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Effects of Industrial and Agricultural Activities on Properties of Groundwater

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ABSTRACT
Investigation of groundwater has been carried out on the objectives of evaluating water quality and to check the impacts of industrial and agricultural activities on the properties of groundwater. The paper presents the heavy metals characteristics of groundwater along the Ghaggar River in lower Siwaliks region. Groundwater sampling was done from different sources viz. tube wells, hand pumps, bore wells and open wells. The study has revealed that chaotic disposal of the wastewater has changed the groundwater properties of the area. In many groundwater samples high concentrations of cadmium (Cd), iron (Fe) and lead (Pb) were reported. Changed groundwater properties may be due to industrial and agricultural activities. This research may be serving as a reference data for further studies on the assessment of water quality in the study area. Since this region depends heavily on these underground water resources as means of their portable water supply.
Keywords: *Groundwater, Industrial, Properties, Wastewater, Agricultural*

INTRODUCTION

Changes in properties of groundwater are caused directly or indirectly by various activities of man. Direct influences start from natural or artificial substances which are introduced by human being into the geochemical cycle of the earth. Ultimately they reach the groundwater zone. Polluted groundwater defined as groundwater that has been affected by man to the extent that it has higher concentrations of dissolved or suspended elements than the maximum permissible concentrations fixed by national or international standards for drinking, industrial or agricultural purposes. Sometimes natural groundwater (not influenced by man) may contain constituents above the prescribed limits then pollution should be defined in these cases as increase in the concentration of the respective constituent above its natural variations [1]. Mineral fertilizers, pesticides and municipal and live stock farms effluents contain heavy metals. Many of these elements such as cadmium, mercury, copper and lead are toxic even at low concentrations. The main sources of groundwater contamination are industrial, municipal and agricultural wastes (both solid and liquid), rocks, sludge and slimes, refuse, pesticides, herbicides, effluents from livestock and poultry farms [2]. Many pollutants are even able to penetrate into groundwater aquifers. In our selected research area, various types of industries like fruit processing industries, small scale electroplating industries, pharmaceutical industries, distilleries, paper industries and electronic industries are located and discharging wastewaters. In last two decades this area has seen the tremendous growth in industrial and agricultural sectors. Various workers have also reported that disposal of treated and untreated industrial wastewaters along with indiscriminate uses of heavy metal containing pesticides, fertilizers, herbicides and fungicides in agriculture activities had resulted in deteriorated water quality [3-5]. The groundwater quality of this area has also been studied in terms of physical and chemical parameters [6]. Some trace metals are vital for physiological functions of living tissue and regulate various biochemical processes. Synthetic chemicals such as pesticides, herbicides and insecticides as well as fertilizer runoffs from agricultural lands and industrial discharge have the potential to impact human health harmfully since they block essential metabolic processes in body [7].
Keeping this in view, the present study was carried out to check the effects of industrial and agricultural activities on the groundwater properties in terms of heavy metals concentrations.

MATERIALS AND METHODS

Groundwater sampling was done from different locations spreading over Haryana and Punjab region in lower Siwaliks. The chosen research area lies between North latitudes 30°00′00″ to 30°50′00″ and

East longitudes 76°11′24″ to 77°07′20″. Groundwater samples were analyzed for some trace elements such as lead (Pb), copper (Cu), mercury (Hg), iron (Fe), zinc (Zn) and cadmium (Cd). The samples were collected during September month of 2006 in narrow mouth hard polyethylene bottle of 250 ml capacity. The collected water samples were acidified using 2 ml of concentrated HNO_3 in order to preserve the metals and to avoid the precipitation. Determination of water samples was carried out according to the standards fixed by APHA [8] by using atomic absorption spectrophotometer (AAS).

RESULTS AND DISCUSSION

Table 1 Results of heavy metals analysis

S. No.	Parameter → Location ↓	Source	Cd	Zn	Fe	Cu	Pb	Hg
1	Badisher-Koti	HP	0.080*	0.227	0.195	ND	ND	ND
2	Bijdoli-Ki-Doli	HP	ND	0.285	1.060	ND	ND	ND
3	Thapali-Narda	OW	ND	0.344	0.195	ND	0.141	ND
4	Burjkotian	HP	0.013	0.087	0.199	ND	0.034	ND
5	Panchkula S-3	BW	ND	ND	0.339	ND	ND	ND
6	Mubarkpur-Camp	HP	0.040	0.016	0.483	ND	0.058	ND
7	Bhankarpur	HP	0.013	0.044	1.080	0.071	ND	ND
8	Manouli-Surat	HP	ND	0.387	0.765	ND	ND	ND
9	Devinagar	HP	0.080	0.060	0.339	0.098	ND	ND
10	Utsar	HP	0.113	0.057	0.601	0.062	ND	ND
11	Surala	HP	0.747	0.080	0.339	ND	ND	0.076
12	Maru	HP	0.113	0.080	0.856	0.677	ND	0.080
13	Devigarh	HP	0.013	0.095	2.123	ND	ND	ND
14	Mohamdpur	TW	0.113	0.079	0.628	ND	ND	ND
15	Sarala	TW	0.080	0.119	0.411	ND	ND	ND
16	Ratanheri	TW	0.247	0.137	ND	ND	ND	ND
WHO (2004) Standards			0.003	0.01-3.0	0.3	2.0	0.01	-

