

Study of the Quality of Ground Waters of Some Villages at Shikohabad, District Firozabad (India)

KM. NEELAM VERMA, VISHAL PATHAK, D.C. YADAV AND PRABHAT PATHAK*

Department of Chemistry

Narain (P.G.) College, Shikohabad-205 135, India

The present paper describes the results of a survey of the physico-chemical characteristics of groundwaters of eight villages at Shikohabad, District Firozabad, U.P. over a period of one year. It can be concluded from this study that the pollutants in water of hand pumps are comparatively higher than the dugwells. Concentrations of chlorides, fluorides are within the limits as prescribed by WHO. On the other hand, nitrate-nitrogen, alkalinity and hardness are much higher. Entry of pollutants to the ground water is quite complex and several processes affect its movement.

INTRODUCTION

The Indian freshwaters are under considerable threats due to the fast pace of industrial development, the country is undergoing in the past one or two decades. A survey made by Agrawal *et al.*¹ shows that 70% of India's freshwaters are polluted by conventional standards.

The quality of groundwater is also of vital importance to human beings for drinking and other domestic purposes. The literature studies reveal that much of the available studies are from urban areas^{2,3}. Not much information is available for rural areas. So it was thought proper to extend the studies to rural areas of Distt. Firozabad. The present paper describes the results of a reconnaissance survey of ground water in certain villages of Shikohabad, District Firozabad.

EXPERIMENTAL

Water samples were analysed as per standard methods laid down by APHA-AWWA-WPCF⁴ and Golterman *et al.*⁵ All the reagents used were of AR grade. Water samples from handpumps and dugwells were collected from eight different villages of Shikohabad, District Firozabad for a period of twelve months from January 1998 to December 1998 at 30 days interval. Plastic containers were used for sampling samples.

RESULTS AND DISCUSSION

The average concentrations of all the parameters studied are given in Table-1. It is apparent from the data for pH that the water is always associated with some kind of alkalinity. High pH is normally associated with a high photosynthetic activity of water^{6,7}.

TABLE-1
 AVERAGE VALUES OF PHYSICO-CHEMICAL PARAMETERS OF GROUND WATER IN THE VILLAGES ADJOINING
 "SIRSA" RIVER AT SHIKOHABAD

Name of the village	Source of water	Depth of source (ft.)	pH	Electrical conductivity mmhos cm^{-1}	Total alkalinity (CaCO_3)	Chloride	Total hardness	Fluoride	Nitrate	$\text{PO}_4\text{-P}$	Silica	Na	K	Ca	Mg
Naushera	A	150	7.72	361.00	361.00	86.20	298.00	0.96	21.15	1.96	24.08	39.62	17.00	61.85	18.78
	B	95	7.54	70.00	381.00	34.96	359.00	0.98	14.22	1.88	44.15	15.19	9.67	86.27	70.70
Bhoora	A	150	7.63	170.00	381.00	26.36	111.00	1.40	13.99	3.02	59.46	50.48	7.65	78.73	31.52
	B	90	7.61	149.00	368.00	27.14	274.00	0.88	9.47	1.79	30.42	35.02	9.00	61.33	11.88
Rithara	A	125	8.33	448.00	600.00	27.10	516.00	0.89	33.65	4.33	27.17	55.06	9.13	108.80	22.06
	B	90	8.04	142.00	483.00	18.15	474.00	1.46		2.10	27.98	10.10	14.16	116.66	102.80
Pachpera	A	150	8.14	149.00	420.00	19.80	113.00	0.81	12.13	4.08	26.51	10.95	9.53	245.45	24.93
	B	90	7.84	47.00	383.00	32.92	271.00	1.05	9.03	1.19	30.28	102.14	7.96	63.77	49.00
Shahzalpur	A	150	7.18	886.00	339.00	6.66	465.00	1.31	7.14	2.05	23.70	11.65	7.64	95.75	27.96
	B	90	7.32	171.00	637.00	4.34	523.00	0.86	19.83	2.53	28.79	92.85	6.51	105.49	46.37
Rahchati	A	150	7.88	186.00	422.00	27.97	755.00	1.04	15.77	4.20	37.17	18.75	16.00	153.77	155.92
	B	95	8.32	644.00	443.00	109.30	989.00	0.89	19.63	2.15	63.02	79.03	16.32	189.33	175.55
Vasternai	A	150	7.66	256.00	435.00	55.47	132.00	1.02	13.51	5.10	29.92	49.45	13.65	89.06	37.13
	B	95	7.51	234.00	457.00	111.38	422.00	0.97	24.40	1.85	28.43	61.69	7.66	76.72	40.33
Chitavali	A	125	8.00	250.00	440.00	23.59	410.00	0.79	8.90	3.11	16.75	43.23	7.90	63.58	45.08
	B	95	8.06	176.00	400.00	8.98	1079.00	1.26	21.17	2.03	29.95	19.16	7.84	111.18	105.19

A = hand pumps B = dugwells

The maximum electrical conductivity was observed in hand pump water samples at Shahzalpur, *viz.*, 886.00 mmhos cm^{-1} and minimum in dugwell waters at Pachpera, *viz.*, 47.00 mmhos cm^{-1} . Electrical conductivity is directly related to total dissolved solids. It does not characterise as a parameter for the suitability for potable purposes.

