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Seasonal variations of heavy metals distribution in water and sediments of kadalur, coastal zone, tamil nadu, india

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ABSTRACT

The objective of this research was to evaluate the degree of heavy metal contamination in coastal areas and the rivers to extent which the sediment quality of the coastal area of Kadalur. In this study, heavy metals such as Zn, Cu, Cr, Cd, Pb and Hg were analysed. The selection of sampling points was based upon the inflow and out flow regions of the coastal area and rivers may be due to agricultural runoff, effluent discharge from the madras atomic power station (MAPS) discharge of tanneries and distilaries at the upstream of the Palar river and to the air – borne vehicular emissions due to the recently developed East Coast Road (ECR). Digestion and analysis of the samples were done by microwave – assisted digestion and atomic absorption spectrophotometry respectively. The observed order of abundance of metals during the present investigation is as follows: station 1 Zn >Cr > Cu > Cd > Hg, Station 2: Zn > Cu > Cr > Pb > Cd > Hg Station 3: Cu > Zn > Pb > Cr > Cd > Hg. This study proves that the level of sustained metal contamination of the coastal area and the river. This prolonged presence in excessive levels of the studied heavy metals in the bed sediments casts doubt on the choice and effectiveness of the any mitigation measures in the long run.

Key words: Heavy Metals, Palar river, Palar estuary, Kadalur sea coast, Atomic absorption spectrophotometry. (ASS).

1. INTRODUCTION

The problems associated with heavy metals in waste and storm water drainage entering the natural urban aquatic ecosystems have been well documented and studied. Heavy metals are widespread pollutants of great environmental concern as they are non-degradable, toxic and persistent with serious ecological ramifications on aquatic ecology (Chopra *et al.,* 2009 and Jumbe, A.S., 2009). Humans have always depended on aquatic resources for food, medicines and materials as well as recreational and commercial purposes such as fishing and tourism. In addition, aquatic ecosystems have significant impact on migratory bird species that use the water bodies as sanctuary and stop-over for food, breeding and nesting. The urban aquatic ecosystems are strongly influenced by long term discharge of untreated domestic and industrial wastewaters, storm water runoff, accidental spills and direct solid waste dumping (Sarika, P.R. and Chandra Mohan Kumar, 2008). All these released pollutants have a great ecological impact on the water quality and its surrounding food web, and its salts are used in the leather tanning industry, the manufacture of catalysts, pigments and paints, fungicides, the ceramic and glass industry and in photography and for chrome plating and corrosion control. Hexavalent compounds and carcinogenic by inhalation and are corrosive to tissue Abhishek, 2008 and He Habi, 2009.

Heavy metals in the sediment are essential to assess the extent of metal pollution. The distribution of heavy metals in solution has widely been recognized as a major factor in the geochemical behavior, transport and biological effects of these elements in natural waters (Ananthan *et al.*, 1992; Karthikeyan *et al.*, 2004, 2007). Moreover, sediment has aptly been called as 'Trace element trap' (Eugenia *et al.*, 2004) because they eventually receive almost all the heavy metals, which enter the aquatic environment (Karthikeyan *et al.*, 2007). The scavenging by suspending particles results in large concentration of pollutants being retained in estuarine sediments (Jurascic and Prohic, 1986). Sediment samples have also been widely used to monitor heavy metal pollution in coastal areas (Aksu et. al., 1998; Karthikeyan

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et.al., 2007). Heavy metal contamination could frequently be identified through analysis.

Abida Begum *et al.*, (2008) reported that the many dangerous chemical elements, if released into the environment, accumulate in the soil and sediments of water bodies. The lower aquatic organisms absorb and transfer them through the food chain to higher trophic levels, including fish. Under acidic conditions, the free divalentions of many metals may be absorbed by fish gills directly from the water.

Rasoanandrasana, 2006 reported that the usual activities of seaport also cause real effect at the proximity of coastline areas. This study allows us to know at the first time the heavy metal level in the sediment. It means that we want to measure cities activities effect in coastal area. And it gives background situation because none sediments study had done at kadalur coastal zone.

The present work was carried out to study the kadalur is a coastal village of Tamilnadu, that located in the neighborhood of the estuarine region Palar river to assess the selected heavy metals (Zn, Cu, Cr, Cd, Pb and Hg) waters at the selected station viz, station 1 (Palar river), Station 2 (Palar estuary) and station 3 (Kadalur sea coast).

2. MATERIALS AND METHODS

For the present study water samples were collected at monthly intervals (for a period of 12 months from July 2009 to June 2010) and were collected in precleaned and acid washed polypropylene bottles of one litre capacity and were immediately kept in an ice box and transported to the laboratory to avoid contamination. Water samples were then filtered through a Millipore fitering unit using a Millipore filter paper (Pore size 0.45µm). The filtered water samples were reconcentrated with APDC – MIBK extraction by following the procedure of Brooks et al. (1967). The heavy metals in water were analysed in air – acetylene Atomic absorption Spectrophotometer (AAS – Model 802). Mercury analysis was quantified by cold vapour technique in mercury analyser (Model 5800 D – 209).

