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DETECTION OF HIGHER CONCENTRATION LEVELS OF CR AND PB IN THE EFFLUENTS AND WATER TABLE OF URBAN AREAS OF WAH

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Abstract

Over the past few decades, due to increase of industrialization and urbanization in the Wah town and surrounding areas, the risk of groundwater contamination has increased greatly. All most all the industrial and municipal waste of Pakistan Ordinance Factories (POF) Wah is being disposed off indiscriminately in the natural surface water stream, Dhamrah Kas Nullah (DKN) having 50 cusecs perennial flow which is a major source of recharge for shallow aquifer under lying new urbanization along the bank of DKN. Practically DKN has become sink for industrial effluent. Due to proven recharge from DKN the unconfined shallow aquifer in the study area became contaminated. Analysis of the water samples from a number of effluents entering into stream and groundwater samples collected from dug wells were tested for health related trace elements. The results indicate that the industrial and municipal effluents contain high amount of health hazard trace elements which are being migrated into the unconfined shallow aquifer due to recharge from DKN and it has become a source of health hazard for local inhabitants. Suggestions to improve the situation are also made.

Keywords: Trace elements, Effluent, Contamination

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1. Introduction

Industrial and urban effluents constitute a major source of metallic pollution of hydrosphere. These effluents when discharged into water ways accumulate the heavy metals in the sediments and contaminate the soil in the adjacent low lying lands. From these water ways, a part of heavy metals are directly recharged into aquifers while the remaining part which is deposited in fields from where it is transferred into various crops and find their way into biosphere through grazing animals. Municipal sewage and industrial effluents also effect aquatic life when such wastes enter the water channels or surface water reservoirs which are used to grow fish or aquatic plants for human consumptions (Khan, 1997).

Various researchers have reported groundwater contamination due to industrialization and urbanization and also proposed remedial measures to protect water resources (Oliver, 1999, Khan and Malik, 1995, Lloyd and Heatncote, 1985, Whitehead et al 1999 and Foster et al 1999).Based on the research studies WHO (1984) and USEPA (1975) and many other countries have recommended safe permissible limits for various types of contamination related to water.

The chemical contamination of groundwater (heavy metals) is a matter of great concern. Most of the heavy metals when found in high concentrations than the permissible limits in groundwater create health problems. Heavy metals are also called as trace elements due to their low levels of concentrations in groundwater (Marsh and Lloyd, 1994). The problems associated with chemical constituents arise primarily from their ability to cause adverse effects after prolonged periods of exposures of particular concern are cumulative poisons and carcinogens (WHO, 1984). Heavy metals of special importance in groundwater are chromium, cadmium, copper, zinc, iron and nickel (Matthess, et al., 1985).

Foster et al (1999) while discussing the role of high population growth in water contamination has reported, "Urban population growth in Asia and Latin America is occurring on a scale, and at a rate, unprecedented in human history. Many of the cities are sited on unconfined or semi confined aquifers, depend on groundwater for much of their water supply and apply to dispose of most of their liquid effluent and solid residues to the ground".

Industrial effluents are the source of heavy metals which ultimately recharged into groundwater and contaminate it (Jackson, 1980). Hence the level of the heavy metals found in industrial effluents and surface water plays a very important role in estimation of groundwater quality of any area. The heavy metals are estimated in groundwater of shallow aquifer (45 to 85 feet) which is commonly used by a large population of the Wah town. This study was performed as a part of Ph D research and partial results are being published through this article.

2. Methodology

Glass sampler attached with string was used to collect water samples from effluents and dug wells. Most of the sampling was focused from shallow aquifer which is being drained through dug wells by motor pumps in the surrounding of the Dhamrah Kas Nullah. Atomic absorption spectrophotometer of model (180-60/80. Atomic Absorption Polarized Zeeman with Flame/Zeeman, accessory unit for model 180-70) were used to estimate trace elements. The standard analytical conditions recommended by the manufacturer for various elements were adopted during experimentation.

