RIVER DUNE BEHAVIOUR IN DREDGED AREAS

Ensuring safe navigation in rivers often requires repeated dredging operations. River dunes are a significant source of shallow areas, so a better understanding of their behaviour can aid decision-making on dredging strategies. This study sought to enhance the comprehension of the behaviour of river dunes in the heavily dredged regions of the River Waal. A new 2D wavelet tool was developed to track and analyse river dunes. In conjunction with the dredging data, this study answered two key research questions: 1) What is the post-dredging behaviour of river dunes? 2) What is the extent of influence of the dredging method, i.e. topping (removing sediment from the crest) or swiping (transferring sediment from the crest to the trough), on these behaviours?

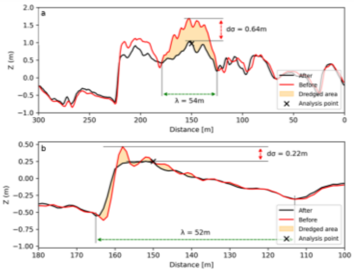

Figure 1: Examples of topping (a) and swiping (b) dredging methods

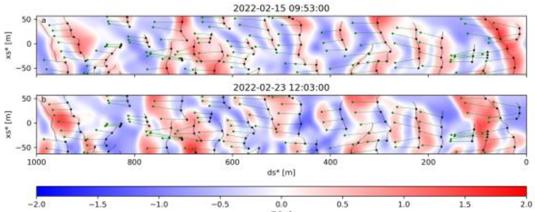

Figure 2: Example of dune crest displacement over a week

The analysis tool makes use of the two-dimensional continuous wavelet transformation, using the 2D Ricker wavelet (Mexican Hat). The wavelet transformation allows for filtering of the bathymetry on different spatial scales and reconstruction of a signal for the dune specific wavelengths of 20-300m. On this reconstructed signal, the dune crests and trough lines are detected. Using the normalised spatial cross correlation technique, the displacements of the dunes are determined between measurements at each time step. Dune height and length are determined based on the displacement direction.

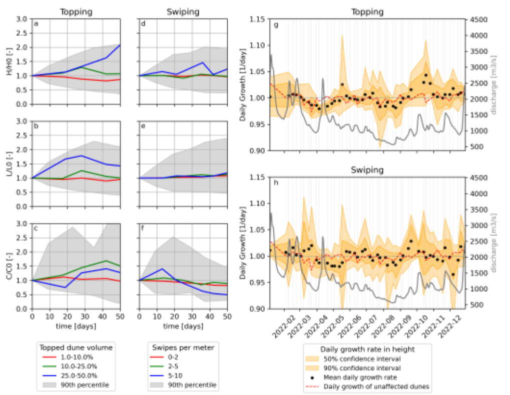

Figure 3: Development of dredged dunes over time. Figures a-f show the growth of the main dune parameters against time, where t=0 is the first measurement after dredging. Figures g and h show the daily growth in hotspot H during 2022 for dunes affected by dredging within the last 5 weeks.

The results confirm that dredging reduces the height of river dunes and causes them to move out of their dynamic equilibrium state. After the intervention, dredged dunes, particularly topped dunes, tend to recover gradually over time, exhibiting slow development. Additionally, the study showed that larger dredging intensities yield greater growth ratios. The growth of dredged dunes exhibits less variation than that of unaffected dunes, and they appear to be more stable in the first week after dredging. This suggests that they are less susceptible to flow conditions and other fluvial processes compared to unaffected river dunes during this period. For the dredging intensities performed in this study, topping has a more pronounced effect on the immediate reduction of dune height than swiping. The intensity of topping or swiping does not significantly affect the change in dune length. Immediately after the intervention, the dune celerity is somewhat higher for swiping. During this period, topped dunes demonstrate a more steady development pattern. Over the long term, topped dunes exhibit higher growth rates than those undergoing swiping, while the latter method is less disruptive to the sediment balance.

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