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ASSESSMENT OF GROUND WATER QUALITY IN AND AROUND LIGNITE MINE OF RAJPARDI, BHARCUH, GUJARAT

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ABSTRACT: Rajpardi lignite mine project, run by Gujarat Mineral Development Corporation, Ltd, Ahmedabad since 1983. Rajpardi is located in south Gujarat near Bharuch district. Production rate of lignite from the mine is approximately 10,00,000 tons per annum since its inception. Therefore, the impact of mining on ground water is likely to happen. In accordance, the present study was undertaken to assess the quality of ground water with respect to utility as portable and irrigation in farm land. Total 14 samples were collected in 10 km radius of mining area in triplicate for all three seasons i.e. winter, summer and post monsoon. Samples were brought to laboratory for the analysis of chemical and physical parameters. For computing the water budget, Gujarat Water Resource Development Corporation, Ltd., data is used. Quality of ground water is pristine except few sampling stations. High concentration of sodium and fluoride can cause impact like high blood pressure and fluorosis after long time consumption. In addition, presence of toxic substance like lead in sample of 1, 2, 3 and 14 are not recommended for drinking and irrigation purpose.

KEYWORDS: Mining, lignite, water quality, heavy metals, water quality index.

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1.INTRODUCTION

Water is nature's most wonderful, abundant and useful compound. About 97.2% of water on earth is salty and only 2.8% is present as fresh water from which about 20% constitutes ground water. Ground water is highly valued because of certain properties not possessed by surface water [1-3].

Both anthropogenic pressures and natural processes account for degradation in surface water and groundwater quality [4-6]. India is endowed with a rich and vast diversity of natural resources, water being one of them. Water is not only essential for the lives of animals and plants, but also occupies a unique position in industries. The quantity and the suitability of groundwater for human consumption and for irrigation are determined by its physical, and chemical properties [7-10]. Its development and management plays a vital role in agriculture production, for poverty reduction, environmental sustenance and sustainable economic development. In some areas of the world, people face serious water shortage because groundwater is used faster than it is naturally replenished. In addition to that industrial development, ever increasing energy demand and population growth have played vital role in promoting mining activity and natural resource depletion. That leads into many and diverse pressures on the quality and the quantity of water resources and on the access to them. Water quality monitoring and assessment is the foundation of water quality management [11]. A study conducted by Singh et al (2011) [12] on assessment of groundwater resources of Panandhro Lignite mine revealed that water table in the sand aquifer are at great risk, due to continuous withdrawal of mining material, mine bottom has gone far below and therefore increase chances of contamination from leachate and surface runoff during monsoon. Moreover, Mining industry is the backbone of industrial development, as it provides raw material to core sector industries, hence in a way it boosts the industrial growth. Therefore, condemning on mining activity is not the solution to save ground water as well as mine product. Present work is an attempt to understand the ground water quality aspects of Rajpardi lignite mine project, run by Gujarat Mineral Development Corporation, Ltd, Ahmedabad. The project was initiated in the year 1983 (Bhatt, 2002) [13] and is likely to last till 2020 for a planned annual production rate of 10, 00,000 tons. The mining at Rajpardi spanning approximately over a period of 40 years would have certainly induced changes in the landscape, soils, and thus likely to have an impact on ground water eminence of the region.

2. MATERIALS AND METHODS

Ground water samples from 14 different locations were collected to assess chemical and physical parameters (Table 1). The sampling was done during the winter, summer and post monsoon times to observe seasonal variability. The study area was divided into two zones viz. core zone (the mining block) and buffer zone (up to a distance of 10 km from the mining block) to see any significant changes in the quality and quantity of surface and ground waters. Total 14 locations were prefixed and samples were collected from bore wells of an average depth of 300 ft during all three seasons. Samples were collected in pre-cleaned plastic sample containers. Water samples were collected in triplicate, labelled and placed in ice box thantransferred to laboratory and were preserved by maintaining at 4ºC for further analysis.For physico-chemical analysis, temperature (ºC), pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), suspended solid, total solids, alkalinity as $CaCO_3$, hardness as $CaCO_3$, Potassium (K), Sodium (Na), Sulphate (SO_4), Chlorine

(Cl) and Fluoride (F), Iron (Fe), Nickel (Ni), Zinc (Zn) and Cupper (Cu), Cobalt (Co), Manganese (Mn), Chromium (Cr), Cadmium (Cd) and lead (Pb) were determined according to the methods prescribed in 1998 by the American Public Health Association (APHA) [14]. F in the GW was measured by ion exchange chromatography [15] and heavy metals were estimated by atomic absorption spectroscopy of Perkin Elmer AAnalyst 200 [14]. Statistical analysis: Data were expressed as Mean ± S.E.M.

