



Effects of inherited resistant layers on channel-bar shape and long-term morphological evolution of the Eems-Dollard Estuary (the Netherlands/Germany)

Harm Jan Pierik (1), Jasper Leuven (1), Marc Hijma (2), Freek Busschers (3), and Maarten Kleinans (1)

(1) Utrecht University, Dept. of Physical Geography, Utrecht, Netherlands (h.j.pierik@uu.nl), (2) Deltares, Utrecht, Netherlands, (3) TNO Geological Survey of the Netherlands, Utrecht, Netherlands

Estuaries increasingly face pressures from e.g. sea-level rise, urbanisation, and damming, leading to disturbed sediment balances, changes in biogeomorphological areas, and hence loss of biodiversity. To mitigate these effects, understanding the functioning of channel-bar systems in estuaries is crucial. Although widely acknowledged as an important driver, little is known about the effects of constraining agents, such as the valley geometry and the presence of either erodible or erosion resistant layers, on long-term evolution of channel and bar patterns in estuaries. Here we show how resistant Pleistocene clays and tills affect channel-bar patterns along the Eems-Dollard estuary, located on the Dutch-German border. We reconstructed the channel-bar pattern evolution of the last two centuries in high detail using historical bathymetry maps. These were subsequently compared to the recently mapped position of resistant layers covering the entire estuary. Results show that resistant layers at ca. 10-15 m – MSL (or two-thirds of the maximum channel depth) cause channels to widen locally where these resistant layers are present. This leads to estuary widening and mid-channel bar formation. Bend curvature causes the effect to propagate at least a meander wavelength in the flood direction. The presence of resistant layers thus strongly determines the position of confluences and bars along the entire estuary. As the estuary has generally imported sediment over the last 200 years, the resistant layers were less exposed and therefore hydrodynamical conditions became more important. In the second half of the 20th century however, dredging has increased channel volume, exposing resistant layers and making them more important drivers for channel-bar morphology again. Because these layers are expected to be further exposed after future human interventions, the insights from this study will help to better manage estuaries in a sustainable way. The results also raise the question to what degree other bar-filled estuaries are the result of either hydromorphodynamics or of geological constraints.