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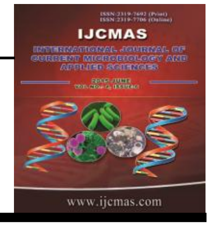

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Original Research Article

Analysis of Heavy Metals in Soil Samples Collected at three Different Industrial Creeks of Surat, India

Alpa Varsani* and Kapila Manoj

Department of Aquatic Biology, Veer Narmad South Gujarat University, Surat-395007, India

**Corresponding author*

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ABSTRACT

A comprehensive analysis of heavy metal was conducted in the soil samples of Industrial creeks located around Surat city. The study performed at three different sampling locations along the industrial creek of Surat for the period of six months from Oct-2012 to March-2013. The results reveal that except hexavalent chromium lead, cadmium and mercury exceed the ISQG limits set for the sediment. Higher values were mainly observed at all sites for Hg. These indicate that heavy metal contamination especially Hg, should be taken into account during development strategies to protect the ecosystem from long term pollution load.

Introduction

Soil is considered as a complex, living, seasonally changing and dynamic component in the ecosystem. Due to the many anthropogenic activities in industrial areas soil may get polluted which may cause major heavy metal contamination and which is more responsible for increasing the pollutants in the soil. Municipal sewage water, industrial effluents and many unwanted wastes like plastic materials, bottles, broken pieces of metal etc. are also dump into the creek near by them. The pollutants are starting to get deposited on the soil when the soil gets accumulated by the toxic substances such as metals, trace elements and other organic substances from domestic and industrial sectors (Rakesh Sharma and Raju, 2013). Heavy metals are natural constituents of the earth's crust. The problem of environmental pollution due to toxic metals has begun to cause concern now in most major metropolitan cities. The pollution level in the environment is increasing due to industrialization, urbanization, anthropogenic activities and natural sources (Hanif *et al.*, 2005; Khan *et al.*, 2009). Human activities have drastically altered the balance and biochemical and geochemical cycles of some heavy metals. The toxic heavy metals entering the ecosystem may lead to geoaccumulation, bioaccumulation and biomagnifications (Pravin *et al.*, 2012). An assessment of the environmental risk due to soil pollution is of particular importance for agricultural and non-agricultural areas, because heavy metals, which are potentially harmful to human health, persist in soils for a very long time (Sana'a Odat and Alshammari Ahmed, 2011). Because of this reason this study was aimed to investigate the quality of the soil and to find out the heavy metal concentrations.

Materials and Methods

To, fulfill the objectives and aims of the study, the samples were collected monthly from three industrial creeks for the period of six months (Oct-2012 to March-2013). Three sites were selected viz. Creek-1 Bhedvad Khadi (Bamroli), Creek-2 Mithi Khadi (Udhana) and Creek-3 Saniya Hamed (Saroli) where domestic sewage and industrial effluent drained. The soil from these sites was collected by adaptive core sampling technique as described in Nybakken (1988). The soil was scooped by pushing 50 cm long acrylic core of 5 cm diameter into soil of the creek. Soil sample were stored in polythene bags and brought to the laboratory for analysis.

The analysis of the metals like cadmium (Cd), lead (Pb), hexavalent chromium (Cr^{+6}) and mercury (Hg) were done by using AAS-Atomic Absorption Spectrophotometer (APHA, 2005).

Results and Discussion

The experimental data on heavy metal content in soil samples collected from different sampling station of industrial creek of Surat is presented in table 1. Total heavy metal sample concentrations were compared to Interim Sediment Quality Guidelines (ANZECC/ARMCANZ, 2000) depicted in table 2.

This scheme provides two values, Interim Sediment Quality Guidelines Low (ISQG L) and ISQG High (ISQG H), which delineate three concentration ranges for a particular chemical. Concentrations below ISQG L values represent a minimal-effects range, which is intended to identify conditions where adverse biological effects would be rarely observed. Concentrations equal to or greater than ISQG L, but below ISQG H, represent a range within which biological effects occur occasionally. Concentrations at or above ISQG H values represent a probable-effects range, above which adverse biological effects frequently occur. Sediment quality guidelines were used to identify conditions under which adverse biological effects may occur (Table 2). ISQG-L also represents a threshold level that triggers the requirement for additional environmental investigative work.

From the present examination it was observed that Cadmium (Cd) concentration at S1, S2 and S3 sampling station lies in the range of 0.239-2.120 mg/kg, 0.239-0.679 mg/kg and 0.082-0.427 mg/kg respectively. It was observed from figure 1 that maximum concentration of Cd was found 2.120 mg/kg in soil at S1 which exceed ISQG Low concentrations. Due to bioavailability and multiple technological applications like batteries, pigments, polymer stabilisation, etc., Cadmium is a very important source of environmental pollution. Cd dispersed in the environment can persist in soils and sediments for decades (Bernard, 2008). When taken up by plants, Cd concentrates along the food chain and ultimately accumulates in the body of people eating contaminated food (Bernard, 2008). By far, the most salient toxicological property of Cd is its exceptionally long half-life in the human body. Once absorbed, Cd irreversibly accumulates in the human body, in particularly in kidneys and other vital organs such the lungs or the liver (Johri *et al.*, 2010).

