Impact of Data Preprocessing on Geospatial Modelling of Methane Concentrations Using Ordinary Kriging

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Abstract

This Geostatistical methods are widely used to derive continuous spatial representations from point-based environmental measurements. However, preprocessing may modify their spatial structure and affect local variability in interpolation results. This study evaluated the effects of local averaging and regular-grid representation on spatial modeling of methane concentrations at a reclaimed municipal solid waste landfill. Methane concentrations measured at 168 locations were log-transformed prior to modeling due to their strongly skewed distribution spanning six orders of magnitude. Three input-data variants were compared: the original observations and two regular representations with grid spacings of 25 × 25 m and 50 × 50 m, derived by local averaging within a 60 m neighborhood. Ordinary kriging was applied using identical semivariogram and interpolation parameters. The resulting surfaces were evaluated against the original observations using error metrics and their ability to preserve spatial patterns, local variability, and extreme values. The original-data model showed the highest agreement with reference data (MAE = 0.14; RMSE = 0.19), whereas both regular-grid variants produced substantially higher errors (MAE = 0.73–0.76; RMSE = 0.93–0.95) and yielded similar results despite differences in point density. Local averaging reduced short-range variability and attenuated local methane maxima while largely preserving the overall spatial pattern. These results demonstrate that increasing the density of locations derived from existing measurements does not necessarily increase spatial information available for geostatistical modeling. Preprocessing prior to kriging should therefore reflect the spatial scale of variability and modeling objective, particularly when preservation of local anomalies is important.

Keywords

Data preprocessing, methane concentration, ordinary kriging, sampling density, spatial aggregation.