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RESEARCH ARTICLE

Status of Heavy Metal Contamination in Nambul River and Some Drainages in Imphal Municipal Areas of Manipur, India

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Abstract: Sediment samples were taken from five collection sites located at different drainages and from a river flowing through the main city market. One collection site is located near dwelling houses about 500 meters away from the market. Sediment samples were analysed for 8 heavy metals using Elemental analysis by AAS-203 method. The results are compared with standard values for the metals prescribed by various agencies. In case of iron, fairly high level of contamination is detected in samples collected from 3 sampling sites. Samples in these sites are found to contain values which are exceeding to the maximum permissible level in wastewater as prescribed by the European Commission (1981 Guide Level). However, other environmental monitoring groups prescribed higher permissible levels of iron in wastewater, more than the amounts detected from all samples. Other sediment samples collected during the present research work contain heavy metal concentrations which are agreeable with the permissible levels regarding the other remaining 7 heavy metals studied. However, the authority concern may take up necessary action to reduce these levels before it may create probable health hazards. The authority may also be advised to monitor the heavy metal contamination in the drainages passing through municipal areas on a regular basis.

Keywords: Imphal municipal council, Dumping ground, Health hazards

Introduction

The contamination of sewages and detritus with a wide range of pollutants has become a matter of concern over the last few decades[1-3], as these are connected ultimately with the human food chain system. The natural aquatic systems may extensively be contaminated with heavy metals released from domestic, industrial and other man-made activities.

Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and a diversity of aquatic organisms[4]. Heavy metals are regarded as toxic to living organisms because of their tendency to accumulate in selected tissues. These elements are introduced into the environment through various routes, smelting processes, fuel combustion, using pesticides in agriculture, industrialisation *etc*. They make their way into aquatic systems, rivers, lakes or oceans through atmospheric fallout, dumping wastes, accidental leaks and runoff of terrestrial systems (industrial and domestic effluents), geological weathering, agricultural chemical use and urban activities of human beings. However, highest concentration of heavy metals and other toxic chemicals are present in the sewages and detritus deposited in canals and small streams and also in dumping grounds of municipal wastes.

In Manipur, all types of domestic wastes and sewages are being dumped either in drainages or in open dumping grounds, which lie in public places like markets or near dwelling houses in cities. The Imphal municipal council is the only governmental agency who takes care of cleaning the waste materials from the city. The cleaning staffs of the council is supposed to collect these materials from the market areas and deposit at dumping grounds, which lie at roadsides at Lamphel. These dumping sites are kept exposed and no one cares for the probable consequences. Heavy metals and other chemicals may be leaching out of these and flow down the nearby canals and finally join to rivers. Due to one or other reasons, the council fails to pick up the wastes regularly and often huge heaps of waste materials lie overflowing down the specially made pits for collection of these materials with all nuisance smells, at different locations in the Imphal city. The obnoxious gases and heavy metals may contaminate with the vegetables and other items sold in the market and in this way, reach the people directly which may cause various health problems.

Some voluntary organisations are coming up to collect domestic wastes from houses by taking small fees for their services, from time to time. But these organisations have no option for further treatment of the collected waste materials and so, simply throw away the wastes at the dumping grounds as done by the municipal council. The workers who are continuously handling these wastages are prone to high risk of contamination with heavy metals and other chemicals which may lead to serious health problems.

Experimental

Sample collection

Sediment samples were collected from five sites on monthly basis for the period from April 2015 to February 2016. The sites are located at (1) Nambul river at Nagamapal (2) Drainage at Lamlong Bazar (3) Drainage at Singjamei market (4) Drainage at ImaKeithel and (5) Drainage near dwelling houses at Khurai.

Analysis of samples

Sediment samples were filtered through 0.45 μm membrane filter (GVS Filter, India polis, IN, USA) into 15 mL centrifuge tubes and the supernatant filtrate was used for further analyses for heavy metals using Elemental analysis by AAS-203 method by the environment research and development laboratory, Manipur. The heavy metals analysed consist of cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb) and zinc (Zn).

