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Variability in Physico – Chemical Parameters of Ground Water of South-West Zone of the Bhiwadi Industrial Area (Alwar)

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ABSTRACT

Ground water quality parameters of South-West zone of Bhiwadi industrial area (Alwar) Rajasthan were assessed in this study. Ground water samples were collected from different location of South- West zone and analysis of parameters such as pH, TDS, BOD, COD, DO, Fluoride, Nitrate, Sulphate, TH, TA and heavy metals were carried. Finding parameters were compared with the WHO water quality parameters. It was found that some of the location under the study fall in polluted zone. The results shown that the areas which near to industries have polluted than the others.

KEY WORDS: Ground water, Parameters, Industrial pollution, Permissible limit, Polluted area.

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INTRODUCTION

Pollution of ground water is an important aspect of environmental pollution with the fast industrialization and urbanization in the world. The principal sources of contaminants of ground water are mines, petroleum processing units, steel, smelter plants, pulp paper, textile and agriculture industries etc. When the waste water of an industry is dumped into streams, it gets into natural sources and causes change in physio-chemical composition of ground water which ultimately becomes unsuitable for use. Many different chemicals and various synthetic products we use today are usually the main causes of ground water pollution[1, 2].

A lot of effluents and wastes discharged by the industries over the years have contaminated the groundwater resources. Bhiwadi is a highly polluted city due to too much industrialization. Many industries leave out his effluents without treatment. This untreated effluent spared on land surface and it enter into aquifer and contaminated the groundwater. This contaminated groundwater cause of many disorders in human being and crops.[3-5]

This paper highlights the various physico-chemical parameters of ground water from various sources of South-West zone of Bhiwadi industrial area, which will helps us to formulate the strategy for mitigating the harmful effects of ions present above the prescribed levels.

EXPERIMENTAL

Material and method

Bhiwadi is located at the East end of Rajasthan in Tijara tehsil of Alwar district. It is within the national capital region, just 55 Kms away from Delhi, 200 Kms from state capital Jaipur and 90 Kms from the district head quarter Alwar. Spread over 3347 acres of land and 3000 acres area proposed for extension, Bhiwadi has about 1455 tiny, small, medium and large industries including MNC industrial units manufacturing various types of products. They include all types of industries like steel, furnance, electronics, engineering, textiles, pharmaceuticals, printing, packaging, cables, rolling mills, food processing, herbal care etc.

Bhiwadi already boasts of big multinational companies, namely, Pepsi, Honda Siel (manufacturers of Honda cars), Orient Craft, Asahi, Jaquar, and Hero Honda, Bausch & Lomb, United Breweries, Ray Ban, Saint Gobain, Federal Moghul, Gillette, Sakata Ink and Ocap Chasis. Other major industries in the city include Relaxo Footwear, Lakhani Footwear,

Jacquar Ltd., Harvest Foods Limited, Kajaria Ceramic Ltd, and SEZ of Mahindra and Mahindra. These companies have acquired huge acres of land in Bhiwadi, made crores of investment and employed thousands of people. Bhiwadi serves as a gateway to Rajasthan.

The present study was planned by selecting ten locations located in South-West Zone of Bhiwadi industrial area and ground water samples were collected from selected locations as per standard procedure. The literature survey showed that no ground water studies were made in these localities so far. Hence the present study was undertaken by authors.

Collection and analysis of ground water samples[3-6]

The ground water samples were collected in pre cleaned one- liter plastic bottles from borewells, handpumps and open wells located in South- West zone of Bhiwadi industrial area. The ground water samples which collected from different sources, analyzed as per standard procedures to know the chemical status of ground water. These groundwater samples were taken two times- pre monsoon and post monsoon. The analyzed data were compared with the water standards given in the Table. Results of ground water samples of South-West zone are summarized in the Table 2, 3, 4 and 5.

DISCUSSIONS

pH : The range of pH of ground water samples was found from 6.5 to 8.2 for pre monsoon samples and 6.5 to 8.4 for post monsoon samples. The pH value varies from 6.5 to 8.4 for both samples. All pH values of both samples are within range according to ISI standards as given in the Table: 1.

Color: The color of ground water samples of pre monsoon and post monsoon are not same. This is indicative of large amounts of organic chemicals and inadequate treatment. There may be little health concerns the color availability in the groundwater. However, it is aesthetically unpleasing.

Odor: Certain odors are indicative of organic or non-organic contaminants that originate from municipal or industrial waste discharges or from natural sources in the ground water samples.

