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USING GEOSTATISTIC ANALYSIS FOR PREDICTION OF SAR IN SOUTH OF IRAN

MARZIEH MOKARRAM*[1], ALI REZA MAHMOODI[2] AND ABDOL RASSOUL ZAREI[2]

[1]Department of Range and Watershed Management, College of Agriculture and Natural Resources of Darab, Shiraz University, Iran
[2]Department of Range and Watershed Management, College of Agriculture, Fasa University, Iran,

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ABSTRACT

Groundwater is the source of about 33 percent of the water that county and city water departments supply to households, agriculture and businesses. So studying of the groundwater quality is importance. This research purpose to prediction of groundwater quality by geospatioal analysis. In the study used sodium adsorption ratio (SAR) for determination of groundwater quality. In this study, an attempt has been made to analyze by Inverse Distance Weighting (IDW) in south of Iran. Also relationship between SAR and Na, Ca and Mg were determined by Multi-layer perceptron (MLR). The results show that the most SAR value is located in the south of the study area. Also MLR was found that there is a positive and significant correlation between SAR and Na (0.852).**

INTRODUCTION

Groundwater forms one of the primary resources for development activities. In recent times, there has been tremendous demand for fresh water due to population growth and intensive agricultural activities. Groundwater quality is the physical and chemical characterization of groundwater, which measures its suitability for human and animal consumption, irrigation and other aims. Irrigation water quality is generally judged by some determining factors such as sodium absorption ratio (SAR), soluble sodium percentage (SSP), residual sodium carbonate (RSC), and electrical conductance (EC) (Richards, 1954). In the study used SAR for determination of waterground quality.

A high SAR concentration in the water leads to the formation of saline soil and the higher concentration of sodium leads to development of alkali soil. Irrigation water could be a source of excess sodium in the soil solution and hence it should be evaluated for this hazard (Sayyed and Wagh, 2011). The sodium or alkali hazards (in using water for irrigation) is calculated by determining the absolute and relative concentrations of cations and is expressed in terms of Sodium adsorption ratio (SAR) which is a simple method to evaluate the danger of high-sodium water (Richards, 1954). Usually SAR less than 3.0 will not be a threat to vegetation while SAR greater than 12.0

*** Corresponding author's email :** Ar_zareiee@Fasau.ac.ir; m.mokarram@shirazu.ac.ir; mahmoodi_150@yahoo.com;

is considered sodic and threatens the survival of vegetation by increasing soil swelling (dispersion) and reducing soil permeability (Kuipers *et al*., 2004). Also recently one of the methods use Geostatistical methods in GIS. The GIS is an effective tool in the estimation of the spatial distribution of environmental variables (Rabah *et al*., 2011). Interpolation can be undertaken utilizing simple mathematical models (e.g., inverse distance weighting, trend surface analysis and splines), or more complex models (e.g., geostatistical methods, such as kriging) (Negreiros *et al*., 2011). The purpose of this study is to employ geostatistical analysis (IDW) for prediction of SAR in north of Darab city in south of Iran. Also relationship between SAR and Na, Ca and Mg were determined by Multi-layer perceptron (MLR).

MATERIALS AND METHODS

Study area

This study was located in north of Darab city in south of Iran. The study area located between 28° 57′ to 28° 06′ northern latitude and 53° 27′ to 55° 55′ eastern longitude (Figure 1).

In order to investigate of groundwater quality used 82 sample points that show in Figure 2.

Inverse Distance Weighting (IDW)

The inverse-distance weighted procedure is versatile, easy to program and understand, and is fairly accurate under a wide range of conditions (Lam, 1983). Using this method, the property at each unknown location for which a solution is sought is given by:

$$\hat{v} = \frac{\sum_{i=1}^{n} \frac{1}{d_i} v_i}{\sum_{i=1}^{n} \frac{1}{d_i}} \quad (1)$$

Where as :υ: value to be estimated, v_i = known value and d_i..., d_n= distances from the n data points to the point estimated n

Sodium Adsorption Ratio (SAR)

The suitability of the groundwater for irrigation from the present area of study was judged by determining the SAR value and they were categorized under different classes. Sodium adsorption ratio (SAR) was computed by using the following formula:

$$SAR = \frac{Na}{\sqrt{(Ca + Mg)/2}} \quad (2)$$

Sodium adsorption ratio is the proportion of sodium to calcium and magnesium, which effect the availability of the water to the crop. Classification of ground water based on SAR and EC for Irrigation purposes show in the Figure 3.

