World Journal of Fish and Marine Sciences 5 (5): 571-574, 2013
ISSN 2078-4589

DOI: 10.5829/idosi.wjfms.2013.05.05.74131

Spatial Variation of Fe, Mn and Ni Concentrations in Sediment and Water of Musa Estuary, Persian Gulf

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Abstract: Musa estuary is located in the northwest Persian Gulf. Each one of its branches and creeks is subjected to different anthropogenic activities. The main aim of current study is to evaluate the levels of Fe, Mn and Ni in the sediment and water of the main creeks. Concentration of studied metals in both water and sediment are measured by using atomic absorption spectrometer. Regarding sediment, the result showed that the highest level of Fe, Mn and Ni were observed in Quay 18, Khor-Zangi and Dock SorSoreh respectively. The results of heavy metals level in water showed that the maximum concentration of Fe, Mn and Ni were observed in Khor-Zangi, Dock SorSoreh and Petrochemical quay respectively. Petrochemical quay receives heavy metals from petrochemical units that are established a decade ago in its bank. Dock SorSoreh is suffering from huge amounts of tankers traffic and oil transportation along its waterway.

Key words: Musa Estuary · Fe · Mn · Ni · Persian Gulf

INTRODUCTION

In marine ecosystems, bottom sediments are known to act as a sink for some kind of contaminants such as heavy metals introduced to their waters from both natural and anthropogenic sources [1-3]. Industrial effluents, agricultural runoffs, oil-related activities and transport, urban effluents and geologic weathering contribute to the heavy metals in the water [4, 5]. Environmental factors such as pH, sediment redox potential, temperature and dissolved oxygen play significant role in metal accumulation in both sediment and organisms [6, 7]. These factors can turn the sediment into a main source of metals by making the deposited heavy metals available for organisms [4, 8-11].

The importance of heavy metal in marine pollution studies is mainly related to its resistance against biological decomposition [8]. Heavy metals are categorized into two main groups, including essential and non-essential metals [12]. The essential ones are vital for enzymes activities, whilst nonessential metals are potentially harmful for biological activities of organisms [13, 14].

Musa estuary is located in the northwest Persian Gulf. Each one of its branches and creeks is subjected to different anthropogenic activities; for example, petrochemical activities, oil-related activities and urban effluent [3, 15, 16]. Therefore, the main aim of current study is to evaluate the levels of Fe, Mn and Ni in the sediment and water of the main creeks of Musa estuary.

MATERIALS AND METHODS

Sampling and Sample Preparation: The samples of sediments and water were collected from different creeks along Musa estuary, the northwest Persian Gulf, during November 2011. The sampling stations were chosen in Petrochemical quay (S1), Dock SorSoreh (S2), Khor-Zangi (S3), Quay 18 (S4), Quay 33 (S5) and Khor-Jafari (S6) (Fig. 1). Using grab, sediment samples were collected from each creek. Surface water samples were collected in polyethylene bottles (washed with nitric acid then deionized water), then were acidified with 10% HNO_3 and filtered through a 0.45 ml membrane filter. Twenty samples of water and sediment were transferred to the laboratory using icebox and kept frozen at -20°C prior to analysis.

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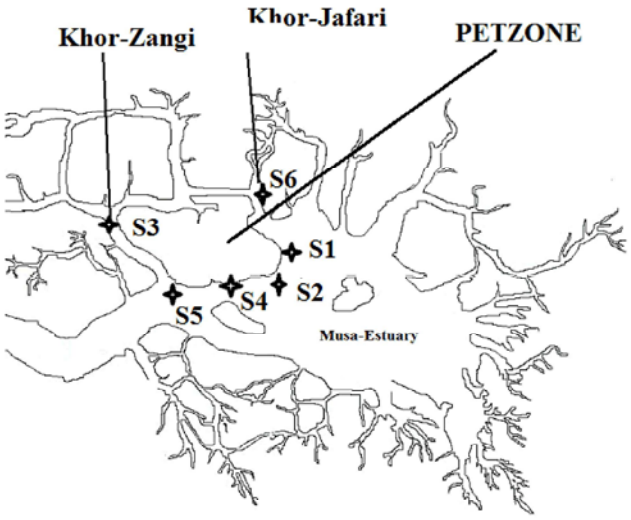

