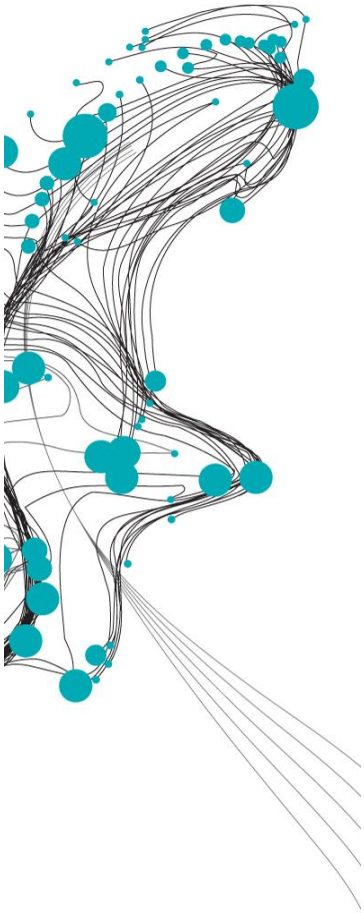
SEDIMENT NOURISHMENTS IN THE RIVER WAAL TO MITIGATE BED DEGRADATION

A NUMERICAL MODELLING STUDY



Over the past century, the bed of the river Waal has degraded by 1-2 meters. Because of the relatively high rate of degradation and because the degradation is not spatially uniform, this poses threats to the various functions of the rivers. Solutions are therefore sought to mitigate bed degradation. Studies have shown that solely implementing measures to decrease the erosivity of the flow is not enough and that sediment nourishments are required to fully stop bed degradation. This study investigates the effect of various sediment nourishments on the bed of the Waal by modelling sediment nourishments in a 1D-model of the Rhine branches. The influence of the sediment composition, initial location, volume and distribution of the nourishment are investigated, as well as the influence of varying discharge conditions due to the uncertainty in discharges.

It is found that sediment nourishments are capable of mitigating bed degradation in the Rhine. However, this requires repeated nourishments with large volumes of sediment. The effects of the nourishments extend further than the original location of the nourishment. As time progresses, the nourishment propagates downstream and disperses. The rates at which this happens mainly depends on the sediment composition and the volume of the nourishment. All nourishments eventually travel into the aggrading section of the Waal, downstream of rkm 915. By placing the nourishment further upstream, the nourishment affects the degrading section of the Waal longer.

When a nourishment is composed of coarser material than the bed, the decreased mobility of the bed causes additional erosion downstream of the nourishment. This can be prevented by distributing the nourishment over multiple parts. The nourishment parts then influence each other in such a way that additional erosion is prevented.

It is shown that when the nourishment volume is increased by a certain factor, the effect of the nourishment is increased by a larger factor. Both the maximum increase in bed level and the length over which the nourishment increases the bed level are increased. Nourishing a larger volume of sediment at once is therefore found to be beneficial. When the larger nourishment is distributed into several smaller parts, the length over which the nourishment reduces erosion is increased even further. When the individual parts are of a sufficiently large volume, the maximum reduction of erosion does not decrease.

Finally, it is shown that discharge variability due to uncertainty in the discharge time series does not cause a shift in trend. However, it is able to cause local and temporal changes in bed level of up to 70 cm, which is larger than the nourishments investigated here. That means that nourishments should be evaluated under various discharge conditions.

In practice, it is likely that the characteristics of a sediment nourishment cannot be freely chosen. The knowledge on sediment nourishments gained in this study can be used as a basis to define a nourishment strategy based on the practical limitations and possibilities.

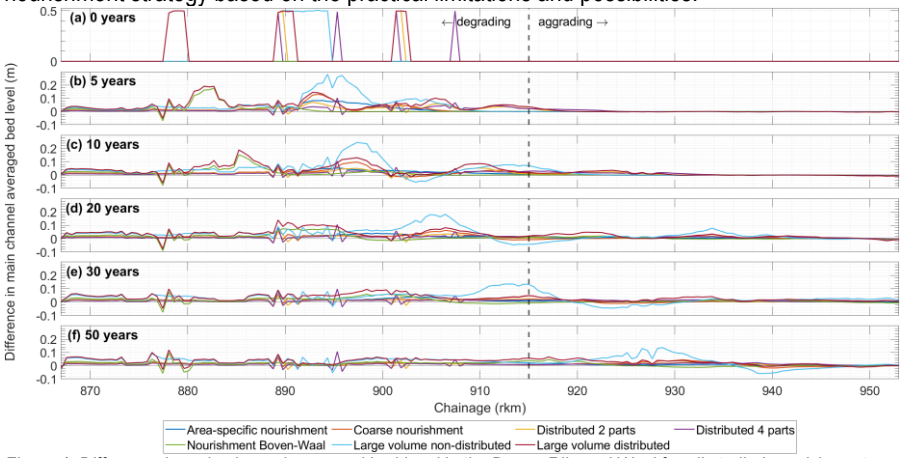


Figure 1: Difference in main channel averaged bed level in the Boven-Rijn and Waal for all studied nourishments compared to the reference simulation at different moments in time. The approximate location at which the trend changes from degrading to aggrading in the reference simulation is indicated as a dashed line at rkm 915.

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