Ground Water Contamination by Effluent from Tanneries in Kasur (Pakistan)

[1]AMMARA HABIB*, [2]NADIA RIAZ, [2]IFTIKHAR AHMAD AND [1]TAHIRA SHAFIQ
[1]*Centre for Environmental Protection Studies, PCSIR Labs, Lahore, Pakistan.*
[2]*College of Earth and Environmental Sciences, University of Punjab, Lahore, Pakistan.*

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Summary: This paper presents the comprehensive quality of ground water contamination due to tannery effluent in different localities of Kasur. Samples were collected from 22 wells both residential and tanneries areas and investigated for physicochemical parameters like pH, conductance, total dissolved solids, alkalinity, chlorides sulfates, nitrates, calcium magnesium, sodium and potassium ions .The levels of these parameters were compared with the WHO guidelines for drinking water standards. The sampling sites closer to tannery areas were more affected than the residential areas. Chlorides, sulfates, total dissolved solids , nitrates, sodium and calcium values 13.6 %, 50 %, 36.3 %, 36 %, 68 % and 73.7 % of samples have exceeded the WHO limits. The given analysis supports the fact that tannery effluent is one of the major causes of ground water contamination.

Introduction

The saturated sub-surface zone (phreatic zone) contains the largest source of unfrozen fresh water in the world. It constitutes 21 % of the entire world's fresh water and 97 % of all the unfrozen fresh water on the earth. The contribution of ground water to the total water supply is largest in arid and semi-arid regions and in some places where geological condition favors ground water storage [1]. Ground water is generally considered a good source of drinking water, due to its hidden storage in the aquifers and inherent purification properties of soil. However, it is proved to be polluted through leaching from dumping sites, improper sewage disposal and industrial activities [2]. The water bodies that carry heavily polluted water pose a great threat to stream, river sand ground water quality. The continuous availability of such waters into unlined drains are permanent sources of chemical leaching to ground water. Quality of ground water varies from place to place [3] .The effluent based soil and ground water pollution aspects have thus remained focus point of several studies on the distribution of heavy metals in effluents in relation to their impact on ground water quality, depth of the aquifer, type of soil and human activities in and around the target area [4-5].

Pakistan is moving towards a rapid industrialization process. Being an agricultural country with well established tradition of cattle breeding has a large livestock population producing about 601 million hides. Availability of raw materials has encouraged rapid growth in tanning industry. There are about 750 tanneries in Pakistan located in Kasur, Sialkot, Karachi, Gujranwala, Multan, Lahore and Peshawar. The tanning industry is notorious for its heavy metals, inorganic and organic matter, dissolved suspended matter, biological oxygen demand and chemical oxygen demand. These tanneries discharge effluents without any treatment into reservoirs and cause severe environmental degradation. The rampant discharge of these effluents is a growing problem in leather industry [6].

The ground water regime in Upper Palar Basin, Tamil Nadu has been highly contaminated in several locations due to discharge of effluents from a large number of tanneries [7]

The leather tannery operations near Peshawar are polluting the Kabul river and threatening its use for domestic and irrigation purposes [8]. Kasur has been known since antiquity, as a centre of trade commerce and agriculture. Kasur has over 230 tanneries located in the Kot Molvi Abdullah, Kot Abdul Qadir, Younis Nagar and Niaz Nagar. Haphazard industrial growth and ineffective implementation of environmental legislation in last 20 years has converted Kasur into a home town of diseases, related with air and ground water pollution. According to the report of Punjab Environmental Protection Department in 1997, the ground water in Kasur has been detected extremely polluted with

*To whom all correspondence should be addressed.

inorganic constituents [9]. The ground water is polluted with chromium and toxic metals due to seepage of industrial effluents. Ground water is the main source of drinking water in Kasur. Hand pumps, domestic motor pumps and tube wells are the major source of ground water for drinking purpose. The quality of ground water has been badly affected chemically and microbiologically due to mixing and seepage of industrial effluents from leaking sewerage lines. Present study is an effort to monitor the concentration and ratio of various pollutants present in the ground water.

Results and Discussion

Analytical data of 22 samples were collected from various deep and shallow wells of Kasur presented in Tables-1 & 2. Data indicate the level of pH water sample falls in the range of 5.26-8.0. Out of 22 samples 19 samples (86.3 %) are within the range of WHO drinking water guidelines [10] and 3 samples (23 %) fall in slightly acidic range which is represented in Fig. 1. The TDS values range from 486-1367 ppm.Tables-2 & 3 show that 13 samples (59 %) have been found to be potable as per WHO drinking water guidelines [10] and 9 samples (40.9 %) are out of WHO limits. The maximum TDS value was found near tannery areas. The value of chlorides which range from 114 to 284 ppm. (Fig. 3) show that out of 22 samples, 19 samples (86.3 %) are within permissible range of drinking water guidelines [10], only 3 samples (13.6 %) crossed the WHO limit. The high chloride content in ground water of Kasur may be due to the reason that the tanneries used salted hides, on washing with water NaCl percolates in ground water. A high level of chloride may cause gastrointestinal problems irritation and diarrhea [11]. Minimum and maximum values of sulfates are shown in Tables-4 & 5 they are 31 to 486 ppm. Only 9 samples (40.9 %) were found within WHO drinking water guideline limit [10] and 13 samples (50 %) are higher than WHO permissible limits. High levels of sulfates were found in tannery areas because sulfates are the most common component of tanneries

Table-1: Sampling localities of Kasur.

