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ASSESSMENT OF METAL POLLUTION IN INTER TIDAL AND BEACH SEDIMENTS ALONG NORTH EAST COAST OF TAMILNADU, INDIA

Senthil Shanmugam*[1], Rajesh Paramasivam[2], RamasamyVenkidasamy[3], Hema Mani[4]

[1]*Department of Physics, Panimalar Engineering College, Poonamallee, Chennai, Tamilnadu, India*
[2]*PG and Research Department of Physics, Poompuhar college (AU), (Affiliated to Bharathidasan University), Melaiyur, Tamilnadu, India*
[3]*Department of Physics, Annamalai University, Annamalainagar, Tamilnadu, India*
[4]*Department of Chemistry, Assistant Professor in Chemistry, University College of Engineering, Anna University, Chennai, Thirukkuvalai Campus, Tamilnadu, India*
**Corresponding author: resh.tpm@gmail.com*

ABSTRACT

The concentrations of major (Al, Fe, Mg, Mn, Na, K and Ca) and trace (Cr, Cu, Ni, Pb and Zn) elements have been determined in inter tidal and beach surface sediments samples collected from North east coast of Tamilnadu, India. Major element analysis showed that the sediments had low concentrations when compared with crustal average and upper continental crust. Using sediment quality guidelines and different types of indexes, current trace elements pollution status in the study area were assessed. Sediment quality guidelines suggest that nickel and lead must be considered as a chemically potential concern in the study area. The indexes used in this study were enrichment factor, geo-accumulation index and modified degree of contamination. Different indexes gave diverse status of inter tidal and beach sediment quality. The results are discussed in the context of the sources and pathways of trace elements in the North east coast of Tamilnadu, India.

Keywords: Sediments, Metal Pollution, Enrichment factor, Geo-accumulation index.

1. INTRODUCTION

The costal environment is the most important one, as they are owned by none and therefore are practically susceptible to misuse and degradation by every body. In this case beaches and inter tidal regions are great concern because they are thickly populated and pollution problems are too many.

Sediments are important carriers of trace metals in the hydrological cycle and because metals are partitioned with the surrounding waters, they reflecting the quality of an aquatic system [1]. The metal content of sediment has natural and anthropogenic components, in heavily polluted sediment, the anthropogenic introduced components by far exceed the natural component and because of their bio-availability constitute a hazard to the marine ecosystem [2]. A lack of global under-standing on the impact of anthropogenic activities in the coastal environment owing to the lack of critical evaluation of elemental contamination in many studies. Metals, including metalloids through the natural components of the Earth's crust, have widely increased their distribution in the environment as a consequence of modern industrial and human activities [3]. Marine sediments, especially in coastal and estuarine regions in the vicinity of urban and harbour areas are becoming increasingly polluted by heavy metals [4].

Not all the elements in the environment are toxic they may be classified as (a) non-critical elements (eg., Na, K, Mg, Ca, Fe, Rb, Sr, Br, Al, Si, Li, P, N, O, etc.), (b) toxic but very insoluble or very rare (REEs, Ti,Zr, W, Ta, Re, Ba, Ru, Ir, Rh, Os, Ga, etc.) and (c) relatively accessible (Cu, Se, Hg, Ni, Pd, Ag, Pb, Zn, Cd, etc). These metals form stable bonds and are active sits in many portions. The elements of categories (b) and (c) serve as catalysts involving electron transfer in several biochemical reactions. As they are eventually incorporated in the portions of living beings, they represent severe health hazards. Heavy metals in the environment have many sources, geologic weathering, industrial processing of ores and metals, uses of metals and metal compounds, leaching of metals from garbage and solid waste dumps, animal and human excreta [5].

Now a days large quantities of industrial wastewater and domestic wastewater drain directly into the tidal regions. Thus, this makes tidal zone areas face a tremendous environmental pressure as a natural purifier and storage of pollutants, especially in coastal estuaries on both sides of tidal regions, with a more serious situation. Heavy metal content of tidal region sediments reflects the real situation of a region's environment and is also an important indication to identify and prevent problems [6, 7].

During the last few decades, the coastal environment of North east coast of Tamilnadu in India has experienced intense developments in industry, tourism, transport, urbanization and aquaculture. This paper reports the concentrations of trace (Cr, Cu, Ni, Pb and Zn) and major (Al, Fe, Mg, Mn, Na, K and Ca) elements for inter tidal and beach sediments of North east coast of Tamilnadu, India. The data were compared with crustal average, upper continental crust, ERL and ERM values. The enrichment factor, geo-accumulation index and modified degree of contamination were computed to assess trace element pollution in the investigated area.

2. MATERIAL AND METHODS

2.1. Study Area

This study took place in North east coast of Tamilnadu in south India bordered on the east by the Bay of Bengal (Fig. 1). The total study area spread over from Port novo (Lat: 11º 30' 59"N; Long 79º 46' 18"E) to Marina beach of Chennai (Lat: 13° 03' 55"N; Long 80° 17'24"E), which covers an area about 200km. The tidal range is 1.2-1.5m for spring tides and 0.3-0.6m for neap tides. Some famous beaches (Marina, Kovalam, Arovil and Silver), historical place (Mahabalipuram) and Industries (SIPCOT) were located in this coastal area.

The study area is complex eco system, because four river estuaries are present. Among these four, Vellar river estuary (High River run off) and Ponnaiyar river estuary (seasonly river run off) are located at the southern part of this area. Cooum river estuary is located at northern part of the area, which is completely used for drainage purpose of Chennai city (one of the biggest metro city in India). Palar river estuary (there is no river run off) located at central part of study area.

