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Relationships between Soil salinity and geopedological units in Saveh plain, Iran

***Nazila Khorsandi[1] and Hadi Chamheidar[2]**

[1]Department of Agriculture, Takestan Branch, Islamic Azad University, Takestan, Iran
[2]Department of Soil Science, Faculty of Agriculture, Shoushtar Branch, Islamic Azad University, Shoushtar, Iran

ABSTRACT

Soil salinity as one of the soil degradation factors is attending in the central area of Iran. This study was conducted to determine the pattern of salinity and sodicity based on kriging method and their relationships with geomorphological units. For this purpose geo-forms units from aerial imagery and lithological units from geological map were extracted and overlaid. Then the unified units for soil sampling was obtained based on this data layer, lithology, topography and plant cover. At each unit at least one profile were studied (totally 25 profile) and EC, pH, SAR and ESP values were measured. After normalizing primary data, the semivariogram was determined and the best model obtained. Finally, maps of these parameters were investigated by kriging method. The number of five landform including piedmont alluvial plain, river alluvial plain, low land, river bed and river terrace were revealed. Among these landforms, the saline and alkaline soils are developed respectively, in river alluvial plain, low land, piedmont alluvial plain, river terrace, river bed. Therefore, the river alluvial plain landform is highly affected by saline and sodic.

Key words: geopedology, kriging, soil salinity, sodic.

INTRODUCTION

In arid and semi-arid regions, accumulation of salt at root zone is as one of the major environmental threats for plant growth [1]. Salinity could be produce at results of use of salty irrigation water, existing high amount of salt in the soil and high level of ground water table [5].

Access to salinity data is performed by point sampling and provide an incomplete view of soil salinity of an area [3]. It is necessary to estimate the soil salinity for regions between sampled points in order to prepare map. Interpolation methods are tools for estimating variables at unknown locations.
Soil salinity could be related with soil type and geomorphology of study area. According Pishkar [8] the alluvial materials in low locations of landscape trend to accumulate of salt especially in places of with low slope. Also, Aiman et al. [1] concluded that geopedological approach could be effective in management of soil salinity.

In this study, the distribution pattern of salinity patches was determined by geostatistical method. To achieve this purpose, the attributed salinity and geopedological maps were overlaid and their relationships were determined.

MATERIALS AND METHODS

Study area: The study area is located in Saveh plain between $50° \, 27' - 50° \, 44' E$ and $34° \, 47' - 34° \, 53' \, N$ in center of Iran (Figure 1). This region characterized with a minimum and maximum height of 892 and 1000 m above sea level, respectively at the area of 43450 ha. Also, the soil moisture and temperature regimes are Aridic and Thermic, respectively.

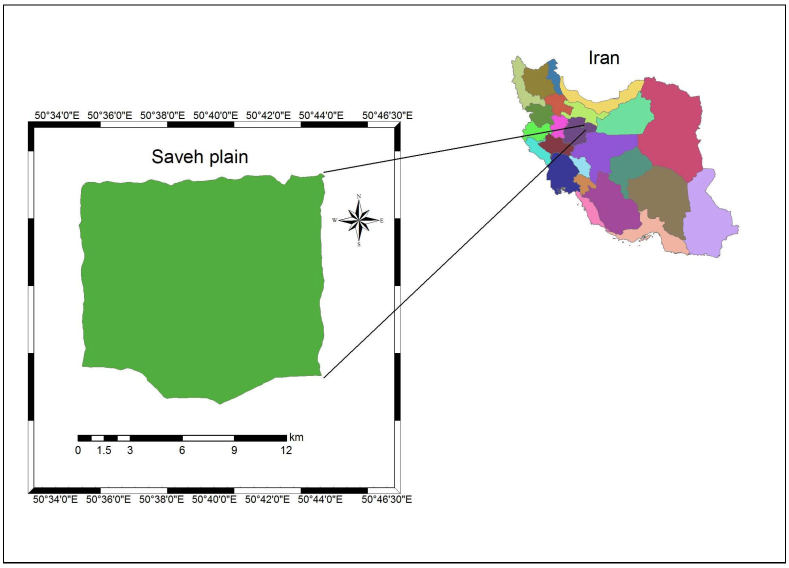


Figure 1. Location map of the study area

Soil Sampling: Determination of geo-forms of region was performed by interpreting aerial imagery at scale of 1:20000. Also, the lithological units were extracted from geological map at scale of 1:100000. The data layers of geo-form and lithological units were overlaid at Illwis software and basic map was prepared for soil sampling. The unified unites on the geopedological knowledge base and lithology, topography and plant cover were obtained. The number of 25 profiles was study.

Soil samples were taken from 0-30 cm depth at each unit. The amount of EC, pH, ESP and SAR were measured for these points.

