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Assessment of surface and ground water for irrigational purposes

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Abstract

To assess the quality of surface and ground water for their irrigation potential, fifteen samples of each irrigation source were collected and were analysed for pH, Electrical conductivity (EC), Total Dissolved Solids (TDS), sodium (Na), calcium (Ca), magnesium (Mg), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), chloride (Cl), sulphate (SO_4^{2-}) and SAR. Chemically gound water was found to be more mineralized than surface water. Based on EC and SAR values all the samples were found within low salinity class and hence were found fit for irrigation purposes. The values indicate that ground water in the study area is the best alternative source of irrigation water for the crops and will certainly enhance the crops yield as compared to the surface water.

I. Introduction

Water nature's most wonderful, abundant and useful compound is fundamental necessity of biota. Without a properly functioning water supply, it is difficult to imagine productive human activity, be it agriculture, forestry, livestock, farming, fisheries, trade or industry. About 97.2% of world's water is found in oceans and seas and the remaining 2.8% of water is found as ground water and surface water, of which ground water (0.59%) is 30 times greater than surface water (0.02%). The quality of water is of paramount significance compared to quantity. The physical, chemical and biological characteristics of water determine its usefulness for municipal, commercial, industrial, agricultural and domestic water supplies [1]. Groundwater quality as one of the most important aspects in water resource studies is largely controlled by discharge and recharges pattern, nature of host and associated rocks, and contaminated activities. In recent years, an increasing threat to ground water quality as well as quantity due to human activities has become of great importance [2].

Currently about 43% of global irrigation, with 45% in India as well as more than 50% of the world's drinking water supply and a large share of global industrial activity depend on groundwater. Quality of water is assuming great importance with the rising pressure on agriculture and rise in standard of living [3]. Further, the excessive amounts of dissolved ions in irrigation water affect soil physically and chemically, thus reducing the primary productivity [4]. Over-abstraction and pollution has resulted in sharp declines in the groundwater quality and quantity, posing a risk to world food production. Nitrates and other ions contaminate the groundwater mainly by leaching [5] and its occurrence can be used to identify aquifer set-tings vulnerable to contamination [6]. Besides, natural factors contributing to its chemical composition are precipitation, geo-logical structure, mineralogy of the watershed, the quality of recharge water and aquifers and geological processes within the aquifer medium [7], [8] but mainly anthropogenic stresses have greatly affected its quality as well as quantity rendering ground water as useless [9], [10].

Few studies have been undergone for the quality of surface and ground waters of Srinagar for their irrigational purposes and the lack of baseline data for agricultural p-lanners and future studies. Therefore, this study was undertaken to find the suitability of surface and ground water sources of the region for irrigational purposes, so as to better understand the prevailing conditions. The study is of broad scope as it will not only help to find out the irrigational quality of the surface and ground water sources of the area.

II. Material and Methods

Forthe current study fifteen samples of each irrigation source (surface and ground water) were randomly collected from major vegetable belts of Srinagar district of Kashmir valley. Water samples from two sources of irrigation were collected in pre acid washed plastic bottles after rinsing them with the same water 3-4 times and were brought to laboratory immediately for analysis of parameters and analysed for pH, Electrical conductivity (EC), Total Dissolved Solids (TDS), sodium (Na), calcium (Ca), magnesium (Mg), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), chloride (Cl), sulphate (SO_4^{2-}) and SAR. pH, EC, TDS, Na and Cl were determined by the standard procedures [11], Ca and Mg by photometric method of by Photometric method [12], CO_3^{2-}, HCO_3^- and SO_4^{2-} were determined titrimetrically [13] and SAR was calculated by the following formula:

$$\mathbf{SAR} = \frac{\mathbf{Na^+}}{\frac{\sqrt{Ca^{2+} + Mg^{2+}}}{2}}$$

III. Results and Discussion

The data on various physico-chemical characteristics of surface and ground water *viz*. pH, electrical conductivity, total dissolved solids, sodium, calcium, magnesium, carbonates, bicarbonates, chlorides and sulphates (mean value of 15 samples) is presented in Table 1. A perusal of data reveals that pH of surface water ranged from 7.53-7.94 with a mean value of 7.73 while as that of ground water ranged from 7.01-8.54 with a mean value of 7.91. The pH is a measure of the hydrogen ion concentration in water. Slightly higher pH in groundwater may be due to limestone rich lithology of the region, liberating Ca and Mg into the solution [14]. Higher values of EC (1.0 dSm^{-1}) were recorded in groundwater in comparison to surface water where a lesser value for EC (0.40dSm^{-1}) was reported. Higher EC in groundwater might be due to enhanced ion exchange and solubilization in the acquifer system [15] and very large variation in the electrical conductivity may be attributed to total dissolved salts. Besides, higher EC may also be due to the long residence time and the existing lithology of the region [16].

TDS of surface water ranged from 115.00-140.00 with a mean value of 130.87, whereas in ground water TDS ranged from 280.00-460.00 with a mean value of 379.00. Total dissolved solids which is general indicator of water quality generally used to understand the amount of contaminant present in the [17]. Higher TDS in ground water may be attributed to the presence of higher concentration of dissolved cations and anions in the said area [15].

