Heavy metal distribution in sediments around Kallur Mandli and Sagar road Industrial estate Shimoga, Karnataka, India

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Abstract: The present study was taken up to identify trace metals as well as to assess the extent of anthropogenic inputs into the Shimoga area. The Kallur mandli and Sagar road industrial estate of shimoga in and around collected sediment samples from ponds, channel and, river for present study. The samples were analyzed heavy metals Viz., Cd, Pb, Ni, Zn, Cu, Mn and Fe. The obtained results are compared with non-polluted sediments of near gadikoppa pond sample, which is away from the industrial activity for used as back ground values. The study area samples exhibits higher concentration of Cd, Pb, Ni, Zn, Cu, Mn and Fe than the unpolluted values. Thus, industrial activity has allowed the accumulation of certain heavy metals by transportation and deposition into surrounding area of pond, channel and river sediment matrix. The contamination of the sediments with metals at few locations is attributed to industries and other anthropogenic causes.

Key Words: Shimoga, Trace elements, pond, channel, river.

1. Introduction:

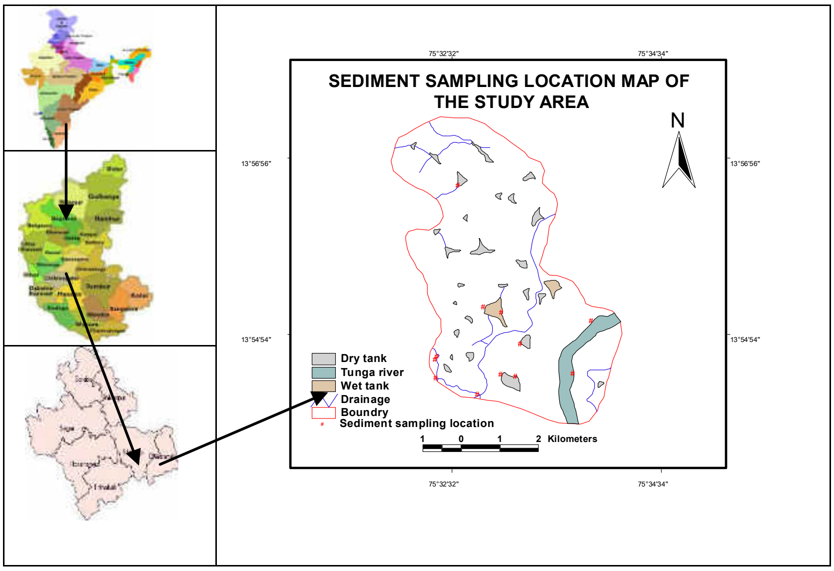
The sediment generally preserves a very good historical record of changes in the fluxes of heavy metals. Sediments geochemistry, together with sediment deposition pattern and contaminant sources are controlling factors of the adsorption-desorption of contaminants onto sediments; these processes are responsible for availability, fate and behavior of the contaminants in the environment. Organic matter, particle size, mineral fraction and microstructure of sediments have been related as the main factors depending on the behavior of organic and inorganic contaminants in sediments (Trivedi et al, 1984; Emmanuel et al, 1994). The suspended particles carrying the contaminants settle into the basin sediments and with time get buried in the sediments.

Among the many environmental parameters, sediments have a more significant importance in the assessment of pollution and management. Due to the physicochemical processes of precipitation and sedimentation, some of the heavy metals that are introduced to an aquatic system are deposited in the sediment. Thus, the sediment provides useful information on the history of the quality of water body (Soma Giri et al, 2013). The sediments assume a special significance in terms of historical record of anthropogenic heavy metals pollution. Consequently, bottom sediments are "SOURCE" as well as "SINK" of contaminants in an aquatic environment (Avil et al, 2002; Govil et al, 2001). There is great concern over the increase in pollution due to heavy metals as a result of increased industrialization (Patel et al, 2005; Tsai et al, 2002). The heavy metals in toxic concentrations can cause serious health problems, thus necessitating systematic and regular monitoring of their concentrations in aquatic bodies. A major problem still exists with the measurement and evaluation of the toxological aspects of persistent chemicals like heavy metals associated with sediments. Several studies have been carried out on heavy metals distribution in the sediments of Indian rivers (Acero et al, 2003; Gurhan, 2007; Lokeshwari et al, 2006; Praveen Kumar, 2005). Most of the developmental activities use natural resources as raw material and waste generated is disposed into different environmental media. The signs of stress on the scarce natural resources are evident from the deteriorating air quality, soil degradation, polluted river and streams and general status of environment in various regions. It is now well recognized that for sustainable development and optimal use of natural resources, environmental considerations is required to be integrated in planning, designing and implementation of development projects cannot be fully realized unless they are environmentally and socially sound and sustainable. Therefore, present study has taken to determine trace elements around Shimoga.