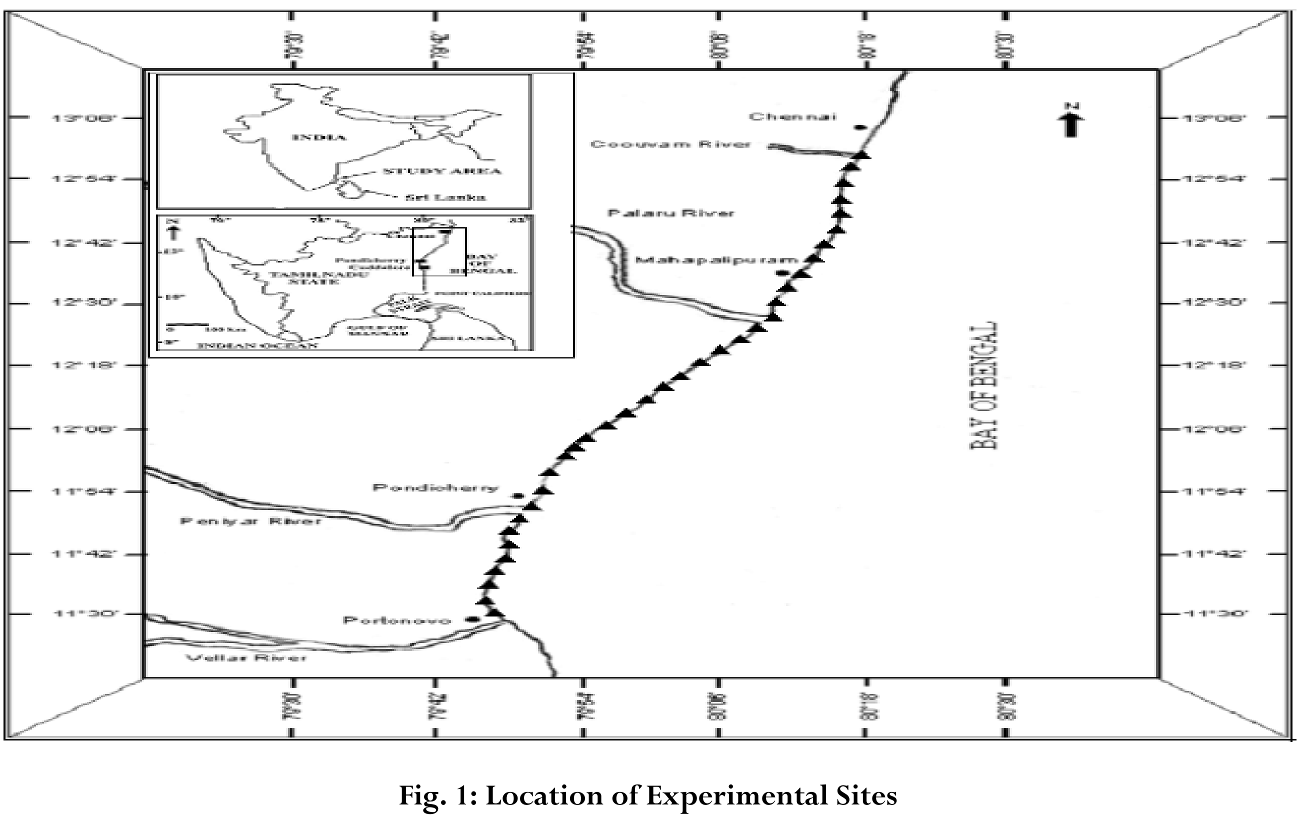

Fig. 1: Location of Experimental Sites

2.2. Sample collection

The total study area covered about 200km, from which, at a distance of 5-6km interval, 35 sampling locations were selected. The exact position of each sampling site was recorded using Hand held GARMIN GPS (Global Positioning System, Model no 12). At each sampling location, two sub sampling sites were selected; among these two, one sample was collected from inter tidal region and another one was from 10-20m away from the high tide, when it made towards the road side. Five samples were collected from each site covering an area of one meter square. All the sediment samples were collected at a depth of 5cm and packed in plastic pouches.

2.3. Sample preparation

All the apparatus used for sample preparation and analyses were soaked in 0.1M nitric acid for 24h and then rinsed several times with Milli-Q deionised water perior to use. Approximately 0.5g dried sediment were weighed and placed into an acid washed Borosil glass vessel to which 10ml of concentrated nitric acid (con HNO3, Merck) was added. After 24hours, 20ml of 4:1 acid mixture (HNO_3: $HClO_4$) was added. The suspensions were evaporated at 80°C until dryness. The final suspensions were filtered through the Millipore unit (Rocker 400) to eliminate the remaining solids and washed by milli Q water. Digestate was transferred to a 100ml high density polyethylene sample bottle for storage.

The sample analysis for Al, Cr, Cu, Fe, Mg, Mn, Ni, Pb and Zn were performed by ICP-OES (Perkin elmer Optima 2100DV) and Na, K, Ca were performed by Flame photometer (Systonics). Calibration was performed for every 5 set of samples using a multi elemental standard solution (Merck) traceable to National Institute of Standards and Technology (NIST) via the standard curve approach.

2.4. Methods for estimating pollutant impact

Various authors [8-10] have proposed pollution impact scales (or ranges) to convert the calculated numerical results into broad descriptive bands of pollution ranging from low to high intensity. Four methods are discussed in the following sections.

2.4.1. *Enrichment Factor (EF)*

Differentiating the metals originating from human activity and those from natural weathering is an essential part of pollution studies. One such technique largely applied is 'normalization' where aluminum is believed to be an index element for the terrigenous and it is refractory element, which is extremely immobile in the marine environment [3]. According to Nolting et al. [11], this method is also a powerful tool for the regional comparison of trace metals content in sediments and can also be applied to determine enrichment factors (EFs).

An enrichment factor was calculated for each metal, by dividing its ratio to the normalizing element by the same ratio found in the chosen baseline [12].

$$EF = (metal/Al)_{sediment} / (metal/Al)_{crust}$$

EFs close to unity point to crusted origin, while EF > 10 are considered to be anthropogenic origin [11].

The formula below used by Sarva M. Praveena et al., [13] has been applied to assess the percentage of anthropogenic and lithogenic contribution.

$$[M]_{Lithogenic} = [Al]_{sample} \times ([M]/[Al])_{lithogenic}$$

Where $([M]/[Al])_{lithogenic}$ corresponds to the average ratio of the earth crust

$$[M]_{Anthropogenic} = [M]_{Total} - [M]_{lithogenic}$$

2.4.2. *Geoaccumulation index (I_{geo})*

Indexes of geo-accumulation for the metal were calculated using Muller's expression:

$$I_{geo} = Log_2\, M_i / 1.5 * M_r$$

Where, M_i, is the concentration of metals in sediments samples, M_r is the pristine value of the element. The factor 1.5 is introduced to minimize the effect of possible variations in the background values which may be attributed to lithologic variations in the sediments [9, 10]. Muller proposed the following descriptive classes for increasing I_{geo} values:

I_{geo} value	I_{geo} class	Designation of sediment quality
>5	6	Extremely contaminated
4-5	5	Strongly to extremely contaminated
3-4	4	Strongly contaminated
2-3	3	Moderately to strongly contaminated
1-2	2	Moderately contaminated
0-1	1	Uncontaminated to moderately contaminated
0	0	Uncontaminated

2.4.3. *Modified degree of contamination (mCd)*

EF and I_{geo} does not aggregate all contaminates into one value. It is necessary to use the estimation of natural background in order to provide a precise identification of anthropogenic heavy metals and their sources. Geochemical background levels used in EF and I_{geo} are the values in crust and shale in order to recognize the anthropogenic enrichment. The modified equation for a generalized approach to calculating the degree of contamination is given below:

$$mCd = \frac{\sum_{i=1}^{i=n} C_f^i}{n}$$

where n = number of analyzed elements and i= ith element (or pollutant) and C_f = contamination factor.

