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Studies of Chemical Contamination and Toxic Pollutants in West Delhi-India

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The high urbanization and industrial growth rate in Delhi city have made it one of the most densely populated regions of India. This has resulted in an increase in the levels of environmental pollution from uncontrolled industrial effluents. The field investigation of chemical contaminants (Hg, Cd, Cr, Pb, Ni, Fe and Zn) and pesticides parameter were determined in underground water, drains, Yamuna river, aquatic plants and soils during the seasons (July–December) of 2001–2002. Nine samples of each reference sample and underground water samples, soils attached aquatic plant samples were collected from Yamuna river, near industrial effluent discharges along 35 km of located surface streams and drains which receive effluents from three major industrial areas. Contents of most parts of metals in soils, water and aquatic plants significantly correlated with each other and either a significant stimulatory or inhibitory effect on seedling plants. A variety of inorganic and organic analytes were detected in river soils and aquatic plants. Toxicity occurred downstream at 5 of the 6 sampling stations based on phytotoxivity and physical appearance of plants and invertebrate survival. The concentration of Hg is higher in drains and underground water found to be 21.5 and 1.5 μg/L respectively..

Key Words: Chemical Contamination, Toxic pollutants.

INTRODUCTION

In Delhi, surface water resources such as rivers and ponds are the main source of water supply in the city. Approximately 65% of ground water in Delhi require purification before use, 33% need constant monitoring and only 2 per cent is found absolutely safe for consumption. The growing industrial sector and ensuing immigration of people pose a heavy burden on the city infrastructure that did not grow in proportion to sanitation. The city also does not have facilities for appropriate treatment of industrial, municipal, domestic and hospital wastes. The prevailing drainage and sewerage systems are open type joining the Yamuna river without appropriate treatment[1,2]

In Delhi city, industrial effluents, agricultural waste and municipal wastewater cause the pollution. The industrial effluent is discharged in Yamuna river and drains which in turn increases the pollution level, *i.e.*, pollution degraded in underground water, causes toxicity (lethality) of aquatic animals and plants[3,4].

Heavy metals are considered as the industrial pollutants while agriculture waste affects the biosphere. In contrast to organic and inorganic pollutants, they cannot be degraded and thereby accumulated in compartments of ecosystem (biomagnifications), underground water, plants and living organisms[5, 6]. Most heavy metals are supposed to be accumulated by aquatic plants and animals pose toxic effects at high trophic levels, including human beings[7, 8]. Besides it is important to collect and compare information on particular concentrations. Some of these pollutants are very persistent, whereas others are more susceptible to physical, chemical and biological transformation[9]. Contaminated water has been shown to adversely affect plants, invertebrates and influence the environmental condition of other biota[10]. The environmental concern associated with the recycling of industrial wastewater and municipal sewage is the potential migration, adsorption-desorption of heavy metals in soils and toxic compounds to the plants and into the aquatic environment.

EXPERIMENTAL

The locations of sampling station are shown in west Delhi city; four blocks sampling sites covering the 35 km stretch of industrial sites have been selected for the study of samples. The flow of water from Najafgarh, Kanjhawala and Alipur areas of west Delhi drain at extreme downstream station city block, is in the proximity of the wastewater discharge points of major industrial activities.

The water samples were collected in sterilized bottle and analyze various chemical and heavy metals in samples[11]. The pH measured by pH meter (Model Systronics 214) and conductivity by conductivity meter (Model Systronics 100). The anion concentrations (NO_3, SO_4, F and PO_4) of the samples were determined with an Auto Chemistry lon Selective Electrode Model 960 (USA). To determine metal contents in water samples, 5 mL of analytical grade concentrated HNO_3 was added to 50 mL of the samples. After digestion of insoluble materials at 80°C for 10 h, the contents of Hg, Cd, Cr, Pb, Ni, Fe and Zn in the water samples were analyzed with an atomic absorption spectrometer.

For elemental analysis, water samples were acidified with 2% nitric acid. Samples were divided in half parts; one portion of each was spiked with known concentration of the analytes in question in order to determine per cent recovery. Blanks and samples were analyzed by atomic absorption spectrometer (AAS 3100 and FIAS 100, Perkin-Elmer, USA). The instrument was standardized frequently (every five samples) with matched standards (Merck, Darmstadt, Germany). Standardization was verified with appropriate external standard. Analyte recovery in spiked samples ranged from 90 to 100%.

