Pedotransfer functions for estimating soil moisture content using fractal parameters in Ardabil province

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Extended abstract

1- Introduction

Soil moisture curve is an important characteristic of soil and its measurement is necessary for determining soil available water content for plant, evapotranspiration and irrigation planning. Direct measurements of soil moisture coefficients are time-consuming and costly. But it is possible to estimate these characteristics from readily available soil properties. The purposes of this study were: 1) development of pedotransfer functions (PTFs) for estimating of soil moisture content at field capacity (FC) and permanent wilting point (PWP) conditions by artificial neural networks system (ANN) and multivariate regression method and 2) investigation effects of using soil primary particles, aggregates and porosity fractal dimensions as a predictor for increasing the accuracy and reliability of these PTFs.

2- Methodology

For this reason, 90 soil samples from three regions (Agricultural land of the Ardabil plain, Forest of the Fandoglo and Rangelands of the Sareyn, which were located in Ardabil province) were collected in random design sampling method. Then FC and PWP coefficients of these soils were measured using pressure plates apparatus. As well as, some readily available properties of soils such as fractal dimensions (primary particles, aggregates, and soil pores), texture, bulk density and particles density, porosity, organic carbon and calcium carbonate equivalent (CCE) were determined by routine laboratory method. Then data were divided into two datasets randomly**:** Training dataset (including 72 soil samples) and test dataset (including 18 soil samples). Regression-PTFs for estimating FC and PWP were developed once by using and once without using of the fractal dimension of primary particles (D_S), the fractal dimension of aggregates (D_f) and fractal dimensions of soil pores (D_v) as independent variables. The predictors of Regression-PTFs once again were used for development of the ANNs-PTFs. Therefor two PTFs were developed for predicting each dependent variable (FC and PWP). Statistical and Neurosolution softwares were used for development of the Regression-PTFs and ANN-PTFs, respectively. Finally, the accuracy and reliability of PTFs were investigated.

3- Results & Discussion

Results showed that FC has a positive significant correlation with soil silt ($r= 0.52^{**}$) and organic carbon content ($r= 0.86^{**}$), and a negative significant correlation with sand ($r= -0.50^{**}$), CCE ($r= -0.74^{**}$), bulk density ($r= -0.64^{**}$), particles density ($r= -0.79^{**}$) and Df ($r= -0.47^{**}$). As well as, there are positive significant correlation between PWP and other soil properties such as soil silt ($r= 0.48^{**}$) and organic carbon content ($r= 0.77^{**}$), and negative significant correlation with sand ($r= -0.50^{**}$), CCE ($r= -0.74^{**}$), bulk density ($r= -0.70^{**}$), particles density ($r= -0.80^{**}$) and Df ($r= -0.52^{**}$). Results also showed that there is a positive significant correlation between FC and PWP ($r= 0.84^{**}$). When fractal dimensions used as independent variables for estimating of FC, three variables (bulk density

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(ρ_b), particles density (ρ_p), and fractal dimension of soil pores (D_s)) included as a predictor in PTFs and these predictors could explain 80% and 98% of variation of FC, at Regression- and ANN-PTFs, respectively. But when fractal dimensions didn't used in modeling, PTFs was developed with four predictors (ρ_b, ρ_p, dg and σ_g) and these predictors could explain 81% and 92% of the variation of FC, at Regression- and ANN-PTFs, respectively. Results also showed that there were no significant differences between the Regression- and ANN-PTF which achieved for the estimation of FC values. As well as, Regression-PTF by using fractal dimensions as independent variables for the estimation of PWP was developed with three predictors (ρ_b, ρ_p and D_s) and these predictors could explain 76% and 92% of the variation of PWP, at Regression- and ANN-PTFs, respectively. But when fractal dimensions weren't used as independent variables, PTFs was developed with two predictors (ρ_b and ρ_p), and these predictors could explain 71% and 85% of the variation of PWP, at Regression- and ANN-PTFs, respectively. Results of the investigation of accuracy and reliability of the PTFs showed that when fractal dimensions used as independent variables for estimating of PWP, only the accuracy and reliability of the ANN-PTF was increased.

4- Conclusions

ANN-PTFs were more accurate than Regression-PTFs. When fractal dimensions of soil primary particles, aggregates, and pores were used as independent variables in modeling for the prediction of FC and PWP, only the fractal dimension of soil pores included as a predictor and increased the accuracy of ANN-PTFs, but it could not increase the accuracy of Regression-PTFs.

Key Words: Field capacity; Fractal dimensions; Soil pedotransfer functions; Soil pores.