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SOME TRACE ELEMENTS INVESTIGATION IN GROUNDWATER AROUND INDUSTRIAL BELT OF ROPAR BLOCK, RUPNAGAR DISTRICT, PUNJAB, INDIA

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ABSTRACT

This paper deals with short review and the determination of five heavy metals viz. Fe, Hg, Pb, As and Cd in the groundwater of Ropar Block of Rupnagar District, Punjab which is also the industrial belt of the district. All activities carried out on the groundwater whether associated with urban, industrial or agricultural activities have impact on groundwater resources. Large scale concentrated source of pollutants such as industrial discharge and subsurface injection of chemicals and hazardous substances are obvious source of groundwater pollutants. The samples were collected from 15 locations from tubewells and handpumps at varying depths around the industrial belt. The analysis was done with the help of Atomic Absorption Spectrophotometer (AAS). Results obtained are compared with safe limits in ppm for heavy metals laid down by WHO (1993). The investigations reveal that most of the study area is highly contaminated due to the presence of Iron which has rendered nearly 95% of the water samples tested, non potable.

INTRODUCTION

The rapid pace of industrialization that has recently become the need of the hour for a developing country like India has turned into a major source of groundwater contamination. Huge inputs of pollutants have been taking the pollutants' level beyond the absorptive capacity of the environment. The industries that induce the pollutants into the groundwater resources from their activities do not strictly regulate their pollutants to safe limits. Most of the industries discharge their effluents without proper treatment into nearby open pits or pass them through unlined channels, which move towards the low lying depressions on land, resulting in the contamination of groundwater (Puranadara and Varadarajan, 2003). The industrial effluents if not treated and properly controlled, can pollute and cause serious damage to the groundwater resources (Shankar *et al*. 2008).

Ropar block of Rupnagar District is the fastest growing city of the Punjab state. This growth has taken toll on the geological resources in the city and groundwater is primarily bone such resource. With the surface water supplies getting exploited, groundwater becomes the only alternate source of good quality water. But there are problems of groundwater contamination in certain parts of the city, particularly the industrial belt. A good number of Industries of differ-

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ent types have been established in the conburation of Ropar Block, which has been loading the environment with ever increasing levels of pollutants. These pollutants may enter the soil/water and degrade the quality of groundwater. The groundwater and the pollutants that it may carry move with such a low velocity that it may take considerable time for the contaminants to move away from the source of pollutants. Once the groundwater is contaminated, it may remain in unusable or even hazardous condition for decades or even centuries (Mishra *et al*. 2005)

Recently, the Central Groundwater Board carried out studies on groundwater quality in Rupnagar District covering major industrial belts and reported that the groundwater was slightly alkaline in nature and the groundwater occurring in these belts showed excessive contamination due to Iron (CGWB, 2007).

STUDY AREA

District Rupnagar in Punjab is part of the kandi belt of the Himalayas and the alluvial plain of the river Sutlaj covering an area of 2680 sq. km. It is situated in north-eastern part of the Punjab state lying between 30^0 34′ to 31^0 26′ N latitude and 76^0 17′ to 76^0 52′E longitude. Physiographically there are main four units: Siwalik Hills, valleys, piedmont plain and alluvial/ flood plain. Siwalik hills have general slope ranging from 25 to 60 percent and most of the hill area is under forests. The piedmont plain covers large area with slope 1 to 6 percent, which is frequently intercepted by choes. This area is partly cultivated and partly under forests and wastelands. The alluvial/ flood plain is marked with the confluence of Sutlej and Sirsa rivers with 1 to 3 percent slope. Most of the area is under cultivation and is used for growing common agricultural crops. The study area falls under semi arid (sub moist) and less hot zone of Punjab. It experiences two wet periods (mid December to mid February and mid June to mid September). The mean annual rainfall in the district is about 862 mm and major portion of it is received during the monsoon season with few showers during winter. The peak of the temperature (37.6^0 C) is observed during the month of June and January is the coldest month with mean monthly temperature falling to 7.1^0 C. Ropar Block of the district with total area of 387 sq kms is the industrial belt of the district. Major source of water for drinking, domestic industrial purposes is groundwater and its quality is getting degraded due to industrialization in the area. In view of the importance for the formulation of a baseline data, an investigation has been conducted to access the toxicity of groundwater for drinking purpose.

