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Statistical study of sedimentary phosphorus content in French reservoirs and identification of P variability driving factors

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Phosphorus (P), an essential element for living organisms, is often considered as the limiting factor of eutrophication in aquatic environments, especially in reservoirs. In order to limit their environmental degradation and to meet the requirements of good ecological quality imposed by the European Water Framework Directive (WFD), actions have been implemented in the past decades to reduce the exogenous P influx to reservoirs. However, despite the decrease in external P inputs to the water from agriculture and domestic wastewater, eutrophication keeps expanding due to sedimentary P flux to the water column. Assessing the quality of sediments in reservoirs and the risk of sedimentary P transfer to the water column is therefore a major issue. The POMOSÉD project aims to investigate the relevance of the WFD regulatory parameters, monitored since 2005, in the evaluation of sediment quality with respect to P. This work presents an inventory of sedimentary P contents in French reservoirs and identifies the factors contributing to the observed P variability from the physico-chemical sedimentary composition and the reservoirs and watersheds characteristics.

Statistical analyses were conducted on sedimentary composition data (total phosphorus (TP), iron (Fe), manganese (Mn), aluminium (Al), Kjeldahl nitrogen (NTK) and organic carbon (OC)) from 219 French reservoirs. The characteristics of their watersheds (geology, altitude, agricultural and artificial surfaces, ...) and their morphology (e.g. depth, surface area, ...) were also included in the statistical analyses.

The sediments showed large variability in the TP concentration varying from 172 to 4350 mg.kg⁻¹ with mean and median values of 1310 and 1060 mg.kg⁻¹ respectively. The variability of sedimentary TP was observed both spatially and temporally. We highlighted significant correlations of TP content with Fe, Al, NTK and OC. We pointed out that the geological substratum, the level of anthropization of the watershed and the depth of the reservoirs are driving factors for TP concentration in sediments. Therefore, the WFD monitoring allows to distinguish several typologies of sediment with respect to TP. The typologies inducing an enrichment in TP of the sediments are crystalline substrate sediments rich in Fe and OC, deep reservoirs inducing anoxia

development and an anthropized watershed. However, an enrichment in TP of the sediments does not necessarily indicate an anthropic pressure as shown by the influence of geology and the composition of sediments. These results might be included into multiple linear models linking PT concentrations to the other elements concentrations (CO and Fe) and the different factors (geology > anthropization > reservoir depth).