Ranges of the modified degree of contamination (mC_d) in beach and inter tidal sediments, the following gradations are proposed [10].

mCd <1.5 Nil to very low degree of contamination

1.5≤ mCd <2 Low degree of contamination

2≤ mCd <4 Moderate degree of contamination

4≤ mCd <8 High degree of contamination

8≤ mCd <16 Very high degree of contamination

16≤ mCd <32 Extremely high degree of contamination

mCd ≥32 Ultra high degree of contamination

3. RESULTS AND DISCUSSION

The mean concentrations of major elements (N =12) in the study area were compared with concentration of elements from crustal average (CA) [12] and upper continental crust (UCC) [14] (table 1). The following was the trend of the decreasing order of mean concentrations of metals

Fe > Al > Mg > Zn > Mn > Cr > Ni > Pb > Cu for beach sediments and Fe > Al > Mg > Mn> Zn > Cr > Cu> Ni > Pb for Inter tidal sediments.

From which, the higher concentration of Fe is observed in the entire study area. The over all Al concentrations are lower than CA and UCC (table 1), which may be due to the abundance of quartz [1]. In inter tidal sediments, the major elements such as Al, Fe, Mg, Mn, Cr, Ni, Na, Ca, Cu and K have lower, Zn and Pb have higher mean concentrations when compared with crustal average. The mean concentrations of Cr, Cu, Zn, Ni and Pb are higher and remaining elements Al, Fe, Mg, Mn, Na, Ca and K are lower than upper continental crust. However, the mean values of Pb and Zn in beach sediments are higher and remaining elements have lower concentration compared with crustal average. But when compared with upper continental crust, the mean concentration of Al, Fe, Mg, Mn, Na, Ca and K are lower and Cr, Cu, Zn, Ni and Pb are higher (table 1). Distribution of major and trace elements concentrations is not uniform in the entire study area which is clearly shown in the fig. 2 and 3 for inter tidal sediments and fig.4 and 5 for beach sediments. Variation of over all major and trace element concentrations may be due to the differences in the sources, either from lithogenic or anthropogenic.