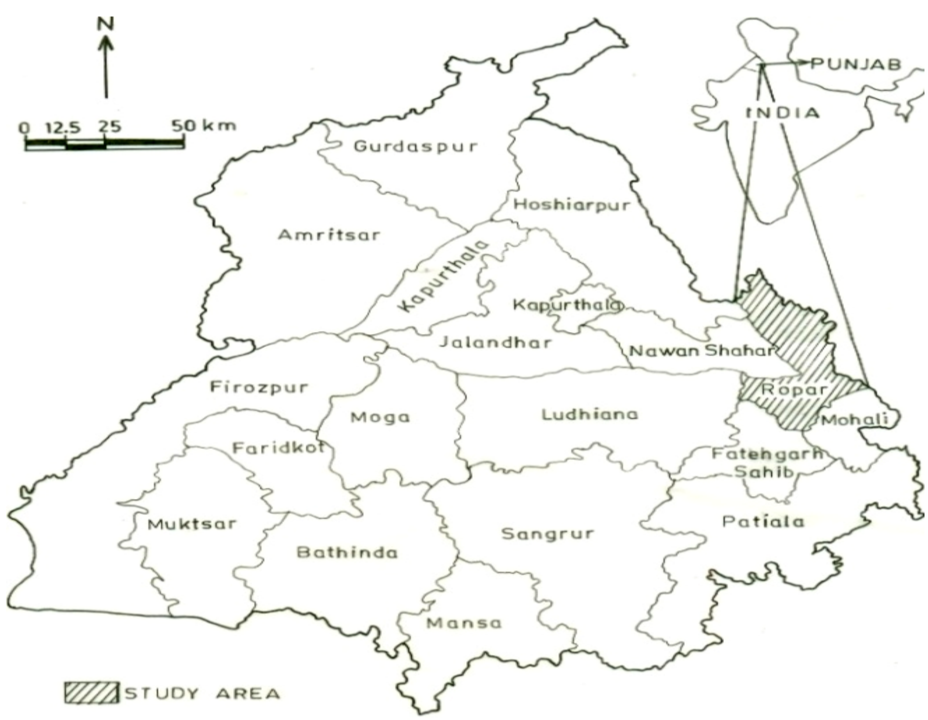

Fig 1a Showing Rupnagar District in Punjab State

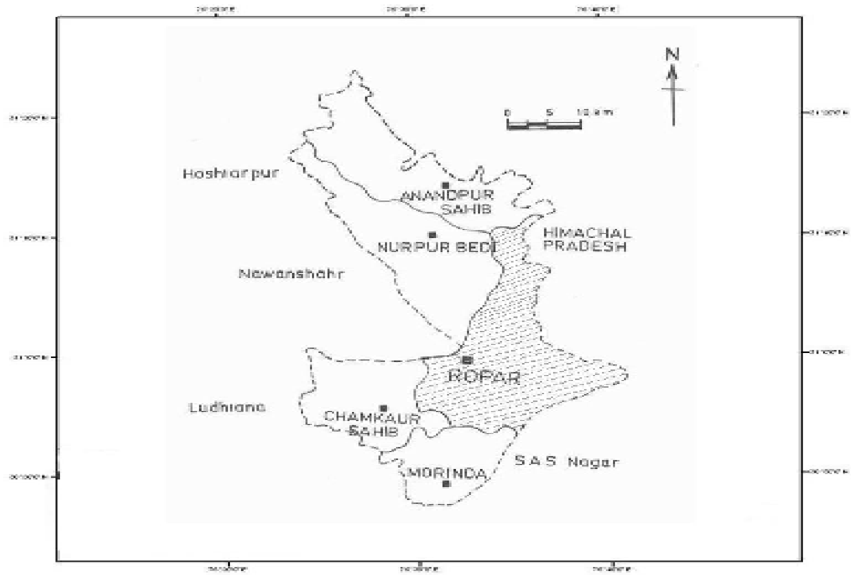

Fig 1b- Location of the Study Area

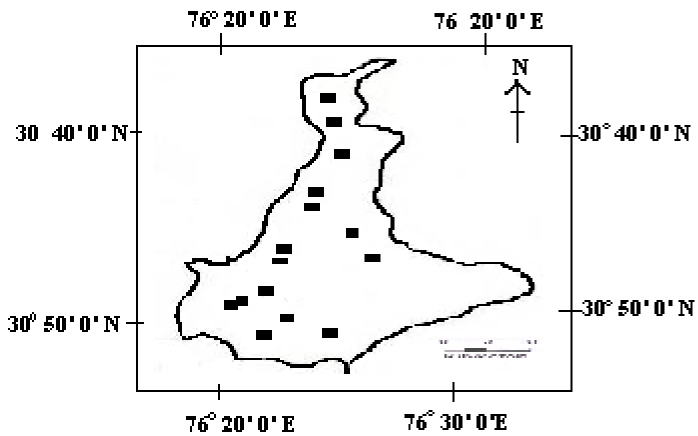

Fig 2. Showing Sampling Locations for Groundwater

WATER RESOURCES IN THE STUDY AREA

Groundwater is the only source of drinking water supply; its quality is degrading due to increasing industrialization and urbanization (Arora, et al, 1985). Depth of groundwater in the study area varies from place to place. The depth to block varies from 8.61 m.b.g.l to 3.43 m.b.g.l.

MATERIALS AND METHODS

Groundwater samples from 15 locations were collected from the industrial belt of the Ropar Block block of Rupnagar district. Samples were collected from Tubewells and Handpumps at varying depths (Fig. 2). Samples were collected in clean polyethylene bottles by following sampling routines set for water quality studies (Hem, 1959). Only analytical reagents grade chemicals were used. Atomic absorption Spectrophotometer was used for the determination of all the trace elements. Resonance lines and hallow cathode lamps of respective metals were used and the instruments was optimize for maximum response. Air and acetylene were used as oxidant and fuel respectively.

RESULTS AND DISCUSSION

The distribution of trace metals in the study area have

Table 1. Showing the range values of heavy metals in the groundwater of Ropar Block and the WHO (1993) drinking water quality guideline values

S.No.	Villages	Type	Depth (mtrs)	Fe (ppm)	Hg (ppm)	As (ppm)	Cd (ppm)	Pb (ppm)
1.	Nohan	HP	42	0.614	0.002	0.000	0.021	0.000
2.	Rangilpur	HP	18	0.234	0.002	0.000	0.02	0.000
3.	Bahadurpur	HP	8	0.420	0.001	0.000	0.001	0.000
4.	Chaunta	TW	49	0.74	0.002	0.000	0.001	0.001
5.	Sangatpur	TW	20	2.01	0.000	0.000	0.02	0.001
6.	Rampur	TW	24	0.48	0.000	0.000	0.000	0.01
7.	Ghanaula	TW	24	3.01	0.002	0.000	0.002	0.02
8.	Indarpur	TW	24	1.62	0.001	0.000	0.000	0.02