Interpolation maps of these different parameters were obtained by kriging method. It is necessary to have the EC, pH, ESP and SAR data to follow from a normal distribution in the ordinary kriging method. The normality of data was controlled by kolmogorov-smirnov test [7]. Semivariogram was used to evaluate spatial correlation of EC, pH, SAR and ESP by GS+ software. The semivariance that quantified spatial variations for all possible pairing of data was calculated by Eq. 1.

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} \{Z(x_i) - Z(x_i + h)\}^2 \quad (1)$$

Where $\gamma(h)$ is the semivariance at each lag (separating distance), h, $N(h)$ is the number of point pairs separated by the giving lag and $z(x_i)$ and $z(x_i + h)$ are results of measuring at x_i and $x_i + h$ locations, respectively. The best model was fitted to semivariogrm functions [4] and its range, sill and nugget were optimized by cross-validation.

RESULTS AND DISCUSSION

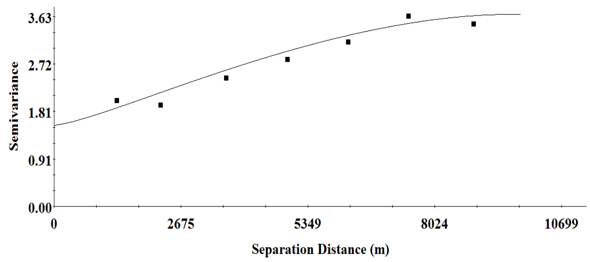
Ordinary kriging was used in order to prepare maps of parameters of EC, pH, SAR and ESP. For this purpose, descriptive statistics of EC, pH, SAR and ESP are given in Table 1. The skewness and coefficient of Kolmogorov-Smirnov test ($P<0.05$) of EC and SAR revealed that these data set were not following the normality distribution. Serious violation of data from normal distribution may be cause ruin the variogram structure [6]. Therefore, the primary data of EC and SAR transformed with lognormal transformation. The Kolmogorov-Smirnov test ($P>0.05$) for lognormal data verified the normal distribution. While, skewness and coefficient of Kolmogorov-Smirnov test of pH and SAR were shown normal distribution.

Table 1. Descriptive statistics of EC, pH, ESP and SAR

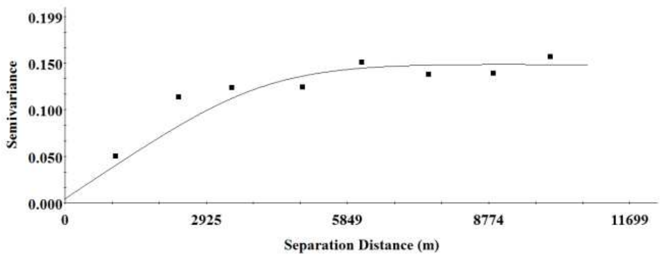
parameter	normality	mean	Standard deviation	CV	Skewness	Kurtosis
EC	non normal	10.44	7.70	73.78	2.49	9.78
EC	normal	0.84	0.34	40.50	0.89	1.59
pH	normal	8.22	0.29	3.61	0.23	-0.19
ESP	normal	30.90	21.38	69.18	0.98	0.66
SAR	non normal	20.19	16.25	80.50	2.34	6.16
SAR	normal	1.19	0.32	27.39	0.45	1.06

At first, the semivariograms of EC, pH, SAR and ESP were evaluated (Figure 2).

EC (0-30 cm)



pH (0-30 cm)