Results and Discussion

Heavy metals exist naturally in the soil from various sources including soil forming processes. Metal-containing solid substances at polluted places can originate from an extensive variation of man-made sources in terms of metal mine stakeouts, leaded gasoline and paints that are lead based, application of fertilizer, discarding high metal wastes in inappropriately protected landfills, animal manures, bio solids (sewage sludge), coal combustion remainders, compost, petrochemicals, pesticides and deposition in atmosphere[5,6].

Huge amounts of fertilizers are frequently applied to soils in concentrated farming systems to deliver suitable nitrogen (N), phosphorus (P) and potassium (K). Metals like Cd and Pb have no physiological actions. Certain phosphatic applications unintentionally add Cd and other possibly dangerous elements for the soil, including F, Pb and Hg. Numerous pesticides widely used in agricultural fields contained considerable amounts of metals. Most fungicides were based on complexes containing Cu, Hg, Pb, Mn or Zn. The supply of various bio solids like composts, cattle's manure and municipal sewage sludge (MSS) to land unconsciously points towards the build-up of heavy metals like As, Cd, Cr. Cu and Pb as well as Hg, Se, Ni, Mo, Zn and Sb, in the soil[6].

The supply of wastewater coming from industrial and municipal sources and associated wastes to soil was quite common in different parts of the globe[7]. Long-term watering of land with such wastewater can finally cause heavy metal build-up in the soil. Zhan-Jun[8] *et al.,* reported that physiochemical properties of soils were changed after long-term wastewater application. They detected high accumulation of heavy metals including Cu, Pb, Cd, Zn and Ni in leafy vegetables grown in wastewater irrigated areas. Vegetable wastes discarded in the market places or at dumping sites finally perished and made way to drains.

The present study shows the presence of heavy metals namely, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn (Table 1). The iron levels in Site No. 2 (Drainage at Lamlong Bazar), site 3 (Drainage at Singjamei market) and Site No.4 (Drainage at ImaKeithel) are recorded higher than the values prescribed by European Commission (1981 Guide Level) and are very close to the maximum permissible value prescribed by I.C.M.R. However, the values recorded in these three sites are agreeable to the standard values prescribed by the other agencies. During the study, no alarming situation were found in other sampling sites for the parameters like cadmium, chromium, copper, manganese, nickel, lead and zinc. The extreme values of the parameters are summarized in Table 1. Except iron, recorded in the three sampling sites mentioned above, all the values recorded in case of the remaining parameters were under the permissible ranges according to the ISI Standards, W.H.O and European Commission (1981 Guide Level) for disposal of waste water. A comparison of the maximum values recorded in the present study with those standard values prescribed by various agencies is shown in Table 2. Graphical representations of the comparison of different heavy metals with the prescribed maximum permissible values are also given in Figure 1-4.

Suggestive remedial measures

The use of metals in different fields or purposes is widening day by day. It closely relates to the development of human civilisation itself. It becomes a common problem throughout the world to take up effective measures for controlling heavy metal contamination. However, the following remedial measures would be suggested at least to slow down the drastic effects of heavy metal contamination.

Table 1. Summary of extreme values of heavy metals at different sampling sites found during April 2015 to February 2016

Sampling site	mg/mL							
	Cadmium	Chromium	Copper	Iron	Manganese	Nickel	Lead	Zinc
Site 1	BDL-0.003	BDL-0.004	0.002-0.006	0.030- 0.060	0.001-0.008	BDL-0.001	BDL-0.003	BDL-0.002
Site 2	BDL-0.003	0.002-0.008	0.005-0.012	0.056-0.098	0.007-0.020	BDL-0.002	BDL-0.006	BDL-0.002
Site 3	BDL-0.003	BDL-0.003	0.001-0.006	0.085-0.099	0.001-0.003	BDL-0.001	BDL-0.003	BDL-0.002
Site 4	BDL-0.003	0.003-0.006	0.004-0.008	0.085-0.099	0.018-0.030	BDL-0.003	0.004-0.018	0.002-0.006
Site 5	BDL-0.002	BDL-0.002	0.003-0.007	0.035-0.060	0.002-0.007	BDL-0.002	BDL-0.003	BDL-0.002