Table: 1 Groundwater sampling locations

Sr. No.	Locations	Source
1	GMDC Colony	Borewell
2	Amod village	Openwell
3	Damlai village	Borewell
4	Babagor Hill	Borewell
5	Ratanpor Village	Openwell
6	Jhagadia near Panchayat Office	Borewell
7	Bhimpor village	Handpump
8	Rajpardi village	Borewell
9	Vanakpor near Rajpardi	Tubewell
10	Krishnapuri	Handpump
11	Haripura on way to Rajpipla	Handpump
12	Mota Sorva	Handpump
13	Jaspor village	Handpump
14	Amaljhar village	Borewell

3. RESULTS AND DISCUSSION

Results (Table 2 – 7) of present paper are compared with the standards given by BIS for Drinking water standard and describe [16]. Standard The ground waters samples have shown range of pH from 6.7 (slightly acidic) to 8.4 (alkaline) which are well within the permissible limits of drinking waters (Anon, 1991) accept pH of station no. 1, 2, 4, 5, 6, 8 & 10 during summer. Reason for alkalinity is may be due to excess of evaporation in high temperature. However, pH 8.4 at station no. 5 in post monsoon is not common. Therefore, contribution from mining activity cannot be overruled. Turbidity ranges from minimum 1.5 to maximum 9.7. Highest turbidity is present in sample collected from station no.3 which is very high as compare to the prescribe limit and not recommended for drinking purpose. EC is ranging from 0.6 (Haripura on way to Rajpipla) in post monsoon to 2.49 (Krishnapuri) in summer. TDS is ranging from 1306 (station no. 1) in post monsoon to 315 (station no. 9) in summer. Hardness of six samples is crossing the permissible limit. It is ranging from minimum 370 to maximum 909. Hardness of station no. 9 is very high and needs purification process before using it for any purpose like drinking and irrigation. Recommended value for potassium is 10 mg/l. However, concentration of potassium is higher in station no. 5, 6, 7, and 9. Concentration of Sodium is significantly higher in all samples and the highest value is 399 and the lowest is 20 which is upper limit of the recommended value [4, 16, 17, 18]. Therefore, population depends on this water source for long period of time will have higher risk of blood pressure. Concentration of SO_4^- is within permissible limit. Concentration of Cl^- is also within limit. Amount of fluoride is higher in station 1 and 2. The population depend on this water may have high risk of fluorosis and diminish IQ level in school going children [15, 19]. All heavy metals like Fe, Ni, Zn, Cu, and Mn are well within prescribe limit. As per WHO guidelines amount of lead is permitted in drinking water up to 0.05 mg/l. However, CPCB has not given any relaxation. Therefore, concentration of lead in station no. 1, 2, 3 and 14 is around 0.003 mg/l which is alarmed and may be due to ongoing mining activity in the area. Even though mining activity in present area has been undertaken since 1983, still water quality is pristine. The reason might be due to the geology and ground water flow of the area. The groundwater flow at Rajpardi is from southeast to northwest, which is in accordance with the surface drainage, which ultimately empties into river Narmada. It may cause contamination to river water. However, the impact may be negligible due to perennial type of it. The surface drainage cuts through the mining block to join the Narmada River. Both quality and quantity have shown steady state condition. The water table conditions in the mine area are difficult to ascertain, though there is continuous discharge of ground water in the mine pit. To reduce this, discharge pumps have been fixed in the mine and water is released into Hakran stream [20].Rajpardi being at an elevation of 60m and above, the surface drainage flows from ESE to WNW, passing through the centre of the lease area. The mine does not receive any surface inflow except in low lying pits. The Hakran stream has been diverted southwest to facilitate the mining operations. In addition to above contaminants, acid mine water is another major issue related to ground water quality around mining area. The present study revealed that the amount of SO_4^- is present in all water samples. Oxygen, water and sulfur rich minerals are necessary for the generation of acid water in the mine. Hence by preventing air and water from coming in contact with these natural materials, the formation of acidic water can be prevented [21] (Anon, 1994). The mine wastewater generated from lignite mine is of two types (1) acid mine water (Figure 1) and (2) mine drainage water. The mine drainage water mainly from the aquifer is continuously pumped out during mining operations. Dust extraction and suppression systems and sanitation would also give rise to some waste water. However, it will not have significant impact of ground water quality due to its ground water flow in opposite direction. The discharged mine water into Hakran Riverhas shown slightly acidic pH, proper monitoring of this water is needed to avoid its adverse influence on biological communities. Effects may range from reduction in diversity of flora and fauna. The acid mine drainage generated in the Amod and Bhuri blocks is continuously neutralized, treated and is used in dust suppression and greenbelt development. Contaminated water is prevented from entering in to the nearby nallas and the treated water is sufficiently used within the mine site. Hence, there is little scope of adverse impact on the natural water bodies, flora and fauna due to acid mine water.Due to the occurrence of clay layer below the acid mine water pond, there is very little scope for the percolation of acidic water to deeper horizons. Due to the prevalence of carbonate matrix in the sands, the acid water is getting neutralized and part of this water is used in the mining operations such as dust suppression etc.The high clay content in the sediments also serves as absorbent/ adsorbent medium for heavy metals, hence preventing their dispersion to the surroundings.The acid mine water accumulating in the pond is suitably neutralized by the application of carbonate rich sediments. The clayey horizon below the acid water pond prevents the seepage of acidic water, high in heavy metals from leaching downwards. The lime treated water is reused in the dust suppression by sprinkling this water on the vehicular tracks in the mine [22, 23].

