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Selection of a Geostatistical Method to Interpolate Soil Properties of the State Crop Testing Fields using Attributes of a Digital Terrain Model[1]

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Abstract—The three most common techniques to interpolate soil properties at a field scale—ordinary kriging (OK), regression kriging with multiple linear regression drift model (RK + MLR), and regression kriging with principal component regression drift model (RK + PCR)—were examined. The results of the performed study were compiled into an algorithm of choosing the most appropriate soil mapping technique. Relief attributes were used as the auxiliary variables. When spatial dependence of a target variable was strong, the OK method showed more accurate interpolation results, and the inclusion of the auxiliary data resulted in an insignificant improvement in prediction accuracy. According to the algorithm, the RK + PCR method effectively eliminates multicollinearity of explanatory variables. However, if the number of predictors is less than ten, the probability of multicollinearity is reduced, and application of the PCR becomes irrational. In that case, the multiple linear regression should be used instead.

Keywords: soil mapping, variogram, ordinary kriging, regression kriging, agrochemical properties

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INTRODUCTION

Effective soil management requires understanding of the distribution pattern of soil properties within the landscape under consideration. However, heterogeneity of the soil cover and spatial variability of its properties cause uncertainty in the estimates of their spatial distribution. In conditions of intensive agriculture, the anthropogenic heterogeneity is also added to the natural heterogeneity of the soil cover. Erosion of the soil cover is the particular example of the reasons for the increase in the variability of soil properties within the agrocenoses of the Republic of Tatarstan.

Traditional methods of soil survey have been criticized for being too qualitative [21, 26]. For example, deterministic interpolation methods, used for construction of soil-agrochemical maps, do not fully account for spatial variability of soil properties and uncertainty of soil cover. In the worst case, maps have a discrete division into classes by elementary sampling sites, to which an average value of the class of nutrient content has been assigned. Thus, unaccounted variability remains within the elementary sampling site, and the final prediction of nutrients distribution is not accurate [31]. In response to this criticism, quantitative models have been developed to describe, classify, and study spatial distribution patterns of soils and their properties in a more objective manner.

Geostatistics allows us to determine a degree of spatial autocorrelation of environmental properties, to use an autocorrelation structure for prediction at unmeasured locations [32], and to quantify scale of spatial variability; it promotes for a better understanding of mechanisms and processes that control the spatial structures [19].

Geostatistics was first applied in soil science in the early 1980s. It was an alternative to traditional methods of representing spatial changes in a soil cover [12]. The first to use the kriging method in a soil survey were Burgess and Webster [21]. Over the past decades, geostatistical methods have successfully been applied to solve problems of digital mapping of the soil cover of agrocenoses and for precision agriculture [14, 15, 34]. A significant number of studies have been devoted to a comparison of spatial prediction methods [23]. Nevertheless, as Samsonova rightly noted, the number of studies that use geostatistical approach in Russian soil science is relatively small [10]. Among the studies of recent years, one can single out the ones contained in the monograph *Geostatistics and Soil Geography* [1] and the studies by Krasilnikov [5] and Efremova with

[1] The article was translated by the authors.

† Deceased.