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What degree of complexity to model the release of metals from solid deposits from water treatment nature-based solutions?

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Inorganic pollutants (trace metals, nutrients) contained in the deposits from water treatment by nature-based solutions can present a major environmental risk for surface and ground water, especially when these residues are reused in agriculture. In risk management related to the remobilization of pollutants retained in porous matrices, geochemical prediction models are often used. These models allow the calculation of the distribution between solid and liquid phase of the pollutants but also their speciation, two fundamental parameters for evaluating the toxicity of a release. But, the fate and transfer of inorganic contaminants in soil/sediment-water systems is particularly complex due to the large variety of chemical forms they can take from their reactions and interactions with the environment. Inorganic contaminants can be complexed, adsorbed and/or exchanged with particulate matter, or co-precipitated with mineral and organic solid phases. Multi-surface models allow the modelling of these complex environments. They can be defined as an assemblage of generic models using thermodynamic constants to describe ion-binding capacity of the various surfaces composing porous matrices. In this study, a multi-surface model was proposed and its complexity level was studied. This purpose conducted to the comparison of three scenarios for modelling the organic matter (OM) as adsorbent compounds. The interactions between metals and organic matter were studied as a function pH. The Humic Ion bindings (Model VII) model [1] to describe ion-binding to fulvic and humic acids has been used. The OM content in the particulate matter has been modulated in the models to express the effective relative sorption capacity. This approach, developed for soils or sediments, has been applied here to a sludge deposit (SD) corresponding to the accumulation of anthropogenic organic matter in vertical flow treatment wetlands, associated with colloidal Fe-oxides with strong influence on the remobilization of major and trace elements retained in the SD. The results showed that for high organic matter content solid deposit as studied here, sorption to organic matter and Fe-oxides is sufficient to globally adequately predict most trace elements release.

1. Tipping, E., Lofts, S., Sonke, J.E., (2011). Environ. Chem. 8, 225.