Sample Codes	Location	Sampling Codes	Loaction
1	KTWMA treatment plant	12	Steel Park (deep well)
2	Niaz Nagar	13	Civil Hospital
3	Baba Ahmad Khan Derwaish	14	Gulberg Town
4	Niaz Nagar	15	Remat Nagar
5	Purani Sabzi Mandi	16	Laari Adda
6	Chowk Baldia	17	Basti Eiday Shah
7	Kot Ghulam Moahmmad	18	Nafees colony
8	Shahbaz Khan Road (official well)	19	Chowk Tehsildaar
9	Shahbaz Khan Road	20	Kot Muraad Khan
10	Officers colony	21	Munir Shaheed Colony
11	Steel Park (shallow well)	22	Basti Eiday Shah

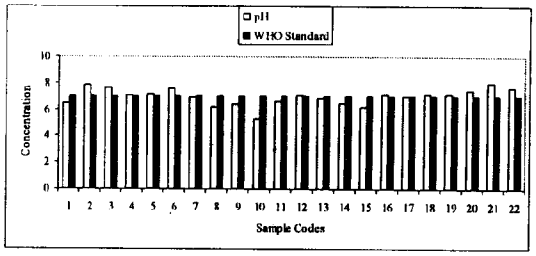

Fig. 1: Comparison of pH values with WHO standards.

Table-2: Level of physico-chemical parameters of water samples of Kasur.

Sample Codes	pH	Temp ° C	E.C (μ S/ cm)	TDS (ppm)	Cl^-
1	6.47	28.5	1304	915	170
2	7.87	33.2	1670	1170	210
3	7.67	31.1	1696	1064	224
4	7.07	30.6	1920	1343	284
5	7.16	28.4	1952	1367	260
6	7.6	36.2	696	486	114
7	6.93	26.8	1399	979	216
8	6.18	32.7	1622	1136	198
9	6.42	34.2	1718	1201	171
10	5.26	25.9	1694	1184	216
11	6.57	33.6	1820	1270	256
WHO guidelines for drinking water quality					
---	6.5-8.5	---	---	1000	250

Table-3: Level of physico-chemical parameters of water samples of Kasur.

Sample Codes	pH	Temp ° C	E.C (μ S/ cm)	TDS (ppm)	Cl^-
12	7.1	26.4	1352	944	179
13	6.88	26.2	1815	1164	160
14	6.48	32.4	1135	791	128
15	6.21	29.4	1285	894	142
16	7.12	32.4	915	637	122
17	7.04	31.1	820	572	99.4
18	7.17	31.5	1200	845	156
19	7.12	32.6	1005	710	159
20	7.4	31.9	913	639	142
21	8	30.2	740	596	140
22	7.64	32.6	949	763	150
WHO guidelines for drinking water quality					
---	6.5-8.5	---	---	1000	250

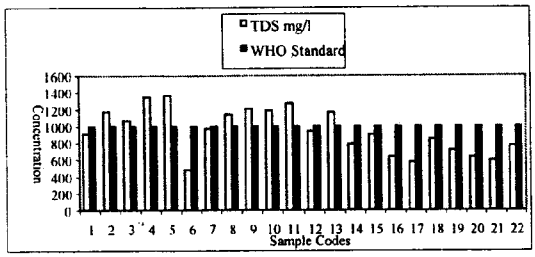

Fig. 2: Comparison of TDS values with WHO standards.

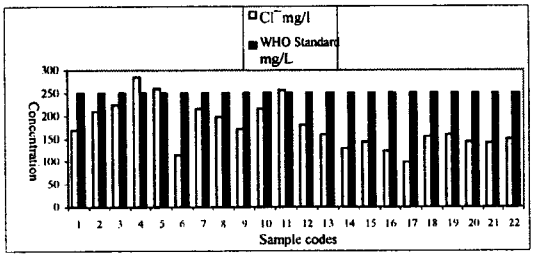

Fig. 3: Comparison of chloride values with WHO standards.

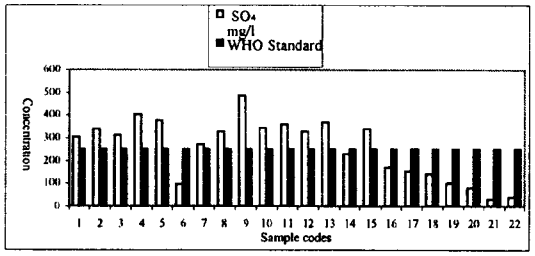

Fig. 4: Comparison of sulfate values with WHO standards.

effluent. Many auxiliary chemicals contain sodium sulfate as a byproduct in manufacturing process of hides.