Table: 2 Physical parameters of the groundwater

Station	pH			Turbidity (NTU)			Conductivity (mS/cm)		
	W	S	P M	W	S	P M	W	S	P M
1	7.5 ± 0.1	8.1 ± 0.09	7.9 ± 0.15	1.9 ±0.06	3.0 ±0.09	1.9 ±0.06	2.08 ±0.15	1.92 ±0.08	2.26 ±0.15
2	7.3 ± 0.09	8.3 ±0.15	7.8 ± 0.09	2.7 ±0.06	2.5 ±0.12	1.5 ±0.09	1.63 ±0.08	1.43 ±0.09	1.61 ±0.09
3	6.8 ± 0.1	7.4 ±0.1	7.3 ±0.1	3.0 ±0.08	9.7 ±0.15	2.3 ±0.1	1.66 ±0.09	0.89 ±0.04	1.02 ±0.15
4	6.8 ± 0.15	8.1 ±0.14	7.4 ±0.09	2.5 ±0.06	2.1 ±0.06	3.3 ±0.09	0.8 ±0.09	1.41 ± 0.13	0.77 ±0.04
5	7.3 ± 0.18	8.2 ±0.16	8.4 ±0.17	2.2 ±0.09	5.8 ±0.16	1.7 ±0.09	1.57 ±0.05	1.6 ±0.09	1.82 ±0.1
6	7.0 ± 0.17	8.1 ±0.1	7.5 ±0.1	2.0 ±0.06	3.4 ±0.15	1.3 ±0.06	2.19 ±0.15	2.33 ±0.17	1.88 ±0.13
7	7.1 ± 0.1	7.8 ±0.13	7.2 ±0.15	4.5 ±0.14	6.5 ±0.14	7.5 ±0.14	2.01 ±0.08	2.08 ±0.09	1.94 ±0.15
8	7.3 ± 0.09	8.3 ±0.15	8.2 ±0.17	2.9 ±0.08	8.6 ±0.14	1.8 ±0.08	2.33 ±0.09	1.76 ±0.09	2.27 ±0.1
9	7.1 ± 0.12	7.5 ±0.14	7.6 ±0.14	1.7 ±0.06	0.7 ±0.13	1.7 ±0.1	1.91 ±0.08	0.68 ±0.06	2 ±0.09
10	7.4 ± 0.14	8.3 ±0.15	7.6 ±0.1	2.0 ±0.08	3.2 ±0.06	1.8 ±0.09	2 ±0.15	2.49 ±0.09	2 ±0.1
11	7.1 ± 0.16	7.7 ±0.09	8.0 ±0.15	2.6 ±0.09	8.1 ±0.15	2.1 ±0.08	0.82 ±0.04	0.71 ±0.04	0.6 ±0.04
12	7.0 ± 0.18	7.8 ±0.17	7.8 ±0.14	2.1 ±0.06	0.3 ±0.04	1.3 ±0.09	0.92 ±0.07	0.6 ±0.05	0.73 ±0.04
13	6.7 ± 0.13	7.7 ±0.15	7.3 ±0.17	2.0 ±0.08	7.8 ±0.14	2.0 ±0.06	1.08 ±0.09	0.78 ±0.04	0.8 ±0.05
14	6.9 ± 0.14	7.6 ±0.14	7.0 ±0.1	3.4 ±0.06	4.7 ±0.13	3.7 ±0.09	2.21 ±0.09	1.75 ±0.17	2.21 ±0.1

