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Master Thesis Abstract

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Construction and application of a 3D-hydrodynamic model of the Schwarzenbach reservoir using Delft3D

In hydraulic engineering, three-dimensional numerical modelling has become particularly attractive to scientists during the last century to simulate complex hydraulic processes and to study intricate riverine systems. One primary reason using 3D numerical models, for instance in reservoir modelling, is its adequacy and capacity to accurately resolve complex flow systems compared to the application of one- or two- dimensional numerical modelling. For this reason, in this study, the three-dimensional numerical modelling software Delft3D is used to construct a model of the Schwarzenbach Reservoir in Germany and subsequently applied to simulate the flow dynamics and hydrodynamic response to different scenarios.

The reservoir Schwarzenbach (SBT), constructed in 1926, is in the northern Black Forest. SBT reservoir has a total storage capacity of 14.4 million m3 which serves as an upper reservoir in a hydro-electric pump-storage system operated by EnBW. The hydraulics in the reservoir are complex since, in addition to the pumped and turbine water, the reservoir gets fed by two natural creeks as well as a transition tunnel. The two surface inflows (creeks) are at the northern head of the reservoir while the transition tunnel is located laterally into the reservoir, creating an intricate flow pattern.

By means of the Delft3D Flow Module, we aim at investigating the significant driving forces of the hydrodynamics within the reservoir. In the first phase, a sensitivity study is conducted to examine the model's robustness for different scenarios and changing parameters. These simulations utilised different discretisation schemes, the influence of wind and different applied turbulence models. The second phase of the thesis focuses on model validation by means of vertical profiles based on flow and temperature data. This data consists of ADCP and temperature measurements conducted by the University of Konstanz in 2016. In the last part, the calibrated model is used to simulate different operation scenarios to finally investigate the influence of reservoir management on the hydraulics in the reservoir.
Keywords: 3D numerical modelling; 3D hydrodynamics; reservoir management; Delft3D; Schwarzenbach reservoir