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Estimating long-term evolution of fine sediment budget in the Iffezheim reservoir using a simplified method based on classification of boundary conditions

Qing Zhang (1), Gudrun Hillebrand (2), Thomas Hoffmann (2), and Reinhard Hinkelmann (1)

(1) Chair of Water Resources Management and Modeling of Hydrosystems, Technische Universität Berlin, Berlin, Germany (qing.zhang@wahyd.tu-berlin.de), (2) Division M - Quantitative Hydrology, Federal Institute of Hydrology, Koblenz, Germany

The Iffezheim reservoir is the last of a series of reservoirs on the Upper Rhine in Germany. Since its construction in 1977, approximately 115,000 m^3 of fine sediments accumulate annually in the weir channel (WSA Freiburg, 2011). In order to obtain detailed information about the space-time development of the topography, the riverbed evolution was measured using echo sounding by the German Federal Waterways and Shipping Administration (WSV). 37 sets of sounding data, which have been obtained between July 2000 and February 2011, were used in this research.

In a previous work, the morphodynamic processes in the Iffezheim reservoir were investigated using a high-resolution 3D model. The 3D computational fluid dynamic software SSIIM II (Olsen, 2014) was used for this purpose (Zhang et al., 2015). The model was calibrated using field measurements. A computational time of 14.5 hours, using 24 cores of a 2.4 GHz reference computer, was needed for simulating a period of three months on a grid of 238,013 cells. Thus, the long-term (e.g. 30 years) simulation of morphodynamics of the fine sediment budget in the Iffezheim reservoir with this model is not feasible.

A low complexity approach of "classification of the boundary conditions of discharge and suspended sediment concentration" was applied in this research for a long-term numerical simulation. The basic idea of the approach is to replace instationary or quasi-steady simulations of deposition by a limited series of stationary ones. For these, daily volume changes were calculated considering representative discharge and concentration. Representative boundary conditions were determined by subdividing time series of discharge and concentration into classes and using central values per class. The amount of the deposition in the reservoir for a certain period can then be obtained by adding up the calculated daily depositions.

This approach was applied to 10 short-term periods, between two successive echo sounding measurements, and 2 longer ones, which include several short-term periods. Short-term periods spread from 1 to 3 months, whereas long-term periods indicate 2 and 5 years. The simulation results showed an acceptable agreement with the measurements. It was also found that the long-term periods had less deviation to the measurements than the short ones. This simplified method exhibited clear savings in computational time compared to the instationary simulations; in this case only 3 hours of computational time were needed for 5 years simulation period using the reference computer mentioned above. Further research is needed with respect to the limits of this linear approach, i.e. with respect to the frequency with which the set of steady simulations has to be updated due to significant changes in morphology and in turn in hydraulics. Yet, the preliminary results are promising, suggesting that the developed approach is very suitable for a long-term simulation of riverbed evolution.

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