9.	Bharatgarh	HP	12	0.55	0.000	0.000	0.000	0.001
10.	Bunga	HP	11	0.43	0.000	0.000	0.000	0.000
11.	Singpur	HP	15	0.23	0.000	0.000	0.000	0.000
12.	Katli	TW	29	0.62	0.000	0.000	0.000	0.000
13.	Sati	TW	55	0.23	0.000	0.000	0.000	0.000
14.	Phulpur	TW	42	0.20	0.000	0.000	0.000	0.000
15.	Manpur	HP	20	0.68	0.001	0.000	0.000	0.000

TW - Tubewell, HP - Handpump

been depicted in Table 1 respectively. Safe limits in ppm as per WHO for drinking purpose use of groundwater are shown in Table 2. The occurrence of trace elements in natural waters is affected both by hydrochemical factors like mineral composition of the rocks, soil characteristics etc as well as by anthropogenic activities and likely to show both temporal and spatial variation. Iron is essential to the human body and its intake through drinking water is normally an insignificant portion of the body requirement (Freeze and Cherry, 1979). The common form of iron for the groundwaters in the Study area is the soluble ferrous ion (Fe^{2+}). When exposed to the atmosphere, Fe^{2+} is oxidised to Fe. In this state it hydrolyses and precipitates as ferric hydroxide, causing a brown discolouration of the water and the characteristic brown stains in sinks and laundered textiles. In addition, Fe^{3+} imparts metallic taste to the water. The maximum permissible concentration of 0.3 ppm (WHO, 1993) in drinking water is primarily for reasons of taste and avoidance of staining of sinks and laundered textiles. However, an upper limit of 1.0 ppm should suffice for most purposes (WHO, 1993).Iron apparently is the most problematic minor ion associated with the groundwaters in the Study area. In 100 % of groundwater samples within the area have total iron concentration greater than 0.3 ppm where as in some samples it crossed concentration above 1mg/L. In the study area Iron concentration varies from 0.20 ppm to 3.01 ppm which shows that water is contaminated by Iron.