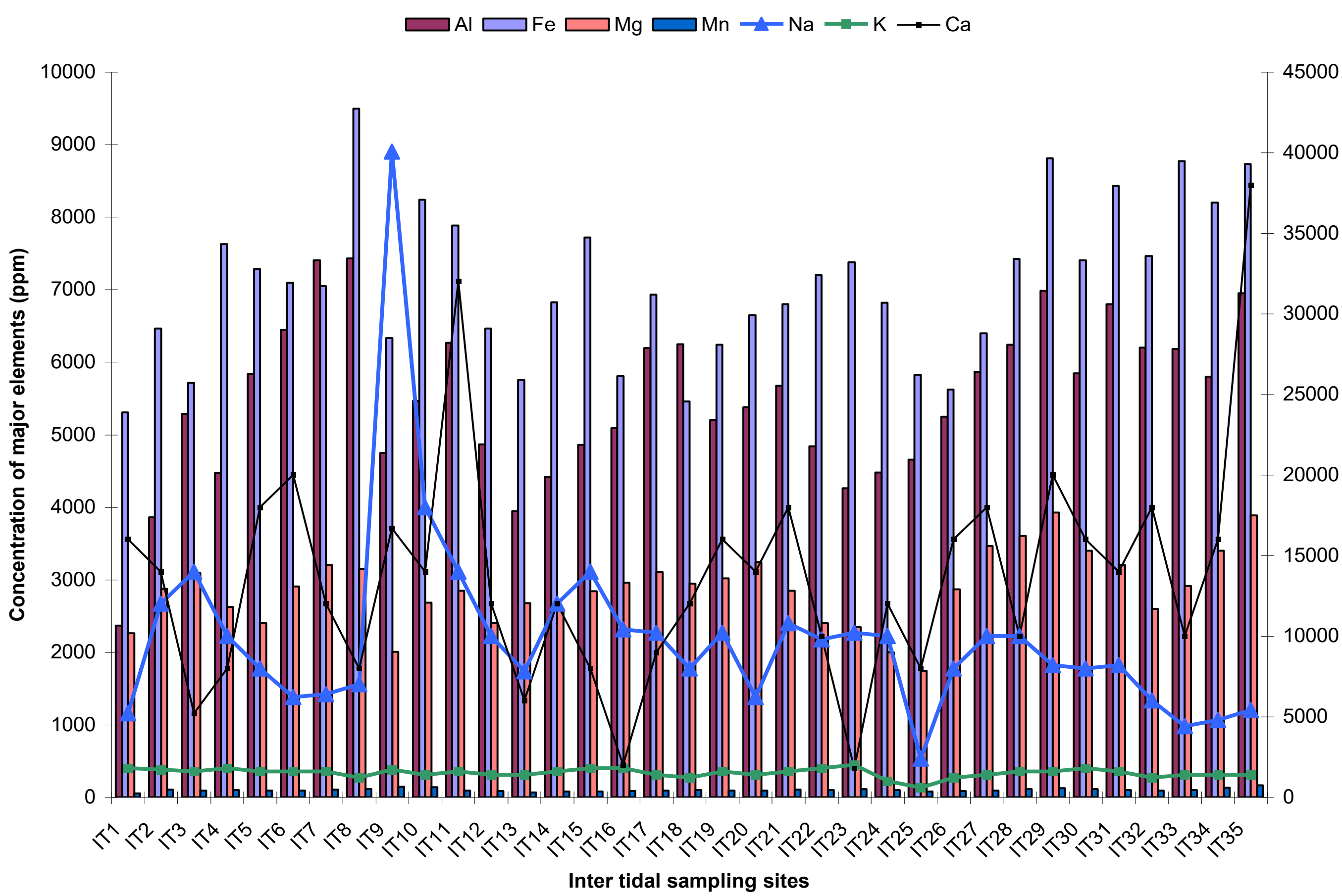

Fig. 2: Distribution of major elements in inter tidal sediments

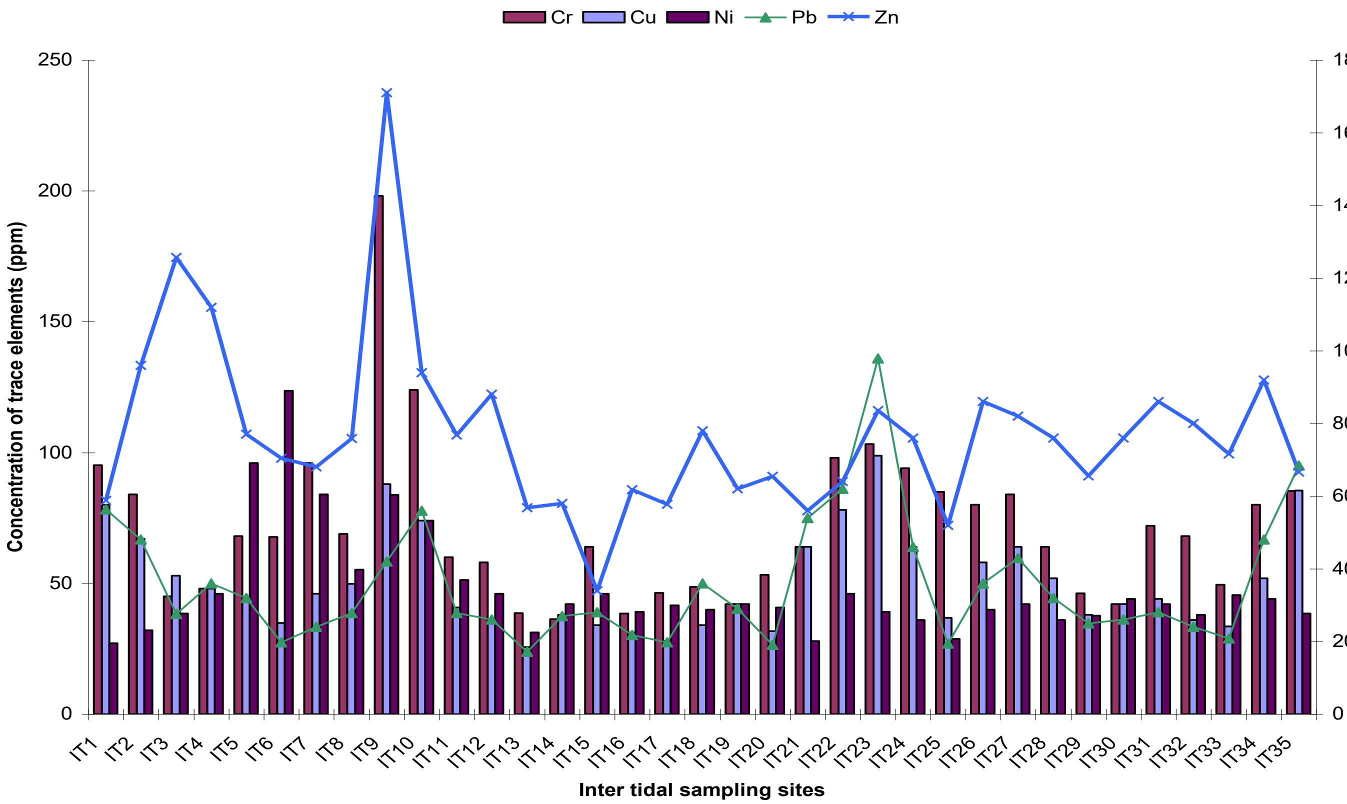

Fig. 3: Distribution of trace elements in inter tidal sediments

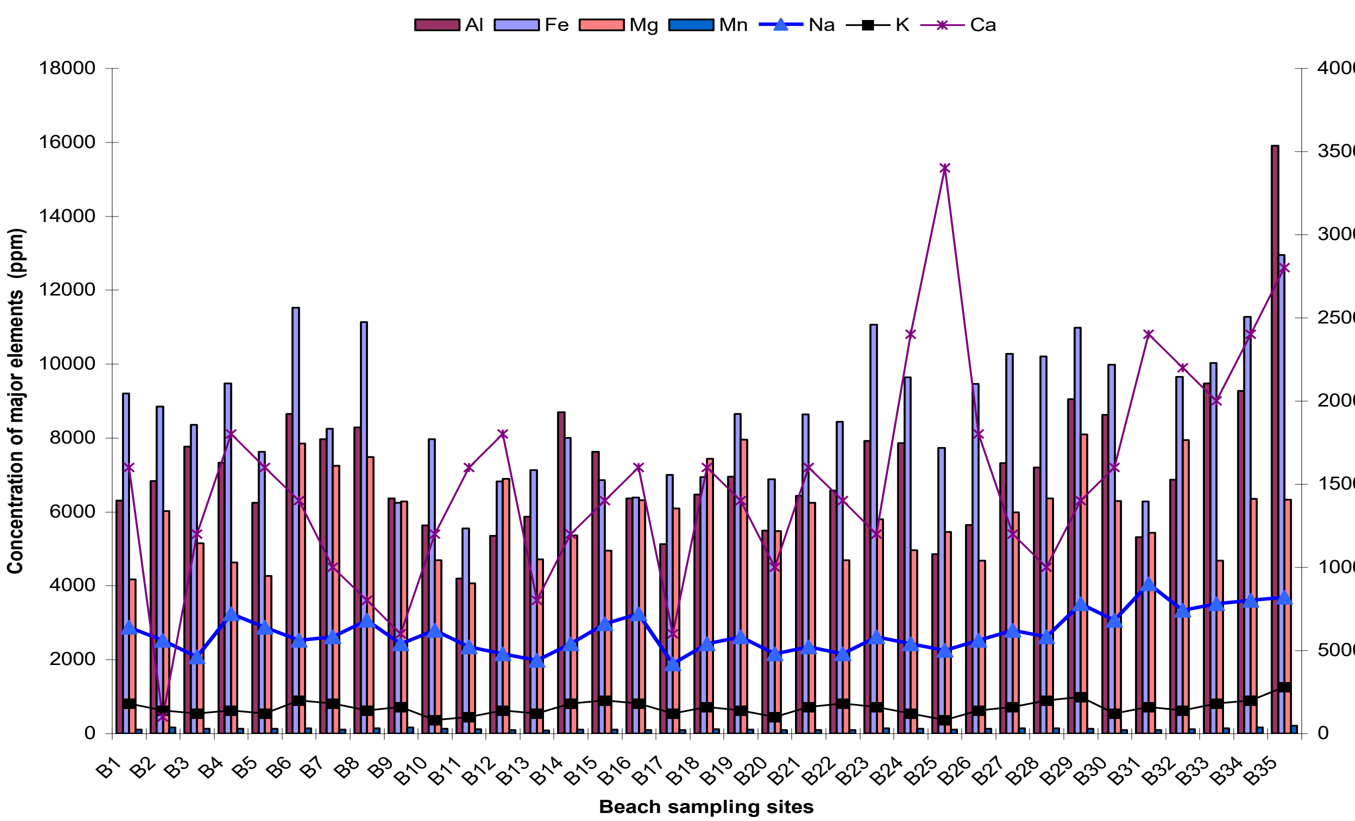

Fig. 4: Distribution of major elements in beach sediments

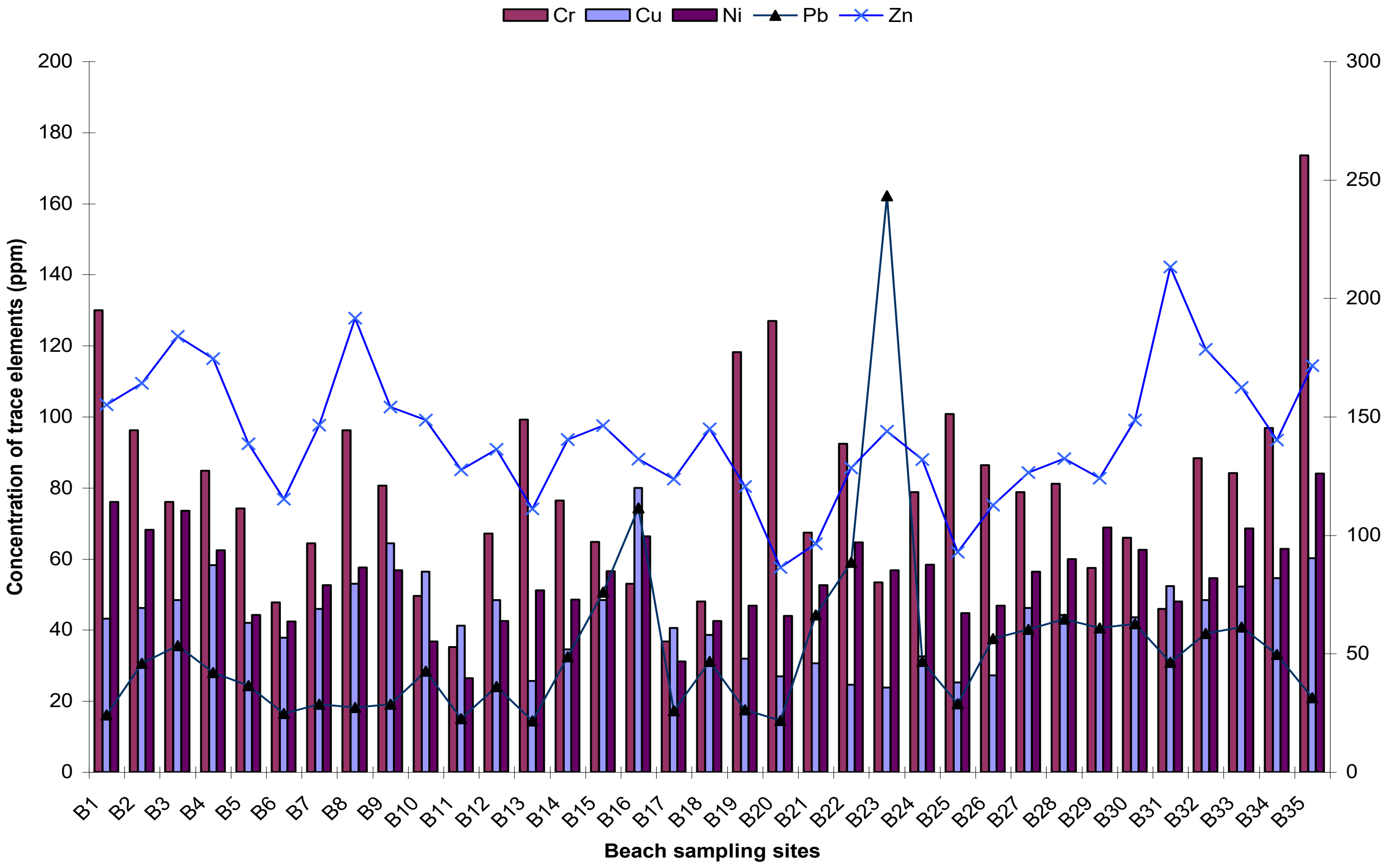

Fig. 5: Distribution of trace elements in beach sediments

3.1. Data interpretation on the basis of Sediment Quality Guidelines

Potential level of biological risk associated with the concentrations of trace metals was identified by comparing the present data with ER-L (effects range low) and ER-M (effects range median) quoted in sediment quality guidelines [15]. The calculated values are shown in table 2. A comparison revealed that Cu, Ni, Pb and Zn in beach sediments and Cu, Ni in inter tidal sediments exceeded their respective ERL screening values (table 2). However, Ni in beach sediments, also exceeded the ERM value given as 51.6. Since toxicity can be expressed as a function of the degree to which metal concentration values exceed ERM [16], it is expected that toxicological perturbations or adverse biological episodes could arise owing to Ni (in beach sediments) is burden in these aquatic systems. Therefore, enhanced metal accumulation and bio-availability within the ecosystems may be significantly increases in transportation activities, industrial effluents discharges, pesticides, could result in antagonistic and synergistic effects on biological species and ecological degradation within the region.

