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RESEARCH ARTICLE

IMPACT OF HEAVY METAL IN SOIL SAMPLES, KARUR, TIRUCHIRAPPALLI AND THANJAVUR DISTRICT, TAMILNADU, INDIA

[1]Abirami, L., [1]Mohamed Sirajudeen, A., [2]Ravichandran, R. and [*,2]Rengarajan, R.

[1]Department of Chemistry, Khadir Mohideen College, Adirampattinam, Tamilnadu, India
[2]Department of Zoology, Government Arts College, Ariyalur, Tamilnadu, India

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ABSTRACT

This study was designed to assess total contents of 6 toxic metals viz., Fe, Hg, Pb, Cr, Cd and As in the fine sediment soil samples collected from industrial zone of Karur, Tiruchirappalli and Thanjavur districts of Tamil Nadu, India during April 2015. Heavy metals were analyzed by using standard methods. Heavy metal concentration in ground water was in following order Fe > Cr > As > Hg > Cd > Pb (ppm). In the present investigation, the high level of heavy metal (Iron) was recorded from Kundur fine sediment samples and low level of heavy metal (Lead) was recorded in Patteswaram and Mathur areas of fine sediment soil samples.

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INTRODUCTION

At many sites around the nation, heavy metals have been mined, smelted, or used in other industrial processes. The waste (tailings, smelter slag, etc.) has sometimes been left behind to pollute surface and ground water. The heavy metals most frequently encountered in this waste include arsenic, cadmium, chromium, copper, lead, nickel, and zinc, all of which pose risks for human health and the environment. They typically are spread out over former industrial sites and may cover acres of land. The soil, a main part of the terrestrial ecosystem, is a habitat for a great number of organisms but at the same time, it is perhaps the most endangered component of our environment, open to influence from a variety of different pollutants arising from human activities (industrial, agricultural, etc.) (Djingova and Kuleff, 2000; Morton-Bermea *et al.*, 2002). Among pollutants, heavy metals have been the subject of particular attention because of their long-standing toxicity when exceeding specific thresholds. Among the key issues in the environmental research on heavy metals is their mobility in the ecosystems and transfer in the food chains (Steinnes *et al.*, 1997, 2000; Donisa *et al.*, 2000; Lin *et al.*, 2002).

****Corresponding author: Rengarajan, R.***
Department of Zoology, Government Arts College, Ariyalur, Tamilnadu, India.

Uncontrolled development in industry, agriculture and urbanization accelerates the input of heavy metals into the environment in many part of the world. Many scientific activities have been devoted to the determination of sources, types, and degree of heavy metal pollution in soil (Einax and Soldt, 1998; Plant *et al.*, 2001).

The heavy metals are potentially toxic to crops, animals and humans when contaminated soils were used for crop production, because heavy metals are easily accumulated in vital organs to threaten crop growing and human health (Sharma *et al.*, 2007). Heavy metal contamination of environment is a worldwide phenomenon that has attracted a great deal of attention (Wong *et al.*, 2002). Heavy metal contamination of soil resulting from wastewater irrigation is a cause of serious concern due to the potential health impacts of consuming contaminated produce (Li *et al.*, 2006).

However, the anthropogenic sources of heavy metals in agricultural soils include mining, smelting, waste disposal, urban effluent, vehicle exhausts, sewage sludge, pesticides, fertilizers application and soon (Alloway, 1995; Kachenko and Singh, 2006; Montagne *et al.*, 2007 and Li *et al.*, 2008). The amount of heavy metals which went into the soil through natural deposition and raining sedimentation are related to the level of development of heavy industry, the city's population density, land utilization and traffic level. Soil contamination became to be heavier as closing to the city (Chen, 2002).