1. Study Area:

The study area is located in a part of Shimoga city, majorly covered by industrial activity at Kallur mandli and sagar road. The Kallur Mandli industrial area, covering an area of 10 acres, it has been established in the year 1992-93, In this study area about 22 industries have been located which are lies in 13°54'42.9" latitudes and 75°33'40.3" longitudes and this area covers Kallur, Mandli, Tunga river and Harakere. The Sagar road
industrial estate covering an area of nearly 10 acres, it has been established in the year 1980, In this area about 75 small scale industries have been located, which are lies in 13°56'49.9" latitudes and 75°33'41" longitudes and it

covers the Gadikoppa and RMC yard which falls in the Survey of India toposheet No. 48 O/9 on 1:50,000 scale. The location map of the study area is shown in the fig.1. The surrounding area of industries covered by agricultural land, residential areas, tanks, channels, part of Tunga river and is most of the waste generated from the industries are deteriorating in soil, water or sediments.



2. Geology of the study area:

In the study area exposed the component of peninsular gneisses. This occurs as scattered outcrops. Minerologically these rocks are granite to granodiorite in composition. Most of these outcrops have been subjected to prolonged weathering processes and therefore outcrops are appears residual in nature. These are also subjected to jointing and fracturing.

3. Methodology:

In the investigated area sediment samples from the pond, channel and river has been collected and analysed by following standard methods proposed by APHA (1980), Trivedy and Goel (1984). The sediment data were compared with the unpolluted sediment (Near Gadikoppa pond) to identify the extent of heavy metals input in the area investigation.

3.1PVC pipe as a sampler

Sediment samples were collected at 12 representative locations in the study area by using half meter long and two inches diameter pvc pipe. For the collection of samples the discharging channels joining at each pond, channel and river is considered where the pvc pipe was placed vertically and pushed down upto a depth of 25 to 30cms carefully collected in the order of top, middle and bottom sediments in a pre-cleaned, labelled polythene bags and stored separately in the laboratory for analysis.

4.2 Sample preparation for trace element analysis

Remove the unwanted substances like smaller stones and organic content in the sediment samples and the samples has been reduced by coning and quartering method till 20gms and then it has been grinded upto fine powder, the powdered sample has been sieved by using a sieve plate of 200mesh and it is stored separately in a small labelled polythene bags. From the stored sample accurately weighed 1gm of sediment sample taken into the 100ml beaker to this added 4ml of perchloric acid and 1ml of conc.HNO_3 heated upto dryness, after drying 5ml of 1N HCl was add and again heated for dryness, after complete digestion the sample was filtered by using a whatman filter paper No.42 and then make in to 100ml by using distilled water. This solution was used for the analysis heavy metals like Cd, Pb, Ni, Zn, Cu, Mn and Fe in Atomic Absorption Spectrometer (Australian Model- GBC 902).

4. Results and Discussion:

From the foregoing analysis it could be noted that the environmental parameters determined for pond, channel and river sediments are of much significance. The presented analytical data are illustrated by diagrams in each of the elements. The result obtained by this analytical data (Table 1.2) is compared with one sample away from the industrial activity. The physicochemical processes of precipitation and sedimentation, some of the heavy metals that are introduced to an aquatic system are deposited in the sediment. Thus, the sediment provides useful information on the history of the quality of the water body (Taymaz et al, 1984; Irbien et al,1999; Khaled et al, 2006 Abida et al, 2009).

The study area shows Cu concentration ranges from 5.8 to 56.2ppm, here 6 sites concentrations gradually increased from bottom to top cross sectional samples and 4 sites shows decreasing rate and one sample shows intermediate means increase - decrease - increasing order from bottom – middle – top respectively. The study area Zn concentration ranges from 13 to 82.3ppm, here 6 sites concentrations gradually increased from bottom to top cross sectional samples and 4 sites shows decreasing rate and one sample shows intermediate means increase - decrease - increasing order bottom – middle – top respectively. The study area Mn concentration ranges from 19.7 to 312. 2ppm, here 7 sites concentrations gradually increased from bottom to top cross sectional samples and 4 sites shows decreasing rate from bottom – middle – top respectively.

Table 1.1 Sampling locations of pond, channel and river sediments with latitude, longitude and elevation of the study area.