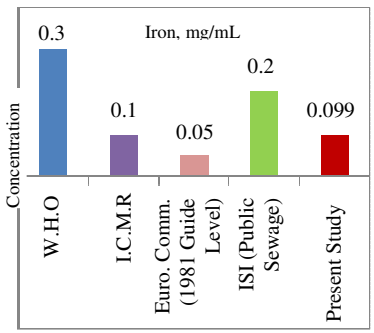

Figure 1. Comparative Iron level with standard values

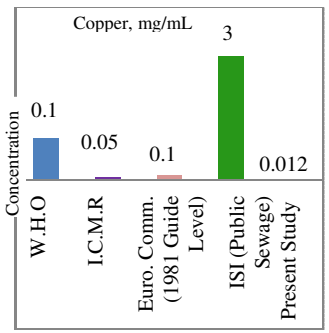

Figure 2. Comparative Copper level with standard values

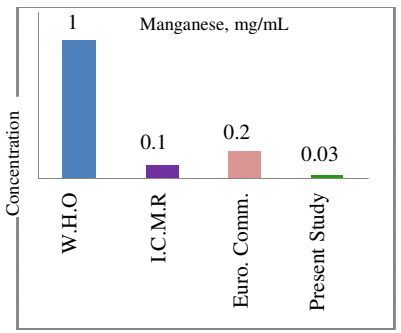

Figure 3. Comparative Manganese level with standard values

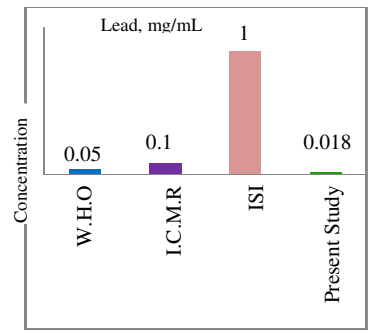

Figure 4. Comparative Lead leve with standard values

Table 2.Comparison of Water Quality Guidelines for domestic uses with values recorded (values are in ppm)

Heavy metals	W.H.O.	I.C.M.R. Permissible	European Commission (1981 Guide Level)	Maximum Permissible Concern	ISI standards for disposal of wastewater (Public sewage)	Maximum value recorded during the study period
Cadmium	--	--	--	--	2.0	0.003
Chromium	0.05	--	--	0.05	2.0	0.008
Copper	1.0	0.05	0.1	--	3.0	0.012
Iron	0.3	0.1	0.05	0.2	--	0.099
Manganese	1.0	0.1	0.2	0.2	--	0.030
Nickel	--	--	--	0.05	--	0.003
Lead	0.05	0.1	--	0.05	1.0	0.018
Zinc	5.0	5.0	0.1	--	15.0	0.006

Controlling indiscriminate use of pesticides and fertilizers

Application of pesticides and fertilizers in large amounts more than the prescribed rates should be checked. We should replace the use of chemical pesticides and fertilizers by substances made of organic matters.

Pre-treatment plant of solid wastes

Municipal wastes consist of varieties of organic as well as inorganic substances. It is high time to undergo pre-treatment of these solid wastes before their final exposure to the environment. Pre-treatment plants for solid wastes and sewages should be established at proper sites adequately.

Wastewater treatment

Direct irrigation with waste water from industrial and municipal sources should be checked. Such water should be allowed to store in settlement tanks atleast for adequate period of time. Waste water treatment systems separate and neutralise organic contaminants. Biological and electrolytic wastewater treatment plants can be used effectively. Secondary treatment process can be done for wastewater to achieve certain degree of effluent quality by using a sewage treatment plant with physical phase separation to remove settleable solids and a biological process to remove dissolved and suspended organic compounds.

Conclusion

The present study indicates that there is excessive iron contamination in three collection sites. The values recorded in these sites exceed the values prescribed by the European Commission and very close to the maximum permissible value prescribed by I.C.M.R. The authority concern may take up necessary action to reduce these levels before it may create probable health hazards. The authority may also be advised to monitor the drainages passing through municipal areas on a regular basis so that it could reduce the input of pollutants in terms of solid and liquid wastes.

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