Heavy metals are the most reported pollutants in fertilizers. Heavy metal content is relatively low in nitrogen and potash fertilizers, while phosphoric fertilizers usually contain considerable toxic heavy metals. Heavy metals in the compound fertilizers are mainly from master materials and manufacturing processes. The content of heavy metals in fertilizers is generally as follows: phosphoric fertilizer> compound fertilizer> potash fertilizer> nitrogen fertilizer (Boyd, 2010). Cd is an important heavy metal contaminant in the soil. Cd is brought to soils with the application of phosphoric fertilizers. Many studies showed that, with the application of a large amount of phosphate fertilizers and compound fertilizers, the available content of Cd in soils increases constantly, and Cd taken by plants increases accordingly. In recent years, the mulch has been promoted and used in large areas, which results in white pollution of soils, because the heat stabilizers, which contain Cd and Pb, are always added in the production process of mulch. This increases heavy metal contamination of soils (Satarug *et al*., 2003).

In recent years, with the development of the global economy, both type and content of heavy metals in the soil caused by human activities have gradually increased, resulting in the deterioration of the environment (Sayyed and Sayadi, 2011; Jean-Philippe *et al*., 2012; Raju *et al*., 2013; Prajapati and Meravi, 2014; Sayadi and Rezaei, 2014; Zojaji *et al*., 2014).

MATERIALS AND METHODS

The present study was carried out by systematic collection of fine sediment soil samples from Karur, (Pugalur station-I and Velayuthapalayam station-II), Tiruchirappalli (Kundur Station-III & Mathur station-IV) and Thanjavur (Patteswaram station-V) Districts, India, during April 2015. The samples of fine sediment soil were collected. All the collected samples were analyzed for Iron, Mercury, Lead, Cadmium, Chromium, and Arsenic. Standard methods were used for collection and analysis of fine sediment soil samples (Buckley and Cranston, 1993).

Metals in Soil

0.25gm soil was digested with 10 ml HF acid and 1ml aquaregia i.e., HCl and HNO_3 in a ratio of 3:1 in a flask. Thereafter, 5.0 ml of $HClO_4$ was added and again heated on heating plate upto dryness and double distilled water was added to make up the volume to 100 ml and filtered through Whatman No. 42 filter paper. Digested soil sample were analyzed for metal concentrations by atomic absorption spectrometer (Buckley and Cranston, 1993).

RESULTS

In the present study, the heavy metal concentrations of fine sediment soil samples are presented (Table 1 and Fig. 1 to 6). The concentration of heavy metals in fine sediment soil samples was observed different areas. Heavy metal concentrations in fine sediment soil samples were in following order Fe > Cr > As > Hg > Cd > Pb (ppm). The maximum heavy metal iron were (45.54± 0.49 ppm) observed in station-III and minimum value found to be 11.55 ± 0.62 ppm) in station-II. Maximum chromium heavy metal was analyzed (2.602 ± 0.097 ppm) in station-IV and minimum was observed (0.417 ± 0.094 ppm) in station-II. The heavy metal arsenic content was measured (0.245 ± 0.052 ppm) in station-II and minimum value was observed (0.107 ± 0.027 ppm) in station-V.

Heavy metal mercury content was found to be maximum (0.0008 ± 0.0009 ppm) in station-V and minimum (0.0001 ± 0.00005 ppm) in station-III and IV. The heavy metal cadmium was measured maximum (0.0006 ± 0.00009 ppm) in station-I and minimum was observed (0.0001 ± 0.00006 ppm) in station-II. The heavy metal lead content found to be maximum (0.0002 ± 0.00008 ppm) in station-I & III and minimum was analyzed (0.0001 ± 0.00005 ppm) in station-IV and V. In the present, the minimum heavy metal lead were observed in station-IV (Mathur - Trichy District) and station-V (Patteswaram – Thanjavur, district). The maximum heavy metal iron content were observed station-III (Kundur – Tiruchirappalli district).

DISCUSSION

In the present observation, the heavy metal concentrations were observed from fine sediment soil samples of Karur, Tiruchirappalli and Thanjavur District, Tamilnadu, India. the minimum heavy metal lead were observed in station-IV (Mathur - Trichy District) and station-V (Patteswaram – Thanjavur, district).

