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The relation between scour holes and subsurface architecture in the Rhine-Meuse delta, the Netherlands

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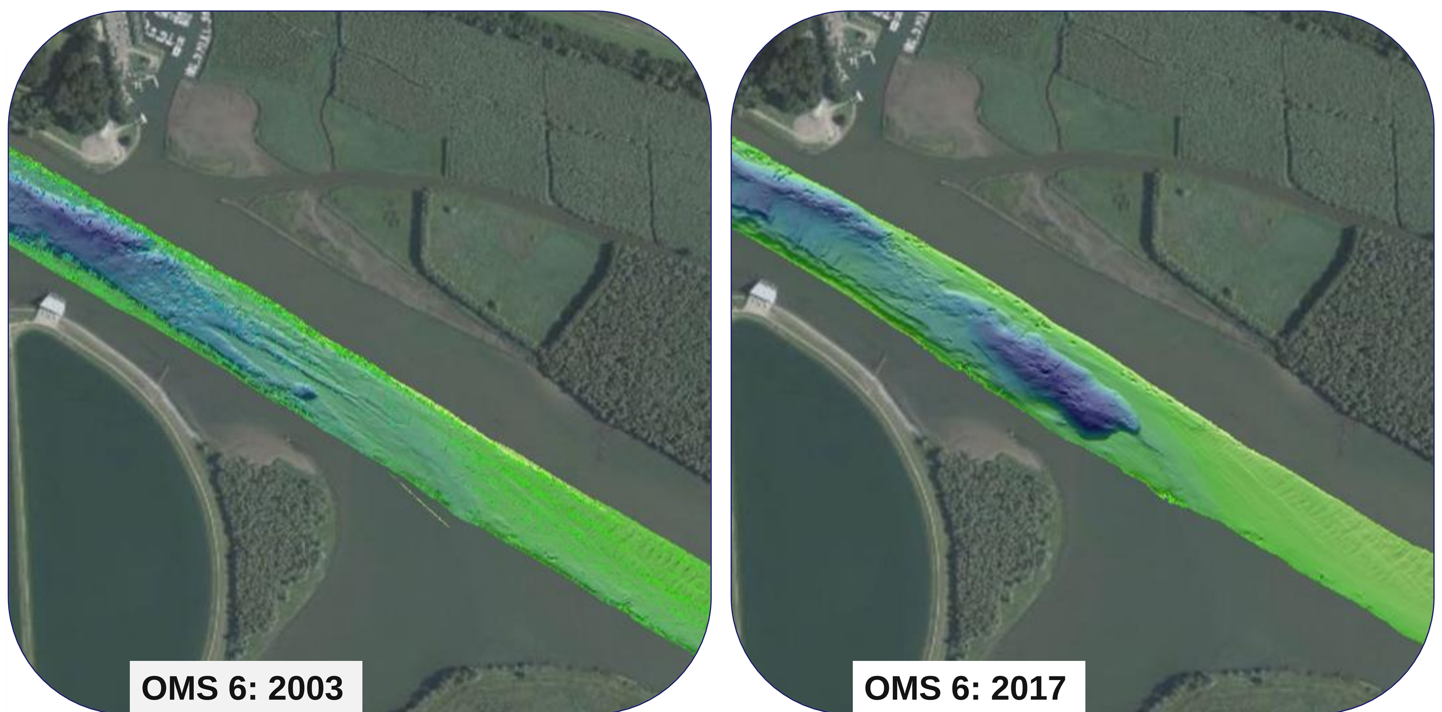
Introduction

Scour holes are deep erosion pits in the river bed of which the formation is influenced by local channel morphology, hydrodynamic conditions and subsurface architecture. Subsurface architecture is an external factor and is therefore of special interest in the study of scour holes. Scour holes reveal where the subsurface locally was erodible. Erodibility is determined by the geological heterogeneity that the river truncated (e.g. crossing an older channel belt sand body). Linking occurrence and evolution of scour holes to 3D subsurface architecture contributes to better insight into the geologic boundary conditions for the formation and geometry of scour holes. In addition to hydrodynamic conditions, substrate conditions may just as well co-control the rate of deepening (Fig. 1), permanency and fixation in depth.

Aims

- Present an inventory of scour holes in the entire Rhine-Meuse delta.
- Link the occurrence of scour holes and their characteristics (e.g. geometry, development) to the subsurface architecture of the study area.