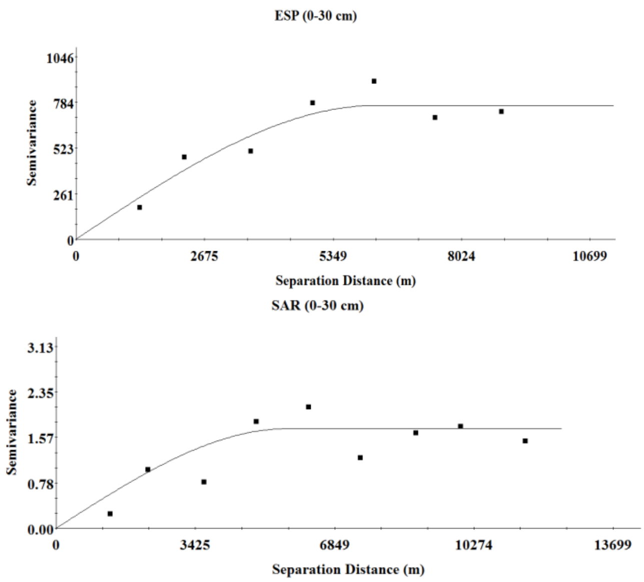


Figure 2. Semivariogram of EC, pH, ESP and SAR values

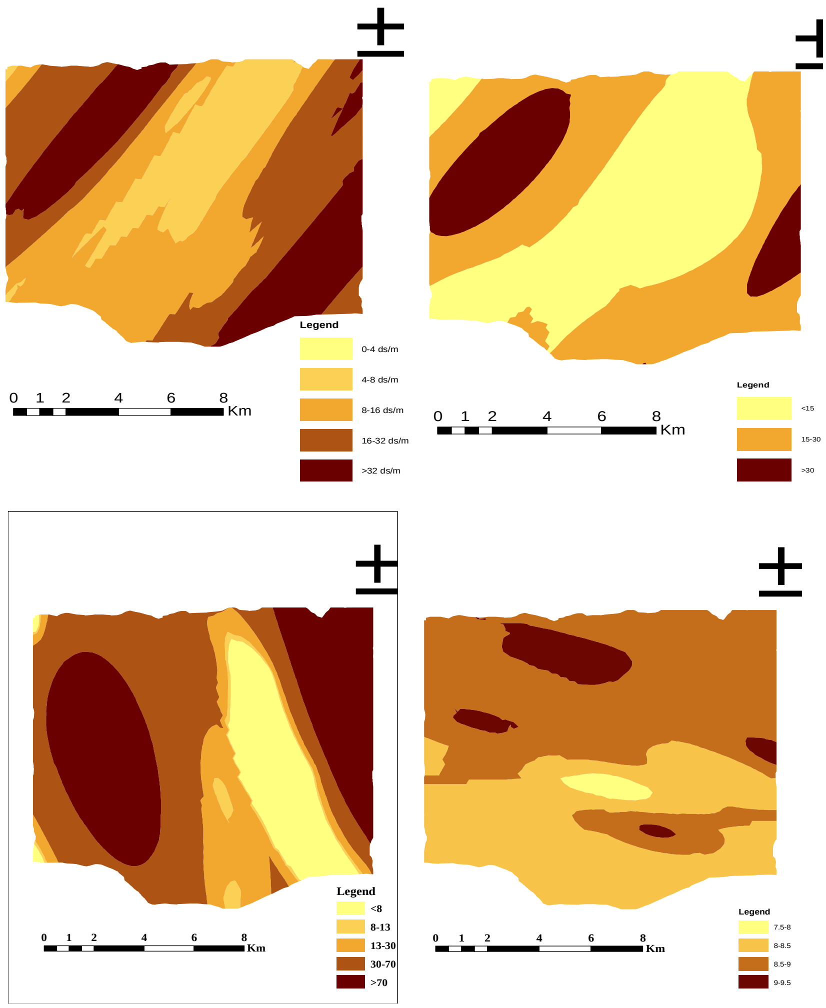


Figure 3. Maps of EC, pH, SAR and ESP

The Gaussian model for EC and the Spherical model for pH, SAR and ESP as optimal model were fitted to semivariogram function by the minimum sum of square of the residual. The Gaussian model explained 97% of variations at semivariogram of EC. Also, the spherical model explained 88%, 90% and 84% of variations of pH, SAR and ESP semivariogram, respectively. Also, the ratio of nugget (C_0) to sill $(C_0 + C)$ of EC, SAR, pH and ESP was 0.23, 0.30, 0.35 and 0.21, respectively. According to Men et al. [7], the $\frac{C_0}{C_0 + C} < 0.5$ presents a strong spatial correlation of EC, pH, SAR and ESP values between stations.

The highest EC and SAR values were observed in low land, while the highest pH and ESP values were revealed in alluvial plain of river (Figure 3).

At low land areas the ground water table is closer to surface, so it could be explain the high values of EC in these locations [9].

CONCLUSION

At each four landform, the maximum area is belong to EC between 4 and 16 ds m^{-1} and SAR >70.

The EC value varies between 0.85 and 42 ds/m in the surface layer. These results showed that 9%, 61%, 19%, 1% and 9% of piedmont alluvial plain, river alluvial plain, low land, river bed and river terrace landforms belong to the saline soils (EC >4 ds m^{-1}), respectively.

The alkalinity reaction (>8.5) in the river alluvial plain, low land, river bed and river terrace landform developed respectively, 1%, 18.55%, 14%, 0.8 and 6.9%. Also, the sodic soils with ESP>15 and SAR>13 are extended respectively, in river alluvial plain (60%), low land (18%), piedmont alluvial plain (9%), river terrace (8.8%), river bed (1.4%).

Therefore, among these landforms, the saline and alkaline soils are developed respectively, in river alluvial plain, low land, piedmont alluvial plain, river terrace, river bed. It could be related to saline water of river and shallow ground water table in this landform.

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