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Numerical analysis of sediment transport in a shallow lozenge-shaped reservoir

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Investigating sediment deposition and re-suspension processes in shallow reservoirs is indispensable for understanding the dynamic of reservoir sedimentation and maintaining the reservoir operating functionality. Regarding the shallow reservoirs, the geometry is a dominant factor affecting the flow fields, and consequently the sedimentation patterns. In the present study, a 3-D numerical model of a shallow lozenge-shaped reservoir with physically symmetric boundaries (i.e. central inlet and outlet channels) is developed and calibrated based on the systematic experimental model. The aim is to track the effect of the reservoir shape on the deposition pattern of suspended sediment inflow. According to the laboratory experiments, simulations are performed in four steps, the first step without sediment particles on the bed (i.e. fixed bed) and three simulations with a moveable bed, based on deposited sediments from the previous simulation steps. The simulations are carried out by means of the three-dimensional numerical model SSIIM 2. For calibration, the model-independent parameter estimation and uncertainty analysis tool PEST is used.
Starting with the simulation, the entering jet deviates to the left side of the reservoir causing a large central recirculation zone. However, due to the deposited sediments along the flow direction, after a while, the flow pattern shifts to the right side during the simulation. These fluctuations in the flow field result in the symmetrically distributed bed topography.
From the results, it can be concluded that the numerical model is capable to reproduce the experimentally-observed asymmetric flow field, although having symmetric reservoir geometry. The results of the simulations also show that the flow direction and its magnitude are highly sensitive to the grid resolution, the inlet channel length, the chosen turbulence model, and the roughness coefficient. The pattern of the morphological bed changes in different cross-sections is in acceptable agreement with the experiments.