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Geostatistical analysis of groundwater level using Euclidean and non-Euclidean distance metrics and variable variogram fitting criteria

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Groundwater level is an important information in hydrological modelling. Geostatistical methods are often employed to map the free surface of an aquifer. In geostatistical analysis using Kriging techniques the selection of the optimal variogram model is very important for the optimal method performance. This work compares three different criteria, the least squares sum method, the Akaike Information Criterion and the Cressie's Indicator, to assess the theoretical variogram that fits to the experimental one and investigates the impact on the prediction results. Moreover, five different distance functions (Euclidean, Minkowski, Manhattan, Canberra, and Bray-Curtis) are applied to calculate the distance between observations that affects both the variogram calculation and the Kriging estimator. Cross validation analysis in terms of Ordinary Kriging is applied by using sequentially a different distance metric and the above three variogram fitting criteria. The spatial dependence of the observations in the tested dataset is studied by fitting classical variogram models and the *Matérn* model. The proposed comparison analysis performed for a data set of two hundred fifty hydraulic head measurements distributed over an alluvial aquifer that covers an area of 210 km^2. The study area is located in the Prefecture of Drama, which belongs to the Water District of East Macedonia (Greece). This area was selected in terms of hydro-geological data availability and geological homogeneity. The analysis showed that a combination of the Akaike information Criterion for the variogram fitting assessment and the Brays-Curtis distance metric provided the most accurate cross-validation results. The Power-law variogram model provided the best fit to the experimental data. The aforementioned approach for the specific dataset in terms of the Ordinary Kriging method improves the prediction efficiency in comparison to the classical Euclidean distance metric. Therefore, maps of the spatial variability of the hydraulic head and of prediction uncertainty were constructed with the different approaches to indicate the prediction differences.