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Large-scale bank restoration in the Overijsselse Vecht River

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Highlights

- The development of 50 km of fully restored banks along the Overijsselse Vecht in the past 10 years is analysed.
- High erosion rates are observed in certain outer bends; most banks display relatively little retreat.
- Flow currents are identified as main driver of bank erosion, and soil composition as main resistance.

Introduction

The water boards Vechtstromen (WVS) and Drents Overijsselse Delta (WDOD) are transforming the river Overijsselse Vecht into a safe and more natural river (Renner et al, 2009). To reach this goal, more dynamics through re-meandering, new side channels, and processes of erosion and sedimentation are enabled. Removing existing bank protections contributes to this. Since 2009, authorities and partners, including both water boards, have been working on the river Vecht to shape the transformation. Several projects and measures have now been implemented. The present study aims to evaluate the morphological evolution of the restored banks, identify the driving factors of erosion, and estimate long-term profiles with their uncertainty bandwidth, in order to support the update of the framework by the water boards. In total, 50 km of restored banks were analysed, including continuous stretches of multiple kilometres. This study was performed as part of a system analysis, including an analysis of the longitudinal adjustment of the river profile to interventions (Witteveen+Bos, 2022).

Methodology

We studied the driving forces of bank erosion by analyzing banklines, using bathymetric survey data (2013, 2016, 2019, 2022), applying structure-from-motion photogrammetry with stereo photos, numerically modelling hydrodynamics (D-HYDRO), carrying out field observations (July 2022), and analysing time series of discharges, water levels and ship passages at sluices (Thorne and Tovey, 1981).

The banklines were delineated along the river using aerial photos of 2013, 2019 and 2021. Three locations were studied in more detail, herein named hotspots, as they showed significant erosion and had sufficient data to investigate dominant erosion factors. After these analyses, long-term bank profiles were estimated from bankline shifts.

Results

All unprotected banks were classified into five categories based on bankline retreat. Most banks showed a shift smaller than 2 m in the period 2013-2021. Some outer bends displayed more erosion, with more than 5 m of retreat (e.g. Varsen bend, Fig. 2).

Flow currents were identified as the dominant driver for bank erosion, and the soil composition as the governing resistance against erosion. Patterns of bank erosion match with the distribution of flow velocity. Secondary factors were cattle trampling (local bank collapse and upper slope reworking) and vegetation. Vessels had a negligible contribution to erosion, opposite to observations at other Dutch rivers (e.g. Duró et al., 2021).

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A bar-mode analysis (Crosato and Mosselman, 2009) and long-term changes in longitudinal profile indicate that the development of alternate bars is not likely in the Vecht. The axis of the main channel is expected to remain in place. Bends with forced bars and large outer-bank erosion may represent local exceptions to that behaviour.

Floods with a lower probability of exceedance of 1/year took place in the past 2 years. Banks that displayed low to none erosion possibly reached a stable position under regular flood events. At these banks only limited erosion (< 5 m) is expected in the long term. Banks that did show significant erosion in recent years are expected to continue to erode at a similar pace in the short term. Their long-term behaviour is more uncertain, especially at newly restored banks where no soil composition data nor evidence of their morphological response to currents are available.

At mild and sharp bends, accretion of the inner bank can increase the erosion of the outer bank, which could lead to local meandering in the long term. Accretion of inner bends is currently not observed. However, the necessary steps for this process (point bar accretion, colonization by vegetation, sediment trapping and soil consolidation) are each observed at separate locations along the river, which indicates that the complete process of bank accretion could take place in the long term. The current regulation of water levels could limit this process.

Discussion and Recommendations

The occurrence of flood events and the bank composition are the most relevant factors that determine bank erosion and in turn contribute to a significant uncertainty in future bank erosion. Soil composition was identified as the main resisting force, but no specific data were available to include this factor in the prediction. A more accurate retreat estimate could be made if soil cores at restored banks would be made and compared to cores at locations where future bank protection removal is planned.

Monitoring of the progress of both bank erosion and bank accretion at sharp inner bends is recommended given the current uncertainties in future morphological developments. The progression of banklines can be followed using aerial photographs and direct measurements. If a bankline reaches a point where erosion is no longer desirable, measures can be taken to (partly) fix the bank (Mosselman et al., 2021) or impede accretion on the inner bank.

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Figure 1. Nature-friendly bank near Varsen on 12-7-2022

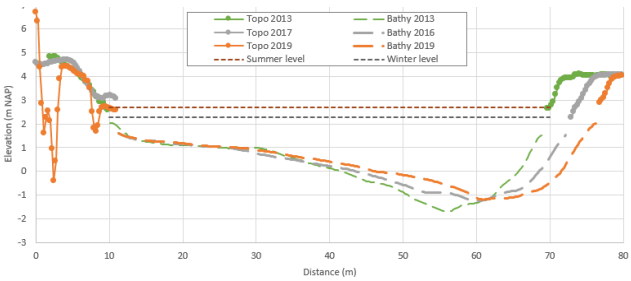

Figure 2. Cross section at one of the hotspot locations near Varsen (rkm 37.3-37.9). The topography above the water level is derived from stereophotographs, the bathymetry with echo-sounder surveys.