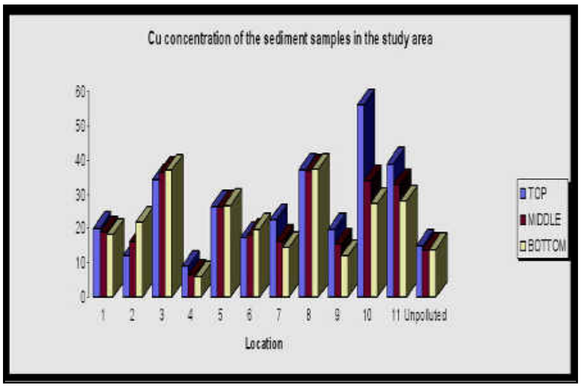
LOCATION NO	LOCATION NAME	ELEVATION	LATITUDE	LONGITUDE
1	Near Rameshwar temple	565	13°54´21.7´´	75°33´79.6´´
2	Harakere within the Mandli Industrial Area	576	13°54´17.6´´	75°33´24.5´´
3	Harakere within the Mandli Industrial Area	574	13°54´27.3´´	75°33´06.4´´
4	Near Harakere Tunga left bank canal	575	13°54´25´´	75°32´80´´
5	Near Harakere Tunga left bank canal	588	13°54´24.2´´	75°32´60´´
6	Near Harakere Tunga left bank canal (Paper mill waste dumping site)	588	13°54´39.4´´	75°32´58.8´´
7	Near Harakere Tunga left bank canal (Paper mill waste dumping site)	588	13°54´39.4´´	75°32´58.8´´
8	Behind Annapurneshwari Saw mill wood and concret blocks	581	13°54´42.9´´	75°33´40.3´´
9	Gopshetty Koppa Kere (Location1)	584	13°55´15´´	75°32´40´´
10	Gopshetty Koppa Kere (Location2)	585	13°55´12.08´´	75°32´45´´
11	Near Tunga Bridge	562	13°54´50´´	75°34´22.6´´
12	Near Gadikoppa pond (Unpolluted sample)	635	13°57’34.0”	75°31’99.6”

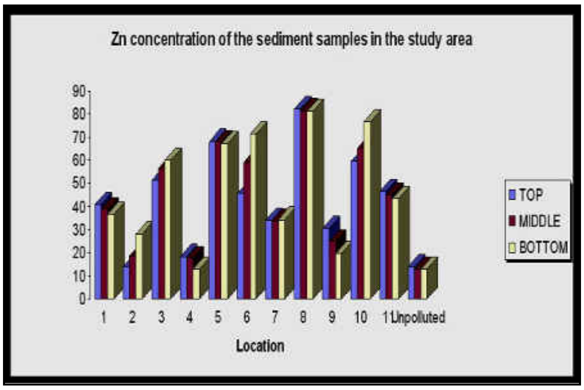
The study area Fe concentration ranges from 507.4 to 14710ppm, here 7 sites concentrations gradually increased from bottom to top cross sectional samples and 3 sites shows decreasing rate and one sample shows intermediate means increase - decrease - increasing order bottom – middle – top respectively. The study area Cd concentration ranges from 0.5 to 1.1ppm, here all the 11sites concentrations gradually increased from bottom to top cross sectional samples. The study area Pb concentration ranges from 16 to 34.5ppm, here 10 sites concentrations gradually increased from bottom to top cross sectional samples and one sites shows decreasing rate from bottom – middle – top respectively. Ni concentration ranges from 11 to 39ppm, here all the 11 sites concentrations gradually increased from bottom to top cross sectional samples.

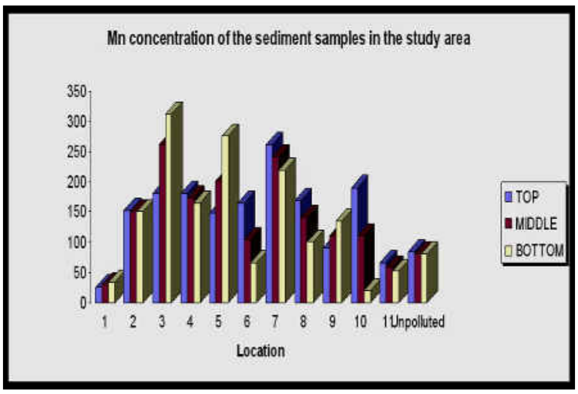
Table 1.2 Trace elements content of pond, channel and river Sediment samples in and around the Kallur Mandli and Sagar Road Industrial estate (Values are in ppm).

