International Journal Of

Recent Scientific Research

ISSN: 0976-3031

Volume: 7(11) November -2015

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THE OFFICIAL PUBLICATION OF
INTERNATIONAL JOURNAL OF RECENT SCIENTIFIC RESEARCH (IJRSR)
http://www.recentscientific.com/ recentscientific@gmail.com

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 6, Issue, 11, pp. 7372-7376, November, 2015

ISSN: 0976-3031

International Journal of Recent Scientific Research

RESEARCH ARTICLE

LEVEL OF HEAVY METALS IN SOIL SEDIMENTS FROM WETLANDS OF THENI AND DINDIGUL DISTRICTS

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ARTICLE INFO

Article History:

Received 06th August, 2015
Received in revised form 14th September, 2015
Accepted 23rd October, 2015
Published online 28st November, 2015

Key words:

Heavy metals, wetlands, sediments, Theni, Dindigul

ABSTRACT

Samples were collected during December 2010 to March 2011 from the wetlands of Theni and Dindigul districts. Spectroscopic method was used to analyse the samples. The heavy metal concentration in Theni is Cd> Pb > Cr but in Dindigul is Cr>Cd>Pb. The study reveals that Cr and Cd are being high in the wetland sediments. Cadmium showed the maximum among the heavy metals in Theni district where as in Dindigul it is Chromium, which may affect the residents in future.

INTRODUCTION

Wetlands support a wide array of flora and fauna and deliver many ecological, climate and societal function. Scientists often refer wetlands as the "kidneys" of the earth because they function as the downstream receivers of water and waste from both natural and human wastes, the Industrial wastes (Mitsch, 2000). In addition, wetlands provide home for a huge diversity of wildlife such as birds, fish, frogs, mammals, insects and plants (Buckton, 2007). In addition to the habitat variables mentioned previously, other variables related to the characteristics of sediments (organic matter content and particle size) and water quality can also directly or indirectly affect the use of wetlands by water birds. The organic matter content in water and sediments affects the growth of aquatic plants, and determines invertebrate abundance (Rehfisch, 1994).

Industrial wastes, agriculture wastewaters, runoffs and atmospheric deposition are major sources of contamination of many surface waters. Runoffs cause sedimentation problems (Karlsson *et al.,* 2010) in receiving streams, rivers and lakes. They can also transport toxic pollutants into catchments (Globel *et al.,* 2007) with potential transfer to the food chain. The prime stages in leather processing are curing, soaking, liming, bating, picking, degreasing and tanning. The discharges and refuges disposed from all these processing stages in leather production causes severe health hazards and environmental problems to the entire ecosystems (Choudhry *et al.*, 2004). Heavy metals can pose health hazards if their concentration exceeds allowable limits (Shpasyk and Parpan, 2004). The treatment process of industrial waste water like reduction, chemical precipitation, ion exchange, reverse osmosis, ion floatation, evaporation, adsorption settling and clarification are some of the methods to remove heavy metals (Gupta *et al*., 1999 Raj, 2004).

Bottom sediments are sensitive indicators for monitoring contaminants as they can act as sink and a carrier for pollutants in the aquatic environment (Vandecasteel *et al*., 2004). Thus, sediment analysis plays an important role in evaluating pollution status in aquatic environment (Pekey, 2006), Karageorgis *et al*., (2002) and Pekey *et al*., (2004) have found out that various kinds of hazardous and toxic substances were accumulated in sediments of the enclosed and semi enclosed areas. The contaminated sediments had great ecological impacts on wetlands (Ulbrich *et al*., 1997).Living organisms require varying amounts of heavy metals. Iron, Cobalt, Copper, Manganese, Molybdenum, and Zinc. Excessive levels can be damaging to the organism. Other heavy metals such as Mercury, Plutonium, and Lead are toxic metals that have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of animals can cause serious illness (www.wikipedia.com, 2011).

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MATERIALS AND METHODS

Heavy Metals

The study area (Meerusamuthiram Pond, Bangarukulam pond and Thamaraikulam Pond) was divided into three regions as pointed sources. From the pointed sources the soil samples were collected. Study area Sankulam was divided into six regions three as non pointed sources (other than the inlet region) and another three as pointed sources where the let pour sludge into the pond. From the pointed and non pointed sources the soil samples were collected. Collected samples were transferred to polyethylene jars which were cleaned by high quality detergents and nitric acid. The samples were refrigerated until further analysis. The samples were taken out of freezer at the time of analysis and dried at 90^{o}C oven. Ground in a mortar with a pestle and a few grams were taken for analysis. Method suggested by Allen *et al*., (1974) was followed to extract the metals from the sediment samples. Ammonium acetate at pH 7 was as extract. About 200-300ml of distilled water was measured in a large beaker; 575ml of glacial acetic acid and 600ml of 0.88 ammonia solution were added in to the beaker and mixed thoroughly. Later the volume was made up to 10 litters and the pH maintained at 7 with drops of acetic acid or ammonia as necessary. About 10g of air dried and sieved sediment was taken in a conical flask and 250 ml extract was added and stirred in a mechanical shaker for one hour. The contents were allowed to settle for some time and filtered through no 44 Whatmann filter papers in to well clean polyethylene bottles and store in refrigerator till analysis with AAS.

