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Spatial Prediction of Hydraulic Zones from Soil Properties and Secondary Data Using Factorial Kriging Analysis

James Bevington (1), Francesco Morari (2), Elia Scudiero (3), Pietro Teatini (4), and George Vellidis (5)

(1) College of Engineering, University of Georgia, Athens, USA, jbevingt@uga.edu, (2) Dipartimento di Agronomia Ambientale e Produzioni Vegetali, Universitá di Padova, Legnaro (PD), Italy, francesco.morari@unipd.it, (3) USDA-ARS, U.S. Salinity Laboratory, Riverside, USA , Elia.Scudiero@ARS.USDA.GOV, (4) Dipartimento di Ingegneria Civile, Edile e Ambientale, Universitá di Padova, Padova, Italy, pietro.teatini@unipd.it, (5) Department of Crop and Soil Sciences, University of Georgia, Tifton, USA, yiorgos@uga.edu

The development of pedotransfer functions (PTF) is an important topic in soil science research because there is a critical need for incorporation of vadose zone phenomena into large scale climate models. Soil measurements are inherently spatially dependent and therefore application of geospatial statistics provides an avenue for estimating soil properties. The aim of this study is to define management zones based on soil hydraulic properties. Samples were collected from 50 locations at 4 depths in a 20.8ha field located in the Po River delta in Italy. Water retention curves (WRC) and unsaturated hydraulic conductivity curves (UHC) and were determined via inversion of measurements taken using the Wind (Dane and Topp, 1994) method. This region is in known to have paleo-channel structures and highly heterogeneous soils. Factorial kriging analysis (FKA) was applied to hydraulic parameters in one data set and soil physical properties in another data set at 4 depths. The mapped principal components (PCs) were used in a fuzzy-c means algorithm to define zones of like properties. To examine the physical significance of these zones, curve parameters and hydraulic curves were investigated. Zones were able to distinguish between θ_s(saturated water content), n (shape parameter) and α (inverse of air entry) while θ_r (residual water content) and Ks (saturated conductivity) were not statistically different between the groups. For curve comparisons, WRC were found to be significantly different between zones at all tensions while effective saturation curves (Se) differ for the majority of tensions (except at 28cm), but UHC did not differ. The spatial relevance of the zones was examined by overlaying hydraulic zones with zones defined using the FKA and fuzzy-c means approach from soil physical properties such as texture and bulk density. The hydraulic zones overlaid with areal accuracy ranging from 46.66% to 92.41%. As there is much similarity between these sets of zones, there is a potential to predict hydraulic zones from zones defined from soil physical properties. This work illustrates the potential to incorporate geospatial statistics in the development of pedotransfer functions.