Influence of Heavy Metals Concentration in Core Sediments of Lower Gadilam River, Cuddalore District, Tamil Nadu, India

T. Manivel [1], M.V.Mukesh[2], A.Chandrasekaran[3], R. Rajmohan[4], R. Premkumar[5]
[1, 2, 3, 4, 5] Department Of Earth Sciences
[1, 2, 3, 4, 5] Annamalai University, Annamalainagar, Tamilnadu, India

Abstract- *This study aim is to find out the concentration level of the following heavy metal (Cu, Ni, Cr, Pb, Zn, Cd, Fe, Mn, & Co) in Lower Gadilam River, Cuddalore district, Tamilnadu. Fourteen core sediment samples of one meter are collected, and each core is sub sampled at an equal interval into three divisions as Top, Middle and Bottom. The extracted samples are analyzed for trace element's concentration by Atomic Absorption Spectrometer (AAS). The results showed that the sediments with Cr, Pb and Cd found below the detection level while rest of other metals was found in higher proportion with increasing depth due to settlement of industrial wastage in the study area. The increase in concentration is more than the background asset value is due to industrial waste and municipal waste and dumping yards near by the river.*

Keywords- Core sediments, heavy metals, Gadilam River, Cuddalore district, Tamil Nadu.

I. INTRODUCTION

Industrial and agricultural activities, mining are the major sources of heavy metals entered in aquatic systems (Tarras-wahalberg et al. 2001). The nature of the sediments is modified by anthropogenic activities and as the impact of these activities has increased in recent years, sediment geochemistry had been pursued with the objective to assess coastal pollution [Praveena, Ahmed, Radojevic, Abdullah, and Aris, (2008), Pekey, Abdel-Ghani, Elchaghaby, Harikumar, Nasir, and Mujeebu Rahman,]. Accumulation or mobilization of trace elements in the sediments of the aquatic environment [Al-Masri, et., al]. Most of the chemical changes take place in or close to the sediment boundary and; for this reason; it is significant to study the geochemical composition of bulk sediments [Hirst, Calvert]. Sediments are important carriers of trace metals in the hydrological cycle, and they effectively collect or release metals into the surrounding waters; thereby, they can reflect the current quality of an aquatic system [Salomons, and Forstner]. Heavy metals are well known environmental pollutions that cause serious health hazard to human; their effects are not immediate and show up after many years (Gulec et al., 2004). The aim of the present study is to identify the accumulation of trace metals and its originating in the study area, and its impact on the environment.

Materials and Method

Study Area

Gadilam river basin is located in parts of Cuddalore and Villupuram districts of Tamil Nadu, India, and it flows eastward to the Cuddalore district. This river is ephemeral in nature, which carries only flood water during the monsoon period. The present study area (Gadilam river) lies between 79°40’ and 79°45’ East longitude; latitude between 11°40 and 11°45’ North. It lies in the toposheet No. 58M/2 of the survey of India. (Figure1). The Gadilam river basin is bounded by Ponnaiyar river basin in the north and the Vellar river basin in the south. The river originates near Sankarapuram and flows through the Cuddalore Villupuram districts and drains at Bay of Bengal at Cuddalore. The area coverage of Gadilam River is about 181.315 Sq. Km. (Figure: 1& 2). The SIPCOT (Small Industries Promotion Corporation of Tamil Nadu) industrial estate with groups of industries that generate multifaceted chemicals and raw materials are discharged along the downstream of the river Gadilam, near the coast at Cuddalore (Prasanna 2008). It also receives a large amount of agricultural runoff along with its course. The lower section of the river’s catchment area is predominantly influenced by sugar cane monoculture and processing, while the upper water course is affected by domestic sewage as well as by wastewater discharge from rural and industrial production.

