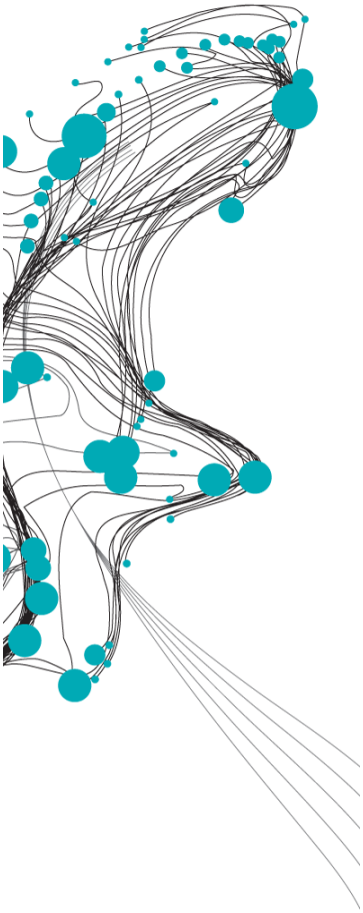
THE EFFECT OF NAVIGATION ON RIVER DUNES



The hypothesis was that river dunes become normative for the navigation depth during low water if sufficient water depth is created around the fixed layers in the Waal. Navigation induces water movement by waves, currents and turbulence, which affects the geometry and celerity of the river dunes.

Up sailing ships (left bank) are heavily loaded and down sailing ships (right bank) are less loaded. By analysing this bank effect, the results showed significant differences of longer dune lengths at the outer sides of the river. Observations showed longer dune lengths at the right bank compared to the left bank (see Figure 1, red color over a greater river width on the left bank). The passing distance from the bank and the underwater volume of the ship predominantly determine the effect of navigation on the groyne field hydrodynamics. Up sailing ships have, therefore, more impact on the hydrodynamics in the groyne field and cause scour holes that are larger and further located into the main channel at the left bank. Thus, the river shoals ('kribvlammen') in between the scour holes affect the dune length results at the outer sides of the river.

The primary navigation tracks in the river were determined by the ship movement data of the Automatic Identity System (AIS). Observations showed again a longer dune length in the left navigation track than in the right navigation track. The river shoals affect the dune length results even in the primary navigation tracks (see Figure 1). 17% more ship passages were observed during the low water period in 2019 than in 2020. However, the significant differences in dune length and celerity between the low water periods are rather related to the difference in water level. For this difference in ship intensity, the effect of hydraulic conditions on the river dunes is, thus, stronger than the effect of ship movement.

This research concludes that navigation only has an indirect impact on the dune length due to the groyne field hydrodynamics. This effect of navigation ca nbe related to the underwater volume of the ship, and not ship intensity. Future work needs to be carried out to quantify the effect of the underwater volume of the ship on the geometry and celerity of river dunes by using the CoVadem data. CoVadem data are direct depth measurements underneath the ship (related to underwater volume of the ship).

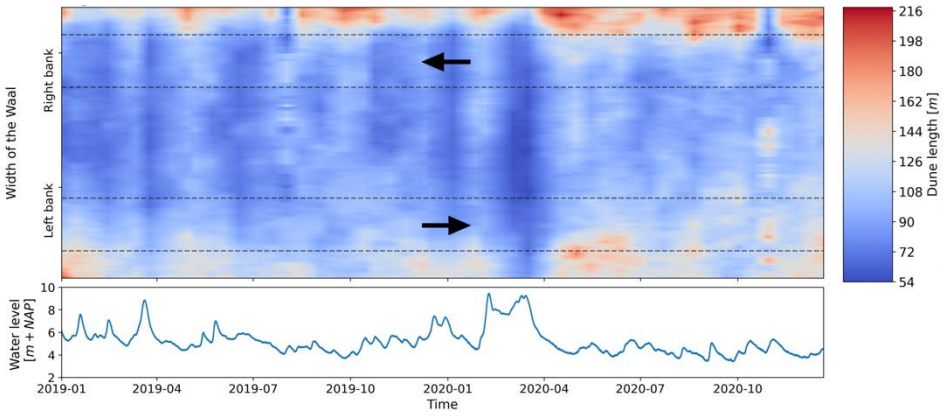


Figure 1: Dune length over the river width for the water level at the Waal section Dodewaard-Ochten for 2019-2020 (average bed level is 0.25 m – NAP). The bottom half of the Waal's width is the left bank and the top half is the right bank (seen from the discharge direction). The dashed lines indicate the primary navigation tracks and the arrows indicate the navigation direction.

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