

Towards a manageable and stable riverbed for the Meuse

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Introduction

The Meuse River shows ongoing bed degradation which threatens infrastructure and nature. During the 2021 flood deep scour holes formed unexpectedly. These scour holes were found to be the result of continuous erosion, tectonics and river widening which lowered water levels and increased bed shear stresses in bottlenecks (Barneveld et al., 2025b). The sediment balance of the Meuse shows an increase in sediment load from zero at the Belgian-Dutch border to 100,000 m³/yr near Lith, the most downstream weir, representing the annual sediment deficit of the river (Figure 1).

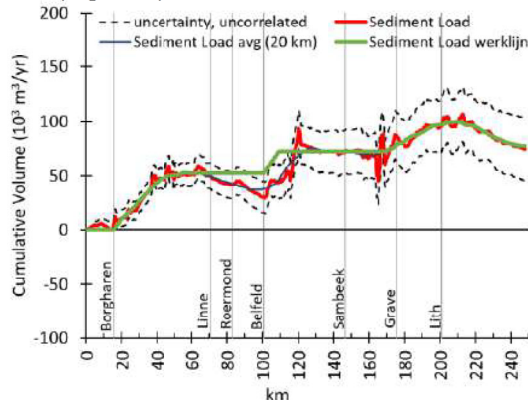


Figure 1 Estimated sediment transport volume along the Meuse River (based on (Barneveld et al., 2025a))

The Room for the River 2.0 program aims at establishing a stable and manageable bed level that contributes to the restoration of natural river dynamics and ensures good navigability. This implies, that the river authority needs to define a bed level that should be maintained: the “baseline riverbed level (BRL)”.

In this study, we evaluate four options for this BRL. The reference bed level is the estimated bed level in fifty years without a policy change. Variant 1 is the current bed level and is therefore the most feasible to construct, Variant 2 is the bed level that is most easy to maintain and Variant 3 is the bed level that restores ecological values of the river. Finally, we assess the efficiency of several interventions to reach and maintain the bed level.

Assessment criteria

The four bed level variants were evaluated based on six main criteria:

- Feasibility: the effort required to achieve the desired bed level through human intervention.

- Manageability: the effort required to keep the bed level within an established bandwidth;
- High water safety, focussing on the change in high water levels;
- Navigability, focussing on the change in navigable water depth;
- Fresh-water availability, focusing on the discharge during low-flow conditions.
- Nature, including the available habitat, inundation frequency of the floodplains and connectivity.

Results

Figure 2 shows the difference in the average bed level within reaches of the Meuse. The reference bed level is compared to the current bed level and then the three variants are compared to the reference bed level.

Reference situation

Without intervention, the bed level in the Meuse River will continue to erode with a sediment deficit of about 100,000 m³/yr. Most erosion occurs in the Common Meuse and this erosion will migrate downstream (Sloff, 2021). Within the Common Meuse, there is a high risk of new deep scour holes resulting in a large decrease of the average bed level (up to 2 m in total).

Variant 1: most feasible

The current bed level is maintained. This means that the yearly deficit of 100.00 m³/yr needs to be compensated for by sediment nourishments. In addition, new scour holes are repaired which requires about 40.000 m³/yr of sediment.

Variant 2: most manageable

In the Meuse river, the absolute bed level has a limited effect on sediment transport and therefore on the sediment deficit. A stable, but more manageable bed level cannot therefore be achieved by changing the bed level. However, in the scour hole reach of the Common Meuse, an addition of a protective top layer could prevent the development of new scour holes. About 1.5 m of alluvial sediment is needed to minimize this risk. This makes maintaining the bed level more manageable, but the annual deficit of about 100.000 m³/yr remains.