3.Results and Discussions

Multi layered aquifer system has been reported by Khan (1997) for Dhamarah Kas Basin which shows that there are two major aquifer, the shallow aquifer located at 45-85 feet depth and deep aquifer at the depth of 130 -300 feet. The shallow aquifer is being exploited by the local population through dugwells and the deep aquifer is pumped out with tubewells installed by POF Authority for municipal and industrial use (Fig. 1). The altitude of water table contour map (Fig. 2) prepared by Khan (1997) for the Wah town indicates that major amount of aquifer recharge is from DKN.

3.

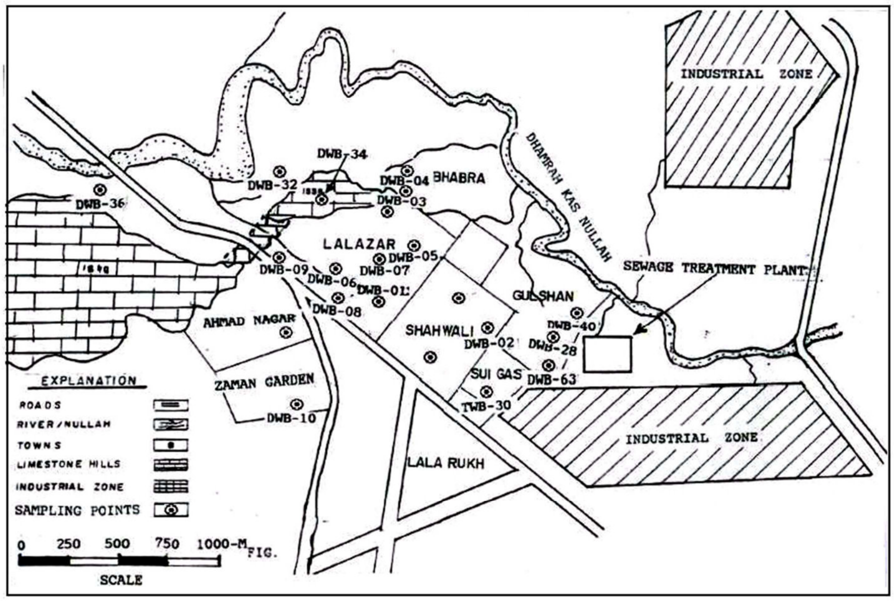

Fig. 1 Location map of study area indicating the dug-well from where sampling was made (Khan, 1997)

