

IDENTIFICATION OF GROUND WATER POLLUTION SOURCES

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Abstract:

Ground water is the major and perennial source of drinking as well as for agricultural and industrial sectors in both urban and rural areas of northern Gujarat. This study has been carried out in the Kadi Taluka of Mehsana district where in absence of other potential surface water bodies, ground water has been experiencing the high rate of over exploitation. Near Mehsana- Chhatral high way, there are around 11 industrial units are running and many more in the south-west downstream from the study area. Due to industrial activities and their uncontrolled discharges, intentional and unintentional, ground water in this region has been highly polluted with heavy metals and organic compounds which contribute to higher COD, Higher Iron and Reddish brown colour in the water. Besides that, over extraction has created ground water trough below the city. To meet the ever increasing demand for fresh water for industrial, as well as agricultural it is essential to restore the ground water quality. The present study focuses on establishing the cause-effect relationship between pollution and the probable responsible industry as well as identifies appropriate remediation technology.

Key Words: Ground water quality, pollution, remediation

INTRODUCTION:

Groundwater is the water locked beneath the ground surface that saturates the pore space in the subsurface.

In North Gujarat, ground water is the only potential source of water for drinking as well as for agricultural and industrial sectors in both urban and rural areas. There are number of industries on Mehsana-Chhatral highway, near village Rajpur. Industries invariably have network of their own wells. Infiltrations of thousands of industrial inorganic and organic chemicals (discharged illegally & irresponsibly) increased since the advent of industrial revolution, and their transfer and in the aquifers beneath ground have badly polluted this perennial source. Besides this, over extraction has created a ground water trough below the city. Hence for the sake of sustainability of water resources, there is need for planning these resources at local as well as regional level.

STUDY AREA:

Study region is scattered in the 20 kms area in the upstream of Village Rajpur in Kadi Taluka of Mehsana District. Rajpur is situated on Ahmedabad - Mehsana state/ national highway. It is about 60 kms away from Ahmedabad and about 8 kms in the Northern direction

of Kadi Taluka. It accommodates number of small and medium scale industrial units including pharmaceutical products, dyes intermediates, Laminate sheets, seamless tubes etc. This area is falling in the upstream part of Narmada canal Command of Sardar Sarovar Project Plate III.

Study was carried out in 2 phases. 1) For the study sampling were carried out from the bore wells of different 9 villages scattered in the upstream of Mehsana-chhatral high way to get an idea about the present quality of ground water and the highly polluted area. 2) Samples of industrial effluents were collected and subjected to GC-MS and ICP-MS in order to establish the cause effect relationship between industry and pollution.

MATERIAL AND METHODS:

The ground water samples were collected as per the standard methods recommended by APHA1. All the physico-chemical analysis was done using the standard methods

TABLE 1 DETAILS OF BORE WELLS (SAMPLING STATIONS)

Village name	Bore well owner's name/ location	Bore well Depth (feet)	Bore well diameter (inch)	Local Water level	Pump HP	Color
Julasan Road	Dushmiya M Khureshi (Downstream Of Fortune Polytech.)	750	12	420	40	Slightly Brown
Rajpur	Kalubha K Pathan (Behind Ambuja intermediates)	700	12	480	40	Slightly Brown
Rajpur	Jamiyatbhai (Left-side- (Behind Ambuja intermediates))	750	12	500	40	Dark Reddish Brown
Ambuja intermediates (main gate)	Own Bore well	700	12	490	52	Reddish Brown
Ambuja intermediates (staff housing)	Own Bore well	565	12	490	52	Reddish Brown
Laxmipura	Gram Panchayat Bore well	700	8	540	35	Clear
Nandasan	Gram Panchayat Bore well	800	10	450	52	Clear
Tankiya	Gram Panchayat Bore well	700	8	540	35	Clear
Ghumasan	Gram Panchayat Bore well	750	8	530	52	Clear
Chandarda	Gram Panchayat Bore well	700	10	530	52	Clear
Anandpura	Gram Panchayat Bore well	800	8	450	52	Clear
Karjisan	Prahladbhai patel's bore- well	700	12	470	85	Clear
Dangarva	Gram Panchayat Bore well	850	8	500	41	Clear

