ASSESSMENT OF TRACE METAL ENRICHMENTS IN FOUR MANGROVE WATERS (MUTHUPETTAI, PICHAVARAM, PARANGIPETTAI AND ENNORE), SOUTHEAST COAST OF INDIA

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Abstract:

The purpose of this study was to investigate the concentrations of heavy metals in four different mangrove ecosystems southeast coast of India during the period 2010 to 2011. The influence of wastewater discharged in dense mangroves region they concentration vary from the Fe content was varied between 423.73 µg/l Muthupettai during summer and 825.64 µg/l in Ennore during monsoon. The Zn content was varied between 5.84 µg/l Muthupettai during Postmonsoon and 32.4 µg/l in Ennore during monsoon. The Mg content was varied between 187.28 µg/l Muthupettai during Postmonsoon and 865.32 µg/l in Ennore during monsoon. The Mn content was varied between 3.12 µg/l Muthupettai during monsoon and 35.21 µg/l in Ennore during monsoon. The Cd content was varied between 0.12 µg/l Muthupettai during premonsoon and 2.35 µg/l in Ennore during monsoon. The Cr content was varied between 0.43 µg/l Muthupettai during postmonsoon and 8.92 µg/l in Ennore during summer. The Hg content was varied between 10 µg/l Muthupettai during monsoon and 309 µg/l in Ennore during summer. The two-way ANOVA showed significant variations between the seasons ($p < 0.01$) and stations ($p < 0.01$).

Key words: Iron, Zinc, Magnesium, Manganese, Cadmium, Chromium & Mercury.

Introduction:

Mangrove ecosystems in the intertidal zone may act as a sink or source of heavy metals in coastal environments because of their variable physical and chemical properties (Pekey, 2006). The recent industrialization of various tropical regions has resulted in a significant input of pollutants into mangroves (Lacerda, 1993 & Tam and Wong, 1993). Among these pollutants heavy metals have received special attention, due to their long term effects on the environment and their property of accumulating in protected depositional environments, where mangroves are also best developed (Harbison, 1981 & Silva et al., 1990). The cycling of organic matter through litter production, decomposition and tidal transport, may eventually export a fraction of the accumulated heavy metals, and therefore convey it to detritus food chains in adjacent coastal waters (Silva, 1988; Murray, 1985). The aim of this research was to quantify the cycling of heavy metals through litter in a red mangrove (*Rhizophora mangle* L.) forest in Sepetiba Bay, city of Rio de Janeiro, a moderately polluted area where mangroves support important fisheries resources and play an important role in the heavy metals cycling in the coastal region (Lacerda et al., 1991b; Lacerda, 1993).

The occurrence of toxic metals in pond, stream and river water affects lives of human and animals that depend upon these water sources for their daily life Soylak, M.,et al., (2006). The role of tidal processes on intertidal surface sediments is frequently stated but the differences at these stages have seldom been investigated, apparently because of methodological constraints (Radojevic et al., 2008; Malvarez et al., 2001). The methodological constraints include determination of tidally influenced areas, data requirements to determine tidal range at coastal sites, definition of problems and development of conceptual models (Malvarez et al., 2001).

2 Material and methods

The present study was carried out on four different areas viz, Muthupettai, Pichavaram, Parangipettai, Ennore in the period of 2008 to 2010. **S**urface water samples were collected in pre-cleaned and acid washed polypropylene bottles of 1 liter capacity and immediately kept in an ice box and transported to the laboratory to avoid contamination. The water samples were then filtered through Millipore filter papers (mesh 0.45µm) using a milipore filtering system. The filtered water samples were pre-concentrated with APDC-MIBK extraction procedure as described by Brooks et al (1967) and aspirated to a flame Atomic Absorption Spectrophotometer (Philips Pye Unicom 1977).

