J. Himalayan Ecol. Sustian. Dev. Vol 4. (2009) *ISSN 0973-7502*

HYDROCHEMICAL ASSESSMENT AND CHARACTERIZATION OF GROUNDWATER IN A PART OF THE JHELUM RIVER BASIN, SRINAGAR, J&K

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ABSTRACT

The hydrochemical investigation was carried out with a view of evaluating major-ion chemistry of groundwater. This paper aims at presenting the assessment of hydrochemistry and characterization of groundwater in a part of the Jhelum river basin, Srinagar, J & K. Representative groundwater samples were collected from bore wells, dug wells and springs. The hydrochemical assessment of groundwater vis-à-vis major ions was made through the estimation of chloride, bicarbonate, sulfate, calcium, magnesium, sodium, potassium, total hardness, pH, electrical conductivity (EC) and total dissolved solids (TDS). The range of the physico-chemical parameters fall well below the maximum permissible limits as recommended by the World Health Organization (WHO) (1993) and the Indian Standards Institution (ISI) (1983), thereby reflecting suitability of groundwater for drinking and domestic purposes.

Attempted characterization of groundwater on conventional Piper-trilinear (1944) diagram indicated three hydrochemical facies / water types, being dominated by the bicarbonates of alkaline-earths i.e., Ca- and Ca-Mg-HCO_3 facies and mixed cation-bicarbonate facies / hybrid waters.

Keywords: Hydrochemical assessment, Jhelum river basin, Srinagar, Piper-trilinear diagram, hydrochemical facies, alkaline-earths, hybrid waters.

INTRODUCTION

Groundwater is that hidden treasure of water that seeps beneath the surface of the ground, collects in natural underground reservoirs known as aquifers, and is the source of water in springs and wells. It is also important for the support of habitat and for maintaining the base flow to rivers. The chemical composition of groundwater is a measure of its suitability as a source of water for human, animal, irrigation and for industrial and other purposes. The quality of water plays a prominent role in promoting both the standard of human health and agricultural production. The history of human civilization reveals that the civilization and water are almost synonymous.

Srinagar district though bestowed with abundant sources of water in the form of surface water bodies (lakes, streams) yet great concern is voiced for rational supplying of domestic and drinking water in both rural and urban Srinagar. Widespread human activities related to urbanization, coupled with population explosion, created intensive anthropogenic pressures on the fresh surface water bodies, which culminated in large scale abuse and misuse of these sources, leading to deterioration of the potable sources of water (used mainly for drinking and domestic supplies). The aesthetic and chemical character of surface water bodies had altered to such an extent that people were forced to search for alternative and reliable source of water- like groundwater.

Consequently, tapping of groundwater for domestic and drinking water supplies has turned out to be a popular and widespread practice in Srinagar. So, considering these developments it becomes imperative to study the hydrochemical characteristics of groundwater in and around Srinagar. Hence, in the present paper an attempt was made to assess the quality of groundwater vis-à-vis major ions and characterize the groundwater in terms of the identified hydrochemical facies / water types.

STUDY AREA

The study area comprises both urban and rural Srinagar, lies between latitudes 34° 3\ - 34° 20\ N and longitudes 74° 42\ to 75° 00\ E. The drainage network comprises river Jhelum and its tributaries- Sindh, Harwan / Telbal, and Dudhganga, with some land-locked water bodies in the form of lakes (Dal, Nageen, Anchar) (Fig.1). Srinagar experiences by and large temperate to Mediterranean type of climate (Hussain, 2005). The winter is cold (min. temperature generally below freezing point) and the summer hot (max temp. recorded in July-August). The average rainfall is 661 mm, the most of which falls in spring i.e., between March and May.

Lithologically, the major part in the outcrops of the study area is covered by volcanic rocks (basalt), limestone, phyllites / slates, unconsolidated / semi-consolidated sediments of the Karewas and the Holocene sediments (alluvium). The subsurface water-bearing horizons are recharged by percolation of precipitation in the outcrops of the upland areas, and leakage from the surface water bodies.

MATERIALS AND METHODS

Groundwater samples were collected from 18 different sampling stations (covering nearly the whole of Srinagar) from bore-wells springs and dug wells, representing various sources of groundwater used in the study area. Representative groundwater samples were collected in clean polyethylene bottles of one liter capacity, which were first cleaned with 10% HNO_3, then rinsed with distilled water, and finally washed thoroughly with the water to be sampled, taking necessary precautions. The parameters were analyzed as per the standard methods (Trivedy and Goel, 1984; APHA, 1998). In-situ measurements included pH, EC and temperature while the analysis of major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, Cl^{-}, SO_4^{2-}) was carried out in the laboratory. Calcium, magnesium, hardness, chloride and bicarbonate were determined by volumetric method. Sodium and potassium were analyzed by flame emission spectrophotometer, and sulfate by spectrophotometer.