Taste: It can be evaluated by a taste test. In the South- West zone ground water samples which are unaffected by industries have agreeable taste.

Turbidity: Turbidity of the South – West zone was found within the range 1 to 18. The values for the pre monsoon samples was found 0.1 to 16.1 NTU and Alupur and UIT

Residential area samples have higher values than the permissible value. In post monsoon samples, the range of turbidity was found 0.2 to 18 and Alupur area sample have higher value than the permissible limits.

Electrical conductivity: Electrical conductivity of this zone was found between range 195 to 1550 microsiemens/cm. The Tables: 2& 4 reveal that Alupur and UIT Residential area samples have higher conductivity than other sources. This is due to pollution of ground water by percolated effluents[7-8].

Biological Oxygen Demand (BOD): The BOD values varied for the pre monsoon samples from 6.9 to 42 mg/l and for the post monsoon samples 18 to 49 mg/l. The range for both samples was found in between 6.9 mg/l to 49 mg/l. The higher values of BOD indicate that the industrial effluents contain large amount of organic matter. This is due to distillery, beverages, oil and food processing industrial units operative in the industrial area. The Table: 2 & 4 show that Alupur area sample have much higher value of BOD than other samples due to mixing of industrial discharges.

Chemical Oxygen Demand (COD): The range of COD for pre monsoon samples 54 to 240 mg/l and for post monsoon samples 7.9 to 276 mg/l. The range varies from 69 to 280 mg/l for both samples. The water with high BOD and COD is totally unsuitable for drinking irrigation, domestic, industrial and other purposes[9-10].

Dissolved Oxygen: The DO values of the South–West region for pre monsoon samples was found in the range from 0.8 mg/l to 3.0 mg/l and for the post monsoon samples 0.5 to 3.1 mg/l. It is indicates that the water is contaminated and it is difficult to survive any aquatic species in this water.

Total coliform: The total coliform range was found from 1MPN/100 to 45MPN/100 for both samples, which shows the presence of coliform and water is bacteriological contaminated. Ground water sample of Alupur,UIT Residential area and City Centre have more total coliform than the permissible limits as per described in IS : 10500-1991.

Total Hardness: The Table: 3 & 5 reveal that the values of total hardness vary from 346 to 890 mg/l for the pre monsoon samples and Ca and Mg Hardness varies from 118 to 439 mg/l and 77 to 285 mg/l respectively. For the post monsoon samples range of TH was found 348 to 1929 mg/l and Ca, Mg Hardness range, 110 to 453 mg/l and 45 to 345 mg/l respectively. All

samples have higher value in the both sessions than the desirable limits as compared to IS-10500-1991 parameters.

Chloride: The chloride contents in the all ground water samples were found in the range from 409 to 1050 mg/l and 590 to 1298 mg/l for the pre and post monsoon samples respectively. Alupur and Group Housing area samples have higher Chloride values for the post monsoon samples than the permissible limits.

Total dissolve solid: The Table: 3 & 5 show the ranges of the total dissolved solids the pre monsoon samples which was found between 799 to 2209 mg/l. The Table indicate that Alupur and Group housing area samples have higher value than the permissible limits. TDS values for the post monsoon samples range 810 to 3287 mg/l and Santhalka, Alupur, Stadium, Group housing area samples have higher TDS value than the permissible limits. It may be conclude that all water sources have more TDS value than the desirable limits[9-11].

Alkalinity: The range of alkalinity for the pre monsoon samples was found 387 to 799 mg/l and maximum alkalinity was found in City Centre area source. The value of TA for the post monsoon samples was ranged in 393 to 646 mg/l and Alupur area sample have maximum alkalinity value. The Table 3 & 5 show that the all sources have higher alkalinity than desirable limits[8].

Nitrate: The Table: 3 & 5 reveal that the values of nitrate for the pre monsoon samples 22 mg/l to 99 mg/l and for post monsoon samples, 29 mg/l to 109 mg/l. All ground water samples have higher value of nitrate than the desrisable limits. This may be due to less rainfall and excessive use of fertilizers and higher concentration of nitrates in industrial effluents discharged by different industries[12-16].

Aluminium: The observed values of Aluminium in South-West zone ground water samples for the pre monsoon samples and post monsoon samples are shown in the Table: 3 & 5 respectively. Alupur area sources have higher value of aluminium ion than permissible limits for post monsoon samples[15-16].

