Available online at www.journalijmrr.com

INTERNATIONAL JOURNAL OF MODERN RESEARCH AND REVIEWS

ISSN: 2347-8314

Int. J. Modn. Res. Revs.
Volume 4, Issue 3, pp 1125-1128, March, 2016

ORIGINAL ARTICLE

SEASONAL VARRIATIONS OF THE HEAVY METAL SEDIMENTS IN NAGAPATTINAM, KARIKAL AND THARANGAMBADI COASTAL, SOUTH EAST COAST OF TAMILNADU, INDIA

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Article History: *Received 2nd March,2016, Accepted 30th March, 2016, Published 31st March,2016*

ABSTRACT

In the present study, some heavy metals (Zn, Cd, Hg and Pb) were seasonally determined in the sediment of the southeast coastal region of Nagapattinam, Karaikal and Tharangambadi, Tamilnadu, India which is an important fishing area of Tamilnadu. Heavy metal levels in sediment were analysed by Atomic Absorption Spectrophotometer (AAS). The analysis of heavy metals in sediments indicated that all the four heavy metals were maximally accumulated and the level of sediments was varied according to the seasons. The constant variation of metals in sediment samples in the various seasons is due to the linking of industrial and un-classified anthropogenic influences. The combined and collective consequences go in front to a serious risk to the entire estuarine environment.

Keywords: Sediments, Heavy metals, AAS

1.INTRODUCTION

Many of the sediments in our rivers, lakes, and oceans have been contaminated by pollutants. Some of these pollutants are directly discharged by industrial plants and municipal sewage treatment plants, others come from polluted runoff in urban and agricultural areas, and some are the result of historical contamination. Contaminated sediments can threaten creatures in the benthic environment, exposing worms, crustaceans and insects to hazardous concentrations of toxic chemicals. Some kinds of toxic sediments kill benthic organisms, reducing the food available to larger animals such as fish. Some contaminants in the sediment are taken up by benthic organisms in a process called bioaccumulation. Among the sediments, metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems (Censi et al., 2006). The metals in the earth are usually taken as the background value of sediments (Forstener and Wittman, 1979). Heavy metals including both essential and non-essential elements have a particular significance in ecotoxicology, Metals such as copper and zinc are generally regarded as essential trace metals (Nduka et al., 2010) because of their valuable role in the metabolic activities of organisms. However, heavy metals like Cadmium, Lead, Nickel and Mercury exhibit extreme toxicity even at trace levels. Most essential metals have been found to be toxic when supplied in concentrations in excess of the optimal levels.

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As a result, there has been a growing interest in determining the heavy metal levels in marine environment. Hence the present work was carried out to find the seasonal variation of heavy metals sediments in the soil of Nagapattinam, Karaikal and Tharangambadi coastal soil southeast of Tamilnadu, India.

2.MATERIALS AND METHODS

Study area

The present study was carried out in the 3 coastal places viz; Nagapattinam, Karaikal, Tharangambadi and located in the southeast coast of Tamilnadu, India. Soil samples were collected various seasons *viz* monsoon (Oct, Nov, Dec), post-monsoon (Jan, Feb, Mar) Summer (Apr, May, Jun) and pre-monsoon (Jul, Aug, Sep) for a period of one year from October 2014 to September 2015 in the study area for the estimation of heavy metals.

Soil samples collection and preparation

Sample collections were made from each station two sediment samples were collected in sealed plastic bags. The sediments were clayey sand type, though the sampling was made on the beach area. Samples were frozen and preserved till further analyses. Sediments were dried, finely powdered and homogenized thoroughly. Samples were analysed for concentration of the trace metals - Zn, Pb, Hg and Cd. For the determination of trace metals, 2 g of the sediment was digested at 90°C with HN03 + HCl04 + HCl mixture in the ratio 1 : 1 : 3 for about 10 h. The acidic solution was centrifuged at 5000 rpm and made up to 25 ml with dil HCl.

Blanks were set up concurrently. All the samples and blanks were then analysed by Atomic Absorption Spectrophotometer (Perkin Elmer model 3110) (APHA, 1998).