3. RESULTS AND DISCUSSION

The result on heavy metals observed during the Station 1 (Palar river), Station 2 (Palar estuary), Station 3 (Kadalur sea coast) during the present study July 2009 to June 2010 is given in Table 1, Table 2 and Table 3. At Station 1, concentration of Zinc in water ranged from 0.81 to 23.87 mgl^{-1} Minimum concentration (0.81 mgl^{-1}) was recorded during summer (May) season and the maximum (23.87 mgl^{-1}) during the monsoon (November) season. Station 2, concentration of zinc in water ranged from 4.37 to 37.86 mgl^{-1}, with minimum concentration (4.37 mgl^{-1}) during summer (May) season and the maximum (37.86 mgl^{-1}) during monsoon (December) season. At Station 3, minimum concentration (3.33 mgl^{-1}) was recorded during summer season (June) and the maximum (32.14 mgl^{-1}) during the monsoon (December) season. In general, minimum concentration of zinc in water was recorded during the summer and the maximum during the monsoon season at all the stations. Zinc was found to be high at Station 2.

At Station 1, minimum (0.67 mgl^{-1}) concentration of copper was recorded during summer (June) season and the maximum (11.38 mgl^{-1}) during monsoon (October) season. At Station 2, minimum Cu concentration (6.69 mgl^{-1}) was recorded during summer (April) and the maximum (17.09 mgl^{-1}) during monsoon (December) season. At Station 3, it was minimum (13.17 mgl^{-1}) during summer April) and the maximum (114.59 mgl^{-1}) during monsoon (November) season. In general, all the stations registered minimum value of Cu in water during turner and the maximum during monsoon season. Copper was found to be high Station 3.

Station 1 registered minimum (1.04 mgl^{-1}) and the maximum (14.83 mgl^{-1}) les of chromium in water during summer (May) and monsoon (November) seasons respectively. Station 2 registered minimum (0.63 mgl^{-1}) and maximum (10.83 mgl''^{1}) values of Cr in water during post monsoon (March) and monsoon (December) seasons respectively. Station 3 registered minimum (0.026 mgl^{-1}) and mm (6.92 mgl^{-1}) values of Cr in water during post monsoon (January) and monsoon (October) seasons respectively. In general, monsoon season recorded maximum values of Cr in water at all the stations. Chromium was found to be high at Station 1.

At Station 1, cadmium was Below Detectable Limit (BDL) during the monsoon (September) season and the maximum (0.066 mgl^{-1}) during monsoon (September) season. At Station 2 minimum (0.03 mgl^{-1}) was recorded during post monsoon (February) and the maximum (0.83 mgl^{-1}) was recorded during the monsoon (October) season. At Station 3, minimum (0.71 mgl^{-1}) was recorded during post monsoon (March) season and the maximum (1.53 mgl^{-1}) was recorded during premonsoon (July) season. Cadmium was found to be high at Station 3.

At Station 1, throughout the study period the lead in water was found to be Below Detectable Limit (BDL). At Station 2, lead in water was BDL during monsoon (November) and maximum (0.41 mgl^{-1}) during the premonsoon (July) At Station 3, it was BDL during post monsoon (January) and maximum (2.61 mgl^{-1}) during the premonsoon (September) season. Lead was found to be high at Station 3.

Concentration of mercury at Station 1 was BDL during summer (May) and the maximum (0.006 mgl^{-1}) was observed during the monsoon (May) season. At Station 2, it was minimum (0.003 mgl^{-1}) during post monsoon (January) season and maximum (0.038 mgl^{-1}) was recorded during monsoon (October; season. At Station 3, it was minimum (0.17 mgl^{-1}) during the premonsoon (July) season and the maximum (0.693 mgl^{-1}) was recorded during the monsoon (December) season. In general, monsoon season recorded the maximum concentration of mercury in water at all the stations. Mercury was found to be high at Station 3.

Low level of Hg in the surface waters might have been caused by the higher ingestion rate of organisms, resuspension of sediments and absorption onto the particulates during the monsoon season at this station. In both stations, the same trend of abundance of different metals was observed in the present study: the essential metal (Zn) recording the maximum concentration and the nonessential metal (Hg) recording the minimum concentration, observed by Ramachandran (1990) in the Bay of Bengal along the Tamil Nadu Coast. Zn and Hg concentrations were high during the pre-monsoon, surrmer and post-monsoon. The higher concentration of metals observed during monsoon could be attributed to the heavy rainfall and subsequent river runoff, bringing much industrial and land derived materials along with domestic, municipal, and agricultural wastes, which include residues of heavy metal containing pesticides (Pragatheeswaran *et al.,* 1986; Senthilnathan and Balasubramanian, 1997; Ananthan *et.al,* 1992, 2005; Karthikeyan *"et al.,* 2004, 2007).