Fig. 1: A map of Musa Estuary and the Studing Stations

Sediment samples were thawed in room temperature before analysis and oven dried at 105°C for 24 hour. Then the samples were powdered in an agate mortar and sieved through a 63-µm mesh [3]. Approximately 1g of the sediment samples from each station was digested with 2 ml of HNO_3 and 6 ml of HCl (Merck, Darmstadt, Germany). The remaining digested solution was made up to certain volume with double distilled water [15, 17].

Apparatus and Reagents: To determine the metals in the samples, a GBC (Savant AA Sigma) flame atomic absorption spectrometer (AAS) was used. All chemical regents were analytical reagent grade (Merck). The glassware and plastic containers were acid washed with nitric acid 10% and rinsed with double distilled water before use. To avoid samples contamination and check the accuracy of the method, blank samples and CRM (Dorm-2, muscle of Dogfish, National Research Council of Canada) were analyzed. The recovery values for all metals were satisfactory and were fallen between90% to 113%.

Statistical Analysis: All data were tested for normal distribution with Shapiro-wilk normality test. Significant differences between heavy metals concentration in the samples of various stations were determined using One-Way analysis of variance (ANOVA) followed by Duncan post hoc test. The level of significance was set at $\alpha = 0.05$.

RESULTS

The concentration of heavy metals and the comparison between creeks are shown in Figs. 2 and 3.

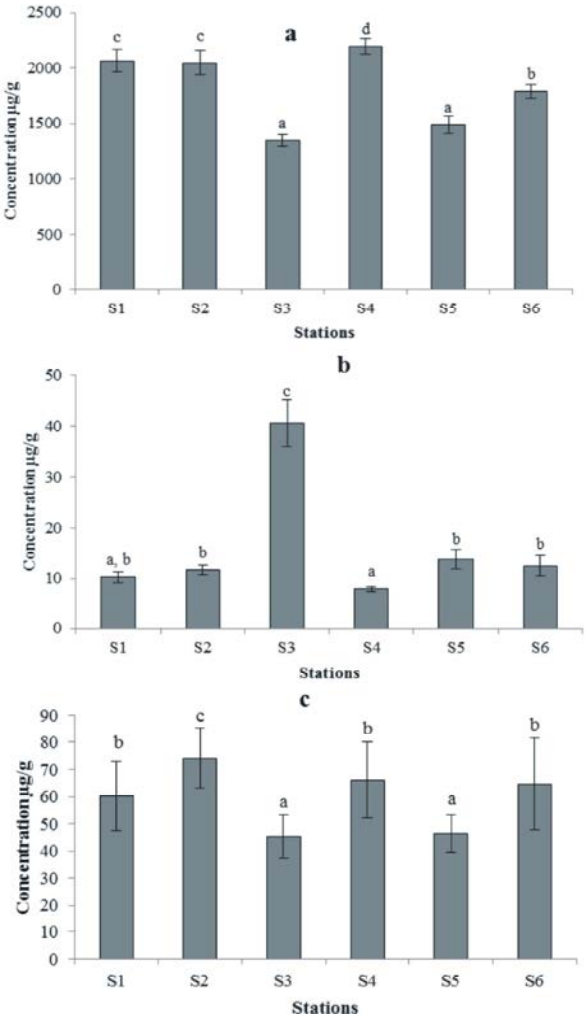

Fig. 2: Concentration of heavy metals in Musa Estuary sediment [a (Fe), b (Mn) and c (Ni)]