TABLE 2- A WATER QUALITY ANALYSIS RESULTS OF BORE WELL SAMPLES

Standards	6.5-8.5		500-2000	300-600	200-400	250-1000	10-45	1-1.5	0.3
Village Name	pH	COD (mg/l)	TDS (mg/l)	Hardness (ppm)	Sulfates (ppm)	Chlorides(ppm)	Nitrates	Fluoride	Iron
Julasan road	7.60	< 20	1660	460	45	496	6.20	0.98	2.60
Rajpur (Behind Ambuja intermediates)	7.97	< 20	1390	525	61	416	11.60	0.82	0.68
Rajpur (Behind Ambuja intermediates)	7.84	38.4	1690	625	103	552	5.90	1.10	9.8
Ambuja Intermediates (Main Gate)	7.50	38.4	1820	650	71	672	4.10	1.35	6.2
Ambuja Intermediates (Staff housing)	7.63	19.2	1810	575	61	736	5.90	1.45	1.9
Laxmipura	8	19.2	750	350	49	152	17.20	0.40	0.03
Nandasan	7.67	17	1060	410	62	160	35.20	0.50	0.03
Tankia	7.45	< 10	1400	610	48	440	4.60	0.88	0.12
Ghumasan	7.51	19.2	1310	510	57	416	11.90	0.82	0.86
Chandarda	7.70	< 10	1390	475	61	416	11.80	0.82	0.04
Anandpura	7.61	< 10	1410	650	76	480	3.20	1.15	0.23
Karjisan	8	19.2	1310	460	87	376	2.60	1.20	0.21
Dangarva	7.93	< 10	1240	435	100	320	2.60	1.10	0.23

TABLE 2- B WATER QUALITY ANALYSIS RESULTS OF BORE WELL SAMPLES

Para-meters	Julasan road	Rajpur (Behind Ambuja intermediates)	Rajpur (Ambliyara bore well)	Ambuja Intermediates (Main Gate)	Ambuja Intermediates (Staff housing)	IS 10500 standards (mg/L)

Arsenic	-	0.0012	0.0024	-	-	0.01-0.05
Chromium	0.0109	0.0062	0.0101	0.0076	0.0241	0.05
Cadmium	-	-	0.0008	0.0002	-	0.01
Lead	-	-	-	0.0025	0.0244	0.05
Zinc	0.0068	0.0169	0.0352	0.0276	0.0757	5
Mercury	0.012	0.01	0.0128	0.0081	-	0.001
Mercury As per NPC REPORT	0.539	0.005	0.006	0.007	0.001	0.001

TABLE 2- C WATER QUALITY ANALYSIS RESULTS OF BORE WELL SAMPLES

SR NO.	VILLAGE NAME	DETECTED ORGANIC COMPOUNDS
S1	Julasan road	2-PYRIDINE CARBOXYLIC ACID 2-PENTOL, 4- METHYL- COMPOUNDS
S2	Rajpur (Behind Ambuja intermediates)	No peaks found
S3	Rajpur (Ambaliyara bore well)	DODECANOIC ACID, 1-METHYLETHYL ESTER N- HEXACANONIC ACID, 2-PYRIDINE CARBOXYLIC ACID, HEXACYCLIC COMPOUNDS
S4	Ambuja Intermediates (Main Gate)	HEPTANE, PHENOL, PHENOL, 3-METHYL- COMPOUNDS CYCLOHEXANE, METYL- COMPOUNDS
S5	Ambuja Intermediates (Staff housing)	2-PENTANOL, 4-METHYL- COMPOUNDS, DODECANOIC ACID DODECANOIC ACID, 1-METHYLETHYL ESTER BENZENESULFONYL CHLORIDE, 4 - CHLORO- COMPOUNDS

TABLE 3 DETAILS OF INDUSTRIES

Name of Industry	Raw materials	Products	Mode of disposal
Milton Industry	Formaldehyde, Melamine, Methanol, Phenol, Papers	Decorative Laminated Sheets	Direct evaporation of phenol-formaldehyde concentrated solution in open & for ww , ETP is provided
Pharmson Chemical	Acetic Acid, Acetic Anhydride , Liquor Chlorine	HCl, MCA,	
Alap chemicals	Acetic Acid, Iron Powder, Nephthalene , HNO ₃ , H ₂ SO ₄ , Soda Ash	Alpha Nephthyl Amine, Spent Acid	Iron sludge is packed on bags and stored in storage area
Krishna Benzyl Pvt ltd	Acetic Acid, Benzoic Acid, Benzyl Chloride, Pyridine, Soda	Benzoic Acetate, Benzyl Alcohol, Benzyl Benzoate, Sodium Benzoate, Sodium Acetate	Residue generated from the process is sold to saddle manufacturers.
Fortune Polytech	No chemicals	Tadpatri	No water consumption
Sandvik Asia pvt ltd.	HCl, HF, HNO ₃ , S.S. bars	S.S.Tubes	No water consumption
Ambuja Intermediates pvt ltd.	Acetanilide, 2,4-DCNB,HCl,H ₂ SO ₄ ,Methanol,NaSH, Dextrose, Hydrogen gas, Soda Ash, PNA	H Acid , DASA, TCB	Earlier It was using Iron reduction method and sludge generated was stored in the evaporation pans for sun drying. Before 3 years process was changed with fully automated and computer operated pollution control equipments .

