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Geostatistical modeling of sediments quality upstream river dams

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The presence of dams on rivers generally leads to an accumulation of sediments upstream. To allow water circulation, the sediments should periodically be dredged. A common dredging technique, called “pumping-dilution”, consists in extracting sediments and then in rejecting them after the dam after an important dilution. It is known that the sediments could potentially be contaminated in the case of waste discharge in the river upstream the dam. Nowadays, the regulatory framework imposes the operator to guarantee that this “pumping-dilution” operation is acceptable for the aquatic system from a sanitary point of view. The inability to provide such guarantee could force the producer to consider more expensive solutions.

Hence the need for the operator to have methods allowing a sustainable management of sedimentary stocks, with a predictive approach of their possible re-mobilization in case of floods and their impact downstream, taking into account various operating and dredging scenarios.
Having experimental measurements of the chemical composition of the sediment is of crucial importance to characterize the stock and also to initialize and validate the numerical models. However, such measurements are inevitably scarce due to campaign/acquisition costs and the amount of sediments to cover: several hectares and several meters for the thickness. Furthermore, chemical concentrations usually present an important spatial heterogeneity, leading to significant uncertainties when predicting globally or locally the sediment’s quality.

Geostatistics provides a suitable framework for analyzing and modeling variables distributed in space and/or time. Using the results of a sampling campaign, several objectives were under study: (i) estimate globally the chemical quality of the sediment stock; (ii) estimate locally the spatial distribution of concentrations and the probability to exceed regulatory thresholds; (iii) provide sampling guidelines for future sampling campaigns. A 3D model of the age of the sediment has been set up, as the chemical concentration of the sediment is mainly contained in specific sediment layers: old sediments, sediments settled on the stock after upstream floods, etc. Also, the difference between the support measurement (small core) and the mesh size for dredging operations has been properly taken into account.

The paper presents the methodological framework which allowed reaching these objectives, which provide important information for analyzing the risk of re-mobilizing pollution in the case of future floods or dredging operations.