



Prediction of Soil Salinity Using Neural Network and Multivariate Regression Based on Remote Sensing Indices and Comparison: A Case Study of Qazvin plain's Salt Marsh

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Extended Abstract

Introduction: The spatial and temporal distribution of salts in the soil, the great extent of the Iranian deserts, and the adverse climatic conditions prevailing over them make it difficult to accurately determine the parameters and field measurements in some cases. In the last two decades, the use of field techniques and their combination with remote sensing data has contributed significantly to preparing baseline maps on saline soils. Accordingly, recent advances in the application of remote sensing technology in salt-affected mapping and management have also reduced the costs of large-scale land monitoring. Many researchers worldwide have been preparing soil salinity maps using satellite imagery, aerial photographs, terrestrial and radiometric techniques based on correlations between salt reflection and soil salinity indices. One of the significant problems in Qazvin Plain is the drainage of the area, which may affect the control of the process of salinization and improvement of its soils and rangelands. Thus, to prevent the progress of the salt area in Qazvin plain, the drainage project had started in 2008. The aim of this study, therefore, was to predict soil salinity in the central drainage basin of Qazvin plain using remote sensing capabilities and an artificial neural network.

Materials and methods: The study area was part of Qazvin province 150 km northwest of Tehran that

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included the saline margin of Qazvin with a longitude of 380000 to 420000 and north latitude of 3920000 to 3980000 (according to UTM). The height of the area was 1135 to 1145 meters above sea level. The major cities adjacent to the area were northwest of Qazvin, vineyards in the west, Abyek in the north, and Dansfahan in the southwest. The central salinity area of the Qazvin plain was about 65,000 hectares. The core area was about 20,000 hectares, and the salinity of these lands was very high. The measurements showed a salinity of 280 dS/m (7 to 8 times the Persian Gulf salinity). About 95% of the lands in this area had an electrical conductivity of more than 20 dS/m, and 65% of the lands had an electrical conductivity of more than 100 dS/m. As for the purposes of this study, soil salinity and vegetation status of the study area were analyzed using satellite imagery and remote sensing indices. Mann-Kendall test was also used to study the time series trends (salinity and vegetation indices derived from satellite images). In order to take advantage of the neural network capabilities and based on the type of data monitored in the design area, the soil salinity prediction process was performed in three cases. In the first case, the soil salinity prediction model was based solely on salinity and vegetation indices monitored in the saline area because the reference land data were only recorded for a few years in the region. However, remote sensing capabilities enabled us to study the process of soil salinity changes over a broad period of time. In the second case, soil salinity was predicted according to the reference land data (groundwater level and SAR and EC indices) of the drainage area. In the third case, considering the timeframe of recording groundwater level data in the observed wells, the process of soil salinity modeling was performed by deleting groundwater level data to keep the model applicable even if the groundwater level was not recorded.

Result: : the results of correlation analysis of mean temporal data showed that GVI had a high negative correlation with all salinity indices, but there was a lower correlation between salinity and other vegetation indices. The results also suggested that the training error was less than the test error in both modeling modes, and the neural network model error was 60% lower than the cubic regression model. The R software showed that the corresponding correlation coefficient was $\tau = -0.63$ and the p-value = 2×10^{-12} , indicating a significant trend. It was found that using multivariate regression modeling had acceptable accuracy in predicting soil salinity in the study area. In the second modeling, EC and SAR indices in the catchment drainage area, vegetation indices, soil salinity indices derived from satellite images, and groundwater level values in the observed wells were used. According to the results, the neural network model had a higher accuracy than the regression model, but its test error was higher than the regression model, and in this case, the results of the neural network model were proved to be of higher accuracy. In the third modeling case, soil salinity was predicted regardless of groundwater levels. In this case, the neural network accuracy was only better in the training mode, and no difference was found in the test mode. Also, by eliminating groundwater level data, the model's prediction accuracy was considerably reduced.

Discussion and Conclusion: In this study, soil salinity was simulated and predicted using the neural network model and regression model in the drainage area of the central saline delta of Qazvin plain. To this end, reference land data and the indices derived from satellite images were used, and a soil salinity prediction model was presented. The results showed that the neural network models could simulate soil salinity with acceptable accuracy, requiring fewer factors than the computer model. Poor results for some models and states also indicated that any structure's neural network models would not principally yield good results, but they require careful selection of the constituent factors. Performing many repetitions and selecting the appropriate factors constitute the network.

Keywords: Drainage, Modeling, Neural network, Qazvin, Soil salinity, Water level.