Table: 3 Physical parameters of the groundwater

Station	T.D.S. (mg/l)			S.S. mg/l			T.S. mg/l		
	W	S	P M	W	S	P M	W	S	P M
1	1105 ±66.3	1126 ±77.8	1306 ±42.4	9 ±1	21 ±2.4	13 ±1.2	1114 ±76	1147 ±88	1319 ±76
2	925 ±77.4	989 ±76.4	914 ±77.8	18 ±2.5	13 ±1.2	5 ±0.4	943 ±55	1002 ±76	919 ±55
3	845 ±42.6	443 ±26.4	609 ±35.8	29 ±3	169 ±22.5	ND	874 ±45	612 ±45	602 ±34
4	315 ±25.8	767 ±32.4	365 ±25.7	12 ±1.3	5 ±0.7	1 ±0.3	327 ±32	772 ±76	366 ±24
5	805 ±32.5	855 ±35.8	1030 ±66.3	9 ±0.9	77 ±10.5	ND	814 ±36	932 ±66	1023 ±67
6	1385 ±42.4	1362 ±77.4	1105 ±37.4	7 ±0.8	25 ±1.2	ND	1392 ±88	1387 ±87	1098 ±56
7	1205 ±75.8	1152 ±77.8	1212 ±79.8	977 ±22	45 ±7	974 ±22	2182 ±101	1197 ±92	2186 ±112
8	1305 ±52.4	924 ±66.3	1325 ±67.3	13 ±2	113 ±11.2	3 ±0.4	1318 ±88	1037 ±65	1322 ±45
9	1015 ±66.3	315 ±22.8	1142 ±56.3	8 ±1	ND	5 ±0.9	1023 ±55	312 ±32	1147 ±67
10	1295 ±77.5	1468 ±67.6	1299 ±66.3	7 ±0.5	25 ±0.6	11 ±1.2	1302 ±69	1493 ±76	1310 ±78
11	345 ±24.6	334 ±25.4	288 ±26.3	12 ±0.8	77 ±1.2	ND	357 ±36	411 ±43	281 ±27
12	395 ±25.8	249 ±27.4	356 ±25.3	9 ±0.4	ND	ND	404 ±46	242 ±26	353 ±25
13	515 ±25.3	374 ±28.4	418 ±24.7	10 ±1.5	109 ±11.2	1 ±0.3	525 ±55	483 ±34	419 ±34
14	1165 ±78.4	994 ±37.4	1172 ±75.8	14 ±1.6	44 ±2.2	20 ±1.3	1179 ±87	1027 ±77	1192 ±79