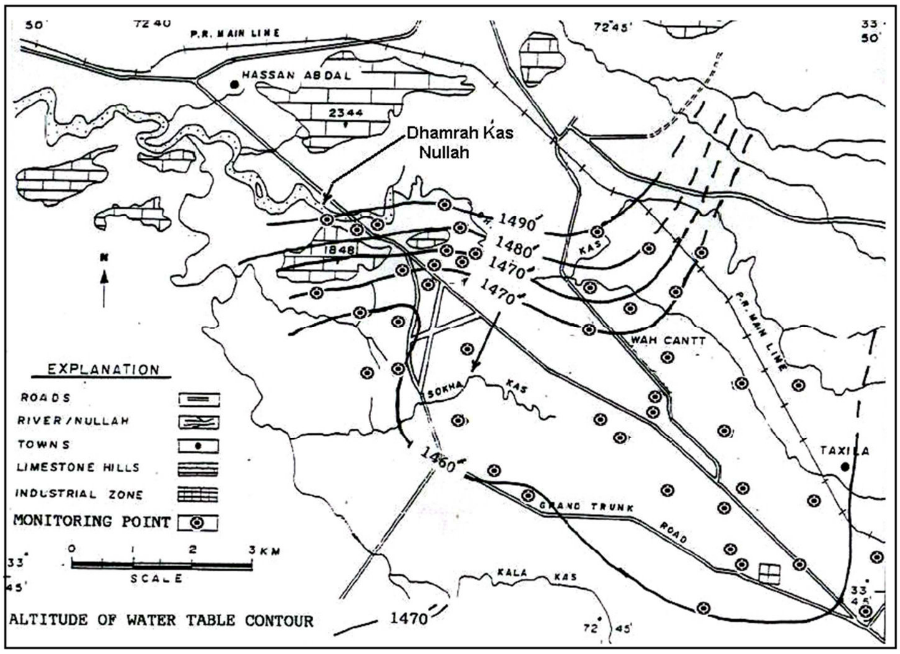

Fig. 2 Altitude of water table contour map, indicating the recharge of groundwater from DKN, (Khan, 1997).

The results of estimation of trace elements from industrial and urban effluents are given in Table 1. The amounts of contaminants are variable from different locations which are probably due to the nature of anthropogenic activity. POF Authority is treating the industrial waste and passing partially sewage water through treatment plant but the system is over loaded which cause high level of contamination in .effluents. The high value of Cr in effluent at sample No. 3 is probably due to industrial waste entering into the effluent.

Table 1 Result of estimated trace elements, in various effluents entering into DKN.

S.No.	Sample No	Cr	Pb	Cd	Cu	Zn	Fe	Ni
		mg/l						
1	1	0.0	0.1	BDL	0.0	0.3	0.1	0.1
2	1-A	0.3	0.0	BDL	0.6	0.3	0.1	BDL
3	2	0.2	0.0	0.1	0.4	0.3	BDL	0.5
4	3	8.8	0.0	0.15	0.1	0.9	0.05	BDL
5	4	0.0	0.5	0.6	0.1	0.2	BDL	0.0
6	5	0.3	0.0	0.05	0.0	0.3	BDL	3.0
7	6	0.1	0.1	0.01	3.0	0.3	BDL	0.1
8	8	0.0	1.3	BDL	0.1	2.5	0.1	BDL
9	9	0.0	0.0	0.02	0.2	0.3	BDL	0.2
10	10	0.0	0.1	0.1	0.2	0.3	0.1	BDL

11	11	0.2	0.1	BDL	0.3	0.9	0.8	0.1
12	12	0.3	0.1	0.1	0.1	1.8	1.7	0.3
13	13	0.3	0.1	BDL	1.4	0.2	0.0	0.1
14	Average	0.85	0.11	0.10	0.49	0.69	0.25	0.38

BDL = (Below detectable limit.)

The results of estimation of trace elements from shallow aquifer of groundwater (45 – 85 feet) are shown in Table 2. The overall picture indicates that Cr and Pb are at elevated concentrations where as Cd, Cu, Zn, Fe and Ni are with in permissible limits according to the guidelines of WHO (1984).

Table 2.Results of trace elements in groundwater from shallow aquifer which is being recharged from DKN.

Sr. No.	**Sample No**	**Cr**	**Pb**	**Cd**	**Cu**	Zn	Fe	Ni
		mg/l						
1	DWT-02	0.1	0.1	BDL	0.0	0.4	BDL	BDL
2	DWT-03	0.3	0.0	BDL	0.1	0.6	0.1	0.1
3	DWT-04	0.3	0.6	0.05	0.0	0.7	BDL	BDL
4	DWT-07	0.1	0.2	BDL	0.0	3.6	0.1	0.0
5	DWT-40	0.1	0.1	BDL	0.0	4.2	0.6	BDL
6	DWT-41	0.2	0.2	BDL	0.3	1.8	BDL	0.1
7	DWT-28	0.2	0.1	BDL	0.8	1.6	BDL	BDL
8	Average	0.19	0.19	0.01	0.17	1.84	0.11	0.1
9	WHO guidelines	0.05	0.05	0.005	1.0	5.0	0.30	-

BDL = (Below detectable limit.)

