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Hydrogeochemical Parameters for Assessment of Groundwater Quality in Loor Plain, Khouzestan, Iran

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ABSTRACT: In the management of water resources, quality of water is just as important as its quantity. In order to know the quality and/or suitability of groundwater for irrigation in Loor plain, 15 water samples dry season were collected and analyzed for various parameters. Based on the analytical results, chemical indices like percent sodium, sodium adsorption ratio, electrical conductivity, chloride, pH, sodium, calcium, magnesium, bicarbonate, total dissolved solids, sulfate, were calculated. The parameters were used to assess the suitability of groundwater for irrigation purpose by comparing with FAO. The sample analysis results that the groundwater is entirely fit for agriculture.
Key words : Hydrochemical parameters, groundwater quality, SAR, Loor plain,

INTRODUCTION

In recent times, there are been a tremendous increase in demand for fresh water due to population growth and intense agricultural activities. Groundwater is principal source of irrigation water in our country and indispensable source of our life. The quality of the groundwater varies from place to place with the depth of water table. The classification, modeling and interpretations of monitoring data are the most important steps in the assessment of water quality causes. It is a very difficult and laborious task to regularly monitor all the parameters even if adequate manpower and laboratory facilities are available. For this reason, in recent years an easier and simpler approach based on statistical correlation, has been developed using mathematical relationship for comparison of chemical parameters (Iyer, C.S et al., 2003; Sarkar Mitali et al., 2006). The correlation coefficient is a helpful tool for the promotion of research in water quality.

MATERIALS AND METHODS

Study area

Loor plain located in the Dezful- Andemeshk plain at the latitude of 31° 51′ to 33° 35′north and longitude of 45° 50′ to 48°14′ west covering an area of approximately 295 sq. km.

METHODS

A total of fifteen groundwater samples were collected in 2.5 liter polyethylene bottles during dry season in July 2013. During the present study, the samples were analyzed for various chemical parameters as described by the American Public Health Association (APHA,1995). These parameters include pH, electrical conductivity (EC), total dissolved solids (TDS), and important cations such as calcium, magnesium, sodium and potassium as well as anions such as bicarbonates, chlorides, sulfates. The Ph AND EC were measured by means of pH meter (Metrohm pH 691) and conductivity meter (Session Con.378). The TDS of the samples were also computed from conductivity meter. Sodium and potassium were determined by flame photometer (Flame photometer 416). Total hardness as $CaCO_3$, Calcium (Ca^{2+}), magnesium (Mg^{2+}), bicarbonate (HCO_3^-) and chloride (Cl^-) were analyzed by titrimetry method. Sulfate (SO_4^{2-}) was analyzed by spectrophotometer. The

statistical analysis has been performed to evaluate correlation coefficients between different pairs of water quality parameters. The linear regression approach was also carried out to quantify the relationship between several independent or predictor variables and dependent variable.

Statistical analysis

Pearson correlation

Pearson correlation coefficient is commonly used to measure and establish the strength of a linear relationship between two variables or two sets of data. It is a simplified statistical tool to show the degree of dependency of one variable to the other (Belkhiri et al., 2010).

Multiple linear regressions

In this study, we have applied the multiple linear regression approach to develop a relationship between several independent variables and dependent variable.

RESULTS AND DISCUSSION

The minimum and maximum concentration i.e. the range of the different chemical parameters of water quality such as pH, electrical conductivity (EC), total dissolved solid (TDS), sodium (Na), potassium (K), sulphate (SO_4^{2-}), calcium (Ca), magnesium (Mg), chloride (Cl) in the study area given in Table 1 along with Mean, Standard Deviation, Variance and Standard Error for dry season.

Table 1. Basic statistics of groundwater in July 2013

No.	parameter	Min. (mg/l)	Max.(mg/l)	Mean	Std.error	Std. Deviation	Variance
1	pH	7.3	8	7.8	0.046	.18	.033
2	EC	220	1846	670.7	103.99	401.2	160973.6
3	TDS	134	1163	411.6	65.19	252.4	63746.6
4	Na^+	2.3	184.2	34.8	11.25	43.57	1898.5
5	K^+	0.39	0.39	0.39	0	0	0
6	Ca^{2+}	32	124	61.3	6.79	26.33	693.5
7	Mg^{2+}	4.8	49.2	23.3	3.4	13.19	174.1
8	Cl^-	10.65	315.95	72.5	19.02	73.68	5430.1
9	SO_4^{2-}	2.33	219.36	586	14.8	57.33	3287.1
10	HCO_3^-	103.7	292.8	188.2	14.35	55.61	3093.03

Table 1 indicates that the pH values of groundwater in the study area range from 7.3- 8 in dry seasons. The pH values of all samples are within the desirable limit (6.5-8.5). TDS is an important parameter for assessing groundwater quality. All samples in dry season cross the permissible limit for TDS (500 mg/l-2000mg/l). The EC values of all samples are within the desirable limit (0.7 ds/m- 3ds/m). Most of the samples fall within the desirable limit for Cl (250 mg/l).