* Each value is mean of three replicates, ND = Not detectable, HP= Hand pump, BW = Bore well, TW = Tube well, OW = Open well
All parameters are expressed in ppm

Table 2: Trace elements tolerance limit for irrigation water (after FWPCF, 1968 and Ayers and Branson, 1975)

Elements	FWPCF (1968)		Ayers and Branson (1975)	
	Continuous	Short term in fine textured soil	Continuous	Short term in fine textured soil
Cd	0.005	0.050	0.01	0.05
Zn	05.00	10.00	2.00	10.00
Fe	-	-	5.00	15.00
Cu	00.20	5.00	0.20	05.00
Pb	05.0	10.00	5.00	10.00
Hg	-	-	-	-

Effects on drinking

The analyzed results of groundwater samples are given in the Table (1). Cadmium is ranged from 0.013 to 0.747 ppm. At 75% stations groundwater had crossed the prescribed limit of WHO [9] for drinking and water was not found fit for drinking. Zinc contents can also enter the groundwater or even in the domestic water from deterioration of galvanized iron and de-zincification of brass. Concentration of zinc ranged 0.016-0.387 ppm. Zinc contents remained well within the prescribed range. In our study, iron concentration varied from a minimum of 0.195 to a maximum of 2.123 ppm. 75% sampling stations exhibited iron concentration above the prescribed limit of drinking. Iron contents crossed prescribed limit and hence, water was not suitable for drinking as such and its use may initiate complex health hazards. The compounds of copper are uncommon in natural waters but they can enter into the drinking water through the copper supply pipes or through the percolation of copper rich effluents to soil strata and then to groundwater. Copper ranged from 0.062 to 0.677 ppm. About 75% locations did not show copper concentrations and remaining 25% sampling sites showed concentration within the range.

The concentration of lead in groundwater depends upon the chemistry and texture of the soil profile because of the high affinity of the metal for adsorption. Soil chemistry plays a significant role in the circulation of lead in groundwater. In our study, concentration of lead varied from 0.034 to 0.141 ppm. At nearly 81% stations lead contents were found below the detectable limit. At three stations it had crossed the maximum permissible limit for drinking. Mercury contents were present only at two sites. 88% sites showed mercury contents below the detectable limit. Toxic effects of inorganic Hg compounds are seen mostly in the kidney [10].

Effects on irrigation

The suitability of groundwater samples in terms of trace elements was checked by comparing the results with prescribed tolerance limits of FWPCF [11] and Ayers and Branson [12] for irrigation. Cadmium is released to the surrounding through waste water and diffuse type of pollution is done by fertilizers and local air pollution. Cadmium is normally less toxic to plants but at increased level it reduces the plant growth. Based on FWPCF and Ayers classification, 50% stations groundwater was not found fit for irrigation even for short term in case of cadmium concentration. In our study, cadmium level was found high at most of the stations and cannot be used continuously.

Zinc is one of the essential nutrients for plants growth. But at higher concentration it may be detrimental in acidic soils. Zinc level remains well within the prescribed tolerance limits and is suitable for irrigation even for continuous term. Iron level shows its utility for irrigation and remains well within the prescribed ranges. Groundwater was suitable for irrigation even for long term in almost all the sites in terms of copper concentration. At one location groundwater was found unsuitable for long term use in terms of copper concentration. Some leafy vegetables such as beans, spinach, lettuce and potatoes are more likely to absorb lead if irrigated with lead polluted wastewater. In study area, lead level was found within the prescribed tolerance limits.

CONCLUSION

Results clearly indicated that the groundwater properties have been adversely affected. The deterioration in water quality is reflected through increased concentrations of cadmium, Iron and lead. Groundwater was found unsuitable even for irrigation purpose as far as cadmium concentration is concerned. The possible cause of groundwater pollution in this region is contamination from discharge from municipal and industrial effluents along with wide-ranging agricultural wastes. A central groundwater board (CGWB) has also found industrial and municipal wastes responsible for groundwater pollution of this region [13]. For accurate evaluation of effects of man's activities on groundwater properties requires information of natural background concentrations also [14].

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