The maximum heavy metal iron content were observed station-III (Kundur – Tiruchirappalli district). The present results for Fr, As, Cd, Cr, Hg and Pb were compared with international reference values for soils (EEA, 1999; Lacatusu, 1998). The results obtained in this work are also compared with similar data for Izmit Gulf surface soil (Yılmaz *et al*., 2003).

Table 1. Heavy metals concentrations in fine sediment samples in different study areas (Karur, Tiruchirappalli and Thanjavur Districts)

Name of Heavy metals	Pugalur (Station –I)	V. Palayam (Station – II)	Kundur (Station – III)	Mathur (Station – IV)	Patteswaram (Station – V)
Iron	28.32 ± 0.33	11.55 ± 0.62	45.54 ± 0.49	30.68 ± 0.54	36.55 ± 0.31
Mercury	0.0005 ± 0.0001	0.0006 ± 0.0001	0.0001 ± 0.00005	0.0001 ± 0.00005	0.0008 ± 0.00009
Lead	0.0002 ± 0.00008	0.0001 ± 0.00005	0.0002 ± 0.00008	0.0001 ± 0.00006	0.0001 ± 0.00005
Chromium	2.132 ± 0.089	0.417 ± 0.094	2.79 ± 0.158	2.602 ± 0.097	1.645 ± 0.094
Cadmium	0.0006 ± 0.00009	0.0005 ± 0.00009	0.0002 ± 0.00008	0.0003 ± 0.00008	0.0001 ± 0.00006
Arsenic	0.121 ± 0.014	0.245 ± 0.052	0.197 ± 0.035	0.137 ± 0.027	0.107 ± 0.027

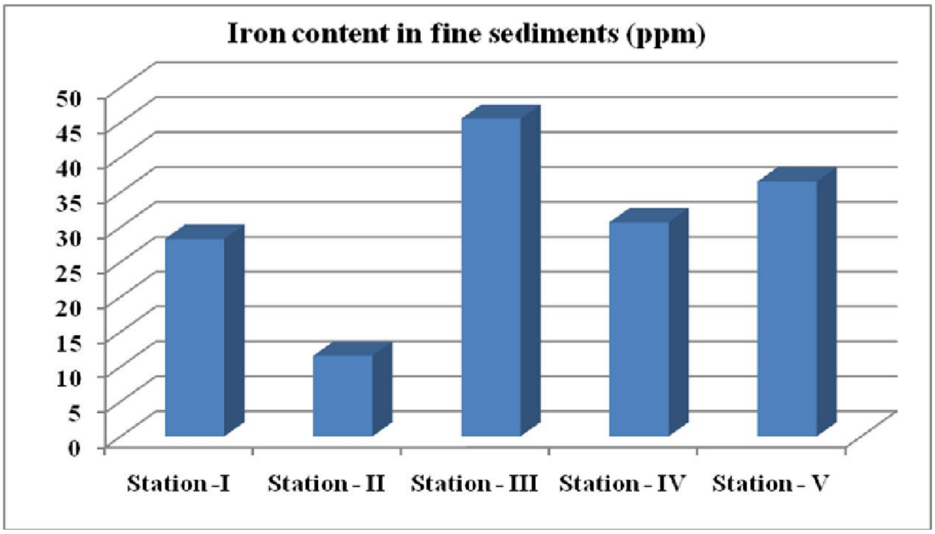

Fig. 1. Iron content (ppm) of fine sediment soil samples in different areas Karur, Tiruchirappalli and Thanjavur Districts