AAS (Atomic Absorption Spectrophotometer)

The choice of method for the determination of heavy metals in the samples depends in the capability to detect extremely low concentration. The latest techniques available are chemical; electrometric and spectroscopic methods (Chandra, 1989) under spectroscopy there are seven techniques namely, Atomic Absorption, Atomic fluorescence, Emission spectroscopy, Flame spectroscopy, x-ray fluoresces, Electron spectroscopy and neutron activation Analysis. AAS has become the mast extensively used equipment for the determination of metals in a wide variety of materials. In this equipment, the element to be analyzed is converted into atomic vapour which in the optical path absorbs monochromatic radiation emitted by a below cathode lamp. The absorption of light is proportional to the concentration of the metal present in the samples according to Beer's Law. Atomic absorption spectrometry works on the principle that neutral or ground state atoms of an element can absorb energy over a service of very narrow wave length. Thus if the light fall on the right wave length impinges on a free ground state atom. The atom may absorb this energy to enter into excited state and the process is called atomic absorption which is explained by Bohr's equation. E1 = E2 + hr i.e., Excited state = Ground state + hr where h is plank's constant and 'r' is frequency of radiation. As the number of atoms in the light path increases, the amount of light absorbed also increases. Light at the resources wave length of initial intensity is focused on the flame cell containing ground state atoms. This initial intensity of light will be decreased by an amount absorbed by the atoms in the cell and then absorbance 'A' can be defined by Beer's law as given below: $A = \log 1_0 / h = abc$ Where 'a' = absorption co-efficient 'b' = length of light path intercepted by the absorption cell and 'c' = concentration & absorption in the cell. The analyses were called our using perk in Elmer model 1100 B Atomic absorption spectrometer. To maintain the analytical quality. Along with every batch of samples, blanks were also ran with the same amount of acids and corrected at the end. Standard solutions were made up in a matrix to match acidity condition in the digestion. Analytical Quality was maintained by all possible mean also duplicate analyses were run on 5% of the samples.

Cadmium (Cd)

Cadmium is a relatively rare metal in the earth's crust, ranking in abundance between mercury and silver. It is silvery white and ductile with a faint blue tinge. The most common mineral containing cadmium is green olkite, obtained as a by product is the refining of zinc and other metals. Cadmium is difficult to separate from zinc and will be present in small amount in commercially available zinc compounds because of their geochemical kinship and incomplete technical separation. It has been implicated as the cause of numerous human deaths and various deleterious effects in fish and wildlife (Cearley and Coleman, 1974; White *et al.,* 1998). Insignificant concentration is toxic to all forms of life, including micro organisms, animals and man (Eisler, 1985). Animals given cadmium in food or water show high blood pressure, iron-poor blood, liver disease, and nerve or brain damage. We don't know if humans get any of these diseases from eating or drinking cadmium. Cadmium salts are more toxic than those of zinc. The department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds may reasonably be anticipated to be carcinogens. This is based on weak evidence of increased lung cancer in humans from breathing cadmium and on strong evidence from animal studies (Wikipedia, 2011).

Chromium (Cr)

Chromium compounds more employed in textile dyeing and leather tanning process. Chromium has three main forms; chromium (0), chromium (III), and chromium (VI). Chromium (III) compounds are stable and occur naturally, in the environment. Chromium (0) does not occur naturally and chromium (VI) occurs only rarely. Chromium compounds have no taste or odder, chromium (III) is an essential nutrient in our diet, but we need only a very small amount. Other forms of chromium are not needed by our bodies. The amount of chromium added to the environment by activities is for greater than the natural process (Eisler, 1980). Chromium merits a special reference for its toxic potential. It is released in the environment from the industries such as electroplating, leather tanning, textile printing and metal finishing. Chromium is one of the important essential elements for plants and animals (Mert and Schwart, 1995). The Department of Health and Human Services has determined that certain chromium (VI) compounds are known carcinogens. This is based on increased lung cancer in some workers who were exposed to chromium.

Animal studies also indicate chromium (VI) is a carcinogen.