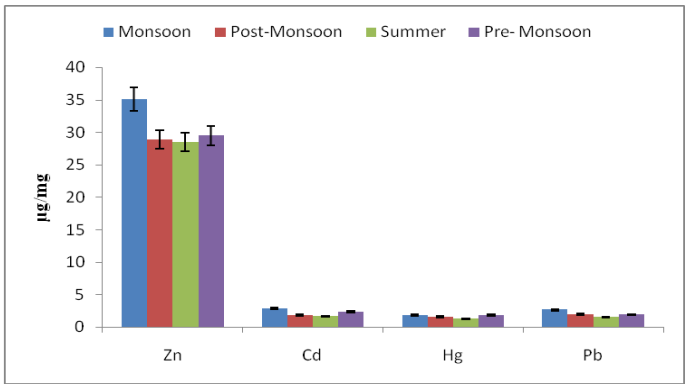
3.RESULTS

In the present study the mean concentration of heavy metal sediments in the Nagapattinam coastal area in monsoon season (Table. 1 and Fig. 1) was found to 35.12±0.13, 2.85±0.16, 1.85±0.21and 2.66±0.50 µg/g for Zn, Cd, Hg and Pb respectively. Similarly 28.93±0.07, 1.83±0.24, 1.60±0.18 and1.98±0.02 µg/g for Zn, Cd, Hg and Pb respectively recorded in post -monsoon. In summer sediments were found to lower when compare to the other seasons viz 28.47±0.08, 1.63±0.16, 1.23±0.22 and1.49±0.31 µg/g for Zn, Cd, Hg and Pb respectively. The level of metal sediments in pre-monsoon season was found to be 29.50±0.49, 2.35±0.38, 1.84±0.07 and 1.94±0.06 µg/mg for Zn, Cd, Hg and Pb respectively. In Nagapattinam coastal the Zn level was found to be higher in all the four season whereas least value was found in Hg (Table.1 and Fig.1). Similarly the sediment levels of different heavy metal was found higher in the monsoon season and followed by the post-monsoon pre-monsoon and summer.

Table.1 Shows seasonal mean variations in concentration of heavy metals Zn, Cd, Hg and Pb sediments (µg/mg) dry weight record in Nagapattinam coastal region during Oct -2014 – Sep 2015

Seasons	Zn	Cd	Hg	Pb
Monsoon	35.12±0.13	2.85±0.16	1.85±0.21	2.66±0.50
Post-Monsoon	28.93±0.07	1.83±0.24	1.60±0.18	1.98±0.02
Summer	28.47±0.08	1.63±0.16	1.23±0.22	1.49±0.31
Pre- Monsoon	29.50±0.49	2.35±0.38	1.84±0.07	1.94±0.06

Fig. 1 Shows seasonal mean variations in concentration of heavy metals Zn, Cd, Hg and Pb sediments (µg /g) dry weight record in Nagapattinam coastal region during Oct -2014 – Sep 2015

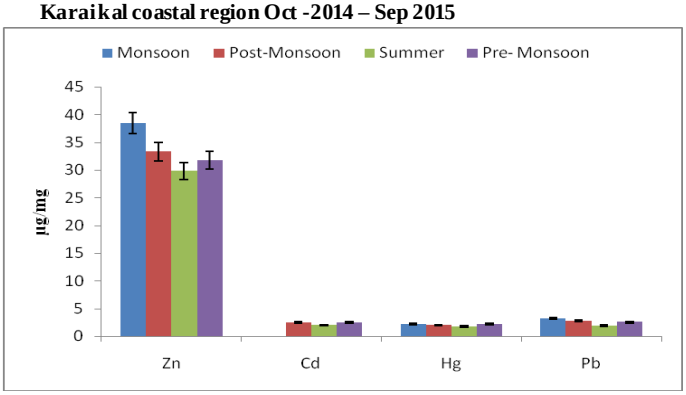


In Karaikal coastal area, the mean concentration of heavy metal sediments in monsoon season was found to be 38.48±0.49, 2.95±0.05, 2.23±0.28 and 3.25±0.27 µg/g for Zn, Cd, Hg and Pb respectively. In post monsoon season the level of the heavy metals Zn, Cd, Hg and Pb were found to be 33.32±0.58, 2.49±0.30, 2.01±0.05 and 2.76±0.21 µg/g. During summer the level of heavy metal sediments were found to be 29.85±0.26, 1.99±0.03, 1.79±0.36 and1.94±0.04 µg/g. The level of metal sediments in pre-monsoon season was found to be 31.75±1.70, 2.52±0.16, 2.22±0.19 and 2.56 ± 0.48 for Zn, Cd, Hg and Pb respectively (Table.1 and Fig .2). The level of Zn was higher and Hg was lesser in the all the season were identified the seasonal pattern of sediments were similar as it was found in the Nagapattinam coastal.

