

FIELD STUDY ON INFLUENCE OF TIDAL CURRENTS ON INTRA-WAVE SEDIMENT TRANSPORT

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INTRODUCTION

Sediment transport by currents and waves determines the evolution of shoals and channels on the ebb-tidal delta. The channels are an important conduit for shipping and are often dredged to maintain access at considerable cost. A better understanding of the sediment transport processes within the channels is the basis for a more cost-effective maintenance strategy. In the vicinity of ebb-tidal inlets, waves from offshore encounter tidal currents. Depending on the tidal phase, incoming waves face strong positive or negative current gradients. Besides changes in wave height, period and direction, the current gradients also affect the nonlinear wave shape and corresponding velocity profile.

Instantaneous sediment transport is a function of the velocity and concentration over the water column: $S(t,z) = u(t,z) * c(t,z)$. Velocity skewness and asymmetry and the timing of the sediment suspension events determine whether waves lead to a net onshore or offshore transport. As these characteristics are likely to vary with the magnitude and direction of the tidal currents, the contribution of wave-induced sediment transport to the total transport is expected to vary with the tidal phase. During ebb, waves and tide oppose each other, leading to shorter, higher and steeper waves. On the contrary, during flood the tide propagates in the same direction as the waves, resulting in longer, lower and milder waves. This will have a clear influence on the combined wave and tidal velocity profile over the vertical. Furthermore, the average depth will be lower during ebb than during flood, leading to more wave-nonlinearity and wave effects in general during ebb.

In this study, a new field dataset is presented on the combined effect of waves and currents on sediment transport. This unique dataset is used to investigate the influence of tidal currents on the velocity and concentration profile and thus the intra-wave sediment transport. The final aim is to improve the present parameterizations in process-based morphological models that currently do not account for the effect of currents on wave nonlinearity.

FIELD CAMPAIGN

An extensive field campaign is currently (August and September 2017) taking place at the Ameland tidal inlet, which is located in the North of the Netherlands between Wadden Islands Terschelling and Ameland.

Five instrument frames have been deployed at the end of August 2017 and are measuring waves, currents and sediment concentration during a period of 5 weeks at different locations on the ebb-tidal delta (Figure 1).

The frames continuously measure flow velocity (3xADV), velocity profiles (2xADCP), suspended concentration (4xOBS), particle size (LISST), bed forms (sonar ripple scanner), conductivity, temperature, and density (CTD) (see Figure 2).

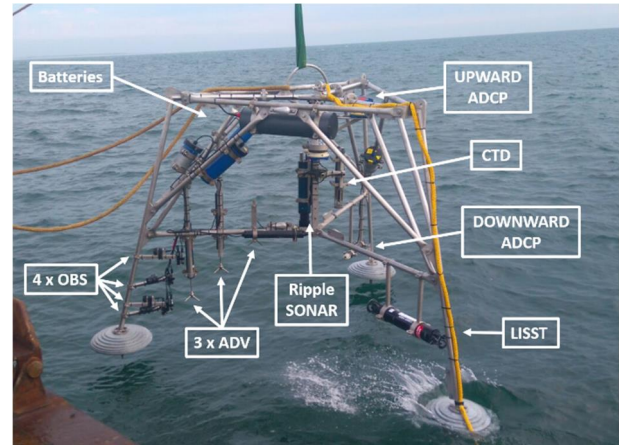


Figure 1 - Deployment of one of the measurement frames on 29 August 2017.

Additionally, eight pressure sensors are deployed around the frames to characterise the spatial distributions of wave characteristics and nonlinearities. The Eulerian measurements obtained at the frames are complemented by Lagrangian current and wave measurements. Two types of drifters will be deployed every day for a spring-neap tidal cycle around the frames to obtain more knowledge on the spatial current patterns.

METHOD

For this study the focus will be on data acquired from the two western frames, which are approximately 700m apart (see Figure 1). The frames are in intermediate water depth (-8 and -5m) and aligned with the ebb-tidal channel, where tidal velocities can be up to 2m/s. The observations will be used to examine the changes in (intra-wave) velocity profiles and corresponding sediment concentrations as a function the tidal flow to estimate the wave-induced sediment transport contribution to the total sediment transport.

RESULTS

By combining the observations at the two frames differences in depth, tidal flow velocities and wave and current directions on the intra-wave and total sediment transport will be assessed. These observations will elucidate the processes that are important for the infilling and/or scouring of channels to be presented at the conference.

ACKNOWLEDGMENTS

The authors want to acknowledge all partners of KUST-GENESE2 and SEAWAD for the collaboration of the field campaign.