3.2. Enrichment Factor (EF) and Geo-accumulation Index (I_{geo})

Table 3 presents the mean values of calculated EFs, anthropogenic and lithogenic percentage for the measured five trace elements (Cr, Cu, Ni, Pb and Zn) with respect to crustal average [12]. The values are in the order of Pb>Zn>Cr>Cu>Ni for inter tidal sediments and Pb>Zn>Cr>Cu>Ni for beach sediments. Figures 6a and 7a show the higher average anthropogenic percentages for inter tidal and beach sediments. However, it is evident that the mean EF values of all the elements are greater than ten, reveal sediment contamination. However a very high mean anthropogenic percentage for Pb (96.69%) and Zn (95.54%) is observed in beach sediments. Aggett and Simpson [17] reported that the major source of lead contamination is from automobile exhaust in two different forms such as lead halides and oxy halides which are likely to be found in the sediments. Much of these are converted quite rapidly in to lead oxides and under some conditions into lead sulphate. These are insoluble species and would appear most likely to be transported in storm water as small particles which probably remain unaltered in the sediments unless their residence times are very long. Exhaust particles not converted to oxide or sulphate by the time they are initially removed by bulk water may dissolve to form soluble lead (II) species. In a combined sewage-storm water system, these soluble lead (II) species may interact with organic matter, and eventually they may adsorb, with or without organic matter, on mineralized material in the sediments.