Fluoride: The Tables: 3 & 5 reveal the range of fluoride in this zone for the pre monsoon samples varies from 0.6 to 6.9 mg/l and Public school and Alupur area sample have higher fluoride values then the permissible limits. The fluoride range for the post monsoon samples was found 0.9 to 7.3 mg/l and Trade Centre, Alupur, Milkpur Gujar and group Housing have higher fluoride values than the permissible limits[14].

Sulphate: Sulphate values were found in the range from 245 to 837 mg/l and 289 to 890 mg/l for pre and post monsoon samples respectively. Village Alupur, Milkpur Gurjar and Citry Centre have higher sulphate values in the both sessions than the permissible limits due to industries effluents percolating in the ground water.

Table 1: Drinking water standards (is: 10500-1991)

S.No.	Parameters	Desirable limit mg/l(ppm)	Permissible limit in the absence of alternate source(ppm)
1.	Colour (Hazen Units)	5	25
2.	Odour	Unobjectionable	-
3.	Taste	Agreeable	-
4.	Turbidity, NT Units	5	10
5.	pH	6.5 – 8.5	No Relaxation
6.	Total Hardness as $CaCO_3$	300	600
7.	Iron as Fe	0.3	1.0
8.	Chloride as Cl	250	1000
9.	Free Residual Chloride	0.2	-
10.	Total Dissolved Solids	500	2000
11.	Calcium as Ca	75	200
12.	Copper as Cu	0.05	1.5
13.	Manganese as Mn	0.1	0.3
14.	Sulphate as SO_4	200	400
15.	Nitrate as NO_3	45	100
16.	Fluoride as F	1.0	1.5
17.	Phenols as C_6H_5OH	0.001	0.002

18.	Mercury as Hg	0.001	No Relaxation
19.	Cadmium as Cd	0.01	No Relaxation
20.	Selenium as Se	0.01	No Relaxation
21.	Arsenic as As	0.05	No Relaxation
22.	Cyanide as CN	0.05	No Relaxation
23.	Lead as Pb	0.05	No Relaxation
24.	Zinc as Zn	5	15
25.	Anionic detergents as MBAS	0.02	1.0
26.	Chromium as Cr	0.05	No Relaxation
27.	Mineral Oil	0.01	0.03
28.	Pesticides	Nil	0.001
29.	Radioactive materials - Alpha emitters, Beq/l - Beta emitters, Pci/l	 - -	 0.1 1.0
30.	Alkalinity as $CaCO_3$	200	600
31.	Aluminium as Al	0.03	0.2
32.	Boron	1	5
33.	Faecal Streptococci	Nil	-
34.	Coliform M.P.N. (in 100 ml)	1	10
35.	Cyclopes (or Guinea Worms)	Nil	Nil

ISI[100-102](1991) * Charges on cations and anions are omitted

Table 2: Physical & Biological Parameters of South- West zone: Pre- monsoon samples

Location / Source	PH	Color	Odour	Turbidity	Taste	Conductivity	BOD	COD	DO	Total Coliform
Santhalka(HP)	6.2	Colorless	UOA	7	Agreeable	980	27	130	10	< 2
Mini Udyog Bhawan(BW)	7.2	Clear	UOA	2.8	Agreeable	645	19	109	0.8	8
Trade Centre(BW)	6.9	Clear	UOA	4.1	Agreeable	1090	38	169	1.09	4
Public School(BW)	6.6	Clear	UOA	0.1	Agreeable	249	23	159	2.9	0.0
Alupur(OP)	7.3	Slightly brown	UOA	16.1	Agreeable	1550	12	64	3.0	18
Milkapur Gujar(HP)	7.0	Clear	UOA	0.4	Agreeable	329	16	108	1.09	6
UIT Residential Area(OP)	8.2	Reddish	OA	10.2	Agreeable	1421	42	240	0.9	4
Group Housing(BW)	7.9	Clear	UOA	1.2	Agreeable	490	10.5	84	1.9	3
Stadium(HP)	7.3	Clear	UOA	<1	Agreeable	195	6.9	54	2.8	0.0
City Centre(HP)	6.9	Clear	UOA	1.0	Agreeable	400	21	102	1.6	7

HP = Handpump BW = Bore well OP = Open well UOA = Unobjectionable OA = Objectionable