Lead (Pb)

Lead is a naturally occurring bluish – gray metal found in small amounts in the earth's crust. It has no special taste or smell. It can be found in all parts of our environment. Most of it came from human activities like mining, manufacturing, and the burning of fossil fuels. Lead affects the red blood cells (Anemia and other effects on the hemopoietic system are the commonest effects) and causes damage to organs including the liver, kidneys, heart, and male gonads, as well as causes effects to the immune system Symptoms are often precipitated by alcohol or exercise. It also affects peripheral airway function and causes lung fibrosis and emphysema. Lead is most soluble and available in water under the conditions of pH, and organic content, and low concentration of suspended sediments, salts of calcium. In surface waters, lead exists in three forms, dissolved labile, dissolved bound and particulate (Benes *et al.*, 1985). The labile forms represent as significant part of the lead input from washout of atmospheric deposits where as particulate and bound forms are common in urban runoff and in industrial effluent (Benes *et al.*, 1985).

RESULT

Heavy metal contaminaton in sediments collected from Tannery Effluent Tank, Dindigul

Heavy metal residues were determined in all the 6 samples collected from Tannery Effluent Tank, Dindigul. The level of heavy metals in sediment collected from two different locations are presented in Chromium recorded the maximum concentration in sediment on Pointed and Non pointed sources followed by Cadmium, whereas Lead showed the minimum concentration. The mean heavy metal in tannery effluent tank decreased following the order Cr> Pb> Cu. To know the variation in heavy metal residues between locations, six samples were collected from both the sites were compared. Metal residues among the location in Tannery Effluent Tank revealed that the sediments from non-pointed source had the maximum load than pointed source (Figure 1). Chromium is a low mobility element, especially under moderately oxidizing and reducing conditions and near-neutral pH values.

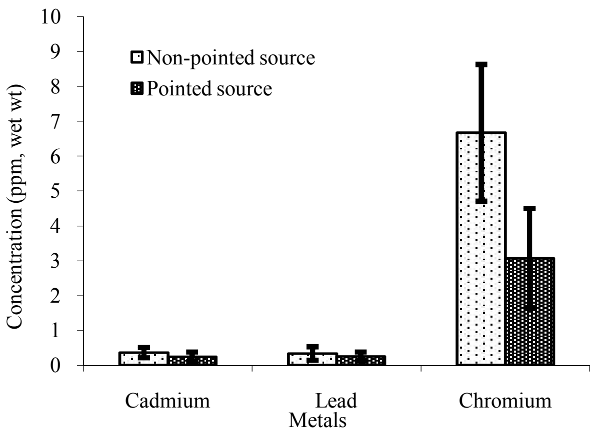

Figure 1 Heavy metal contamination (Mean ± SE) in the sediments collected From Tannery Effluent Tank, Dindigul.

The chromium levels in the study area ranged from 2.76 – 8.97 ppm with an average of 6.67. The normal range of chromium in soil is 100 mg/kg. In Tannery Effluent Tank the results showed that the mean concentration of the heavy metals was lower than potential effect levels.

Heavy metal contamination in sediments collected from Thamaraikulam, Bangarukulam, Meerusamuthram pond, Theni

Heavy metal residues were determined in all the 9 samples collected from Thamaraikulam, Bangarukulam, Meerusamuthram pond, Theni. The level of heavy metals in sediment collected from different locations are presented in Cadmium recorded the maximum concentration in sediment on some Pointed sources followed by Lead, whereas Chromium showed the minimum concentration. The mean heavy metal in Bangarukulam decreased following the order Cd> Pb> Cr, in Thamaraikulam pond Pb> Cd> Cr and the Meerusamuthram pond the order Cd> Pb>Cr. To know the variation in heavy metal residues between locations, 9 samples were collected from 3 sites. Metal residues among the location in Thamaraikulam pond, Bangarukulam, Meerusamuthram pond revealed that the sediments had the maximum load in some pointed sources (Figure 2). The Cadmium levels in the study area ranged from 0.41– 0.209 ppm with an average of 0.085.

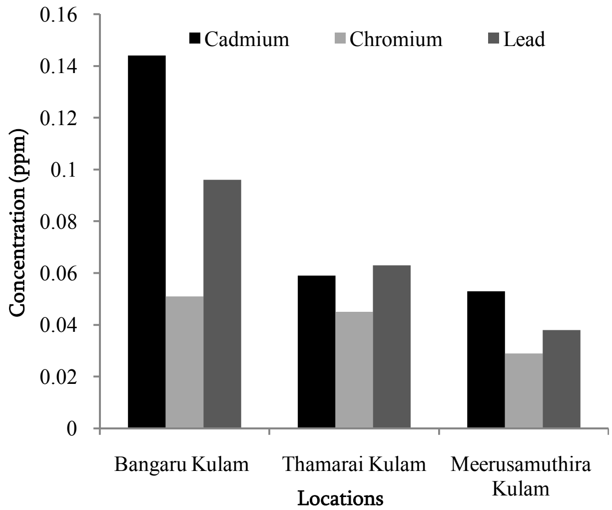

Figure 2 Heavy metal contamination (ppm ; Mean ± SE) in he sediments collected from various ponds in Theni District.

