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Importance of sediment grain-size and density parameterization in hydromorphodynamic modelling: A case study on a small river system

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In the last two centuries, many areas have undergone a rather fast demographic, industrial and urban development. This intense land occupancy affected the quality of surface waters, which become the receptacle of anthropogenic effluents from various origins. In this context, several rivers in North-Eastern France were strongly modified (rectification of river bed, dam building) and received high amounts of industrial and domestic effluents due to past steel-making activities installed nearby water resources. As a consequence of these past effluent inputs in the river, and although part of the settled material was dredged and removed from the riverbeds, these often remain contaminated. During flood events, the remobilization of these riverbed sediments can strongly impact water and even soil quality. In this context, there is consequently a clear need for predicting the potential resuspension and transport of sediment in these heavily polluted river systems.

Hydromorphodynamic models are powerful tools for predicting the potential mobilization and transport of sediment in river ecosystems. Recent studies even showed that they are able to predict suspended sediment matter concentration in small river systems satisfyingly. However, modelling exercises often neglect suspended sediment properties (e.g. particle site distribution and density), even though such properties are known to directly control the sediment particle dynamics in the water column during flood events.

This study has two objectives. On the one hand, it aims to further develop an existing hydromorphodynamic model based on the dynamic coupling of TELEMAC-3D (v7p1) and SISYPHE (v7p1) in order to enable an enhanced parameterization of the sediment grain-size and density distributions. On the other hand, it evaluates and discusses the added-value of the new development for improving sediment transport and riverbed evolution predictions. To this end, we evaluate the sensitivity of the model to the parameterization of sediment grain-size distribution, sediment density and suspended sediment concentration at the upstream boundary. As a test case, the model is used to simulate a flood event in a small-scale river, the Orne River in north-eastern France. The results show substantial discrepancies in bathymetry evolution depending on the model setup. Moreover, the sediment model based on an enhanced sediment grain-size distribution (10 classes) and with distributed sediment density outperforms the model with only two sediment grain-size classes in terms of simulated suspended sediment concentration.