Filtered water (1 liter) was divided into two 500 ml aliquots and the pH was adjusted to 4±0.1 by carefully drop-wise addition of 50%HNO_3. The trace metals were pre-concentrated and separated from the bulk matrix by complication with APDC and extracted into MIBK. The organic layer containing the metal chelates was collected and was back extracted with 50% HNO_3 and diluted with metal free double distilled water to a minimum quantity (25 ml). This solution was aspirated to the Flame Atomic Absorption Spectrophotometer for trace metal quantification.

Result & Discussion:

The present investigation that the study area has been subjected to relatively free of heavy metal pollution. Among the seven metals studied, iron was found to be more and zinc was low in the water and sediment of all the stations throughout the study period. Iron is the dominant trace element both in water and sediments. In this study, the Iron content was varied between 423.73 µg/l Muthupettai during summer and 825.64 µg/l in Ennore during monsoon. During Monsoon the maximum Iron content was 825.64 µg/l recorded in Ennore and the minimum 683 µg/l was in Muthupettai. During postmonsoon season the maximum Iron content was 678.32 µg/l recorded in Ennore and the minimum 545 µg/l was in Muthupettai. During summer season the maximum Iron content was 548.4 µg/l recorded in Ennore and the minimum 423.73 µg/l was in Muthupettai. During premonsoon season the maximum Iron content was 521.56 µg/l recorded in Ennore and the minimum 109.25 µg/l was in Muthupettai. The two-way ANOVA showed significant variations between the seasons ($p < 0.01$) and stations ($p < 0.01$). (Table.1) (Fig.1). This high level may be due to mining at the source of the River Vellar (Subramanian et al., 1981). In this study, the Zinc content was varied between 5.84 µg/l Muthupettai during Postmonsoon and 32.4 µg/l in Ennore during monsoon. During Monsoon the maximum Zinc content was 32.4 µg/l recorded in Ennore and the minimum 11.54 µg/l was in Muthupettai. During postmonsoon season the maximum Zinc content was 31.25 µg/l recorded in Ennore and the minimum 5.84 µg/l was in Muthupettai. During summer season the maximum Zinc content was 26.5 µg/l recorded in Ennore and the minimum 16.48 µg/l was in Muthupettai. During premonsoon season the maximum Zinc content was 28.4 µg/l recorded in Ennore and the minimum 10.74 µg/l was in Muthupettai. The two-way ANOVA showed significant variations between the seasons (NS) and stations ($p < 0.01$). (Table.2) (Fig.2). The concentration of Zn, Mg, Mn, Cd and Cr was found to increase during monsoon superseded by premonsoon and increased to monsoon seasons in all the stations. In this study, the Magnesium content was varied between 187.28 µg/l Muthupettai during Postmonsoon and 865.32 µg/l in Ennore during monsoon. During Monsoon the maximum Magnesium content was 865.32 µg/l recorded in Ennore and the minimum 524.6 µg/l was in Muthupettai. During postmonsoon season the maximum Magnesium content was 658.4 µg/l recorded in Ennore and the minimum 187.28 µg/l was in Muthupettai. During summer season the maximum Magnesium content was 569.8 µg/l recorded in Ennore and the minimum 295.08 µg/l was in Muthupettai. During premonsoon season the maximum Magnesium content was 547.3 µg/l recorded in Ennore and the minimum 190.35 µg/l was in Muthupettai. The two-way ANOVA showed significant variations between the seasons (NS) and stations ($p < 0.01$). (Table.3) (Fig.3). Zn and Mn always have a tendency to couple with organic carbon and decomposition of the mangrove vegetative remains are found to release the accumulated heavy metals back to sediments, and this process might be responsible for the strong association Zn and Mg with organic carbon (Badarudeen *et al*., 1996). The effluent discharge from