RESULTS AND DISCUSSION

Hg, Cd Cr and Pb are highly toxic metals to human even in low concentrations. The heavy metals in ground water except iron, which is present in appreciable concentration in ground water, have been below the prescribed permissible limit. Iron in ground water samples was found in concentration ranges between 0.39 and 19.45 mg/L. The presence of Hg, Pb, Cr and Cd was observed in higher concentrations than permissible limits of WHO. The concentration ranges of Ni and Zn were found well below the permissible limits.

City Block

The presence of cadmium in groundwater samples was relatively high in comparison to other blocks. The Cd range is found between NT to 1.70 μg/L in these samples. The level of various heavy metals in ground water Pb/Ni/Fe/Zn was 50/300/1900/2000 μg/L respectively. The location and sources of ground water depicting excess concentration of heavy metal beyond prescribed permissible limit. The drinking water is not suitable because of presence of Cr and Pb heavy metals. The ground water of Munirika, UPSC, Sarita Vihar and Vasant Enclave contains excess of heavy metals. The sulphate/nitrate concentration in ground water was 7.0–2065/1.5–1590 mg/L. While fluoride/phosphate concentration ranges in ground water 0.12–12.55/0.05–0.40 mg/L respectively.

Block Alipur

In block Alipur, a total number of 35 samples were analyzed for metals in which 54.28% samples have depicted cadmium as not traceable. While there was presence of cadmium in 16 samples, which ranged between not traceable (NT) up to 0.70 μg/L. Alipur block of ground water is contaminated by chromium (14 μg/L) and lead (140 μg/L) and these values are recorded at Khempur, Mamurpur and Samaypur.

The maximum value was recorded at a hand pump located at Burari. The sulphate/nitrate concentration in ground water was found to be 39–1145/0.06–275 mg/L. While fluoride/phosphate concentration range in ground water was 1.5–84.9/0.50–2.20 mg/L respectively.

Block Kanjhawala

The value of cadmium in ground water samples ranged between NT to 0.06 μg/L in the block. The maximum value was reported from a hand pump at Sauda. In this block 60.86% groundwater samples have indicated presence of cadmium but within prescribed permissible limits indicating that cadmium is not a problem parameter, with reference to ground water quality viewpoint. The sulphate/nitrate concentration in ground water 52–2325/0.01–852 mg/L. While fluoride/phosphate concentration ranges in ground water 0.08–10.5/0.03–0.39 mg/L respectively.

Block Najafgarh

The cadmium ranged between not traceable to 14.0 μg/L. The range of concentration is highest amongst all the blocks. The maximum value was recorded from a hand pump at Mandela Khurd where nickel content was also reported quite high, suggesting the possibility of contamination from overlying surface source or from a process discharge. The value was 1.5 times higher than the BIS permissible limt, while 4.7 times higher than the prescribed WHO guideline value of 3.0 microgram per litre.

The locations and sources of ground water depicting excessive concentration of heavy metal beyond prescribed maximum permissible limit of Cd and Pb 140, 238 μg/L. The sulphate/nitrate concentration in ground water 38–950/10–688 mg/L. While Fluoride/phosphate concentration ranges in ground water 0.25–11.50/0.11–7.6 mg/L respectively.

PHYSICO-CHEMICAL DATA IN DRINKING WATER (mg/L) OF DIFFERENT BLOCKS

Parameters	City	Alipur	Kanjhawala	Najafgarh
pH	7.6	8.56	8.46	8.45
EC	10600	7900	9920	13200
Nitrate	1590	275	852	688
Sulphate	2065	1145	2325	950
Fluoride	12.55	84.9	10.5	11.5
Phosphate	0.40	2.20	0.39	7.6