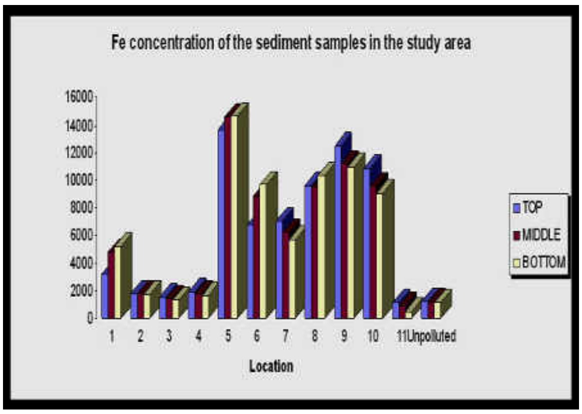
LOCATION		Cu	Zn	Mn	Fe	Cd	Pb	Ni
1	*TOP*	20.3	41	25.24	3175	0.81	27.5	29
	MIDDLE	19.1	38.6	30.5	4800	0.8	26	19
	BOTTOM	18.3	36.5	33.5	5210	0.67	20	13
2	*TOP*	12	14	152.8	1794	1.1	34.5	25

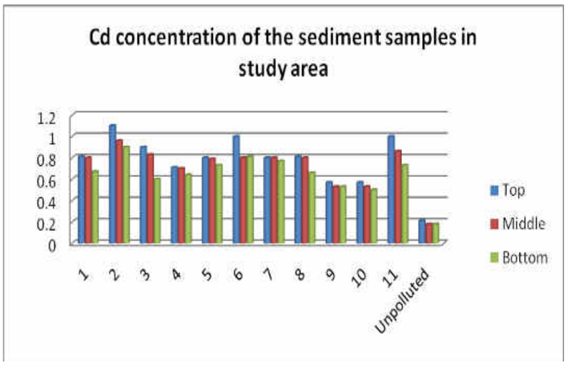
	MIDDLE	16.2	18.5	151.6	1756	0.96	34	19
	BOTTOM	21.8	28.2	150.7	1719.5	0.9	28	18
3	*TOP*	34.3	51.5	181.6	1545	0.9	34	24
	MIDDLE	36.5	56.3	262	1412	0.83	31	19
	BOTTOM	37.2	59.8	312.2	1320	0.6	23	19
4	*TOP*	9	18.3	181.8	1898.5	0.71	29	14
	MIDDLE	6.5	17.5	172.3	1785	0.7	23	14
	BOTTOM	5.8	13	165.2	1625	0.64	23	11
5	*TOP*	26.5	68	148.6	13725	0.8	23.5	19
	MIDDLE	26.5	67.8	201	14620	0.79	21	19
	BOTTOM	26.9	67.4	276.2	14710	0.73	21	16
6	*TOP*	17.3	45.6	164.2	6760	1	17.5	39
	MIDDLE	18.2	59.2	105	8900	0.8	18	38
	BOTTOM	19.9	71.2	66.2	9690	0.81	19	30
7	*TOP*	22.6	34	262.3	7075	0.8	23.5	31
	MIDDLE	16.5	33.6	241	6200	0.8	23	30
	BOTTOM	14.5	34.4	220.1	5705	0.77	23	30
8	*TOP*	37.3	82.3	169.4	9650	0.81	27.5	29
	MIDDLE	37	81.5	140	9500	0.8	23	19
	BOTTOM	37.4	81.1	101.2	10385	0.66	20	17
9	*TOP*	19.9	30.4	89.7	12500	0.57	23	29
	MIDDLE	15.6	24.6	111.2	11200	0.53	23	19
	BOTTOM	12.1	19.7	134.4	10975	0.53	20.5	13
10	*TOP*	56.2	59.4	190	10865	0.57	17.5	19
	MIDDLE	34	65.4	110	9600	0.53	16	19
	BOTTOM	27.5	76.5	19.7	9100	0.50	16	13
11	*TOP*	39	46.7	66.9	1119.1	1	26.5	39
	MIDDLE	33	45.1	58.1	885	0.86	26	38
	BOTTOM	28	43.3	51.8	507.4	0.73	24	33
12 Unpolluted	*TOP*	15	14	85	1200	0.21	16	19
	MIDDLE	14	13	80	1150	0.18	14	15
	BOTTOM	14	13	81	1130	0.18	10	9