Table.1 Heavy metal content in soil samples collected at different sampling sites of Industrial creek of Surat

Site	Parameter	Unit	Oct-2012	Nov-2012	Dec-2012	Jan-2013	Feb-2013	Mar-2013
Bhedvad Khadi (Bamroli)(S1)	Cd	mg/kg	0.239	0.319	0.507	2.120	1.260	0.950
	Pb	mg/kg	17.197	21.272	16.149	32.160	52.350	31.890
	Cr^{+6}	mg/kg	ND	ND	ND	ND	ND	ND
	Hg	mg/kg	4.558	2.736	1.985	2.760	3.470	1.440
Mithi Khadi (Udhana) (S2)	Cd	mg/kg	0.679	0.239	0.302	0.567	0.328	ND
	Pb	mg/kg	33.529	12.587	16.741	28.23	31.400	24.270
	Cr^{+6}	mg/kg	ND	ND	ND	ND	ND	ND
	Hg	mg/kg	1.757	2.047	0.862	0.823	1.200	ND
Saniya Hamed (Saroli)(S3)	Cd	mg/kg	ND	0.159	0.082	0.427	0.419	ND
	Pb	mg/kg	7.600	17.751	10.360	20.430	28.130	7.590
	Cr^{+6}	mg/kg	ND	ND	ND	ND	ND	ND
	Hg	mg/kg	5.058	12.060	8.024	0.752	1.120	ND

ND- Not detected (Green = above ISQG Low, Red = above ISQG High)

Table.2 Recommended sediment quality guidelines (ANZECC/ARMCANZ, 2000)

Element	ISQG Low (mg/kg)	ISQG High (mg/kg)
Cd	1.5	10
Pb	50	220
Cr	80	370
Hg	0.15	1