Multiple regression models

The general form of the regression equations is n according to Eq. 3:

$$Y=A_0 + A_1X_1 + A_2X_2 + \ldots + b_nX_n \quad (3)$$

Where Y is the dependent variable, A0 is the intercept, A_1. . .bn are regression coefficients, and X_1– X_n are independent variables referring to basic groundwater properties.

The general purpose of multiple regressions is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable. The contents of available SAR was made related to Ca, Na and Mg properties by constructing regression equations using the stepwise procedure of SPSS (2002).

RESULTS

SAR analysis

In order to prediction availability of SAR used Na, Mg and Ca that descriptive statistics show in Table 1. According to Table 1 the maximum value of Na, Mg and Ca are 58.71, 47.50 and 52.50 respectively.

Table 1. Descriptive statistics of the dataset

Parameter	Na	Mg	Ca
Maximum	58.71	47.50	52.50
Minimum	0.10	0.50	1.50
Average	7.71	6.62	6.60
STDEV	11.21	9.46	8.56

Prediction of SAR by using geostatistic analysis

In the study area used from IDW. IDW interpolation produces show in Figure 4. The lowest output in Ca, Na and Mg are 1.5, 0.1 and 0.5 respectively while the

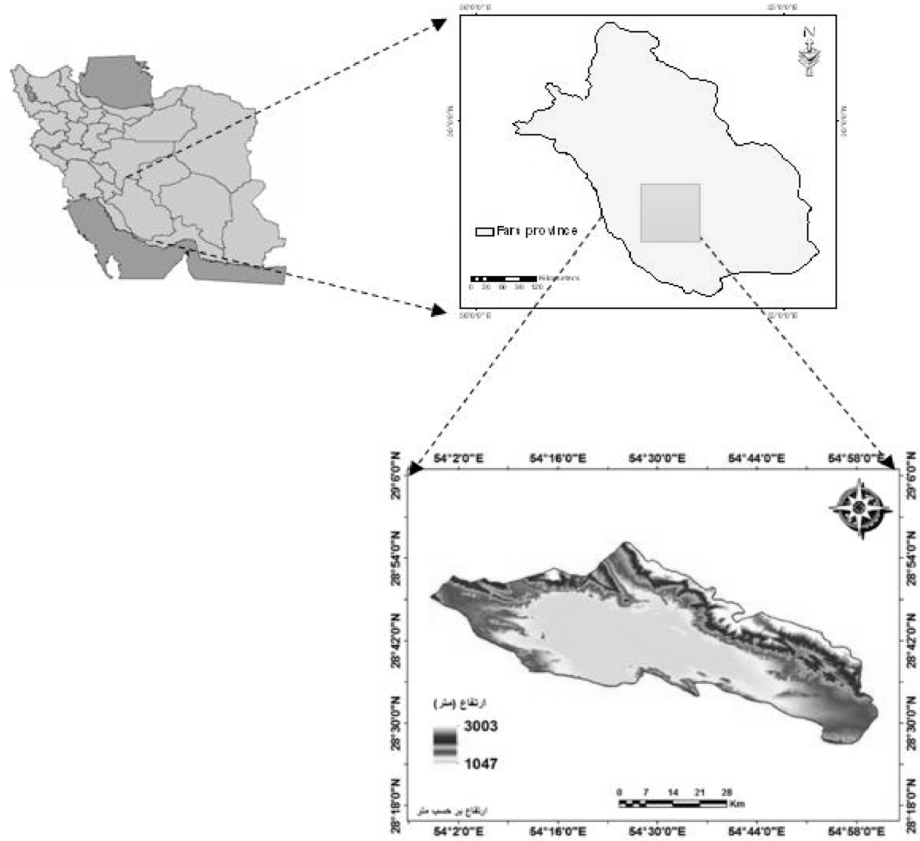

Fig. 1 Position of study area

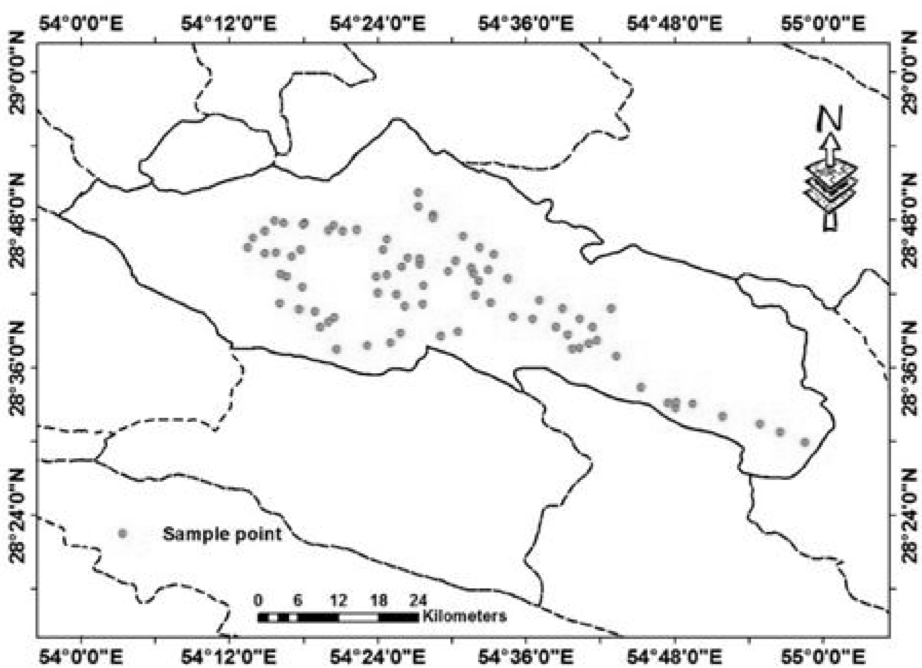

Fig. 2 Position of sample points in the study area

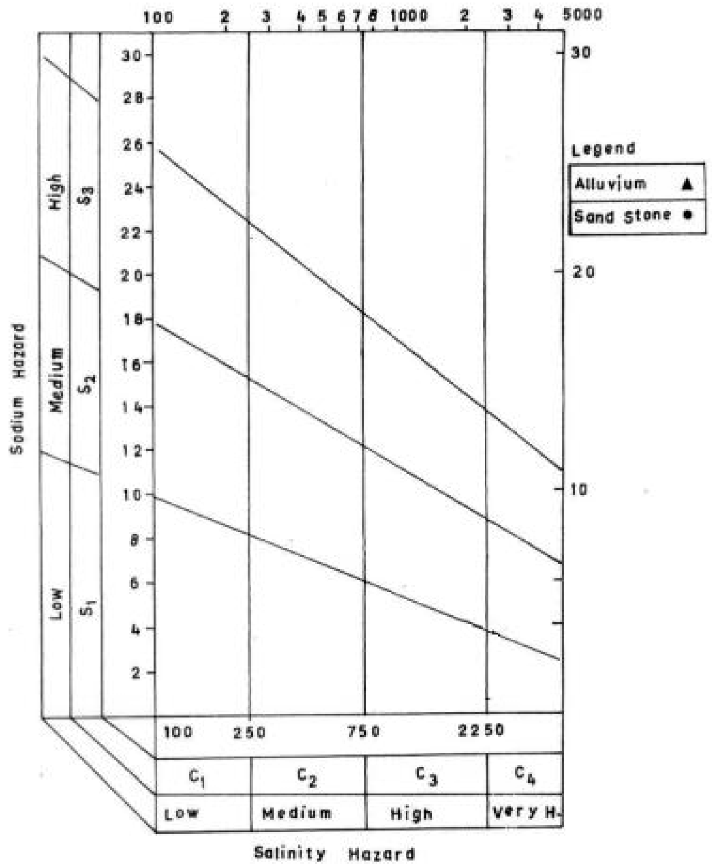

Fig. 3 Classification of ground water based on SAR and EC for Irrigation purposes (After U.S. Salinity Laboratory, 1954)

