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Adjusting distances using landscape factors and fuzzy logic in geostatistics

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Interpolation of point measurements using geostatistical techniques can yield distributed datasets from relatively small numbers of sample points. Traditional geostatistics is based on the spatial autocorrelation concept that nearby things are more related than distant things. This study uses additional landscape information to redefine the Cartesian concept of 'distant things' with quantifiable factors (i.e., topography, land use, soil characteristics) so that similar sampling points are considered closer than dissimilar sampling points. Soil moisture, pH, carbon and nitrogen content were measured in the mineral and organic soil layers at 100 sampling points each randomly located within 100-m² grid cells covering 3 km². Using a fuzzy logic approach, the 'closer' similar points move is thresholded to achieve better semivariogram models improving kriging estimates. This provides a method to lower the nugget associated with the semivariogram thereby better representing small scale variability in the measured data. Also, more stable sills in the semivariogram were created with the new distance concept lowering the weighted sum of squares of differences between the experimental and model semivariogram. The improvement in representing spatial variation of measured data is seen with lower mean standard error for cross-validation of the kriging based on transformed distance. By lowering the nugget, small scale variations are better represented using spatially sparse datasets providing a way to increase information about a distributed property without increasing the number of sampling points.