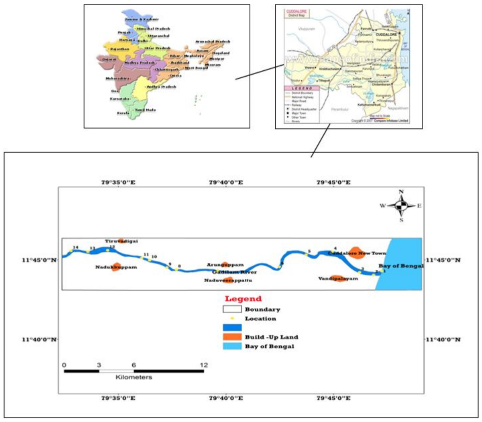

Figure 1. Study area location map

II. SAMPLING

Nearly fourteen stations in the river basin have been visited whereupon divided into fourteen cores sediment samples were collected randomly up to Panruti Town Bridge, including river mouth of the Gadilam River. Samples were carried out by 1m PVC and kept in freezer to get compact and then all samples divided by three sections like, Top, Middle and Bottom. After divided the sample in the laboratory, dead shells were separated from sediments, and the mixed saline content was removed from the grains by washing with water. In the laboratory, the collected samples were deep frozen at -4° to avoid soil contamination and dried in a hot-air oven at 40°C before crushed to powder using agate mortar (Shetye et al., 2009). The samples subjected to analyze trace metals using the AAS (Elico) method by using a series of solution over the range 2-10mg/l.

II. RESULTS AND DISCUSSION

The study was carried out to determine heavy metal's concentration (Cu, Ni, Cr, Pb, Zn, Cd, Fe, Mn, & Co) in sediments in lower Gadilam River, Figure 2 shows the sample locations and Table 1, 2 & 3 shows the average concentration of heavy metals in sediments. The study was carried out to know the vertical distribution of heavy-metal variations in the river system from river mouth to Panrutti Town Bridge.

Copper

The average concentration for copper in sediment was found in Top 4.68mg/kg, Middle 5.88mg/kg and in Bottom section 6.48mg/kg. The copper concentration was observed an increasing trend from top to bottom section of the core and this is reported to be more than the tolerance limits (Trivedy, 1990 & TNCPCB Report, 2015). The average concentration of copper was found higher in Thiruvadigai area especially in bottom section of the core with compare to other location of the study area due to heavy influence of discharging industrial wastage (Chandrasekaran, et. al., 2013). In general, increase of copper from the marine to the river zone is reported Sankaranarayanan and Reddy (1973). Occurrence of higher concentration of copper in the sediments can also be attributed to the resulting of natural weathering of soil and discharges from industries and sewage-treatment plants (Hutchinson 1988; Romo-Kroger et al. 1994; Wu et al., 2001).

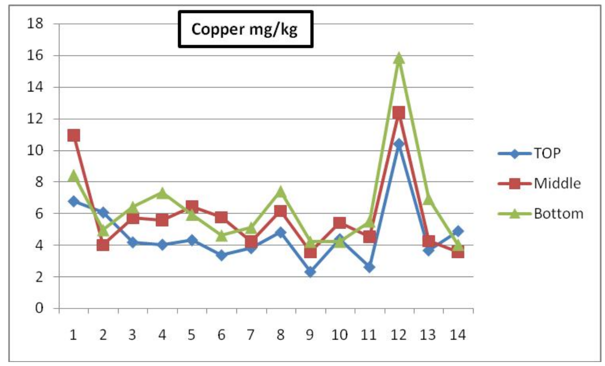

Figure 2. Gadilam River Heavy Metal distributions in Sediments Copper

Nickel

The nickel trace element average ranges spread in the study area 7.13mg/kg, 8.20mg/kg and 9.70mg/kg as top, middle and bottom section of the core sample. The highest concentration of nickel was found in 31.63mg/kg in bottom section of the core at Thiruvadhigai due to continue mixing of industrial effluent nearby Nellikuppam. A considerable part of nickel finds its way into the environment as a result of the burning of diesel oil containing nickel (Baralkiewicz, Siepak 1999).

