Accuracy Assessment of Geo-Statistics and Artificial Neural Networks Methods to Estimate Threshold Wind Velocity: A Case of Jazinak Region, Sistan Plain

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Extended abstract

1- Introduction

Threshold wind velocity is a major influencing variable in transportation of soil particles and dust production. It is considered as an important component in many theoretical equations and numerical models due to its importance in wind erosion studies (Stout & Zobeck, 1996). The wind tunnel method (fixed and portable), empirical relationships and sediment traps are the common methods to estimate the threshold wind velocity (Refahi, 2005). Estimation of this variable can assist researchers to recognize critical points, in addition to providing suitable activities to prevent depletion of limited resources in desert region. This study aimed at comparing the accuracy of geo-statistical techniques (Kriging and Co-kriging) and artificial neural network model, estimating the threshold of wind velocity, selecting more accurate methods to be used in wind erosion combating projects, as well as identifying more important variables in threshold wind velocity in the Sistan region.

2- Methodology

The study site with an area of 60 km^2 lies within 30º 49′ 43″ to 30º 54′ 49″ N latitude and 61º 30′ 22″ to 61 º 37′ 05″ E between Sistan river and Fourth Chah-Nimeh reservoir which supplies drinking water of Zabol and Zahedan cities. Threshold wind velocity was measured using wind tunnel in 60 points of the topsoil. Soil sampling was done at the same points. Soil dataset was checked for normal distribution, then threshold wind velocity estimation and validation of obtained results, were respectively done by using the Kriging and Co-kriging and cross validation methods. The multi-layered perceptron model was implemented and obtained results were evaluated using root mean squared error statistics and coefficient of determination, after data standardization and determining the model architecture using trial and error method.

3- Results

Based on the results, among the geo-statistic methods, co- kriging interpolation method with spherical variogram model in comparison with kriging method was determined as an optimal model for the estimation of the threshold wind velocity (R^2= 0.60 and RMSE= 0.45). Study of the importance of effective variables also indicated that the variables related to soil texture (clay, silt, sand percents), acidity, salinity, organic matter percent, average weight of particles diameter and the percentage of surface soil gravel were the main contributors to the accuracy of predictive models and hence determining the threshold wind velocity in the study area. The overall assessment of the models used showed that the lower error rate and therefore, the more precise estimation of thresholds

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wind velocity erosion in the present study, were carried out by multi-layer perceptron model with three layers and three neurons per layer which utilizes Gaussian' transfer function and Levenberg-Marquardt training rule.

4- Discussion & Conclusions

According to the results, the Co-kriging method enabled to perform interpolation with high precision because it utilizes an auxiliary variable and uses covariance between two variables for interpolation (Lark et al., 2014). Furthermore, some capabilities such as increasing data processing power, problems related to measuring some variables, as well as, the correlation between measured variables and the availability of various software tools has increased the usage of this estimation method in various environmental studies (Amini et al., 2002). Performance superiority of the Co-kriging method compared to the Kriging method, has also been reported by Behnia et al. (2016). Likewise, a set of soil characteristics has the greatest effect on the threshold wind velocity in the Sistan region. In line with this findings, it has been reported that the soil crust properties affect the threshold wind velocity; as a result, the threshold value varies in soils with different characteristics (Webb et al., 2016). According to the findings of this research, it is stated that due to utilization of the pair of input and output patterns, artificial neural networks are as powerful tool in various studies related to natural resources. In general, it can be said that through the development of vegetation using native species in the southern and western parts of the study area can increase the threshold of wind erosion in these areas in addition to reducing soil erodibility and its consequences.

Key Words: Sistan plain, Geostatic, Threshold wind velocity, artificial neural networks.