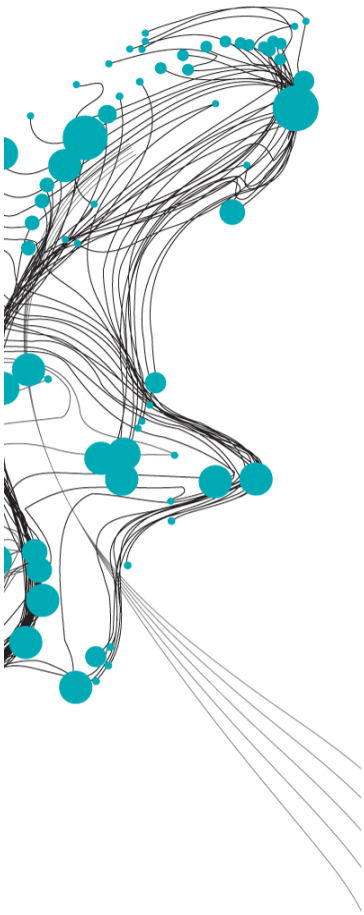
Supply-driven nourishment strategies for mitigating bed degradation in the Waal



In the past several decades, the summer bed of the Waal has eroded between 1-2 metres. This causes problems for different river functions. Sediment nourishments are needed to mitigate and counteract the ongoing erosion. This research aims to identify different sources of sediment near the Waal and their efficacy in mitigating bed degradation.

Using a 1D model of the Dutch Rhine branches, sediment nourishments are modelled. Four different sources are investigated over a period of 50 years: Area Vision Midden-Waal (7,500,000 m^3), mooring facility Spijk (750,000 m^3), Maas-Waal Canal maintenance (200,000 m^3), and downstream aggradation (570,000 m^3). The identified sources typically contain sediment that is finer than the nourishment location in the Boven-Waal.

The nourishments influence the bed level, the geometric mean grain size, and the discharge distribution at the Pannerdensche Kop. It is found that large nourishments are capable of counteracting river bed erosion in specific reaches of the Waal. The nourishments cause a fining of the bed, which makes it more erodible. The nourishments also mitigate skewing of the discharge distribution. For the smaller nourishments, similar observations are made regarding the different parameters. However, as these sources contained less sediment, their effects are much smaller and only have a noticeable influence during the first few years of the simulation.

Singular nourishments investigated in this study only delay bed erosion, as their nourished volumes are insufficient. To counteract erosion, repeated nourishments are required. This research included three scenarios with varying ratios of nourishment frequency to nourishment volume. The length of placement area for nourishments remained the same, resulting in higher nourishment heights for larger volumes. This led to increased morphological changes for larger nourishments, causing greater fluctuations in bed levels. Smaller, more frequent nourishments resulted in smaller fluctuations. From a morphological point of view, it is desired to decrease these fluctuations as the presence of a nourishment forms an obstacle on the bed, and thus to nourish more frequently. On the other hand, it can be preferable to minimise the nourishment frequency to reduce the disturbance of ecosystems.

The efficiency of a nourishment scheme is determined by normalising the mitigation with the amount of sediment nourished in that scheme. The most effective source is not the most efficient source. This hypothesises that the sediment required to mitigate erosion can be reduced by selecting an appropriate source. In this research, singular nourishments from the Maas-Waal canal and downstream aggradation had the highest efficiencies.

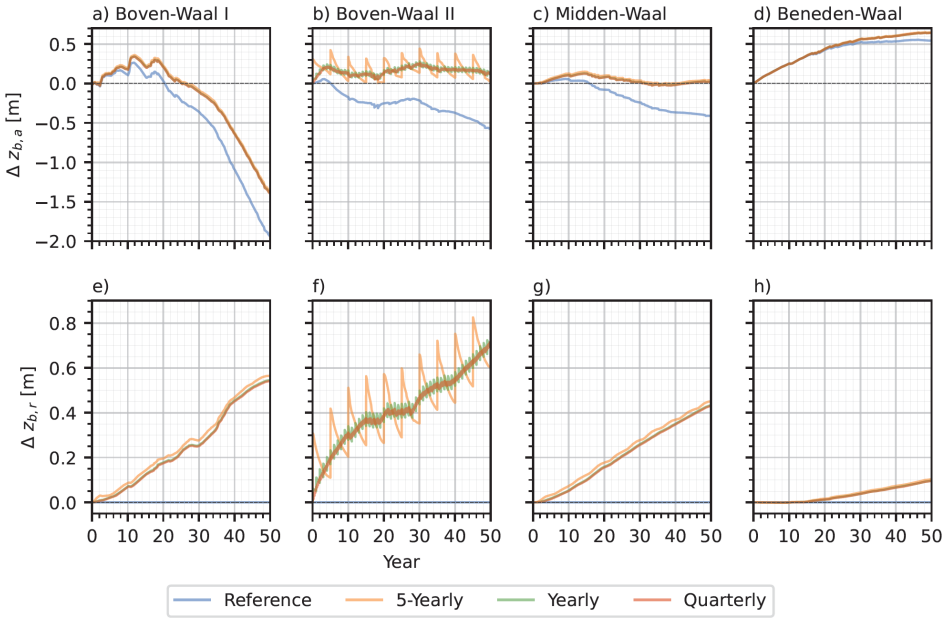


Figure 1: Reach averaged bed level change in the Waal for the Area Vision Midden-Waal nourishments with respect to the a-d) initial reach averaged bed level and e-h) reference reach averaged bed level.

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