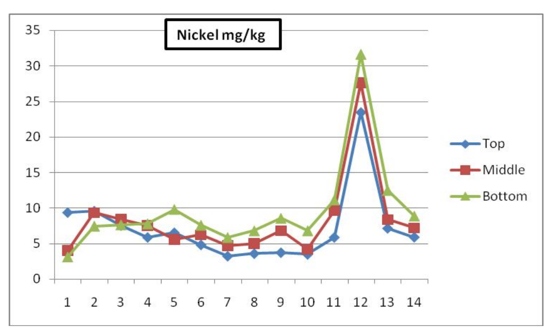

Figure 3. Gadilam River Heavy Metal distributions in Sediments Nickel

Zinc

The average zinc trace element found 10.62mg/kg, 14.99mg/kg and 16.69mg/kg and maximum concentration was observed in the study area 48.60mg/kg, 58.60mg/kg and 63.96mg/kg top, middle and bottom section respectively. Zinc concentration was found quite high in the study area due to the number of sources, including industrial discharges, sewage effluent and runoff (Boxall et al., 2000). Input of organic wastes into the river, which comes from municipal sewage, contributes to the zinc increase in sediments (Alagarsamy, 1991). In the absence of suitable binding sites, zinc may be mobilized (ICF 1986). In alkaline soils, the chemistry of zinc is dominated by interactions with organic ligands. The ecological toxicity of sediment is complex and appears to be correlated to the ratio of zinc to acid volatile sulfide (Berry et al. 1996; Di Toro et al. 1992; Sibley et al. 1996). During weathering these elements are mobilized easily and find their way into oceans with an average concentration of about 20ppb and municipal refuse, automobiles and agricultural use of pesticides and fungicides containing $ZnSO_4$ as the additional sources of environmental pollution (Dara 1993).

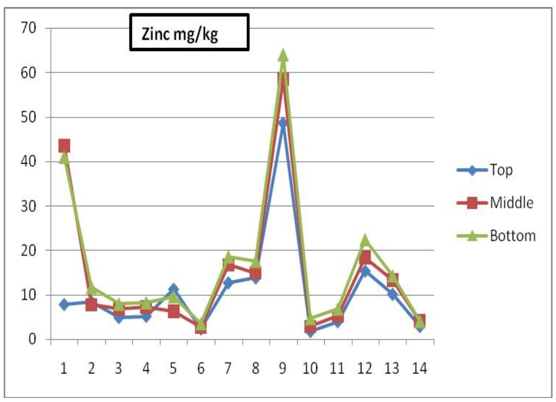

Figure 4. Gadilam River Heavy Metal distributions in Sediments Zinc

Iron

In the study area, iron was found very high amount throughout the study area. The iron concentration ranges from 301.50-350mg/kg in al section (Top, Middle and Bottom) of the core sample except in river mouth. In river mouth the iron concentration was found quite high due to fisher boat repairing is under process nearby the fort. The high amount of iron was found in downstream nearby fishery's area this could be one of the reasons for increased iron concentration, and other sources may due to municipal wastages and discharge of urban water. Iron concentration is high due to its spread high in the earth crust. Iron is ubiquitous in all fresh water/sediment environments and often reaches significantly higher concentrations in water and sediments than other trace metals. High iron concentration in fresh water/Sediments has long been considered a problem (Silambarasan, et., al 2012).