Lead may occur in association with sulphides. In the Ananadpur Sahib Block, concentration of lead varies from 0.0 ppm to 0.02 ppm. In majority of the samples lead is below detection limit. High lead concentrations result in metabolic poisoning that manifest in symptoms such as tiredness, lassitude, slight abdominal discomfort, irritation, anemia and, in the case of children, behavioral changes (WHO, 1980). The WHO (1993) recommended guideline limit for lead level for water potability is 0.01 ppm. The relatively high lead concentrated water occurs around the industries producing fertilizers and Chlor alkali units. Thus, people living around this area are potentially at risk of metabolic poisoning. Children under 5 years, and pregnant women are particularly at potential risk of elevated lead levels in the blood stream (Moskowitz *et al*. 1986). Nonetheless, the lead levels are only slightly above the recommended.

The WHO (1993) permissible guideline limit for mercury concentration in potable water is 0.001 ppm. In the study area, the concentration of mercury in groundwaters varies within the range 0.0–0.002 ppm (Table 1). However concentration of mercury is found in the water samples which are located just near the industrial units. Mercury contamination causes irritation to the gastro intestinal tract and can cause nausea, vomiting, pain, ulceration, and diarrhoea and kidney damage, including kidney failure (WHO, 1980). Consequently, mercury poses the most physiological problem associated with groundwater for drinking purposes. People living in the Ropar Block are potentially exposed to the danger of diseases associated with oral ingestion of inorganic mercury. There is, therefore, there is a need to control the usage of mercury in the environment.

Table 2. Showing the range values of Trace elements in the groundwater of Ropar Block Block and the WHO (1993) drinking water quality guideline values

Element	Groundwater Samples		WHO (1993)
	Range of values	Mean Values	Guideline Maximum Value
Iron	0.20- 3.01	1.65	0.3 ppm
Arsenic	Nil	nil	0.01 ppm
Lead	0.0-	0.02	0.01 0.01 ppm
Mercury	0.000 -0.002	0.001	0.001 ppm
Cadmium	0.00 -0.02	0.01	0.03 ppm

Cadmium (Cd) is a naturally occurring metallic element that is used for electroplating and galvanization processes, in the production of pigments, in batteries, as a chemical reagent, and in miscellaneous industrial processes (ATSDR, 1989). The cadmium content in the study area varies from 0.000ppm to .02 ppm. WHO has prescribed 0.03 ppm cadmium as the guideline value for drinking water (WHO, 1993).Cd in the study area is well within the prescribed limit of WHO. The drinking water having more than 0.01ppm of cadmium can cause bronchitis, emphysema, anemia and renal stone formation in animals. Drinking water is generally contaminated with galvanized iron pipe and platted plumbing fittings of the water distribution system.

CONCLUSION AND RECOMMENDATIONS

Systematic study of the chemical data obtained as a result of analysis of groundwater samples collected around the industrial belt of Ropar Block of Rupnagar district where population is dependent on the groundwater sources. According to the analysis of some groundwater samples collected from the studied area, Hg and As are not found beyond limit, while lead and cadmium at various places crossed the maximum desirable limits where as Iron in all the water samples are found towards higher sides. Untreated effluents discharge in open pools and soak pits on ground surface causing direct leaching of toxicants into the aquifer system. Unsaturated zone consisting of sand that allows the industrial effluents to reach groundwater faster. To avoid further pollution of groundwater water and to reduce toxic elements industrial effluents need treatment before disposal. Solid waste disposal in open areas, depressions and low lying areas needs to be banned. Action is required against industrialists which do not treat industrial effluents. The presence of metals above the permissible limits in the domestic water is of serious concern; it could cause not only change in taste but also serious ailments. The quality of groundwater is thus important to safeguard as all activities in the town depend on the long term sustainability of groundwater resources.

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