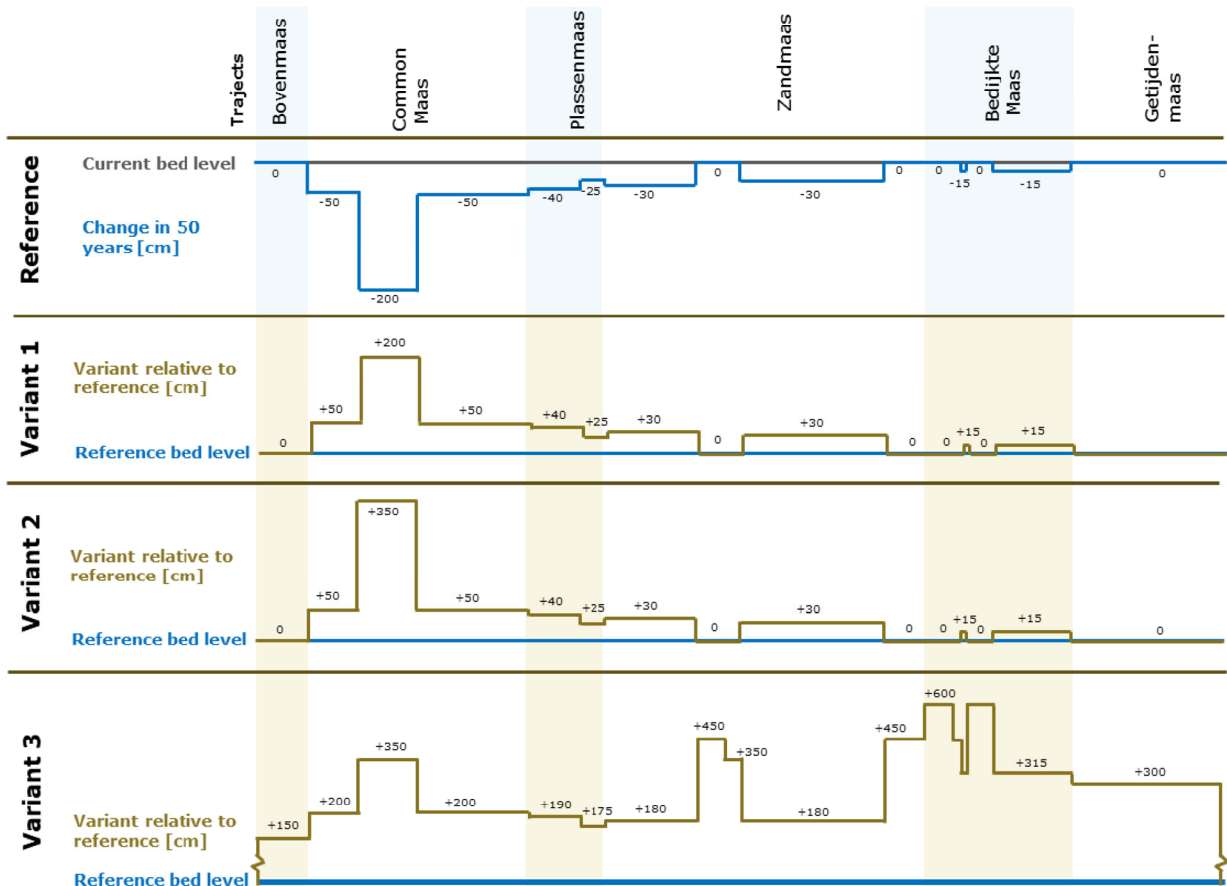


Figure 2 The reference bed level in 50 years relative to the current level. The bed level of the three variants relative to the reference level.

Variant 3: ecological restoration

An optimal bed level for all functions does not exist as the functions conflict with each other. Variant 3 therefore focusses solely on nature. The most direct link between nature and the bed level is through the inundation frequency of the floodplain. To achieve significantly higher frequencies, the required bed level increase is very large (up to 6 m). The larger inundation frequencies will reduce the sediment transport, but a deficit remains.

Interventions

There are several interventions that show potential to reduce the sediment deficit and to make maintaining the bed level more manageable:

Stop sediment extraction

Currently, sediment that is dredged for maintaining the main channel is extracted from the river. This dredged volume is estimated to be around 50,000 m³/yr which is similar to the sediment deficit downstream of the Common Meuse. By reusing dredged sediment within the river, the deficit may be halved. Due to the large uncertainties in the sediment balance (Figure 1), it is recommended that this intervention be monitored and evaluated regularly after implementation.

Prevent scour holes Common Meuse

Increasing the top layer thickness in the reach where scour holes may develop or creating a fixed layer could prevent the development of scour holes during peak flows. This reduces the repair costs after such events. In addition, local widening can reduce the bed shear stress.

Conclusions

Maintaining the current bed level in the Meuse River seems to be the most feasible and manageable variant. Additional interventions are needed to reduce the yearly sediment deficit and the risk of scour holes.

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