According to Marija Romic and Davor Romic [18], the main sources of zinc pollution are from industry, the use of liquid manure, composted materials and agro-chemicals such as fertilizers and pesticides in agriculture. The higher average anthropogenic percentage for Cu (90.72%), Cr (88.13 %) and Ni (88.01 %) is found in inter tidal region. Selvaraj et al., [1] suggested that waste water discharges from industries are responsible for the enhanced concentrations of Cr and Ni in tidal zone sediments. Cu present in igneous rocks chiefly occurs in sulphid minerals, which are oxidized during weathering and Cu is released in to solution [19].

To know the metal contamination level, I_{geo} values are calculated for trace elements and are shown in table 2. The negative I_{geo} values found in the table are the results of relatively low levels of contamination for some metals in some sampling sites. The highest range of I_{geo} class (0-4) for lead in beach sediments indicating that the study area is uncontaminated to strongly contaminated.

Figures 6b and 7b show the percentage of pollution intensity (I_{geo} class) for measured trace elements. From this, it is observed that 85% of inter tidal sites and 71% of beach sites are uncontaminated by Zn. Among five trace elements, Pb and Ni are predominantly contaminated in both sampling sites (> 90%). For Cu and Cr, 50 % of inter tidal and 28% in beach sampling sites are uncontaminated. By comparing the figures (6a and 6b) for inter tidal and (7a and 7b) for beach, more than 85% of sampling sits are polluted by trace elements Cr, Cu, Ni, Zn and Pb, which comes from anthropogenic source.

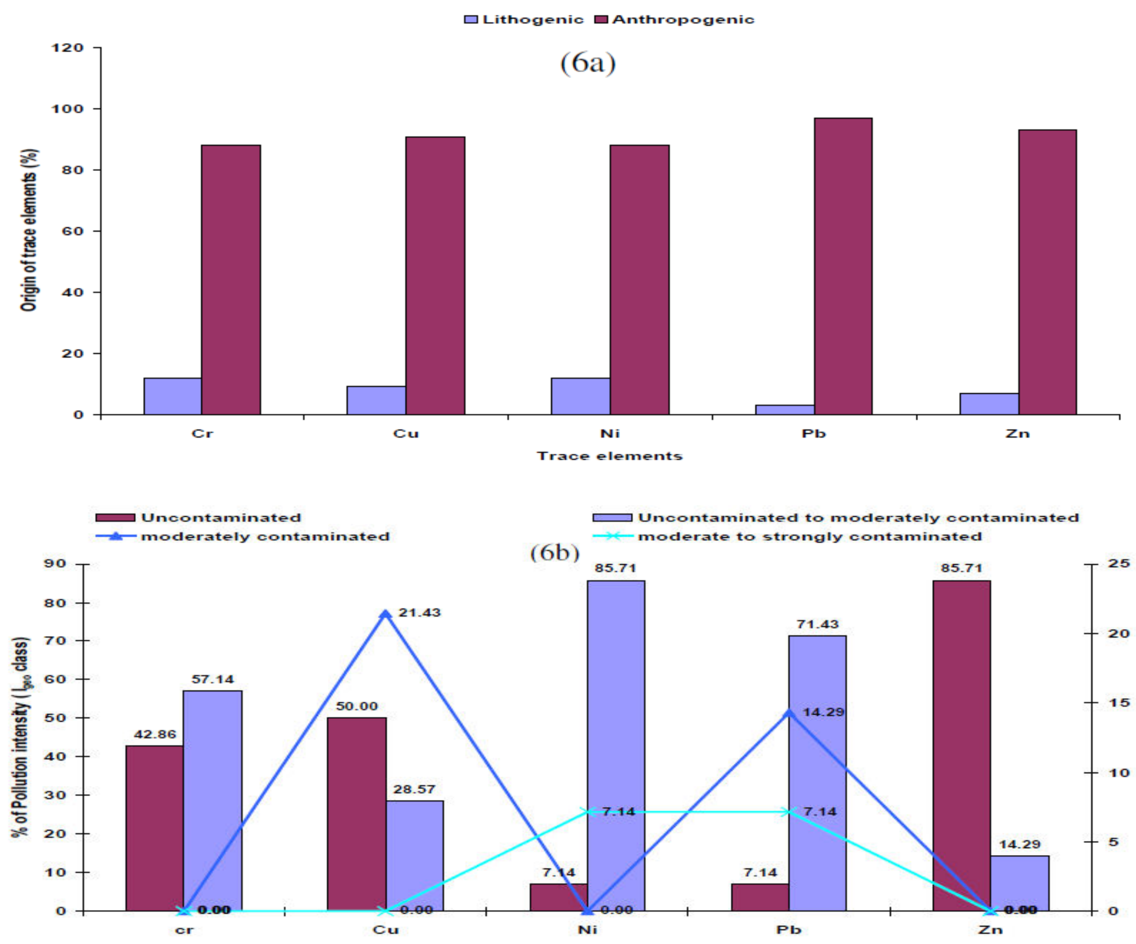

Fig. 6a and 6b: Mean Lithogenic and Anthropogenic Percentage and Percentage of Pollution intensity (I_{geo} class) for Inter tidal sediments