The mean value for sodium in surface and ground water recorded were 14.59 mg l^{-1} and 51.52 mg l^{-1}, for calcium 33.92 mg l^{-1} and 74.59 mg $l^{-1}$and 13.57 mg l^{-1} and 53.11 mg $l^{-1}$for magnesium respectively. Among cations, calcium was dominant followed by magnesium and sodium. Calcium and magnesium ions present in groundwater are particularly derived from leaching of limestone, dolomites, gypsum and anhydrites, besides calcium exchange process [15]. The possible source of sodium concentration in groundwater is due to dissolution and weathering of sodium bearing minerals. Moreover, sodium ion concentration in groundwater might also be due to silicate weathering [15]. As weathering and ion exchange processes are the major solute acquisition mechanism controlling the concentration of chemical constituents in groundwater besides the inputs from anthropogenic sources [18]. The source of major ions in groundwater may also be attributed to lithogenic and anthropogenic activities as groundwater is more prone and vulnerable to contamination [16]. The higher calcium and magnesium in groundwater might be due to enhanced disposal of sewage and domestic wastes in the area [19].

Table 1 Comparison between physico-chemical characteristics of surface and ground water (n=15)

Parameters	Surface Water		Ground water	
	Mean±S.E	Range	Mean±S.E	Range
pH	7.73±0.035	7.53-7.94	7.91±0.11	7.01-8.54
EC(dSm^{-1})	0.40±0.018	0.29-0.52	1.08±0.06	0.75-1.32
TDS (mg l^{-1})	130.87±1.867	115.0-140.0	379.0±14.1	280.0-460.0
Na (mg l^{-1})	14.59±0.540	10.50-18.10	51.52±4.37	25.00-83.00
Ca (mg l^{-1})	33.92±1.202	28.13-42.81	74.59±3.08	59.12-95.52
Mg (mg l^{-1})	13.57±0.591	9.47-17.28	53.11±5.03	27.77-98.63
CO_3^{2-}(mg l^{-1})	1.41±0.084	1.00-2.12	6.21±0.32	4.28-8.20
HCO_3^-(mg l^{-1})	51.11±1.603	40.07-62.13	235.0±10.2	180.6-300.5
Cl (mg l^{-1})	26.68±1.912	16.12-38.06	27.70±0.60	10.90-22.56
SO_4^{2-} (mg l^{-1})	0.89±0.101	0.42-1.56	3.53±0.18	2.06-5.02
SAR	0.09±0.008	0.05-0.14	2.40±0.08	2.02-3.24

Table 2 Guidelines for Evaluation of Quality of Irrigation Water (BIS (IS: 10500:1991))

S. No.	Class	EC (dSm^{-1})	SAR
1	Excellent	<1.5	<10
2	Good	1.5-3.0	10-18
3	Medium	3.0-6.0	18-26
4	Bad	6.0-8.0	>26
5	Very bad	>8.0	>26

The carbonate and bicarbonate concentration in groundwater is derived from carbonate weathering as well as dissolution of carbonic acid in the aquifers [15]. Higher values of carbonate (6.21 mg l^{-1}) and bicarbonates (235.00 mg l^{-1}) were recorded in ground water in comparison to surface water. The increase in the bicarbonate may be attributed to availability of the carbonate minerals in the area.

Chlorides ranged from 16.12-38.06 mg l^{-1} with a mean value of 26.68 mg l-1 in surface water and 10.90-22.56 mg l^{-1}in ground water with a mean value of 27.70 mg l-1. The natural process such as weathering, dissolution of salt deposits and irrigation drainage return flow are responsible for higher chloride content in groundwater [15].

Sulphates can be found in almost all natural water and the origin of most sulphate compounds is the oxidation of sulphite ores, the presence of shales or the industrial wastes [19]. Higher sulpahte concentration was recorded in ground water with mean value of 3.53 mg l^{-1} as compared to surface water (0.89 mg l^{-1}). The principle source of sulphates in groundwater is from evaporite minerals, gypsum and anhydrite. [15] also stated that sulphate ion concentrations are derived from weathering of sulphate and gypsum bearing sedimentary rocks.

Sodium adsorption ratio of water is directly related to the adsorption of sodium by soil and is valuable criterion for determining the suitability of the water for irrigation [15]. Sodium adsorption ratio was higher in case of ground water with a mean value of 2.40 and lower in surface water which exhibited a mean value of 0.09. On comparing with the Irrigation Water standards of BIS (IS: 10500:1991) (Table 2) EC and SAR fall in the low salinity hazard class and hence found excellent for irrigation purposes.

IV. Conclusion

Physico-chemical analysis revealed that ground water is highly mineralized than surface water. Calcium and magnesium are the dominant cations and bicarbonates the dominant anions. Furthermore, EC and SAR of both surface and ground water fall within the low salinity class, hence fit for the irrigation purposes. Ground water will be beneficial and will help in the reduction of water demand and can be used as best alternative source of irrigation water and will surely increase the yield.

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