Table 3: Chemical Parameters of South -West zone: Pre- monsoon samples

Location / Source	Cl^-	NO_3^-	TDS	PO_4^{-3}	SO_4^{-2}	Al^{+3}	F^-	Cd	Hg	Cu	As	Pb	Cr	Fe	Zn	Hardness	Ca-Hard Ness	Mg-Hard Ness	Alkalinity	Oil & Grease
Santhalka (HP)	456	45	799	0.006	245	0.02	0.9	ND	ND	0.02	ND	ND	0.01	0.9	2.9	459	168	88	568	ND
Mini Udyog Bhawan (BW)	409	36	1180	0.02	458	ND	1.3	ND	ND	ND	ND	ND	ND	ND	5.7	589	280	119	490	ND
Trade Centre (BW)	567	28	1656	0.0	289	0.1	0.6	ND	ND	ND	0.002	ND	ND	0.2	3.2	478	159	99	456	ND
Public School (BW)	545	42	1378	ND	370	ND	6.9	ND	ND	0.05	ND	ND	ND	0.09	1.0	389	118	68	390	ND
Alupur (OP)	1050	99	2209	1.1	837	0.9	4.5	ND	ND	1.2	ND	0.02	ND	8.6	13.9	890	439	180	569	3.6
Milkapur Gujar (HP)	750	72	1180	0.2	375	0.06	1.5	ND	ND	ND	ND	0.001	0.02	ND	ND	346	189	98	489	ND
UIT Residential Area(OP)	685	89	1567	ND	275	ND	1.0	ND	ND	ND	0.001	ND	ND	0.02	ND	578	179	102	387	ND
Group Housing (BW)	850	41	2189	0.001	398	1.3	1.4	ND	ND	0.01	ND	ND	0.001	1.0	ND	598	239	128	480	9.07
Stadium (HP)	940	39	1657	ND	298	ND	1.2	ND	ND	0.04	ND	ND	ND	ND	0.09	489	189	77	579	ND
City Centre (HP)	695	52	1490	ND	310	0.2	1.3	ND	ND	ND	ND	0.04	ND	0.08	1.4	567	367	250	599	ND

(ND = Not Detectable)

Table 4: Physical & Biological Parameters of South -West zone: Post- monsoon samples

Location / Source	pH	Color	Odour	Turbidity	Taste	Conductivity	BOD	COD	DO	Total Coliform
Santhalka(HP)	7.4	Colorless	UOA	1.9	Agreeable	654	23	128	1.4	< 4
Mini Udyog Bhawan(BW)	6.5	Clear	UOA	0.2	Agreeable	345	ND	7.9	2.5	8
Trade Centre(BW)	7.9	Clear	UOA	1.8	Agreeable	480	37	243	0.5	6
Public School(BW)	7.1	Clear	UOA	2.6	Agreeable	899	18	108	1.9	9
Alupur(OP)	8.0	Slightly brown	OA	18	Agreeable	1380	49	276	0.7	18
Milkapur Gurjar (HP)	7.0	Clear	UOA	5.9	Agreeable	960	17	98	1.5	4
UIT Residential Area(OP)	8.4	Reddish	UOA	6.8	Agreeable	785	38	179	2.1	29
Group Housing (BW)	6.9	Clear	UOA	1.09	Agreeable	287	0.0	29	3.1	6
Stadium(HP)	7.1	Clear	UOA	7.2	Agreeable	569	19.6	94	0.9	ND
City Centre(HP)	8.1	Clear	UOA	3.1	Agreeable	280	19	89	2.2	12

HP = Handpump BW = Bore well OP = Open well UOA = Unobjectionable OA = Objectionable

Table 5: chemical Parameters of South- West zone: Post - monsoon samples

Location / Source	Cl^-	NO_3^-	TDS	PO_4^{-3}	SO_4^{-2}	Al^{+3}	F^-	Cd	Hg	Cu	As	Pb	Cr	Fe	Zn	Hard ness	Ca-Hard Ness	Mg-Hard ness	Alkal inity	Oil & Grease
Santhalka (HP)	678	29	2398	ND	378	ND	1.4	ND	ND	ND	ND	ND	0.02	0.9	ND	564	279	98	543	ND
Mini Udyog Bhawan (BW)	876	39	1564	0.02	345	ND	1.2	ND	ND	0.02	ND	0.02	ND	1.1	2.9	489	180	80	582	ND
Trade Centr (BW)	659	44	1459	ND	298	ND	4.2	ND	ND	ND	ND	ND	0.01	0.4	ND	749	210	103	495	ND
Public School (BW)	342	69	810	ND	324	ND	0.9	ND	ND	ND	ND	ND	ND	0.9	0.8	348	110	99	489	ND
Alupur (OP)	1298	109	2478	0.9	890	1.09	7.3	0.01	ND	0.8	ND	ND	1.02	12.3	16.3	1929	675	345	646	18
Milkapur Gujar(HP)	590	43	1980	0.002	620	0.03	2.9	ND	ND	0.01	ND	0.01	ND	0.009	4.3	453	115	45	393	ND
UIT Residential Area(OP)	520	49	2265	ND	289	ND	1.2	ND	ND	ND	ND	ND	ND	0.4	ND	1578	222	70	613	ND
Group Housing (BW)	1020	56	3287	1.0	399	ND	3.2	0.02	ND	0.06	ND	ND	0.001	2.1	18.03	1387	278	134	609	8.05
StAdium (HP)	650	38	2129	0.003	298	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND	785	190	87	448	
City Centre(HP)	565	59	1687	ND	418	0.2	1.1	ND	ND	0.4	ND	ND	0.05	1.0	ND	982	453	149	ND	0.86