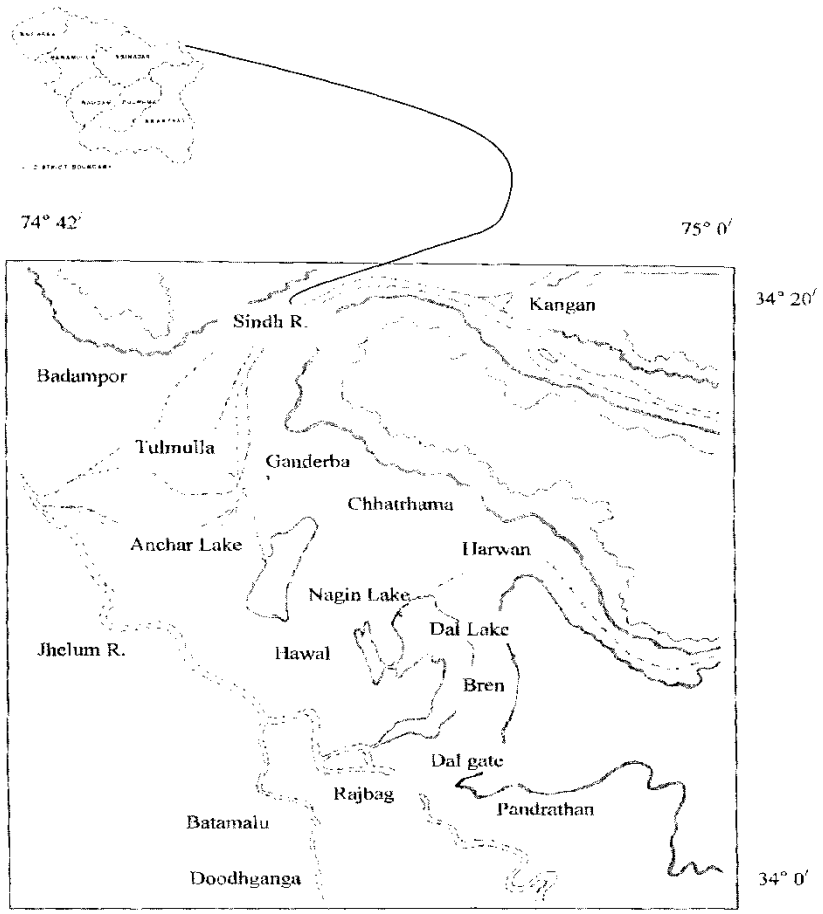

Fig. 1. Locations and coordinates of Srinagar District

RESULTS AND DISCUSSION

Based on the above parameters, major ion chemistry of groundwater was evaluated and the results of the physico-chemical parameters are given in Table 1. The range of various parameters analyzed has been compared with the WHO (World Health Organization) and the ISI (Indian Standards Institution), Table 2.

Table 1: Results of physico-chemical parameters of groundwater samples

Location	pH	EC µS/cm	TDS mg/L	T A mg/L	T H mg/L	Ca^{++} mg/L	Mg^{++} mg/L	Na^{+} mg/L	K^{+} mg/L	Cl^{-} mg/L	SO_4^{--} mg/L
Shalimar	7.12	254	163	95	90	26	6	38	4.7	60	3.12
Sadpora	7.27	596	381	285	180	52	12	35	4.0	15	2.70
Shehama	7.18	495	317	315	265	90	9	15	3.0	9	2.00
Harwan	7.40	300	192	225	179	50	13	28	6.0	24	1.60
Bren	7.87	713	456	380	330	96	20	34	3.5	56	4.00
Habbak	7.56	815	521	350	340	127	18	29	0.0	72	3.80
Gulabag	8.10	635	406	355	315	75	31	8	5.0	24	1.80
Gandarbal	8.03	510	326	280	215	72	8	15	3.5	13	3.90
Nagabal	8.09	710	454	310	280	80	19	29	1.2	47	3.10
Sadakadal	8.03	1008	645	455	365	100	25	70	8.0	93	3.60
Bachhpora	8.03	570	365	250	215	45	25	40	4.0	55	4.00
Sadrabal	8.02	770	493	445	315	72	16	60	3.0	51	3.50
Lalbazar	7.70	485	310	230	215	43	25	20	5.0	45	2.20
Qamarwari	7.35	930	595	425	410	115	25	40	1.5	70	3.30
Jawaharnagar	7.30	585	370	320	245	60	22	40	3.5	50	2.20
Pandrethan	7.10	530	339	280	220	60	16	32	3.0	25	3.00
Dalgate	7.33	570	365	290	250	63	20	20	2.8	40	4.00
Babadem	7.82	685	502	240	185	32	25	55	6.0	75	4.50

