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Abstract: The upper Rhine River is a highly harnessed and regulated river. Its main channel is navigable and its water is used for agriculture, drinking water supply and electricity production. EDF (a French electricity company) is in charge of eight dams on the upper Rhine River for producing hydro-electricity. In order to increase the safety and the competiveness of the installations, but also to reduce their environmental impact, the sediment dynamic in these reservoirs has become a key factor to control and predict. In this study, we focused on the Marckolsheim reservoir, which is located 50 kilometres upstream the city of Strasbourg. Since its construction in 1961, this reservoir has been filled continuously with cohesive sediments, partially contaminated.

To keep the water level suitable for navigation, the dam is regulated with a high-frequency repositioning of its gates. This regulation, combined with the bifurcation configuration of the channel, leads to a complex and unsteady hydrodynamic in the reservoir. Furthermore, the high temporal variations of suspended sediment supply makes the deposition in the reservoir even more difficult to predict. Two field campaigns were performed in 2015 and 2016 under two different discharge conditions, with the objectives of estimating hydraulic and suspended sediment transport variables.

The numerical codes TELEMAC-2D and SISYPHE were used to simulate in 2D (integrated along the water depth) the hydrodynamic and the suspended sediment transport on this site. A ten kilometres long model was built and calibrated with the measured data of the 2015 and 2016 field campaigns, but also with measurements of sediment parameters that have been done previously, like erosion tests (Westrich, 2010). The originality of this model consists in an explicit 3D representation of the dam gates. An algorithm was implemented in TELEMAC in order to adapt the gates position at each time step, in conformity with the real regulation rules followed by the dam operator. By using upstream measured data of discharge and suspended sediment concentration as boundary conditions, a six months period was simulated thank to the EDF R&D clusters. The comparison of the simulated results with bathymetric surveys shows good agreements if specific properties of sediments related to settling processes are taken into account.

Finally, a new method is proposed in order to simulate the dynamics of the contaminated sediments. The SISYPHE code has been modified for allowing the simulation of two cohesive sediment classes: one class for contaminated sediment, one class for the non-contaminated ones. A 3D spatial distribution of the contaminated sediments in the reservoir has been defined in the layer representation of SISYPHE. The long-term simulation gives interesting highlights of the effect of flood events on the resuspension conditions of the contaminated sediments.