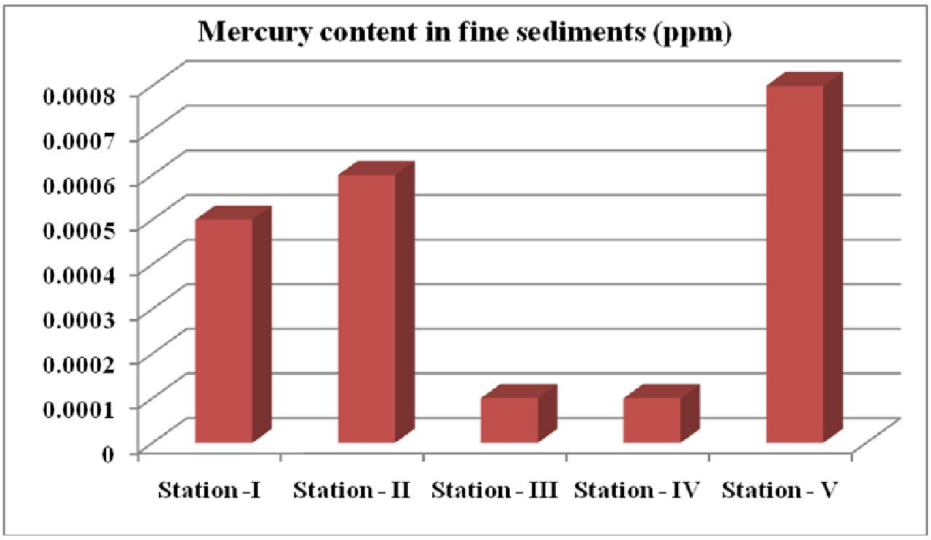

Fig. 2. Mercury content (ppm) of fine sediment soil samples in different areas Karur, Tiruchirappalli and Thanjavur Districts

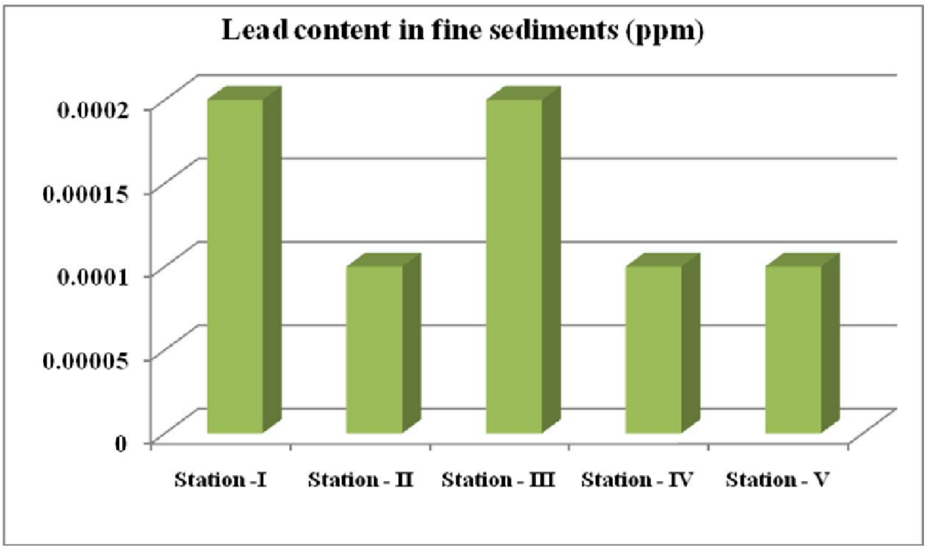

Fig. 3. Lead content (ppm) of fine sediment soil samples in different areas Karur, Tiruchirappalli and Thanjavur Districts