(ND= Not Detectable)

Iron: The range of iron for the pre monsoon samples varies from 0.02 to 8.6 mg/l and Alupur area sources have higher values than the permissible limits. Iron values for the post monsoon samples varies from 0.09 to 12.3 mg/l. The Table: 5 show that Alupur and group Housing area samples have higher values than the permissible limits in post monsoon samples.

Lead: The Tables: 3 & 5 reveal the range of lead varies from 0.01 to 0.04 mg/l for both samples. Desirable limits for lead is 0.05 mg/l. Hence, the data obtained indicate the low degree pollution due to this element.

Mercury: The concentration of mercury in the ground water samples of South-West zone for pre and post monsoon samples was not detectable. The result has shown in the Tables: 3 &5.

Arsenic: The heavy metal arsenic is not detectable in ground water samples for pre and post monsoon samples.

Cadmium: The range of Cd occurrence varies for pre and post monsoon samples were found 0.001 to 0.2 mg/l which is in the permissible limits.

Chromium: The concentration of Cr was varies for the pre monsoon samples 0.001 to 0.02 mg/l and for post monsoon 0.001 to 1.02 mg/l. All values were found within range as compared to recommended standards.

Copper: This heavy metal concentration for the pre monsoon samples varies from 0.01 to 1.2 mg/l and for the post monsoon samples 0.01 to 0.8 mg/l. The concentration of Cu was found within range for both samples as compared to recommended standards.

Zinc: The range of Zn for the pre monsoon samples was found 0.09 to 13.9 mg/l and the range of post monsoon was found 0.8 to 18.3 mg/l. All values of pre monsoon samples are within ranged. According to BIS standard the range of Zn is 5 mg/l to 15 mg/l. Concentration of Zn for post monsoon samples higher than the permissible limits for Alupur and Group Housing area samples.

CONCLUSIONS

Considering all the investigated problematic chemical constituents collectively, suitability of water for drinking purpose has been decided by author as given below.

- Excellent to Good – All chemical constituents below desirable limits.
- Good to Permissible - All chemical constituents between desirable and permissible limit. 1 to 5 constituents may be below desirable limits.

- Doubtful to Unsuitable - If all constituents except any one of pH. Chloride, T.D.S. and T.H. are below permissible limits.
- Unsuitable -If any one of direct health affecting constituent (nitrate and fluoride) or 2 to 6 constituents are above permissible limits.
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Table 6: Drinking water quality status in South – West Zone

Location / Source	Samples Collected			
	Pre –Monsoon	Remarks	Post-Monsoon	Remarks
Santhalka(HP)	Good	In limit	Good	TDS higher
Mini Udyog Bhawan(BW)	Good	SO_4^{2-} higher	Good	In limit
Trade Centre(BW)	Good	In limit	Doubtful	F^-, TH higher
Public School(BW)	Doubtful	F^- higher	Doubtful	NO_3^- higher
Alupur(OP)	Unsuitable	Not fit for drinking	Unsuitable	Not fit for drinking
Milkapur Gujar(HP)	Doubtful	NO_3^- higher	Doubtful	F- higher
UIT Residential Area(OP)	Doubtful	TDS, Total coliform, NO_3^- higher	Doubtful	TDS, TH TA, NO_3^- higher
Group Housing(BW)	Good	TDS higher	Unsuitable	Not fit for drinking
Stadium(HP)	Good	TH higher	Good	TDS higher
City Centre(HP)	Good	In limit	Doubtful	Cl^-, TA, TDS TH higher

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