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## Joint spatial modelling of sediment nutrients and their ratio in Lake Balaton (Hungary) using multivariate geostatistics

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Eutrophication, water quality and environmental status of lakes is a global issue that depends not only on the quality and quantity of nutrients stored in lake sediments but also on their relative content. On the example of Lake Balaton (Hungary), we jointly modelled the spatial distribution of the nutrients nitrogen and phosphorus, and their ratio (i.e. nitrogen to phosphorus ratio) in the sediments of the lake and then provided spatial predictions at different supports (i.e. point, basin and entire lake) with the associated prediction uncertainty. The objective of our study was to illustrate the merits of applying multivariate geostatistics when spatial modelling of more than one variable is targeted at various scales in water ecosystems. Exploratory variography confirmed that there is a spatial interdependency between the nutrients and therefore it is better to jointly model their spatial distribution. The results revealed that by the application of multivariate geostatistics the spatial interdependency existing between the nutrients under study can be explicitly taken into account and exploited in the course of spatial modelling to provide coherent and more accurate spatial predictions that could support the complex assessment of the water quality and environmental status of Lake Balaton. Besides, stochastic realizations reproducing the joint spatial variability of the two nutrients can be generated that allow to compute stochastic realizations of their ratio, furthermore, to provide spatially aggregated predictions for larger supports (e.g. basins or entire lake) with the associated prediction uncertainty, which may be better fit to the end-users' demands on spatially explicit information about sediment nutrients. Our study highlighted that it is worthy of applying multivariate geostatistics in case spatial modelling of two or more variables, which jointly vary in space, is targeted in water ecosystems.

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