Table 1 Heavy metals parameter observed during July 2009 – June 2010 at station 1

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Annual Average
Zn	10.11	12.89	14.23	16.97	23.87	18.08	0	0	0	0	0.81	1.18	8.17
Cu	6.92	8.03	8.68	10.33	9.18	11.38	0	0	0	0	2.03	0.67	4.76
Cr	5.97	8.62	7.79	12.88	14.83	10.39	0	0	0	0	1.04	2.33	5.57
Cd	0.018	0.031	0	0.054	0.066	0.028	0	0	0	0	0.03	0.087	0.02
Pb	0	0	0	0	0	0	0	0	0	0	0	0	0
Hg	0.003	0.005	0.004	0.004	0.006	0.005	0	0	0	0	0	0.002	0.002

Table 2 Heavy metals parameter observed during July 2009 – June 2010 at station 2

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Annual Average
Zn	11.71	14.92	20.38	28.93	32.32	37.86	12.13	6.34	4.92	5.83	4.37	6.66	15.48
Cu	5.87	3.93	10.92	17.09	14.33	15.09	11.11	10.92	8.93	6.69	7.03	6.87	9.89
Cr	7.13	5.09	6.34	10.49	8.86	10.63	3.06	1.97	0.63	4.44	5.09	3.79	5.62
Cd	0.49	0.68	0.74	0.83	0.67	0.78	0.32	0.03	0.27	0.33	0.41	0.52	0.50
Pb	0.41	0.13	0.07	0.03	0.056	0.067	0.084	0.071	0.10	0.18	0.120	0.16	1.42
Hg	0.022	0.0120	0.019	0.038	32.32	0.013	0.003	0.005	0.0041	0.011	0.016	0.013	0.015

Table 3 Heavy metals parameter observed during July 2009 – June 2010 at Station 3

Parameters	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Annual Average
Zn	13.84	10.91	12.42	30.65	26.79	32.14	18.03	11.94	9.07	6.07	5.44	3.33	15.05
Cu	27.97	43.93	59.86	87.94	114.59	100.08	64.91	48.72	53.53	13.17	20.04	18.92	54.47
Cr	3.92	4.61	3.29	6.92	5.89	5.05	0.026	0.69	1.37	1.29	2.11	3.09	3.18
Cd	1.53	1.24	0.99	1.26	1.59	1.96	0.88	0.83	0.71	0.89	0.77	0.91	1.13
Pb	0.93	1.38	2.61	1.04	1.22	1.67	0	0.083	0.149	0.84	0.63	0.48	11.03
Hg	0.017	0.284	0.309	0.447	0.364	0.693	0.194	0.239	0.298	0.219	0.254	0.336	0.3

Concentration of heavy metals (Zn, Cu, Cr, Cd, Pb, and Hg) in the waters of present study area were found not uniform. Concentrations of dissolved metals especially of Cu and Zn were high during the summer season. Cd and Hg concentrations were high during the summer and post-monsoon season. Generally, the natural sources ' of heavy metals in coastal waters are through land and river runoff, and the mechanical and chemical weathering of rocks. The components also were washed from the atmosphere through rainfall, " windblown dust, forest fire, and volcanic particles, adding to the "distribution of heavy metals in water (Bryan, 1984),Low levels of Cu in the surface water during the monsoon could be due to the adsorption of Cu on to the particulate matter and consequent settlement to the bottom.

The common aqueous species are hydroxides and carbonates of Pb^{2+}. Lead in water comes from industrial, mines and smelter discharges before being deposited in the sediment sinks. Lead is non essential for plants and animals and is toxic by ingestion-being a cumulative poison. Lead is also used in the production of lead acid batteries, solder, alloys, cable sheathing, pigments, rust inhibitors, ammunition, glazes and plastic stabilizers. Tetraethyl and tetramethyl lead are important because of their extensive use as antiknock compounds in petrol Easten, et. al., 2005, Abbasi 1998 and World Health organization on 2004. Lead toxicity leads to anaemia both by impairment of haemo-biosynthesis and acceleration of red blood cell destruction. Both are dose related. Lead also depresses sperm count. In addition, Pb can also produce a damaging effect on the kidney, liver, male and nervous system, blood vessels and other tissues Sharma, R. and S. Pervez 2003.

Ananthan (2005) has observed minimal Pb concentration during premonsoon and summer and maximal during monsoon season from Pondicherry marine environs, whereas, pillai (1994) has observed the occurrence of minimal value during post monsoon and maximal values during summer season from the Cuddalore – uppahar estuary.

Chromium was minimal during summer (station 1) and post monsoon (stations 2 and 3) and maximal during monsoon season at all the stations. The observed high value of Cr during monsoon could be attributed to the palar river discharge as it carries tannery and distillery effluents from the upstream. Very high levels of Cr in Palar river at upstream were also observed by Kanagaraj 2000. The low values of Cr during summer and post monsoon seasons could be due to the lesser amount or lack of rainfall that ultimately reduces the quantity of river flow.

The relative enrichement of Cd and Cu in the near shore sediments during the post – monsoon could be attributed to the particulate fractions derived from the river runoff caused by monsoonal flow and occurrence of relatively higher percentage of particulate matter (Satyanarayana *et al.*, 1990; Ananthan *et al.*, 1992, 2005). The present baseline information of the heavy metals in water form a useful tool for further ecological assessment and monitoring of these coastal ecosystems of Kadalur estuary.

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