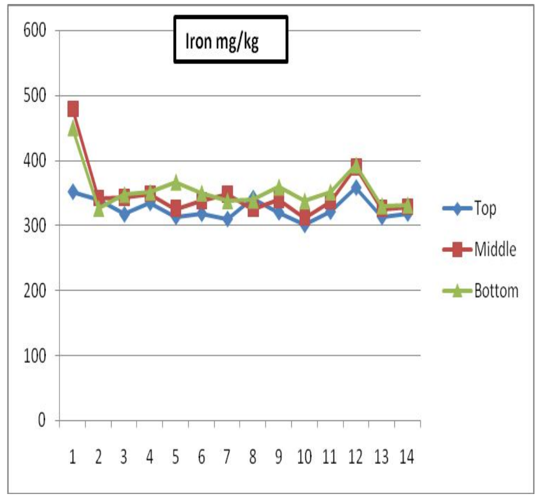

Figure 5. Gadilam River Heavy Metal distributions in Sediments Iron

Manganese

Manganese is mostly found in trace elements in the lattice structure of most rock forming silicates or it occurs as major element in carbonates or oxides. Manganese is precipitated as hydroxides in the estuarine and near shore areas as the less saline river water rich in manganese mixes with high saline low manganese sea water. However the dissolved manganese in sediments are dissolved in the pure water below the surface sediments due to the biogeochemical processes and it can also diffuse up to the oxidized sediment interface and can be precipitated as oxide or oxy-hydroxide (Selvaraj et, al 2003). Fe-Mn oxy –hydroxides are observed to be a major controlling factor for trace metal accumulation when compared to organic carbon (Banerjee et, al 2005). The average concentration of manganese in the study area 6.12mg/kg in top, 7.77mg/kg in middle and 9.40mg/kg in bottom most section of the core sediment. The manganese concentration was observed quite high in river mouth core sediment 31.29, 35.43 & 30.5mg/kg respectively top, middle & bottom section. In the study area, the higher amount manganese concentration is due to lithogenic sources such as Basalt, Shale, Limestone and sandstone (Solai, etc., al 2013).

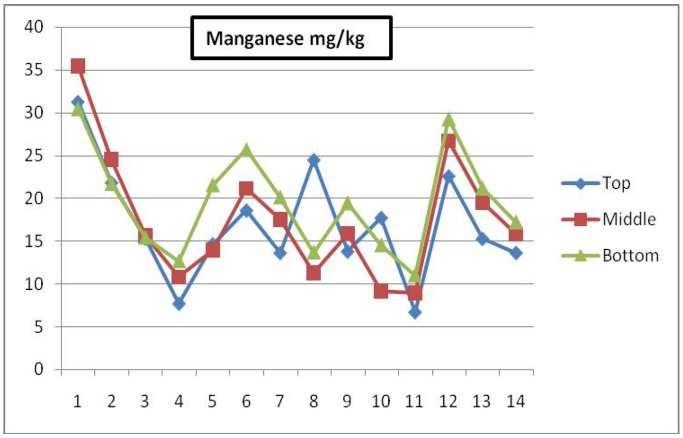

Figure 6. Gadilam River Heavy Metal distributions in Sediments Manganese

Cobalt

The cobalt concentration was found in the study area from 6.12mg/kg, 7.77mg/kg & 9.40mg/kg respectively top, middle and bottom. The cobalt concentration was quite high in bottom section of the core at Thiruvadigai due to mixing of industrial waste threw channel in to the part of the study area. The occurrence of cobalt in the earth's surface varies greatly, and the source of cobalt pollution (apart from industrial waste) is the burning of cobalt (Baralkiewicz, Siepak 1999). Positive correlation between cobalt and Fe in the present investigation indicates association of cobalt with ferric hydroxides. The strong affinity of cobalt for manganese and iron hydroxides has been will described by several authors (Hema Achyuthan., Richardmohan, 2002). Mobility of cobalt is intermediate and is controlled by adsorption and co-precipitation with iron and manganese oxides.

