4.890	-3.669	-0.633	1.364	1.390
8	**Malayatoor**	-1.840	-4.140	-2.929	-1.426	0.536	2
	Average	-1.107	-4.423	-2.416	-0.544	1.144	1.237

TABLE XIV

CONTAMINATION FACTOR, DEGREE OF CONTAMINATION AND POLLUTION LOAD INDEX OF SEDIMENTS FROM PERIYAR RIVER

SI No.	Sampling stations	Contamination factor(C^i_f)						Degree of contamination(C_d)	PLI
		Fe	Mn	Zn	Cu	Pb	Cd		
1	**Manjaly**	0.783	0.028	0.292	0.684	2.18	1.833	5.8	0.509
2	**Kothad**	0.325	0.020	0.107	0.348	1.445	1.433	3.678	0.281
3	**Edayar**	1.188	0.547	1.620	2.884	6.92	15.166	28.325	2.613
4	**Eloor**	1.199	0.553	1.528	2.946	7.175	15.833	29.234	2.640
5	**Aluva**	0.665	0.029	0.300	1.617	3.676	4.5	10.787	0.732
6	**Chowara**	0.696	0.025	0.071	0.706	3.03	0.366	4.894	0.314
7	**Kalady**	0.777	0.050	0.117	0.966	3.861	3.933	9.704	0.636
8	**Malayatoor**	0.418	0.085	0.196	0.558	2.175	6	9.432	0.608

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