TABLE 4 DETAILS OF INDUSTRIAL BORE WELLS

Name of Industry	Location	Bore well Depth (m)	Bore well dia (m)	Local Water level (m)	Pump HP	Color (Co-Pt)
Krishna Benzyl (closed)	Own Bore well	194	0.15	132	7.5	Reddish Brown
Alap chemicals	Own well	210	0.2	144	30	Reddish Brown
Milton Industry (new)	Own well	210	0.25	144	30	Clear

Pharmson Chemicals	Own bore well	222	0.20	150	7.5	Reddish brown = 55
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TABLE 5-A WATER QUALITY DEAILS OF INDUSTRIAL BORE WELLS AND INDUSTRIAL EFFLUENT

Para-meters	Milton Laminates Bore-well	Alap Chemicals Borewell	IS 10500 standards (mg/l)	Ambuja Intermediate s effluent	Chadarda
Arsenic	-	-	0.01-0.05	0.0079	
Chromium	-	-	0.05	0.9370	
Cadmium	-	-	0.01	0.0088	
Lead	-	-	0.05	0.0513	
Ferrous	0.0871	-	0.3	85.95	
Zinc	0.0979	0.0455	5	0.7557	
Mercury	-	0.0034	0.001	-	0.0033

TABLE 6 IDENTIFIED PROBABLE INDUSTRIAL SOURCES OF GROUND WATER CONTAMINATION

POLLUTANTS	PROBABLE SOURCES
IRON	Ambuja Intermediates pvt. Ltd (<i>The industry was using evaporation ponds in the past for natural drying of Iron Sludge. Iron may be leached out through the leakages in the evaporation ponds or may be dumped.</i>) Alap Chemicals (<i>Generates Iron sludge but their storage area although old but is fully cemented.</i>)
Organic Compounds	Krishna Benzyl Pvt ltd Ambuja Intermediates Pvt. Ltd Milton Laminates (<i>Direct evaporation of phenol-formaldehyde mixture in open</i>)

RESULTS & DISCUSSION:

TABLE 7 SUMMERY OF WATER QUALITY ANALYSIS RESULTS

Locations Parameters	Julasan Road	Ambuja Intermediates (Main Gate)	Ambuja Intermediate s (Staff Housing)	Rajpur (Behind Ambuja Intermediates)	Ambliyara well (Behind Ambuja Intermediates)	Milton Laminates	Alap Chemicals
pH	7.60	7.50	7.63	7.97	7.84	7.7	7.9
COD	20	38.4	19.2	12	38.4		
TDS	1660	1820	1810	1390	1690		
Hard-Ness	460	650	575	525	625		
Sulfates	45	71	61	61	103		
Chlorides	496	672	736	416	552		
Nitrates	6.20	4.10	5.90	11.60	5.90		
Flouride	0.98	1.35	1.45	0.82	1.10		
Iron	2.60	6.2	1.9	0.68	9.8		
Color (Co-Pt)	45	55	50	55	82		

Arsenic	-	-	-	0.0012	0.0024	-	-
Cadmium	0.0109	0.0076	0.0241	0.0062	0.0101	-	-
Chromium	-	0.0002	-	-	0.0008	-	-
Lead	-	0.0025	0.0244	-	-	-	-
Zinc	0.0068	0.0276	0.0757	0.0169	0.0352	0.0979	0.0455
Mercury	0.012	0.0081	-	0.01	0.0128	-	0.0034

POLLUTION INDICATING PARAMETERS: PH, TDS, COD, IRON, COLOUR AND MERCURY

CONTAMINANTS OF CONCERN (COC): ORGANIC COMPOUNDS (COD), IRON, COLOUR

Mercury is not considered as one of the COC as there is a strong probability of mercury's natural presence in the earth crust of the region as it is found present even in the ground water of village chandarda, which is away from this industrial zone.

Initially samples were collected from the identified villages scattered in the 20 kms north-east upstream of Mehsana-Chhatral high way. COD is observed higher in the bore wells collected from three villages namely Anandpura, Karjisan and Dangarva.

During site visit, it was known that some bore wells near Mehsana-Chhatral highway are giving colored water. Hence further study was narrowed down to those bore wells. Quality analysis results showed the ground water in this region is contaminated with iron, heavy metals and organic compounds. The sampling location of Rajpur village (Behind Ambuja intermediates) carries minimum concentration of Iron showing the Brown color in water whereas the sampling location of Ambaliyara well carries maximum concentration of Iron showing the dark Reddish brown color in ground water. Reddish Brown is due to Ferric iron. Ferrous iron gets oxidized in the aquifer to ferric iron, which gives color.

During Sampling, details of chemical industries were collected in order to identify the probable industrial sources of ground water pollution which are tabulated in Table 6. Iron may be leaked out through the leakages in the evaporation ponds or may be dumped below the surface which is now leached out as ferric iron (Fe(+3)) and giving color in the ground water as the atmosphere in the aquifers below the surface is oxidative

Conclusion:

- Water quality analysis results of the samples collected definitely indicate that the ground water in the study area is polluted as reflected in particular by the presence of organics, COD, color and Iron concentration.***
- Iron (Ferric) concentration in the study area varies from 0.60 mg/L to 9.8 mg/L. It is observed that the intensity of color increases with the increase in concentration of Iron indicating the direct probable relationship between the intensity of color and concentration of Iron.***

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- 2) Gujarat Pollution Control Board, Gandhinagar
- 3) ERM, Delhi (online guidance)