The values of alkalinity, Ca, Na, Mg, NO_3 are presented in Tables-4 and 5. Alkalinity values varied in range of 124-360 ppm. The values of calcium–ions vary from 42 to 168 ppm, 16 samples (72.7 %) have exceeded the WHO drinking water guidelines limits [10]. High levels of nitrate were found in both tannery and residential areas, the maximum value varies from 210 ppm to 22 ppm respectively. Fig. 6 represents that only 7 samples (31.8 %) are within the WHO drinking water limit.

The values of Mg –ions range from 11 to 52 ppm. Only 2 samples (9 %) are out of WHO

Table-4: Level of cations and anions in water samples of Kasur.

Sample codes	SO_4 (ppm)	Alkalinity (ppm)	Ca+2 (ppm)	Mg-ion (ppm)	K^+ (ppm)	Na^+ (ppm)	NO3 (ppm)
1	304	140	85	32	22	140	150
2	342	206	62	44	11	220	170
3	313.3	188	104	52	26	204	200
4	407	230	87	24	28	302	210
5	376	316	96	42	17	260	124
6	96	124	42	11	4	96	48
7	270	188	110	21	14	160	56
8	328	272	128	32	7	170	132
9	486	170	92	24	15	243	164
10	346	254	104	24	20	220	120
11	360	258	116	24	14	240	180
WHO guidelines for drinking water quality							
-----	250	No Value	75	50	3-5	200	50

Table-5: Level of cations and anions in water samples of Kasur.

Sample codes	SO_4 (ppm)	Alkalinity (ppm)	Ca+2 (ppm)	Mg-ion (ppm)	K^+ (ppm)	Na^+ (ppm)	NO3 (ppm)
12	330	160	149	26	10	90	42
13	370	280	90	26	8	224	76
14	232	190	80	18	13	130	150
15	342	142	66	34	8	160	52
16	170	160	61	25	9	90	37
17	156	146	65	17	9	80	44
18	140	184	100	40	8	135	11
19	103	160	110	30	6	85	22
20	80	269	42	21	7	110	45
21	31	360	116	20	16	140	24
22	39	256	168	40	8	180	26
WHO guidelines for drinking water quality							
------	250	No Value	75	50	3-5	200	50

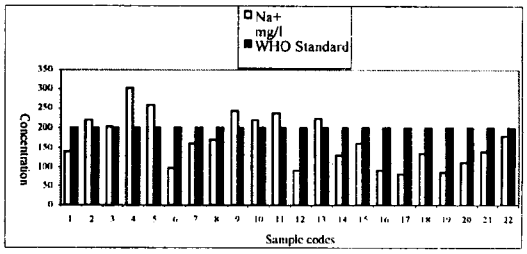

Fig. 5: Comparison of Na+ values with WHO standards

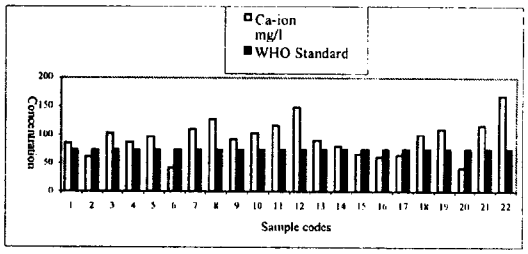

Fig. 6: Comparison of Ca-ion values with WHO standards.

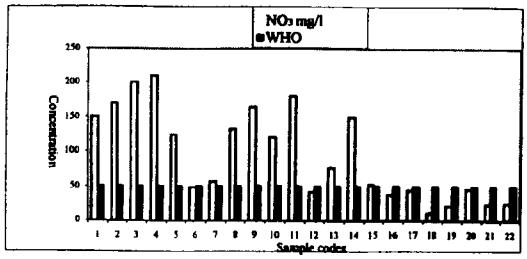

Fig. 7: Comparison of nitrate values with WHO standards.

guideline limit [10] and 20 samples (90.9 %) have permissible limits of WHO standard. Sodium levels of 8 samples are high and 14 samples are within the WHO drinking water limits.

Experimental

Sampling

Water samples of wells were collected from twenty two different locations of Kasur in clean polyethylene bottles. Before sampling, bottles were pre cleaned with detergent, washed with plenty of tap water and finally with de-ionized water. Sample bottles were then dried, cooled at room temperature, recapped and labeled. Before sampling each bottle was rinsed to pre-concentrate with the sample of water. Ground water samples were brought to the laboratory and immediately stored at 4°C and analyzed. All necessary precautions were observed during sampling, storage and transportation of samples [12].

Analytical Procedures

A-R grade chemicals were used in the preparation of reagents and standards. Physico-chemical analysis was preformed for each sample in triplicate and average values were recorded. pH, conductivity and temperature were measured immediately after collection of each sample using pH meter and conductivity meter. All other analysis in this study was completed within 48 hours of each sampling. Sulfates were determined by turbidmetirc method, total dissolved solids were determined by heating at 180 °C, chlorides by argintometric titration, alkalinity by acidimetric titration with HCl and calcium and magnesium ions were determined by EDTA titration method whereas sodium and potassium were determined by Flame photometer [12].

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