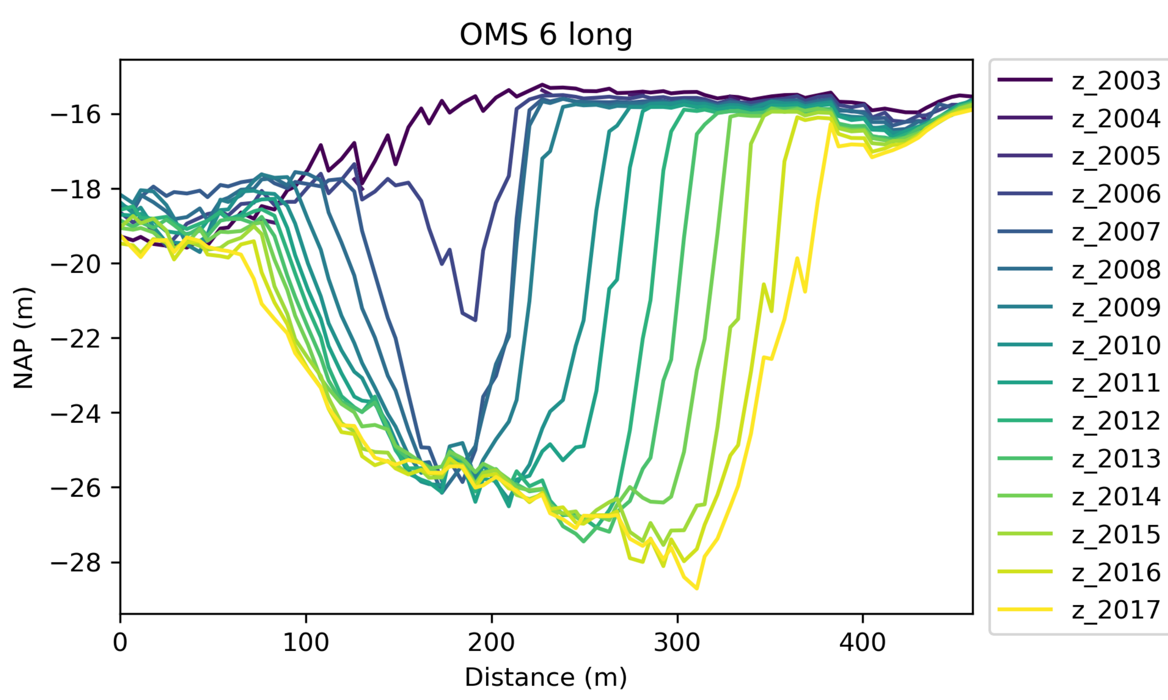


Figure 1. Longitudinal development of OMS 6 scour hole in the Oude Maas. After 2003 there is a rapid acceleration of incision due to a breach in the resistant layer of Wijchen, exposing a less resistant sand body highlighting the importance of geology.

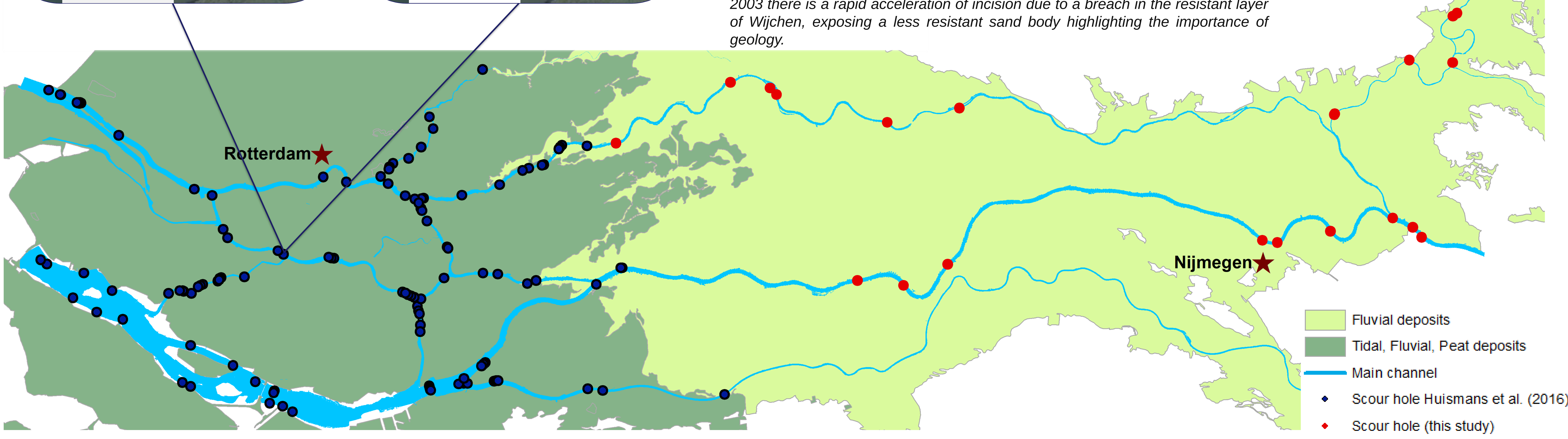


Figure 2. Locations of scour holes identified in the active channels in the study area in relation to the large scale buildup of the subsurface. The central and upper parts of the delta are dominated by fluvial deposits and the lower part is generally made up by an alternation of tidal, fluvial and peat deposits. Black dots (n=120) are lower delta scour holes (Huismans et al., 2016). Red dots are central and upper delta scour holes (this study).

Methods

1. Identification

We identify scour holes using a time series of bathymetry data (Fig. 1 & Fig 2):
- Period 1990 – 2018 (Δt 1 year).
- Resolution: 1 m, 5 m.
- Study area: Rhine-Meuse delta (Fig. 2).