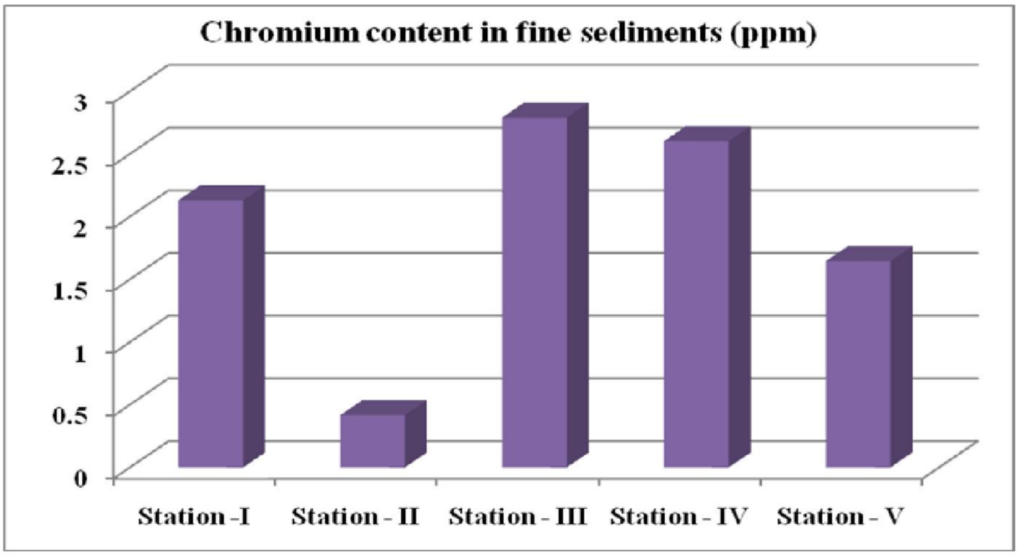

Fig. 4. Chromium content (ppm) of fine sediment soil samples in different areas Karur, Tiruchirappalli and Thanjavur Districts

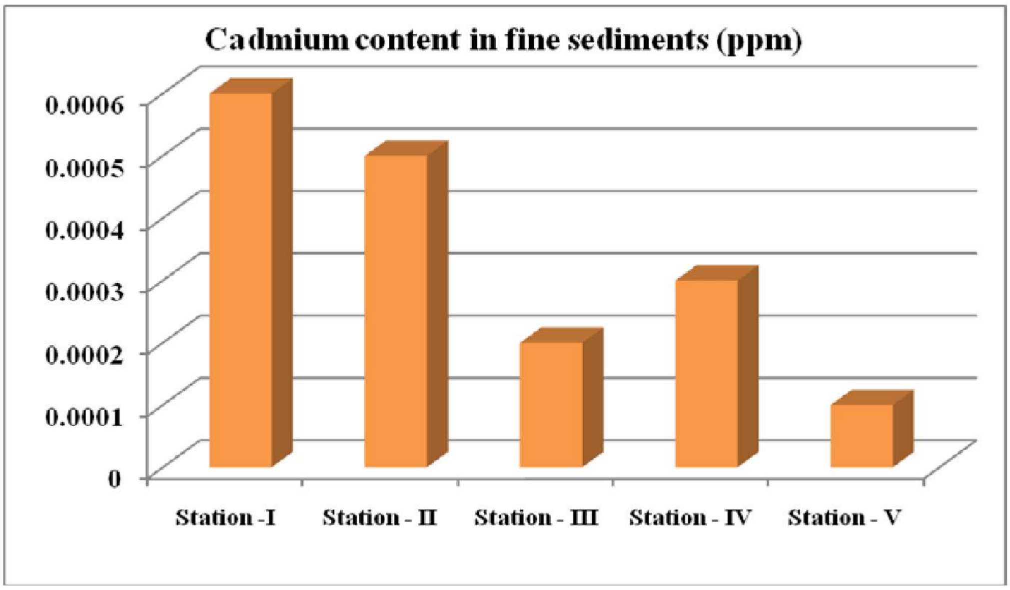

Fig. 5. Cadmium content (ppm) of fine sediment soil samples in different areas Karur, Tiruchirappalli and Thanjavur Districts