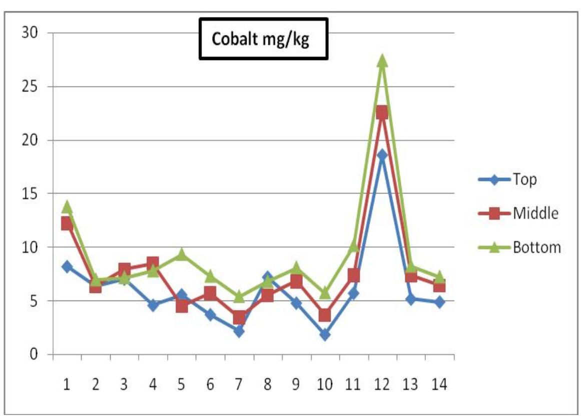

Figure 7. Gadilam River Heavy Metal distributions in Sediments Cobalt

Table 1. Gadilam River Heavy Metal distributions in Sediments Top Section

Top Section-Heavy Metals in mg/kg						
LOCATION	Cu	Ni	Zn	Fe	Mn	Co
RIVER MOUTH	6.77	9.36	7.8	352.08	31.29	8.19
RIVER MOUTH 2	6.06	9.56	8.37	340.84	21.84	6.35
SELLANKUPPAM	4.17	7.53	4.87	317.57	15.31	7.03
CUDDALORE TOWN BRIDGE	4.02	5.85	5.14	335.13	7.7	4.57
PATHIRIKUPPAM	4.31	6.51	11.24	313.75	14.65	5.55
THIRUVANDHIPURAM	3.35	4.8	2.3	318.6	18.6	3.7
ARUNGUNAM	3.8	3.2	12.67	310.4	13.63	2.15
NADUVEERAPATTU 1	4.8	3.56	13.75	342.4	24.5	7.2
NADUVEERAPATTU 2	2.3	3.7	48.6	320.6	13.8	4.78
NARIMEDU	4.37	3.45	1.73	301.5	17.73	1.84
MUTHUNARAYANAPURAM	2.6	5.85	3.93	321.7	6.7	5.7
THIRUVADHIGAI	10.4	23.48	15.31	358.5	22.6	18.59
PANAIYARKUPPAM	3.66	7.13	10.1	313.73	15.28	5.16
PANRUTTI	4.88	5.88	2.83	318.82	13.64	4.88
AVERAGE	**4.68**	**7.13**	**10.62**	**326.12**	**16.95**	**6.12**
MAX	**10.4**	**23.48**	**48.6**	**358.5**	**31.29**	**18.59**
MIN	**2.3**	**3.2**	**1.73**	**301.5**	**6.7**	**1.84**

Table 2. Gadilam River Heavy Metal distributions in Sediments Middle Section

Middle Section-Heavy Metals in mg/kg						
LOCATION	Cu	Ni	Zn	Fe	Mn	Co
RIVER MOUTH	10.93	4.02	43.61	479.35	35.43	12.27
RIVER MOUTH 2	3.98	9.34	7.86	341.92	24.51	6.37
SELLANKUPPAM	5.69	8.41	6.99	342.96	15.58	7.93
CUDDALORE TOWN BRIDGE	5.57	7.56	7.32	348.3	10.74	8.5
PATHIRIKUPPAM	6.41	5.57	6.42	325.89	13.92	4.53
THIRUVANDHIPURAM	5.75	6.24	2.84	337.93	21.13	5.74
ARUNGUNAM	4.2	4.7	16.8	348.1	17.5	3.47
NADUVEERAPATTU 1	6.15	5.03	15.02	324.82	11.29	5.54
NADUVEERAPATTU 2	3.56	6.8	58.6	339.6	15.86	6.85
NARIMEDU	5.4	4.18	2.98	312.07	9.17	3.68
MUTHUNARAYANAPURAM	4.5	9.7	5.3	337	8.9	7.4
THIRUVADHIGAI	12.4	27.62	18.44	389.82	26.69	22.63
PANAIYARKUPPAM	4.23	8.38	13.45	325.82	19.45	7.37
PANRUTTI	3.55	7.22	4.22	328.88	15.78	6.45
AVERAGE	**5.88**	**8.2**	**14.99**	**348.75**	**17.57**	**7.77**
MAX	**12.4**	**27.62**	**58.6**	**479.35**	**35.43**	**22.63**
MIN	**3.55**	**4.02**	**2.84**	**312.07**	**8.9**	**3.47**

III. CONCLUSION

In the study area the studied metals was found quite high in bottom section of the core sample due to industrial waste and municipal waste settled down in bottom section.

The fact that heavy metals in sediments increased with increasing depth indicates that heavy metals determined are mostly of industrial origin and mostly settled in the bottom of the river sediments by the dumped waste water in the study area. Especially iron (Fe) values are found very high near river mouth due to fisher's boat damage parts dumps near by the river and moderates high throughout the study area due to industrial waste and municipal waste. The results indicated that the river was moderately affected in upstream and extremely affected in downstream by heavy metals. However, there is a need for monitoring pollution levels in the river and there is lots of studies to be carry out in the river for protecting the riverine environment.

REFERENCES

[1] Abdel-Ghani, N. T., Elchaghaby, G. A. Influence of operating conditions on the removal of Cu, Zn, Cd and Pb ions from wastewater by adsorption. Int. J. Environ. Sci. Tech., Vol.4 (4), 2007, pp.451-456.

[2] Agnes MRUTU, Hudson H. NKOTAGU, Gebhard B. LUILO., Spatial distribution of heavy metals in Msimbazi River mangrove sediments in Dar es Salaam coastal zone, Tanzania, ISSN 0976 – 4402, Volume 3, No 5, 2013.