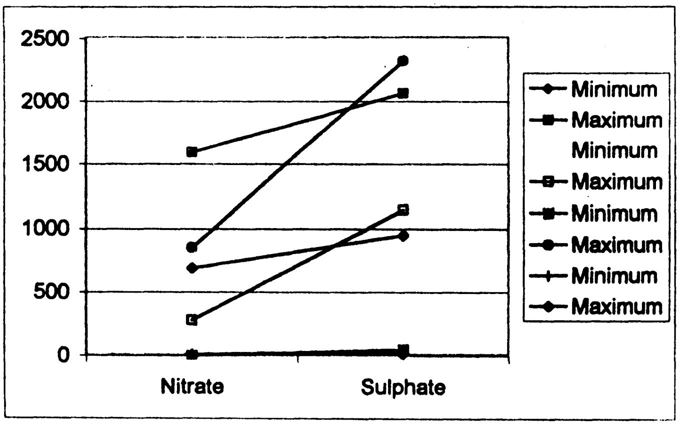

Fig. 1. Comparison of the nitrate and sulphate concentrations

HEAVY METAL CONCENTRATION OF DRAINS OF DIFFERENT BLOCKS

Parameters	City	Alipur	Kanjhawala	Najafgarh
Hg (μg/L)	1.45	12.5	0.85	—
Cd (μg/L)	140	2.70	5.60	114.0
Cr (μg/L)	180.0	630.0	150.0	210.0
Pb (μg/L)	538.0	438.0	239.0	838.0
Ni (μg/L)	692.0	805.0	423.0	361.0
Iron (mg/L)	79.47	37.52	47.22	65.85
Zn (mg/L)	531.4	52.99	13.14	5.6

The heavy metals are continuously released into the aquatic environment from natural process such as geological metamorphosis, weathering of rocks, soil bacterial activities, but the anthropogenic activities like chemical, metal processing, electroplating, metal polishing and cleaning, paint manufacture, battery manufacture and mining etc. have greatly increased the mobilization of most metals into the environment components.

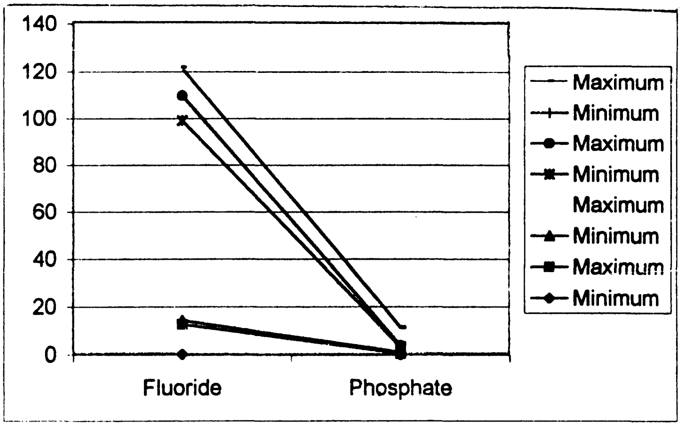

Fig. 2. Comparison of the concentration of fluoride and phosphate in ground water

HEAVY METAL CONCENTRATION OF DRINKING WATER OF DIFFERENT BLOCKS

Parameters	City	Alipur	Kanjhawala	Najafgarh
Hg (μg/L)	0.45	0.08	0.08	0.80
Cd (μg/L)	14.00	0.70	0.60	14.00
Cr (μg/L)	140.00	60.00	50.00	20.00
Pb (μg/L)	238.00	38.00	39.00	238.00
Ni (μg/L)	292.00	105.00	123.00	161.00
Iron (mg/L)	19.47	7.52	17.22	5.85
Zn (mg/L)	3.14	2.99	3.14	0.06

Detection limits: Lead = 0.5 μg/L, mercury = 0.5 μg/L, nickel = 0.5 μg/L, cadmium = 0.5 μg/L, zinc = .005 mg/L

The toxicity of metal in water depends on the degree of oxidation of given metal ions together with the forms in which it occurs. The ionic form of metal is the most toxic form but the toxicity is reduced if the ions are bound into complexes with natural organic matter such as fulvic and humic acids. Under certain conditions, metallo-organic low molecular compounds formed in natural waters exhibit toxicities greater than the uncombined form. The ground water often occurs in association with geological material containing soluble minerals; higher concentration of dissolved salts containing metals are normally expected in ground water. The types and concentration of salts depend on the geological environment, sources and movements of water.

The heavy metals can cause bio-chemical effects such as inhibition of enzymes, genetic damages and hypertension. Some heavy metals are carcinogenic. There are evidences that the presence of heavy metals in excessive concentration in potable water is associated with chronic diseases. The mortality from various types of cancer and concentration of several trace elements in water supplies has also been reported.

The toxic heavy metals manifest a gradual increase in their concentrations in drains, while they contaminate ground water in City, Okhla, Alipur, Najafgarh and Kanjhawala blocks. The drinking water is not suitable for consumption because it violates the permissible limits of WHO.

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