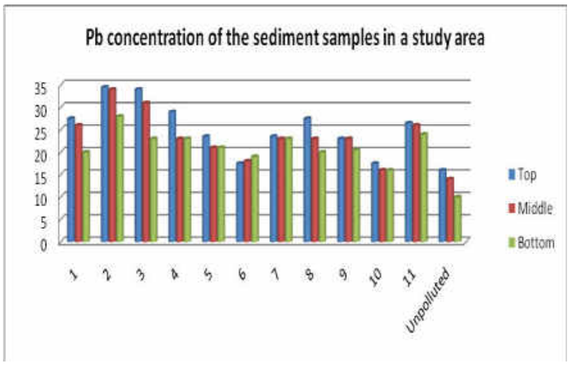


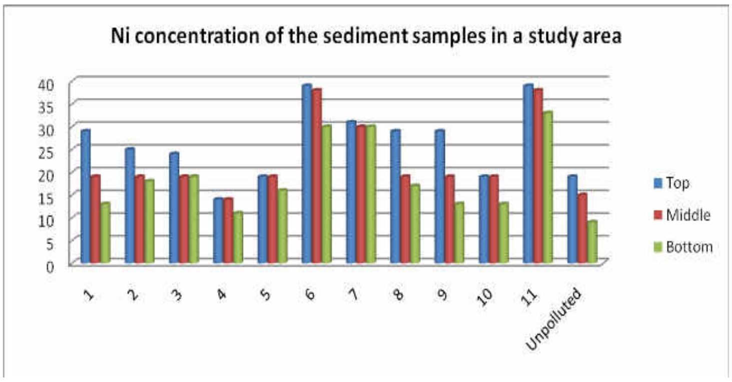












The obtained data of all the sites compared with unpolluted samples, Cu, Zn, Ni is exceeded in all the locations except location 4 i.e., near Harakere left bank canal, the concentration of Mn and Fe is also exceeded the concentration when compared with unpolluted sediment in all the locations except at location 11 near Tunga bridge. Cd and Pb concentration is exceeded compared to unpolluted samples in all the cross sections. The obtained and interpreted data of cross sectional samples gives clear evidence about sediment containing trace elements viz., Cu, Zn, Mn, Fe, Cd, Pb and Ni is source of lithology/soil/anthrophogenic or by any other nature. Most of the trace elements are gradually increased from bottom to top cross sectional samples, very few are reverse stage and three elements in one sample there is no orientation. Sediments are major repositories for metals and, in addition to providing the environmental status; they are also used to estimate the level of pollution in a region (Thomas et al,, 1984; Emmanual et al., 1994; Sarika et al,2008).

The study area is dominated by industrial activity and is generated large amount of solid and liquid. The generated wastes are sometimes disposed in nearby place, adjacent to drainage, river, tank, channels etc. The fluctuated sediment concentration in a samples is clearly indicates its part of anthropogenic and industrial activity in a surrounding area, due to this activity wastes were leached from soil or carried through water leads to contamination of sediment.

5. Conclusion:

The analyzed trace metals in the sediments of the study area show two to five fold increased concentration, when compared with unpolluted sediment samples. The above results clearly explain that the wastes generated by the industries as well as anthropogenic activities contributed these trace metals into the natural system along with natural contribution. This contamination may be occurred by improper drainage system in the study area which results the disposal of wastes with unsatisfactory manner. The improper disposal of wastes have been washed by surface run-off and it gets into the nearby surface water bodies and finally deposited in the sediments which also results the deterioration of water and sediments of surface water bodies. Distribution characteristics of metal concentrations and consequently the sediment quality of the study area is the result of combined influence of natural conditions, i.e. geological backgrounds and human activity. Thus, it is reasonable to conclude that the increased concentrations of metals in the sediments is due to direct discharge of industrial, urban and other wastes into the river, channel, pond, etc. Overall, the toxic trace elements in the sediment of the study arae, especially for Pb and Cu, pose a high potential for severe impact on aquatic plants and other organisms and could act as secondary sources of pollution in the overlying water column (Soma giri et al, 2013). The results of this study indicate that monitoring and immediate managerial measures must be taken to avoid further potentially toxic metal pollution of river sediments. Continuous monitoring and further studies of the area are recommended to ascertain long-term effects. Further investigation is also recommended for seasonal variability of toxic metals in the study area along with isotopic tracing of the metals. If the industrial area development board authority should insist a proper drainage system in the area of investigation and also to guide about the proper disposal of wastes in the study area. This will minimize the pollution of the natural environment and also protect our environment for future generation.

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