The range of chromium is 0.1 mg/l to 0.3 mg/l with an average value of 0.19 mg/l. The average level of chromium 0.19 mg/l of groundwater has been compared with WHO (1984) and USEPA (1975), which indicates that the chromium level is about four time higher than the USEPA and WHO recommended limits. Even the minimum level found in groundwater of 0.1 mg/l is higher than the required level for drinking water. The lead concentration has been estimated between 0.1 mg/l to 0.6 mg/l in various dugwells and all the values are higher than WHO recommendations.

The range of cadmium in groundwater is from below detectable limit to 0.05 mg/l with an average estimated level of 0.01 mg/l. The comparison of average value of cadmium with USEPA recommended limits are equal. However, in most of the dug-wells the cadmium is below detectable limit and only dug-well DWT-04 has higher values. This high contamination is probably due to recharge from contaminated nullah which receives industrial waste water.

The estimation of copper, in groundwater indicates that it ranges from 0.0 mg/l to 0.8 mg/l with average value of 0.17 mg/l and all the values are with in permissible limit. Copper is an essential element in human metabolism playing role in erythrocyte formation, release of tissue iron and the development of bone, the central nervous system and connective tissue (WHO, 1984).

The comparison for zinc indicates that all the results are below the maximum permissible limit fixed by USEPA and WHO. The concentration of zinc in tap water can be considerably higher than in surface water owing to the leaching of zinc from galvanized pipes, brass and zinc containing fittings (Zoetemann and Brinkman, 1975).

The concentration of iron ranges from below detectable limit to 0.6 mg/l, with average value of 0.4 mg/l, the comparison reveals that it is with in safe limits except sample collected from DWT-40 where it is double than the permissible level. The nickel concentration ranges from below detectable limit to 0.1 mg/l. In a number of dug-well its level is below detectable limit. For nickel USEPA and WHO have not fixed any limit or guideline value. However according to WHO (1984), nickel quantities to a level of 5 mg/l did not produce any considerable toxic effect. The graphic comparison of various contaminants having higher and low values from WHO recommended guidelines are given in Figs. 3 and 4 respectively.

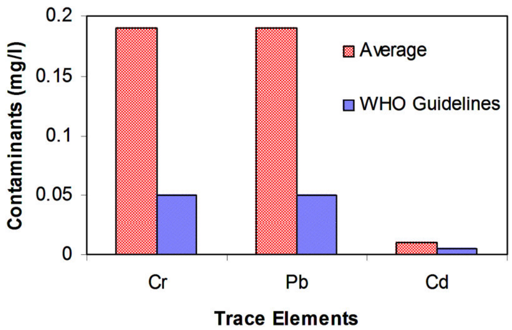

Fig.3 Comparison of trace elements having higher concentration than WHO guidelines

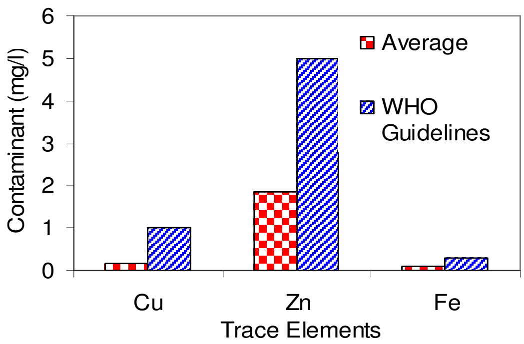

Fig. 4 Comparison of trace elements having concentration within permissible limit of WHO

4. Conclusions and Recommendations

The estimation of trace elements Cr, Pb, Cd, Cu, Zn, Fe and Ni indicate that the average estimated values for Cr, Pb have crossed the recommended limits of WHO guidelines values and Cd is within limits of USEPA recommendations. The concentrations of Cu, Zn, Fe and Ni are within permissible limits of WHO and USEPA

It is suggested that pumping from shallow aquifer in Lalazar, Babra and Gulshan area through dugwells should be stopped forth with and periodic monitoring of all the effluents and groundwater wells is also suggested to investigate the cause of contamination and remedial measures.

Acknowledgement

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