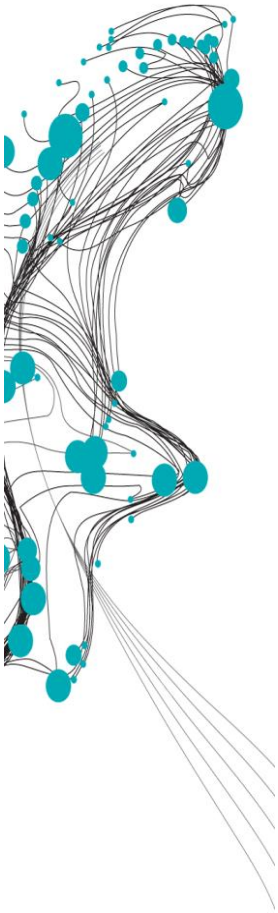
CALIBRATING A HYDRAULIC RIVER MODEL USING BATHYMETRY AND ROUGHNESS

A CASE STUDY ON THE RIVER WAAL



Rivers shape the landscape and are vital for human activities, but can cause dangerous flooding. Therefore, accurate prediction of river behaviour is important. Hydraulic river models simulate flow patterns, water levels, and sediment transport. The accuracy of these models can be improved by calibrating them.

The roughness of the river bed and floodplains is a key calibration parameter due to its uncertainty and its influence on the water level. An alternative to the roughness that is not used as often as a calibration parameter is the bathymetry. The roughness and the bathymetry have the largest impact on predicting inundation and flow characteristics. Research on using bathymetry as a calibration parameter is limited. Investigating its effect on water levels and calibration accuracy is valuable.

The objective was to compare total roughness, main channel roughness, and bathymetry as calibration parameters for accurate water level simulation. The study area that was used is the river Waal from the observation station Pannerdense kop to the observation station Hardinxveld.

A sensitivity analysis compared the effect of the total roughness, main channel roughness and bathymetry on the water level. Next, all three parameters were used as calibration parameters to simulate the water level for the discharge wave of 1995. The river was calibrated in steps by dividing the river into six sections. Validation was done using the 1993 and 2011 discharge waves. The accuracy in the calibration and validation was determined using the Root Mean Square Error (RMSE).

Results showed that total roughness and main channel roughness had a greater influence on the water level than bathymetry within the selected roughness values and bathymetry height ranges. Bathymetry showed a linear relationship with the water level, while both roughness variants had a slight nonlinear relationship. The roughness values and bathymetry height mainly increased during the calibration. Validation yielded comparable average RMSE values for the total roughness, main channel roughness and bathymetry, see Table 1 and Figure 1. This means that comparable accuracy can be achieved when using the total roughness, main channel roughness, or bathymetry as calibration parameters.

Further research is recommended to explore the effect of bathymetry as a calibration parameter on water levels and calibration accuracy, considering different study areas, modelling approaches, and discharge ranges. It is also recommended to investigate the effect that the shape of a cross-section has on the effects of the bathymetry on the water level.

Table 1. Average RMSE values (in m) for each calibration variant.

Calibration parameter	Calibration	Validation 1993	Validation 2011	Validation average
Roughness	0.159	0.157	0.104	0.130
Bathymetry	0.181	0.164	0.144	0.154
Main channel roughness	0.165	0.177	0.089	0.133

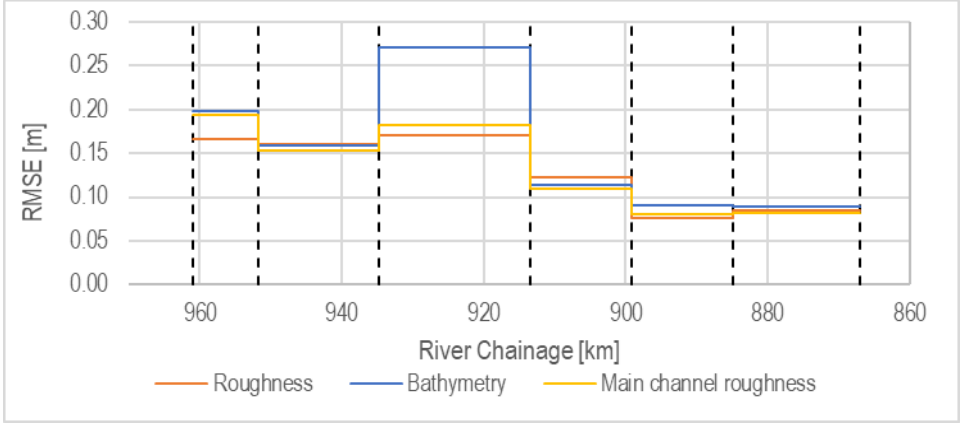


Figure 1: Comparison of the average RMSE values of the calibration variants after validation.

Jaap Gerrits

Graduation Date:
29 June 2023

Graduation committee:
University of Twente
Dr.ir. M.J. Booij
Dr.ir. A. Bomers
P. Khorsandi Kuhanestani

UNIVERSITY OF TWENTE.