To Aggrade or to Erode: Side Channels alongside Longitudinal Training Walls

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Introduction

Ongoing riverbed degradation in the Waal River threatens navigability and alters discharge distribution within the Rhine delta (Arbós et al., 2024). Within the Dutch Room for the River 2.0 programme, creating multi-channel system is considered to mitigate this degradation. Longitudinal Training Walls (LTW) are a variant on such a system in which during intermediate and high flows part of the discharge is conveyed by a side channel. This reduces the flow velocity and thereby sediment transport in the main channel during these morphologically-important discharges. By reducing the sediment transport, LTWs can mitigate further bed incision.

Recent numerical modelling demonstrated that replacing groynes by LTWs along a 50 km reach of the Waal River can stop riverbed degradation (Barneveld et al., 2025). However, the computations predicted substantial sedimentation in the side channels resulting in an estimated maintenance need of approximately 200,000 m³ per year. The bed of the side channels was schematized with a nonerodable layer which effectively suppressed sediment outflow from the start of the computations resulting in sediment accumulation. The large maintenance need strongly influences the predicted long-term feasibility of LTWs.

The objective of this research is to determine the effect of side channel bed erodibility on its morphological development and maintenance need. We focus on the sensitivity to sediment layer thickness and initial grain size.

Method

A two-dimensional Delft3D model of the Waal River (Sloff et al., 2024; Barneveld et al., 2025) is applied to simulate side channel development. Fourteen side channels (80–100 m wide) are schematized along the inner-bends of the river with overlapping inlets and outlets. We computed five scenarios with two erodible layer thicknesses (0.4 m and 1.0 m) combined with fine and coarse grain sizes and a non-erodible reference case (0.0 m).

Results

An erodible side-channel bed fully changes the morphological response (Fig 1). Instead of net sedimentation, net erosion occurs. The amount of erosion increases with layer thickness: a 1.0 m erodible layer yields substantially more erosion than a 0.4 m layer, demonstrating that sediment export is constrained by sediment erodibility. A coarser initial grain size further reduces sediment transport, erosion and thereby maintenance need.

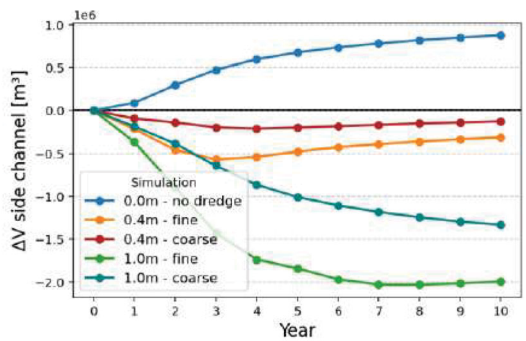

Figure 1. Total yearly sediment volume change over all side channels with respect to the initial bed.

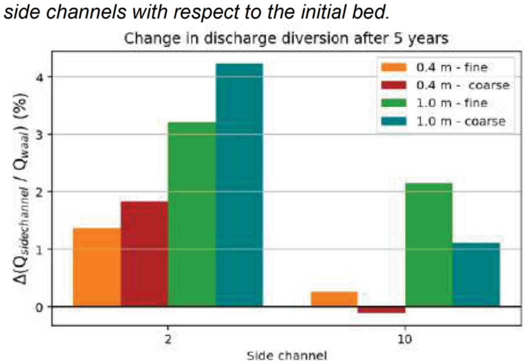

Figure 2. Change in discharge conveyance of the side channel after 5 years of computation for an upstream (2) and downstream side channel (10).

The observed erosion enhances discharge through the side channels, leading to an increased discharge conveyance in the side channel reducing discharge in the main channel (Fig. 2). This discharge increase can result in large aggradation of the main channel.

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Discussion

The results show that instead of 200.000 m^3/yr of aggradation in the side channel, with a slightly different assumption on erodibility a similar amount of yearly erosion can be expected. It shows the sensitivity of the model to such assumptions and the need for further research. We identify the following two main uncertainties:

Grid resolution

The grid is relatively coarse for the small channels that are considered. Additonalg rid cells over the width are needed to calculate the morphodynamics in a channel. In the model, the side channel is represented by only 3-4 grid cells. A model with a finer resolution might lead to a different discharge and sediment transport in the side channel and a change in sediment supply.

Sediment inflow over the sill

The entrance weir of the side channel is fully implemented in the bed schematisation, and this reduces the sediment supply to the side channel by bed slope effects. The bed slope relation used is calibrated on the 2D morphodynamics but overestimates the bed slope effect compared to experimental values (Baar et al., 2018). In addition, the model does not take suspended bed-material load nor the complex flow near weirs into account (De Ruijsscher et al. 2020). This results in large uncertainty in the sediment supply and thereby the bed-level development.

Conclusion

The computations show that the side channel is as likely to erode as to sedimentate. In Barneveld et al. (2025), the sediment transport in the side channel was underestimated resulting in sedimentation. The largest uncertainty now is the sediment supply to the side channel. This requires a more detailed model with additional calibration and validation.

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