

Impact of the flood protection project "Rhesi" on the Alpine Rhine estuary and the Lake of Constance



Fig. 1: Rhine extension (river mouth of the Alpine Rhine) into the Lake of Constance - the huge amount of sediment conveyed into the lake can be clearly seen (image courtesy of the Internationale Rheinregulierung IRR)

The main goal of the flood protection project "Rhesi – Rhein, Erholung und Sicherheit" is to enhance flood water protection on the international river reach of the Alpine Rhine. It is planned to increase the discharge capacity from the actual 3'100 m³/s up to at least 4'300 m³/s, possibly up to 5'800 m³/s. This leads to larger water and sediment volumes conveyed into the Alpine Rhine estuary and the Lake of Constance. To examine the consequences, two numerical models were developed: VAW ETH Zurich investigates the river mouth, whereas the engineering society Prof. Kobus and Partner GmbH deals with the Lake of Constance.

Both models were successfully calibrated and validated. The calibration was done using a flood event in 2005 with a peak discharge of 2'252 m³/s which corresponds to a return period of 30 years. The validation was carried

out using minor flood events in 2008 where the highest discharge did not exceed a return period of approximately 2 years. Yearly measurements of morphological changes within the two extension dams (see Fig. 1) were used to rate the accuracy of the calibration and the validation.

The numerical model of the river mouth is a depth-averaged two-dimensional model. It consists of the Rhine extension (two dams into the Lake of Constance with a length of approximately 4 kilometers) and the surrounding shallow water zones. Two grain fractions allow simulating bed and suspended load transport.

Discharge measurement at Diepoldsau and water level measurements at Romanshorn were used as boundary conditions. The sediment supply at the upper boundary was derived using discharge and sediment measurements at Diepoldsau which allowed the formulation of a relation between discharge (Q) and sediment transport (S). The quality of the results is strongly influenced by the uncertainties of this S-Q-relation. Nevertheless the results of the numerical model are close to the real measurements. The mass fluxes out of the Rhine extension into the Lake of Constance serve as a boundary condition for the numerical model of the Lake of Constance.

In the second part of the project, different scenarios such as HQ₁₀₀, HQ₃₀₀ or EHQ, are simulated. This will illustrate the behavior of the Rhine extension and its effects on the Lake of Constance. This offers a valuable prediction tool to evaluate structural measures on the one hand and the long term development of the river mouth on the other hand.

Keywords:	flood protection project "Rhesi", Alpine Rhine estuary, Rhine extension, Lake of Constance, bed load transport, suspended load transport, river mouth developments, coupling of numerical models, S-Q-relation, estuary morphology
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