industries, various domestic and household sources enhance the concentration of Heavy metals during monsoon. Higher organic carbon values recorded in the winter coincided with the elevated level of Zn and Mg in sediments. Besides, the release of organically bound heavy metals through influx from river runoff might have also contributed elevated level Zn and Mg, despite it is meager amount. The extensive use of antifouling paints during the peak fishing season in winter would have released cuprous oxide which in turn enriches the Cu content in the water (Ananthan, 1995). In this study, the Manganese content was varied between 3.12 µg/l Muthupettai during monsoon and 35.21 µg/l in Ennore during monsoon. During Monsoon the maximum Manganese content was 35.21 µg/l recorded in Ennore and the minimum 3.12 µg/l was in Muthupettai. During postmonsoon season the maximum Manganese content was 30.21 µg/l recorded in Ennore and the minimum 4.42 µg/l was in Muthupettai. During summer season the maximum Manganese content was 29.54 µg/l recorded in Ennore and the minimum 11.63 µg/l was in Muthupettai. During premonsoon season the maximum Manganese content was 28.78 µg/l recorded in Ennore and the minimum 17.32 µg/l was in Muthupettai. The two-way ANOVA showed significant variations between the seasons ($p<0.05$) and stations ($p < 0.01$). (Table.4) (Fig.4). In summer slight elevation of these metals might be due to the low salinity and high pH in water that might have caused the adsorption of these metals, leading to their removal from the water column. The low concentration of Zn and Mg in premonsoon might be due to the prevailing lower pH which renders dissolved metal carbonate complexes to release free metal irons into the water column. Ananthan (1995) found that phytoplankton would consume more magnesium and zinc. Evidently high density of phytoplankton population during monsoon consumed more magnesium and zinc leading to their low concentration in the premonsoon season. In this study, the Cadmium content was varied between 0.12 µg/l Muthupettai during premonsoon and 2.35 µg/l in Ennore during monsoon. During Monsoon the maximum Cadmium content was 2.35 µg/l recorded in Ennore and the minimum 0.57 µg/l was in Muthupettai. During postmonsoon season the maximum Cadmium content was 2.31 µg/l recorded in Ennore and the minimum 0.24 µg/l was in Muthupettai. During summer season the maximum Cadmium content was 2.25 µg/l recorded in Ennore and the minimum 1.59 µg/l was in Muthupettai. During premonsoon season the maximum Cadmium content was 2.21 µg/l recorded in Ennore and the minimum 0.12 µg/l was in Muthupettai. The two-way ANOVA showed significant variations between the seasons ($p<0.01$) and stations ($p < 0.01$). (Table.5) (Fig.5). In this study, the Chromium content was varied between 0.43 µg/l Muthupettai during postmonsoon and 8.92 µg/l in Ennore during summer. During Monsoon the maximum Cadmium content was 8.65 µg/l recorded in Ennore and the minimum 0.98 µg/l was in Muthupettai. During postmonsoon season the maximum Cadmium content was 7.65 µg/l recorded in Ennore and the minimum 0.43 µg/l was in Muthupettai. During summer season the maximum Cadmium content was 8.92 µg/l recorded in Ennore and the minimum 4.12 µg/l was in Muthupettai. During premonsoon season the maximum Cadmium content was 8.23 µg/l recorded in Ennore and the minimum 1.24 µg/l was in Muthupettai. The two-way ANOVA showed significant variations between the seasons ($p<0.01$) and stations ($p < 0.01$). (Table.6) (Fig.6). Chromium exerts its effect on the epithelial cells of the intestine and can also modify the rate of glucose transport. One of the study conducted on the intestine of rainbow trout reflected a low rate of glucose absorption by epithelial cells. (Stokes RM., et al., 1965).

