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Spatial Analysis of Groundwater Quality in Karstic Aquifers under Urbanization Stress: A Methodological Assessment

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Decision makers are increasingly relying on groundwater quality mapping using geospatial / statistical analysis tools coupled with Geographic Information Systems (GIS) that transform monitoring data into more readable maps for informed decisions. These tools are dependent on various interpolation methods that are invariably applied without proper knowledge of underlying assumptions thus often generating non-validated or unreliable maps. This study examines the accuracy of commonly used interpolation schemes with cross-validation using field measurements collected during groundwater sampling campaigns in three coastal cities along the eastern Mediterranean. The performance and accuracy of interpolation methods was scrutinized with multiple cross-checking approaches including (1) the leave-one-out, (2) matching with water quality standardized categories, and (3) cross-checking with the physical vulnerability of tapped aquifers. A total of 380 interpolation scenarios were generated using several combinations of interpolation methods (Inverse Distance Weight (IDW), Kriging and Co-Kriging), semi-variogram models (Spherical and Exponential), data transformation, and several water quality parameters including single and multiple contaminant indicators, in three cities and for different seasons. The results showed that Kriging and Co-Kriging produced relatively better statistical indicators, whereas the IDW matched better the field measurements when a lumped approach of six water quality categories was adopted. While it can be argued that there is no one "best" interpolation method or a semi-variogram model that fits all data, it was evident that the GIS-based interpolation methods exhibited better matching at the three surveyed cities in comparison with groundwater vulnerability assessment models such as DRASTIC and EPIK.