Figure.1 Comparison of cadmium concentration with ISQG at all sites

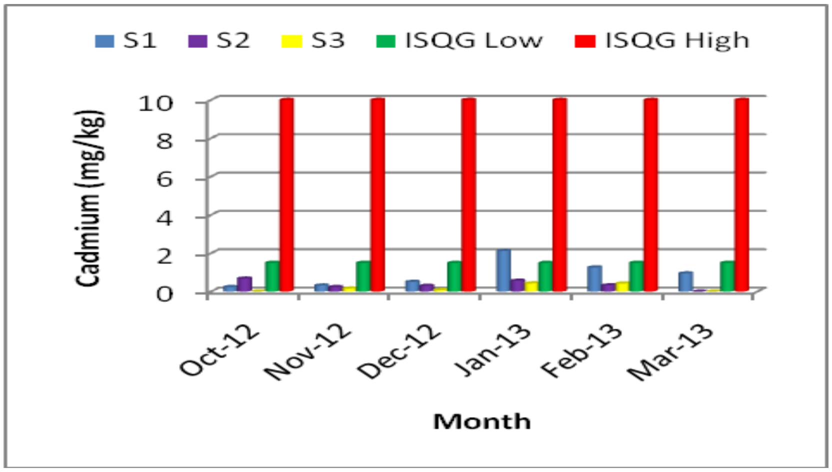


Figure.2 Comparison of lead concentration with ISQG at all sites

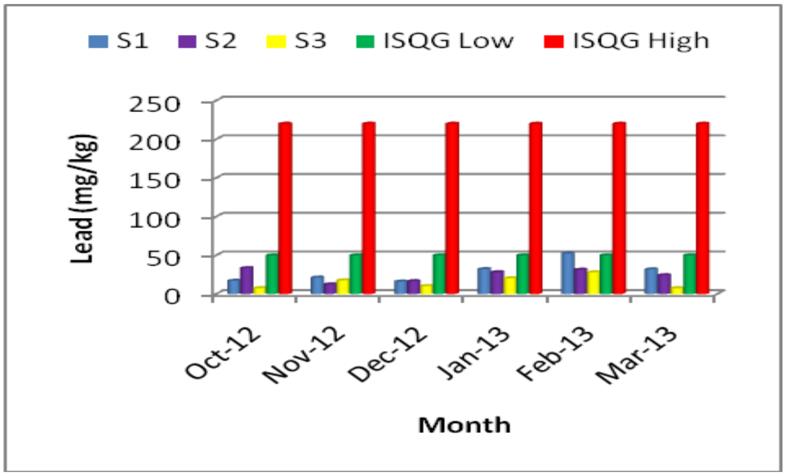
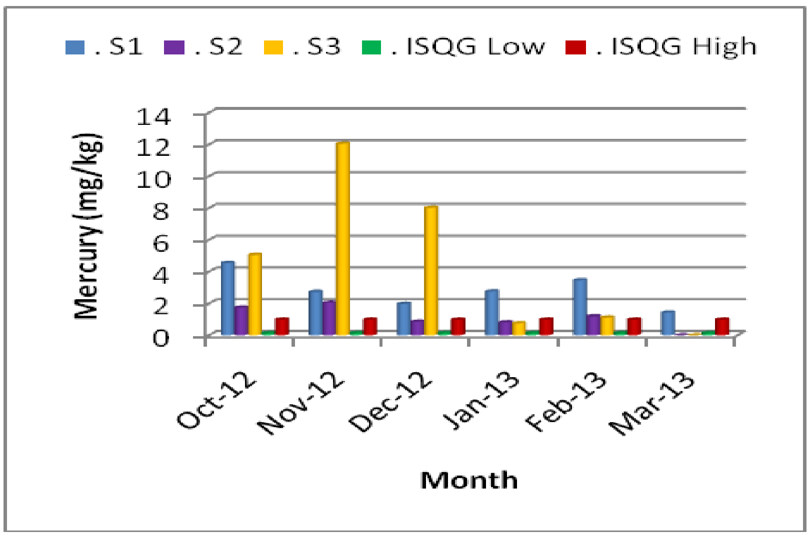


Figure.3 Comparison of mercury concentration with ISQG at all sites



In addition to its extraordinary cumulative properties, Cd is also a highly toxic metal that can disrupt a number of biological systems, usually at doses that are much lower than most toxic metals (Godt *et al.*, 2006).

Present experimental data showed that Lead (Pb) concentration at S1, S2 and S3 sampling station lies in the range of 16.149-52.350 mg/kg, 12.587-33.529 mg/kg and 7.590-28.130 mg/kg respectively. It was observed from figure 2 that maximum concentration of Pb was 52.35 mg/kg in soil at S1 that exceed ISQG Low concentrations. Lead is a well known metal toxicant and it is gradually being phased out of the materials that human beings regularly use. Lead concentrations in aquatic and terrestrial vertebrates tend to increase with increasing age of the organism, and to localize in hard tissues such as bone and teeth. Tetramethyl lead reportedly was produced from biological and chemical methylation of several inorganic and organic Pb compounds in the aquatic environment, and has been detected at low concentrations in marine mussels, lobsters, and bony fishes. Wastes from Pb mining activities have severely reduced or eliminated populations of fish and aquatic invertebrates, either directly through lethal toxicity or indirectly through toxicity to prey species. Health advisories warning anglers against eating Pb contaminated fish have been posted in Missouri (Schmitt and Finger, 1987) Acute toxicity of Pb in invertebrates is reported at concentration of 0.1–10 mg/l (Ram *et al.*, 2011).

In the present investigation hexavalent chromium was not found in soil at any site.

From the results it was observed that Hg concentration at S1, S2, S3 sampling station lies in the range of 1.440-4.558 mg/kg, 0.823-2.047 mg/kg and 0.752-12.060 mg/kg respectively. Hg concentration at S1 exceed ISQG High concentrations in all the months where as at S2 and S3 some where it exceed ISQG Low concentrations and some where it exceed ISQG High concentrations as shown in figure 3. It was observed that maximum concentration of Hg was 12.060 mg/kg in soil at S3. Mercury is a strong phytotoxic as well as genotoxic metal (Fridovich, 1986). High concentration of mercury, which could pose an ecological hazard, leading to contamination of plants (Cho and Park, 2000; Zhou *et al.,* 2007), aquatic resources and bioaccumulation in the food chain. Although elemental mercury is relatively innocuous and non-toxic, it can be converted to organomercurials, which are particularly toxic and are retained in the cells of plants and living organisms. Recent studies have also reported that the inorganic mercury is transformed into methylmercury through microbial activity, which is the most toxic and most bioavailable form of mercury for living organisms (Pravin *et al.,* 2012). Bodaly *et al.* (1998) have reported that treated sewage water discharged into rivers and similar water bodies could result in an appreciable increase in the build up of alkyl mercury.

The effluents consisting of both domestic and industrial sewage is released into the creeks without any treatment, probable sources of the heavy metals in Industrial creeks of Surat. Untreated industrial and domestic waste water is a serious threat to the organism dwelling in the creek and also for them where the water of the creek emptied into the ecosystem. The results reveal that except Hexavalent Chromium Lead, Cadmium and Mercury exceed the ISQG limits set for the sediment. Higher values were mainly observed at all sites for Hg. These indicate that heavy metal contamination especially Hg, should be taken into account during development strategies to protect the ecosystem from long term pollution load.

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