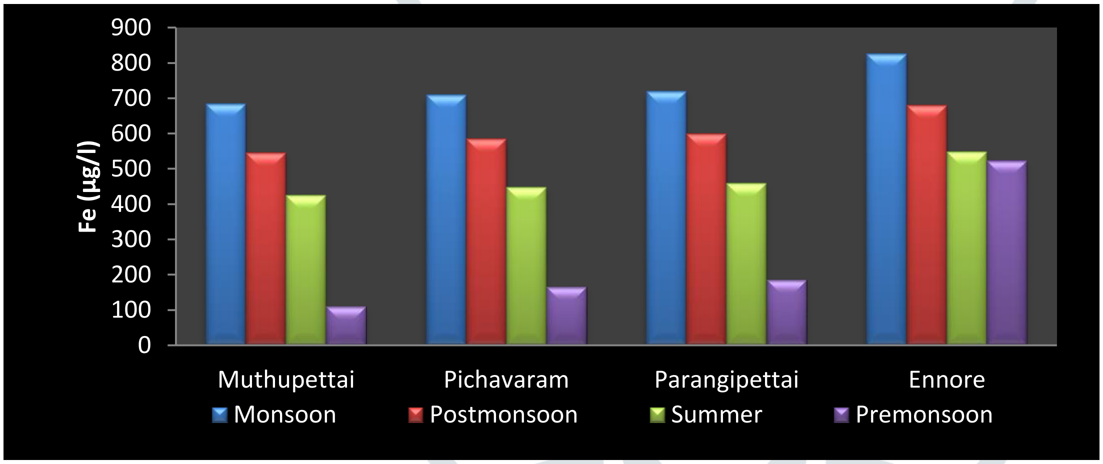

Fig 1. Seasonal variation of Iron concentrations in water

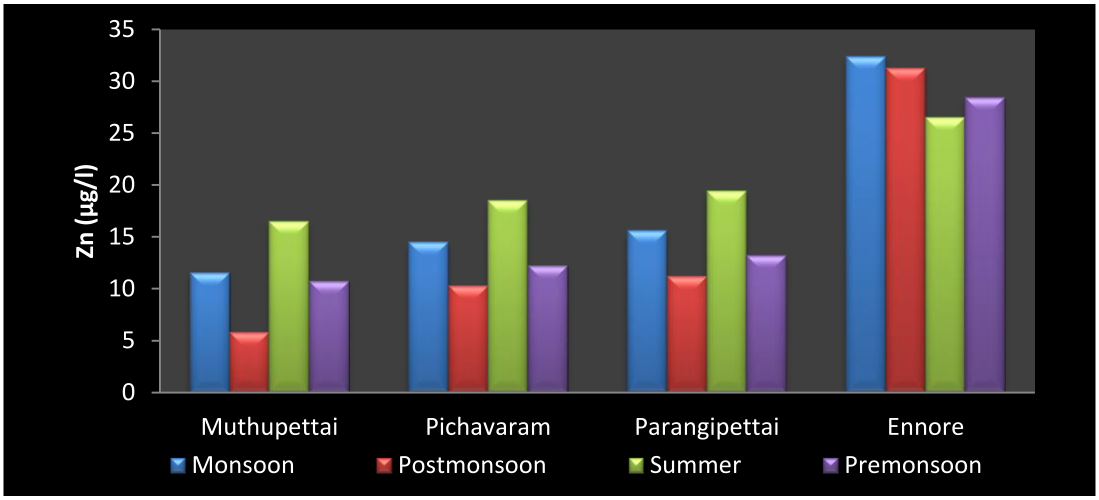

Fig 2. Seasonal variation of Zinc concentrations in water

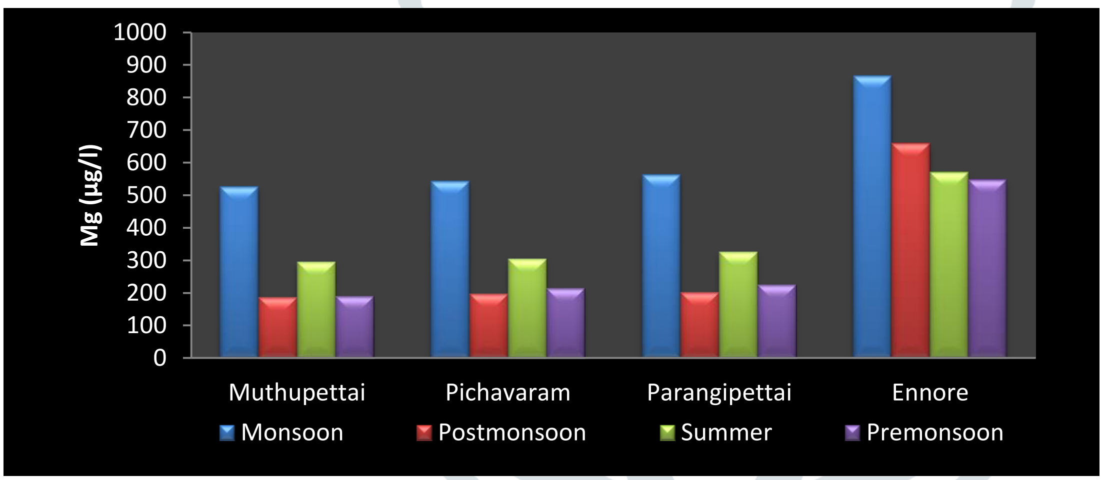

Fig 3. Seasonal variation of magnesium concentrations in water

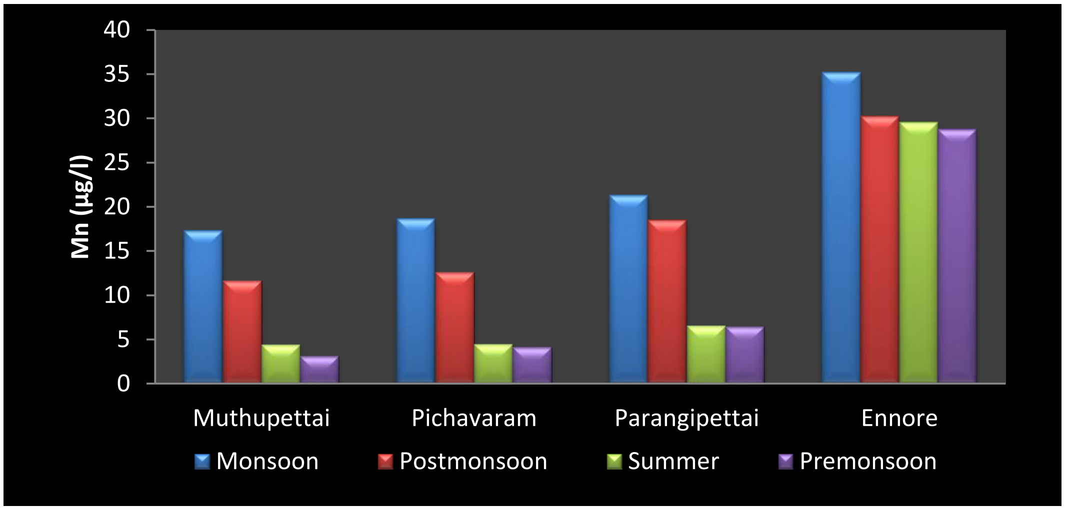

Fig 4. Seasonal variation of manganese concentrations in water

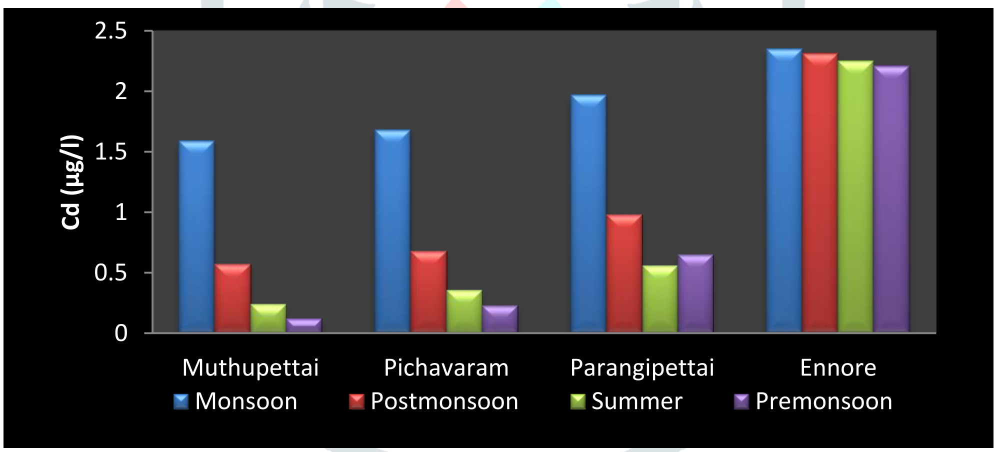

Fig 5. Seasonal variation of cadmium concentrations in water

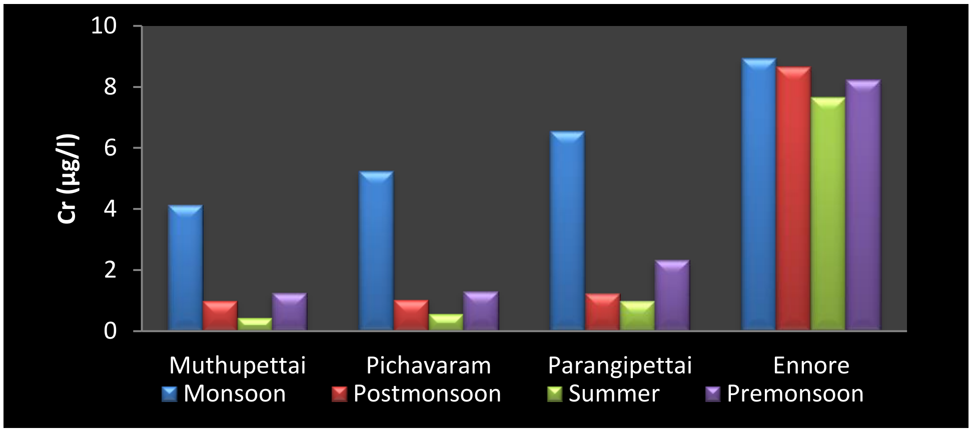

Fig 6. Seasonal variation of chromium concentrations in water