TA: Total Alkalinity, TH: Total Hardness

Table 2: Range in values of various physico-chemical parameters of groundwater

Constituent	Range	WHO (1993)		ISI (1983)	
		Acceptable limit	Max. permissible limit	Acceptable limit	Max permissible limit
pH	7.10 - 8.10	7 – 8.5	6.5 – 9.2	6.5 – 9.2	9.2
EC (µS/cm)	254 - 1008	-	1600	800	4800
TDS (mg/L)	163 - 645	500	1500	500	3000
Ca2+ (mg/L)	26 - 115	75	200	-	-
Mg2+ (mg/L)	6 - 25	<30 (if SO4 is 250 mg/L)	150 (if SO4 is 250 mg/L)	30	100
T. Hardness (mg/L)	90 - 410	100	500	300	600
Na+ (mg/L)	8 - 70	-	200	-	-
K+ (mg/L)	0 - 8	-	12	-	-
HCO3- (mg/L)	9 - 93	-	-	250	1000
Cl- (mg/L)	95 - 455	200	250	-	-
SO^2_4 (mg/L)	1.6 - 4.50	200	400	150	400

Drinking water Quality

Water for drinking and domestic purposes should be colourless, odorless, and free from turbidity. The groundwater of the study area is odorless and free from visible impurities / turbidity. The range of the parameters as given in Table 2 indicated that the concentrations of various constituents fall well below the established guidelines of the WHO (1993) and the ISI (1983) for drinking and domestic purposes. The groundwater samples analyzed showed basic nature (pH: 7.10 – 8.10) with alkaline earths (Ca^{2+} and Mg^{2+}) exceeding alkalis (Na^{+}, K^{+}) and weak acids (HCO_3^{-}, CO_3^{--}) exceeding over strong acids (Cl^{-} and SO_4^{--}). The values of TDS (163 mg/L – 645 mg/L) and EC (254 µS/cm – 1008 µS/cm) fall in freshwater category with low to slightly-high-salinity. The range of hardness (90 mg/L - 410 mg/L) indicated moderately hard to very hard water types (>300 mg/L) (Sawyer and MaCarty, 1967), Table 3.

Table 3: Water classes based on hardness (Sawyer and MaCarty, 1967)

Hardness mg/L as CaCO3	Water Class	No. of samples
0 - 75	Soft	0
75- 150	Moderately hard	01
150 – 300	Hard	11
Over 300	Very hard	06

Graphical representation and characterization of groundwater

Piper (1944) proposed trilinear graphical method to characterize water based on its major ion constituents. The trilinear diagrams are useful in bringing out chemical relationships among groundwater samples in more definite terms rather than with other possible plotting methods (Walton, 1970). The hydrochemical data was plotted on the Piper-trilinear diagram (Fig. 2) which indicated that most of the groundwater samples plotted in the zone which is characteristic of alkaline earths- alkaline earths exceeding alkalis and weak acids exceeding strong acids. Accordingly, three hydrochemical facies were identified which included the primary facies of Ca- and Ca-Mg-HCO_3 and mixed-cation-bicarbonate facies / hybrid water types. This chemical imprint taken by the groundwater indicated that meteoric character is largely retained in the subsurface horizons, hinting toward the possible limited migratory history of the groundwater in the subsurface. The dominance of Ca- and Ca-Mg-HCO_3 facies may correspond to the upper zone (Freeze and Cherry, 1979) i.e., indicative of shallow system.

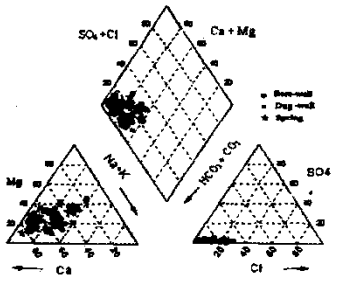

Fig. 2. Piper-Trilinear Diagram

CONCLUSION

Through the complex interplay of hydrogeological processes, the chemical imprint taken by the groundwater results in its large scale characterization as primary facies i.e., Ca- and Ca-Mg-HCO_3, and secondary facies or hybrid water types.

The present study also revealed that groundwater in the aquifers of Srinagar is fresh and alkaline in nature. Ca^{2+} and Mg^{2+} are the dominant cations and bicarbonate as the dominant anion. The excess of alkaline-earths impart hardness to the groundwater of the area.

The quality assessment of groundwater vis-à-vis major ions reflected its suitability for drinking and domestic consumption in terms of the established standards of the WHO (1993) and the ISI (1983).

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