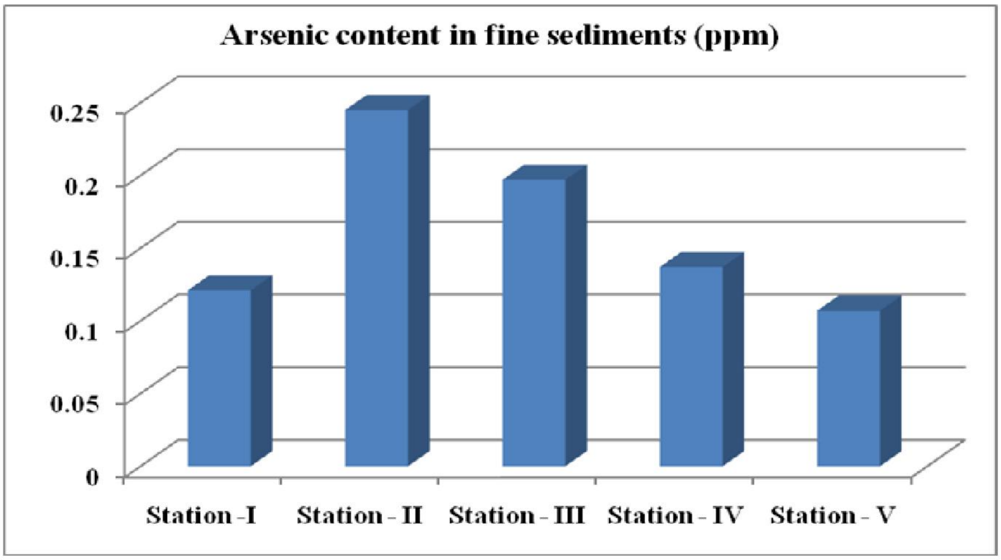

Fig. 6. Aresnic content (ppm) of fine sediment soil samples in different areas Karur, Tiruchirappalli and Thanjavur Districts

The two sets of data show good agreement for rural soil. Yılmaz *et al.,* mean values for Cu, Zn and Pb were 21, 56 and 16 ppm, respectively whereas our median values for Cu, Zn and Pb are 16.2, 44.5 and 18.9 respectively. The present median values also show close agreement in most cases with world median values for soil (Bowen, 1979). As we all know, Cd was a non-essential elements of human health with a high biological toxicity, it mainly accumulated in the surface soil, which enter the body mainly through the digestive system (Shallari *et al.*, 1998). The toxic level of chromium in soil is around 2-50 ppm (Bergmann, 1992), and in comparison with this value chromium measurements were very low in the investigation area. The addition of artificial fertilizer and pesticides causes an increase of lead levels in agricultural soil. In addition, lead comes from industrial and domestic wastewater and air pollution resulting from vehicle exhaust output and incineration of fossil fuels into the environment (Ndrok Were, 1984).

Moreover, toxic elements may also become stabilized due to high soil pH which may result in less element concentrations in the soil solution. This may restrain the absorbability of the elements from the soil solution and translocation into plant tissues (Liu *et al*., 2005). Cadmium and lead are nonessential elements and their presence even at very low concentration causes adverse health effects to human health (Mahaffey 1990). Dietary cadmium accumulates principally in the kidneys and liver (McLaughlin *et al.*, 1999; Muchuweti *et al.,* 2006). In the present study, recommends to the regulatory agencies to control the heavy metals entry from the various non points to protect the aquatic environment and human health. Heavy metals in the soil refers to some significant heavy metals of biological toxicity, including mercury (Hg), cadmium (Cd), lead (Pb), chromium (Cr), and arsenic (As), etc. With the development of the global economy, both type and content of heavy metals in the soil caused by human activities have gradually increased in recent years, which have resulted in serious environment deterioration

Conclusion

Results obtained from this study showed that, there are variations in the metal contents of the soil from one location to the other. Comparison of the level of contamination showed that, the concentrations of the heavy metals in the fine sediment soil at the areas of study were also found to be higher. This is an indication of low contamination of the area of study from anthropogenic sources. This suggests a significant risk to this population given the toxicity of these metals and the fact that for many, hand dug wells and bore holes are the only sources of their water supply in this environment.

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