Table . 2 Shows seasonal mean variations in concentration of heavy metals Zn, Cd, Hg and Pb sediments (µg/g) dry weight recorded in Karaikal coastal region Oct -2014 – Sep 2015

Season	Zn	Cd	Hg	Pb
Monsoon	38.48±0.49	2.95±0.05	2.23±0.28	3.25±0.27
Post-Monsoon	33.32±0.58	2.49±0.30	2.01±0.05	2.76±0.21
Summer	29.85±0.26	1.99±0.03	1.79±0.36	1.94±0.04
Pre- Monsoon	31.75±1.70	2.52±0.16	2.22±0.19	2.56±0.48

Fig. 2 Shows seasonal mean variations in concentration of heavy metals Zn, Cd, Hg and Pb sediments (µg/g) dry weight recorded in Karaikal coastal region Oct -2014 – Sep 2015

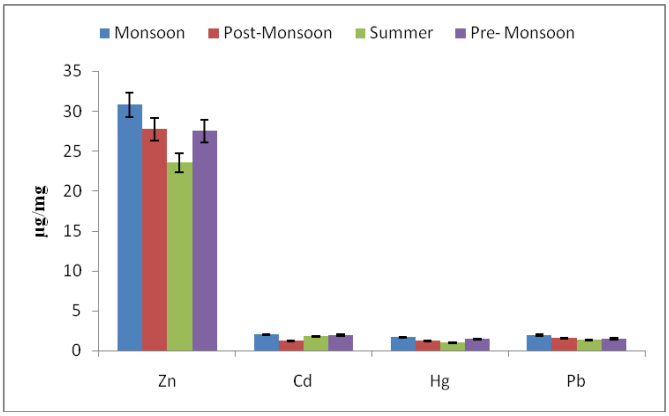


The mean concentration of heavy metal sediments in the Tharangambadi coastal area was found to be 30.76±0.58, 2.03±0.05, 1.66±0.02 and1.94±0.05 µg/g for Zn, Cd, Hg and Pb respectively in the monsoon season. In post monsoon season it was found to 27.72±1.50, 1.22±0.17, 1.26±0.25 and1.57±0.03 µg/g for Zn, Cd, Hg and Pb respectively. During summer the level of heavy metal sediments were found to be 23.56±0.29, 1.17±0.10, 1.03±0.02 and 1.36±0.15 and for Zn, Cd, Hg and Pb respectively. The level of metal sediments in pre- monsoon season was found to be 27.5±0.4, 1.95±0.07, 1.49±0.07 and1.52±0.08 µg/g for Zn, Cd, Hg and Pb respectively (Table.3 and Fig.3). The pattern of heavy metal sediments level and seasonal patterns were found identical with the other coastal region.

Table . 3 Shows seasonal mean variations in concentration of heavy metals Zn, Cd, Hg and Pb sediments (µg/g) dry weight recorded in Tharangambadi coastal region Oct -2014 – Sep 2015

Season	Zn	Cd	Hg	Pb
Monsoon	30.76±0.58	2.03±0.05	1.66±0.02	1.94±0.05
Post-Monsoon	27.72±1.50	1.22±0.17	1.26±0.25	1.57±0.03
Summer	23.56±0.29	1.17±0.10	1.03±0.02	1.36±0.15
Pre- Monsoon	27.5±0.4	1.95±0.07	1.49±0.07	1.52±0.08

Fig. 3 Shows seasonal mean variations in concentration of heavy metals Zn, Cd, Hg and Pb sediments (µg / g) dry weight recorded in Tharangambadi coastal region Oct -2014 – Sep 2015



4.DISCUSSION

This study has confirmed that sediments are important hosts for toxic metals. It has been shown that sediment permit the detection of heavy metals that may be may be either absent or in low concentration in the water column. The present investigations has revealed the concentration of certain heavy metals sediments such as Zn, Cd, Hg and Pb and were generally high with mean values when compared with recommended values for marine environment (Sekabira et al., 2010). The occurrence of enhanced concentrations of heavy metals in coastal sediments such as that obtained from Lagos lagoon can be a good indication of man induced pollution rather than by natural enrichment through geological weathering. Sediment is the major depository of metals in some cases, holding more than 99 percent of total amount of a metal present in the aquatic system (Odiete, 1999).

The heavy metal concentrations in the sediments in the present study are ranked as follows Zn> Cd> Hg > Pb. The above results supported by Chinnaraja et al, (2011*)* they have observed the concentration of heavy metal as Co > Zn > Ni > Pb > Cd in Tamilnadu coastal region.

The concentration of heavy metal found higher in the monsoon lower in the summer in the present study .The above result is supported by several authors similarly some results found to be contradiction to the present study (Venkatraman et al., 2011).