2. Database

We create a combined database Koopmans (2017) and this study of scour holes with:
1. Geometric attributes.
2. Development.
3. Additional conditions (e.g. morphology).

3. Subsurface architecture

Characterization of regional subsurface buildup and architectural elements (Fig. 3) around scour holes. We work towards identification of relevant architectural elements and geologic sequences.

Architectural elements

A) Fluvial **B) Tidal**

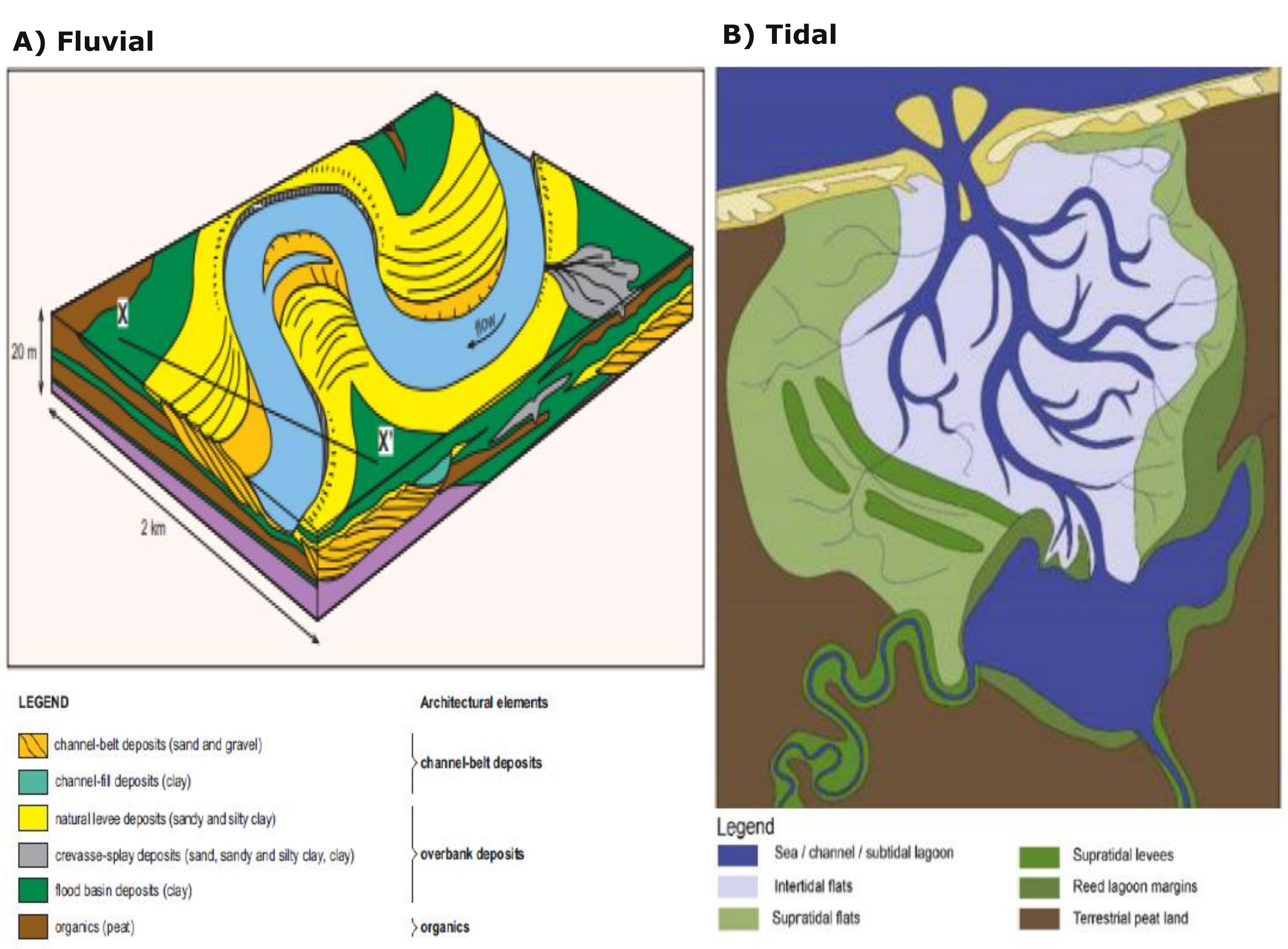


Figure 3. A) Conceptual block diagram of meandering river and associated architectural elements (adapted from Gouw, 2007). B) Conceptual outline of tidal system and associated architectural elements (adapted from Pierik et al., 2016).

Preliminary results

A total of 26 new scour holes have been identified in the central and upper delta adding to 120 previously identified ones by Huismans et al. (2016) for the lower delta. Most of these objects have been stable features for the last four years.

Future research

We expect scour hole development (e.g. rapid vs. gradual deepening; Fig. 1) is related to geological sequences in the subsurface. We aim to map out the lithostratigraphic units and geologic sequences in relation to scour holes at the base of the active river channel. This provides insight into the distribution of resistant layers and allows to identify potential weak spots regarding new scour holes if, and when such a layer is breached by erosion.

References

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