DISCUSSION

Heavy metal residues were determined in the wetlands of Theni and Dindigul Districts. In the present study Chromium, Cadmium and Lead were analysed. In Dindigul District Chromium was recorded as the maximum concentration but in Theni it was in minimum concentration in sediments. The heavy metal levels in tannery effluent tank decreased following the order Cd> Pb>Cr. Chromium is mainly used for leather processing in Leather industry, Dindigul. In Theni it is a non polluted from Chromium. In Theni District Cadmium was recorded as the maximum concentration but in Dindigul it was in minimum concentration. The heavy metal levels in Theni ponds decreased following the order Cd> Pb> Cr. Cadmium is essential metal for human and other organism in trace amount, Usage of fertilizer and other chemicals in the paddy field may be the major source of Cadmium. If Cadmium level increases it may not cause any problems to any organism. Moreover Cadmium levels recorded in the present study are well below the Maximum Residue Levels (MRL). But in the study of Bai *et al*., (2011) reported that the metal levels decreased following the order Pb> Cr> As> Ni> Zn> Cd> Cu from a Typical Plateau Lake wetland, China. The results of Cong Hu *et al.,* (2010) showed that the single risk indices of heavy metals were ranked in the order of Cd > Pb > Ni > Cr in The East Dongting Lake Wetland. Analysis of Pearl river Estuary in South China for the sampling sites showed that among all of anthropogenic pollutions, industrial wastewater was major sources of heavy metals especially for Cd, Cr, Cu and Zn. (Honggang Zhang *et al*., 2015)

Chromium

In Dindigul District the chromium levels ranged from 2.76 – 8.97 ppm with an average of 6.67 but in Theni District the chromium levels ranged from 0.011 – 0.059 ppm with an average of 0.042. The normal range of chromium in soil is 100 mg/kg (Wedepohl, 1995) all the samples in our study area were below the normal range. But the Srinivasa Crowd *et al*., (2010) reported that all the samples were exceeded the normal value in the area of Jajmau (kanpur) and Unnao industrial areas of the Ganga plain, Uttar Pradesh, India. Wetlands of Dindigul District likely to be highly polluted with Chromium. Several health problems are related to Chromium consumption such as chronic ulceration and perforation of the nasal septum and allergic skin reactions (Farag *et al.,* 2006; Goyer, 1986) may arise in future.

Cadmium

In the wetlands of Theni District, the Cadmium level ranged from 0.041– 0.209 ppm with an average of 0.085 but in Dindigul it was 0.08– 0.057 ppm with an average of 0.36. In Theni District. Wetlands are highly polluted with Cadmium. Higher concentration of Cadmium may be because agricultural usage and less samples size. Cadmium and some of its compounds are considered carcinogenic and may cause damage to all types being kidneys and liver (Dodds-Smith, 1992). Among the major sources for Cd concentration by atmospheric deposition are smelting, burning of plastic and fossil fuels and steel mill plants. Municipal sludge also contributes to increase Cd content to soil sediments.

Lead

When compared to Theni District the Lead concentration is high in Dindigul District. The measured concentrations of Pb in the sediment samples in Theni, were in the range of 0.014 – 0.160 ppm with an average of 0.066 and in Dindigul District the range is 0.67 – 0.1 ppm with an average of 0.34. When compared to Theni District, Dindigul District wetlands are highly polluted with Lead. Low levels of Pb were recorded in sediments from study area. Pb is number two in the top 20 list of the most poisoning heavy metals targeting organs like bones, brain, blood, kidneys, reproductive and cardiovascular systems and thyroid gland (Homady *et al*., 2002). In sediments, the Pb despite is found only in small quantities in nature (Adriano, 2001). Pb possessed potential bioavailability because of the association with reducible and oxidizable species and could be released and entered into the food chain in Sediments of Riverine Wetlands Located in the Huaihe River Watershed, China (Hezhong Yuan *et al.,* 2015).

CONCLUSION

Heavy metals contamination in the soil sediments were analysed in the wetlands of Theni and Dindigul districts. In Dindigul district, Chromium is high followed by Cadmium and Lead but in Theni district, Cadmium is high followed by Lead and Chromium. Although controlling measures are taken in the industries, the accumulation of Chromium is high in Tannery Effluent Tank, Dindigul. This could be potentially harmful to the residents in future. Cadmium is high in Theni district which may lead to biomagnifications in future to the consumers.

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How to cite this article:

Kayalvizhi J, Nirmala T and Medona Mary R., Level of Heavy Metals In Soil Sediments From Wetlands of Theni and Dindigul Districts. *International Journal of Recent Scientific Research Vol. 6, Issue, 11, pp. 7372-7376, November, 2015*

ISSN 0976-3031
9 770976 303009 >