High values of total alkalinity, *viz.*, 600 mg/L, were observed in water samples from hand pump at Rithara and 637 mg/L from dugwell at Shahzalpur. Such waters may cause excessive encrustation in distribution pipes as these waters have a positive saturation index. High values associated with water bodies seem apparently polluted. Waters with such high values of alkalinity are not fit for irrigation purposes.

In general, waters with hardness less than 120.00 mg/L as CaCO_3 are desirable. In ICMR (1975) standards a desirable limit for this parameter has been set at 300 mg/L but waters with hardness up to 600 mg/L are allowed. Very high values of total hardness as CaCO_3 have been recorded, the highest (1079.00 mg/L) being in dugwell waters at Chitavali and 755.00 mg/L in handpumps at Rahchati. It is obvious that from the viewpoint of this parameter the ground water samples have rather high soap consumption or soap wastage capacities and their use for laundering purposes without prior treatment will result in considerable soap wastage.

Most of the samples exceed the prescribed limits set by WHO (1984). Hardness does not have any ill impact on human health though some evidences have been given to indicate its role in heart diseases.⁸

More than 50% of dugwell water samples have fluoride content below 1.0 mg/L whereas the rest have fluoride content in the range of 1.02–1.46 mg/L. The highest value (1.46 mg/L) has been recorded in the dugwell water at Rithara village. It is reported that dental fluorosis⁹ may occur in those cases where water contains fluoride more than 1.0 mg/L.

Limits for maximum concentration of chloride have been set on the basis of taste preferences. However, large amounts of chloride, when calcium and magnesium are also present, lead to an increase in water's corrosiveness and may adversely affect water quality by acquiring harmful elements by corrosion of metallic pipes through which it may be transported for use.

The highest concentration of chloride, *viz.*, 86.20 mg/L in hand pump water at Naushera and 111.38 mg/L in dugwell water at Vastemai has been recorded. The importance of chloride as an indicator of sewage pollution has been emphasized by Thresh *et al.*¹⁰

Highest values of nitrate, *viz.*, 33.65 mg/L were noted in hand pump water at Rithara and 24.40 mg/L in dugwell water at Vastemai. The lowest value of nitrate was recorded in hand pump water, *viz.*, 7.14 mg/L at Shahzalpur.

Nitrates generally owe their origin mainly to anthropogenic sources and as such high values are not expected. The high values of nitrates in few waters may be attributed to the garbage in the vicinity of water source and excessive use of nitrogenous fertilizers. Nitrate toxicity in human beings was reported by Comly¹¹ and diagnosed as methaemoglobinaemia. This illness is generally confined to infants.

The highest concentrations of $\text{PO}_4\text{-P}$ (5.10 mg/L) have been recorded in hand pumps at Vastemai. The $\text{PO}_4\text{-P}$ alone is not harmful to man but in association with high value of calcium may cause kidney stone.

Sodium is an essential element but may adversely affect people with cardiac, renal and circulatory problems. The sodium content in water samples from hand pumps is somewhat lower and its maximum concentration was found at Rithara, viz., 55.06 mg/L. So the use of this water is better than the water samples of the dugwell.

A study of the results recorded in Table-1 shows that 65% of water samples have potassium less than 10 mg/L. The high concentration, viz., 17.00 mg/L was observed at Naushera village, which is still below the harmful limits. Potassium is not of much concern from health point of view, but its large quantities may be laxative.

Calcium is an essential element of human nutrition. Although, insufficient amount may induce adverse physiological effects. Concentrations, as high as 1800 mg/L as Ca^{2+} , have proved to be harmless. The maximum values, viz., 245.45 mg/L of Ca^{2+} was recorded in hand pump water at Pachpera and 189.33 mg/L in dugwell water at Rahchati.

Magnesium is a non-toxic element. Its presence is beneficial for the heart and nervous system. Taste considerations limit its concentration in potable water. The I.C.M.R. standards have laid down an acceptable limit of 50–100 mg/L. However, potable waters having concentrations greater than 50 mg/L exert mild laxative effect. Highest concentration 155.92 mg/L was found in hand pump water and 177.55 mg/L in dugwell water at Rahchati.

Before identifying pollution, a brief idea of the various processes which affect pollution of ground water is given below:

TABLE-2
PROCESSES AND REACTIONS CAPABLE OF GENERATING AND/OR
ATTENUATING POTENTIAL POLLUTANTS

Geochemical Reactions	Physical processes
Solution-precipitation	Transport phenomenon
Acid-base reaction	Flow (path and rate)
Oxidation-reduction	Dilution
Adsorption-desorption	Dispersion
Complexation (ligand formation)	Filtration
Biochemical processes	Evaporation/gas movement
Organic decomposition	Biophysical processes
Cell synthesis	Transport of pathogens

The entry of pollutants to the ground water body through the root zone and intermediate zone referred as the vadose zone is quite complex and several processes, as outlined above (Table-2) will affect its movement, till it reaches the saturated zone. In the aquifer also attenuation of the pollutant is likely to occur

through mixing with the ground water and through adsorption on the granular materials through which ground water is circulating. In the normal natural ground waters and in the enclosing solids only certain species are normally present and available for reaction in meaningful concentrations. These species include dissolved calcium, magnesium, sodium, potassium, bicarbonate, sulphate, chloride and silica. In the surrounding porous bodies we find the additional components of iron, aluminium and possibly carbonates.

Another important phenomenon that affects the movement of pollutant to the pheratic zone is that of adsorption or ion-exchange. The pH of the soils is, however, an important factor to be taken into consideration.

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