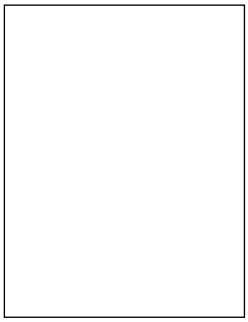

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Evaluation of Different Predictor Models of the Detailed Particle Size Distribution

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ABSTRACT

An accurate mathematical representation of particle-size distributions (PSDs) is required to estimate soil hydraulic properties or to compare texture measurements from different classification systems. However, many databases do not contain the full particle-size distribution, but instead contain only the clay, silt and sand mass fractions. The object of this study were to evaluate the ability of four PSD models (the Skaggs model, the Fooladmand model, the Gray model and the Fredlund model) to predict detailed PSD from limited data and to determine the effects of texture on the performance of the individual PSD models. The mean absolute error (MAE) and root mean square error (RMSE) were used to measure the goodness of fit of the models and the Akaike's information criterion (AIC) was used to compare the quality of model fits. The performance of all PSD models except the Gray model improved with the increase in clay content in soils. This result showed that Gray model has less dependency on soil texture. The Fredlund model was the best for describing the PSDs of all soil textures except in sand textural class. However, the Gray model showed better performance as the sand content increased. The results indicated that the Fredlund model showed the best performance and the least values of all evaluation criteria and can be used by limited soil textural data.

Key Words: Fredlund model, Gray model, Particle size distribution, Modeling

INTRODUCTION

The soil particle-size distribution (PSD) is one of the most fundamental physical attributes of soil due to its strong influence on other soil properties related to water movement, productivity and soil erosion (Hwang and Hong, 2006; Huang and Zhang, 2005). A conventional particle-size analysis involves the measurement of the mass fraction of clay, silt and sand and use of these fractions to find the textural class using a textural diagram (Gee and Bauder, 1986). A more complete description of texture is obtained by using a PSD model that best fits experimental data. Modeling of PSD is of interest from two viewpoints; fundamental pedological characterization of the soil, or as a basis for estimation of soil hydraulic properties, such as the water retention and hydraulic conductivity function. Selecting the most appropriate model to represent soil particle-size distribution is important to estimate more precisely soil hydraulic properties (Bittelli *et al.*, 1999). There are two basic approaches to the representation of PSD: via parametric models of the full distribution (e.g. Fredlund *et al.*, 2000 and Buchan *et al.*, 1993) or more simply via statistical transformation of limited three-fraction texture data (e.g., Shirazi and Boersma, 1984; Skaggs *et al.*, 2001).

Fredlund *et al.* (2000) provided two parametric models to estimate PSD that have greater flexibility for fitting a wide variety of soils. Many researchers compared Fredlund's model with other PSD models and reported that it had the best performance for most soil textural classes (Hwang *et al.*, 2002; Hwang, 2004; Botula et al., 2013). A detailed PSD is required to use Fredlund model, while many databases do not contain the full PSD, but instead contain only the clay,