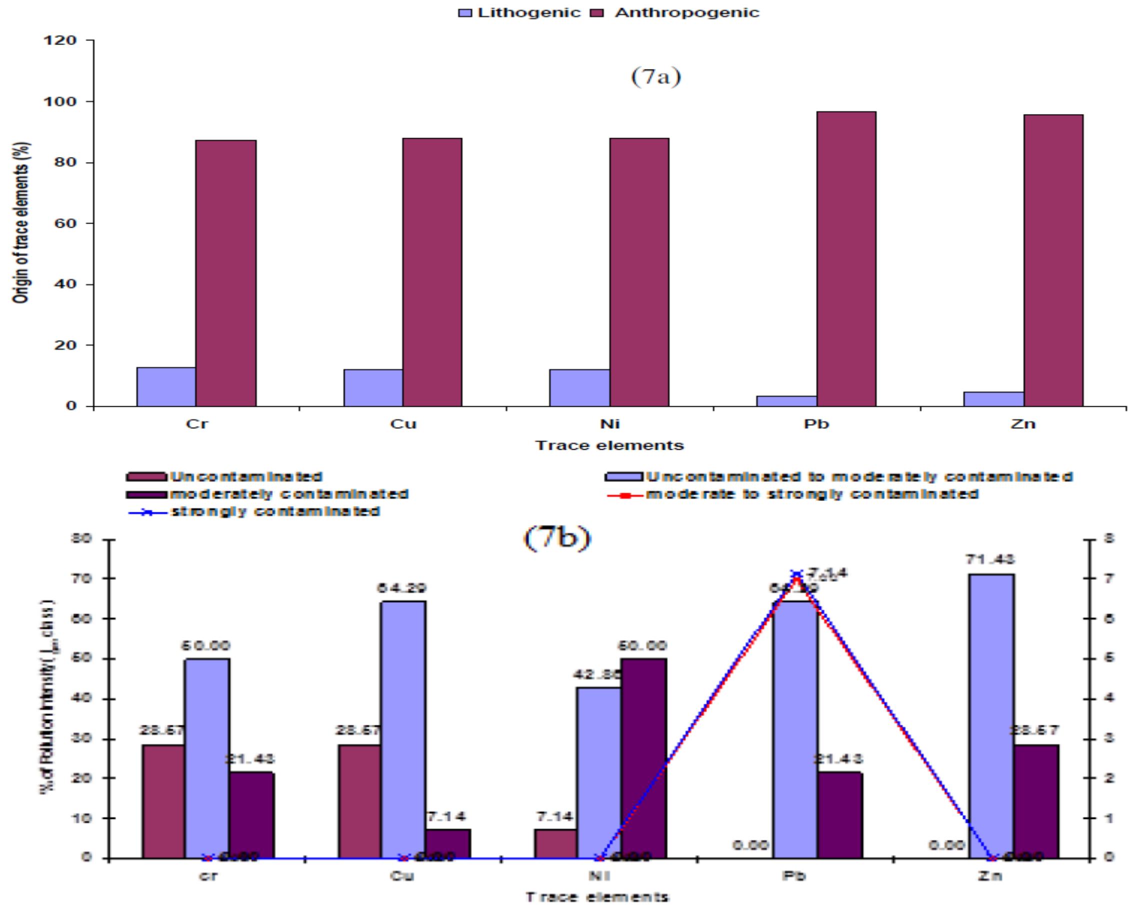

Fig. 7a and 7b: Mean Lithogenic and Anthropogenic Percentage and Percentage of Pollution intensity (I_{geo} class) for Beach sediments

3.3. Modified degree of contamination

The modified degree of contamination (mCd) provides an integrated assessment of the over all enrichment and contamination impact of groups of pollutants in sediments. The average mCd value 1.9 is observed for inter tidal sediments and 2.78 for beach sediments. Inter tidal sediments are having low degree of contamination and beach sediments are moderate degree of contamination.

3.4. Inter element correlation

Because of the various natures of the chemical elements, the bedrock material composition and depositional environment and other conditions, the contents of heavy metals in sediments often show different relevance. Therefore, the study of relevance between major elements (Al, Fe, Mn, Mg, Na, K and Ca) and trace elements (Cr, Cu, Ni, Pb and Zn) are used to understand and identify the distribution. In this study the correlation coefficient is obtain by SPSS 16.0 statistical analysis software. Table 4 and table 5 show the 12x12 correlation matrix. Metals like Al, Fe, Mg and Mn show good correlation among each other ($r = 0.5$ to $r = 0.9$), suggesting that both depositional environment and common sources areas, influence metal distribution in both inter tidal and beach sediments.

In beach sediments Mg shows strong positive correlation with Al, Fe and K (table 5), suggesting its derivation from continental weathering and its negative association with Ca indicates that these two elements have different sources. Alumina showed a strong linear relation ($r = 0.84$)(table 5) in beach sediments and negative correlation ($r = -0.2$) (table 4) in inter tidal sediments with K, indicated that the higher amount of feldspar minerals present in beach sediments and lower amount of feldspar minerals are present in the inter tidal sediments. The negative correlation of Pb (table 4) with all elements suggested that the sources of this Pb might be from agricultural and aquaculture [20] (Rajesh Kumar Ranjan et al., 2008). However the exact source of lead could not be delineated. The poor association of

Mn with other metals (Cr, Cu, Ni, Pb and Zn) suggested that the Mn-oxides may be only a minor host phase for these elements in inter tidal environment. A good positive correlation of Fe with Mn and Ni and negative correlation of Fe with Pb implied that oxic to sub-oxic and then to anoxic vertical gradients might be present in the inter tidal sediments [20].

Table 1: Elemental Concentrations of Inter tidal sediments and beach sediments

Study Area		Elemental Concentrations											
		Al (%)	Fe (%)	Mg (%)	Mn (ppm)	Cr (ppm)	Cu (ppm)	Zn (ppm)	Ni (ppm)	Pb (ppm)	Na (%)	Ca (%)	K (%)
Inter tidal sediments	Avg	0.547	0.709	0.287	99.43	72.03	50.38	77.31	48.12	35.38	0.984	1.37	0.150
	Max	0.743(8)	0.949(8)	0.393(29)	164(35)	198(9)	98.76(23)	171.00(9)	123.63(6)	97.85(23)	4.005(9)	3.8(31)	0.2(23)
	Min	0.237(1)	0.530(1)	0.175(25)	52.4(1)	38.4(4)	25.6(13)	52(25)	27.2(1)	17.2(13)	0.240(25)	0.18(23)	0.06(25)
Beach sediments	Avg	0.719	0.872	0.588	121.45	80.88	43.02	150.4	55.08	52.41	0.607	1.514	0.154
	Max	1.59(35)	1.295(35)	0.809(29)	214.2(35)	173.6(35)	80.00(16)	265.2(16)	84(35)	243.2(23)	0.9(33)	3.4(25)	0.28(35)
	Min	0.419(11)	0.55(11)	0.406(11)	83.2(13)	35.2(11)	23.8(12)	86.4(20)	26.4(11)	18.8(25)	4200(16)	0.4(25)	0.28(35)
CA*		8.23	5.63	2.33	950	100	55	70	75	12.5	2.36	4.15	2.09
UCC+		7.74	3.08	1.35	527	35	14.3	52	18.6	17	2.5	2.9	2.8

Avg- Average, Max- Maximum, Min- Minimum, Crustal Average (S.R.Taylor, 1964), Upper Continental Crust+ (Wedepohl, 1995) and () - represents site number.*