Table: 4 Seasonal variations in the alkalinity and hardness of the groundwater

Station	Alkalinity as $CaCO_3$ mg/l			Hardness as $CaCO_3$ mg/l								
				T			Ca			Mg		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	631 ±34	524 ±31	524 ±32	172 ±19	126 ±16	130 ±17	69 ±8	14 ±3	27 ±3	103 ±11	112 ±13	103 ±11
2	619 ±33	522 ±30	534 ±31	114 ±18	224 ±21	187 ±18	26 ±4	12 ±1	23 ±2	88 ±9	212 ±21	164 ±16
3	363 ±24	172 ±21	224 ±22	480 ±26	243 ±22	205 ±20	302 ±31	137 ±17	166 ±17	178 ±18	106 ±12	39 ±4
4	161 ±14	340 ±24	164 ±18	123 ±14	243 ±23	111 ±9	49 ±4	18 ±3	60 ± 7	74 ±8	225 ±23	51 ±5
5	585 ±35	612 ±32	604 ±41	181 ±16	77 ±8	64 ±6	155 ±19	14 ±3	27 ±4	26 ±2	63 ±6	37 ±4
6	395 ±34	494 ±31	404 ±29	428 ±32	243 ±21	196 ±14	189 ±18	141 ±15	94 ±7	239 ±22	102 ±9	102 ±14
7	470 ±41	378 ±28	475 ±28	222 ±26	341 ±28	226 ±16	136 ±12	43 ±8	135 ±11	86 ±8	298 ±29	91 ±8
8	757 ±66	328 ±27	344 ±30	218 ±24	181 ±16	151 ±15	89 ±9	59 ±6	51 ±5	129 ± 2	122 ±11	100 ±9
9	526 ±31	144 ±14	434 ±32	756 ±38	106 ±11	309 ±29	354 ±30	78 ±8	19 ±2	402 ±34	28 ±2	290 ±28
10	89 ±14	909 ±41	92 ±15	216 ±24	137 ±14	219 ±24	34 ±3	12 ±2	37 ±4	182 ±16	125 ±23	182±19
11	258 ±21	214 ±22	214 ±19	141 ±13	164 ±15	177 ±19	59 ±5	35 ±4	49 ±4	82 ±8	129 ±24	128 ±15
12	323 ±28	172 ±21	174 ±21	290 ±21	145 ±17	177 ±18	158 ±18	49 ±5	87 ±7	132 ±14	96 ±8	90 ±9
13	354 ±29	186 ±22	174 ±20	334 ±29	204 ±20	253 ±22	200 21±	55 ±5	102 ±8	134 ±13	149 ±17	151±16
14	596 ±31	284 ±24	59.4 ±7	458 ±31	321 ±28	463 ±38	204 ±22	37 ±4	252 ±11	254 ±24	284 ±28	211 ±23

Table: 5(a). Seasonal variations in the major cations and anions of the groundwater

Station	K^+ mg/l			Na^+ mg/l			SO_4^{--} mg/l		
	W	S	P M	W	S	P M	W	S	P M
1	7.5 ±1.2	7.6 ±1.3	7.9 ±1.2	339 ±34	354 ±55	299 ±65	39.5 ±6	78 ±13	16 ±2
2	79 ±15	4.6 ±0.9	4.4 ±0.9	265 ±43	189 ±22	199 ±22	65 ±4	69 ±12	16 ±3
3	6.5 ±1.5	5.4 ±1.2	5.2 ±0.8	103 ±43	67 ±11	57 ±7	84 ±7	69 ±13	35 ±6
4	5.1 ±0.9	6.4 ±.0.9	5.6 ±0.9	81 ±33	169 ±25	57 ±6	12.6 ±2.2	73 ±11	24 ±4
5	10 ±1.3	7.5 ±1.1	8.5 ±1	218 ±24	304 ±34	257 ±56	24.4 ±1.1	65 ±12	25 ±5
6	13 ±2	9.3 ±2.1	7.8 ±1.2	240 ±25	339 ±32	194 ±45	12.5 ±0.8	104 ±18	18 ±3
7	162 ±23	8.3 ±2.3	165 ±23	254 ±27	224 ±33	275 ±23	263 ±33	129 ±14	265 ±23
8	6.7 ±1.7	6.3 ±1.4	8.2 ±1.3	364 ±55	265 ±24	349 ±34	39 ±10	119 ±15	164 ±16
9	32 ±8	4.9 ±0.8	6.6 ±1.2	74 ±21	754 ±67	399 ±37	88 ±12	38 ±8	54 ±12
10	5.5 ±1.4	5.3 ±0.9	5.7 ±0.9	329 ±25	432 ±56	331 ±38	6.6 ±0.7	82 ±9	7 ±0.8
11	4.6 ±0.8	4.4 ±0.9	4.8 ±0.9	94 ±23	72 ±23	32 ±5	7.5 ±0.8	30 ±4	7 ±0.7
12	5.2 ±0.9	4.6 ±1.1	5.2 ±0.8	40 ±8	30 ±7	20 ±3	31 ±6	11 ±0.7	16 ±3
13	4.8 ±1.1	4.2 ±0.9	4.5 ±0.8	30 ±6	132 ±36	25 ±3	13.6 ±0.1	24 ±2	29 ±4
14	4.9 ±1.2	4.7 ±0.9	4.8 ±0.9	227 ±67	92 ±22	224 ±76	99 ±11	72 ±5	13.4 ±0.9

Table: 5(b). Seasonal variations in the major cations and anions of the groundwater