In this study, the Mercury content was varied between 10 µg/l Muthupettai during monsoon and 309 µg/l in Ennore during summer. During Monsoon the maximum Mercury content was 213 µg/l recorded in Ennore and the minimum 10 µg/l was in Muthupettai. During postmonsoon season the maximum Mercury content was 154 µg/l recorded in Ennore and the minimum 18 µg/l was in Muthupettai. During summer season the maximum Mercury content maximumwas 309 µg/l recorded in Ennore and the minimum 26 µg/l was in Muthupettai. During premonsoon season the maximum Mercury content was 156 µg/l recorded in Ennore and the minimum 24 µg/l was in Muthupettai. The two-way ANOVA showed not significant variations between the seasons ($p<0.01$) and stations ($p < 0.05$). (Table.7) (Fig.7). Mercury is the most toxic of the heavy metals (Gerlach, 1981) and occupies the sixth position in the list of hazardous compounds (Nascimento and Chartone-Souza, 2003). Animal health is also seriously threatened by mercury pollution in the ocean. The effects of high mercury levels on animal health were revealed by the severe mercury poisoning in Minamata Bay in which many animals exhibited extremely strange behaviors and high mortality rates after consuming contaminated seafood or absorbing mercury from the seawater. The cat population essentially disappeared due to cats drowning in the ocean and simply collapsing dead and it became commonplace to witness birds falling out of the sky and fish swimming in circles. (Harada, et al., (1995).