In the study area, the observed zinc concentration may be from industrial wastages and anthropogenic activities. Zinc is present not only in rock and soil, but also in air, water and the biosphere. Plants, animals and humans contain zinc, and this metal is used for anti corrosion coatings, roof cladding, batteries and some specialized alloys.

According to Eaton (2005) Cd is released into the atmosphere by fossil fuel and by the burning of agricultural and municipal wastes, including dried sewage sludge. It is used in nickel cadmium batteries PVC plastic and Paint Pigments. Cadmium sulphide and selenide and are commonly used a pigments in plastics.

Lead occurs in nature at an average crustal abundance of 16 µ g-1. Like soils in the terrestrial system, sediments are the primary sinks for lead in the aquatic environment. For deep ocean sediments, the natural average value is about 47 µ g-1 but with wide fluctuations (Craig, 1980). Lead values in bay, estuarine and other coastal sediments (marsh environments) have been much altered by man's activities the above study support our report. Nolting et al., (1999) observed that the low and constant Pb concentrations indicating the minor importance of anthropogenesis input from the Laptev Sea in contrast to other areas of the world as anthropogenesis inputs are considered to be the major source of elevated Pb concentrations in marine sediments (Nolting et al., 1999).

It is also said that the higher concentration observed lead due to lithogenic sources, industrial wastages and sometimes anthropogenic activities. Natural sources of lead into the surface environment arise from the weathering of geological materials and emissions from the atmosphere from volcanoes, windblown dust, sea spray, biogenic material and forest fires. Lead occurs naturally in small concentrations in all rocks and soils, and lead metal is used in ammunition, as oxides in glass and ceramics and in metal casting. There is a general trend observed that for zinc, decreasing its concentration based on monsoon variations. Zinc can enter the aquatic environment from a number of sources, including industrial discharges, sewage effluent and runoff (Boxall et al., 2000). Input of organic wastes into the coastal, which comes from municipal sewage, contributes to the Zn increase in sediments.

The identified trace metals in sediments of study area surface sediments are moderately or strongly contaminated, to some extent; probably as a result of anthropogenic activities. It is observed that, in general, lowest metal concentrations are found during the monsoon, compared to the pre- and post-monsoon. The comparison of the metal levels in the sediments from different areas of the coastal indicated that there is a detectable anthropogenic input to the in the coastal region of the study area. The trace metals Zn, , Cd, Hg and Pb, showed the influence of organic wastes from municipal sewage entering an industrial waste to the coastal region. Mercury is a metal which is liquid at normal temperatures and pressures. Mercury also forms organo metallic compounds, some of which have found industrial and agricultural use. This organo metallic compounds are stable, although some are readily broken down by living organisms, while others are not readily biodegraded (Arakel, 1992). The burning of fossil fuels is a source of mercury. The chloralkali industry, the wood pulping industry release significant amounts of mercury (Abernathy, 1999). Although the use of mercury is decreasing, high concentrations of the metal are still present in sediments associated with the industrial applications of mercury. Mercury concentration in sediments of study area shows a maximum value of 0.9 mg/kg and minimum of 0.1mg/kg. The higher amount of mercury in sediments may be due to the treated and untreated effluents discharges directly into the bay from heavy chemical industries and harbour which located on the shore of the coastal. The elevated level of mercury in sediments is said to be toxic and harmful to the society, which can affect the total environment directly or indirectly.

In the present study the heavy metal concentrations were high in the monsoon followed by pre- monsoon, post-monsoon and summer at all the study area. 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 (Senthilnathan and Balasubramanian, 1997; Ananthan et al., 1992, 2005, 2006; Karthikeyan et al., 2004, 2007).

5.CONCLUSION

In the present study the heavy metal sediments were found higher in the Karaikal followed by Nagapattinam and Tharangambadi. The higher sediments pollution was found in Karaikal costal may be due to various anthropogenic pressure as well the newly constructed fort may be also reason for this

high pollution in the coast. It is proposed that continuous monitoring and further studies in the area should be carried out soon to ascertain long-term effects of anthropogenic impact and to assess the effectiveness of minimizing the human activity to upgrade the marine environment in the Nagapattinam, Karaikal and Tharangambadi coastal of the east coast of India as the industrial and sewage activities influence the geochemical process in the marine systems.

The present baseline information of the heavy metals in sediments would form a useful tool for further ecological assessment and monitoring of these coastal ecosystems of the selected area of the east cost of the Tamil Nadu, India.

6.ACKNOWLEDGEMENTS

The authors are greatly acknowledging Dr. G. Jonas Gunasekaran, *Principal* TBML college, Porayar, for providing necessary facilities for the entire study and his valuable suggestion.

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