Title of the project:
Understanding the river bed dynamics of the scour hole at the IJsselkop

Assignment no.:	**Internal/external:**
16.24	External
Head graduation committee: Prof. dr. Suzanne Hulscher Dr. Jord Warmink	**Daily advisor:** Ir. Marthe Oldenhof externalIr. Michiel Reneerkens (RWS-ON)
Name(s) of participating companies or institutes: Rijkswaterstaat Oost-Nederland	**Start of the project:** January 2025

Required courses:
Data Analysis, Mathematical Physics, River Morphodynamics, River Flow Processes

Short description and objective of the project:
The bed level of the Rhine branches in the Netherlands is highly dynamic. Due to human interventions, river geometry and varying discharges, the river bed aggrades and degrades over time. Local variations in flow velocity and the susceptibility of the river bed result in morphological effects. These effects can often be seen in sharp river bends and at bifurcations or locations where the composition of the river bed is highly heterogeneous (e.g. layers of easily and hardly erodible material) (Huismans et al., 2021). The variation in river geometry results in changes in flow direction and pressure gradients. This alters the sediment transport capacity and consequently results in local erosion and sedimentation. The local high erosion rates can induce the formation of deep scour holes (Vermeulen et al., 2014). These scour holes are generally 100 meters in length, tens of meters in width and at least one meter deep (Nittrouer et al., 2011).

One of these scour holes is located at the bifurcation of the Nederrijn river and the IJssel river, at the IJsselkop (Figure 1). The weirs at Driel control the discharge in the Nederrijn and affect the discharge distribution at the IJsselkop. Due to this weir control, the scour hole at the IJsselkop is highly dynamic and changes its dimensions under these varying discharges. The dimensions of the hole increased significantly during the peak discharges in 2021 (Figure 2). After these peak discharges, Rijkswaterstaat performed a quick analysis to check whether the increased scour hole threatened the stability of the river bifurcation. This was not the case and therefore no actions were taken. During the winter of 2023, another flood wave was observed at the IJssel river. It is unknown to what extent this flood wave affected the scour hole dynamics.

Figure 2: River bifurcation Nederrijn and IJssel river (IJsselkop). Source: www.siebeswart.nl

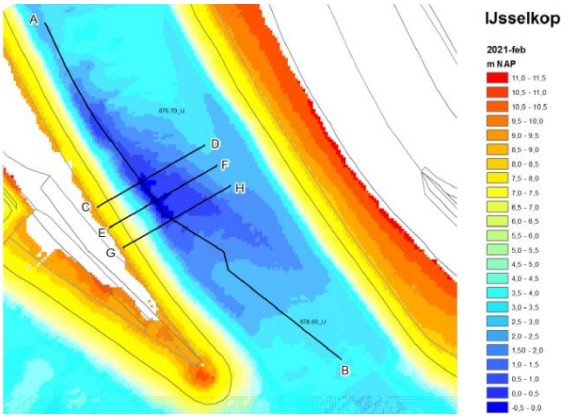

Figure 2: Bathymetry at the IJsselkop (Reneerkens, 2021)

The objective of this study is to get a better understanding on the dynamics of the scour holes at the IJsselkop caused by discharge variations and to assess possible threats.
The research can be divided into two steps:

1. Data analysis of multibeam measurements of the river bed around the IJsselkop to identify the range of migration and deformation of the scour hole.
2. Possible model simulations of the scour hole with a simplified CFD model (Computational Fluid Dynamics) to simulate the behaviour of the scour hole under varying discharges.

The start of the MSc thesis should be in January 2025 or later. Course preparation can start from 1 November 2024. The MSc project can be performed as an external assignment at Rijkswaterstaat Oost Nederland.

References

Huismans, Y., Koopmans, H., Wiersma, A., de Haas, T., Berends, K., Sloff, K., & Stouthamer, E. (2021). Lithological control on scour hole formation in the Rhine-Meuse Estuary. *Geomorphology*, *385*. https://doi.org/10.1016/j.geomorph.2021.107720

Nittrouer, J. A., Mohrig, D., Allison, M. A., & Peyret, A. P. B. (2011). The lowermost Mississippi River: a mixed bedrock-alluvial channel. *Sedimentology*, *58*(7), 1914-1934. https://doi.org/10.1111/j.1365-3091.2011.01245.x

Reneerkens, M. (2021). *Erosiekuil IJsselkop 2015-2021*.

Vermeulen, B., Hoitink, A. J. F., van Berkum, S. W., & Hidayat, H. (2014). Sharp bends associated with deep scours in a tropical river: The river Mahakam (East Kalimantan, Indonesia). *Journal of Geophysical Research: Earth Surface*, *119*(7), 1441-1454. https://doi.org/10.1002/2013jf002923