maximum output in Ca, Na and Mg are 52.5, 58.7 and 47.5 respectively.

In the finally according to Eq. 2 SAR map was preparing that show in Figure 5.

Relationships between available SAR with groundwater properties

The calculated simple linear correlation coefficients (r) between SAR and independent variables are summarized in Table 2. It was found that there is a positive and significant correlation between SAR and Na (0.852**).

Prediction of SAR by using MLR

For predicting SAR through MLR model, first the most important input variables were selected using stepwise method, and then linear interaction term of these basic groundwater properties were investigated. Results indicated that Na and Mg were the most important properties determining SAR parameters

Table 2. Simple linear coefficient correlations (r) among SAR and groundwater properties.

	SAR	na	mg	ca
SAR	1	.852**	.289**	.270*
na	.852**	1	.657**	.603**
mg	.289**	.657**	1	.818**
ca	.270*	.603**	.818**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

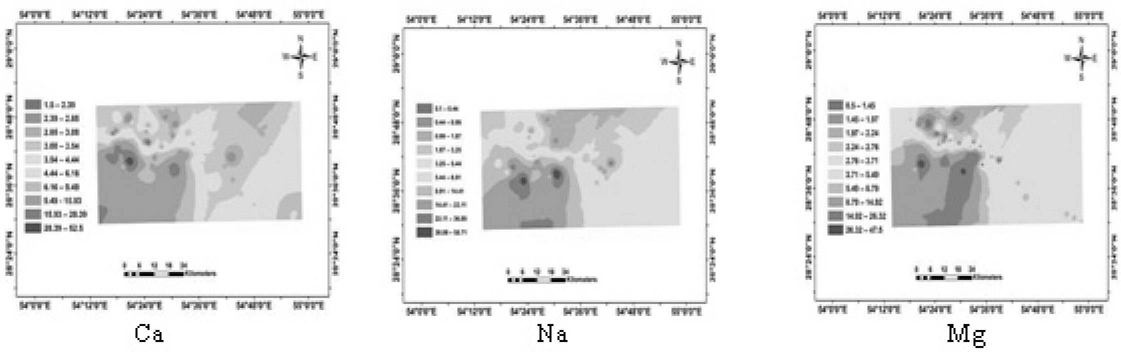

Fig. 4 Ca, Na and Mg values in the study area

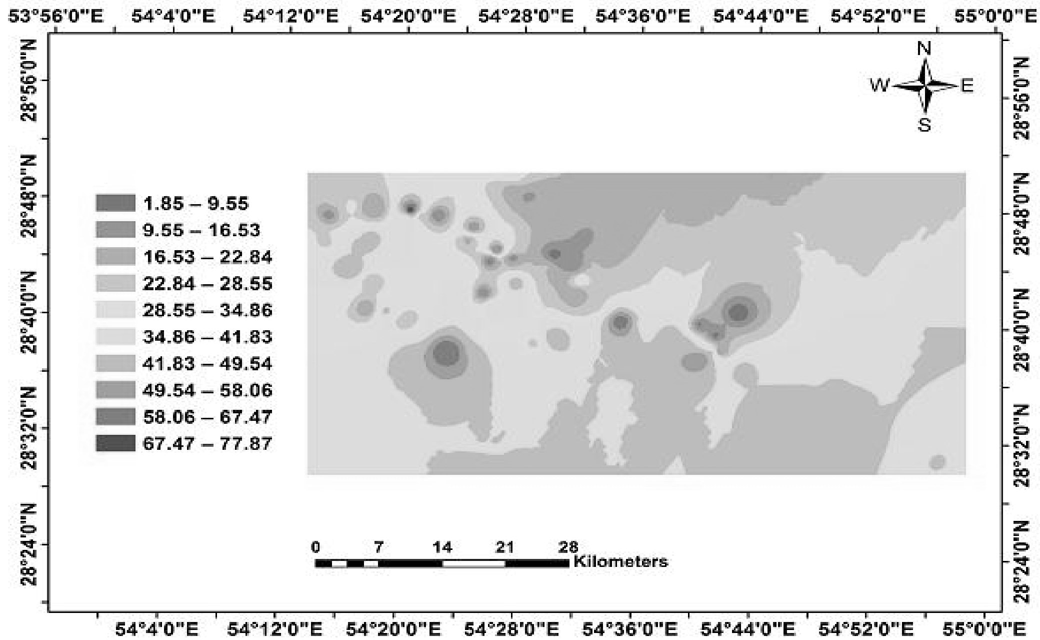

Fig. 5 SAR map in the study area

Table 3. MLR model summary for available SAR prediction.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.852a	.726	.722	1.194741079397203	.726	211.711	1	80	.000
2	.924b	.854	.851	.875843876449818	.129	69.862	1	79	.000

a. Predictors: (Constant), na ; **b.** Predictors: (Constant), na, mg

(Tables 3 and 4).

CONCLUSION

The aim of this study was to provide SAR and mapping methods that are in common for prediction of SAR. Our case study showed that the IDW method is more accurate for predicting the spatial patterns of SAR. Also in this study MLR was used for predicted SAR. Also relationship between SAR and Na, Ca and

Table 4. Performance indices (R, R2 and MSE) and coefficients of variables for different MLR models for SAR values

Coefficientsa											
Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tole-rance	VIF
1	(Constant)	.861	.164		5.262	.000					
	na	.196	.013	.852	14.550	.000	.852	.852	.852	1.000	1.000
2	(Constant)	1.134	.124		9.125	.000					
	na	.268	.013	1.164	20.456	.000	.852	.917	.878	.569	1.759
	mg	-.127	.015	-.476	-8.358	.000	.289	-.685	-.359	.569	1.759

a. Dependent Variable: SAR

As observed from this table for test dataset, the R2 values have been obtained 1, for SAR.

Mg were determined by Multi-layer perceptron (MLR). The results show that the most SAR value is located in the south of the study area. Also MLR was found that there is a positive and significant correlation between SAR and Na (0.852**).

REFERENCES

Kuipers, J., MacHardy, K., Merschat, W., *et al*. 2004. Coal bed methane-produced water: Management options for sustainable development. *11th International Petroleum Environmental Conference*. Albuquerque, NM, USA.

Lam, N.S. 1983. Spatial interpolation methods review. *The American Cartographer*. 10 : 129-149.

Negreiros, J., Costa, A.C. and Painho, M. 2011. Evaluation of stochastic geographical matters: Morphologic geostatistics, conditional sequential simulation and geographical weighted regression. *Trends Applied Sci. Res*. 6 : 237-255.

Richards, LA. 1954. Diagnosis and improvement of saline and alkali soil, *Agricultural Handbook* 60. USDA, Washington, USA

Rabah, F.K.J., Ghabayen, S.M. and Salha, A.A. 2011. Effect of GIS interpolation techniques on the accuracy of the spatial representation of groundwater monitoring data in gaza strip. *Journal of Environmental Science and Technology*. 4 (6) : 579-589.

Sayyed, M.R.G. and Sayadi, M.H. 2011. Variations in the heavy metal accumulations within the surface soils from the Chitgar industrial area of Tehran. *Proceedings of the International Academy of Ecology and Environmental Sciences*. 1 (1): 36-46.

U.S. Salinity Laboratory staff, Diagnosis and improvement of saline and alkali soils, U.S. Deptt. *Agr. Handbook.* 60 (1954).