The correlation (r) measures the degree of association that exists between two variables one taken as dependent variable. It is evident from Table 2 that during dry season, highly positive correlation coefficient characterized by r = 0.9 to 1.0 is observed between EC-Na, EC- Ca, EC-Mg, EC- HCO_3^- and TDS-Na, TDS-HCO_3^-, TDS- Ca, TDS- Mg, TDS- EC and Ca- HCO_3^-, Na- Cl, Mg- HCO_3^- . As indicated in Table 2, pH has little association with most of the water quality parameters in dry season.

Table 2. Correlation matrix indicating July- 2013

parameter	pH	EC	TDS	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-
pH	1									
EC	-0.737	1								
TDS	-0.742	1	1							
Na^+	-0.758	0.934	0.943	1						
K^+	0	0	0	0	1					
Ca^{2+}	-0.769	0.933	0.928	0.802	0	1				
Mg^{2+}	-0.503	0.908	0.901	0.747	0	0.83	1			
Cl^-	-0.818	0.964	0.969	0.98	0	0.874	0.793	1		
SO_4^{2-}	-0.634	0.874	0.876	0.826	0	0.737	0.812	0.839	1	
HCO_3^-	-0.601	0.913	0.904	0.734	0	0.934	0.946	0.806	0.719	1

Regression analysis was conducted to investigate the relationships between TDS and other water properties, which shows significant correlation with TDS (r = 0.7 to 1) using SPSS. The [SO_4], [Cl], [EC] were considered as independent variables and TDS as a dependent variable. An analysis of residuals was developed and R^2 values were studied. Among all candidate equations, the equation where this ratio was closer to 1 was selected. The descriptors and the regression coefficient of this model are presented in Table3. The positive sign of the beta coefficient pertaining to these variables indicates that there is a positive relationship between TDS and elements of groundwater properties [SO_4], [Cl], [EC]. The selected regression equation is given by:

$$TDS= 4.94 + 0.6\ EC+ 8.5\ Cl + 0.7\ SO_4 – 3.7\ Ca$$

Table 3. Summary of multiple linear regressions predicting TDS

Regression	Coefficients
β0	4.94
EC (β1)	0.6
Cl (β2)	8.5
SO4 (β3)	0.7
Ca (β4)	-3.7

Correlation	Coefficient
Multiple R	1.000
R square	1.000
Adjusted R Square	1.000

The actual and predicted value for TDS for dry season was plotted in a graph (Fig 1)

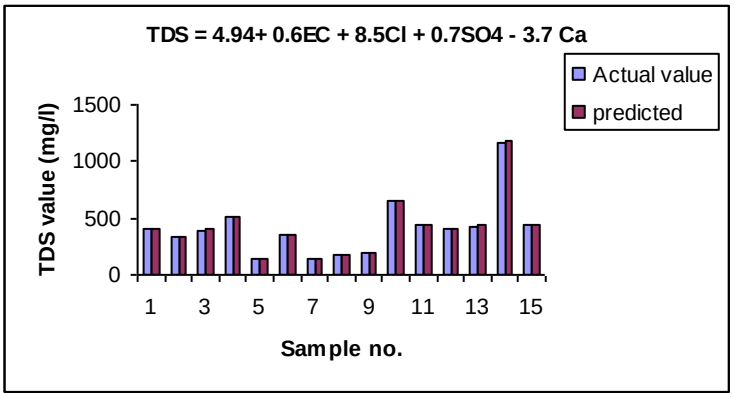

Figure 1. Actual Vs predicted values for TDS (dry season)

CONCLUSION

Multivariate statistical method used in this study (Pearson correlation coefficients and multiple linear regressions) help to find statistically important factors in data variability and thus improve conclusions in environmental impact studies. Pearson correlation matrix was applied to all the collected water samples for identifying the possible statistical relationship between different pairs of ground water quality parameters. A highly strong correlation was observed between Ca^{2+} and HCO_3^- in dry season, which gives us an idea about the total hardness of water. A multiple linear regression was used to establish relationship between TDS and other chemical water properties. The positive sign of the regression coefficient indicates that there is a positive relationship between TDS and elements of groundwater properties: [SO_4], [Ca], [Cl], [EC]. It can be concluded that the total dissolved solids and electrical with most of the elements in the groundwater.

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