[3] Al-Masri, M. S., Aba, A., Khalil, H. and Al-Hares, Z. Sedimentation rates and pollution history of a dried lake. Science of the Total Environment, Vol.293, 2002, pp. 177-189.

[4] Banerjee K., Senthilkumar B., Purvaja R., and Ramesh R., Sedimentation and trace metal distribution in selected locations of Sundarbans (2005).

[5] Baralkiewicz. D, Siepak. D, 1999. Chromium, Nickel and Cobalt in Environmental Samples and Existing Legal Norms. Polish Journal of Environmental Studies Vol. 8, No. 4 (1999), 201-208.

[6] Calvert, S. E. The mineralogy and geochemistry of near shore sediments. In: Riley JP, Chester R (eds) Chemical oceanography, Academic Press, London. 1976, pp.187-280.

[7] Dara S. S., Environmental chemistry and pollution control, S. Chand & Company Ltd., New Delhi, 191-199 (1993).

[8] Gulec, C.W.; Lol, C.P; Jang, C.S.; Wang, S.W.and Hsueh, Y.M. (2004). Bioaccumulation of arsenic compounds in aquaculture clams (Meretrix lusoria) and assessment of potential carcinogenic risks to human health by ingestion. Chemosphere (2007) (in press) 2007. 04.038.

[9] Harikumar, P. S., Nasir, U. P. and Mujeebu Rahman, M. P. Distribution of heavy metals in the core sediments of a tropical wetland system. Int. J. Environ. Sci. Tech., Vol.6 (2), 2009, pp. 225-232.

[10] Hema Achyuthan., Richardmohan.D., Trace metals concentrations in the sediment cores of estuary and tidal zones between Chennai and Pondicherry along the east coast of India, Indian Journal of marine Sciences, 31(2),141-149 (2002).

[11] Hirst, D. M. The geochemistry of modern sediments from the Gulf of Paria–II. The location and distribution of trace elements. Geochim. Cosmochim. Acta.,Vol. 26, 1962, pp.1147-1187.

[12] Mohiuddin, K. M., Zakir, H. M., Otomo, K., Sharmin, S. and Shikazono, N. Geochemical distribution of trace metal pollutants in water and sediments of downstream of an urban river. Int. J. Environ. Sci. Tech., Vol.7 (1), 2010, pp. 17-28.

[13] Pekey, H. Heavy Metal Pollution Assessment in Sediments of the Izmit Bay, Turkey. Environ.Monit.Assess., Vol.123, 2006, pp. 219-31.

[14] Praveena, S. M., Ahmed, A., Radojevic, M., Abdullah, M. H. and Aris, A. Z. (2008). Heavy Metals in Mangrove surface Sediment of Mengkabong Lagoon, Sabh: Multivariate and Geo- Accumulation Index Approaxcches. Int. J. Environ. Res. Vol.2 (4), 2008, pp. 139-148.

[15] Salomons, W. and Forstner, U. Metals in Hydrocycle. Springer-Verlag, New York, 1984, pp.63-98.

[16] Selvaraj K. RamMohan V., Srinivasalu Jonathan M.P., Siddartha R., Distribution of Nondetrital Trace Metals in Sediment Cores from Ennore Creek, Southeast Coast of India, Journal Geological Society of India, 62,191-204 (2003).

[17] Silambarasan. K, Senthilkumaar. P and Velmurugan. V. (2012). Studies on the distribution of heavy metal concentrations in River Adyar, Chennai, Tamil Nadu. European Journal of Experimental Biology, 2012, 2 (6):2192-2198.

[18] Solai, M. Suresh Gandhi. M, Kasilingam. K and

Sriraman. E, (2013). Heavy Metal Accumulation in the Surface Sediments off Pondicherry, Bay of Bengal, South East Coast of India. ISSN: 2319-8753 Vol. 2, Issue 10, October 2013.

[19] Tarras-Wahlberg, N., Flachier, A., Lane S.N., and Sangfors, O., Environmental impacts and metal exposure of aquatic ecosystems in rivers contaminated by small scale gold mining: the Puyango River basin, Southern Ecqador. Sci/ Total Environ. 278 (2001) 239-61.