Conclusion:

The major source of heavy metals in Ennore mangrove forest is anthropogenic such as from industrial sources and construction, aquaculture, agricultural and domestic. The reverie organisms do not affect any harmful metals thorough water column. It is also essential that reduce such contamination and avoid the leaching of waste water from industrial area. Further more study needed Ennore station.

Reference:

1. Ananthan, G., (1995). Plankton ecology and heavy metal studies in the marine environs of Pondicherry, India. Ph.D. Thesis, Annamalai University, India, 208pp.
2. Badarudeen, A. (1996). Texture and geochemistry of sediments of a tropical mangrove ecosystem, southeast coast of India. Environ.Geol-27;164-169.
3. Brooks, R.R., Presley, B. J., and Kaplan, I. R. (1967), APDC MIBK extraction system for the determination of trace metals in saline waters by atomic absorption spectroscopy. Talanta, 14, pp 809 816.
4. De Lacerda LD, Santelli RE, Duursma EK, Abrao JJ. Environmental geochemistry in tropical and subtropical environments, Springer-Verlag, New York, 2004.
5. Gerlach, A. S. (1981). Marine Pollution. Diagnosis and Therapy. SpringerVerlag Berlin eidelberg New York: pp. 218.
6. Harada, Masazumi (1995). "Minamata Disease: Methylmercury Poisoning in Japan Caused by Environmental Pollution". *Critical Reviews in Toxicology*. **25:1** (1): 1–24.
7. Harbison P., (1986), Mangrove mud a sink and a source for trace metals. Marine Pollution Bulletin, 17, pp 246-250.
8. Kobayashi, J., (1971). Relation between the "itai-itai" disease and the pollution of river water by cadmium from a mine. Adv. Wat. Pollut. Res. 1, 1-32.
9. Lacerda L.D., Carvalho C.E.V., Tanizaki K.F., Ovallel A.R.C. and Rezende C.E., (1993), The biogeochemistry and trace metals distribution of mangrove rhizospheres. Biotropica, 25, pp 252-257.
10. Malvarez GC, Cooper JAG, Jackson DWT. Relationships between wave-induced currents and sediment grain size on a sandy tidal-flat. Journal of Sedimentary Research. (2001); 71: 705-12.
11. Murray, W. (1996). Mechanisms controlling the distribution of trace elements in oceans and lakes. Advances in Chemistry Series, 216, 153-184.

12. Pekey H. Heavy Metals Pollution Assessment in Sediments of the Izmit Bay, Turkey. Environmental Monitoring and Assessment (2006); 123: 219-31.
13. Philips, D.H.J (1977) the use of biological indicator organisms to monitor trace metal pollution in marine and estuarine environments. A review: Environ pollut 13. 281 – 317.
14. Radojevic M, Praveena SM, Abdullah MH. (2008). Statistical perspective and pollution indicator in Mengkabong mangrove sediment Sabah. Applied Modern Science 2008; 2: 131-43.
15. Silva C.A.R., Lacerda L.D. and Rezende C.E., (1990), Heavy metal reservoirs in a red mangrove forest, Biotropica., 22, pp 339-345.
16. Soylak,M. and N.D.Erdogan., (2006). Copper (II) - rubeanic acid co-precipitation system for separation- pre concentration of trace metal ions in environmental samples for their flame atomic absorption spectrometric determinations. J. Hard mater 137 (2): 105-41.
17. Stokes RM, Fromm PO. Effects of chromate on glucose transport by the gut of rainbow trout. Physiological Zoology. (1965); 38:202-205.
18. Subramanian, V., R. Van Grieken, and L. Van't dack, (1987). Heavy metals distribution in the sediments of Ganges and Brahmaputra rivers: Environmental Geology and Water Science, v. 9, p. 93–103.
19. Tam, N.F.Y., Wong, Y.S., (1999). Mangrove soils in removing pollutants from municipal water water of different salinities. Journal of Environmental quality 28, 556-564.