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Linking dune dynamics and preservation: a unique approach using multibeam and parametric echo sounding time series, River Waal, Netherlands

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Dunes are ubiquitous features in most sand- and gravel-bed rivers worldwide and are key elements of sediment transport. Their variable height may also interfere with shipping routes and help dictate shipping loads. Knowledge of dune dynamics and spatio-temporal sediment transport is thus essential in understanding river dynamics and for the navigability, sustainable management and maintenance of rivers, especially in times of more extreme floods. To date, most morphodynamic studies of river-beds have been based on either bathymetric time series or sub-bottom profiling data, but not collected at the same time and the sub-bottom data not in time series. As such, these data do not allow for the identification of spatio-temporal variations of sediment storage in, and reactivation of, the shallow sub-surface as related to dune kinematics. Our field study, reported here, sought to address this gap in knowledge by investigating the stratification produced by dunes in the shallow subsurface through sub-bottom profiler time series in combination with bathymetric time series and vibracores.

In three areas of varying grain size in the River Waal, Netherlands, we collected four 7-km long tracks of high-resolution sub-bottom profiler data (Parametric Echo Sounder, PES) and, simultaneously, multibeam echo sounder (MBES) data. In two repeat surveys in areas 2 and 3, and four repeat surveys in area 1, data were acquired to gain insight into the preservation and reactivation of dune deposits over short-term periods of 1 day to 3 weeks. Interpretation of the sub-bottom data is aided using 18 vibracores of 4 – 5 m depth.

Initial analyses show the migration and morphological change of the large dunes, thereby

obliterating dunes mapped during the first survey, and the presence of superimposed small dunes. The PES data of large dunes exhibit foresets, reactivation surfaces where superimposed dunes migrated down the lee slopes, and strong near-horizontal reflectors at the base of large dunes, interpreted as the lower bounding surface. The surveys also identified dune stratification preserved below the active dune scour depth, and several horizontal reflectors at depth.

Coupling these sedimentary structures in the bed profile data to both the simultaneous MBES data and a unique longer-term MBES time series, comprising two-weekly surveys (2005-2021) and half-yearly surveys (from 1999), provides an unparalleled opportunity to date these sedimentary structures, *(1)* to investigate longer-term aggradation and dune preservation and *(2)* to link these to flood and depositional events over the past decades. Here, we present initial results. This field dataset and approach yield a unique, high-resolution, spatio-temporal reconstruction of sediment preservation that significantly contributes to the insight into sediment storage times and preservation of dune-scale sedimentary structures in river beds. These field data also help to improve data-driven modelling.