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Mapping soil resistance under different soil water content conditions using indicator kriging

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In many agricultural problems, it is of interest to map the zones where the variable under study shows the probability of being greater than a threshold value. Soil resistances higher than 2 MPa might difficult the establishment of cultures; therefore, further management or tillage techniques should be undertaken.
The aim of this work was to map soil resistance using geostatistical techniques, therefore, an analysis of the spatial distribution of soil compaction and the influence of soil water content on the resistance to penetration was carried out. The studied clay-textured soil was managed under no-tillage practices. Soil resistance was described by the cone index which was obtained using a penetrometer. This attribute was assessed at 5 different depths, i.e. 0-10 cm, 10-20 cm, 20-30 cm, 30-40 cm and deeper than 40 cm, whereas soil water content was described at 0-20 cm and 20-40 cm. In the end, 73 data points were surveyed. Soil water conditions varied during the five different samplings.
Statistical analysis showed that datasets followed a normal distribution, therefore, no transformation was required. Studied attributes showed low and non-significant correlation coefficients which impeded the application of cross-variogram and cokriging techniques. Because of the limited number of measured data, only the omnidirectional semivariogram was computed, and hence the spatial variability is assumed to be identical in all directions.
Spatial dependence was observed in 33 out of 35 data series, both for cone index and soil water content. Fitted theoretical structures corresponded to exponential models in 20 cases, 10 Gaussian models and 3 spherical models. Nugget effect varied from 0 to 44.4 depending on the dataset and spatial dependence maximum range was 90 m. A strong spatial dependence was observed in 18 of the data sets whereas only 2 showed a weak autocorrelation.
Taking into account the 2 MPa threshold, indicator kriging was used to map the soil resistance distribution allowing the identification of site-specific management zones which permit the adoption of precision agriculture techniques, specifically, tillage practices. The application of these methodologies is discussed regarding the results of this analysis.