Table 2: I_{geo}, ERL and ERM of selected trace elements

Trace elements	Average concentration (ppm)		ERL	ERM	Calculated geo accumulation Index (I_{geo})				I_{geo} class		Sediment quality	
	Inter tidal sediments	Beach sediments			Inter tidal sediments		Beach sediments		Inter tidal sediments	Beach sediments	Inter tidal sediments	Beach sediments
					Max	Min	Max	Min				
Cr	72.03	80.88	81	370	1.92	-0.45	1.73	-0.58	0-2	0-2	Uncontaminated to Moderately contaminated	Uncontaminated to Moderately contaminated
Cu	50.38	43.02	34	240	1.40	-0.55	1.09	-0.66	0-2	0-2	Uncontaminated to Moderately contaminated	Uncontaminated to Moderately contaminated
Zn	77.31	150.4	150	410	1.13	-0.58	1.45	-0.66	0-2	0-2	Uncontaminated to Moderately contaminated	Uncontaminated to Moderately contaminated
Ni	48.12	55.08	20.9	51.6	2.15	-0.04	1.59	0.15	0-3	0-2	Uncontaminated to Strongly contaminated	Uncontaminated to Moderately contaminated
Pb	35.38	52.41	46.7	218	2.38	-0.12	3.7	-0.08	0-3	0-4	Uncontaminated to Strongly contaminated	Uncontaminated to Strongly contaminated

Table 3: Enrichment Factor, M-Lithogenic (%) and M-Anthropogenic (%) of trace elements

Parameters		Elements				
		Cr	Cu	Ni	Pb	Zn
EF (Inter tidal sediments)	Avg	10.71	14.95	9.18	46.79	16.08
	Max	33.10(1)	50.65(1)	21.07(6)	151.12(23)	29.21(1)
	Min	5.45(29)	6.77(17)	5.91(29)	20.23(6)	10.98(17)
M-Litho in % (Inter tidal sediments)	Avg	11.86	9.27	11.99	3.33	6.88
	Max	18.28(29)	14.77 (17)	16.91(29)	4.94 (6)	9.11 (17)
	Min	3.01 (1)	1.97 (1)	4.74 (6)	0.64 (1)	3.42 (1)
M-Anthro(Inter tidal sediments)	Avg	88.13	90.72	88.01	96.67	93.11
	Max	96.99 (1)	98.02 (1)	95.25 (6)	99.36 (1)	96.58 (1)
	Min	81.71(29)	85.22 (17)	83.08(29)	95.06 (6)	90.89 (17)
EF (Beach sediments)	Avg	9.76	9.71	8.77	49.24	25.01
	Max	19.03(20)	18.83 (16)	13.23 (1)	202.12(23)	47.13 (33)
	Min	4.55(6)	4.5 (23)	5.38(6)	12.99 (31)	12.68(31)
M-Litho(Beach sediments)	Avg	12.68	12.07	12.15	3.31	4.46
	Max	22.06 (6)	22.22 (23)	18.57 (6)	7.64 (35)	7.88 (35)
	Min	5.27 (20)	5.31 (16)	7.55 (1)	0.49 (23)	2.12 (33)
M-Anthro (Beach sediments)	Avg	87.31	87.93	87.85	96.69	95.54
	Max	94.73(20)	94.69 (16)	92.44 (1)	99.51(23)	97.88 (33)
	Min	77.94 (6)	77.78 (23)	81.43 (6)	92.35 (35)	92.11 (35)

( ) - represents site number

Table 4: Inter element correlation for Inter tidal sediments

	Al	Cr	Cu	Fe	Mg	Mn	Ni	Pb	Zn	Na	K	Ca
Al	1											
Cr	0.161	1										
Cu	0.143	0.284	1									
Fe	0.812	0.081	0.181	1								
Mg	0.826	-0.331	-0.049	0.617	1							
Mn	0.731	-0.13	0.134	0.769	0.751	1						
Ni	0.669	0.303	0.173	0.523	0.389	0.272	1					
Pb	-0.419	-0.072	0.592	-0.064	-0.484	-0.145	-0.176	1				
Zn	0.246	-0.135	0.706	0.264	0.258	0.283	0.403	0.353	1			
Na	0.049	-0.518	0.28	-0.153	0.287	0.258	0.098	0.187	0.605	1		
K	-0.22	-0.676	0.043	-0.062	0.048	0.001	0.109	0.52	0.425	0.574	1	
Ca	0.403	0.063	0.006	0.423	0.343	0.519	0.23	0.02	-0.041	-0.251	-0.012	1

Table 5: Inter element correlation for Beach sediments

	Al	Cr	Cu	Fe	Mg	Mn	Ni	Pb	Zn	Na	K	Ca
Al	1	0.519	0.307	0.838	0.474	0.926	0.678	0.094	0.187	0.479	0.839	0.215
Cr		1	-0.026	0.374	-0.148	0.449	0.564	-0.301	-0.124	0.112	0.275	0.267
Cu			1	-0.018	0.192	0.166	0.416	-0.025	0.901	0.618	0.466	0.139
Fe				1	0.618	0.843	0.55	0.203	-0.039	0.331	0.708	0.04
Mg					1	0.399	0.149	0.087	0.084	0.355	0.497	-0.131
Mn						1	0.511	0.152	0.064	0.354	0.677	0.268
Ni							1	0.191	0.46	0.489	0.657	0.178
Pb								1	0.277	0.128	0.153	-0.086
Zn									1	0.596	0.344	0.051
Na										1	0.711	0.405
K											1	0.214
Ca												1

4. CONCLUSION

Good environmental quality is essential for sustaining coastal and marine ecosystems, commercial and recreational fisheries, and economic growth in coastal communities. The health of coastal and marine ecosystems is affected by sediment quality. The results of the major elemental analysis show the low values of Al, Fe, Mg and Mn when compared with CA and UCC. An estimation of possible environmental toxicity impacts via comparison of metal concentrations with sediment quality guidelines showed that Cu, Pb, Ni and Zn in beach sediments and Cu and Ni in inter tidal sediments occurred at concentrations above individual metal ERL. However Ni in beach sediments exceeded the ERM. Normalization of total trace metals to Al and their ratios with crustal average demonstrate the higher mean enrichment factor for Pb, Zn, Cu, Cr and Ni revealing contamination of sediments by these metals from external sources such as industrial and modern population activities. The percentage of anthropogenic and lithogenic origin for trace elements, showed that more than 90% of Pb accumulated from anthropogenic origin. The sources of pollution include industrial effluents, transport, agricultural and aquaculture. The I_{geo} values showed that all the trace metals are in class2, expect Pb in beach sediments, which is in class 4. The calculated values of heavy metal contamination (mCd) indicated that inter tidal sediments are low degree of contamination and beach sediments are moderate degree of contamination. The data presented here confirmed the metal contamination, at least by Pb and Ni, is a significant factor in the beach sediments of North east coast of Tamilnadu in India and justifies the need for continuous monitoring of sediment contamination.

The environmental protection of coastal areas should draw the attention of all levels of government and administrative departments in charge of marine protection and they should take effective protection measures, such as ocean management agencies strengthening law enforcement efforts, rational development of marine resources, maritime industries sewage treatment, increasing investment in science and technology and scientific protection measures of coastal zone environment.

Conflict of interest

None declared

5. REFERENCES

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