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A 2D hydro-morphodynamic modelling approach for predicting suspended sediment propagation and related heavy metal contamination in floodplains: a sensitivity analysis

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Recent years have seen a growing awareness for the central role that fine sediment loads play in transport and diffusion of pollutants by rivers and streams. Suspended sediment can potentially carry important amounts of nutrients and contaminants, such as trace metals among which some are recognized as Potential Harmful Elements (PHE). These threaten water quality in rivers and wetlands and soil quality in floodplains. Currently, many studies focusing on sediment transport modelling deal with marine and estuarine areas. Some studies evaluate sediment transport at basin scales and often evaluate yearly sediment fluxes using hydrologic and simplified hydraulic models. Some more theoretical studies develop and improve numerical models on the basis of physical model experiments. As a matter of fact, sediment transport modelling in small rivers at reach/floodplain scale is a rather new research field.

In this study, we aim at simulating sediment transport at the floodplain scale and the single flood event scale in order to predict sediment spreading on alluvial soils. This simulation will help for the estimation of the potential pollution of soils due to the transport of PHEs by suspended sediments.

The model is based upon the Telemac hydro-informatic system (i.e. dynamical coupling of Telemac-2D and Sysiphe). As empirical and semi-empirical parameters need to be calibrated for such a modelling exercise, a sensitivity analysis is proposed. In parallel to the modelling exercise, an extensive hydrological/geochemical database has been set up for two flood events. The most sensitive parameters were found to be the hydraulic friction coefficient and the sediment particle settling velocity in water. Using the two monitored hydrological events for calibration and validation, it was found that the model is able to satisfyingly predict suspended sediment and dissolved pollutant transport in the river channel. In addition, a qualitative comparison between simulated sediment deposition in the floodplain and a soil contamination map obtained from in situ measurements shows that the preferential zones for deposition identified by the model are realistic.