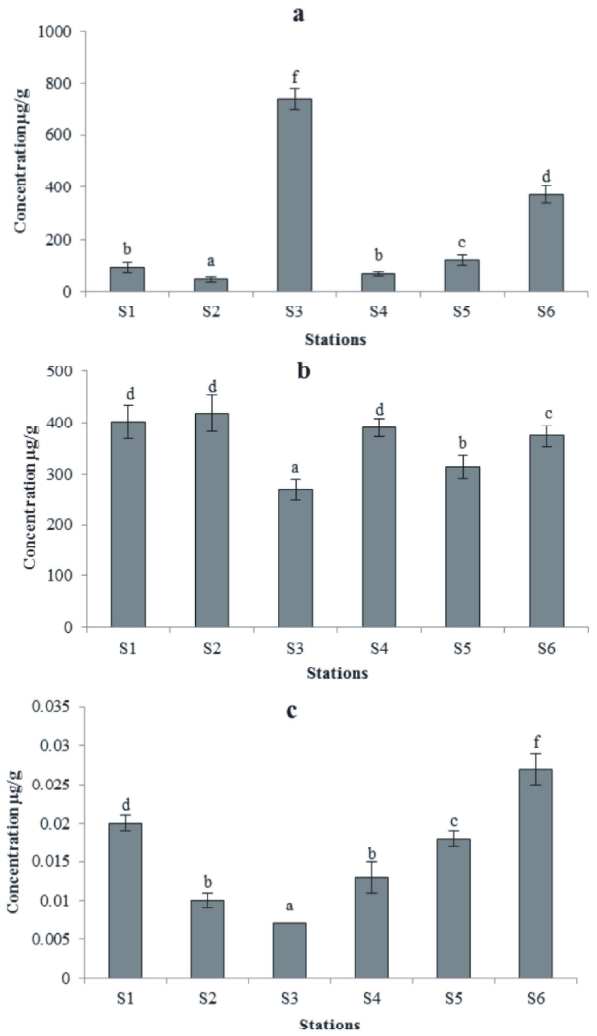

Fig. 3: Concentration of heavy metals in Musa Estuary water [a (Fe), b (Mn) and c (Ni)]

In the case of sediment, the highest concentration of Fe (2193.42 µg/g) was observed in S4. The comparison showed that the concentration of Mn (40.5 µg/g) in S3 sediment was significantly higher than that in the other stations. The concentration of Ni in S2 sediment was significantly higher than that in the other stations. Regarding water, the highest concentrations of Fe (740.7 µg/g), Mn (417.75 µg/g) and Ni (0.027 µg/g) were recorded in S3, S2 and S1 respectively.

DISCUSSION

The significant differences, which observed among metals concentrations in different creeks, indicate that there are different sources for heavy metals input along Musa estuary [3, 15-17]. In addition, physicochemical factors that could control the amount of heavy metal in suspended phase and deposited phase, are different among stations [9, 10].

S1 is the nearest creek to petrochemical units and construction of Petzone [16-18]. In 1993, about 1.22 Km^2 of Musa Estuary (an area of Jafari creek) was drained off for Petrochemical Special Economic Zone (Petzone) and introduced as Petzone area. S1 is located in this area and receives huge quantities of Petzone constructions wastewaters. S2 is located between Petzone and Imam port. This creek is served as a waterway for supertankers and ships traffic as well as receives petrochemical wastewaters [3]. Therefore, the high level of Ni that observed in this creek could be attributed to its location and oil-related transportation in this area. S3 is located between Petzone and Mahshahr city [17]. Thus, heavy metal concentration in this creek may be due to discharge of sewage and urban effluents in this area.

CONCLUSION

This study showed that the concentration of the heavy metals varied among creeks. Khor-Zangi, Dock SorSoreh and Petrochemical quay have the highest concentration of the metals because they receive petrochemical wastewater, Imam port and urban effluents. Enrichment of Ni metal in Dock SorSoreh may be related to oil-related activities in the area.

ACKNOWLEDGEMENT

This study was supported by Khorramshahr Marine Science and Technology University.

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