Station	Cl^- mg/l			F^- mg/l		
	W	S	P M	W	S	P M
1	228 ±44	255 ±33	232 ±34	0.8 ±0.07	0.58 ±0.09	1.56 ±0.09
2	109 ±22	72 ±12	76 ±13	1.6 ±0.08	0.46 ±0.08	1.97 ±0.05
3	221 ±24	140 ±17	113 ±19	0.9 ±0.07	0.6 ±0.09	0.98 ±0.06
4	88 ±11	144 ±15	66 ±8	0.45 ±0.05	0.8 ±0.05	ND
5	102 ±14	92 ±16	76 ±9	0.7 ±0.05	0.61 ±0.09	0.36 ±0.05
6	399 ±26	289 ±21	190 ±22	0.52 ±0.06	ND	1.08 ±0.08
7	230 ±24	262 ±20	234 ±23	0.75 ±0.08	0.56 ±0.08	0.77 ±0.07
8	218 ±17	295 ±22	382 ±34	0.56 ±0.05	0.3 ±0.05	0.9 ±0.05
9	189 ±16	59 ±7	175 ±21	0.53 ±0.04	0.47 ±0.09	0.69 ±0.06
10	140 ±12	82 ±9	141 ±18	0.86 ±0.09	0.57 ±0.09	0.84 ±0.09
11	34 ±5	45 ±6	35 ±7	0.38 ±0.07	ND	0.67 ±0.08
12	36 ±6	30 ±4	45 ±6	0.53 ±0.08	0.74 ±0.09	0.78 ±0.05
13	55 ±7	51 ±7	56 ±7	0.55 ±0.09	0.53 ±0.07	0.98 ±0.08
14	239 ±22	172 ±22	243 ±24	0.75 ±0.07	0.69 ±0.07	0.73 ±0.05

Table: 6 Seasonal variations in the heavy metals in the groundwater

Station	Fe mg/l			Ni mg/l			Zn mg/l			Cu mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2	0.08	0.08	0.07	0.06	0.07	0.05	ND	ND	ND	ND	ND	ND
3	0.05	0.07	0.04	ND	ND	ND	0.04	0.05	0.04	ND	ND	ND
4	0.52	0.52	0.52	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	0.05	0.07	0.04	ND	ND	ND	ND	ND	ND
6	0.15	0.17	0.15	0.05	0.06	0.05	ND	ND	ND	0.03	0.04	0.03
7	ND	ND	ND	0.09	0.1	0.09	ND	ND	ND	ND	ND	ND
8	ND	ND	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND
9	0.07	0.03	ND	0.03	0.03	ND	ND	ND	ND	ND	ND	ND
10	0.1	0.09	0.07	ND	ND	ND	0.1	0.12	0.08	ND	ND	ND
11	ND	ND	0.06	0.06	0.06	0.03	0.05	0.05	ND	ND	ND	ND
12	0.22	0.32	0.07	0.07	0.09	ND	0.02	0.03	0.06	0.03	0.03	ND
13	0.05	0.07	ND	ND	ND	0.04	ND	ND	0.03	ND	ND	ND
14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 7: Seasonal variations in the heavy metals in the groundwater

Station	Co mg/l			Mn mg/l			Cr mg/l			Cd mg/l			Pb mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	ND	ND	ND	0.03	0.03	0.02	ND	ND	ND	ND	ND	ND	0.03	0.03	0.03
2	0.05	0.06	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06	0.07	0.05
3	0.03	0.03	0.03	0.04	0.04	0.04	ND	ND	ND	ND	ND	ND	0.03	0.04	0.03
4	0.04	0.05	0.04	0.03	0.04	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	0.04	0.05	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
6	0.04	0.04	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7	0.03	0.12	0.07	0.03	0.03	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
8	ND	ND	0.1	0.04	0.04	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
9	ND	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	0.07	0.03	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12	0.03	0.04	0.02	0.05	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
13	ND	ND	ND	0.03	0.03	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND
14	0.08	0.09	0.06	0.04	0.04	0.01	ND	ND	ND	ND	ND	ND	0.03	0.03	0.04

Figure 1: Discharging of treated acid mine water into the Hakran stream

4. CONCLUSION

In conclusion, ongoing mining activity since 1983 has no major impact on ground water quality accept hardness and turbidity related issues in some of the sampling station. The most significant impact is the presence of high sodium and fluoride. However, presence of toxic metal like lead in water samples cannot be neglected when using for drinking and irrigation. Therefore, treatment of water is highly recommended before usage for the purpose of drinking and irrigation.

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CONFLICT OF INTEREST

Authors have no any conflict of interest.

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